SCDOT

US 21 over Harbor River Bridge Replacement

Design-Build Project - P026862 - Beaufort County, SC

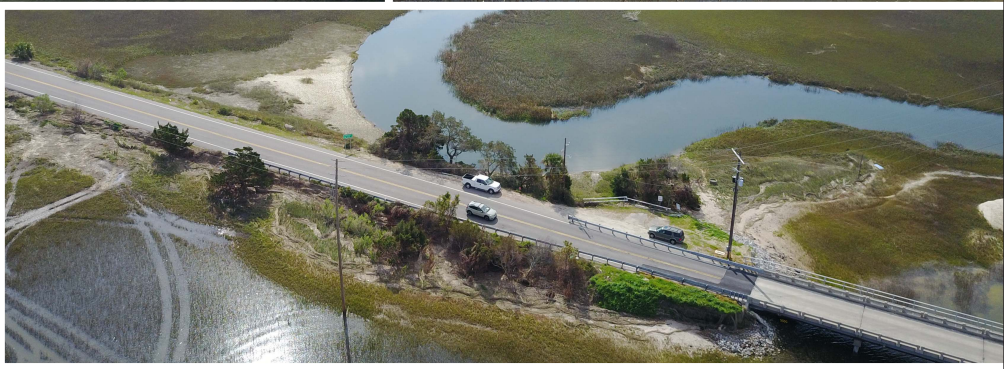
PRELIMINARY ROADWAY GEOTECHNICAL REPORT











October 2, 2017

UNITED INFRASTRUCTURE GROUP

INFRASTRUCTURE CONSULTING & ENGINEERING

Preliminary Roadway Geotechnical Services

US 21 Over Harbor River Bridge Replacement Project
Beaufort County, South Carolina

for

Infrastructure Consulting and Engineering

October 2, 2017

GeoEngineers

8410 154th Avenue NE
Redmond, Washington 98052
425.861.6000

Preliminary Roadway Geotechnical Services

US 21 Over Harbor River Bridge Replacement Project
Beaufort County, South Carolina

File No. 18461-007-01

October 2, 2017

Prepared for:

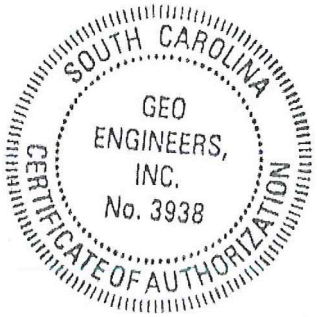
Infrastructure Consulting and Engineering
1021 Briargate Circle
Columbia, South Carolina 29210

Attention: Andy Gillis, PE

Prepared by:

GeoEngineers, Inc.
8410 154th Avenue NE
Redmond, Washington 98052
425.861.6000





Zachary A. Simpson, PE
Geotechnical Engineer

Ivy A. Harmon, PE (LA)
Geotechnical Engineer

Heidi P. Cashman, PE (WA)
Senior Geotechnical Engineer

King H. Chin, PE
Principal

ZAS:IAH:HPC:KHC:nld

Disclaimer: Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Table of Contents

1.0 INTRODUCTION 1

2.0 GEOTECHNICAL EMBANKMENT DESIGN AND CONSTRUCTION ISSUES 1

3.0 EMBANKMENT PERFORMANCE LIMITS 1

4.0 SUBSURFACE SOIL CONDITIONS 3

4.1. Geologic Setting 3
4.2. Preliminary Field Exploration Program 3
4.3. Subsurface Conditions 3
4.4. Groundwater Conditions 4

5.0 PRELIMINARY LABORATORY TESTING PROGRAM 4

6.0 SOIL DESIGN PARAMETERS 4

6.1. Consolidation Parameters 4
6.2. Shear Strength Parameters 5
6.2.1. Holocene Silts and Clays 5
6.2.2. Sands 5
6.2.3. Hawthorn Marl 6
6.2.4. Cooper Formation 6
6.2.5. Embankment Fill 6

7.0 SEISMIC INPUT PARAMETERS FOR BRIDGE EMBANKMENT DESIGN 7

8.0 GEOTECHNICAL EMBANKMENT DESIGN ANALYSES 7

8.1. West Embankment 1 9
8.2. West Embankment 2 9
8.3. West Embankment 3 9
8.4. West Bridge Embankment 4 10
8.5. East Bridge Embankment 1 11
8.6. East Embankment 2 12
8.7. East Embankment 3 13

9.0 PRELIMINARY GEOTECHNICAL EMBANKMENT DESIGN RECOMMENDATIONS 13

10.0 FIELD EXPLORATION AND LABORATORY TESTING PROGRAM 14

11.0 LIMITATIONS 16

12.0 REFERENCES 16

LIST OF FIGURES

Figure 1. Vicinity Map
Figures 2A through 2C. Exploration Location Plans
Figure 3A through 3C. US 21 Profile
Figure 4. Over-Consolidation Ratio (OCR) with Depth
Figure 5. Moisture Content vs. Compression Index
Figure 6. Moisture Content vs. Cre/Cce Ratio
Figures 7 and 8. Ground Surface ADRS Curves
Figures 9 through 24. Global Stability Results

APPENDICES

Appendix A. Field Explorations
Appendix B. Laboratory Testing
Appendix C. Soil Parameter Determination
Appendix D. Consolidation Analyses
Appendix E. Soil Liquefaction Analyses
Appendix F. Slope-W Analyses
Appendix G. Ground Improvement Analyses
Appendix H. Report Limitations And Guidelines For Use

1.0 INTRODUCTION

This report presents the results of GeoEngineers' preliminary embankment design analyses and recommendations for the US 21 over Harbor River Bridge replacement project in Beaufort County, South Carolina. The project site is shown relative to surrounding physical features on the Vicinity Map in Figure 1 and on the preliminary site exploration plans shown in Figures 2A through 2C. We understand that the project consists of two earthen roadway embankments and a new bridge that is about 3,400 feet in length.

2.0 GEOTECHNICAL EMBANKMENT DESIGN AND CONSTRUCTION ISSUES

Construction of the roadway and bridge embankments requires placing fill up to about 18 feet high at the bridge end bents. The weight of the fill and the traffic loading will cause the compressible soils to consolidate and settle. For most of the roadway embankments, a preload program with vertical wick drains will be implemented to induce the soil consolidation settlement during the preload period to keep the post-construction roadway settlement lower than the specified long-term roadway embankment settlement performance limits per South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM). The roadway embankments are classified as ROC III for the project.

The total height of the roadway embankments and preload fill required to induce soil consolidation settlement will be on the order of more than 20 feet near the bridge end bents. As the underlying soils settle, they also deform laterally, which can apply lateral stress onto the existing structures that are located within proximity of the preload fill. The use of wick drains will reduce the lateral undrained soil deformation induced by soil consolidation settlement. However, if existing structures are located adjacent to the new embankment fill, ground improvement may be required to reduce the amount of consolidation settlement and help mitigate the effects of the lateral undrained soil deformation that can adversely impact the adjacent structures.

The bridge embankments for this project are classified as ROC I, and therefore will be designed to meet the performance limits at the Extreme Event I (EE I) Limit State per SCDOT GDM. In order to meet the performance limits at the EE I limit state, ground improvement and reinforced soil slopes will be implemented within the bridge embankment footprint, which extends about 75 feet from the toe of the fore slope at the bridge end bents. Per the project Request for Proposal (RFP), The roadway embankments for this project are not required to be designed to meet the performance limits at the EE I Limit State.

Key geotechnical embankment construction issues include management of fill placement and careful instrumentation and monitoring during construction to ensure that the objectives of the preload program are achieved and to prevent subsurface soil failure from occurring during construction.

3.0 EMBANKMENT PERFORMANCE LIMITS

The embankment design is completed to confirm that the embankment settlement and global instability performance limits specified in the project RFP and in Chapter 10 of the SCDOT GDM are met. Tables 1 through 5 below presents the embankment performance limits at both the Service Limit State (SLS) and EE I Limit State that are specified for this project.

TABLE 1. EMBANKMENT SETTLEMENT PERFORMANCE LIMITS AT SLS

Deformation ID No.		Performance Limit Description	ROC	
			I	III
		Minimum Design Life (Years)	100	100
Settlement (Longitudinal)	EV-01	Max. settlement along the profile grade	8.00”	8.00”
	EV-02	Max. settlement rate per year after roadway has been paved	0.10”	0.20”
	EV-03	Max. differential settlement over 50 feet of embankment longitudinally after roadway has been paved	1.00”	2.00”

TABLE 2. BRIDGE/EMBANKMENT TRANSITION SETTLEMENT PERFORMANCE LIMITS AT SLS

Deformation ID No.		Performance Limit Description	ROC
			I
Settlement (Longitudinal)	EV-05	Max. differential settlement between end bent and end of approach slab (inches), L_{slab} measured in feet	0.075 x L_{slab}

TABLE 3. EMBANKMENT SETTLEMENT PERFORMANCE LIMITS AT EE I LIMIT STATE

Deformation ID No.		Performance Limit Description	Design Earthquake	ROC
				I
Settlement (Longitudinal)	EV-03	Max. differential settlement over 50 feet of embankment longitudinally after roadway has been paved	FEE	1.00”
			SEE	2.00”

TABLE 4. BRIDGE/EMBANKMENT TRANSITION SETTLEMENT PERFORMANCE LIMITS AT EE I LIMIT STATE

Deformation ID No.		Performance Limit Description	Design Earthquake	ROC
				I
Settlement (Longitudinal)	EV-05	Max. differential settlement between end bent and end of approach slab (inches), L_{slab} measured in feet	FEE	0.075 x L_{slab}
			SEE	0.100 x L_{slab}

TABLE 5. EMBANKMENT GLOBAL INSTABILITY PERFORMANCE LIMITS AT EE I LIMIT STATE

Deformation ID No.		Performance Limit Description	ROC
			I
Vertical Displacement	GI-01	Max. at top of the slope failure surface	FEE: 1.00” SEE: 2.00”
	GI-02	Max. at bottom of the slope failure surface	FEE: 1.00” SEE: 2.00”

Deformation ID No.		Performance Limit Description	ROC
			I
Lateral Displacement	GI-03	Max. at top of the slope failure surface	FEE: 3.00” SEE: 4.00”
	GI-04	Max. at bottom of the slope failure surface	FEE: 3.00” SEE: 4.00”

4.0 SUBSURFACE SOIL CONDITIONS

4.1. Geologic Setting

The geology of the site was described in more details in the geotechnical baseline report prepared by F&ME Consultants, Inc. (F&ME 2017). Generally, the site soils are anticipated to be Holocene deposits consisting of silt, clay and sand, underlain by tertiary deposits consisting of a relatively thin layer of Hawthorn Marl of Miocene age (~23 MYA). The marl thickness at this site is expected to vary from 10 to 30 feet, which is underlain by the tertiary deposits consisting of calcareous, sandy limestone. The upper limestone is considered part of the Cooper Group, and consists of Oligocene (~36 MYA) and late Eocene (~40-50 MYA) age deposits.

The site is located within seismically active region. According to the geologic map titled “Structural Features of South Carolina” produced by South Carolina Department of Natural Resources, Geologic Survey, the major sources identified in the site vicinity are the Garner-Edisto fault, an east-to-west trending, normal fault traversing Beaufort and Jasper Counties in South Carolina. Published geologic maps generally show that this area has a high potential for liquefaction during substantial seismic events.

4.2. Preliminary Field Exploration Program

A preliminary field exploration program was completed by F&ME for this project. The field exploration program included 27 borings and 11 cone penetration tests (CPTs). Figures 2A through 2C show the locations of these borings and CPTs completed along the project alignment. Boring and CPT logs of the preliminary field exploration program are presented in Appendix A, Field Explorations.

4.3. Subsurface Conditions

Subsurface conditions at the site were evaluated by reviewing the exploration logs and laboratory test results completed by F&ME for this project. In general, the soils observed in the explorations completed at the project site consist of Holocene Deposits, Hawthorn Marl and Cooper Limestone Formation. A generalized soil profile along the project alignment is presented in Figures 3A through 3C, US 21 Profile.

Holocene deposits were encountered in all the explorations, and generally consist of interbedded soft to stiff silt, clay and very loose to very dense sand, generally consistent with the geologic map published for the region. The thickness of the Holocene deposits generally ranges from 50 to 65 feet within the embankment areas. The thickness of silt and clay soils encountered in the explorations range between 5 and 35 feet.

Hawthorn Marl was also encountered in all the explorations that were terminated below Elevation -40 feet mean sea level (MSL). The Hawthorn Marl was encountered to approximately Elevation -79 to -90 feet below ground surface or mudline and consists of stiff to hard clay of variable plasticity.

The Cooper Limestone Formation was encountered below the Hawthorn Marl and generally consists of very stiff to hard clay.

4.4. Groundwater Conditions

Groundwater level measurements were completed by F&ME as part of their preliminary geotechnical study. Based on the geotechnical baseline report, groundwater was encountered between Elevation 0 to +3 feet MSL. Groundwater was anticipated to fluctuate with tidal level in Harbor River and is expected to vary by location and season. For the preliminary design analyses, we assumed the design groundwater level at Elevation 0 feet MSL.

5.0 PRELIMINARY LABORATORY TESTING PROGRAM

A preliminary laboratory testing program was completed by F&ME for this project. The laboratory testing program included moisture content, Atterberg Limits, grain size distribution, consolidated undrained (CU) triaxial, consolidation, unconfined compression, electro-chemical, and resonant column tests. Data sheets presenting the results of the preliminary laboratory testing program are included in Appendix B, Laboratory Testing.

6.0 SOIL DESIGN PARAMETERS

Soil design parameters were developed for the general soil units encountered at the project site. The four general soil units include:

- Holocene silts and clays;
- Holocene sands;
- Hawthorn Marl; and
- Cooper Formation.

The soil design parameters developed for use in the engineering analyses include the consolidation properties of compressible silts and clays and shear strength parameters of each soil unit.

6.1. Consolidation Parameters

Seven consolidation tests that were previously performed by F&ME were also reviewed and used to develop the consolidation parameters for the silts and clays used in our preliminary consolidation analyses. Figure 4 presents the stress history of the underlying silts and clays expressed in over-consolidation ratio (OCR) profile, computed using the pre-consolidation pressures determined using the preliminary consolidation test results.

The other two consolidation parameters that we need for our preliminary consolidation analyses are the compression index ($C_{c\varepsilon}$) and recompression index ($C_{r\varepsilon}$). Table 6 presents the range of $C_{c\varepsilon}$ and $C_{r\varepsilon}$

computed for the compressible soils at the west and east embankment areas using the preliminary consolidation test results.

TABLE 6. COMPRESSION AND RECOMPRESSION RATIOS (PRELIMINARY CONSOLIDATION TEST RESULTS).

Embankment	Ccε	Crε
West	0.24 to 0.48	0.027 to 0.053
East	0.36	0.052

Our assessment of the Ccε and Crε values indicates that the compressible soils encountered within the west embankment area are consistent with the values determined for the east embankment. In addition, we also developed a correlation between soil moisture content and compression index that was used in our preliminary consolidation analyses, presented in Figure 5. Our assessment also shows that the ratios of recompression index and compression index generally range from 0.11 to 0.14, as presented in Figure 6, therefore a ratio of 0.13 was selected for use in our analyses.

In order to evaluate the rate of soil consolidation during the preload period and design service life, the coefficient of consolidation, Cv, is estimated and used in the consolidation analyses. The Cv values determined using the preliminary consolidation tests results at the various loading pressures were evaluated and reviewed. Based on our evaluation and review of the preliminary consolidation test results, we used a Cv value of 0.035 ft^2/day in our preliminary consolidation analyses.

6.2. Shear Strength Parameters

The subsurface soil shear strength properties were characterized based on standard penetration test (SPT) in-situ testing for sand, and laboratory testing results for clay. The following section presents the methods and preliminary soil shear strength parameters determined for this project.

6.2.1. Holocene Silts and Clays

The Holocene deposits encountered along the west and east embankment generally consist of 5 to 35 feet thick of soft to medium stiff silts and clays. The shear strength of the cohesive silts and clays is dependent on the stress history of the soil itself. The stress history of the silts and clays was evaluated and the results are presented in Figure 4.

The Stress History and Normalized Soil Engineering Parameters (SHANSEP) approach was used to define soil shear strength as a function of vertical effective stress and the OCR of the soil. Shear strength (S_u) of the silts and clays was determined using the following SHANSEP equation:

$$s_u = 0.22\sigma_v' OCR^{0.8}$$

6.2.2. Sands

The shear strength parameters of the Holocene sand unit encountered at the project site will be expressed as internal friction angle (ϕ') for the static conditions and residual strength (Sr) for the earthquake conditions, if the sand is determined to be potentially liquefiable under the design earthquake events. The internal friction angle was derived using the correlation developed by Terzaghi et al, (1996) between SPT blow counts (corrected for depth and hammer efficiency) and relative density. Residual effective friction angle was also derived per SCDOT GDM recommendations using the Idriss and Boulanger (2008)

correlations between SPT blow counts (corrected for depth and hammer efficiency as well as fines content). The Meyerhof's and Idriss & Boulanger (2008) correlations used are presented below:

Terzaghi et al, 1996 correlation:

$$\phi' = -0.0027(N_{1\text{-}60})^2 + 0.4333(N_{1\text{-}60}) + 27.184$$

Idriss and Boulanger (2008) Correlation:

$$Sr/\sigma'_v = \exp\left(N_{1\text{-}60cs\text{-}Sr}/16 + ((N_{1\text{-}60cs\text{-}Sr} - 16) / 21.2)^3 - 3\right)$$

Sand shear strength parameters relevant to the proposed design were evaluated using area specific data. Specific layers were delineated using recorded blow count information. Area specific blow counts, friction angles, and residual strength parameters were determined using the information presented in Appendix C, Soil Parameter Determination.

6.2.3. Hawthorn Marl

The F&ME geotechnical baseline report does not present any laboratory testing for the Hawthorn Marl. Based on our assessment of the in-situ SPT and CPT data, it is our opinion that the Hawthorn Marl has similar shear strength characteristics to the Cooper Marl, which is a well-studied soil formation. For the preliminary analyses, we estimated that the Hawthorn Marl has an undrained shear strength of 4 kips per square foot (ksf), which is the average published shear strength for the Cooper Marl. The undrained shear strength was reduced by 15 percent under the seismic loading conditions. For final design analyses, laboratory tests will be completed to refine the shear strength parameters for the Hawthorn Marl soil unit.

6.2.4. Cooper Formation

The F&ME geotechnical baseline report does not include any laboratory shear strength tests for the Cooper Formation for depths of interest. We estimated the shear strength characteristics by comparing the shear wave velocities of the Hawthorn Marl and the Cooper Formation. Our comparison shows that the shear wave velocity of the Cooper Formation is at least 1.5 times higher than the shear wave velocity measured in the Hawthorn Marl. Since the shear strength and shear wave velocity (indicative of shear modulus) is directly related, we estimated a shear strength of 6 ksf for the Cooper Formation in our preliminary analyses. We will complete laboratory shear strength tests to refine the shear strength of the Cooper Formation for use in the final design analyses.

6.2.5. Embankment Fill

Since the embankment fill will meet the SCDOT material specification for structural fill and will be compacted to at least 95 percent of the maximum dry density (MDD) per ASTM D1557, we estimated an internal friction angle of 38 degrees to calculate the shear strength of the embankment fill. We will complete laboratory shear strength tests to refine the friction angle of the embankment fill for use in the final design analyses.

7.0 SEISMIC INPUT PARAMETERS FOR BRIDGE EMBANKMENT DESIGN

The seismic input parameters used in the bridge embankment design analyses were provided in the RFP based on the site-specific response analyses completed by F&ME for the project. Table 7 below presents the seismic input parameters for bridge embankment design. Figures 7 and 8 presents the ground surface ADRS curves for the west and east bridge embankment, respectively.

TABLE 7. SEISMIC INPUT PARAMETERS FOR BRIDGE EMBANKMENT DESIGN

ADRS Design Parameters	West Bridge Embankment		East Bridge Embankment	
	FEE	SEE	FEE	SEE
M_w	7.3	7.3	7.3	7.3
PGA (g)	0.14	0.26	0.12	0.29

8.0 GEOTECHNICAL EMBANKMENT DESIGN ANALYSES

The roadway embankments were delineated into seven representative zones for use in the geotechnical design analyses. These seven zones are delineated based on ROC categories, subsurface soil conditions and embankment height, as summarized in Table 8 below.

TABLE 8. EMBANKMENT ZONES

Embankment Zone	ROC	Station Range	Embankment Height Range (feet)
West Embankment 1	III	59+00 and lower	Less than 4
West Embankment 2	III	59+00 to 69+00	4 to 13
West Embankment 3	III	69+00 to 69+65	13 to 14
West Bridge Embankment 4	I	69+65 to 70+40 (Begin Bridge)	14 to 18
East Bridge Embankment 1	I	103+80 (End Bridge) to 104+55	15 to 17
East Embankment 2	III	104+55 to 112+00	7 to 15
East Embankment 3	III	112+00 and higher	0 to 7

Preliminary consolidation analyses were completed to evaluate the preliminary estimated preload fill required in each of the embankment zones that will meet the SLS settlement performance limits summarized in Tables 1 and 2 presented above. Two sets of one-dimensional (1D) consolidation analyses were completed. The first set of analysis was completed to estimate the amount of settlement that needs to be induced during the preload period. The required preload fill is then estimated by adding 3.2 feet of fill (equivalent to about 400 pounds per square foot (psf), which includes traffic loading and future pavement overlay) to the settlement computed. The second set of analysis was completed to estimate the post-construction roadway consolidation settlement under the 400 psf traffic and pavement overlay loading assuming that the underlying soils will be in the recompression state after the preload program is completed. The preliminary consolidation analyses were completed using an in-house spreadsheet and the

calculations are provided in Appendix D, Consolidation Analyses. For final design, the computer program Settle3D will be used to complete the consolidation analyses using the refined consolidation parameters.

Preliminary global stability analyses were also completed for two static conditions (staged construction and end of construction) to check that the demand/capacity (D/C) ratios for slope stability are acceptable. The preliminary global stability analyses were completed using the computer program SlopeW with Morgenstein-Price analysis method. We included geotextile reinforcement in the SlopeW analyses. A reinforcement equivalent to a Mirafi 1000/100 was used underneath all of the roadway embankments and reinforcement equivalent to Mirafi HP570 was used in the West and East Bridge Embankments. The SlopeW global stability calculations are presented in Appendix E, Soil Liquefaction Analyses.

For both the West and East Bridge Embankments, we also completed soil liquefaction analyses under both FEE and SEE events to confirm that the bridge embankment settlement performance at EE I Limit State as presented in Tables 3 and 4 above are met. Soil liquefaction potential was evaluated by comparing the cyclic shear stress ratio (CSR), and the Demand (D) induced by the design earthquake with the cyclic resistance ratio (CRR), the Capacity (C) of the soil to resist liquefaction. The ratio of CSR (Demand, D) to CRR (Capacity, C) results in the liquefaction triggering resistance ratio for Sand-Like soils $(D/C)_{SL\text{-}Sand}$, and is equivalent to the inverse of the Factor of Safety (1/FS) traditionally used for evaluating liquefaction potential. Full liquefaction occurs when $(D/C)_{SL\text{-}Sand} > \varphi_{SL\text{-}Sand}$, where $\varphi_{SL\text{-}Sand}$ is the triggering resistance factor for the onset of liquefaction required by the GDM. The GDM defines the onset of "Full Liquefaction" for the SEE design earthquake when $(D/C)_{SL\text{-}Sand} > 0.90$ and for the FEE design earthquake when $(D/C)_{SL\ Sand} > 0.85$. Soil liquefaction analyses were completed using the semi-empirical method developed by Idriss and Boulanger (2008) using an in-house spreadsheet. The liquefaction induced settlements of the saturated sands were estimated based on Idriss and Boulanger (2008). Appendix F presents the preliminary liquefaction analysis calculations completed for this project.

In addition to soil liquefaction analysis, preliminary pseudo-static global stability and Newmark analyses were also completed to check that the west and east bridge embankments meet the embankment global instability performance limits at EE I limit state as presented in Table 5 above. Pseudo-static global stability analyses were completed using the computer program SlopeW to determine the yield acceleration for each design section. The bridge embankment seismic deformations were estimated using the simplified Newmark Method described in Section 13.17.2 and Equation 13-106 of the SCDOT GDM. For ROC I bridge embankment, the calculated Newmark displacement will be multiplied by 2.

For the ROC 1 West and East Bridge Embankment, timber piles will be implemented to meet the performance limits at EE I limit state. Timber piles are also planned within the West Roadway Embankment 3 located adjacent to the existing Harbor River Bridge pile foundations to minimize the impacts of the roadway embankment construction. The ground improvement design was completed using the British Standard Method (BS 8006) of the Catenary Design Approach as outlined in Section 19.9.3.1 of the SCDOT GDM to estimate the embankment settlement. Ground improvement calculations for the West and East Bridge Embankment, as well as for the West Roadway Embankment 3 are presented in Appendix G, Ground Improvement Analyses.

The following sections present a summary of the results of the consolidation, global stability, Newmark and soil liquefaction analyses completed for the design sections selected for each of the embankment zones delineated for this project.

8.1. West Embankment 1

Consolidation analyses were completed based on the soil profile encountered in boring B-7. Table 9 below summarizes the results of our preliminary consolidation analyses completed for West Embankment 1.

TABLE 9. WEST EMBANKMENT 1 – SUMMARY OF CONSOLIDATION ANALYSES RESULTS

Exploration	Preload Induced Settlement (feet)	Preload Fill Thickness (feet)	Estimated Long Term Roadway Settlement (inches)
B-7	0.1	3.3	1.1

The preliminary slope stability cross section was developed at Station 59+00, which we identified as the worst-case soil condition within West Embankment 1. Appendix E presents the soil layers and input parameters used in the preliminary slope stability analyses. Figures 9 and 10 present the results of the slope stability analyses for both staged construction and end of construction conditions. The results indicate that the D/C is less than 0.67 (i.e. FS > 1.5), therefore, is satisfactory.

8.2. West Embankment 2

Consolidation analyses were completed based on soil profiles encountered in CPT-5, and borings B-8 and B-9. Table 10 below summarizes the results of our preliminary consolidation analyses completed for West Embankment 1.

TABLE 10. WEST EMBANKMENT 2 – SUMMARY OF CONSOLIDATION ANALYSES RESULTS

Exploration	Preload Induced Settlement (feet)	Preload Fill Thickness (feet)	Estimated Long Term Roadway Settlement (inches)
CPT-5	0.2	3.4	1.9
B-8	0.4	3.6	2.3
B-9	1.8	5.0	6.4

The preliminary global stability cross section was developed at Station 69+00, which we identified as the worst-case soil condition within West Embankment 2. Appendix E presents the soil layers and input parameters used in the preliminary global stability analyses. Figures 11 and 12 present the results of the global stability analyses for both staged construction and end of construction conditions. The results indicate that the D/C is less than 0.67 (i.e. FS > 1.5), therefore, is satisfactory.

8.3. West Embankment 3

Consolidation analyses were completed based on soil profiles encountered in CPT-6. Table 11 below summarizes the results of our preliminary consolidation analyses completed for West Embankment 3.

TABLE 11. WEST EMBANKMENT 3 – SUMMARY OF CONSOLIDATION ANALYSES RESULTS

Exploration	Preload Induced Settlement (feet)	Preload Fill Thickness (feet)	Estimated Long Term Roadway Settlement (inches)
CPT-6	1.2[1]	4.4	1.1[1]

Notes:

Preload induced settlement and long-term roadway settlement are controlled by the timber pile ground improvement program as presented in Appendix G. The long-term embankment settlement is estimated as the vertical settlement induced by difference of 1 percent strain in the high strength geotextile.

The preliminary global stability cross section was developed at Station 69+65, which we identified as the worst-case soil condition within West Embankment 3. Appendix E presents the soil layers and input parameters used in the preliminary global stability analyses. Figures 13 and 14 present the results of the global stability analyses for both staged construction and end of construction conditions. The results indicate that the D/C is less than 0.67 (i.e. FS > 1.5), therefore, is satisfactory.

8.4. West Bridge Embankment 4

Consolidation analyses were completed based on interpreted soil profile at Station 70+40. Table 12 below summarizes the results of our preliminary consolidation analyses completed for West Bridge Embankment 4.

TABLE 12. WEST BRIDGE EMBANKMENT 4 – SUMMARY OF CONSOLIDATION ANALYSES RESULTS

Exploration	Preload Induced Settlement (feet)	Preload Fill Thickness (feet)	Estimated Long Term Roadway Settlement (inches)
Interpreted Soil Profile	0.5[1]	3.7	1.2[1]

Notes:

Preload induced settlement and long-term embankment settlement are controlled by the timber pile ground improvement program as presented in Appendix G. The long-term embankment settlement is estimated as the vertical settlement induced by difference of 1 percent strain in the high strength geotextile. Timber pile settlement reduction ratio is estimated to be 85 percent.

Tables 13, 14 and 15 present the results of the soil liquefaction analyses completed using the soil profiles encountered in boring B-9.

TABLE 13. WEST BRIDGE EMBANKMENT 4 – SUMMARY OF LIQUEFACTION ANALYSES RESULTS FOR SEE

Boring No.	Boring Elevation (feet)	Potentially Liquefiable Soil Layers $(D/C)_{SL\text{-}Sand} = 1/FS > 0.90$				
		Depth Intervals and Thickness Shown in Parenthesis (feet)				Total Thickness (feet)
		Layer 1	Layer 2	Layer 3	Layer 4	
B-9	2.6	1 – 16 (15)	41 – 51 (10)	-	-	25

TABLE 14. WEST BRIDGE EMBANKMENT 4 – SUMMARY OF LIQUEFACTION ANALYSES RESULTS FOR FEE

Boring No.	Boring Elevation (feet)	Potentially Liquefiable Soil Layers $(D/C)_{SL\text{-}Sand} = 1/FS > 0.85$				
		Depth Intervals and Thickness Shown in Parenthesis (feet)				Total Thickness (feet)
		Layer 1	Layer 2	Layer 3	Layer 4	
B-9	2.6	1 – 16 (15)	41 – 51 (10)	-	-	25

TABLE 15. WEST BRIDGE EMBANKMENT 4 – LIQUEFACTION INDUCED SETTLEMENT

Boring	Settlement under SEE, inches	Settlement under FEE, inches
B-9	16.4	16.4

By implementing the timber pile ground improvement system, we estimated that the settlement reduction at the West Bridge Embankment 4 is about 85 percent, therefore, the effective liquefaction induced settlement for both the SEE and FEE is about 2.5 inches.

The preliminary global stability cross section was developed at Station 70+40, which we identified as the worst-case soil condition within West Bridge Embankment 4. Appendix E presents the soil layers and input parameters used in the preliminary global stability analyses. Figures 15 and 16 present the results of the global stability analyses for both staged construction and end of construction conditions. The results indicate that the D/C is less than 0.67 (i.e. FS > 1.5), therefore, is satisfactory.

Figure 17 shows the results of the pseudo-static slope stability analysis with a yield acceleration of 0.29g. Using the Simplified Newmark Method, the estimated seismic lateral deformations under the FEE and SEE are negligible as the yield acceleration is higher than the design peak ground acceleration.

8.5. East Bridge Embankment 1

Consolidation analyses were completed based on soil profiles encountered in CPT-8. Table 16 below summarizes the results of our preliminary consolidation analyses completed for East Bridge Embankment 1.

TABLE 16. EAST BRIDGE EMBANKMENT 1 – SUMMARY OF CONSOLIDATION ANALYSIS RESULTS.

Exploration	Preload Induced Settlement	Preload Fill Thickness	Estimated Long Term Roadway Settlement (inches)
CPT-8	0.5[1]	3.7	1.2[1]

Note:

1) Preload induced settlement and long-term embankment settlement are controlled by the timber pile ground improvement program as presented in Appendix G. The long-term embankment settlement is estimated as the vertical settlement induced by difference of 1 percent strain in the high strength geotextile. Timber pile ground improvement settlement reduction ratio is estimated to be 75 percent.

Tables 17, 18 and 19 present the results of the soil liquefaction analyses completed using the soil profiles encountered in borings B-16.

TABLE 17. EAST BRIDGE EMBANKMENT 1 – SUMMARY OF LIQUEFACTION ANALYSES RESULTS FOR SEE

Boring No.	Boring Elevation (feet)	Potentially Liquefiable Soil Layers $(D/C)_{SL\text{-}Sand} = 1/FS > 0.90$				
		Depth Intervals and Thickness Shown in Parenthesis (feet)				Total Thickness (feet)
		Layer 1	Layer 2	Layer 3	Layer 4	
B-16	2.4	0 – 3 (3)	16 – 46 (30)	56 – 66 (10)	-	43

TABLE 18. EAST BRIDGE EMBANKMENT 1 – SUMMARY OF LIQUEFACTION ANALYSES RESULTS FOR FEE

Boring No.	Boring Elevation (feet)	Potentially Liquefiable Soil Layers $(D/C)_{SL\text{-}Sand} = 1/FS > 0.85$				
		Depth Intervals and Thickness Shown in Parenthesis (feet)				Total Thickness (feet)
		Layer 1	Layer 2	Layer 3	Layer 4	
B-16	2.4	0 – 3 (3)	21 – 26 (5)	31 – 46 (15)	56 – 66 (10)	33

TABLE 19. EAST BRIDGE EMBANKMENT 1 – LIQUEFACTION INDUCED SETTLEMENT

Boring	Settlement under SEE, inches	Settlement under FEE, inches
B-16	18.2	14.6

By implementing the timber pile ground improvement system, we estimated that the settlement reduction at the West Bridge Embankment 4 is about 75 percent, therefore, the effective liquefaction induced settlements for both the SEE and FEE are about 4.6 and 3.6 inches, respectively.

The preliminary global stability cross section was developed at Station 103+80, which we identified as the worst-case soil condition within East Bridge Embankment 1. Appendix E presents the soil layers and input parameters used in the preliminary global stability analyses. Figures 18 and 19 present the results of the global stability analyses for both staged construction and end of construction conditions. The results indicate that the D/C is less than 0.67 (i.e. FS > 1.5), therefore, is satisfactory.

Figure 20 shows the results of the pseudo-static slope stability analysis with a yield acceleration of 0.46g. Using the Simplified Newmark Method, the estimated seismic lateral deformations under the FEE and SEE are negligible as the yield acceleration is higher than the design peak ground acceleration.

8.6. East Embankment 2

Consolidation analyses were completed based on soil profiles encountered in borings B-16 and B-2. Table 20 below summarizes the results of our preliminary consolidation analyses completed for East Embankment 2.

TABLE 20. EAST EMBANKMENT 2 – SUMMARY OF CONSOLIDATION ANALYSIS RESULTS.

Exploration	Preload Induced Settlement (feet)	Preload Fill Thickness (feet)	Estimated Long Term Roadway Settlement (inches)
B-16	0.6	3.8	0.9
B-2	0.5	3.7	0.8

The preliminary global stability cross section was developed at Station 104+55, which we identified as the worst-case soil condition within East Embankment 2. Appendix E presents the soil layers and input parameters used in the preliminary global stability analyses. Figures 21 and 22 present the results of the global stability analyses for both staged construction and end of construction conditions. The results indicate that the D/C is less than 0.67 (i.e. FS > 1.5), therefore, is satisfactory.

8.7. East Embankment 3

Consolidation analyses were completed based on soil profiles encountered in boring B-5. Table 21 below summarizes the results of our preliminary consolidation analyses completed for East Embankment 3.

TABLE 21. EAST EMBANKMENT 3 – SUMMARY OF CONSOLIDATION ANALYSIS RESULTS.

Exploration	Preload Induced Settlement (feet)	Preload Fill Thickness (feet)	Estimated Long Term Roadway Settlement (inches)
B-5	0.1	3.3	1.0

The preliminary global stability cross section was developed at Station 112+00, which we identified as the worst-case soil condition within East Embankment 3. Appendix E presents the soil layers and input parameters used in the preliminary global stability analyses. Figures 23 and 24 present the results of the global stability analyses for both staged construction and end of construction conditions. The results indicate that the D/C is less than 0.67 (i.e. FS > 1.5), therefore, is satisfactory.

9.0 PRELIMINARY GEOTECHNICAL EMBANKMENT DESIGN RECOMMENDATIONS

Based on the results of our preliminary analyses, the following are our preliminary geotechnical embankment design recommendations for this project:

- Prior to constructing the roadway embankments and walls, the site will need to be cleared, stripped, grubbed, and all obstructions such as pavements or other structures removed from the footprint of the embankments.
- Based on the subsurface soil conditions encountered within the footprint of the embankments, we anticipate that the site does not require mucking except at a few localized areas where thick, very soft and highly organic soils are encountered. Prior to fill placement, subgrade evaluation should be completed by probing with a ½-inch-diameter steel probe rod to identify areas that require mucking.
- Preload fill will be required within the roadway embankments to pre-induce consolidation soil settlement during the preload period. The feasible preload duration is determined to be 18 months, and wick drains will be installed to help expedite the preload program to ensure that it is completed

within the 18-month period. Table 22 below summarizes the range of preload fill thickness identified within four of the seven delineated embankment zones and the wick drain spacing, if needed.

TABLE 22. PRELIMINARY RECOMMENDED PRELOAD FILL THICKNESS AND WICK DRAIN SPACING

Embankment Zone	Station Range	Preload Fill Thickness above Design Grade (feet)	Wick Drain Spacing (feet)
West Roadway Embankment 1	59+00 and lower	< 3.5	N/A
West Roadway Embankment 2	59+00 to 69+00	3.5 to 5.0	6.0-foot Square Pattern
East Roadway Embankment 2	104+55 to 112+00	3.5 to 4.0	6.0-foot Square Pattern
East Roadway Embankment 3	112+00 and higher	< 3.5	N/A

- West Roadway Embankment Section 3 that extends from Station 69+00 to 69+65, is located adjacent to the existing Harbor River Bridge pile foundations. Therefore, ground improvement consisting of timber piles will be installed at spacing ranging between 6 to 7 feet in square grids to reduce the undrained lateral soil deformation to prevent additional lateral soil stress that can adversely impact the existing Harbor River Bridge pile foundations.
- To meet the performance limits at EE I limit state, ground improvement consisting of timber piles installed at spacing ranging from 5 to 6 feet in square grids will be required within the West and East Bridge Embankments, extending from Station 69+65 to 70+40 and from Station 103+80 to 104+55, respectively.
- The embankment fill placement should be completed by staged construction using normal weight fill that meets the SCDOT material specifications as structural fill. The rate of fill placement should be managed such that subsurface soil failure does not occur throughout construction.
- Geotechnical instrumentation should be implemented to monitor soil settlement and deformation during construction to ensure that the objectives of the preload program are achieved and to prevent subsurface soil failure from occurring during construction. We recommend that the geotechnical instrumentation program include Settlement Plates, Piezometers and Inclinometers. The quantity and location of the instrumentation will be developed as part of the final embankment design package.

10.0 FIELD EXPLORATION AND LABORATORY TESTING PROGRAM

A field exploration and laboratory testing program has been developed to supplement the preliminary exploration and laboratory testing program completed and to refine the soil input parameters used in the preliminary geotechnical design analyses for this project. Soil test borings (SPT) will be performed at each proposed bent location, except at bent 17 where existing boring information is sufficient. Four borings, four CPTs and two dilatometer tests (DMT) are also planned within the new roadway embankment footprint. Borings will be terminated a minimum of 20 feet below the planned foundation tip elevations for the bridge borings, and a minimum of two times the proposed embankment height. All borings will conform to the

guidelines in the SCDOT GDM (2010). Table 23 below presents a summary of the borings, CPTs and DMT planned along the project alignment.

TABLE 23. SUMMARY OF FIELD INVESTIGATION PLAN

Exploration ID	Exploration Type	Station	Proposed Termination Elevation (feet, below MSL)	Drilling Equipment and Access
EB1	Boring	70+40.50	-133	Marsh Buggy
B2	Boring	72+03	-131	Marsh Buggy
B3	Boring	73+70.50	-132	Marsh Buggy
B4	Boring	75+38	-132	Marsh Buggy
B5	Boring	77+05.50	-133	Marsh Buggy
B6	Boring	78+73	-155	Barge
B7	Boring	80+40.50	-155	Barge
B8	Boring	82+08	-155	Barge
B9	Boring	83+75.50	-155	Barge
B10	Boring	85+43	-155	Barge
B11	Boring	87+10.50	-155	Barge
B12	Boring	88+78	-155	Barge
B13	Boring	90+45.50	-155	Barge
B14	Boring	92+13	-155	Barge
B15	Boring	93+80.50	-155	Barge
B16	Boring	95+48	-155	Barge
B17	Boring	97+15.50	-135	NA
B18	Boring	98+83	-133	Marsh Buggy
B19	Boring	100+50.50	-133	Marsh Buggy
B20	Boring	102+18	-133	Marsh Buggy
EB21	Boring	103+80.50	-133	Marsh Buggy
101	Boring	66+00	-49	Marsh Buggy
102	Boring	68+00	-49	Marsh Buggy
103	Boring	105+00	-74	Marsh Buggy
104	Boring	107+00	-74	Marsh Buggy
CPT-1	Cone Penetration Test	63+00	-79	Marsh Buggy
CPT-2	Cone Penetration Test	67+00	-79	Marsh Buggy
CPT-3	Cone Penetration Test	109+00	-79	Marsh Buggy
CPT-4	Cone Penetration Test	112+00	-79	Marsh Buggy
DMT-1	Dilatometer Test	70+40.50	-64	Marsh Buggy
DMT-2	Dilatometer Test	103+80.50	-62	Marsh Buggy

We also developed a laboratory testing program consisting of performing laboratory tests using the soil samples obtained from the borings. The objective of the laboratory testing program is to evaluate pertinent physical and engineering characteristics of the soils encountered along the project alignment. Results of the laboratory tests will be used to characterize soil conditions at the site and refine representative design soil profiles and parameters for use in the engineering analyses. Table 24 below presents a summary of the laboratory tests planned for this project.

TABLE 24. SUMMARY OF LABORATORY TESTING PROGRAM

Laboratory Tests	Soil Samples	Quantity
Moisture Content	Near Surface Soils, Holocene Silts/Clays, Hawthorn Marl	38
Proctor	Embankment Fill	4
Atterberg Limits	Near Surface Soils, Holocene Silts/Clays, Hawthorn Marl	40
Grain Size with No. 200 Wash	Near Surface Soils, Holocene Sand	30
Consolidation Test	Near Surface Soils, Holocene Silts/Clays, Hawthorn Marl	20
CU Triaxial Test with pore pressure measurement	Embankment Fill, Near Surface Soils, Holocene Silts/Clays, Hawthorn Marl, Cooper Formation	40
Organic content	Near Surface Soils (top 5 feet)	5

11.0 LIMITATIONS

We have prepared this Preliminary Roadway Geotechnical Report for use by UIG-ICE Design Build Team and the SCDOT for design and construction of the US 21 over Harbor River Bridge Replacement project in Beaufort County, South Carolina.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

Any electronic form or hard copy of this document (email, text, table, and/or figure), if provided, and any attachments are only a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to Appendix H titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

12.0 REFERENCES

F&ME Consultants, Inc, (2017) "Geotechnical Base Line Report – US 21 (Sea Islands Parkway) Bridge over Harbor River, Beaufort County, South Carolina," February 24, 2017.

F&ME Consultants, Inc, (2017) "Site-Specific Seismic Reponses Analysis Report – US 21 (Sea Islands Parkway) Bridge over Harbor River, Beaufort County, South Carolina," March 10, 2017.

Idriss, I.M. and Boulanger, R.W., (2008) “Soil Liquefaction During Earthquakes,” Earthquake Engineering Research Institute (EERI), EERI Monograph MNO-12.

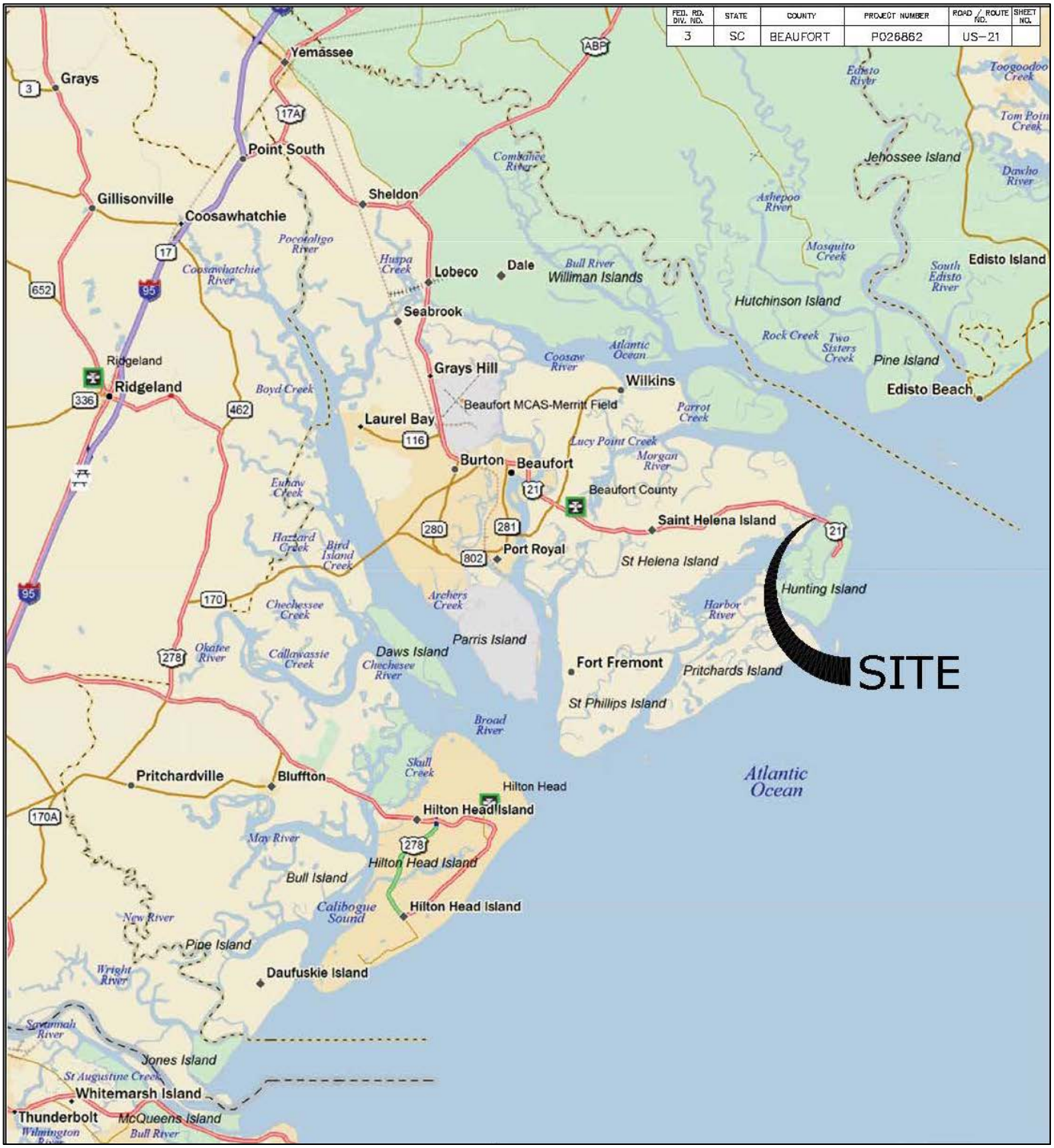
South Carolina Department of Transportation Geotechnical Manual, SCDOT GDM, (2008).

Terzaghi, K., Peck, R.B., and Mesri, G. (1996). “Soil Mechanics in Engineering Practice,” 3rd Ed., Wiley, New York, pg 549.

Willoughby, Howard, and Nystrom, (2005). “Generalized Geologic Map of South Carolina,” South Carolina Department of Natural Resources Geological Survey.

FIGURES

GeoEngineers



Vicinity Map

US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 1

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: F&ME Consultants. Geotechnical Base Line Report, dated 2/24/2017.

18461-007-01



Legend

Cone Penetration Test Location

N
W
E
S

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: F&ME Consultants. Geotechnical Base Line Report, dated 2/24/2017.

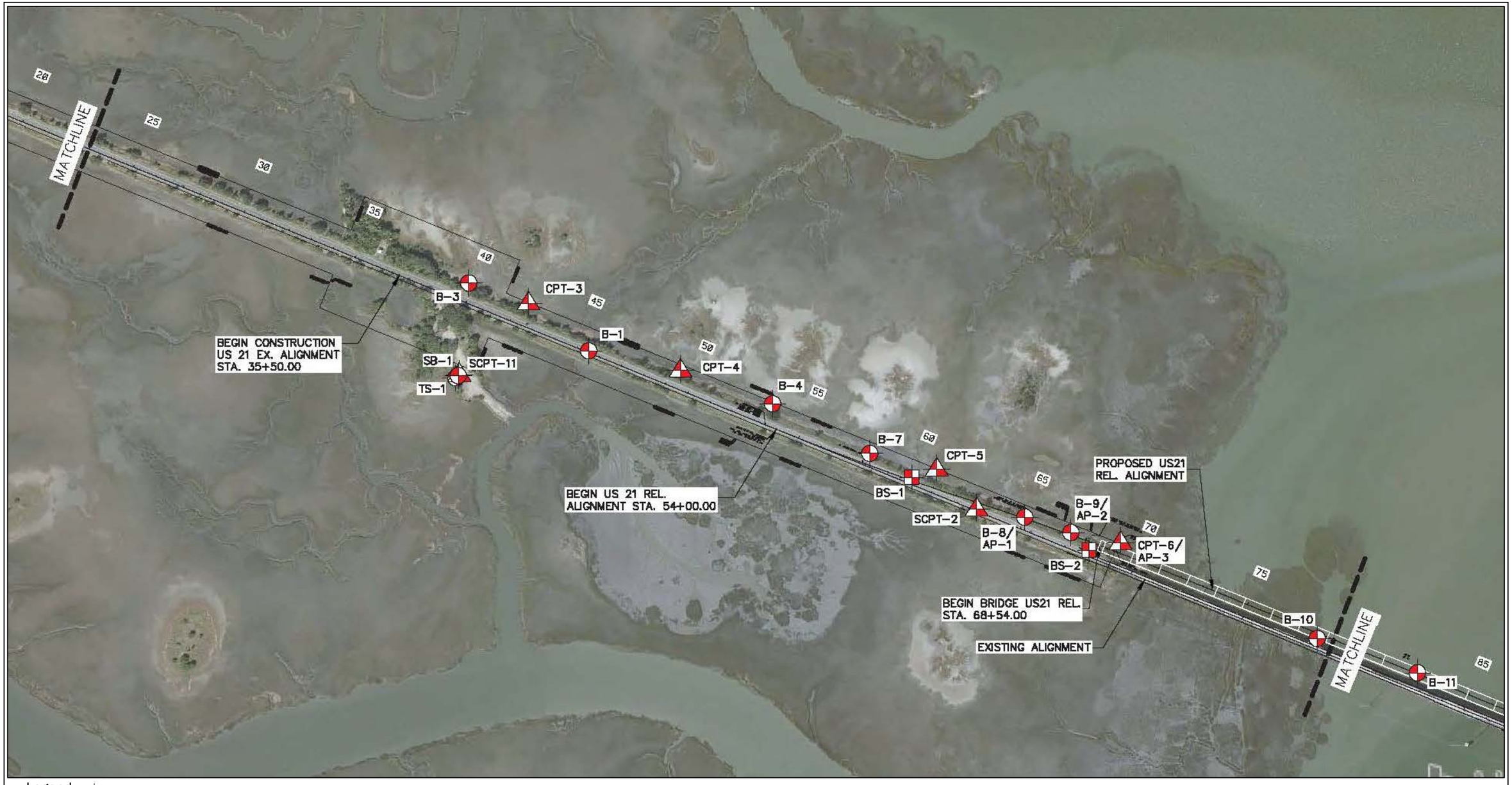
18461-007-01

Exploration Location Plan

US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 2A



Legend

- Soil Test Boring Location
- Bulk Sample Location
- Cone Penetration Test Location

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: F&ME Consultants. Geotechnical Base Line Report, dated 2/24/2017.

N W E S

Exploration Location Plan

US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 2B

18461-007-01



Legend

- Soil Test Boring Location
- Bulk Sample Location
- Cone Penetration Test Location

N
W E
S

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: F&ME Consultants. Geotechnical Base Line Report, dated 2/24/2017.

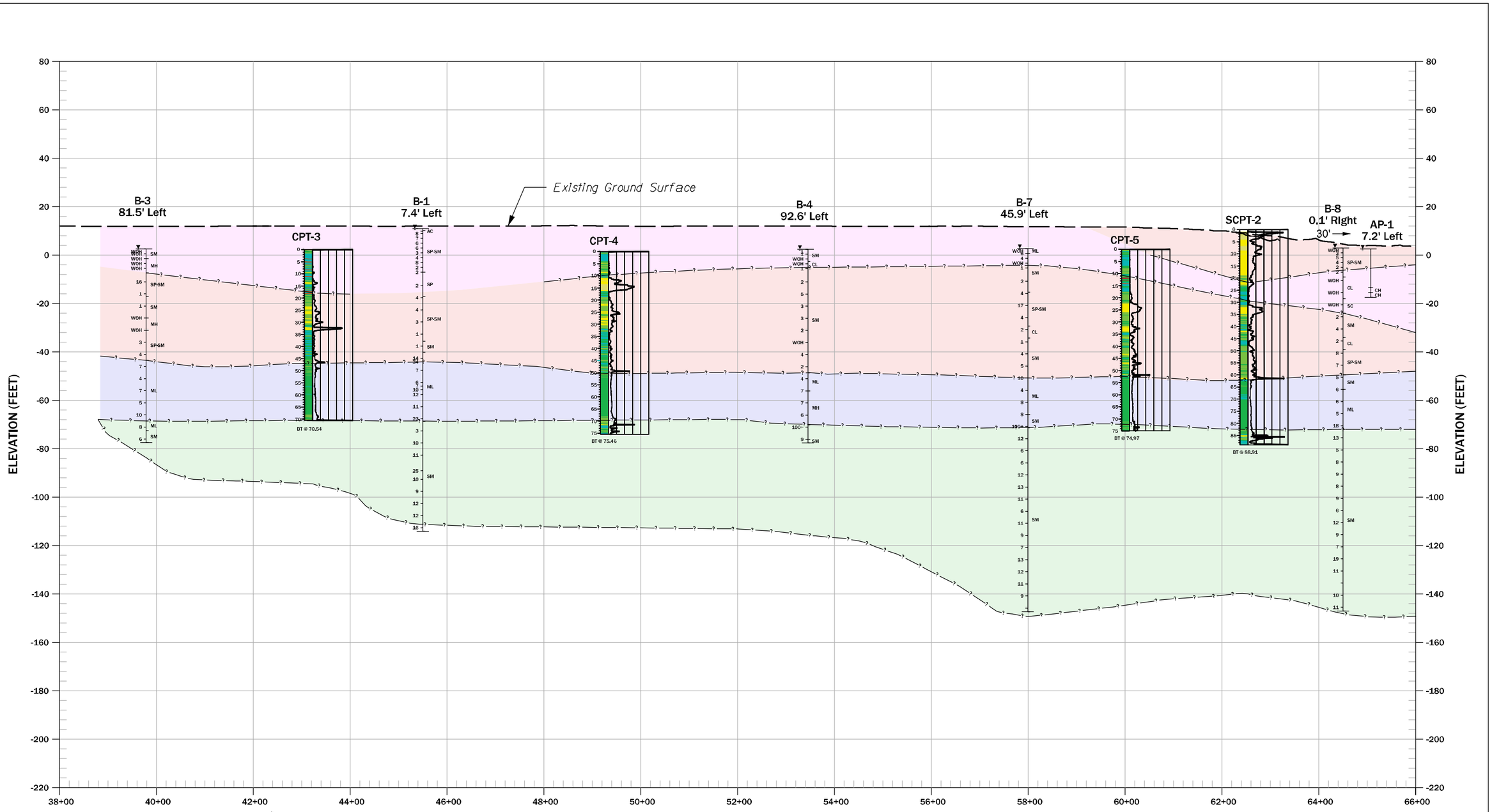
Exploration Location Plan

US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 2C

18461-007-01



Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Legend

- Surficial Holocene - Soft to Med. Stiff Silts and Clays
- Surficial Holocene - Loose to V. Dense Sands
- Hawthorn Marl
- Cooper Group Limestone

Horizontal Scale: 1"=200'
Vertical Scale: 1"=40'
Vertical Exaggeration: 5X

200 0 200
Feet

US-21 Generalized Subsurface Profile

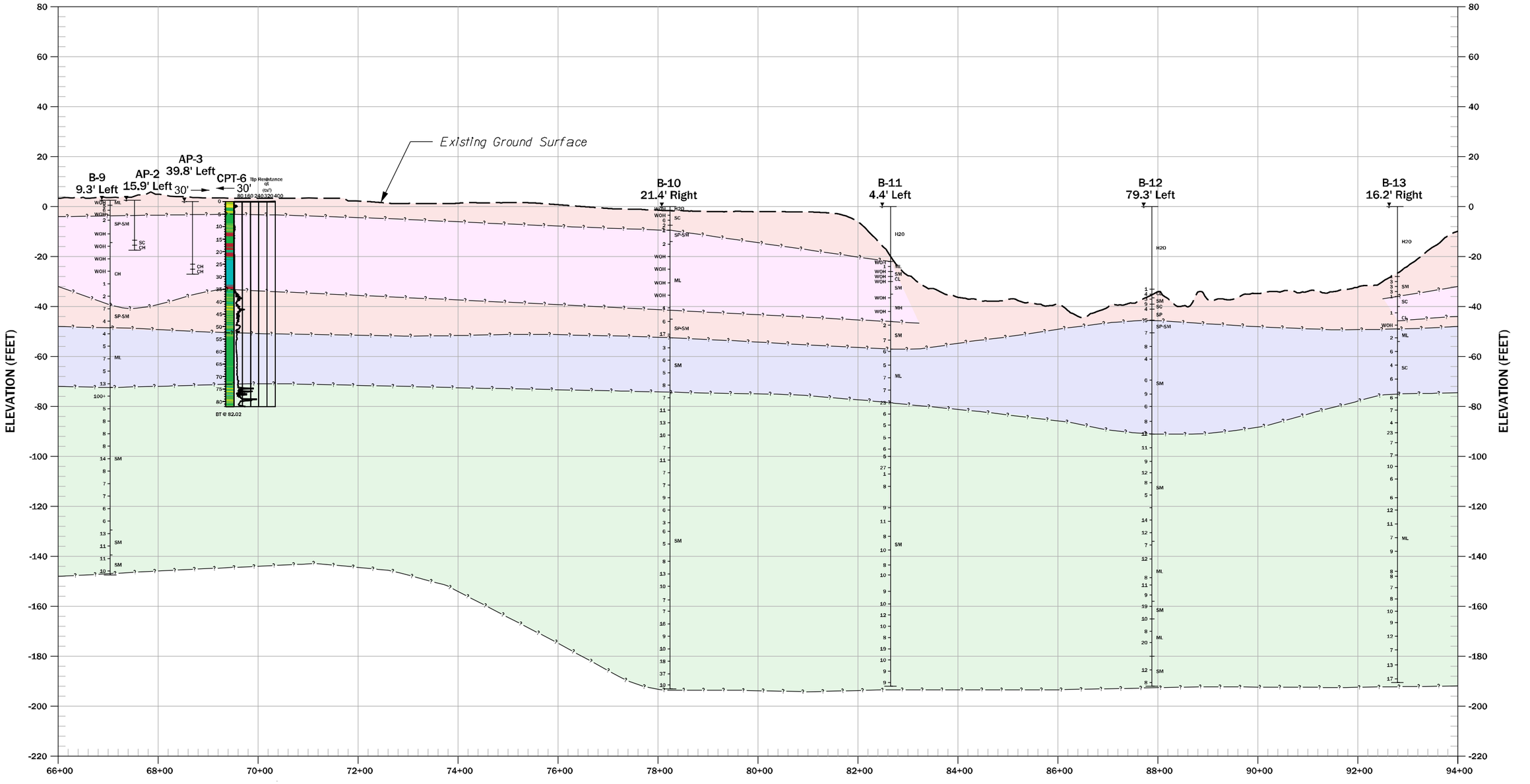
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GEOENGINEERS

Figure 3A

P:\18\18461007\CAD\00\GeoTech Report\R00\01846100700_F03_Soil Profile.dgn syl Figure 3A 17x11 (in.) 200.0000 ft / in. 12:24:30 PM 10/2/2017

P:\18\18461007\CAD\00\GeoTech Report\R00\018461007700_F03_Soil Profile.dgn
syl Figure 3B 17x11 (In.) 200.0000 ft / in. 12:30:48 PM 10/2/2017



Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Legend

- Surficial Holocene - Soft to Med. Stiff Silts and Clays
- Surficial Holocene - Loose to V. Dense Sands
- Hawthorn Marl
- Cooper Group Limestone

Horizontal Scale: 1"=200'
Vertical Scale: 1"=40'
Vertical Exaggeration: 5X

200 0 200
Feet

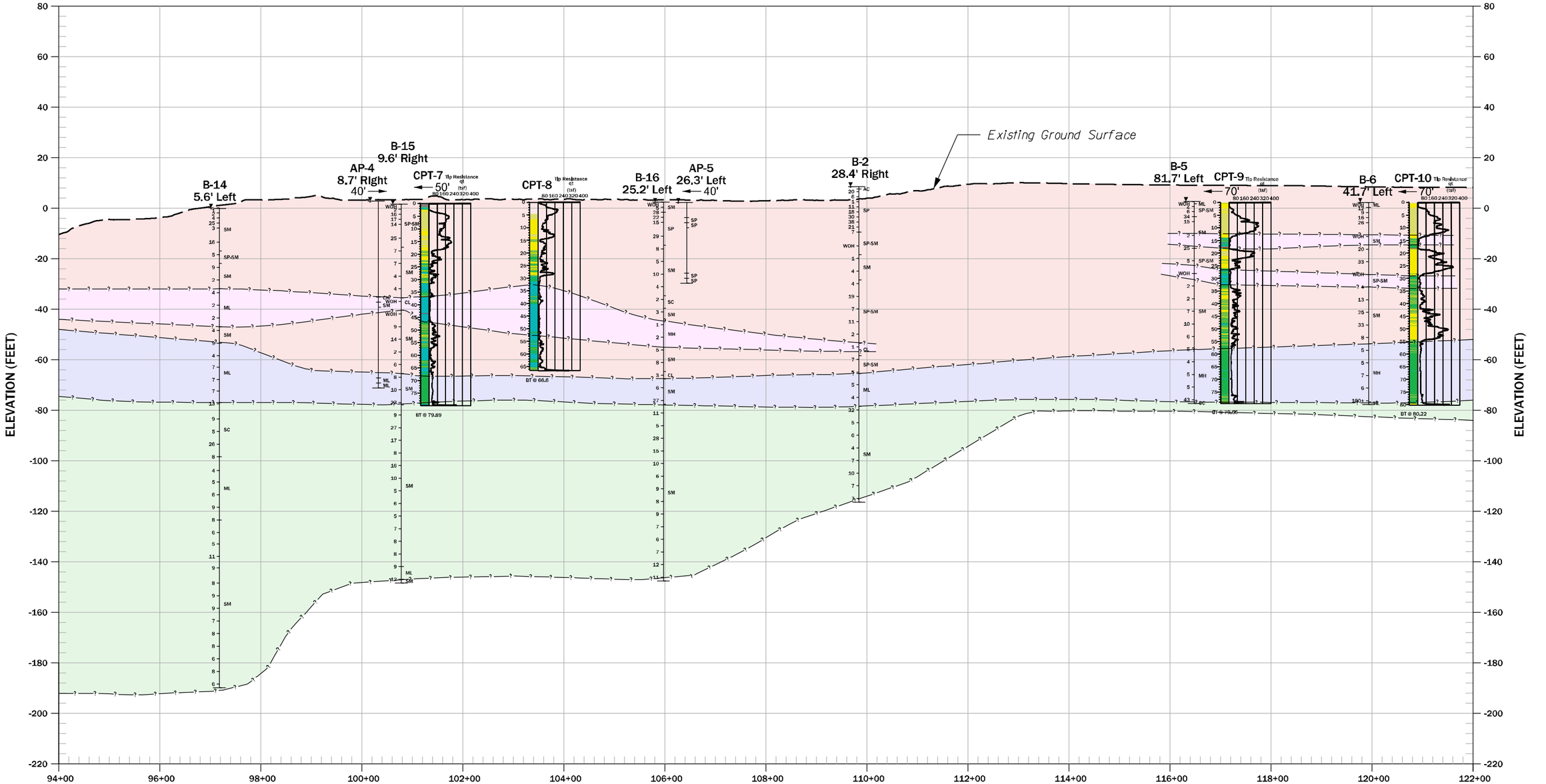
US-21 Generalized Subsurface Profile

US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 3B

P:\18_18461007\CAD\00\GeoTech Report\R00\018461007700_F03_Soil Profile.dgn 10/2/2017 12:31:20 PM 200.0000 ft / in. 17x11 (In.) Figure 3C syl



Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Legend

- Surficial Holocene - Soft to Med. Stiff Silts and Clays
- Surficial Holocene - Loose to V. Dense Sands
- Hawthorn Marl
- Cooper Group Limestone

Horizontal Scale: 1"=200'
Vertical Scale: 1"=40'
Vertical Exaggeration: 5X

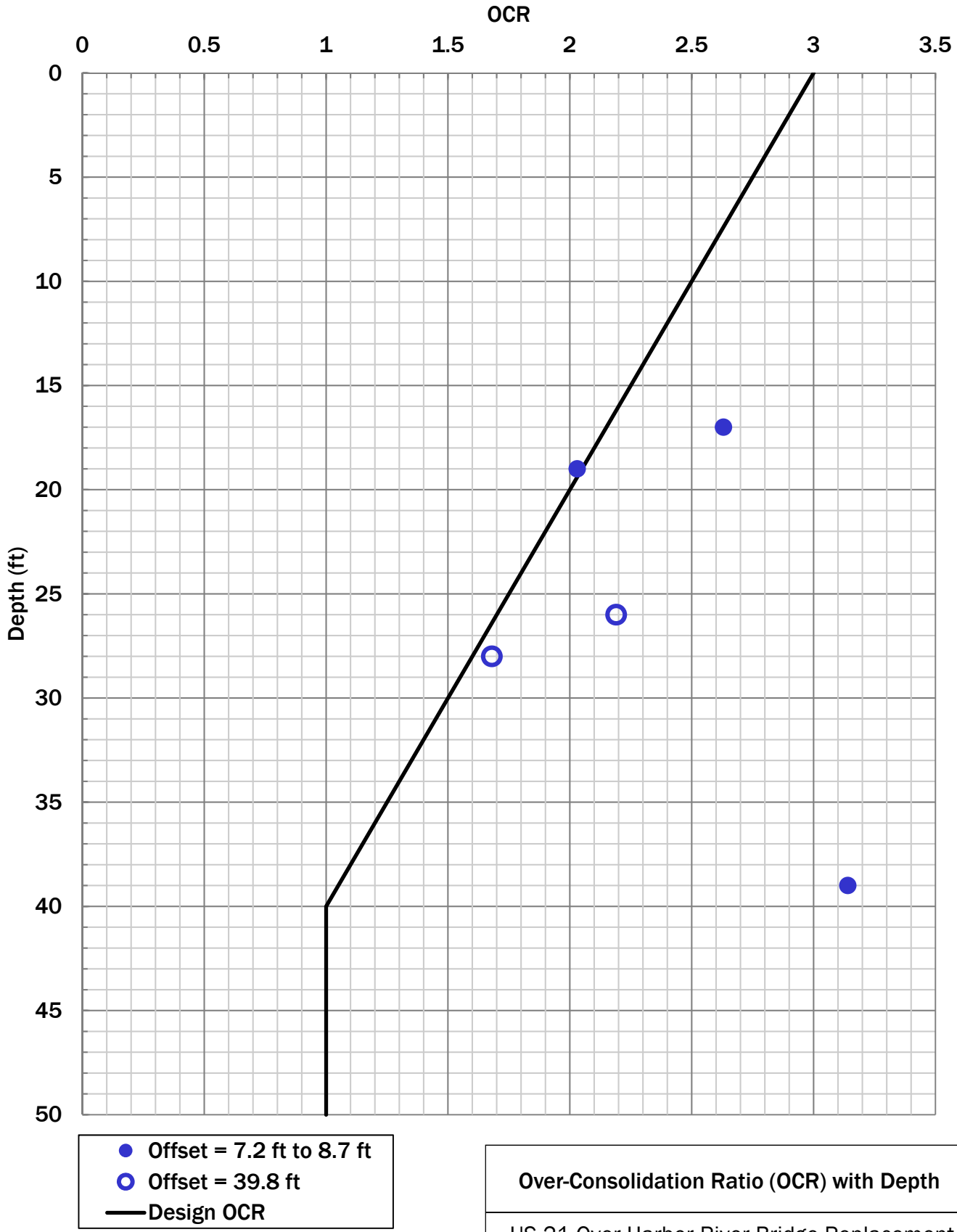
200 0 200
Feet

US-21 Generalized Subsurface Profile

US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 3C



Note:
1. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

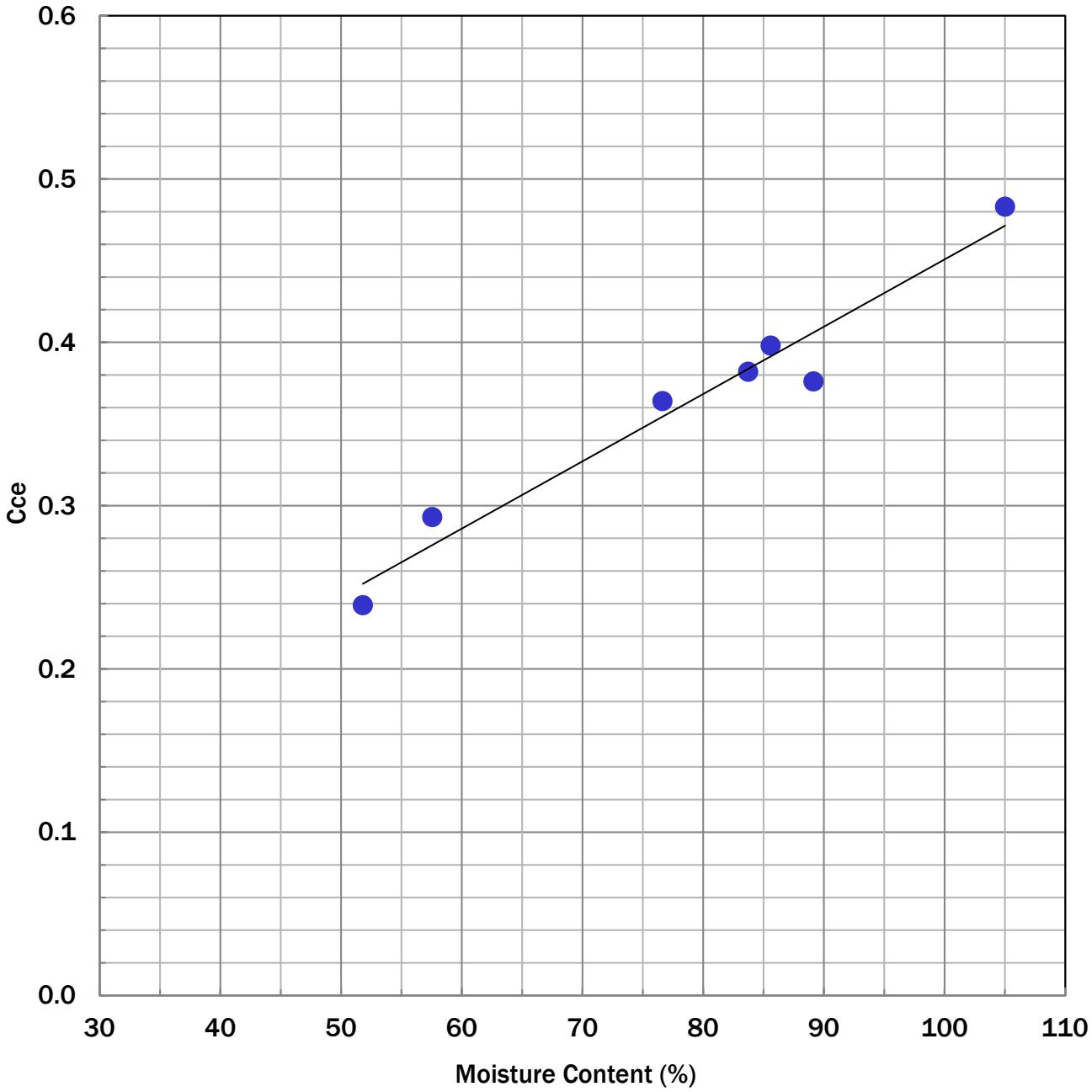
Over-Consolidation Ratio (OCR) with Depth

US-21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 4

18461-007-01 Date Exported: 09/29/17



● Consolidation Test Result
Equation of Trendline, y = 0.0041x + 0.0387

Compression Index, Cce

Note:
1. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

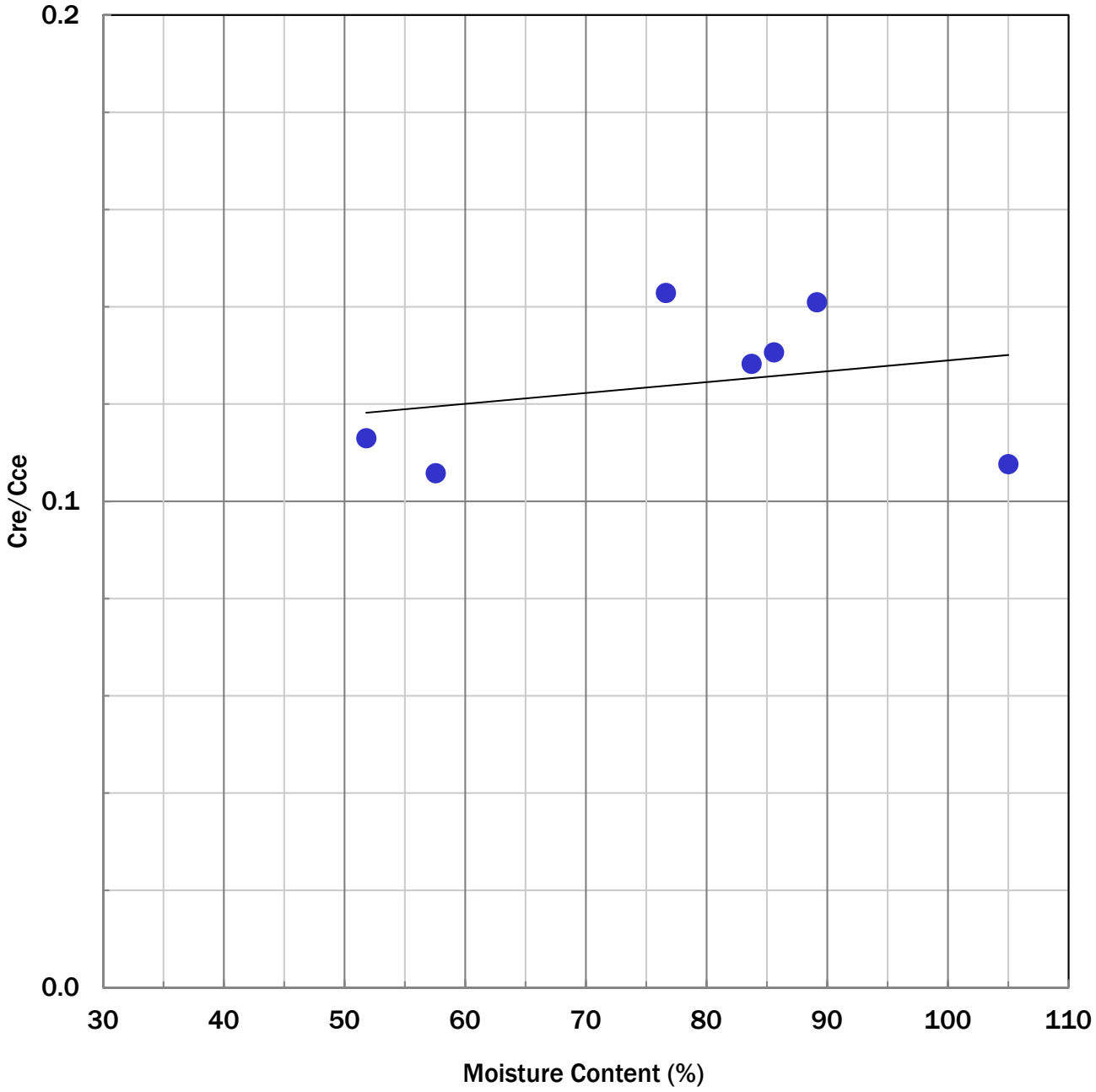
Moisture Content vs. Compression Index

US-21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 5

18461-007-01 Date Exported: 09/29/17



● Consolidation Test Result
Equation of Trendline y = 0.0002x + 0.1067

Recompression Index, Cre
Compression Index, Cce

Note:
1. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Moisture Content vs. Cre/Cce Ratio

US-21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

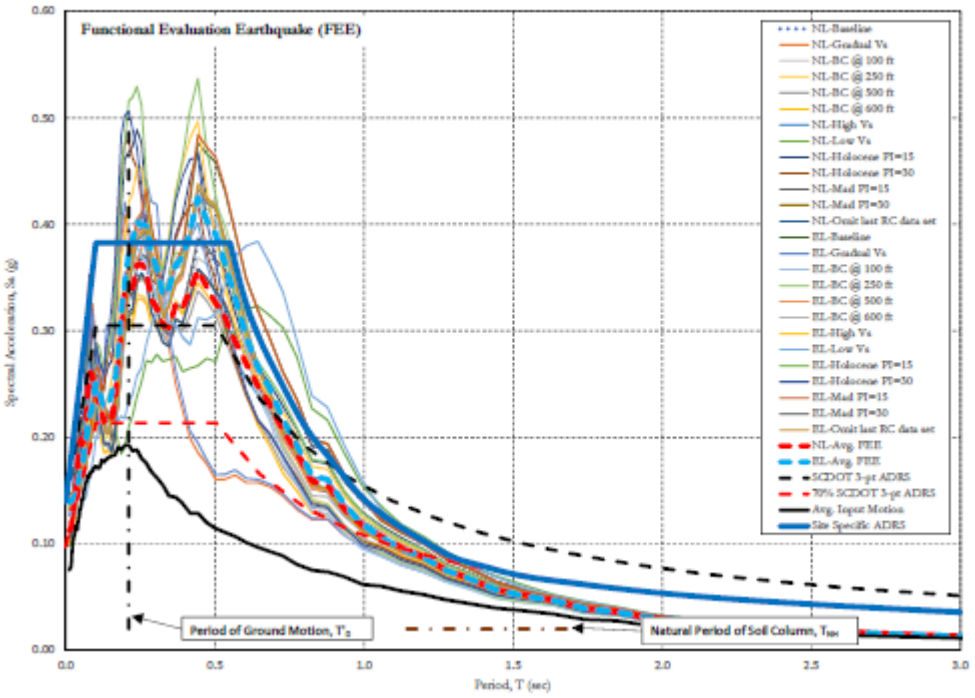
GeoEngineers

Figure 6

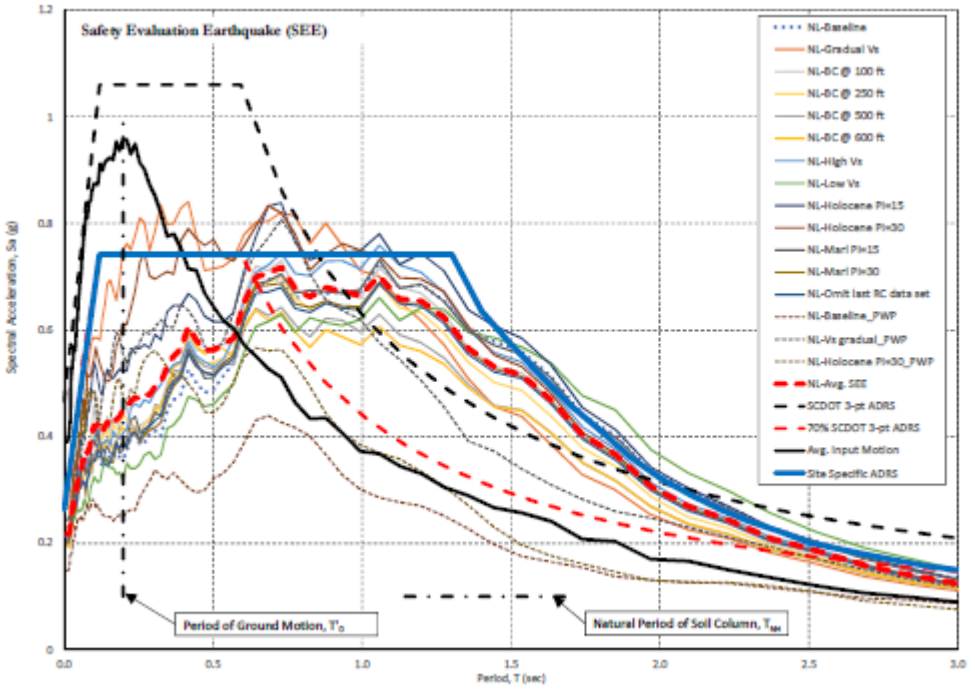
18461-007-01 Date Exported: 09/29/17

WEST GROUND SURFACE ADRS CURVES w/o GROUND MODIFICATION

(for beginning of bridge embankment)



T	Sa
sec	g
0.00	0.14
0.05	0.26
0.10	0.38
0.15	0.38
0.20	0.38
0.25	0.38
0.30	0.38
0.40	0.38
0.50	0.38
0.55	0.38
0.60	0.33
0.65	0.29
0.70	0.26
0.80	0.21
0.90	0.17
1.00	0.14
1.10	0.12
1.20	0.10
1.30	0.09
1.40	0.08
1.50	0.07
1.60	0.07
1.70	0.06
1.80	0.06
1.90	0.06
2.00	0.05
2.10	0.05
2.20	0.05
2.30	0.05
2.40	0.04
2.50	0.04
2.60	0.04
2.70	0.04
2.80	0.04
2.90	0.04
3.00	0.04



T	Sa
sec	g
0.00	0.26
0.03	0.36
0.05	0.47
0.12	0.74
0.15	0.74
0.20	0.74
0.25	0.74
0.30	0.74
0.35	0.74
0.40	0.74
0.50	0.74
0.60	0.74
0.70	0.74
0.80	0.74
0.90	0.74
1.00	0.74
1.10	0.74
1.20	0.74
1.30	0.74
1.40	0.64
1.50	0.57
1.60	0.51
1.70	0.46
1.80	0.41
1.90	0.36
2.00	0.32
2.10	0.29
2.20	0.26
2.30	0.24
2.40	0.22
2.50	0.20
2.60	0.19
2.70	0.18
2.80	0.17
2.90	0.16
3.00	0.15

Reference: Site-Specific Seismic Response Analysis Report prepared by F&ME Consultants, Inc dated March 10, 2017

West Ground Surface ADRS Curves

US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

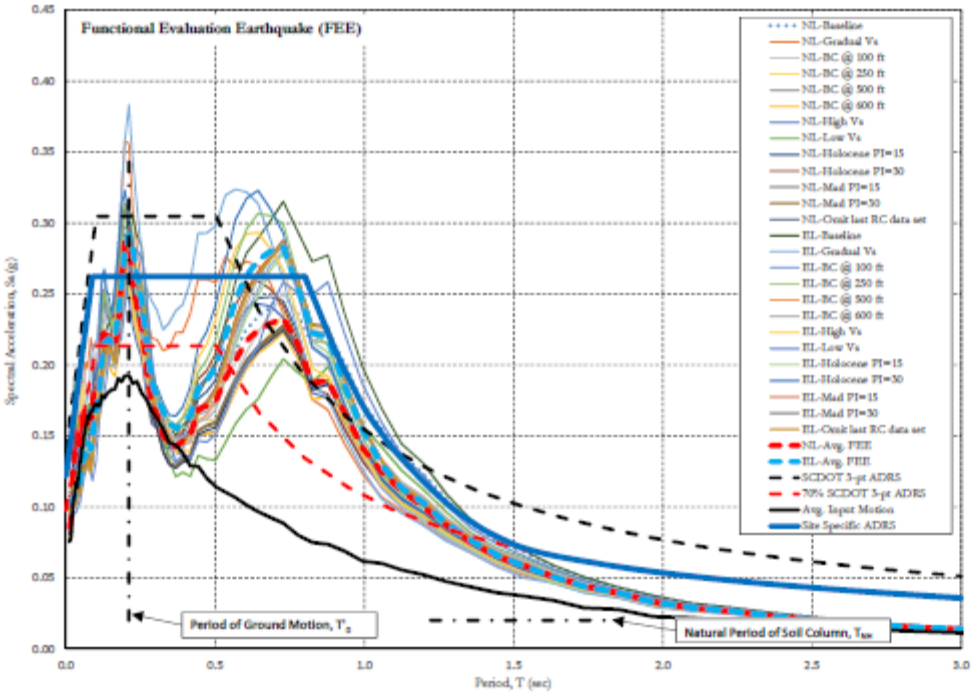
GeoEngineers

Figure 7

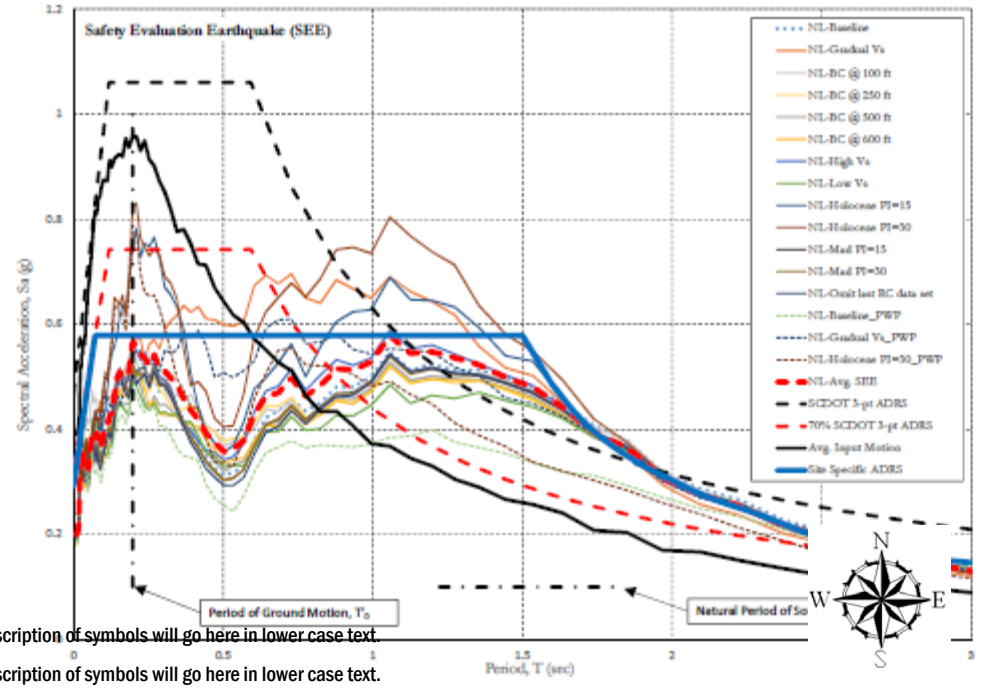
18461-007-01 9/29/17

EAST GROUND SURFACE ADRS CURVES w/o GROUND MODIFICATION

(for end of bridge embankment)



T	Sa
sec	g
0.00	0.12
0.09	0.26
0.20	0.26
0.30	0.26
0.40	0.26
0.50	0.26
0.60	0.26
0.70	0.26
0.80	0.26
0.90	0.21
0.95	0.19
1.00	0.17
1.05	0.15
1.10	0.14
1.15	0.13
1.20	0.12
1.25	0.11
1.30	0.10
1.35	0.09
1.40	0.08
1.50	0.07
1.60	0.07
1.70	0.06
1.80	0.06
1.90	0.06
2.00	0.05
2.10	0.05
2.20	0.05
2.30	0.05
2.40	0.04
2.50	0.04
2.60	0.04
2.70	0.04
2.80	0.04
2.90	0.04
3.00	0.04



T	Sa
sec	g
0.00	0.29
0.07	0.58
0.10	0.58
0.15	0.58
0.20	0.58
0.25	0.58
0.30	0.58
0.35	0.58
0.40	0.58
0.45	0.58
0.50	0.58
0.60	0.58
0.70	0.58
0.80	0.58
0.90	0.58
1.00	0.58
1.10	0.58
1.20	0.58
1.30	0.58
1.40	0.58
1.50	0.58
1.60	0.48
1.70	0.42
1.80	0.37
1.90	0.33
2.00	0.30
2.10	0.28
2.20	0.25
2.30	0.24
2.40	0.21
2.50	0.19
2.60	0.18
2.70	0.17
2.80	0.16
2.90	0.15
3.00	0.15

Description of symbols will go here in lower case text.

Description of symbols will go here in lower case text.

Reference: Site-Specific Seismic Response Analysis Report prepared by F&ME Consultants, Inc dated March 10, 2017

East Ground Surface ADRS Curves

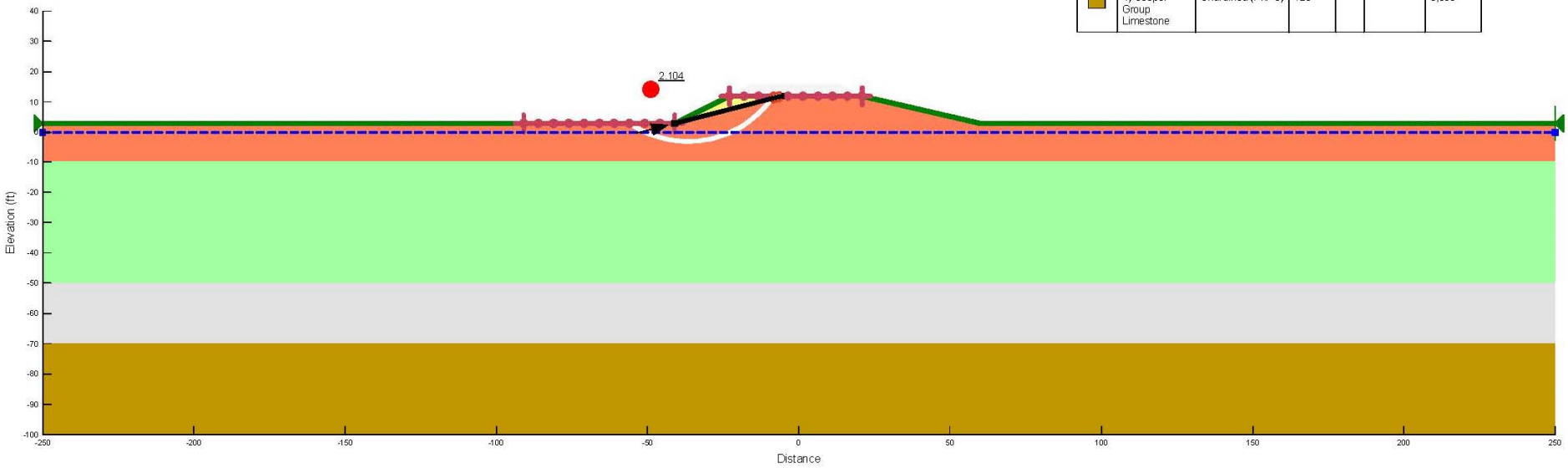
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 8

18461-007-01 9/29/17

Color	Name	Model	Unit Weight (pcf)	Phi' (°)	Tau/Sigma Ratio	Cohesion (psf)
	Compacted Fill	Mohr-Coulomb	125	38		
	1) Silt/Clays	S=f(overburden)	95		0.46	
	2) Sands	Mohr-Coulomb	100	29		
	3) Hawthorn Marl	Undrained (Phi=0)	120			4,000
	4) Cooper Group Limestone	Undrained (Phi=0)	120			6,000



Legend

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

Global Stability - Staged Construction
West Embankment 1 (Station 59+00)

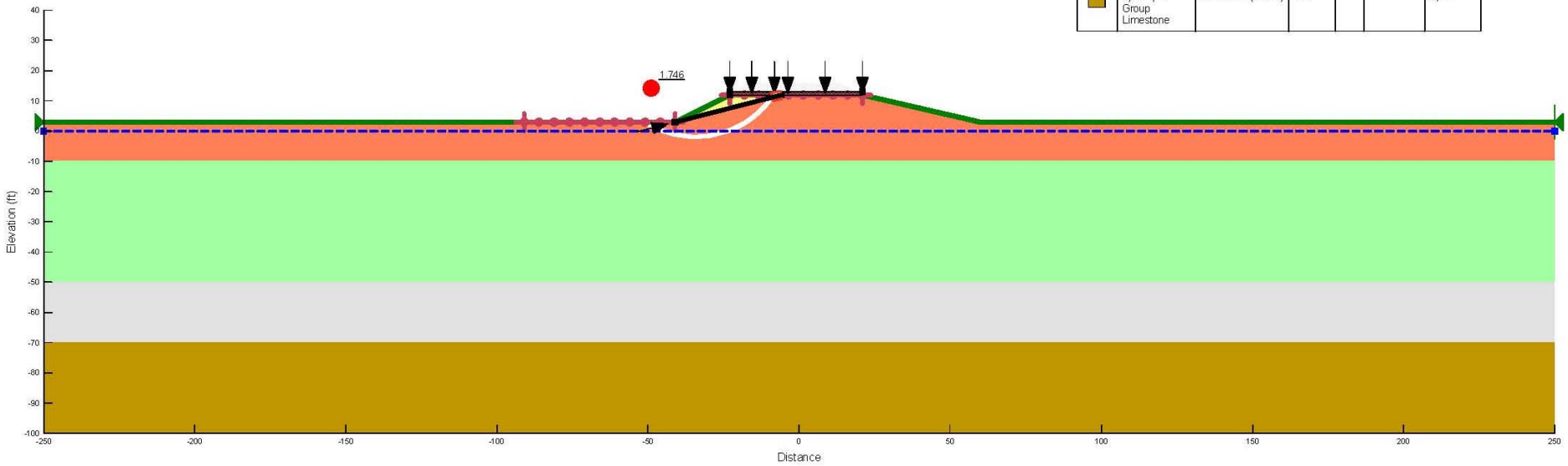
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 9

18461-007-01 Date Exported: 09/28/17

Color	Name	Model	Unit Weight (pcf)	Phi' (°)	Tau/Sigma Ratio	Cohesion (psf)
	Compacted Fill	Mohr-Coulomb	125	38		
	1) Silt/Clays	S=f(overburden)	95		0.46	
	2) Sands	Mohr-Coulomb	100	29		
	3) Hawthorn Marl	Undrained (Phi=0)	120			4,000
	4) Cooper Group Limestone	Undrained (Phi=0)	120			6,000



Legend

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

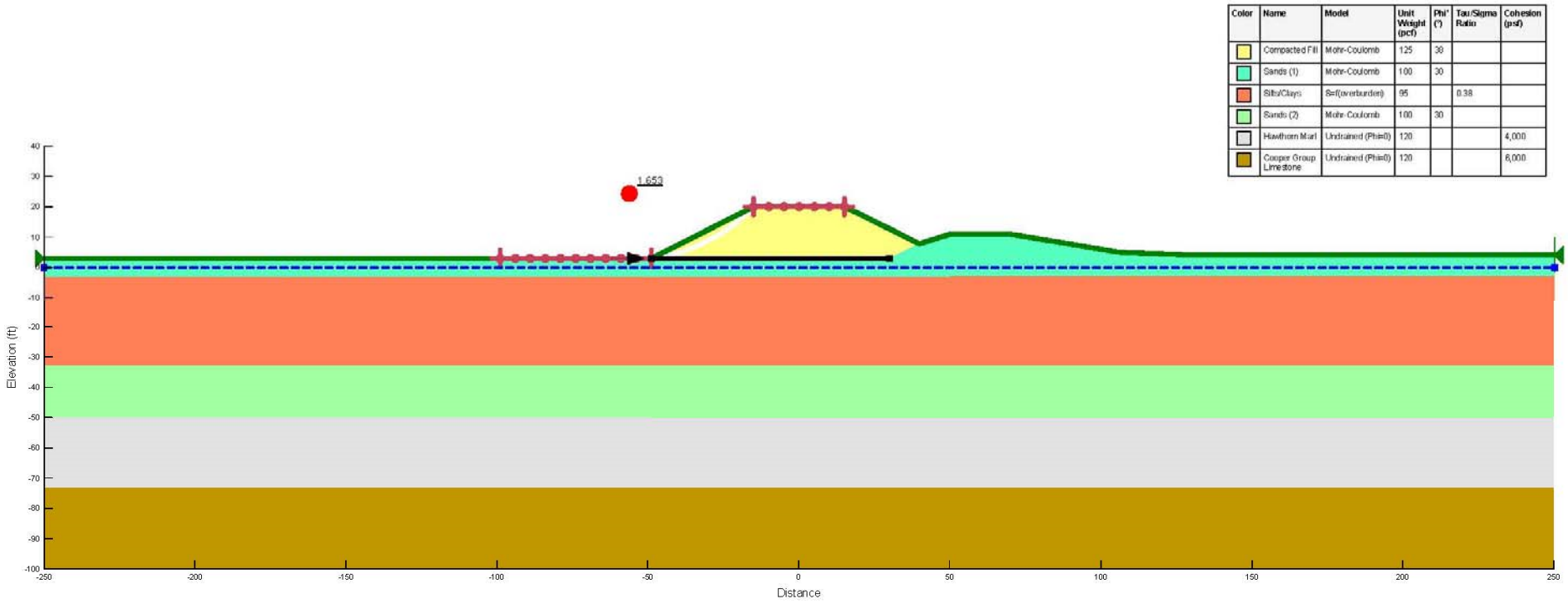
Global Stability - End of Construction
West Embankment 1 (Station 59+00)

US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 10

18461-007-01 Date Exported: 09/28/17



Color	Name	Model	Unit Weight (pcf)	Phi' (°)	Tau/Sigma Ratio	Cohesion (psf)
	Compacted Fill	Mohr-Coulomb	125	30		
	Sands (1)	Mohr-Coulomb	100	30		
	Silts/Clays	Sef(overburden)	95		0.38	
	Sands (2)	Mohr-Coulomb	100	30		
	Hawthorn Marl	Undrained (Phi=0)	120			4,000
	Cooper Group Limestone	Undrained (Phi=0)	120			6,000

Legend

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

Global Stability - Staged Construction
West Embankment 2 (Station 69+00)

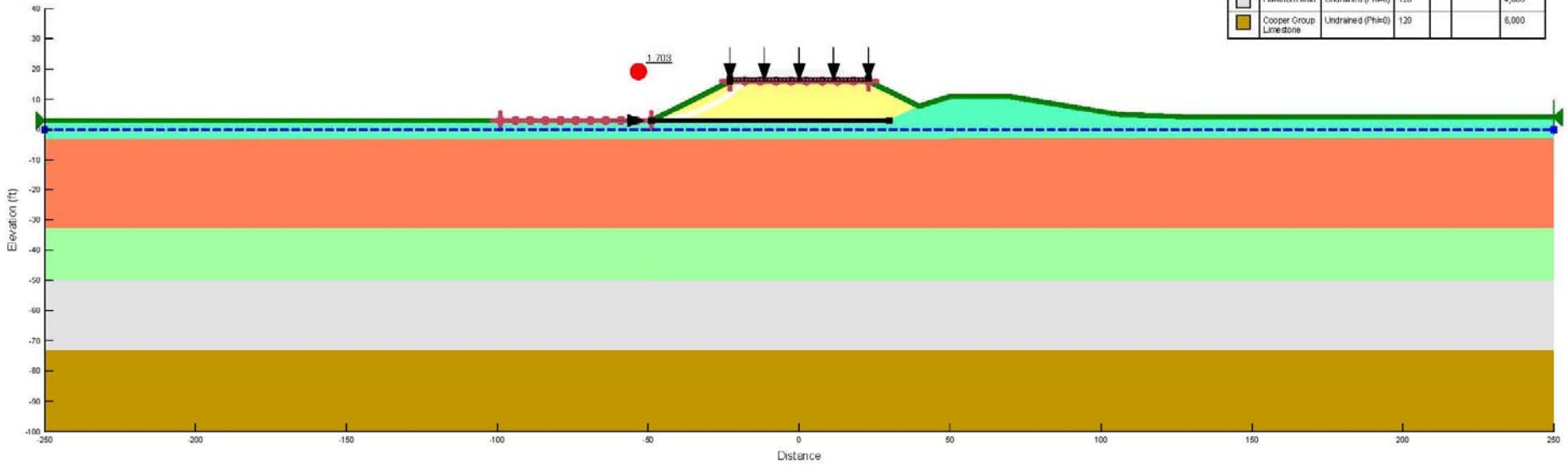
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 11

18461-007-01 Date Exported: 09/28/17

Color	Name	Model	Unit Weight (pcf)	Phi' (°)	Tau/Sigma Ratio	Cohesion (psf)
	Compacted Fill	Mohr-Coulomb	125	38		
	Sands (1)	Mohr-Coulomb	100	30		
	Silts/Clays	S=f(overburden)	95		0.38	
	Sands (2)	Mohr-Coulomb	100	30		
	Hawthorn Marl	Undrained (Phi=0)	120			4,000
	Cooper Group Limestone	Undrained (Phi=0)	120			6,000



Legend

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

Global Stability - End of Construction
West Embankment 2 (Station 69+00)

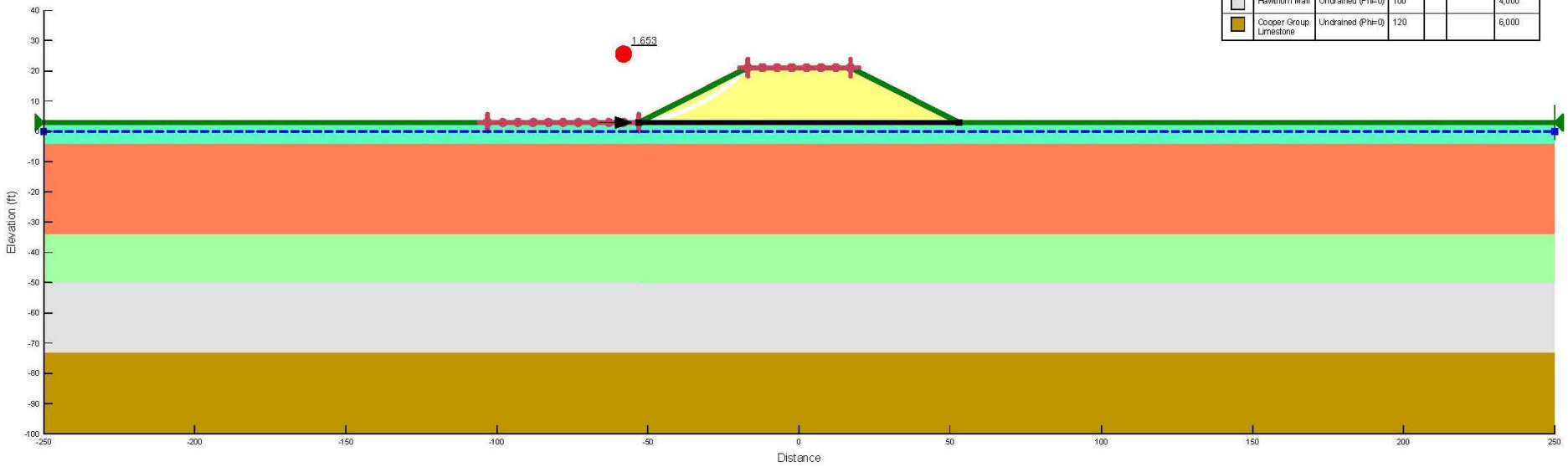
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 12

18461-007-01 Date Exported: 09/28/17

Color	Name	Model	Unit Weight (pcf)	Phi' (°)	Tau/Sigma Ratio	Cohesion (psf)
	Compacted Fill	Mohr-Coulomb	125	38		
	Sands (1)	Mohr-Coulomb	100	30		
	Silts/Clays	S=f(overburden)	95		0.37	
	Sands (2)	Mohr-Coulomb	100	30		
	Hawthorn Marl	Undrained (Phi=0)	100			4,000
	Cooper Group Limestone	Undrained (Phi=0)	120			6,000



Legend

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

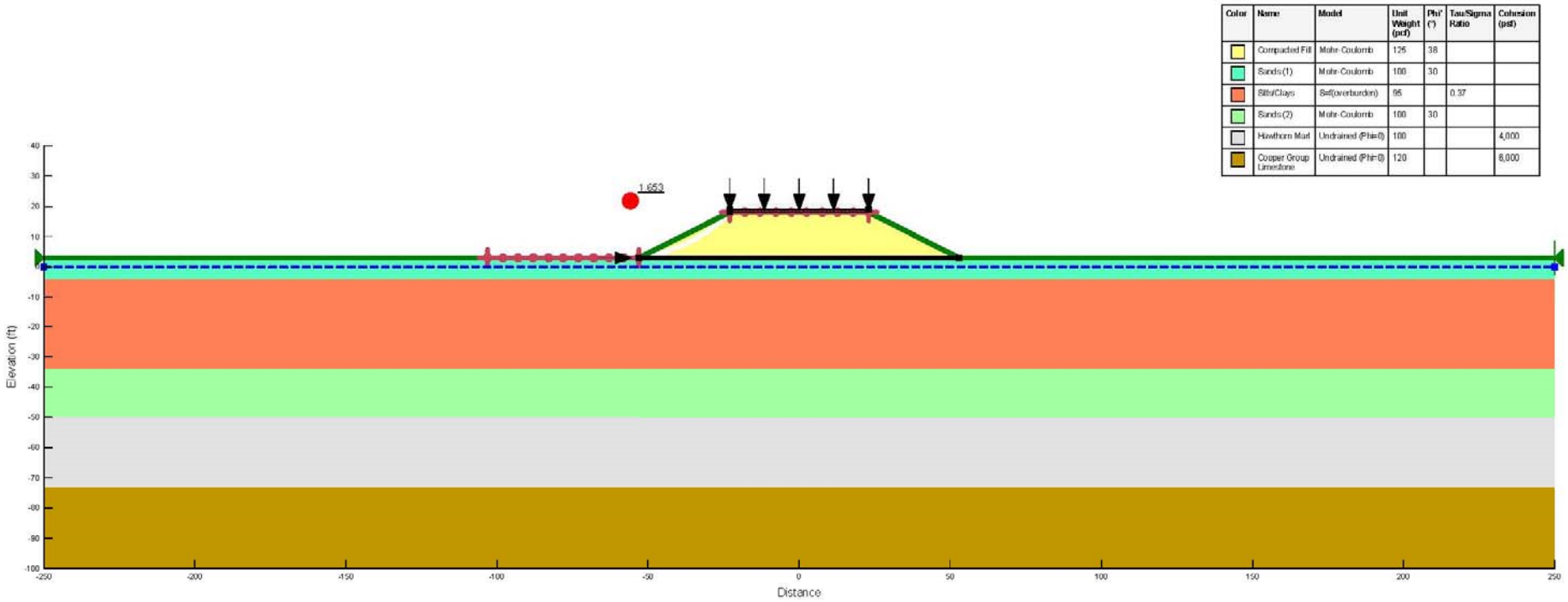
Global Stability - Staged Construction
West Embankment 3 (Station 69+65)

US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 13

18461-007-01 Date Exported: 09/28/17



Legend

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

Global Stability - End of Construction
West Embankment 3 (Station 69+65)

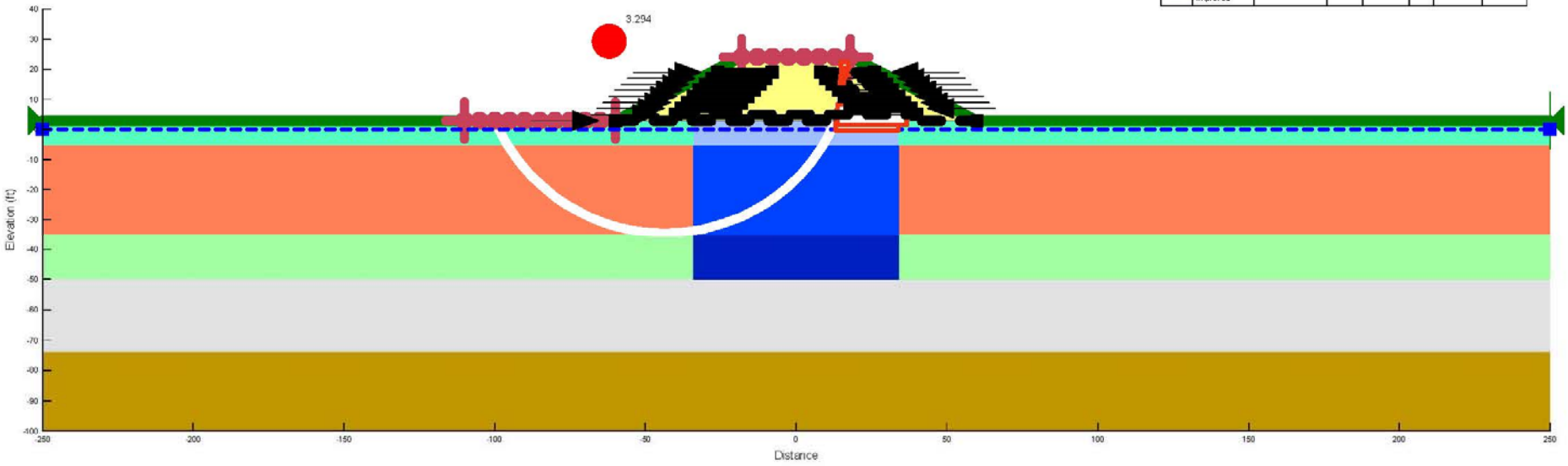
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 14

18461-007-01 Date Exported: 09/28/17

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio	Cohesion (psf)
	Compacted Fill	Mohr-Coulomb	125	0	38		
	Sands (1)	Mohr-Coulomb	100	0	30		
	Silts/Clays	S=f(overburden)	95			0.36	
	Sands (2)	Mohr-Coulomb	100	0	30		
	Hawthorn Marl	Undrained (Phi=0)	120				4,000
	Cooper Group Limestone	Undrained (Phi=0)	120				6,000
	Sands (1) - Improved	Mohr-Coulomb	100	348	30		
	Silts/Clays - Improved	Mohr-Coulomb	95	348	19.8		
	Sands (2) - Improved	Mohr-Coulomb	100	348	30		



Legend

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

Global Stability - Staged Construction (Improved)
West Embankment 4 (Station 70+40)

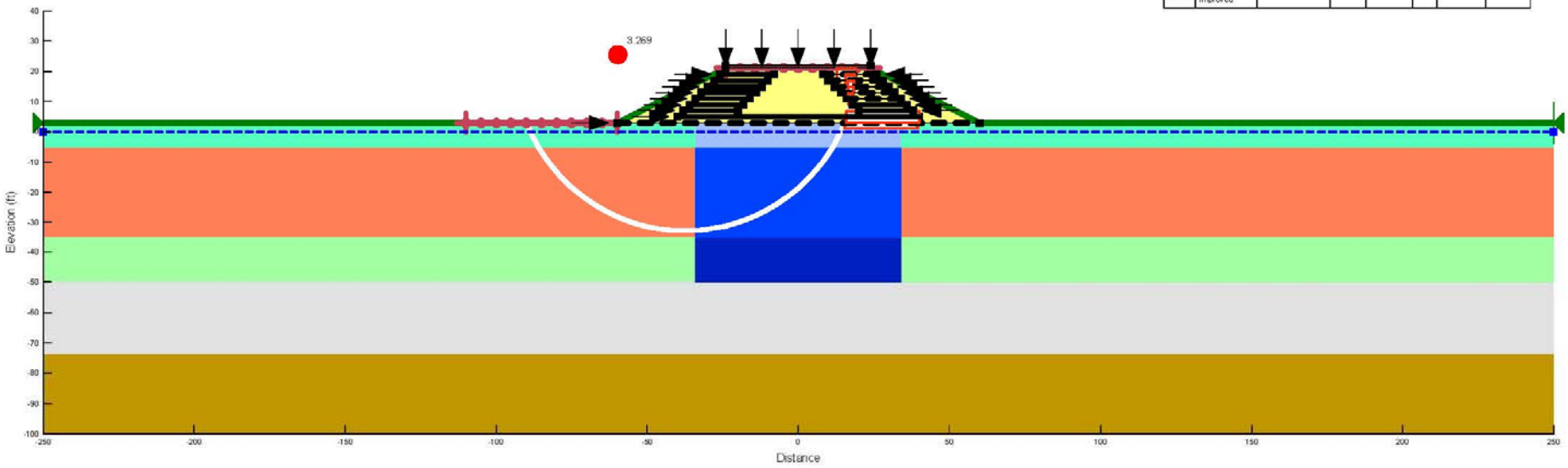
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 15

18461-007-01 Date Exported: 09/28/17

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio	Cohesion (psf)
	Compacted Fill	Mohr-Coulomb	125	0	38		
	Sands (1)	Mohr-Coulomb	100	0	30		
	Silts/Clays	S=f(overburden)	95			0.36	
	Sands (2)	Mohr-Coulomb	100	0	30		
	Hawthorn Marl	Undrained (Phi=0)	120				4,000
	Cooper Group Limestone	Undrained (Phi=0)	120				8,000
	Sands (1) - Improved	Mohr-Coulomb	100	348	30		
	Silts/Clays - Improved	Mohr-Coulomb	95	348	19.8		
	Sands (2) - Improved	Mohr-Coulomb	100	348	30		



Legend

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

Global Stability - End of Construction (Improved)
West Embankment 4 (Station 70+40)

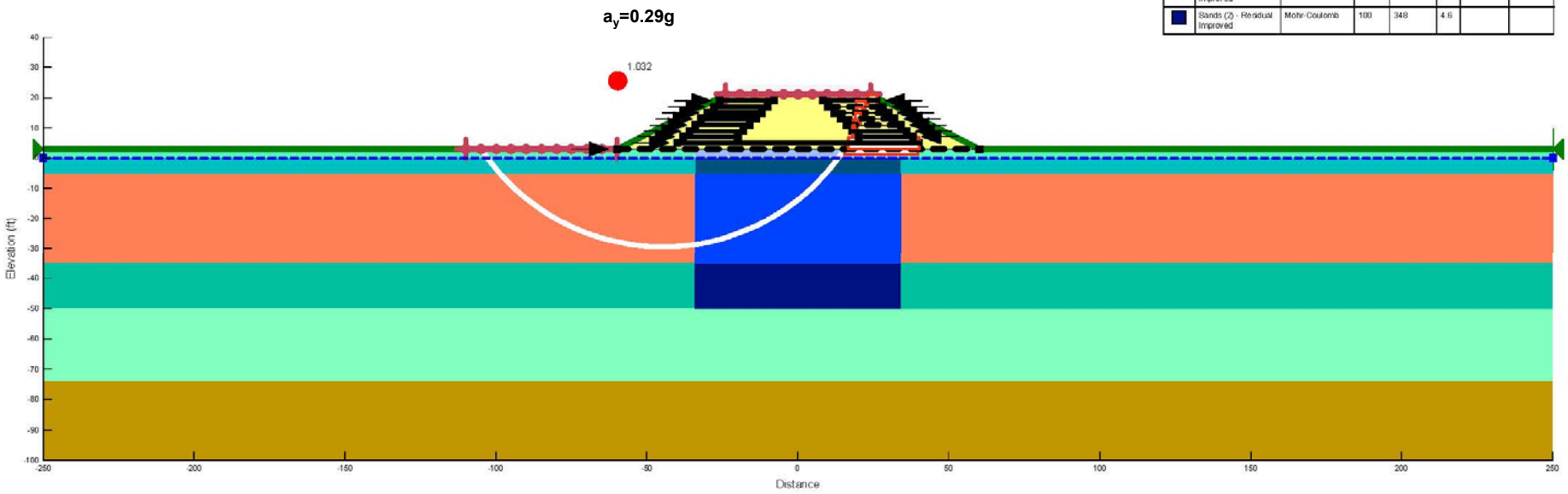
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 16

18461-007-01 Date Exported: 09/28/17

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio	Cohesion (psf)
	Compacted Fill	Mohr-Coulomb	125	0	38		
	Sands (1)	Mohr-Coulomb	100	0	30		
	Silts/Clays	S=f(overburden)	95			0.36	
	Cooper Group Limestone	Undrained (Phi=0)	120				6,000
	Sands (1) - Improved	Mohr-Coulomb	100	348	30		
	Silts/Clays - Improved	Mohr-Coulomb	95	348	19.6		
	Sands (1) - Residual	S=f(overburden)	100			0.09	
	Sands (2) - Readual	S=f(overburden)	100			0.09	
	Hawthorn Marl - Seismic	Undrained (Phi=0)	120				3,400
	Sands (1) - Residual Improved	Mohr-Coulomb	100	348	4.6		
	Sands (2) - Residual Improved	Mohr-Coulomb	100	348	4.6		



Legend

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

Global Stability - Earthquake (Improved)
West Embankment 4 (Station 70+40)

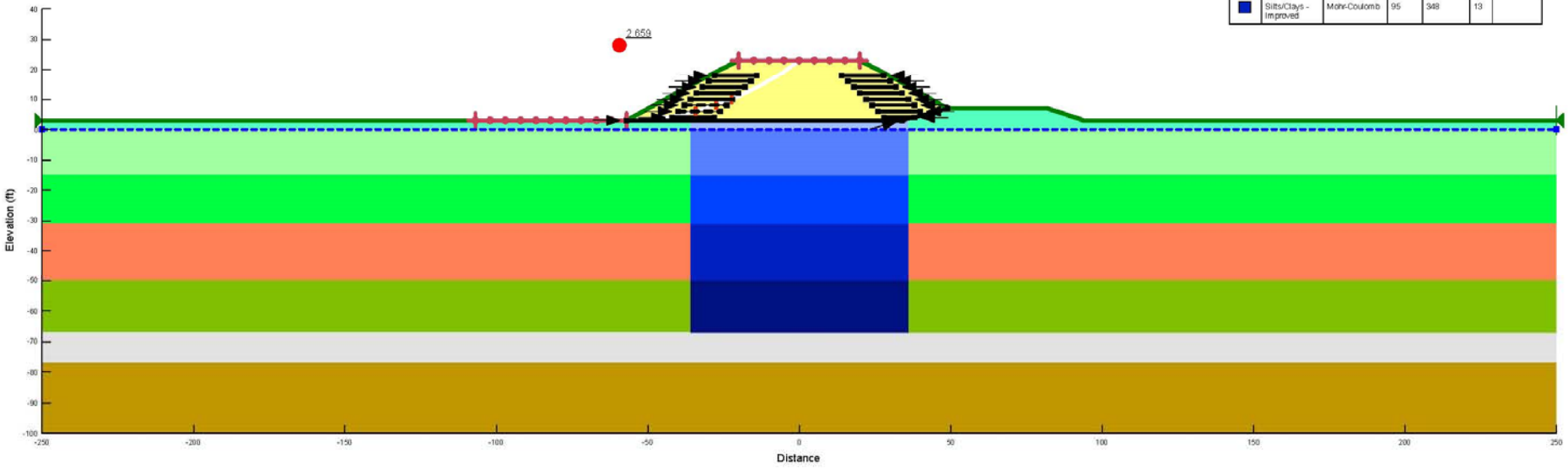
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 17

18461-007-01 Date Exported: 09/28/17

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio
	Compacted Fill	Mohr-Coulomb	125	0	38	
	Sands (1)	Mohr-Coulomb	100	0	30	
	Sands (2)	Mohr-Coulomb	120	0	41	
	Sands (3)	Mohr-Coulomb	100	0	30	
	Silts/Clays	S=f(overburden)	95			0.23
	Sands (4)	Mohr-Coulomb	100	0	30	
	Hawthorn Marl	Mohr-Coulomb	120	4,000	0	
	Cooper Group Limestone	Mohr-Coulomb	120	6,000	0	
	Sands (1) - Improved	Mohr-Coulomb	100	348	30	
	Sands (2) - Improved	Mohr-Coulomb	120	348	41	
	Sands (3) - Improved	Mohr-Coulomb	100	348	30	
	Sands (4) - Improved	Mohr-Coulomb	100	348	30	
	Silts/Clays - Improved	Mohr-Coulomb	95	348	13	



Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

Global Stability - Staged Construction (Improved)
East Embankment 1 (Station 103+80)

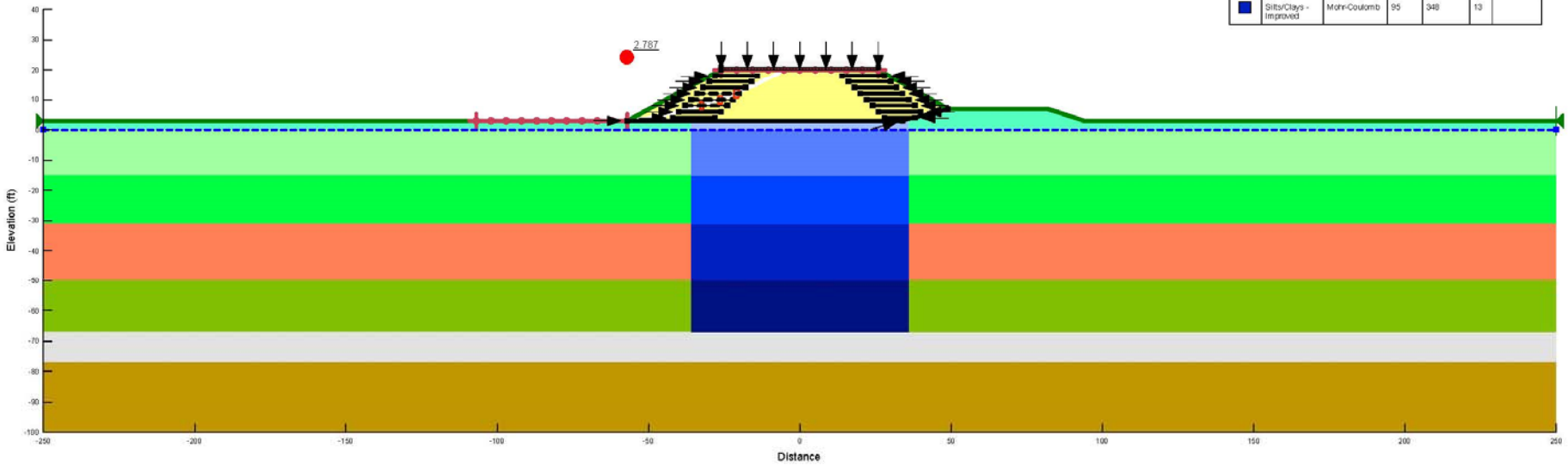
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 18

18461-007-01 Date Exported: 09/28/17

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio
	Compacted Fill	Mohr-Coulomb	125	0	38	
	Sands (1)	Mohr-Coulomb	100	0	30	
	Sands (2)	Mohr-Coulomb	120	0	41	
	Sands (3)	Mohr-Coulomb	100	0	30	
	Silts/Clays	S=f(overburden)	95			0.23
	Sands (4)	Mohr-Coulomb	100	0	30	
	Hawthorn Marl	Mohr-Coulomb	120	4,000	0	
	Cooper Group Limestone	Mohr-Coulomb	130	8,000	0	
	Sands (1) - Improved	Mohr-Coulomb	100	348	30	
	Sands (2) - Improved	Mohr-Coulomb	120	348	41	
	Sands (3) - Improved	Mohr-Coulomb	100	348	30	
	Sands (4) - Improved	Mohr-Coulomb	100	348	30	
	Silts/Clays - Improved	Mohr-Coulomb	95	348	13	



Legend

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

Global Stability - End of Construction (Improved)
East Embankment 1 (Station 103+80)

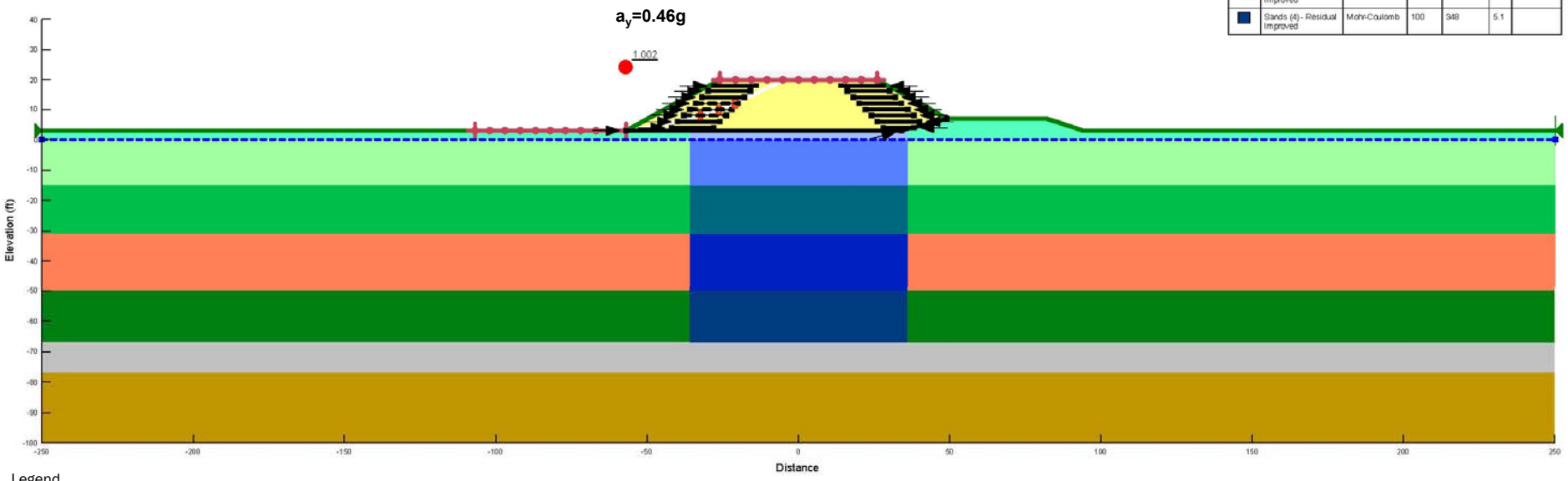
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 19

18461-007-01 Date Exported: 09/28/17

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Tau/Sigma Ratio
	Compacted Fill	Mohr-Coulomb	125	0	38	
	Sands (1)	Mohr-Coulomb	100	0	30	
	Sands (2)	Mohr-Coulomb	120	0	41	
	Silts/Clays	S=f(overburden)	95			0.23
	Cooper Group Limestone	Mohr-Coulomb	120	6,000	0	
	Sands (3) - Residual	S=f(overburden)	100			0.09
	Sands (4) - Residual	S=f(overburden)	100			0.09
	Hawthorn Marl - Seismic	Mohr-Coulomb	120	3,400	0	
	Sands (1) - Improved	Mohr-Coulomb	100	348	30	
	Sands (2) - Improved	Mohr-Coulomb	120	348	41	
	Silts/Clays - Improved	Mohr-Coulomb	95	348	13	
	Sands (3) - Residual Improved	Mohr-Coulomb	100	348	5.1	
	Sands (4) - Residual Improved	Mohr-Coulomb	100	348	5.1	



Legend

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

Global Stability - Earthquake (Improved)
East Embankment 1 (Station 103+80)

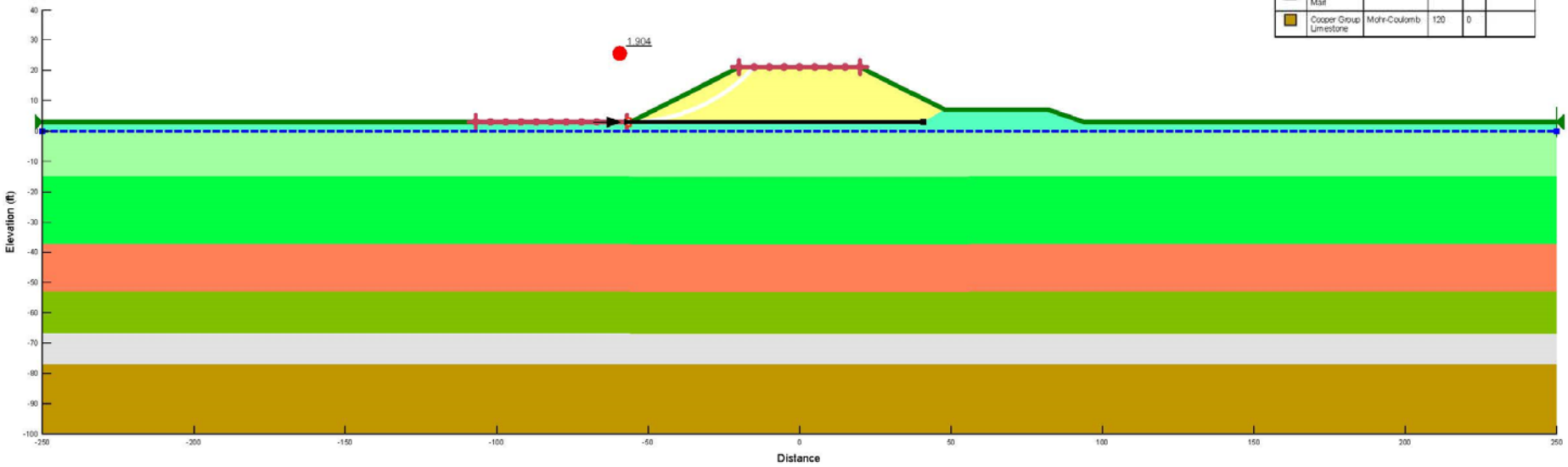
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 20

18461-007-01 Date Exported: 09/28/17

Color	Name	Model	Unit Weight (pcf)	Phi' (°)	Tau/Sigma Ratio
	Compacted Fill	Mohr-Coulomb	125	38	
	Sands (1)	Mohr-Coulomb	100	30	
	Sands (2)	Mohr-Coulomb	120	41	
	Sands (3)	Mohr-Coulomb	100	30	
	Silts/Clays	S=f(overburden)	95		0.22
	Sands (4)	Mohr-Coulomb	100	30	
	Hawthorn Marl	Mohr-Coulomb	120	0	
	Cooper Group Limestone	Mohr-Coulomb	120	0	



Legend

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

Global Stability - Staged Construction
East Embankment 2 (Station 104+55)

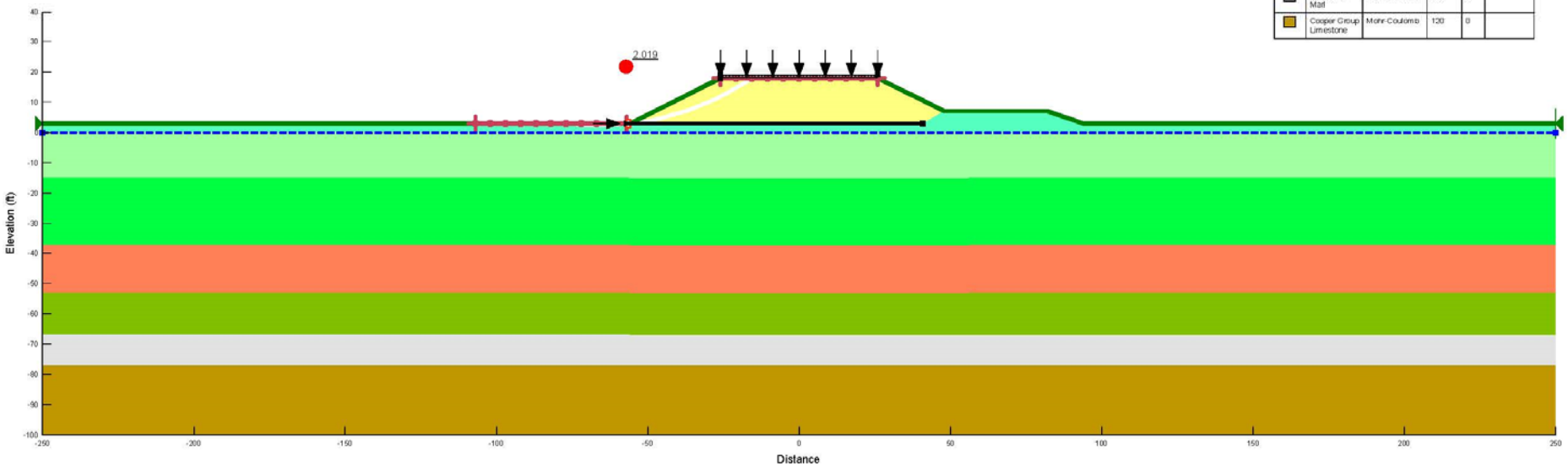
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 21

18461-007-01 Date Exported: 09/28/17

Color	Name	Model	Unit Weight (pcf)	Phi' (°)	Tau/Sigma Ratio
	Compacted Fill	Mohr-Coulomb	125	38	
	Sands (1)	Mohr-Coulomb	100	30	
	Sands (2)	Mohr-Coulomb	120	41	
	Sands (3)	Mohr-Coulomb	100	30	
	Silts/Clays	S=f(overburden)	95		0.22
	Sands (4)	Mohr-Coulomb	100	30	
	Hawthorn Marl	Mohr-Coulomb	120	0	
	Cooper Group Limestone	Mohr-Coulomb	120	0	



Legend

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

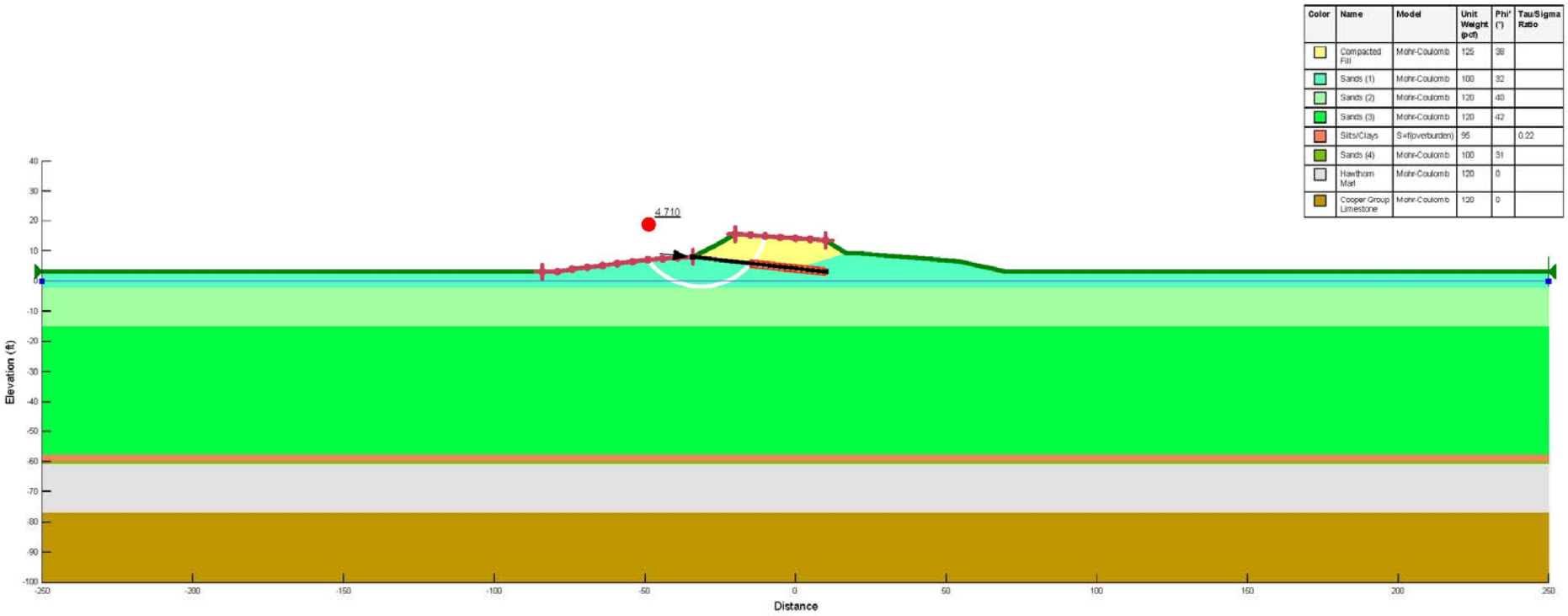
Global Stability - End of Construction
East Embankment 2 (Station 104+55)

US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 22

18461-007-01 Date Exported: 09/28/17



Color	Name	Model	Unit Weight (pcf)	Phi' (°)	Tau/Sigma Ratio
	Compacted Fill	Mohr-Coulomb	125	38	
	Sands (1)	Mohr-Coulomb	100	32	
	Sands (2)	Mohr-Coulomb	120	40	
	Sands (3)	Mohr-Coulomb	120	42	
	Silts/Clays	S=f(overburden)	95		0.22
	Sands (4)	Mohr-Coulomb	100	31	
	Hawthorn Marl	Mohr-Coulomb	120	0	
	Cooper Group Limestone	Mohr-Coulomb	120	0	

Legend

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

Global Stability - Staged Construction
East Embankment 3 (Station 112+00)

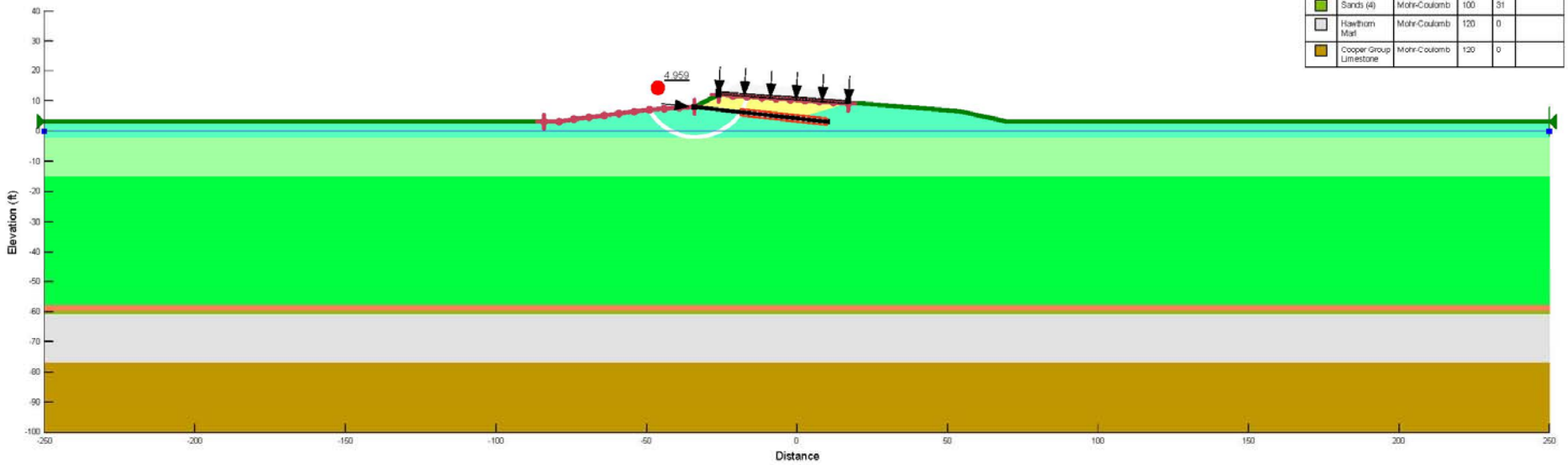
US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 23

18461-007-01 Date Exported: 09/28/17

Color	Name	Model	Unit Weight (pcf)	Phi' (°)	Tau/Sigma Ratio
	Compacted Fill	Mohr-Coulomb	125	38	
	Sands (1)	Mohr-Coulomb	100	32	
	Sands (2)	Mohr-Coulomb	120	40	
	Sands (3)	Mohr-Coulomb	120	42	
	Silts/Clays	S=f(overburden)	95		0.22
	Sands (4)	Mohr-Coulomb	100	31	
	Hawthorn Marl	Mohr-Coulomb	120	0	
	Cooper Group Limestone	Mohr-Coulomb	120	0	



Legend

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: GeoStudio 2016 v. 8.16.1.13452 – Slope/W Analysis

Global Stability - End of Construction
East Embankment 3 (Station 112+00)

US 21 Over Harbor River Bridge Replacement
Beaufort County, South Carolina

GeoEngineers

Figure 24

18461-007-01 Date Exported: 09/28/17

APPENDICES

GeoEngineers

APPENDIX A
Field Explorations

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-1		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	R. Wessinger	**Boring Location:**	45+50	**Offset:**	7.4'-LT	**Alignment:**	ALT 1B
Elev.:	10.9 ft	**Latitude:**	32.408695	**Longitude:**	-80.465492	**Date Started:**	8/26/2014
Total Depth:	125 ft	**Soil Depth:**	125 ft	**Core Depth:**	N/A ft	**Date Completed:**	8/28/2014
Bore Hole Diameter (in):	6	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	82%
Core Size:	N/A	**Driller:**	Independence	**Groundwater:**	**TOB** NR	**24HR**	8.3 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	Road								
	0.8	Asphalt (9.5")		1.0						
		EMBANKMENT FILL		2.0	SS-1	12	14			
		Loose to Very Loose, Moist, Dark Yellowish Brown, Non-Plastic, Strongly Reactive, Poorly Graded Fine to Coarse SAND (SP-SM/A-1-b) with Silt and Gravel and Trace of Organics, Munsell=10YR 4/4		4.0	SS-2	6	4	4	4	8
5.9				6.0	SS-3	5	3	4	4	7
		@SS-3: Organics=1.15%		8.0	SS-4	5	2	4	4	6
		@SS-4: Organics=1.07%		10.0	SS-5	4	2	4	2	6
0.9		@SS-5: Dark Gray, Munsell=5Y 4/1, LL=NP, PL=NP, PI=NP, NMC=19.3%, %#200=7.3		12.0	SS-6	1	1	2	2	3
		@SS-6: Wet, Weakly Reactive		14.0	SS-7	3	2	2	4	4
		@SS-7: Fine Sand, (A-3), LL=NP, PL=NP, PI=NP, NMC=19.2%, %#200=8.0		16.0	SS-8	4	4	4	4	8
-4.1		@SS-8: Organics=0.31%		18.0	SS-9	1	1	1	2	2
	18.0	**ENGINEERED FILL**			SS-10	1	1	1	WOH	2
-9.1		Very Loose, Wet, Dark Gray, Non-Plastic, Weakly Reactive, Poorly Graded Fine SAND (SP/A-3), Munsell=5Y 4/1		23.5	SS-11	1	1	1		2
		@SS-10: LL=NP, PL=NP, PI=NP, NMC=27.4%, %#200=3.3								
-14.1				28.5	SS-12	1	2	2		4
	28.0	**HOLOCENE**								
-19.1		Very Loose, Wet, Very Dark Greenish Gray, Non-Plastic, Weakly Reactive, Poorly Graded Fine SAND (SP-SM/A-3) with Silt and Trace of Shell Fragments, Munsell=5GY 3/1		33.5	SS-13	2	2	2		4
		@SS-12: LL=NP, PL=NP, PI=NP, NMC=34.7%, %#200=7.4								
-24.1				38.5	SS-14	2	1	2		3
-29.1										
		@SS-15: (A-2-4), LL=NP, PL=NP, PI=NP, NMC=33.8%, %#200=11.0		43.5	SS-15		1/12"	1		1
-34.1	46.5									

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-1		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	R. Wessinger	**Boring Location:**	45+50	**Offset:**	7.4'-LT	**Alignment:**	ALT 1B
Elev.:	10.9 ft	**Latitude:**	32.408695	**Longitude:**	-80.465492	**Date Started:**	8/26/2014
Total Depth:	125 ft	**Soil Depth:**	125 ft	**Core Depth:**	N/A ft	**Date Completed:**	8/28/2014
Bore Hole Diameter (in):	6	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	82%
Core Size:	N/A	**Driller:**	Independence	**Groundwater:**	**TOB** NR	**24HR**	8.3 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	Notes
		Very Loose, Wet, Very Dark Greenish Gray, Non-Plastic, Weakly Reactive, Silty Fine SAND (SM/A-2-4), Munsell=5GY 3/1	48.5	SS-16	WOH/12"				1	
-39.1	51.0	@SS-16: LL=NP, PL=NP, PI=NP, NMC=59.0%, %#200=33.2								
		HAWTHORN MARL Stiff, Moist, Very Dark Greenish Olive, Low to Medium Plasticity, Weakly Reactive, SILT (ML/A-4) with Phosphate Nodules/Lenses, Munsell=5GY 3/2	53.5	SS-17	2	4	10		14	
-44.1		@SS-18: Hard	55.0	SS-18	4	26	8		34	*For Hammer Calibration*
		@SS-19: Firm to Stiff	58.5	SS-19	3	3	4		7	
-49.1										
			63.5	SS-20	3	3	3		6	
-54.1			65.0	SS-21	3	3	4		7	*For Hammer Calibration*
			66.5	SS-22	3	5	5		10	*For Hammer Calibration*
			68.5	SS-23	5	5	7		12	
-59.1										
			73.5	SS-24	2	4	7		11	
-64.1										
	79.5	@SS-25: Very Stiff	78.5	SS-25	5	5	18		23	
-69.1		**COOPER GROUP LIMESTONE** Medium Dense, Moist, Light Greenish Gray, Non-Plastic to Low Plasticity, Strongly Reactive, Silty Fine to Coarse SAND (SM/A-2-4) with Phosphate Nodules and Trace of Shell Fragments, Munsell=5GY 7/1	83.5	SS-26	4	1	2		3	
-74.1		@SS-26: Very Loose to Loose								
			88.5	SS-27	3	3	7		10	
-79.1										

● SPT N VALUE ●

PL MC LL

▲ FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-1
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	R. Wessinger	**Boring Location:**	45+50	**Offset:**	7.4'-LT	**Alignment:**	ALT 1B
Elev.:	10.9 ft	**Latitude:**	32.408695	**Longitude:**	-80.465492	**Date Started:**	8/26/2014
Total Depth:	125 ft	**Soil Depth:**	125 ft	**Core Depth:**	N/A ft	**Date Completed:**	8/28/2014
Bore Hole Diameter (in):	6	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	82%
Core Size:	N/A	**Driller:**	Independence	**Groundwater:**	**TOB** NR	**24HR**	8.3 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Medium Dense to Loose, Moist, Light Greenish Gray, Non-Plastic to Low Plasticity, Strongly Reactive, Silty Fine to Coarse SAND (SM/A-2-4) with Phosphate Nodules and Trace of Shell Fragments, Munsell=5GY 7/1		93.5	SS-28	2	4	7		11
-84.1										
-89.1				100.0	SS-29	6	12	13		25
				103.5	SS-30	2	5	5		10
-94.1										
				108.5	SS-31	2	4	5		9
-99.1										
		@SS-32: No Phosphate Nodules or Shell Fragments		113.5	SS-32	3	4	8		12
-104.1										
				118.5	SS-33	4	5	7		12
-109.1										
				123.5	SS-34	6	8	8		16
-114.1	125.0	Boring Terminated at 125.0 Feet								
-119.1										
-124.1										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-2		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	R. Wessinger	**Boring Location:**	109+84	**Offset:**	28.4'-RT	**Alignment:**	ALT 1B
Elev.:	8.6 ft	**Latitude:**	32.401896	**Longitude:**	-80.446292	**Date Started:**	9/2/2014
Total Depth:	125 ft	**Soil Depth:**	125 ft	**Core Depth:**	N/A ft	**Date Completed:**	9/3/2014
Bore Hole Diameter (in):	6	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	82%
Core Size:	N/A	**Driller:**	Independence	**Groundwater:**	**TOB** NR	**24HR**	5.9 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	Road								
	1.0	Asphalt (11.5")		1.0						
		EMBANKMENT FILL		2.0	SS-1	11	15			
		Medium Dense to Loose, Dry to Moist, Very Pale Brown, Non-Plastic, Weakly Reactive, Poorly Graded Fine SAND (SP/A-3) with Trace of Organics, Munsell=10YR 7/3		4.0	SS-2	9	10	10	10	20
3.6				6.0	SS-3	3	4	2	2	6
		@SS-3: Dark Olive Brown, Munsell=2.5Y 3/3, Organics=0.56%		8.0	SS-4	1/12"	1	1		1
		@SS-4: Very Loose, Wet, Very Dark Grayish Brown, Munsell=2.5Y 3/2, LL=NP, PL=NP, PI=NP, NMC=28.7%, %#200=4.9		10.0	SS-5	7	6	5	4	11
-1.4				12.0	SS-6	3	4	14	16	18
		@SS-5: Medium Dense to Dense, LL=NP, PL=NP, PI=NP, NMC=27.9%, %#200=2.5		14.0	SS-7	4	10	20	23	30
-6.4		@SS-6: Organics=0.45%		16.0	SS-8	8	18	20	17	38
				18.0	SS-9	6	11	10	8	21
	18.0	**ENGINEERED FILL**			SS-10	3	3	4	8	7
-11.4		Loose to Very Loose, Wet, Gray, Non-Plastic, Weakly Reactive, Fine SAND (SP-SM/A-3) with Silt and Trace of Organics, Munsell=5Y 5/1		23.5	SS-11	WOH/18"				WOH
		@SS-10: LL=NP, PL=NP, PI=NP, NMC=26.5%, %#200=6.3								
-16.4				28.5	SS-12	1/12"	1			1
	27.0	@SS-11: Very Dark Greenish Gray, Munsell=5GY 3/1, Organics=1.25%								
		HOLOCENE		33.5	SS-13	1	2	2		4
-21.4		Very Loose, Wet, Very Dark Greenish Gray, Non-Plastic, Weakly Reactive, Silty Fine SAND (SM/A-2-4), Munsell=5GY 3/1								
		@SS-12: LL=NP, PL=NP, PI=NP, NMC=30.3%, %#200=14.0		38.5	SS-14	1	3	1		4
-26.4										
	37.0			43.5	SS-15	3	9	10		19
		Very Loose, Wet, Dark Gray, Non-Plastic, Weakly Reactive, Poorly Graded Fine SAND (SP-SM/A-3) with Silt and Trace of Shell Fragments, Munsell=10Y 4/1								
-31.4		@SS-14: LL=NP, PL=NP, PI=NP, NMC=29.3%, %#200=8.8		48.5	SS-16	2	3	4		7
		@SS-15: Medium Dense to Loose								
-36.4										
-41.4										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-2		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	R. Wessinger	**Boring Location:**	109+84	**Offset:**	28.4'-RT	**Alignment:**	ALT 1B
Elev.:	8.6 ft	**Latitude:**	32.401896	**Longitude:**	-80.446292	**Date Started:**	9/2/2014
Total Depth:	125 ft	**Soil Depth:**	125 ft	**Core Depth:**	N/A ft	**Date Completed:**	9/3/2014
Bore Hole Diameter (in):	6	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	82%
Core Size:	N/A	**Driller:**	Independence	**Groundwater:**	**TOB** NR	**24HR**	5.9 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Medium Dense, Wet, Dark Gray, Non-Plastic, Weakly Reactive, Poorly Graded Fine SAND (SP-SM/A-3) with Silt and Trace of Shell Fragments, Munsell=10Y 4/1	53.5	SS-17	2	4	7		11
-46.4		@SS-17: Very Dark Grayish Green, Munsell=5Y 3/2, LL=NP, PL=NP, PI=NP, NMC=28.4%, %#200=10.0							
		@SS-18: Very Loose	58.5	SS-18	1	1	1		2
-51.4	62.0								
		Very Soft, Wet, Very Dark Gray, Low to Medium Plasticity, Weakly Reactive, CLAY (CL/A-6), Munsell=5Y 3/1	63.5	SS-19	WOH/12"		1		1
-56.4	67.0								
		Loose, Wet, Dark Gray, Non-Plastic, Weakly Reactive, Fine SAND (SP-SM/A-3) with Silt, Munsell=5Y 4/1	68.5	SS-20	1	3	4		7
-61.4									
	74.0		73.5	SS-21	1	2	3		5
-66.4		**HAWTHORN MARL**							
		Firm to Soft, Moist, Dark Olive Gray, Non-Plastic to Low Plasticity, Weakly Reactive, SILT (ML/A-4), Munsell=5Y 3/2	78.5	SS-22	1	1	4		5
-71.4									
		@SS-23: Strongly Reactive	83.5	SS-23	2	2	2		4
-76.4	87.0								
		COOPER GROUP LIMESTONE	88.5	SS-24	20	26	6		32
		Dense, Moist, Olive, Non-Plastic, Strongly Reactive, Silty Fine to Coarse SAND (SM/A-2-4) with Phosphate Nodules/Lenses, Munsell=5Y 4/3							
-81.4									
		@SS-25: Loose to Very Loose, Light Olive Gray, Munsell=5Y 6/2	93.5	SS-25	1	1	4		5
-86.4									
		@SS-26: Greenish Gray, Munsell=10Y 6/1	98.5	SS-26	2	2	4		6
-91.4									

● SPT N VALUE ●

PL MC LL

▲ FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-2		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	R. Wessinger	**Boring Location:**	109+84	**Offset:**	28.4'-RT	**Alignment:**	ALT 1B
Elev.:	8.6 ft	**Latitude:**	32.401896	**Longitude:**	-80.446292	**Date Started:**	9/2/2014
Total Depth:	125 ft	**Soil Depth:**	125 ft	**Core Depth:**	N/A ft	**Date Completed:**	9/3/2014
Bore Hole Diameter (in):	6	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	82%
Core Size:	N/A	**Driller:**	Independence	**Groundwater:**	**TOB** NR	**24HR**	5.9 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Very Loose to Loose, Moist, Olive, Non-Plastic, Strongly Reactive, Silty Fine to Coarse SAND (SM/A-2-4) with Phosphate Nodules/Lenses, Munsell=5Y 4/3		103.5	SS-27	1	2	2		4
-96.4				108.5	SS-28	1	2	5		7
-101.4				113.5	SS-29	1	4	6		10
-106.4				118.5	SS-30	2	2	5		7
-111.4				123.5	SS-31	2	3	4		7
-116.4	125.0	Boring Terminated at 125.0 Feet								
-121.4										
-126.4										
-131.4										
-136.4										
-141.4										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-3		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	J. Stewart	**Boring Location:**	39+79	**Offset:**	81.5'-LT	**Alignment:**	ALT 1B
Elev.:	2.5 ft	**Latitude:**	32.409483	**Longitude:**	-80.467111	**Date Started:**	9/15/2015
Total Depth:	80 ft	**Soil Depth:**	80 ft	**Core Depth:**	N/A ft	**Date Completed:**	9/15/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Deidrich D-25	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	80%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0.5 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	Marsh								
		HOLOCENE		0.0	SS-1	WOR/12"	WOH/12"			WOH
		Very Loose, Wet, Black, Non-Plastic, Silty Fine SAND (SM/A-4(0)), Munsell=GLEY1 2.5/N		2.0	SS-2	WOR/24"				WOH
	4.0	@SS-1: LL=NP, PL=NP, PI=NP, NMC=36.9%, %#200=37.5		4.0	SS-3	WOR/24"				WOH
-2.5		@SS-2: No Recovery		6.0	SS-4	WOR/24"				WOH
		Very Soft, Wet, Black, High Plasticity, Elastic SILT (MH/A-7-5(36)) with Trace of Organics, Munsell=GLEY1 2.5/N		8.0	SS-5	WOR/18"	1			WOH
	9.8	@SS-3: Organics=3.55%								
-7.5		@SS-4: LL=74, PL=49, PI=25, NMC=151.6%, %#200=98.5		13.5	SS-6	12	8	8		16
		Very Loose, Wet, Dark Greenish Gray, Non-Plastic, Poorly Graded Fine SAND (SP-SM/A-3) with Silt, Munsell=GLEY1 4/10Y								
-12.5		@SS-6: Medium Dense, Greenish Gray, Moist, Munsell=GLEY1 5/N, LL=NP, PL=NP, PI=NP, NMC=26.1%, %#200=7.7		18.5	SS-7	1	1/12"			1
	19.5	@SS-7: Very Loose, Moist to Wet								
-17.5		Very Loose, Moist to Wet, Black, Non-Plastic, Silty Fine to Coarse SAND (SM/A-2-4) with Gravel and Shells, Munsell=GLEY1 2.5N		23.5	SS-8	1/12"		1		1
-22.5		@SS-8: Very Dark Greenish Gray, Munsell=GLEY1 3/10Y, LL=NP, PL=NP, PI=NP, NMC=29.3%, %#200=24.5								
	28.5			28.5	SS-9	WOH/18"				WOH
-27.5		Very Soft, Moist to Wet, Very Dark Greenish Gray, High Plasticity, Elastic SILT (MH/A-7-5(32)) with Trace of Shells, Munsell=GLEY1 3/10Y								
		@SS-9: LL=58, PL=31, PI=27, NMC=101.1%, %#200=96.6		33.5	SS-10	WOH/18"				WOH
	33.5									
-32.5		Very Loose, Moist to Wet, Very Dark Greenish Gray, Non-Plastic, Poorly Graded Fine SAND (SP-SM/A-3) with Silt and Trace of Shells, Munsell=GLEY1 3/10Y		38.5	SS-11	WOH	1	2		3
		@SS-11: LL=NP, PL=NP, PI=NP, NMC=30.2%, %#200=10.4								
-37.5										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-3		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	J. Stewart	**Boring Location:**	39+79	**Offset:**	81.5'-LT	**Alignment:**	ALT 1B
Elev.:	2.5 ft	**Latitude:**	32.409483	**Longitude:**	-80.467111	**Date Started:**	9/15/2015
Total Depth:	80 ft	**Soil Depth:**	80 ft	**Core Depth:**	N/A ft	**Date Completed:**	9/15/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Deidrich D-25	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	80%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0.5 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Very Loose, Moist to Wet, Dark Gray, Non-Plastic, Poorly Graded Fine SAND (SP-SM/A-3) with Silt and Trace of Shells, Munsell=GLEY1 4/N	43.5	SS-12	4	3	1		4
-42.5	46.0	**HAWTHORN MARL**							
		Firm to Soft, Moist, Dark Grayish Olive, Non-Plastic to Low Plasticity, SILT (ML/A-4), Munsell=10Y 4/2	48.5	SS-13	2	3	4		7
-47.5									
		@SS-14: Very Dark Grayish Brown, Munsell=10YR 3/2	53.5	SS-14	1	2	2		4
-52.5									
			58.5	SS-15	2	3	4		7
-57.5									
			63.5	SS-16	2	2	3		5
-62.5									
		@SS-17: Stiff, Olive Brown, Munsell=2.5Y 4/4	68.5	SS-17	4	4	6		10
-67.5	71.0	**COOPER GROUP LIMESTONE**							
		Stiff to Firm, Moist, Light Greenish Gray, Non-Plastic, Strongly Reactive, SILT (ML/A-4) with Sand, Munsell=GLEY1 7/5GY	73.5	SS-18	4	5	3		8
-72.5	75.0	Loose, Moist, Light Gray/Black, Non-Plastic, Strongly Reactive, Silty Fine to Medium SAND (SM/A-2-4) with Trace of Shells, Munsell=GLEY1 7/N and 2.5/N	78.5	SS-19	4	2	4		6
-77.5	80.0	@SS-19: Light Greenish Gray, Munsell=GLEY1 7/5GY							
		Boring Terminated at 80.0 feet							

● SPT N VALUE ●

PL MC LL

▲ FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-4
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	R. Wessinger	**Boring Location:**	53+45	**Offset:**	92.6'-LT	**Alignment:**	ALT 1B
Elev.:	2.4 ft	**Latitude:**	32.408077	**Longitude:**	-80.463008	**Date Started:**	9/16/2015
Total Depth:	80 ft	**Soil Depth:**	80 ft	**Core Depth:**	N/A ft	**Date Completed:**	9/16/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Deidrich D-25	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	80%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 2 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	Marsh		0.0	SS-1	WOH/12"				1
		HOLOCENE		2.0						
		▽Very Loose, Wet, Dark Grayish Brown, Non-Plastic, Silty Fine SAND (SM/A-2-4) with Trace of Organics, Munsell=2.5Y 4/2			SS-2	WOH/12"			1	1
		@SS-2: LL=NP, PL=NP, PI=NP, NMC=52.5%, %#200=31.9		4.0	SS-3	WOH/24"				WOH
-2.6	5.0	@SS-3: Organics=2.68%		6.0	SS-4	WOH/24"				WOH
	7.5	Very Soft, Wet, Dark Olive Gray, Medium to High Plasticity, CLAY (CL/A-7) with Trace of Shells, Munsell=5Y 3/2		8.0	SS-5	WOH	1/12"		1	1
-7.6		Very Loose to Loose, Wet, Dark Gray, Non-Plastic, Silty Fine SAND (SM/A-2-4), Munsell=5Y 4/1								
		@SS-5: LL=NP, PL=NP, PI=NP, NMC=32.9%, %#200=26.0		13.5	SS-6	1	1	1		2
-12.6		@SS-6: LL=NP, PL=NP, PI=NP, NMC=31.8%, %#200=15.1								
		@SS-7: Olive Gray, Munsell=5Y 5/2		18.5	SS-7	2	3	2		5
-17.6										
		@SS-8: Dark Olive Gray, with Trace of Shells, Munsell=5Y 3/2, LL=NP, PL=NP, PI=NP, NMC=27.8%, %#200=22.0		23.5	SS-8	2	2	1		3
-22.6										
		@SS-9: Greenish Gray, Munsell=GLEY1 5/1		28.5	SS-9	1	2	1		3
-27.6										
		@SS-10: LL=NP, PL=NP, PI=NP, NMC=35.8%, %#200=21.6		33.5	SS-10	WOH	1	1		2
-32.6										
				38.5	SS-11	WOH/18"				WOH
-37.6										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-4		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	R. Wessinger	**Boring Location:**	53+45	**Offset:**	92.6'-LT	**Alignment:**	ALT 1B
Elev.:	2.4 ft	**Latitude:**	32.408077	**Longitude:**	-80.463008	**Date Started:**	9/16/2015
Total Depth:	80 ft	**Soil Depth:**	80 ft	**Core Depth:**	N/A ft	**Date Completed:**	9/16/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Deidrich D-25	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	80%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 2 ft	**24HR**	TIDAL

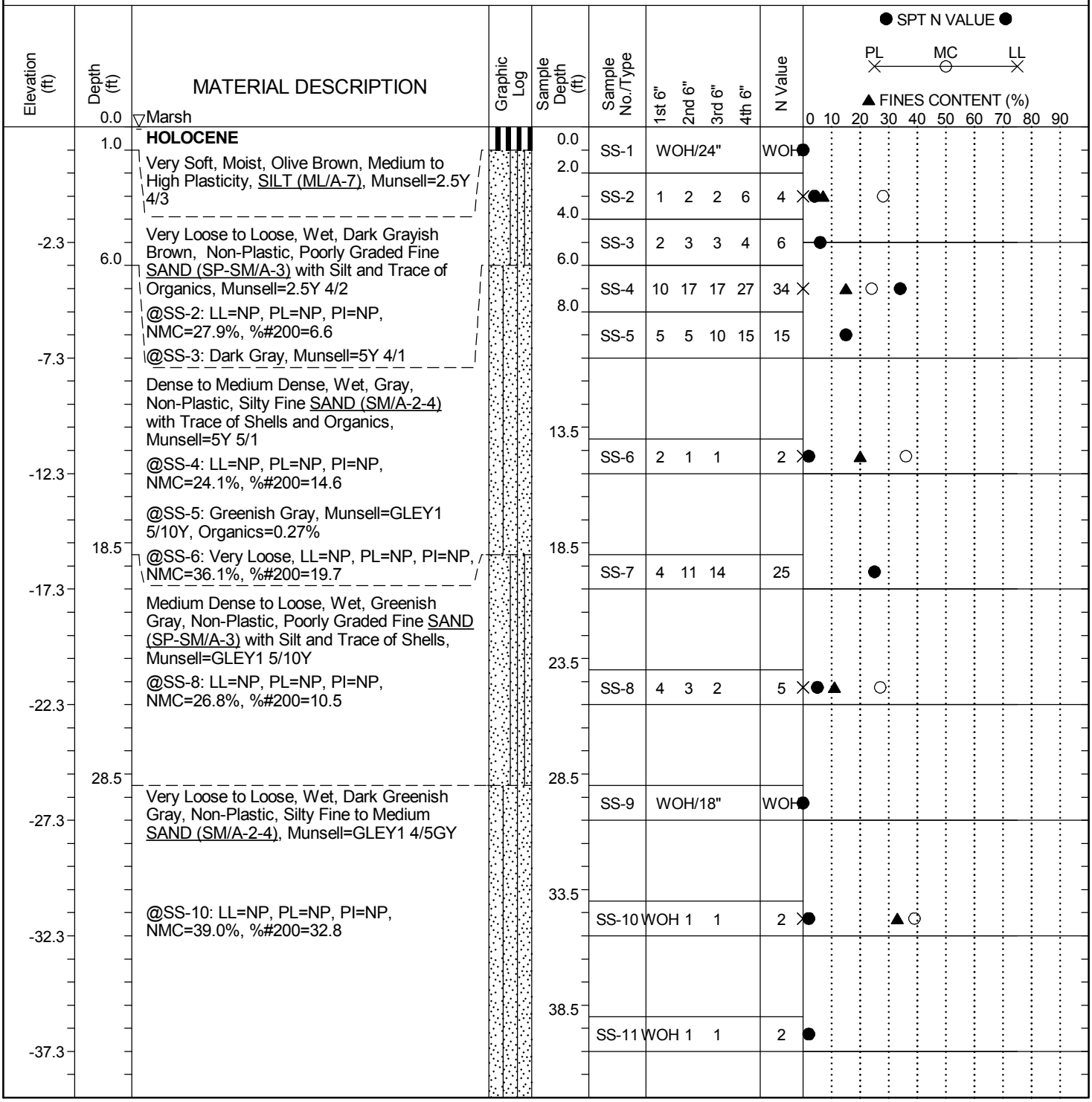
Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		Very Loose, Wet, Greenish Gray, Non-Plastic, Silty Fine SAND (SM/A-2-4), Munsell=GLEY1 5/1	43.5	SS-12	1	2	2		4	
-42.6			48.5	SS-13	2	1	1		2	
-47.6		@SS-13: LL=NP, PL=NP, PI=NP, NMC=31.8%, %#200=17.0								
	51.0	**HAWTHORN MARL**								
		Very Soft to Soft, Wet, Olive Gray, Non-Plastic, SILT (ML/A-4) with Sand, Calcaceous, Munsell=5Y 4/2	53.5	SS-14	2	2	2		4	
-52.6			58.5	SS-15	1	3	4		7	
	58.5	Firm, Moist, Dark Olive Gray, High Plasticity, Sandy Elastic SILT (MH/A-7-5(16)), Calcaceous, Munsell=5Y 3/2								
-57.6			63.5	SS-16	3	3	4		7	
-62.6		@SS-16: Very Dark Grayish Brown, Munsell=2.5Y 3/2, LL=71, PL=35, PI=26, NMC=64.5%, %#200=53.1								
			68.5	SS-17	2	2	4		6	*Lost Casing Shoe, Switched to*
-67.6		@SS-17: Olive Gray, Munsell=5Y 4/2								
	72.5	**COOPER GROUP LIMESTONE**	73.5	SS-18	50/5"				100+	*Roller Cone*
-72.6		@SS-18: No Recovery								
	78.5		78.5	SS-19	3	4	5		9	
-77.6	80.0	Loose, Wet, Light Olive Gray, Non-Plastic, Strongly Reactive, Silty Fine SAND (SM/A-2-4) with Phosphate Nodules, Calcaceous, Munsell=5Y 6/2								
		Boring Terminated at 80.0 feet								

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-5		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	R. Wessinger	**Boring Location:**	116+48	**Offset:**	81.7'-LT	**Alignment:**	ALT 1B
Elev.:	2.7 ft	**Latitude:**	32.400844	**Longitude:**	-80.444475	**Date Started:**	9/17/2015
Total Depth:	80 ft	**Soil Depth:**	80 ft	**Core Depth:**	N/A ft	**Date Completed:**	9/17/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Deidrich D-25	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	80%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL



LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-5
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	R. Wessinger	**Boring Location:**	116+48	**Offset:**	81.7'-LT	**Alignment:**	ALT 1B
Elev.:	2.7 ft	**Latitude:**	32.400844	**Longitude:**	-80.444475	**Date Started:**	9/17/2015
Total Depth:	80 ft	**Soil Depth:**	80 ft	**Core Depth:**	N/A ft	**Date Completed:**	9/17/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Deidrich D-25	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	80%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Loose, Wet, Dark Greenish Gray, Non-Plastic, Silty Fine to Medium SAND (SM/A-2-4), Munsell=GLEY1 4/5GY	43.5						
-42.3		@SS-12: LL=NP, PL=NP, PI=NP, NMC=33.4%, %#200=20.9		SS-12	2	3	4		7
			48.5						
		@SS-13: Greenish Gray, with Trace of Shells, Munsell=GLEY1 5/10Y		SS-13	2	4	6		10
-47.3									
			53.5						
		@SS-14: LL=NP, PL=NP, PI=NP, NMC=38.9%, %#200=26.0		SS-14	1	2	4		6
-52.3									
	58.5	**HAWTHORN MARL**	58.5						
		Firm to Soft, Moist, Olive, Medium to High Plasticity, Elastic SILT (MH/A-7), Munsell=5Y 4/4		SS-15	2	2	3		5
-57.3									
		@SS-16: Non-Reactive	63.5						
				SS-16	1	2	2		4
-62.3									
			68.5						
				SS-17	2	2	3		5
-67.3									
			73.5						
				SS-18	2	2	3		5
-72.3									
			78.5						
	79.5			SS-19	3	10	33		43
-77.3	80.0	**COOPER GROUP LIMESTONE**							
		Dense, Wet, Dark Gray, Clayey GRAVEL (GC), Munsell=5Y 4/1							
		Boring Terminated at 80.0 feet							

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-6
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	R. Wessinger	**Boring Location:**	119+93	**Offset:**	41.7'-LT	**Alignment:**	ALT 1B
Elev.:	2.3 ft	**Latitude:**	32.39997	**Longitude:**	-80.443953	**Date Started:**	9/18/2015
Total Depth:	80 ft	**Soil Depth:**	80 ft	**Core Depth:**	N/A ft	**Date Completed:**	9/18/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Deidrich D-25	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	80%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	Marsh		0.0	SS-1	WOH/24"				WOH
	2.0	**HOLOCENE** Very Soft, Wet, Dark Olive, Non-Plastic to Low Plasticity, Sandy SILT (ML/A-4), Munsell=5Y 3/2		2.0	SS-2	WOH	6	6	6	12
-2.7		Medium Dense to Loose, Wet, Dark Olive, Non-Plastic, Silty Fine SAND (SM/A-2-4) with Trace of Organics, Munsell=5Y 3/2		4.0	SS-3	2	2	7	7	9
		@SS-2: Organics=0.53%		6.0	SS-4	9	7	9	14	16
		@SS-3: Dark Grayish Brown, Munsell=2.5Y 4/2, LL=NP, PL=NP, PI=NP, NMC=28.4, %#200=17.2		8.0	SS-5	6	10	16	20	26
-7.7		@SS-4: Grayish Olive/Greenish Gray, Munsell=10Y 5/2 & GLEY1 10Y 5/1								
		@SS-5=> LL=NP, PL=NP, PI=NP, NMC=24.6%, %#200=15.7		13.5	SS-6	WOH/18"				WOH
-12.7		@SS-6: Very Loose, Dark Greenish Gray, Munsell=GLEY1 4/10Y, LL=NP, PL=NP, PI=NP, NMC=34.8%, %#200=26.1								
		@SS-7: Medium Dense to Dense		18.5	SS-7	6	9	11		20
-17.7										
		@SS-8: LL=NP, PL=NP, PI=NP, NMC=24.8%, %#200=13.7		23.5	SS-8	11	14	19		33
-22.7										
	28.5			28.5	SS-9	WOH/18"				WOH
-27.7		Very Loose, Wet, Greenish Gray, Non-Plastic, Poorly Graded Fine SAND (SP-SM/A-2-4) with Silt, Munsell=GLEY1 5/5GY								
		@SS-9: LL=NP, PL=NP, PI=NP, NMC=28.8%, %#200=11.0								
	33.5			33.5	SS-10	WOH	2	2		4
-32.7		Very Loose, Wet, Greenish Gray, Non-Plastic, Silty Fine SAND (SM/A-2-4), Munsell=GLEY1 5/5GY								
		@SS-11: Medium Dense, LL=NP, PL=NP, PI=NP, NMC=27.5%, %#200=18.3		38.5	SS-11	3	3	10		13
-37.7										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-6
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	R. Wessinger	**Boring Location:**	119+93	**Offset:**	41.7'-LT	**Alignment:**	ALT 1B
Elev.:	2.3 ft	**Latitude:**	32.39997	**Longitude:**	-80.443953	**Date Started:**	9/18/2015
Total Depth:	80 ft	**Soil Depth:**	80 ft	**Core Depth:**	N/A ft	**Date Completed:**	9/18/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Deidrich D-25	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	80%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Medium Dense to Dense, Wet, Greenish Gray, Non-Plastic, Silty Fine SAND (SM/A-2-4), Munsell=GLEY1 5/5GY	43.5	SS-12	9	10	15		25
-42.7			48.5	SS-13	8	17	16		33
-47.7		@SS-13: with Trace of Shell Fragments	53.5	SS-14	6	5	3		8
-52.7		@SS-14: Loose	58.5	SS-15	1	2	3		5
	56.0	**HAWTHORN MARL**	63.5	SS-16	1	2	3		5
-57.7		Firm, Wet to Moist, Dark Olive Gray, Medium to High Plasticity, Sandy Elastic SILT (MH/A-7) with Phosphate Nodules, Calcaceous, Munsell=5Y 3/2	68.5	SS-17	2	3	4		7
-62.7			73.5	SS-18	1	2	4		6
-67.7			78.5	SS-19	4	50/5"			100+
-72.7									
	79.0								
-77.7	80.0	**COOPER GROUP LIMESTONE** Hard, Moist, Dark Olive Brown, Low Plasticity, Sandy SILT (ML/A-4) with Trace of Gravel, Calcaceous, Munsell=2.5Y 3/3							
		Boring Terminated at 80.0 feet							

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-7		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	C. Piercy	**Boring Location:**	57+99	**Offset:**	45.9'-LT	**Alignment:**	ALT 1B
Elev.:	2.7 ft	**Latitude:**	32.407501	**Longitude:**	-80.461704	**Date Started:**	7/19/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/20/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	▽Marsh		0.0						
		HOLOCENE								
	2.0	Very Soft, Wet, Dark Olive Gray, Low Plasticity, Weakly Reactive, SILT (ML) with Trace of Organics (Wood), Munsell=5Y 3/2		2.0	SS-1	WOR/24"				WOR
				4.0	SS-2	2	4	5	4	9
-2.3		Loose to Very Loose, Wet, Gray, Non-Plastic, Strongly Reactive, Silty Fine to Medium SAND (SM/A-2-4) with Trace of Shell Fragments, Munsell=5Y 5/1		6.0	SS-3	2	3	1	1	4
				8.0	SS-4	WOR/12"	WOH/12"			WOH
		@SS-3: LL=NP, PL=NP, PI=NP, NMC=24.2%, %#200=12.8			SS-5	WOH	1/12"		2	1
-7.3		@SS-4: No Recovery								
		@SS-5: Very Dark Gray, Weakly Reactive, Munsell=5Y 3/1, LL=NP, PL=NP, PI=NP, NMC=33.1%, %#200=18.2		13.5	SS-6	WOH	1	1		2
-12.3		@SS-6: Weakly Reactive, Fine to Coarse Sand, LL=NP, PL=NP, PI=NP, NMC=31.3%, %#200=18.9								
	18.0			18.5	SS-7	2	2	2		4
-17.3		Very Loose, Wet, Very Dark Gray, Non-Plastic, Weakly Reactive, Poorly Graded Fine to Coarse SAND (SP-SM/A-2-4) with Silt, Munsell=5Y 3/1								
		@SS-7: LL=NP, PL=NP, PI=NP, NMC=24.2%, %#200=10.8		23.5	SS-8	7	8	9		17
-22.3		@SS-8: Medium Dense, Strongly Reactive								
		@SS-9: Very Loose, Dark Greenish Gray, Weakly Reactive, Munsell=GLEY1 4/10GY		28.5	SS-9	3	2	2		4
-27.3										
	32.0			33.5	SS-10	2	1	1		2
		Very Soft, Wet, Dark Greenish Gray, Low to Medium Plasticity, Weakly Reactive, Fine Sandy CLAY (CL), Munsell=GLEY1 4/5G								
-32.3										
	37.0			38.5	SS-11	1/12"			1	1
		Very Loose to Loose, Wet, Dark Greenish Gray, Non-Plastic, Weakly Reactive, Silty Fine to Medium SAND (SM/A-2-4), Munsell=GLEY1 4/10GY								
-37.3										
		@SS-12: LL=NP, PL=NP, PI=NP, NMC=38.0, %#200=17.9		43.5	SS-12	2	2	2		4
-42.3										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-7
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	57+99	**Offset:**	45.9'-LT	**Alignment:**	ALT 1B
Elev.:	2.7 ft	**Latitude:**	32.407501	**Longitude:**	-80.461704	**Date Started:**	7/19/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/20/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%)
		Loose, Wet, Dark Greenish Gray, Non-Plastic, Weakly Reactive, Silty Fine to Medium SAND (SM/A-2-4), Munsell=GLEY1 4/10GY	48.5							
-47.3		@SS-13: Dark Gray, Munsell=GLEY1 4/N		SS-13	1	2	3		5	Hard Lense from 52.5 to 53.0 feet
	53.5	**HAWTHORN MARL**	53.5	SS-14	4	5	5		10	
-52.3		Stiff, Wet, Olive Gray, Non-Plastic to Low Plasticity, Weakly Reactive, Sandy SILT (ML/A-4) with Phosphate Nodules, Munsell=5Y 4/2								
		@SS-15: Soft to Firm	58.5	SS-15	2	2	2		4	Hard Lense from 58.0 to 58.5 feet
-57.3										
			63.5	SS-16	3	4	4		8	
-62.3										
	68.5	Loose, Wet, Olive Gray, Non-Plastic to Low Plasticity, Non-Reactive, Silty Fine SAND (SM/A-2-4), Munsell=5Y 4/2	68.5	SS-17	3	4	4		8	
-67.3										
	74.0	**COOPER GROUP LIMESTONE**	73.5	SS-18	750/5.5"				100+	
-72.3		Very Dense, Wet, Dark Greenish Gray, Non-Plastic to Low Plasticity, Non-Reactive, Silty Fine SAND (SM/A-2-4) with Phosphate Nodules, Calcaceous, Munsell=GLEY1 4/5GY	78.5	SS-19	30	6	6		12	
-77.3		@SS-19: Medium Dense to Loose, Light Greenish Gray, Strongly Reactive, Munsell=GLEY1 7/5GY								
		@SS-20: Greenish Gray, Fine to Medium Sand, Munsell=GLEY1 6/10Y	83.5	SS-20	3	2	4		6	
-82.3										
		@SS-21: No Recovery	88.5	SS-21	2	3	3		6	
-87.3										

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-7		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	C. Piercy	**Boring Location:**	57+99	**Offset:**	45.9'-LT	**Alignment:**	ALT 1B
Elev.:	2.7 ft	**Latitude:**	32.407501	**Longitude:**	-80.461704	**Date Started:**	7/19/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/20/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
				93.5							
		@SS-22: No Recovery			SS-22	3	5	7		12	
-92.3											
				98.5							
		Medium Dense to Loose, Wet, Greenish Gray, Non-Plastic to Low Plasticity, Non-Reactive, Silty Fine to Medium SAND (SM/A-2-4) with Phosphate Nodules, Calcaceous, Munsell=GLEY1 6/10Y			SS-23	4	6	7		13	
-97.3											
				103.5							
		@SS-24: Light Greenish Gray, Munsell=GLEY1 7/10Y			SS-24	4	5	6		11	
-102.3											
				108.5							
					SS-25	3	3	3		6	
-107.3											
				113.5							
					SS-26	4	5	6		11	
-112.3											
				118.5							
					SS-27	3	3	6		9	
-117.3											
				123.5							
		@SS-28: Fine Sand			SS-28	3	3	4		7	
-122.3											
				128.5							
					SS-29	4	7	6		13	
-127.3											
				133.5							
					SS-30	4	5	7		12	
-132.3											

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-7
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	57+99	**Offset:**	45.9'-LT	**Alignment:**	ALT 1B
Elev.:	2.7 ft	**Latitude:**	32.407501	**Longitude:**	-80.461704	**Date Started:**	7/19/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/20/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		Medium Dense to Loose, Wet, Light Greenish Gray, Non-Plastic to Low Plasticity, Non-Reactive, Silty Fine SAND (SM/A-2-4) with Phosphate Nodules, Calcaceous, Munsell=GLEY1 7/10Y		138.5	SS-31	4	5	6		11	●
-137.3											
		@SS-32: Greenish Gray, Munsell=GLEY 1 6/5GY		143.5	SS-32	4	4	5		9	● *Rod Slipped and Blow Counts*
-142.3											
				148.5	SS-33			6			*Not Recorded for Top Foot*
-147.3	150.0	Boring Terminated at 150.0 feet									
-152.3											
-157.3											
-162.3											
-167.3											
-172.3											
-177.3											

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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-8		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	C. Piercy	**Boring Location:**	65+00	**Offset:**	0.1'-RT	**Alignment:**	ALT 1B
Elev.:	3.0 ft	**Latitude:**	32.406749	**Longitude:**	-80.459611	**Date Started:**	7/25/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/26/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	▽Marsh								
		HOLOCENE		0.0	SS-1	WOH/24"				WOH
		Very Loose to Loose, Wet, Dark Gray, Non-Plastic, Weakly Reactive, Poorly Graded Fine SAND (SP-SM/A-2-4) with Silt and Trace of Shell Fragments, Munsell=2.5Y 4/1		2.0						
				4.0	SS-2	1	1	2	2	3
-2.0		@SS-2: Gray, Strongly Reactive, Munsell=5Y 5/1		6.0	SS-3	2	2	3	3	5
		@SS-3: LL=NP, PL=NP, PI=NP, NMC=24.0%, %#200=11.9		8.0	SS-4	2	3	1	1	4
-7.0				10.0	SS-5	2	1	1	2	2
	12.0				SS-6	2	1	1		2
		Very Soft, Wet, Very Dark Gray, Medium Plasticity, Weakly Reactive, Sandy Lean CLAY (CL/A-6(8)), Munsell=5Y 3/1		13.5	SS-7	WOH/18"				WOH
-12.0										
				18.5	SS-8	WOH/18"				WOH
		@SS-8: LL=34, PL=20, PI=14, NMC=73.8%, %#200=67.5								
-17.0	21.0									
		Very Loose, Wet, Very Dark Gray, Medium Plasticity, Weakly Reactive, Clayey Fine to Medium SAND (SC/A-2-6(0)), Munsell=5Y 3/1		23.5	SS-9	WOH/18"				WOH
-22.0		@SS-9: LL=30, PL=19, PI=11, NMC=54.5%, %#200=34.9								
	27.0			28.5	SS-10	1	1	1		2
		Very Loose, Wet, Dark Gray, Non-Plastic, Weakly Reactive, Silty Fine to Medium SAND (SM/A-2-4) with Trace of Shell Fragments, Munsell=5Y 4/1								
-27.0		@SS-10: LL=NP, PL=NP, PI=NP, NMC=38.8%, %#200=22.0		33.5	SS-11	1	2	2		4
-32.0	37.0			38.5	SS-12	1	1	1		2
		Very Soft, Wet, Dark Greenish Gray, Medium Plasticity, Weakly Reactive, Fine Sandy CLAY (CL), Munsell=GLEY1 4/10GY								
-37.0										
	42.0			43.5	SS-13	5	3	5		8
		Loose, Wet, Gray, Non-Plastic, Weakly Reactive, Poorly Graded Fine SAND (SP-SM/A-3) with Silt, Munsell=GLEY1 5/N								
-42.0		@SS-13: LL=NP, PL=NP, PI=NP, NMC=27.3%, %#200=6.5								
				48.5	SS-14	3	3	4		7
		@SS-14: LL=NP, PL=NP, PI=NP, NMC=37.1%, %#200=8.2								
-47.0										
	52.5									

SPT N VALUE ● PL MC LL ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90

Hard Lense from 51.5 to 52.5 feet

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-8
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	65+00	**Offset:**	0.1'-RT	**Alignment:**	ALT 1B
Elev.:	3.0 ft	**Latitude:**	32.406749	**Longitude:**	-80.459611	**Date Started:**	7/25/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/26/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		HAWTHORN MARL		53.5							
-52.0		Loose, Wet, Olive Gray, Medium Plasticity, Non-Reactive, Silty Fine to Medium SAND (SM/A-2-6) with Phosphate Nodules, Munsell=5Y 4/2			SS-15	3	3	2		5	
	58.5			58.5							
-57.0		Firm, Wet, Olive Gray, Low to Medium Plasticity, Non-Reactive, Fine Sandy SILT (ML/A-4), Munsell=5Y 4/2			SS-16	3	3	3		6	
				63.5							
-62.0					SS-17	3	2	4		6	
				68.5							
-67.0					SS-18	2	2	3		5	
				73.5							
		@SS-19: Very Stiff			SS-19	3	4	14		18	*Hard Dense from 75.0 to 75.5 feet*
-72.0	75.0	**COOPER GROUP LIMESTONE**									
		Medium Dense to Loose, Wet, Light Greenish Gray, Low Plasticity, Strongly Reactive, Silty Fine to Medium SAND (SM/A-2-4), Calcaceous, Munsell=GLEY1 7/5GY		78.5	SS-20	21	8	5		13	
-77.0											
				83.5							
-82.0					SS-21	3	2	3		5	
				88.5							
		@SS-22: No Recovery			SS-22	2	3	5		8	
-87.0											
				93.5							
		@SS-23: No Recovery			SS-23	2	4	5		9	
-92.0											
				98.5							
					SS-24	3	3	5		8	
-97.0											
		@SS-25: Greenish Gray, Munsell=GLEY1 6/5GY		103.5							
					SS-25	4	4	5		9	

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-8
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	65+00	**Offset:**	0.1'-RT	**Alignment:**	ALT 1B
Elev.:	3.0 ft	**Latitude:**	32.406749	**Longitude:**	-80.459611	**Date Started:**	7/25/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/26/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		Loose to Medium Dense, Wet, Greenish Gray, Low Plasticity, Strongly Reactive, Silty Fine to Medium SAND (SM/A-2-4), Calcaceous, Munsell=GLEY1 6/5GY		108.5	SS-26	3	3	3		6	
-107.0				113.5	SS-27	3	4	8		12	
-112.0				118.5	SS-28	3	3	6		9	
-117.0				123.5	SS-29	3	3	4		7	
-122.0				128.5	SS-30	7	8	11		19	
-127.0				133.5	SS-31	4	5	6		11	
-132.0				138.5	SS-32			10			*Rod Slipped and Blow Counts*
-137.0				143.5	SS-33	3	4	6		10	*Not Recorded for Top Foot*
-142.0				148.5	SS-34	3	4	7		11	
-147.0	150.0	Boring Terminated at 150.0 feet									
-152.0											

SC_DOT G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-9		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	C. Piercy	**Boring Location:**	67+04	**Offset:**	9.3'-LT	**Alignment:**	ALT 1B
Elev.:	2.6 ft	**Latitude:**	32.406583	**Longitude:**	-80.458978	**Date Started:**	7/27/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/28/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	Marsh	0.0	SS-1	WOH/24"				WOH
	2.0	**HOLOCENE** Very Soft, Wet, Dark Gray, Medium Plasticity, Weakly Reactive, SILT (ML/A-4) with Fine Sand and Trace of Organics (Wood), Munsell=10YR 4/1	2.0	SS-2	WOH	2	3	2	5
-2.4	5.0	Loose to Very Loose, Wet, Dark Gray, Non-Plastic, Strongly Reactive, Poorly Graded Fine to Coarse SAND (SP-SM/A-3) with Silt, Munsell=5Y 4/1	4.0	SS-3	4	3	3	3	6
			6.0	SS-4	WOH/24"				WOH
			8.0	SS-5	1	1	1	2	2
-7.4	10.0	@SS-2: LL-NP, PL=NP, PI=NP, NMC=22.6%, %#200=7.7							
		@SS-3: LL=NP, PL=NP, PI=NP, NMC=21.9%, %#200=7.2	13.5	SS-6	WOH/18"				WOH
-12.4	15.0	@SS-4: No Recovery							
	17.0	@SS-5: Weakly Reactive, Fine Sand, LL=NP, PL=NP, PI=NP, NMC=25.6%, %#200=10.3	18.5	SS-7	WOH/18"				WOH
-17.4		@SS-6: Very Dark Gray, Munsell=5Y 3/1							
		Very Soft, Wet, Very Dark Gray, High Plasticity, Weakly Reactive, Fat CLAY (CH/A-7-5(24)) with Fine Sand, Munsell=5Y 3/1	23.5	SS-8	WOH/18"				WOH
-22.4									
			28.5	SS-9	WOH/18"				WOH
-27.4		@SS-9: LL=58, PL=30, PI=28, NMC=88.5%, %#200=79.1							
			33.5	SS-10	WOH/12"		1		1
-32.4									
			38.5	SS-11	1	1	1		2
-37.4		@SS-11: Dark Gray, Munsell=5Y 4/1							
	42.0	Loose to Very Loose, Wet, Gray, Non-Plastic, Weakly Reactive, Poorly Graded Fine SAND (SP-SM/A-3) with Silt, Munsell=GLEY1 5/N	43.5	SS-12	2	3	4		7
-42.4		@SS-12: LL=NP, PL=NP, PI=NP, NMC=25.6%, %#200=7.5							
			48.5	SS-13	2	2	2		4
-47.4	51.0								

SPT N VALUE ● PL × MC ○ LL × ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-9		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	C. Piercy	**Boring Location:**	67+04	**Offset:**	9.3'-LT	**Alignment:**	ALT 1B
Elev.:	2.6 ft	**Latitude:**	32.406583	**Longitude:**	-80.458978	**Date Started:**	7/27/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/28/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		HAWTHORN MARL								
		Soft to Firm, Wet, Olive, Low to Medium Plasticity, Non-Reactive, Fine to Medium Sandy SILT (ML/A-4), Munsell=5Y 5/3	53.5	SS-14	2	2	2		4	Hard Lense from 51.5 to 52.0 feet
-52.4										
		@SS-15: Olive Gray, Munsell=5Y 4/2	58.5	SS-15	1	2	3		5	
-57.4										
			63.5	SS-16	2	3	4		7	
-62.4										
			68.5	SS-17	2	2	3		5	
-67.4										
			73.5	SS-18	5	4	9		13	Hard Lense from 75.0 to 78.0 feet
		@SS-18: Stiff, Weakly Reactive								
-72.4	75.0	**COOPER GROUP LIMESTONE**								
		Very Dense, Wet, Light Greenish Gray, Low Plasticity, Strongly Reactive, Silty Fine to Medium SAND (SM/A-2-4), Calcaceous, Munsell=GLEY1 7/5GY	78.5	SS-19	750/5.5"				100+	
-77.4										
		@SS-20: Loose to Medium Dense, Greenish Gray, Munsell=GLEY1 6/10Y	83.5	SS-20	2	2	3		5	
-82.4										
		@SS-21: Light Greenish Gray, Munsell=GLEY1 7/5GY	88.5	SS-21	2	3	5		8	
-87.4										
		@SS-22: No Recovery	93.5	SS-22	2	3	5		8	
-92.4										
			98.5	SS-23	3	3	5		8	
-97.4										

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-9
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	67+04	**Offset:**	9.3'-LT	**Alignment:**	ALT 1B
Elev.:	2.6 ft	**Latitude:**	32.406583	**Longitude:**	-80.458978	**Date Started:**	7/27/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/28/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
-102.4		Medium Dense to Loose, Wet, Light Greenish Gray, Low Plasticity, Strongly Reactive, Silty Fine to Medium SAND (SM/A-2-4), Calcaceous, Munsell=GLEY1 7/5GY		103.5	SS-24	4	5	9		14
-107.4				108.5	SS-25	3	3	5		8
-112.4				113.5	SS-26	3	3	4		7
-117.4				118.5	SS-27	4	3	4		7
-122.4				123.5	SS-28	3	2	4		6
-127.4				128.5	SS-29	2	2	4		6
-132.4	132.0	Stiff, Wet, Greenish Gray, Low Plasticity, Strongly Reactive, Fine Sandy SILT (ML/A-4), Calcaceous, Munsell=GLEY1 6/5GY		133.5	SS-30	4	5	8		13
-137.4				138.5	SS-31	5	5	6		11
-142.4	142.0	Medium Dense to Loose, Wet, Non-Plastic to Low Plasticity, Greenish Gray, Strongly Reactive, Silty Fine SAND (SM/A-2-4), Calcaceous, Munsell=GLEY1 6/5GY		143.5	SS-32	3	4	7		11
-147.4	150.0	Boring Terminated at 150.0 feet		148.5	SS-33	3	4	6		10

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

SC_DOT G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-10
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	J. Wessinger	**Boring Location:**	78+24	**Offset:**	21.4'-RT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.405352	**Longitude:**	-80.455652	**Date Started:**	6/23/2016
Total Depth:	193 ft	**Soil Depth:**	191.5 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/27/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	▽River							
	1.5	WATER	1.5						
		HOLOCENE							
-5.0		Very Loose to Loose, Wet, Black, Low Plasticity, Clayey Fine SAND (SC/A-4(1)) with Trace of Shell Fragments/Organics, Munsell=5Y 2.5/1	3.5	SS-1	WOR/24"				WOR
	7.5	@SS-2: LL=26, PL=17, PI=9, NMC=50.0%, %#200=41.1	5.5	SS-2	WOH/24"				WOR
		@SS-3: Dark Greenish Gray, Munsell=GLEY1 4/10Y	7.5	SS-3	2	4	2	2	6
-10.0			9.5	SS-4	2	1	1	1	2
				SS-5	1	1	1	1	2
	14.0	Very Loose, Wet, Dark Greenish Gray, Non-Plastic, Fine SAND (SP-SM/A-3) with Silt and Trace of Shell Fragments, Munsell=GLEY1 4/10Y	15.0	SS-6	1	1	1		2
-15.0		@SS-4: LL=NP, PL=NP, PI=NP, NMC=24.1%, %#200=7.9							
-20.0		Very Soft, Wet, Greenish Gray, Low Plasticity, Sandy SILT (ML/A-4(2)) with Trace of Organics, Munsell=10GY 5/1	20.0	SS-7	WOH/18"				WOH
-25.0		@SS-8: LL=33, PL=26, PI=7, NMC=58.3%, %#200=57.2	25.0	SS-8	WOH/18"				WOH
-30.0		@SS-9: Dark Greenish Gray, Munsell=5GY 4/1	30.5	SS-9	WOH/18"				WOH
-35.0			35.5	SS-10	WOH/18"				WOH
-40.0			40.5	SS-11	WOH/12"		1		1
-45.0	45.0	Loose to Medium Dense, Wet, Greenish Gray, Non-Plastic, Fine to Coarse SAND (SP-SM/A-3) with Silt and Trace of Shell Fragments, Munsell=GLEY1 5/10Y	46.0	SS-12	2	3	3		6
-50.0		@SS-12: LL=NP, PL=NP, PI=NP, NMC=21.9%, %#200=6.0	51.0	SS-13	4	7	10		17
	52.5								

SPT N VALUE

PL MC LL

▲ FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-10		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	J. Wessinger	**Boring Location:**	78+24	**Offset:**	21.4'-RT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.405352	**Longitude:**	-80.455652	**Date Started:**	6/23/2016
Total Depth:	193 ft	**Soil Depth:**	191.5 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/27/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
-55.0		**HAWTHORN MARL** Very Loose to Loose, Wet, Dark Gray, Medium Plasticity, Strongly Reactive, Silty Fine to Medium SAND (SM/A-2-6(0)), Munsell=5Y 4/1 @SS-14: LL=39, PL=27, PI=12, NMC=58.1%, %#200=31.0 @SS-15: Weakly Reactive		56.5	SS-14	1	1	2		3
-60.0				61.5	SS-15	3	2	4		6
-65.0				66.5	SS-16	2	2	3		5
-70.0				71.5	SS-17	3	4	4		8
-75.0	74.5	**COOPER GROUP LIMESTONE** Loose to Medium Dense, Wet, Light Greenish Gray, Medium Plasticity, Strongly Reactive, Silty Fine to Medium SAND (SM/A-3), Calcaceous, Munsell=GLEY1 7/10Y		76.5	SS-18	1	1	6		7
-80.0				81.5	SS-19	3	6	5		11
-85.0				86.5	SS-20	34	7	6		13
-90.0				91.5	SS-21	2	4	12		16
-95.0				96.5	SS-22	2	3	4		7
-100.0				101.5	SS-23	5	5	6		11

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-10
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	J. Wessinger	**Boring Location:**	78+24	**Offset:**	21.4'-RT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.405352	**Longitude:**	-80.455652	**Date Started:**	6/23/2016
Total Depth:	193 ft	**Soil Depth:**	191.5 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/27/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Loose to Very Loose, Wet, Light Greenish Gray, Medium Plasticity, Strongly Reactive, Silty Fine to Medium SAND (SM/A-3), Calcaceous, Munsell=GLEY1 7/10Y		106.5	SS-24	4	4	3		7
-110.0				111.5	SS-25	3	3	4		7
-115.0				116.5	SS-26	4	4	5		9
-120.0				121.5	SS-27	3	3	3		6
-125.0		@SS-28: Olive Gray, Munsell=5Y 4/2		126.5	SS-28	3	2	1		3
-130.0		@SS-29: Greenish Gray, Munsell=GLEY1 6/10Y		130.0	SS-29	3	3	3		6
-135.0				135.0	SS-30	2	2	3		5
-140.0				142.0	SS-31	3	4	4		8
-145.0		@SS-32: Medium Dense to Loose		147.0	SS-32	4	7	6		13
-150.0				152.0	SS-33	3	4	6		10
-155.0				157.5						

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-10
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	J. Wessinger	**Boring Location:**	78+24	**Offset:**	21.4'-RT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.405352	**Longitude:**	-80.455652	**Date Started:**	6/23/2016
Total Depth:	193 ft	**Soil Depth:**	191.5 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/27/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
-160.0		Loose to Medium Dense, Wet, Greenish Gray, Medium Plasticity, Strongly Reactive, Silty Fine to Medium SAND (SM/A-3), Calcaceous, Munsell=GLEY1 6/10Y		162.0	SS-34	3	3	4		7
					SS-35	3	3	4		7
-165.0				167.0	SS-36	4	7	9		16
-170.0				172.0	SS-37	4	4	5		9
-175.0				177.0	SS-38	4	5	5		10
-180.0				182.0	SS-39	5	9	9		18
-185.0		@SS-40: Dense		187.0	SS-40	12	8	29		37
-190.0				191.5						
	193.0	@SS-41: Loose			SS-41	4	5	5		10
-195.0		Boring Terminated at 193.0 feet								
-200.0										
-205.0										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

SC_DOT G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-11		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	J. Wessinger	**Boring Location:**	82+65	**Offset:**	4.4'-LT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.404954	**Longitude:**	-80.454298	**Date Started:**	6/29/2016
Total Depth:	192 ft	**Soil Depth:**	170 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/30/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	▽River								
		WATER								
-5.0										
-10.0										
-15.0										
-20.0										
	22.0	**HOLOCENE**		22.0						
-25.0	26.0	Very Soft, Wet, Dark Greenish Gray, Low Plasticity, Sandy SILT (ML/A-4) with Trace of Shell Fragments/Organics, Munsell=GLEY1 4/10Y		24.0	SS-1	WOR/24"				WOH
	28.0			26.0	SS-2	4	1/18"			1
	30.0			28.0	SS-3	WOH/24"				WOH
-30.0		Very Loose, Wet, Dark Greenish Gray, Non-Plastic, Silty Fine SAND (SM/A-2-4) with Trace of Shell Fragments, Munsell=GLEY 1 4/10Y, LL=22, PL=NP, PI=NP, NMC=33.7%, %#200=18.1		30.0	SS-4	WOH/24"				WOH
	35.0				SS-5	WOH/24"				WOH
-35.0				36.5	SS-6	WOH/18"				WOH
-40.0		Very Soft, Wet, Dark Greenish Gray, Low Plasticity, Sandy CLAY (CL/A-4(2)) with Trace of Organics, Munsell=GLEY1 4/5GY, LL=26, PL=17, PI=9, NMC=57.6%, %#200=52.1		42.0	SS-7	WOH/18"				WOH
-45.0	46.0	Very Loose, Wet, Dark Greenish Gray, Non-Plastic, Silty Fine SAND (SM/A-2-4) with Trace of Shell Fragments, Munell=GLEY1 4/5GY, LL=NP, PL=NP, PI=NP, NMC=30.5%, %#200=15.3		47.5	SS-8	1	1	1		2
-50.0		Very Soft, Wet, Dark Greenish Gray, High Plasticity, Elastic SILT (MH/A-7-5(25)), Munsell=GLEY1 4/5GY		53.5	SS-9	4	3	4		7
-55.0	57.0	@SS-6: LL=58, PL=35, PI=23, NMC=93.7%, %#200=87.9		58.0	SS-10	2	3	3		6
-60.0		Very Loose to Loose, Wet, Gray, Low Plasticity, Silty Fine to Medium SAND (SM/A-2-4) with Trace of Shell Fragments, Munsell=GLEY1 5/N		63.5	SS-11	2	2	3		5
-65.0		**HAWTHORN MARL**								

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Hard Lense from 55.0 to 55.5 feet

LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-11
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	J. Wessinger	**Boring Location:**	82+65	**Offset:**	4.4'-LT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.404954	**Longitude:**	-80.454298	**Date Started:**	6/29/2016
Total Depth:	192 ft	**Soil Depth:**	170 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/30/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
-70.0		**HAWTHORNE MARL** Firm, Wet, Olive Gray, Low Plasticity, Strongly Reactive, Sandy SILT (ML/A-4), Munsell=5Y 4/2		68.5	SS-12	2	3	4		7
-75.0				73.5	SS-13	2	3	4		7
	78.5			78.5	SS-14	3	10	13		23
-80.0		**COOPER GROUP LIMESTONE** Loose to Medium Dense, Wet, Very Dark Gray, Non-Plastic, Weakly to Strongly Reactive, Silty Fine SAND (SM/A-4(0)) with Phosphate Nodules, Calcaceous, Munsell=5Y 3/1		83.0	SS-15	2	2	4		6
-85.0		@SS-15: Light Brownish Gray, Munsell=2.5Y 6/2, LL=31, PL=NP, PI=NP, NMC=45.3%, %#200=46.0		87.5	SS-16	2	2	3		5
-90.0		@SS-16: No Recovery		92.5	SS-17	3	2	3		5
		@SS-17: Greenish Gray, Munsell=GLEY1 6/10Y		97.0	SS-18	7	3	3		6
-95.0										
-100.0				100.0	SS-19	3	2	3		5
-105.0				104.5	SS-20	3	7	20		27
		@SS-21: No Recovery		107.0	SS-21	1/18"				1
-110.0				112.0	SS-22	2	3	5		8
-115.0		@SS-22: Light Greenish Gray, Munsell=GLEY1 7/5GY								
-120.0				120.5	SS-23	3	4	5		9
-125.0				126.0	SS-24	4	5	6		11
-130.0				132.0	SS-25	3	3	5		8

SPT N VALUE ●

PL ✕ MC ○ LL ✕

▲ FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-11
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	J. Wessinger	**Boring Location:**	82+65	**Offset:**	4.4'-LT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.404954	**Longitude:**	-80.454298	**Date Started:**	6/29/2016
Total Depth:	192 ft	**Soil Depth:**	170 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/30/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
-135.0		Loose to Medium Dense, Wet, Light Greenish Gray, Non-Plastic, Weakly to Strongly Reactive, Silty Fine SAND (SM/A-4(0)) with Phosphate Nodules, Calcaceous, Munsell=GLEY1 7/5GY		137.5	SS-26	4	4	6		10
-140.0				143.5	SS-27	3	3	5		8
-145.0		@SS-27: Greenish Gray, Munsell=GLEY1 5/10Y		147.5	SS-28	3	4	6		10
-150.0				154.0	SS-29	4	4	5		9
-155.0				159.0	SS-30	2	4	6		10
-160.0				163.5	SS-31	3	5	7		12
-165.0				168.0	SS-32	3	4	6		10
-170.0				172.5	SS-33	3	3	5		8
-175.0		@SS-34: Light Greenish Gray, Munsell=GLEY1 7/10Y		177.0	SS-34	4	8	11		19
-180.0				181.5	SS-35	3	4	6		10
-185.0				186.0	SS-36	1	4	5		9
-190.0		@SS-37: Munsell=GLEY1 7/5GY		190.5	SS-37	2	4	5		9
	192.0	Boring Terminated at 192.0 feet								
-195.0										
-200.0										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-12		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	R. Wessinger	**Boring Location:**	87+88	**Offset:**	79.3'-LT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.404595	**Longitude:**	-80.45264	**Date Started:**	7/6/2016
Total Depth:	192 ft	**Soil Depth:**	159 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/11/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	▽River								
		WATER								
-5.0										
-10.0										
-15.0										
-20.0										
-25.0										
-30.0										
	33.0	Very Soft to Soft, Wet, Dark Gray, Low to Medium Plasticity, Sandy CLAY (CL/A-6), with Trace of Shell Fragments/Organics, Munsell=GLEY 1 4/N		33.0	SS-1	3	1/18"			1
-35.0	36.5			35.0	SS-2	1	2	2	2	4
	39.0	Very Loose, Wet, Dark Gray, Non-Plastic, Silty Fine SAND (SM/A-2-4), Munsell=GLEY1 4/N, LL=NP, PL=NP, PI=NP, NMC=32.9%, %#200=23.8		37.0	SS-3	2	2	1	1	3
-40.0	41.0			39.0	SS-4	2	6	3	3	9
		Loose, Wet, Dark Gray, Low Plasticity, Clayey Fine SAND (SC/A-2-4), Munsell=GLEY1 4/N		41.0	SS-5	4	2	2	1	4
-45.0	45.5			45.5	SS-6	1	4	1		5
		Very Loose, Wet, Gray, Non-Plastic, Fine SAND (SP/A-1), Munsell=GLEY1 5/N								
-50.0	50.5	Loose, Wet, Dark Gray, Non-Plastic, Fine to Coarse SAND (SP-SM/A-3) with Silt and Trace of Shell Fragments, Munsell=GLEY1 4/N, LL=NP, PL=NP, PI=NP, NMC=24.6%, %#200=10.4		50.5	SS-7	4	3	4		7
-55.0		**HAWTHORN MARL**		56.0	SS-8	4	2	6		8

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-12
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	R. Wessinger	**Boring Location:**	87+88	**Offset:**	79.3'-LT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.404595	**Longitude:**	-80.45264	**Date Started:**	7/6/2016
Total Depth:	192 ft	**Soil Depth:**	159 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/11/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
-60.0		**HAWTHORN MARL** Loose to Very Loose, Wet, Olive Gray, Non-Plastic, Weakly Reactive, Silty Fine to Medium SAND (SM/A-5(0)) with Trace of Shell Fragments, Munsell=5Y 4/2	61.0	SS-9	2	2	2		4
-65.0		@SS-9: No Shell Fragments, LL=51, PL=NP, PI=NP, NMC=81.2%, %#200=48.0							
-70.0		@SS-10: Very Dark Greenish Gray, Munsell=GLEY1 3/10Y	69.5	SS-10	1	3	3		6
-75.0			75.0	SS-11	2	4	5		9
-80.0		@SS-12: Medium Plasticity, A-7-5(4), LL=44, PL=31, PI=13, NMC=61.8%, %#200=46.6	80.0	SS-12	2	3	3		6
-85.0			86.0	SS-13	WOH	3	5		8
-90.0	91.0	**COOPER GROUP LIMESTONE** Medium Dense to Loose, Wet, Very Dark Greenish Gray, Non-Plastic, Non-Reactive to Strongly Reactive, Silty Fine to Coarse SAND (SM/A-4(0)) with Phosphate Nodules, Calcaceous, Munsell=GLEY1 3/10Y	91.0	SS-14	26	5	7		12
-95.0		@SS-15: Light Greenish Gray, Munsell=GLEY1 7/10Y, LL=30, PL=NP, PI=NP, NMC=33.7%, %#200=49.7	96.5	SS-15	4	6	5		11
-100.0			102.0	SS-16	2	4	5		9
-105.0		@SS-17: Greenish Gray, Munsell=5GY 6/1	106.5	SS-17	2	4	8		12
-110.0			110.5	SS-18	4	6	2		8

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-12		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	R. Wessinger	**Boring Location:**	87+88	**Offset:**	79.3'-LT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.404595	**Longitude:**	-80.45264	**Date Started:**	7/6/2016
Total Depth:	192 ft	**Soil Depth:**	159 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/11/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		Loose to Medium Dense, Wet, Greenish Gray, Non-Plastic, Non-Reactive to Strongly Reactive, Silty Fine to Coarse SAND (SM/A-4(0)) with Phosphate Nodules, Calcaceous, Munsell=5GY 6/1		115.5	SS-19		2	3		5	*Not Recorded for Top 6"*
-120.0		@SS-20: Greenish Gray, Munsell=GLEY1 6/10Y		120.5	SS-20						*Rod Slipped and Blow Counts*
-125.0				125.5	SS-21	4	6	8		14	*Rod Slipped and Blow Counts*
-130.0				130.5	SS-22	5	4	8		12	*Not Recorded*
	134.0										
-135.0		Firm to Stiff, Greenish Gray, Medium to High Plasticity, Strongly Reactive, Fine Sandy SILT (ML/A-6), Munsell=GLEY1 6/10Y		135.5	SS-23	3	2	5		7	
-140.0				141.0	SS-24	3	4	8		12	
-145.0											
				148.5	SS-25	3	4	4		8	
-150.0				151.5	SS-26	4	5	6		11	
-155.0				155.5	SS-27	4	4	5		9	
	158.0										
-160.0		Medium Dense to Loose, Wet, Greenish Gray, Low Plasticity, Strongly Reactive, Silty Fine SAND (SM/A-2-4), Munsell=GLEY1 6/10Y		160.0	SS-28	5	7	12		19	
	165.0										
-165.0		Stiff to Firm, Wet, Light Greenish Gray, Low to Medium Plasticity, Strongly Reactive, Fine Sandy SILT (ML/A-4), Munsell=GLEY1 7/10Y		165.0	SS-29	4	4	6		10	
-170.0				170.0	SS-30	3	4	4		8	

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-12
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	R. Wessinger	**Boring Location:**	87+88	**Offset:**	79.3'-LT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.404595	**Longitude:**	-80.45264	**Date Started:**	7/6/2016
Total Depth:	192 ft	**Soil Depth:**	159 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/11/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
-175.0		Very Stiff, Wet, Light Greenish Gray, Low to Medium Plasticity, Strongly Reactive, Fine Sandy SILT (ML/A-4), Munsell=GLEY1 7/10Y		174.5	SS-31	4	7	13		20
-180.0	180.0	Medium Dense, Wet, Greenish Gray, Low to Medium Plasticity, Strongly Reactive, Silty Fine SAND (SM/A-3), Munsell=GLEY1 6/10Y		180.0	SS-32					
-185.0				185.5	SS-33	4	5	7		12
-190.0		@SS-34: Loose		190.5	SS-34	4	4	4		8
	192.0	Boring Terminated at 192.0 feet								
-195.0										
-200.0										
-205.0										
-210.0										
-215.0										
-220.0										
-225.0										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Pushed Spoon for Sample, but

Blo Counts Not Recorded

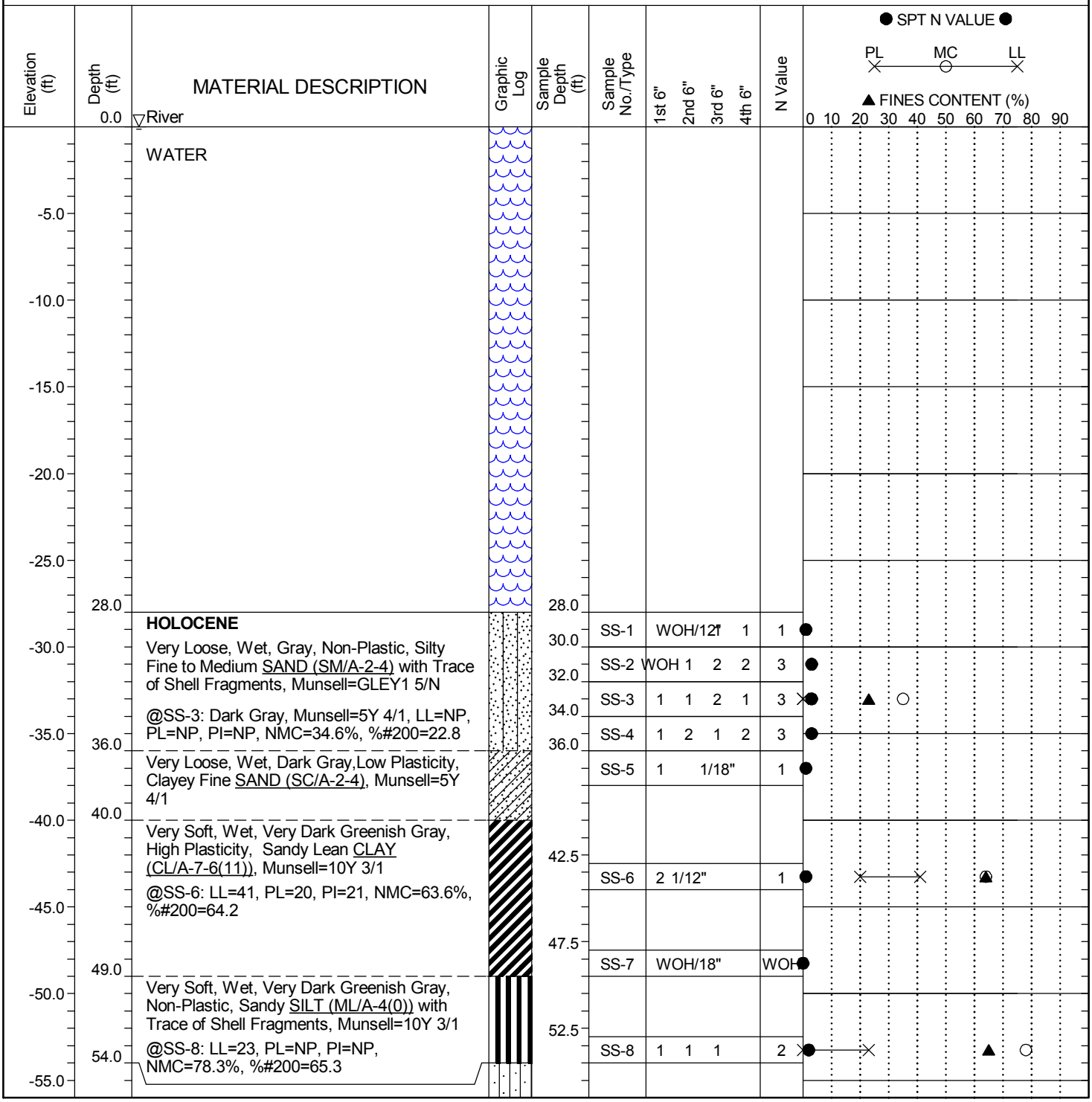
LEGEND

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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-13		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	J. Wessinger	**Boring Location:**	92+79	**Offset:**	16.2'-RT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.403837	**Longitude:**	-80.451288	**Date Started:**	6/16/2016
Total Depth:	190.5 ft	**Soil Depth:**	162.5 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/21/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL



LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-13
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	J. Wessinger	**Boring Location:**	92+79	**Offset:**	16.2'-RT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.403837	**Longitude:**	-80.451288	**Date Started:**	6/16/2016
Total Depth:	190.5 ft	**Soil Depth:**	162.5 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/21/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		HAWTHORN MARL		58.0							
-60.0		Very Loose to Loose, Moist, Dark Greenish Gray, High Plasticity, Weakly Reactive, Clayey Fine to Medium SAND (SC/A-7-6(11)), Munsell=10Y 4/1			SS-9	7	3	3		6	
				63.5							
-65.0		@SS-10: LL=67, PL=29, PI=38, NMC=73.8%, %#200=43.9			SS-10	2	2	2		4	
				69.0							
-70.0		@SS-11: No Recovery			SS-11	3	2	4		6	
-75.0	75.0	**COOPER GROUP LIMESTONE**		76.5							
		Firm, Moist, Greenish Gray, Low Plasticity, Strongly Reactive, Sandy SILT (ML/A-4(1)) with Phosphate Nodules, Calcaceous, Munsell=GLEY1 6/1			SS-12	1	3	3		6	
-80.0		@SS-13: Olive Gray, Munsell=5Y 5/2		81.5	SS-13	3	3	4		7	
-85.0				86.5							
		@SS-14: No Recovery			SS-14	2	2	2		4	
-90.0				90.5							
		@SS-15: Very Stiff			SS-15		11	12		23	*Rod Slipped and Blow Counts Not Recorded for Top 6"*
-95.0		@SS-16: Firm to Stiff, Light Greenish Gray, Munsell=GLEY1 7/10Y		94.5	SS-16	3	3	4		7	
				99.5							
-100.0		@SS-17: LL=30, PL=24, PI=6, NMC=37.3%, %#200=50.2			SS-17	3	4	3		7	
				104.0							
-105.0					SS-18	3	3	7		10	
				109.0							
-110.0		@SS-19: No Recovery			SS-19	3	3	3		6	

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-13		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	J. Wessinger	**Boring Location:**	92+79	**Offset:**	16.2'-RT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.403837	**Longitude:**	-80.451288	**Date Started:**	6/16/2016
Total Depth:	190.5 ft	**Soil Depth:**	162.5 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/21/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
-115.0		Firm to Stiff, Moist, Greenish Gray, Low Plasticity, Strongly Reactive, Sandy SILT (ML/A-4(1)) with Phosphate Nodules, Calcaceous, Munsell=5GY 6/1		116.5	SS-20	3	3	3		6
-120.0				121.5	SS-21	5	5	7		12
-125.0				127.0	SS-22	3	4	7		11
-130.0				132.5	SS-23	2	3	4		7
-135.0				138.0	SS-24	3	4	5		9
-140.0										
-145.0		@SS-25: Olive Gray, Munsell=5Y 5/2		146.0	SS-25	4	4	4		8
		@SS-26: No Recovery		148.0	SS-26	3	3	5		8
-150.0		@SS-27: Light Greenish Gray, Munsell=GLEY1 7/5Y		152.5	SS-27	3	3	4		7
-155.0				157.0	SS-28	4	4	4		8
-160.0				162.0	SS-29	3	5	5		10
-165.0		@SS-30: Greenish Gray, Munsell=GLEY1 6/10Y		166.5	SS-30	2	4	5		9

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-13
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	J. Wessinger	**Boring Location:**	92+79	**Offset:**	16.2'-RT	**Alignment:**	ALT 1B
Elev.:	0.0 ft	**Latitude:**	32.403837	**Longitude:**	-80.451288	**Date Started:**	6/16/2016
Total Depth:	190.5 ft	**Soil Depth:**	162.5 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/21/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
-170.0		Stiff to Firm, Moist, Greenish Gray, Low Plasticity, Strongly Reactive, Sandy SILT (ML/A-4(1)) with Phosphate Nodules, Calcaceous, Munsell=GLEY1 6/10Y		172.0						
					SS-31	4	5	7		12
-175.0				177.5						
					SS-32	2	2	5		7
-180.0				183.5						
					SS-33	6	5	8		13
-185.0				189.0						
		@SS-34: Very Stiff								
-190.0	190.5				SS-34	7	9	8		17
		Boring Terminated at 190.5 feet								
-195.0										
-200.0										
-205.0										
-210.0										
-215.0										
-220.0										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-14		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	J. Wessinger	**Boring Location:**	97+18	**Offset:**	5.6'-LT	**Alignment:**	ALT 1B
Elev.:	0.1 ft	**Latitude:**	32.403431	**Longitude:**	-80.449948	**Date Started:**	6/13/2016
Total Depth:	190 ft	**Soil Depth:**	190 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/15/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0.1 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	Marsh		0.0						
		HOLOCENE		2.0	SS-1	WOH	/12"	1	2	1
		Very Loose, Wet, Dark Gray, Non-Plastic, Silty Fine SAND (SM/A-2-4) with Trace of Shell Fragments, Munsell=GLEY1 4/N		4.0	SS-2	2	1	1	1	2
-4.9				6.0	SS-3	1/12"		4	7	4
		@SS-4: Medium Dense, Light Gray, Munsell=GLEY1 7/N		8.0	SS-4	6	10	15	10	25
		@SS-5: Very Loose, LL=NP, PL=NP, PI=NP, NMC=32.4%, %#200=13.8			SS-5	1	2	1	2	3
-9.9				13.5						
		@SS-6: Medium Dense			SS-6	4	8	8		16
-14.9				18.5						
	17.0	Loose, Wet, Greenish Gray, Low Plasticity, Fine SAND (SP-SM/A-3) with Silt, Munsell=GLEY1 6/5GY			SS-7	3	1	4		5
-19.9				23.5						
	22.0	Loose to Very Loose, Wet, Dark Gray, Non-Plastic to Low Plasticity, Silty Fine SAND (SM/A-2-4) with Trace of Shell Fragments, Munsell=GLEY1 9/N			SS-8	2	2	7		9
-24.9		@SS-8: LL=NP, PL=NP, PI=NP, NMC=38.6%, %#200=17.6		28.5						
		@SS-9: Fine to Medium Sand, (A-4(1)), LL=31, PL=24, PI=7, NMC=50.9%, %#200=43.7			SS-9	1	1	1		2
-29.9	32.0			33.5						
		Soft to Very Soft, Wet, Dark Gray, Medium Plasticity, Sandy SILT (ML/A-7-5(4)), Munsell=GLEY1 4/N			SS-10	2	2	2		4
-34.9				38.5						
		@SS-11: LL=47, PL=36, PI=11, NMC=56.1%, %#200=52.0			SS-11	WOH	/12"	2		2
-39.9				43.5						
					SS-12	1	1	1		2
-44.9	47.0			48.5						
		Very Loose, Wet, Greenish Black, Non-Plastic, Silty Fine SAND (SM/A-2-4), Munsell=GLEY1 2.5/10Y			SS-13	WOH	2	2		4
-49.9		@SS-13: LL=NP, PL=NP, PI=NP, NMC=46.2%, %#200=30.1								
	53.5			53.5						

SPT N VALUE ●

PL ✕ MC ○ LL ✕

▲ FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-14		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	J. Wessinger	**Boring Location:**	97+18	**Offset:**	5.6'-LT	**Alignment:**	ALT 1B
Elev.:	0.1 ft	**Latitude:**	32.403431	**Longitude:**	-80.449948	**Date Started:**	6/13/2016
Total Depth:	190 ft	**Soil Depth:**	190 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/15/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0.1 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
-54.9		**HAWTHORN MARL** Stiff to Firm, Moist, Dark Olive Gray, Low Plasticity, Non Reactive, SILT (ML/A-4), Calcaceous, Munsell=5Y 3/2 @SS-15: Soft to Firm			SS-14	2	5	4		9	
				58.5	SS-15	WOH	2	2		4	
-59.9											
				63.0	SS-16	3	3	4		7	
-64.9											
				68.0	SS-17	3	3	4		7	
-69.9											
				72.5	SS-18	3	3	4		7	
-74.9											
	77.0	**COOPER GROUP LIMESTONE** Medium Dense to Loose, Wet, Gray/Black, Low Plasticity, Weakly Reactive, Clayey Fine to Coarse SAND (SC/A-2-4) with Phosphate Nodules, Calcaceous, Munsell=5Y 6/1 & 2.5/1 @SS-20: Light Olive Gray, Strongly Reactive, Munsell=5Y 6/2		77.5	SS-19	16	4	9		13	
-79.9											
				83.5	SS-20	2	2	7		9	
-84.9											
				88.5	SS-21	2	2	3		5	*Hard Lense from 87.0 to 88.0 feet*
-89.9											
				93.5	SS-22	7	16	10		26	
-94.9											
	98.5	Firm to Soft, Wet, Greenish Gray, Non-Plastic to Low Plasticity, Strongly Reactive, Sandy SILT (ML/A-4), Calcaceous, Munsell=GLEY1 5/10Y		98.5	SS-23	2	3	5		8	
-99.9											
				104.0	SS-24	2	2	2		4	
-104.9											

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-14
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	J. Wessinger	**Boring Location:**	97+18	**Offset:**	5.6'-LT	**Alignment:**	ALT 1B
Elev.:	0.1 ft	**Latitude:**	32.403431	**Longitude:**	-80.449948	**Date Started:**	6/13/2016
Total Depth:	190 ft	**Soil Depth:**	190 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/15/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0.1 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		Firm, Wet, Greenish Gray, Non-Plastic to Low Plasticity, Strongly Reactive, Sandy SILT (ML/A-4), Calcaceous, Munsell=GLEY1 5/10Y		108.5	SS-25	3	2	3		5	
-109.9											
				113.5	SS-26	2	3	3		6	
-114.9											
		@SS-27: Stiff		118.5	SS-27	4	4	5		9	
-119.9											
	123.5			123.5	SS-28	3	3	5		8	
		Loose, Moist, Gray, Strongly Reactive, Non-Plastic to Low Plasticity, Silty Fine SAND (SM/A-2-4), Calcaceous, Munsell=5Y 6/1									
-124.9				128.5	SS-29	3	2	4		6	
-129.9											
		@SS-30: No Recovery		133.0	SS-30	3	2	3		5	
-134.9											
		@SS-31: Medium Dense, Greenish Gray, Munsell=GLEY1 7/10Y		138.0	SS-31		5	6		11	*Rod Slipped and Blow Count*
-139.9											
		@SS-32: No Recovery		142.5	SS-32	4	4	5		9	*N Recorded for Top 6"*
-144.9											
		@SS-33: Loose, Fine to Coarse Sand		148.5	SS-33	3	4	4		8	
-149.9											
		@SS-34: No Recovery		153.5	SS-34	4	4	5		9	
-154.9											
				158.5	SS-35	3	4	5		9	
-159.9											

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-14
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	J. Wessinger	**Boring Location:**	97+18	**Offset:**	5.6'-LT	**Alignment:**	ALT 1B
Elev.:	0.1 ft	**Latitude:**	32.403431	**Longitude:**	-80.449948	**Date Started:**	6/13/2016
Total Depth:	190 ft	**Soil Depth:**	190 ft	**Core Depth:**	N/A ft	**Date Completed:**	6/15/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0.1 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Loose, Moist, Greenish Gray, Strongly Reactive, Non-Plastic to Low Plasticity, Silty Fine SAND (SM/A-2-4), Calcaceous, Munsell=GLEY1 7/10Y		163.5	SS-36	3	3	4		7
-164.9				168.5	SS-37	4	3	5		8
-169.9				173.5	SS-38	2	3	5		8
-174.9				178.5	SS-39	3	3	3		6
-179.9				183.5	SS-40	3	4	4		8
-184.9		@SS-40: No Recovery		188.5	SS-41	3	2	4		6
-189.9	190.0	Boring Terminated at 190.0 feet								
-194.9										
-199.9										
-204.9										
-209.9										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

SC_DOT G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

LEGEND

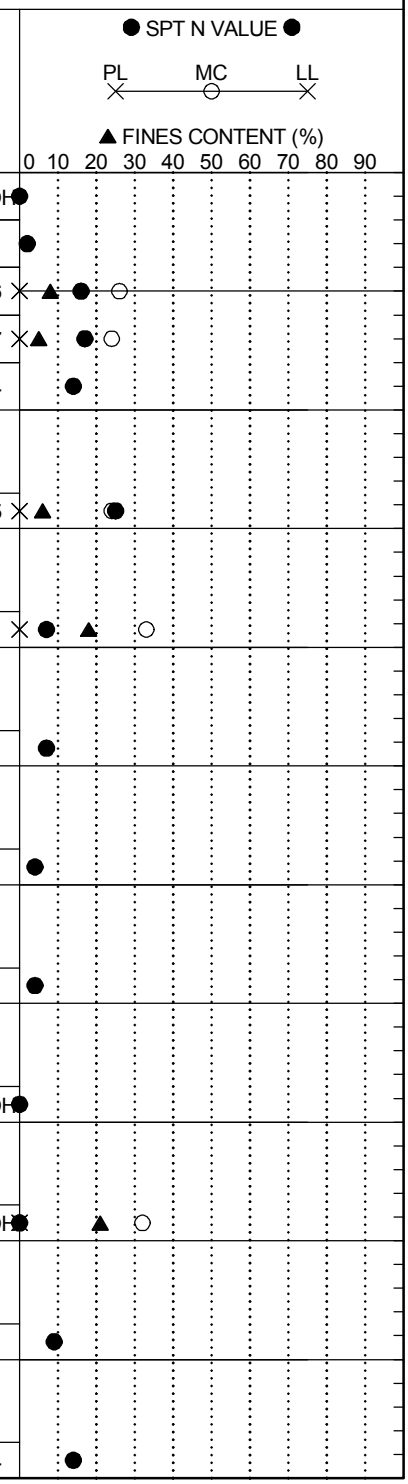
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-15		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	C. Piercy	**Boring Location:**	100+78	**Offset:**	9.6'-RT	**Alignment:**	ALT 1B
Elev.:	1.6 ft	**Latitude:**	32.403014	**Longitude:**	-80.448888	**Date Started:**	8/3/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	8/3/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION
	0.0	▽Marsh
		HOLOCENE
		Very Loose, Wet, Very Dark Gray, Non-Plastic, Non-Reactive, Poorly Graded Fine SAND (SP-SM/A-3) with Silt, Munsell=5Y 3/1
-3.4		@SS-2: Dark Gray, Munsell=5Y 4/1
		@SS-3: Medium Dense, Gray, Weakly Reactive, Munsell=5Y 5/1, LL=NP, PL=NP, PI=NP, NMC=26.2%, %#200=8.2
-8.4		@SS-4: LL=NP, PL=NP, PI=NP, NMC=23.5%, %#200=5.1
		@SS-6: LL=NP, PL=NP, PI=NP, NMC=23.8%, %#200=5.5
-13.4	17.0	
		Loose to Very Loose, Wet, Gray, Non-Plastic, Weakly Reactive, Silty Fine to Medium SAND (SM/A-2-4) with Trace of Shell Fragments, Munsell=5Y 5/1
-18.4		@SS-7: LL=NP, PL=NP, PI=NP, NMC=33.2%, %#200=17.5
-23.4		
-28.4		
		@SS-10: Dark Gray, Munsell=5Y 4/1
-33.4	37.0	
		Very Soft, Wet, Dark Gray, Medium Plasticity, Weakly Reactive, Fine Sandy CLAY (CL/A-4) with Trace of Organics, Munsell=GLEY1 4/N
-38.4	42.0	@SS-11: Organics=4.15%
		Very Loose to Loose, Wet, Dark Gray, Non-Plastic, Weakly Reactive, Silty Fine to Medium SAND (SM/A-2-4) with Trace of Shell Fragments, Munsell=5Y 4/1
-43.4		@SS-12: LL=NP, PL=NP, PI=NP, NMC=31.6%, %#200=20.7
-48.4		
		@SS-14: Medium Dense

Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
0.0	SS-1	WOH/24"				WOH
2.0	SS-2	1	1	1	5	2
4.0	SS-3	7	7	9	4	16
6.0	SS-4	6	8	9	12	17
8.0	SS-5	5	6	8	11	14
13.5	SS-6	5	11	14		25
18.5	SS-7	3	2	5		7
23.5	SS-8	3	3	4		7
28.5	SS-9	3	2	2		4
33.5	SS-10	WOH	1	3		4
38.5	SS-11	WOH/18"				WOH
43.5	SS-12	WOH/18"				WOH
48.5	SS-13	3	3	6		9
53.5	SS-14	5	6	8		14



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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-15
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	100+78	**Offset:**	9.6'-RT	**Alignment:**	ALT 1B
Elev.:	1.6 ft	**Latitude:**	32.403014	**Longitude:**	-80.448888	**Date Started:**	8/3/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	8/3/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		Very Loose to Loose, Wet, Dark Gray, Non-Plastic, Weakly Reactive, Silty Fine to Medium SAND (SM/A-2-4) with Trace of Shell Fragments, Munsell=5Y 4/1	58.5	SS-15	1	1	1		2	
-58.4			63.5	SS-16	3	3	3		6	
-63.4	67.0									
		HAWTHORN MARL Loose to Medium Dense, Wet, Olive Gray, Low Plasticity, Weakly Reactive, Silty Fine SAND (SM/A-2-4), Munsell=5Y 4/2	68.5	SS-17	3	3	5		8	
-68.4		@SS-18: Olive, Munsell=5Y 4/3	73.5	SS-18	4	5	5		10	
-73.4			78.5	SS-19	3	7	16		23	*Hard Layer from 79.5 to 81.5 feet*
-78.4	79.5	**COOPER GROUP LIMESTONE** Medium Dense to Loose, Dark Olive Gray, Low Plasticity, Weakly to Highly Reactive, Silty Fine to Medium SAND (SM/A-2-4) with Phosphate Nodules, Calcaceous, Munsell=5Y 3/2	83.5	SS-20	4	4	5		9	
-83.4		@SS-20: Greenish Gray, Munsell=GLEY1 6/10Y	88.5	SS-21	2	14	13		27	
-88.4		@SS-21: Light Grayish Olive, Munsell=10Y 6/2	93.5	SS-22	3	5	12		17	
-93.4		@SS-22: Light Greenish Gray, Munsell=GLEY1 7/10Y	98.5	SS-23	4	4	4		8	
-98.4			103.5	SS-24	3	4	12		16	
-103.4		@SS-25: Greenish Gray, Munsell=GLEY1 6/5GY	108.5	SS-25	3	4	6		10	

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-15
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	100+78	**Offset:**	9.6'-RT	**Alignment:**	ALT 1B
Elev.:	1.6 ft	**Latitude:**	32.403014	**Longitude:**	-80.448888	**Date Started:**	8/3/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	8/3/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Loose, Dark Greenish Gray, Low Plasticity, Weakly to Highly Reactive, Silty Fine to Medium SAND (SM/A-2-4) with Phosphate Nodules, Calcaceous, Munsell=GLEY1 6/5GY	113.5	SS-26	3	2	3		5
-113.4			118.5	SS-27	3	2	4		6
-118.4			123.5	SS-28	3	1	4		5
-123.4			128.5	SS-29	3	3	4		7
-128.4			133.5	SS-30	4	5	3		8
-133.4			138.5	SS-31	4	3	5		8
-138.4									
	143.5	Stiff, Wet, Greenish Gray, Low Plasticity, Strongly Reactive, Fine Sandy SILT (ML/A-4), Calcaceous, Munsell=GLEY1 6/10Y	143.5	SS-32	4	3	6		9
-143.4									
	148.5		148.5	SS-33	4	4	8		12
-148.4	150.0	Medium Dense, Wet, Greenish Gray, Low Plasticity, Strongly Reactive, Silty Fine SAND (SM/A-2-4), Calcaceous, Munsell=GLEY1 6/10Y							
		Boring Terminated at 150.0 feet							
-153.4									
-158.4									

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

SC_DOT G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-16		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	C. Piercy	**Boring Location:**	105+97	**Offset:**	25.2'-LT	**Alignment:**	ALT 1B
Elev.:	2.4 ft	**Latitude:**	32.402552	**Longitude:**	-80.447291	**Date Started:**	8/1/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	8/2/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	Marsh		0.0	SS-1	WOH/24"				WOH
		HOLOCENE		2.0						
		Very Loose to Loose, Wet, Gray, Low Plasticity, Weakly Reactive, Silty Fine to Medium SAND (SM/A-2-4) with Trace of Organics (Wood), Munsell=5Y 5/1		4.0	SS-2	2	2	3	3	5
-2.6	4.0	@SS-2: Dark Grayish Brown, Munsell=2.5Y 4/2		6.0	SS-3	5	12	16	21	28
				8.0	SS-4	6	11	11	17	22
					SS-5	4	5	10	14	15
-7.6		Medium Dense, Wet, Gray, Non-Plastic, Weakly Reactive, Poorly Graded Fine SAND (SP/A-3) with Trace of Shell Fragments, Munsell=5Y 6/1		13.5	SS-6	7	13	16		29
-12.6		@SS-4: Non-Reactive, LL=NP, PL=NP, PI=NP, NMC=24.5%, %#200=2.1								
	17.0	@SS-6: LL=NP, PL=NP, PI=NP, NMC=24.3%, %#200=2.1		18.5	SS-7	1	2	6		8
-17.6		Loose to Very Loose, Wet, Dark Gray, Non-Plastic, Weakly Reactive, Silty Fine SAND (SM/A-2-4) with Trace of Shell Fragments, Munsell=5Y 4/1		23.5	SS-8	2	2	3		5
-22.6		@SS-8: Gray, Munsell=5Y 5/1, LL=NP, PL=NP, PI=NP, NMC=37.4%, %#200=13.9								
				28.5	SS-9	3	4	6		10
-27.6										
				33.5	SS-10	2	2	2		4
-32.6										
	37.0	Very Loose, Wet, Dark Gray, Medium Plasticity, Weakly Reactive, Clayey Fine SAND (SC/A-6(4)), Munsell=5Y 4/1		38.5	SS-11	1	1	1		2
-37.6	42.0	@SS-11: LL=36, PL=21, PI=15, NMC=56.7%, %#200=46.6		43.5	SS-12	2	1	2		3
-42.6	47.0	Very Loose, Wet, Dark Gray, Non-Plastic, Weakly Reactive, Silty Fine SAND (SM/A-2-4), Munsell=5Y 4/1		48.5	SS-13	WOH/12"				1
		Very Soft, Wet, Dark Gray, High Plasticity, Weakly Reactive, Elastic SILT (MH/A-7-5(25)) with Few Organics, Munsell=GLEY1 4/N, LL=75								
-47.6		@SS-13: LL=75, PL=35, PI=40, NMC=84.8%, %#200=91.0		53.5	SS-14	1	1	1		2
-52.6		@SS-14: Organics=7.22%								
	57.5									

SPT N VALUE ● PL × MC ○ LL × ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	B-16		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	C. Piercy	**Boring Location:**	105+97	**Offset:**	25.2'-LT	**Alignment:**	ALT 1B
Elev.:	2.4 ft	**Latitude:**	32.402552	**Longitude:**	-80.447291	**Date Started:**	8/1/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	8/2/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Loose, Wet, Dark Gray, Non-Plastic, Weakly Reactive, Silty Fine SAND (SM/A-2-4), Munsell=5Y 4/1	58.5	SS-15	WOH	2	3		5
-57.6			63.5	SS-16	3	3	5		8
-62.6	67.0								
		Soft, Wet, Dark Gray, Medium Plasticity, Weakly Reactive, Fine Sandy CLAY (CL/A-4), Munsell=5Y 4/1	68.5	SS-17	2	1	2		3
-67.6	70.0	**HAWTHORN MARL**							
		Very Loose to Loose, Wet, Olive Gray, Low Plasticity, Weakly Reactive, Silty Fine SAND (SM/A-2-4), Munsell=5Y 4/2	73.5	SS-18	3	2	4		6
-72.6			78.5	SS-19	3	4	23		27
-77.6	80.0	@SS-19: Medium Dense, Dark Olive Gray, Munsell=5Y 3/2							
		COOPER GROUP LIMESTONE							
		Medium Dense to Loose, Wet, Light Greenish Gray, Low Plasticity, Strongly Reactive, Silty Fine to Medium SAND (SM/A-2-4), Calcaceous, Munsell=GLEY1 7/5GY	83.5	SS-20	4	6	5		11
-82.6			88.5	SS-21	3	2	3		5
-87.6		@SS-21: Greenish Gray, Munsell=GLEY1 6/10Y							
			93.5	SS-22	24	20	8		28
-92.6		@SS-22: Light Greenish Gray, Munsell=GLEY1 7/10Y							
			98.5	SS-23	8	10	5		15
-97.6									
			103.5	SS-24	3	4	6		10
-102.6		@SS-24: Greenish Gray, Munsell=GLEY1 6/5GY							
			108.5	SS-25	3	2	4		6
-107.6									
			113.5	SS-26	4	4	5		9

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Hard Layer from 81.0 to 81.5 feet

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	B-16
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	105+97	**Offset:**	25.2'-LT	**Alignment:**	ALT 1B
Elev.:	2.4 ft	**Latitude:**	32.402552	**Longitude:**	-80.447291	**Date Started:**	8/1/2016
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	N/A ft	**Date Completed:**	8/2/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Loose to Medium Dense, Wet, Greenish Gray, Low Plasticity, Strongly Reactive, Silty Fine to Medium SAND (SM/A-2-4), Calcaceous, Munsell=GLEY1 6/5GY		118.5	SS-27	3	3	5		8
-117.6				123.5	SS-28	5	3	6		9
-122.6				128.5	SS-29	3	3	4		7
-127.6		@SS-29: No Recovery		133.5	SS-30	4	3	3		6
-132.6		@SS-30: No Recovery		138.5	SS-31	3	4	3		7
-137.6				143.5	SS-32	5	6	6		12
-142.6				148.5	SS-33	3	4	7		11
-147.6	150.0	Boring Terminated at 150.0 feet								
-152.6										
-157.6										
-162.6										
-167.6										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	TS-1		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	M. Touchberry	**Boring Location:**	40+78	**Offset:**	305.9'-RT	**Alignment:**	ALT 1B
Elev.:	6.4 ft	**Latitude:**	32.408395	**Longitude:**	-80.467293	**Date Started:**	11/16/2015
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	0 ft	**Date Completed:**	11/17/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	Ameridrill	**Groundwater:**	**TOB** 4 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	Grassed Parking Area								
		EMBANKMENT FILL		0.0						
		Medium Dense, Dry to Moist, Dark Reddish Brown, Non-Plastic, Fine to Medium SAND (SP-SM/A-1) with Silt, Munsell= 5YR 2.5/2		2.0	SS-1	3	5	6	6	11
	3.0	Loose to Very Loose, Wet, Very Dark Gray, Non-Plastic, Silty Fine SAND (SM/A-2-4) with Trace of Shell Fragments, Munsell=GLEY1 3/N		4.0	SS-2	5	6	3	5	9
1.4				6.0	SS-3	2	2	1	1	3
		@SS-4: Medium Dense to Dense, Dark Greenish Gray, Munsell=GLEY1 4/10Y, LL=NP, PL=NP, PI=NP, NMC=25.9%, %#200=13.9		8.0	SS-4	2	5	9	13	14
		@SS-5: Greenish Gray, Munsell= GLEY1 5/10Y		10.0	SS-5	15	22	15	8	37
-3.6		@SS-6: Very Loose, Very Dark Greenish Gray, Munsell=GLEY1 3/10Y		12.0	SS-6	1	1	1	2	2
	12.0	**ENGINEERED FILL**		12.0						
		Medium Dense, Wet, Greenish Gray, Non-Plastic, Fine SAND (SP-SM/A-1) with Silt, Munsell=GLEY1 5/10Y		14.0	SS-7	3	7	7	11	14
-8.6	15.5	@SS-8: Very Loose, Light Greenish Gray, Munsell=GLEY1 7/10Y		16.0	SS-8	2	2	2	2	4
		HOLOCENE		18.0	SS-9	WOH/24"				WOH
		Very Loose to Loose, Wet, Very Dark Greenish Gray, Low Plasticity, Silty, Clayey Fine SAND (SC-SM/A-4(0)), Munsell=GLEY1 3/10Y		20.0	SS-10	WOH	1	3	4	4
-13.6		@SS-9: LL=25, PL=21, PI=4, NMC=52.2%, %#200=49.7		22.0	SS-11	WOH	3	6	4	9
	21.0	Loose to Medium Dense, Wet, Greenish Gray, Non-Plastic, Silty Fine SAND (SM/A-2-4), Munsell=GLEY1 5/10Y		24.0	SS-12	5	7	8	6	15
-18.6		@SS-12: LL=NP, PL=NP, PI=NP, NMC=26.7%, %#200=16.3		26.0	SS-13	2	2	4	4	6
	26.0	@SS-13: with Trace of Shell Fragments								
		Very Soft, Wet, Very Dark Greenish Gray, Medium Plasticity, Sandy SILT (ML/A-7-6(9)) with Trace of Shell Fragments, Munsell=GLEY1 3/10Y		28.0	SS-14	WOH	1	1	1	2
-23.6		@SS-14: LL=42, PL=27, PI=15, NMC=65.5%, %#200=65.6		30.0	SS-15	WOH/18"			1	WOH
	32.0			32.0	SS-16	WOH/24"				WOH

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	TS-1
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	M. Touchberry	**Boring Location:**	40+78	**Offset:**	305.9'-RT	**Alignment:**	ALT 1B
Elev.:	6.4 ft	**Latitude:**	32.408395	**Longitude:**	-80.467293	**Date Started:**	11/16/2015
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	0 ft	**Date Completed:**	11/17/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	Ameridrill	**Groundwater:**	**TOB** 4 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Very Loose, Wet, Very Dark Greenish Gray, Non-Plastic, Silty Fine SAND (SM/A-2-4) with Shell Fragments, Munsell=GLEY1 3/10Y	34.0	SS-17	3	1/12"		1	1
-28.6		@SS-17: LL=NP, PL=NP, PI=NP, NMC=40.2%, %#200=28.3	36.0	SS-18	1	1	2	2	3
			38.0	SS-19	1	1	1	1	2
			40.0	SS-20	2	2	1	1	3
-33.6	41.0		42.0	SS-21	2	1	2	1	3
		Soft to Very Soft, Wet, Very Dark Greenish Gray, Non-Plastic to Low Plasticity, SILT (ML/A-4), Munsell=GLEY1 3/10Y	44.0	SS-22	1	1	1	WOH	2
	44.0	@SS-22: with Fine Sand and Trace of Shell Fragments	44.0	SS-23	WOH	2	1	3	3
-38.6		Very Loose, Wet, Very Dark Greenish Gray, Non-Plastic, Silty Fine to Coarse SAND (SM/A-2-4), Munsell=GLEY1 3/10Y, LL=NP, PL=NP, PI=NP, NMC=24.0%, %#200=12.2	46.0	SS-24	7	10	11	5	21
	46.0		48.0	SS-25	2	6	11	8	17
	48.0	Medium Dense, Wet, Gray, Non-Plastic, Poorly Graded Fine to Coarse SAND (SP-SM/A-1-b) with Silt and Trace of Shell Fragments, Munsell=GLEY1 5/N, LL=NP, PL=NP, PI=NP, NMC=20.1%, %#200=9.8	50.0	SS-26	2	3	3	5	6
-43.6		**HAWTHORN MARL**	52.0	SS-27	3	3	3	4	6
		Very Stiff, Moist, Olive/Dark Greenish Gray, Low Plasticity, Sandy SILT (ML/A-5(4)), Munsell=10Y 4/4 & 4/2	54.0	SS-28	4	5	5	5	10
		@SS-26: Firm	56.0	SS-29	WOH	2	2	3	4
-48.6		@SS-27: with Trace of Shell Fragments	58.0	SS-30	4	4	4	5	8
		@SS-28: Very Stiff, Dark Grayish Olive, Munsell=10Y 4/2	60.0	SS-31	2	2	4	5	6
		@SS-29: Soft to Firm, LL=44, PL=39, PI=5, NMC=62.4%, %#200=64.2	62.0	SS-32	3	4	6	8	10
-53.6			64.0						
		@SS-32: Stiff							

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	TS-1
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	M. Touchberry	**Boring Location:**	40+78	**Offset:**	305.9'-RT	**Alignment:**	ALT 1B
Elev.:	6.4 ft	**Latitude:**	32.408395	**Longitude:**	-80.467293	**Date Started:**	11/16/2015
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	0 ft	**Date Completed:**	11/17/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	Ameridrill	**Groundwater:**	**TOB** 4 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
-58.6		Very Stiff to Stiff, Moist, Dark Grayish Olive, Low Plasticity, Sandy SILT (ML/A-5(4)), Munsell=10Y 4/2	66.0	SS-33	7	7	9	10	16
			68.0	SS-34	2	4	5	6	9
				SS-35	3	5	6	6	11
-63.6			70.0	SS-36	3	4	6	9	10
	72.0	Stiff, Moist, Dark Grayish Olive, High Plasticity, Sandy Elastic SILT (MH/A-7-5(16)), Munsell=10Y 4/2	72.0	SS-37	4	4	6	15	10
-68.6	75.0	@SS-37: LL=55, PL=32, PI=23, NMC=61.7%, %#200=67.4	74.0	SS-38	15	19	23	26	42
		=> Hard	76.0	SS-39	4	5	8	10	13
		COOPER GROUP LIMESTONE	78.0	SS-40	8	10	18	24	28
		Hard, Moist, White, Low Plasticity, Sandy SILT (ML/A-4(4)) with Phosphate Nodules, Munsell=GLEY1 8/N							
-73.6		@SS-39: Stiff to Very Stiff, LL=31, PL=23, PI=8, NMC=44.5%, %#200=64.7	80.0	SS-41	4	4	5	6	9
	81.0	Loose to Medium Dense, Moist, Gray, Non-Plastic, Silty Fine SAND (SM/A-4(0)), Munsell=5Y 6/1	82.0	SS-42	3	3	3	11	6
		@SS-41: LL=NP, PL=NP, PI=NP, NMC=42.6%, %#200=49.1	84.0	SS-43	3	8	18	24	26
-78.6			86.0	SS-44	3	4	6	12	10
			88.0	SS-45	5	6	7	10	13
-83.6		@SS-46: Light Olive Gray, Munsell=5Y 6/2	90.0	SS-46	2	2	4	5	6
			92.0	SS-47	5	6	6	9	12
			94.0	SS-48	6	7	14	18	21
-88.6	96.0		96.0						

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	TS-1		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	M. Touchberry	**Boring Location:**	40+78	**Offset:**	305.9'-RT	**Alignment:**	ALT 1B
Elev.:	6.4 ft	**Latitude:**	32.408395	**Longitude:**	-80.467293	**Date Started:**	11/16/2015
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	0 ft	**Date Completed:**	11/17/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	Ameridrill	**Groundwater:**	**TOB** 4 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Stiff to Very Stiff, Moist, Light Greenish Gray, Non-Plastic, Sandy SILT (ML/A-4(0)), Munsell=GLEY1 5GY 7/1		98.0	SS-49	2	4	8	12	12
					SS-50	9	11	19	29	30
-93.6				100.0	SS-51	11	6	8	25	14
				102.0	SS-52	4	5	6	17	11
		@SS-53: LL=NP, PL=NP, PI=NP, NMC=33.4%, %#200=56.8		104.0	SS-53	5	6	15	24	21
-98.6				106.0	SS-54	4	6	12	22	18
				108.0	SS-55	5	5	7	16	12
-103.6		@SS-56: Firm to Stiff		110.0	SS-56	1	4	4	13	8
				112.0	SS-57	4	4	6	10	10
		@SS-58: Hard		114.0	SS-58	7	13	19	29	32
-108.6		@SS-59: Stiff to Very Stiff		116.0	SS-59	4	5	7	17	12
				118.0	SS-60	4	9	13	20	22
-113.6		@SS-61: Firm to Stiff, LL=NP, PL=NP, PI=NP, NMC=35.4%, %#200=55.3		120.0	SS-61	3	3	4	13	7
				122.0	SS-62	3	4	5	8	9
		@SS-63: Hard		124.0	SS-63	7	14	21	30	35
-118.6		@SS-64: Stiff to Very Stiff		126.0	SS-64	WOH	5	9	25	14
				128.0						

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	TS-1
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	M. Touchberry	**Boring Location:**	40+78	**Offset:**	305.9'-RT	**Alignment:**	ALT 1B
Elev.:	6.4 ft	**Latitude:**	32.408395	**Longitude:**	-80.467293	**Date Started:**	11/16/2015
Total Depth:	150 ft	**Soil Depth:**	150 ft	**Core Depth:**	0 ft	**Date Completed:**	11/17/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550X	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	Ameridrill	**Groundwater:**	**TOB** 4 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
-123.6		Very Stiff to Hard, Moist, Light Greenish Gray, Non-Plastic, Sandy SILT (ML/A-4(0)), Munsell=GLEY1 5GY 7/1		130.0	SS-65	3	4	13	46	17
				132.0	SS-66	8	14	31	32	45
		@SS-67: Stiff to Very Stiff			SS-67	3	5	5	12	10
-128.6				134.0	SS-68	9	13	15	18	28
				136.0	SS-69	4	6	8	22	14
				138.0	SS-70	5	5	7	16	12
-133.6				140.0	SS-71	5	9	12	16	21
				142.0	SS-72	5	4	5	16	9
				144.0	SS-73	5	11	17	25	28
-138.6				146.0	SS-74	4	5	6	13	11
				148.0	SS-75	7	9	15	35	24
-143.6	150.0	Boring Terminated at 150.0 feet								
-148.6										

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

LEGEND

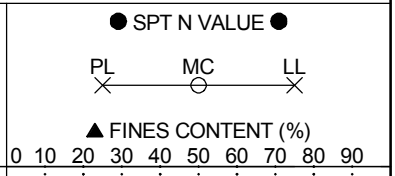
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SC_DOT G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	SB-1		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	M. Miller	**Boring Location:**	40+85	**Offset:**	293.6'-RT	**Alignment:**	ALT 1B
Elev.:	6.8 ft	**Latitude:**	32.408419	**Longitude:**	-80.467258	**Date Started:**	7/6/2016
Total Depth:	520 ft	**Soil Depth:**	520 ft	**Core Depth:**	250 ft	**Date Completed:**	7/14/2016
Bore Hole Diameter (in):	5	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Failing 1500	**Drill Method:**	RW/RC	**Hammer Type:**	Automatic	**Energy Ratio:**	75.4%
Core Size:	NQ	**Driller:**	Huss	**Groundwater:**	**TOB** 6 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
	0.0	Gravel/Grassed Parking Area								
		EMBANKMENT FILL		0.0						
		Medium Dense to Dense, Dry, Gray, Non-Plastic, Silty Fine SAND (SM/A-2-4) with Gravel, Munsell=7.5YR 3/2		2.0	SS-1	8	12	13	13	25
				4.0	SS-2	11	14	17	18	31
1.8		▽@SS-2: Brown, Munsell=10YR 5/3		6.0	SS-3	1	2	2	2	4
		@SS-3: No Recovery, Very Loose		8.0	SS-4	1	3	7	13	10
				10.0	SS-5	6	9	12	11	21
-3.2	10.0	**ENGINEERED FILL**		12.0	SS-6	3	3	2	2	5
		Loose, Wet, Gray, Non-Plastic, Silty Fine to Medium SAND (SM/A-2-4) with Trace of Shells, Munsell=5Y 5/1		14.0	SS-7	1	2	4	7	6
-8.2	16.0			16.0	SS-8	7	5	2	3	7
		HOLOCENE		18.0	SS-9	1	WOH/18"			WOH
		Very Loose to Loose, Wet, Dark Gray, Non-Plastic, Silty Fine SAND (SM/A-2-4) with Trace of Shells, Munsell=5Y 4/1		20.0	SS-10	4	5	3	4	8
-13.2		@SS-10: Organics=1.92%		22.0	SS-11	8	5	5	7	10
		@SS-11: Gray, Fine to Medium Sand, Munsell=5Y 5/1		24.0	SS-12	2	2	8	5	10
-18.2				26.0	SS-13	3	2	6	6	8
		@SS-14: Dark Olive Gray, Fine Sand, Munsell=5Y 3/2		28.0	SS-14	2	WOH	1	1	1
		@SS-15: Gray, Munsell=5Y 6/1		30.0	SS-15	1	1	7	15	8
-23.2		@SS-16: Dense		32.0	SS-16	7	18	21		39
		@SS-17: Loose to Very Loose, Dark Gray, Fine to Coarse Sand, Munsell=5Y 4/1		34.0	SS-17	3	4	2	1	6
-28.2				36.0	SS-18	1	2	1	2	3
		@SS-19: Organics =1.42%		38.0	SS-19	2	2	2	1	4
				40.0	SS-20	2	2	2	4	4
-33.2	40.0	**HAWTHORN MARL**		42.0	SS-21	1	1/12"		2	1
		Very Loose, Wet, Dark Gray, Non-Reactive to Weakly Reactive, High Plasticity, Clayey Fine SAND (SC/A-2-7(2)) with Trace of Shell Fragments, Munsell=GLEY1 4/N		44.0	SS-22	1	1/12"		1	1
-38.2		@SS-23: LL=42, PL=20, PI=22, NMC=55.4%, %#200=31.9		46.0	SS-23	1/12"		1	1	2
				48.0	SS-24	WOH	1	1	6	2
		@SS-25: Medium Dense, Gray, Strongly Reactive, Munsell=5Y 4/1		50.0	SS-25	7	7	6	2	13



Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	SB-1		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	M. Miller	**Boring Location:**	40+85	**Offset:**	293.6'-RT	**Alignment:**	ALT 1B
Elev.:	6.8 ft	**Latitude:**	32.408419	**Longitude:**	-80.467258	**Date Started:**	7/6/2016
Total Depth:	520 ft	**Soil Depth:**	520 ft	**Core Depth:**	250 ft	**Date Completed:**	7/14/2016
Bore Hole Diameter (in):	5	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Failing 1500	**Drill Method:**	RW/RC	**Hammer Type:**	Automatic	**Energy Ratio:**	75.4%
Core Size:	NQ	**Driller:**	Huss	**Groundwater:**	**TOB** 6 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		Medium Dense to Loose, Wet, Olive, Non-Reactive, High Plasticity, Clayey Fine SAND (SC/A-2-7(2)) with Trace of Shell Fragments, Munsell=5Y 5/3	52.0	SS-26	6	13	13	12	26
			54.0	SS-27	2	4	4	5	8
-48.2		@SS-27: Olive Gray, Munsell=5Y 4/2	56.0	SS-28	3	4	4	6	8
			58.0	SS-29	3	3	3	5	6
			60.0	SS-30	2	2	3	4	5
-53.2		@SS-31: Dark Olive Gray, Munsell=5Y 3/2	62.0	SS-31	2	2	4	4	6
			64.0	SS-32	2	3	5	5	8
-58.2		@SS-33: Olive Gray, Munsell=5Y 4/2	66.0	SS-33	3	4	6	6	10
			68.0	SS-34	4	5	7	8	12
			70.0	SS-35	4	4	5	7	9
-63.2			72.0	SS-36	4	5	6	7	11
			74.0	SS-37	3	6	9	9	15
-68.2		@SS-39: Dense	76.0	SS-38	5	8	19	50/1.5"	27
	77.0	**COOPER GROUP LIMESTONE**	78.0	SS-39	33	21	28	20	49
		Dense to Medium Dense, Wet, Light Greenish Gray, Non-Plastic, Non-Reactive, Silty Fine SAND (SM/A-4(0)), Munsell=GLEY1 7/10Y		SS-40	2	6	11	13	17
-73.2			83.5						
		@SS-41: Loose		SS-41	3	3	4		7
-78.2			88.5						
		@SS-42: No Recovery		SS-42	2	2	3		5
-83.2			93.5						
		@SS-43: Weakly Reactive, LL=NP, PL=NP, PI=NP, NMC=44.7%, %#200=41.3		SS-43	6	4	2		6
-88.2			98.5						
		@SS-44: Non-Reactive		SS-44	4	4	5		9

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	SB-1		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	M. Miller	**Boring Location:**	40+85	**Offset:**	293.6'-RT	**Alignment:**	ALT 1B
Elev.:	6.8 ft	**Latitude:**	32.408419	**Longitude:**	-80.467258	**Date Started:**	7/6/2016
Total Depth:	520 ft	**Soil Depth:**	520 ft	**Core Depth:**	250 ft	**Date Completed:**	7/14/2016
Bore Hole Diameter (in):	5	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Failing 1500	**Drill Method:**	RW/RC	**Hammer Type:**	Automatic	**Energy Ratio:**	75.4%
Core Size:	NQ	**Driller:**	Huss	**Groundwater:**	**TOB** 6 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		@SS-45: Medium Dense to Loose		103.5	SS-45	4	5	6		11
-98.2				108.5	SS-46	3	4	4		8
-103.2				113.5	SS-47	5	3	11		17
-108.2				118.5	SS-48	2	1	2		3
-113.2		@SS-48: Very Loose								
	122.0	Firm, Wet, Light Greenish Gray, Medium Plasticity, Non-Reactive to Strongly Reactive, Fine Sandy SILT (ML/A-7-5(8)), Munsell=GLEY1 7/10Y		123.5	SS-49	4	4	4		8
-118.2		@SS-50: Hard		128.5	SS-50	15	33	50/3.5"		83+
-123.2		@UD-1: LL=42, PL=30, PI=12, NMC=38.0%, %#200=66.3		130.0	UD-1	%REC=100				
		@SS-51: Stiff		133.5	SS-51	5	6	7		13
-128.2										
	138.5	Very Stiff to Stiff, Wet, Light Greenish Gray, High Plasticity, Strongly Reactive, Fat CLAY (CH/A-7-6(33)), Munsell=GLEY1 7/10Y		138.5	SS-52	12	12	8		20
-133.2		@SS-52: LL=63, PL=29, PI=34, NMC=68.0%, %#200=86.3		143.5	SS-53	4	5	5		10
-138.2	145.0	Stiff, Wet, Light Greenish Gray, Medium Plasticity, Strongly Reactive, Sandy SILT (ML/A-6(6)), Munsell=GLEY1 7/10Y		145.0	UD-2	%REC=100				
		@UD-2: LL=38, PI=25, PI=13, NMC=33.1%,		148.5	SS-54	5	7	7		14

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	SB-1
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	M. Miller	**Boring Location:**	40+85	**Offset:**	293.6'-RT	**Alignment:**	ALT 1B
Elev.:	6.8 ft	**Latitude:**	32.408419	**Longitude:**	-80.467258	**Date Started:**	7/6/2016
Total Depth:	520 ft	**Soil Depth:**	520 ft	**Core Depth:**	250 ft	**Date Completed:**	7/14/2016
Bore Hole Diameter (in):	5	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Failing 1500	**Drill Method:**	RW/RC	**Hammer Type:**	Automatic	**Energy Ratio:**	75.4%
Core Size:	NQ	**Driller:**	Huss	**Groundwater:**	**TOB** 6 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
		%#200=57.3								
-148.2		Stiff, Wet, Light Greenish Gray, Medium Plasticity, Strongly Reactive, Sandy SILT (ML/A-6(6)), Munsell=GLEY1 7/10Y		158.5	SS-55	4	4	5		9
-153.2										
-158.2	166.0									
		Loose to Medium Dense, Wet, Light Greenish Gray, Non-Plastic, Strongly Reactive, Silty Fine SAND (SM/A-4(0)), Munsell=GLEY1 7/10Y		168.5	SS-56	6	8	10		18
-163.2				170.0	UD-3	%REC=0				
-168.2										
		@SS-57: LL=NP, PL=NP, PI=NP, NMC=32.9%, %#200=43.5		178.5	SS-57	8	12	15		27
-173.2										
-178.2										
	188.5			188.5						
		Firm to Stiff, Wet, Greenish Gray, Medium Plasticity, Strongly Reactive, Fine Sandy SILT (ML/A-7-6(6)), Munsell=GLEY1 6/10Y			SS-58	4	3	5		8
-183.2										
-188.2				198.5						
				200.0	SS-59	5	5	7		12

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	SB-1
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	M. Miller	**Boring Location:**	40+85	**Offset:**	293.6'-RT	**Alignment:**	ALT 1B
Elev.:	6.8 ft	**Latitude:**	32.408419	**Longitude:**	-80.467258	**Date Started:**	7/6/2016
Total Depth:	520 ft	**Soil Depth:**	520 ft	**Core Depth:**	250 ft	**Date Completed:**	7/14/2016
Bore Hole Diameter (in):	5	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Failing 1500	**Drill Method:**	RW/RC	**Hammer Type:**	Automatic	**Energy Ratio:**	75.4%
Core Size:	NQ	**Driller:**	Huss	**Groundwater:**	**TOB** 6 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6" 2nd 6" 3rd 6" 4th 6"	N Value
-198.2		Stiff to Very Stiff, Wet, Greenish Gray, Medium Plasticity, Strongly Reactive, Fine Sandy SILT (ML/A-7-6(6)), Munsell=GLEY1 6/10		UD-4	%REC=95	
		@UD-4: LL=43, PL=27, PI=16, NMC=32.0%, %#200=52.1	208.5			
-203.2				SS-60	5 7 9	16
-208.2			218.5			
-213.2				SS-61	5 6 6	12
	221.0	Very Stiff to Hard, Wet, Greenish Gray, Medium Plasticity, Strongly Reactive, SILT (ML/A-7-5(15)) with Sand, Munsell=GLEY1 6/10Y				
-218.2			228.5			
			230.0	SS-62	11 12 21	33
-223.2		@UD-5: LL=48, PL=30, PI=18, NMC=32.6%, %#200=77.7		UD-5	%REC=99	
-228.2						
	238.5	Very Stiff to Hard, Wet, Greenish Gray, Medium Plasticity, Strongly Reactive, Lean CLAY (CL/A-6(16)), Munsell=GLEY1 6/10Y	238.5			
				SS-63	8 9 12	21
-233.2		@SS-63: LL=40, PL=23, PI=17, NMC=34.4%, %#200=87.8				
-238.2			248.5			
	250.0		250.0	SS-64	26 39 34	73

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	SB-1		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	M. Miller	**Boring Location:**	40+85	**Offset:**	293.6'-RT	**Alignment:**	ALT 1B
Elev.:	6.8 ft	**Latitude:**	32.408419	**Longitude:**	-80.467258	**Date Started:**	7/6/2016
Total Depth:	520 ft	**Soil Depth:**	520 ft	**Core Depth:**	250 ft	**Date Completed:**	7/14/2016
Bore Hole Diameter (in):	5	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Failing 1500	**Drill Method:**	RW/RC	**Hammer Type:**	Automatic	**Energy Ratio:**	75.4%
Core Size:	NQ	**Driller:**	Huss	**Groundwater:**	**TOB** 6 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		END ROTARY WASH BORING. START NQ CORING						
		COOPER GROUP LIMESTONE						
		Greenish Gray, Very Plastic, Weakly to Strongly Reactive, Sandy Fat CLAY (CH/A-7-6(34)), Munsell=GLEY1 5/5GY						
-248.2		@252.6': UC Strength=143.5 psi		255.0	NQ-1			
				257.0	NQ-2			
		@UD-6: LL=76, PL=21, PI=55, NMC=31.6%, %#200=65.1			UD-6	%REC=100		
-253.2				260.0	NQ-3			
-258.2				265.0	NQ-4			
-263.2				270.0	NQ-5			
-268.2	275.0	Wet to Moist, Greenish Gray, Low Plasticity, Strongly Reactive, SILT (ML/A-4(1)) with Fine Sand, Munsell=GLEY1 5/5GY		275.0	NQ-6			
		@NQ-6: LL=32, PL=30, PI=2, NMC=30.1%, %#200=71.3		277.0	UD-7	%REC=100		*Pitcher Barrel Crimped, Damaged*
-273.2				280.0	NQ-7			*Sample*
-278.2				285.0	NQ-8			
-283.2				290.0	NQ-9			
-288.2				295.0	NQ-10			
				297.0				
				298.0	UD-8	%REC=100		*Encountered Refusal at 12"*
		@299.2': UC Strength=166.5 psi						

LEGEND

Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	SB-1		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	M. Miller	**Boring Location:**	40+85	**Offset:**	293.6'-RT	**Alignment:**	ALT 1B
Elev.:	6.8 ft	**Latitude:**	32.408419	**Longitude:**	-80.467258	**Date Started:**	7/6/2016
Total Depth:	520 ft	**Soil Depth:**	520 ft	**Core Depth:**	250 ft	**Date Completed:**	7/14/2016
Bore Hole Diameter (in):	5	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Failing 1500	**Drill Method:**	RW/RC	**Hammer Type:**	Automatic	**Energy Ratio:**	75.4%
Core Size:	NQ	**Driller:**	Huss	**Groundwater:**	**TOB** 6 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value
	303.0	Wet to Moist, Greenish Gray, Low Plasticity, Strongly Reactive, SILT (ML/A-4(1)) with Fine Sand, Munsell=GLEY1 5/5GY	303.0	NQ-11		
-298.2		Wet to Moist, Greenish Gray, Low Plasticity, Strongly Reactive, Gravelly SILT (ML/A-4(1)) with Sand, Munsell=GLEY1 5/5GY @NQ-12: LL=37, PL=34, PI=3, NMC=30.3%, %#200=53.3	308.0	NQ-12		
-303.2				NQ-13		
-308.2			313.0	NQ-14		
-313.2			318.0	NQ-15		
-318.2		@324.3': UC Strength=85.9 psi	323.0	NQ-16		
-323.2		@NQ-17: Moderately Reactive	328.0	NQ-17		
-328.2			333.0	NQ-18		
-333.2		@NQ-19: Medium Plasticity, Strongly Reactive, A-6(12)), LL=40, PL=26, PI=14, NMC=25.9%, %#200=82.9	338.0	NQ-19		
-338.2			343.0	NQ-20		
			348.0			

SPT N VALUE: PL, MC, LL

FINES CONTENT (%): 0 10 20 30 40 50 60 70 80 90

Continued Next Page

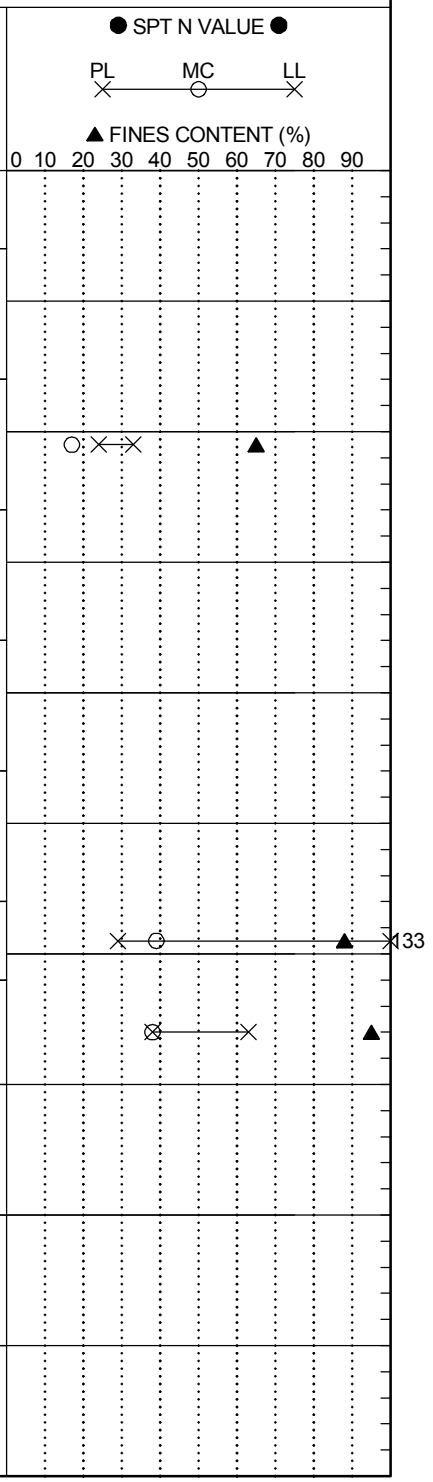
LEGEND

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	SB-1
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	M. Miller	**Boring Location:**	40+85	**Offset:**	293.6'-RT	**Alignment:**	ALT 1B
Elev.:	6.8 ft	**Latitude:**	32.408419	**Longitude:**	-80.467258	**Date Started:**	7/6/2016
Total Depth:	520 ft	**Soil Depth:**	520 ft	**Core Depth:**	250 ft	**Date Completed:**	7/14/2016
Bore Hole Diameter (in):	5	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Failing 1500	**Drill Method:**	RW/RC	**Hammer Type:**	Automatic	**Energy Ratio:**	75.4%
Core Size:	NQ	**Driller:**	Huss	**Groundwater:**	**TOB** 6 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value
		Wet to Moist, Greenish Gray, Low Plasticity, Strongly Reactive, Gravelly SILT (ML/A-4(1)) with Sand, Munsell=GLEY1 5/5GY		353.0	NQ-21		
-348.2					NQ-22		
	358.0	Wet to Moist, Greenish Gray, Low Plasticity, Strongly Reactive, Sandy SILT (ML/A-4(4)), Munsell=GLEY1 5/5GY		358.0			
-353.2		@NQ-23: LL=33, PL=24, PI=9, NMC=17.4%, %#200=64.6			NQ-23		
		@359.0': UC Strength=236.4 psi		363.0			
-358.2					NQ-24		
				368.0			
-363.2					NQ-25		
	373.0	Wet to Moist, Greenish Gray, Very Plastic, Strongly Reactive, Fat CLAY (CH/A-7-6(104)), Munsell=GLEY1 5/5GY		373.0			
-368.2					NQ-26		
		@UD-9: LL=133, PL=29, PI=104, NMC=39.3%, %#200=87.8		378.0			
-373.2					UD-9	%REC=100	
	381.0	**OCALA LIMESTONE**		381.0			
		Wet to Moist, Greenish Gray, High Plasticity, Strongly Reactive, Elastic SILT (MH/A-7-5(31)), Munsell=GLEY1 5/5GY			NQ-27		
-378.2		@NQ-27: LL=63, PL=38, PI=25, NMC=38.3%, %#200=94.7		385.0			
		@381.3': UC Strength=233.5 psi			NQ-28		
-383.2				390.0			
					NQ-29		
-388.2				395.0			
					NQ-30		
				400.0			



Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862	**County:**	Beaufort	**Boring No.:**	SB-1		
Site Description:	US 21 Bridge Replacement over Harbor River			**Route:**	US 21		
Eng./Geo.:	M. Miller	**Boring Location:**	40+85	**Offset:**	293.6'-RT	**Alignment:**	ALT 1B
Elev.:	6.8 ft	**Latitude:**	32.408419	**Longitude:**	-80.467258	**Date Started:**	7/6/2016
Total Depth:	520 ft	**Soil Depth:**	520 ft	**Core Depth:**	250 ft	**Date Completed:**	7/14/2016
Bore Hole Diameter (in):	5	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Failing 1500	**Drill Method:**	RW/RC	**Hammer Type:**	Automatic	**Energy Ratio:**	75.4%
Core Size:	NQ	**Driller:**	Huss	**Groundwater:**	**TOB** 6 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value	● SPT N VALUE ● PL MC LL ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		Wet to Moist, Greenish Gray, High Plasticity, Strongly Reactive, Elastic SILT (MH/A-7-5(31)), Munsell=GLEY1 5/5GY		405.0	NQ-31			
-398.2								
				410.0	NQ-32			
-403.2								
				415.0	NQ-33			
-408.2								
				420.0	NQ-34			
-413.2								
				425.0	NQ-35			
-418.2								
				430.0	NQ-36			
-423.2								
				435.0	NQ-37			
-428.2								
	440.0			440.0	NQ-38			
-433.2		Wet to Moist, Greenish Gray, Low Plasticity, Strongly Reactive, Fine Sandy SILT (ML/A-4)						
				445.0	NQ-39			
-438.2								
				450.0	NQ-40			

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	SB-1
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	M. Miller	**Boring Location:**	40+85	**Offset:**	293.6'-RT	**Alignment:**	ALT 1B
Elev.:	6.8 ft	**Latitude:**	32.408419	**Longitude:**	-80.467258	**Date Started:**	7/6/2016
Total Depth:	520 ft	**Soil Depth:**	520 ft	**Core Depth:**	250 ft	**Date Completed:**	7/14/2016
Bore Hole Diameter (in):	5	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Failing 1500	**Drill Method:**	RW/RC	**Hammer Type:**	Automatic	**Energy Ratio:**	75.4%
Core Size:	NQ	**Driller:**	Huss	**Groundwater:**	**TOB** 6 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		Wet to Moist, Greenish Gray, Low Plasticity, Strongly Reactive, Fine Sandy SILT (ML/A-4)		455.0	NQ-41			
-448.2								
				460.0	NQ-42			
-453.2								
				465.0	NQ-43			
-458.2								
				470.0	NQ-44			
-463.2								
				475.0	NQ-45			
-468.2								
				480.0	NQ-46			
-473.2								
				485.0	NQ-47			
-478.2								
				490.0	NQ-48			
-483.2	490.0	**SANTEE LIMESTONE**						
		Wet to Moist, Greenish Gray, Low Plasticity, Strongly Reactive, Fine Sandy SILT (ML/A-4)			NQ-49			
-488.2				495.0				
					NQ-50			
	500.0							

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	SB-1
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	M. Miller	**Boring Location:**	40+85	**Offset:**	293.6'-RT	**Alignment:**	ALT 1B
Elev.:	6.8 ft	**Latitude:**	32.408419	**Longitude:**	-80.467258	**Date Started:**	7/6/2016
Total Depth:	520 ft	**Soil Depth:**	520 ft	**Core Depth:**	250 ft	**Date Completed:**	7/14/2016
Bore Hole Diameter (in):	5	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	Failing 1500	**Drill Method:**	RW/RC	**Hammer Type:**	Automatic	**Energy Ratio:**	75.4%
Core Size:	NQ	**Driller:**	Huss	**Groundwater:**	**TOB** 6 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		Core Sampling Terminated at 500 feet. Borehole advanced to 520 feet using roller cone to facilitate geophysical testing.						
-498.2								
-503.2								
-508.2								
-513.2	520.0	Boring Terminated at 520.0 feet						
-518.2								
-523.2								
-528.2								
-533.2								
-538.2								

SC_DOT G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	AP-1
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	65+07	**Offset:**	7.2'-LT	**Alignment:**	ALT 1B
Elev.:	2.5 ft	**Latitude:**	32.406761	**Longitude:**	-80.459581	**Date Started:**	7/27/2016
Total Depth:	20 ft	**Soil Depth:**	20 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/27/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value
	0.0	▽Marsh					
		DRILL TO 16.0 FEET					
-2.5							
-7.5							
-12.5							
	16.0	Wet, Very Dark Gray, Very Plastic, Sandy Fat CLAY (CH/A-7-6(24)), Munsell=5Y 3/1, LL=65, PL=21, PI=44, NMC=63.0%, %#200=61.0		16.0	UD-1	%REC=100	
	18.0	Wet, Very Dark Gray, Very Plastic, Fat CLAY (CH/A-7-5(60)) with Sand, Munsell=5Y 3/1, LL=111, PL=34, PI=77, NMC=86.3%, %#200=73.3		18.0	UD-2	%REC=100	
-17.5	20.0	Boring Terminated at 20.0 Feet					

● SPT N VALUE ●

PL MC LL

▲ FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

11

LEGEND

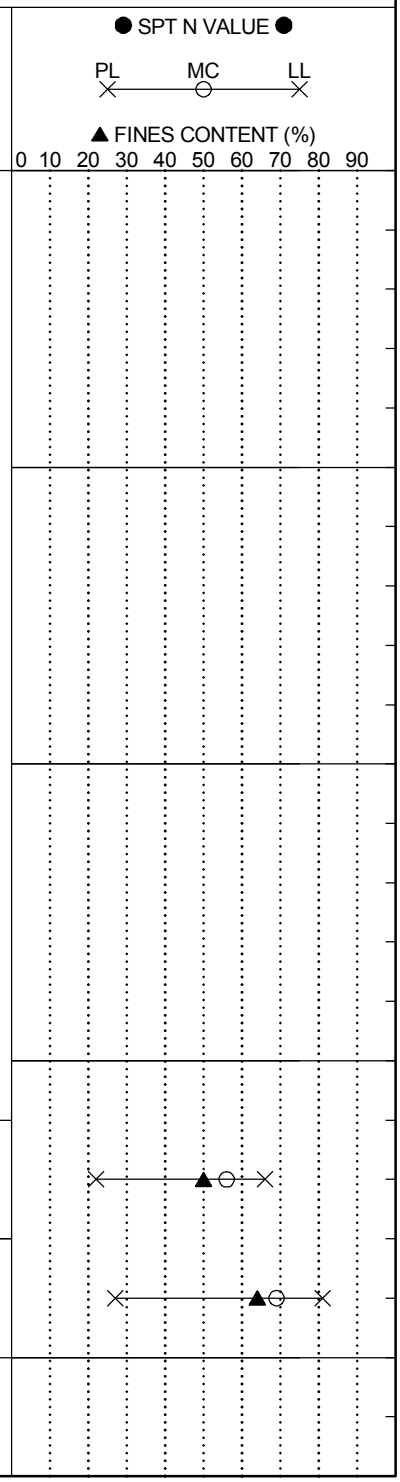
SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SC_DOT G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	AP-2
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	67+03	**Offset:**	15.9'-LT	**Alignment:**	ALT 1B
Elev.:	2.6 ft	**Latitude:**	32.406601	**Longitude:**	-80.458973	**Date Started:**	7/28/2016
Total Depth:	20 ft	**Soil Depth:**	20 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/28/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value
	0.0	▽Marsh					
		DRILL TO 16.0 FEET					
-2.4							
-7.4							
-12.4							
	16.0	Wet, Very Dark Gray, Very Plastic, Clayey SAND (SC/A-7-6(17)), Munsell=5Y 3/1, LL=66, PL=22, PI=44, NMC=56.0%, %#200=49.9		16.0	UD-1	%REC=100	
	18.0	Wet, Very Dark Gray, Very Plastic, Sandy Fat CLAY (CH/A-7-6(33)), Munsell=5Y 3/1, LL=81, PL=27, PI=54, NMC=69.3%, %#200=63.5		18.0	UD-2	%REC=100	
-17.4	20.0	Boring Terminated at 20.0 Feet					



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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	AP-3
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	69+09	**Offset:**	39.8'-LT	**Alignment:**	ALT 1B
Elev.:	2.0 ft	**Latitude:**	32.406462	**Longitude:**	-80.458322	**Date Started:**	7/28/2016
Total Depth:	29 ft	**Soil Depth:**	29 ft	**Core Depth:**	N/A ft	**Date Completed:**	7/28/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%)
	0.0	▽Marsh DRILL TO 25.0 FEET						
-3.0								
-8.0								
-13.0								
-18.0								
-23.0	25.0	Wet, Very Dark Gray, Very Plastic, Fat CLAY (CH/A-7-6(50)) with Sand, Munsell=5Y 3/1, LL=85, PL=27, PI=58, NMC=83.0%, %#200=79.5		25.0	UD-1	%REC=100		
	27.0	Wet, Very Dark Gray, Very Plastic, Fat CLAY (CH/A-7-6(43)) with Sand, Munsell=5Y 3/1, LL=74, PL=25, PI=49, NMC=78.8%, %#200=81.4		27.0	UD-2	%REC=100		
-28.0	29.0	Boring Terminated at 29.0 Feet						

FINES CONTENT (%): 0 10 20 30 40 50 60 70 80 90

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 G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	AP-4
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	100+73	**Offset:**	8.7'-RT	**Alignment:**	ALT 1B
Elev.:	1.6 ft	**Latitude:**	32.403021	**Longitude:**	-80.448901	**Date Started:**	8/4/2016
Total Depth:	74 ft	**Soil Depth:**	74 ft	**Core Depth:**	N/A ft	**Date Completed:**	8/4/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value	● SPT N VALUE ● PL MC LL ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
	0.0	▽Marsh DRILL TO 38.0 FEET						
-3.4								
-8.4								
-13.4								
-18.4								
-23.4								
-28.4								
-33.4								
	38.0			38.0				
-38.4	40.0	Wet, Dark Gray, Very Plastic, Fat CLAY (CH/A-7-6(34)) with Sand, Munsell=GLEY1 4/N, LL=71, PL=24, PI=47, NMC=69.0%, %#200=71.3		40.0	UD-1	%REC=60		
	42.0				UD-2	%REC=100		
-43.4		Wet, Dark Gray, Non-Plastic, Silty Fine to Medium SAND (SM/A-2-4), Munsell=GLEY1 4/N, LL=NP, PL=NP, PI=NP, NMC=33.8%, %#200=21.5 DRILL TO 70.0 FEET						

Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	AP-4
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	100+73	**Offset:**	8.7'-RT	**Alignment:**	ALT 1B
Elev.:	1.6 ft	**Latitude:**	32.403021	**Longitude:**	-80.448901	**Date Started:**	8/4/2016
Total Depth:	74 ft	**Soil Depth:**	74 ft	**Core Depth:**	N/A ft	**Date Completed:**	8/4/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value	● SPT N VALUE ● PL MC LL ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		DRILL TO 70.0 FEET						
-53.4								
-58.4								
-63.4								
-68.4	70.0			70.0				
	72.0	Wet, Olive Gray, Non-Plastic, Sandy Fine SILT (ML/A-4(0)), Munsell=5Y 4/2, LL=NP, PL=NP, PI=NP, NMC=58.8%, %#200=52.0		72.0	UD-3	%REC=100	×	▲ ○
	74.0				UD-4	%REC=100		
-73.4		Wet, Olive Gray, Non-Plastic, Sandy Fine SILT (ML/A-4(0)), Munsell=5Y 4/2						
		Boring Terminated at 74.0 feet						
-78.4								
-83.4								
-88.4								
-93.4								

LEGEND

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

SC_DOT G5396 - HARBOR RIVER SPT AND CPT.GPJ FME2017.GDT 2/14/17

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	AP-5
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	106+03	**Offset:**	26.3'-LT	**Alignment:**	ALT 1B
Elev.:	2.3 ft	**Latitude:**	32.402547	**Longitude:**	-80.44727	**Date Started:**	8/2/2016
Total Depth:	32 ft	**Soil Depth:**	32 ft	**Core Depth:**	N/A ft	**Date Completed:**	8/2/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" 2nd 6" 3rd 6" 4th 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
	0.0	▽Marsh DRILL TO 6.0 FEET						
-2.7	6.0	Wet, Gray, Non-Plastic, Poorly Graded Fine SAND (SP/A-3), Munsell=5Y 6/1, LL=NP, PL=NP, PI=NP, NMC=21.6%, %#200=3.0		6.0	UD-1	%REC=80		
	8.0	Wet, Gray, Non-Plastic, Poorly Graded Fine SAND (SP/A-3), Munsell=5Y 6/1		8.0	UD-2	%REC=60		
-7.7	10.0	DRILL TO 28.0 FEET						
-12.7								

LEGEND

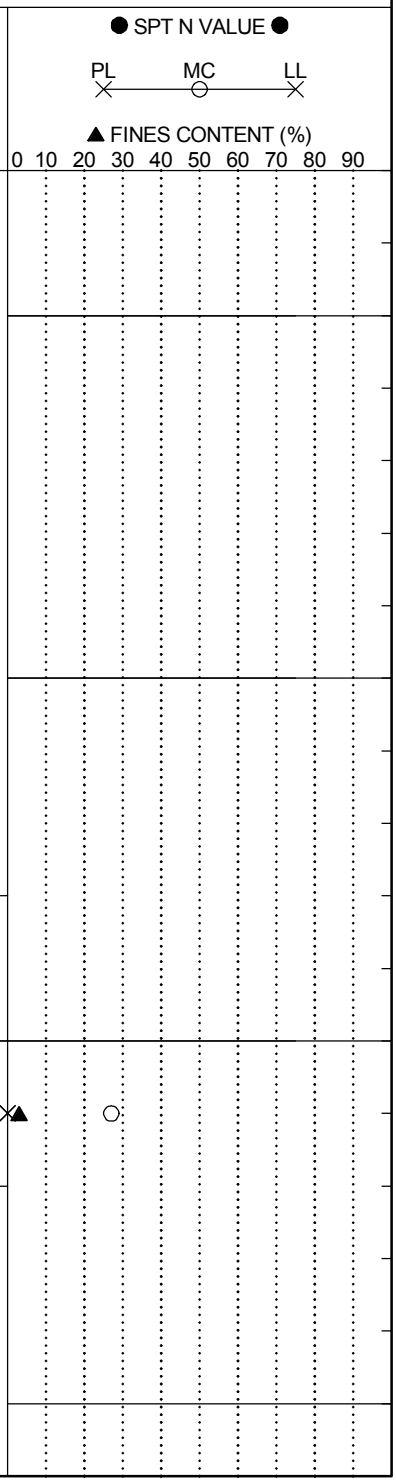
Continued Next Page

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

SCDOT Soil Test Log

Project ID:	P026862			**County:**	Beaufort	**Boring No.:**	AP-5
Site Description:	US 21 Bridge Replacement over Harbor River					**Route:**	US 21
Eng./Geo.:	C. Piercy	**Boring Location:**	106+03	**Offset:**	26.3'-LT	**Alignment:**	ALT 1B
Elev.:	2.3 ft	**Latitude:**	32.402547	**Longitude:**	-80.44727	**Date Started:**	8/2/2016
Total Depth:	32 ft	**Soil Depth:**	32 ft	**Core Depth:**	N/A ft	**Date Completed:**	8/2/2016
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45B	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	83.1%
Core Size:	N/A	**Driller:**	M.A.D.	**Groundwater:**	**TOB** 0 ft	**24HR**	TIDAL

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6" / 2nd 6" / 3rd 6" / 4th 6"	N Value
		DRILL TO 28.0 FEET					
-17.7							
-22.7							
	28.0	Wet, Gray, Non-Plastic, Poorly Graded Fine SAND (SP/A-3), Munsell=5Y 5/1		28.0	UD-3	%REC=100	
-27.7	30.0	Wet, Gray, Non-Plastic, Poorly Graded Fine SAND (SP/A-3), Munsell=5Y 5/1, LL=NP, PL=NP, PI=NP, NMC=26.6%, %#200=2.9		30.0	UD-4	%REC=100	
	32.0	Boring Terminated at 32.0 feet					
-32.7							



LEGEND

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

F&ME CONSULTANTS

US 21 Bridge Replacement over Harbor River
Beaufort County, South Carolina
Project Number :P026862

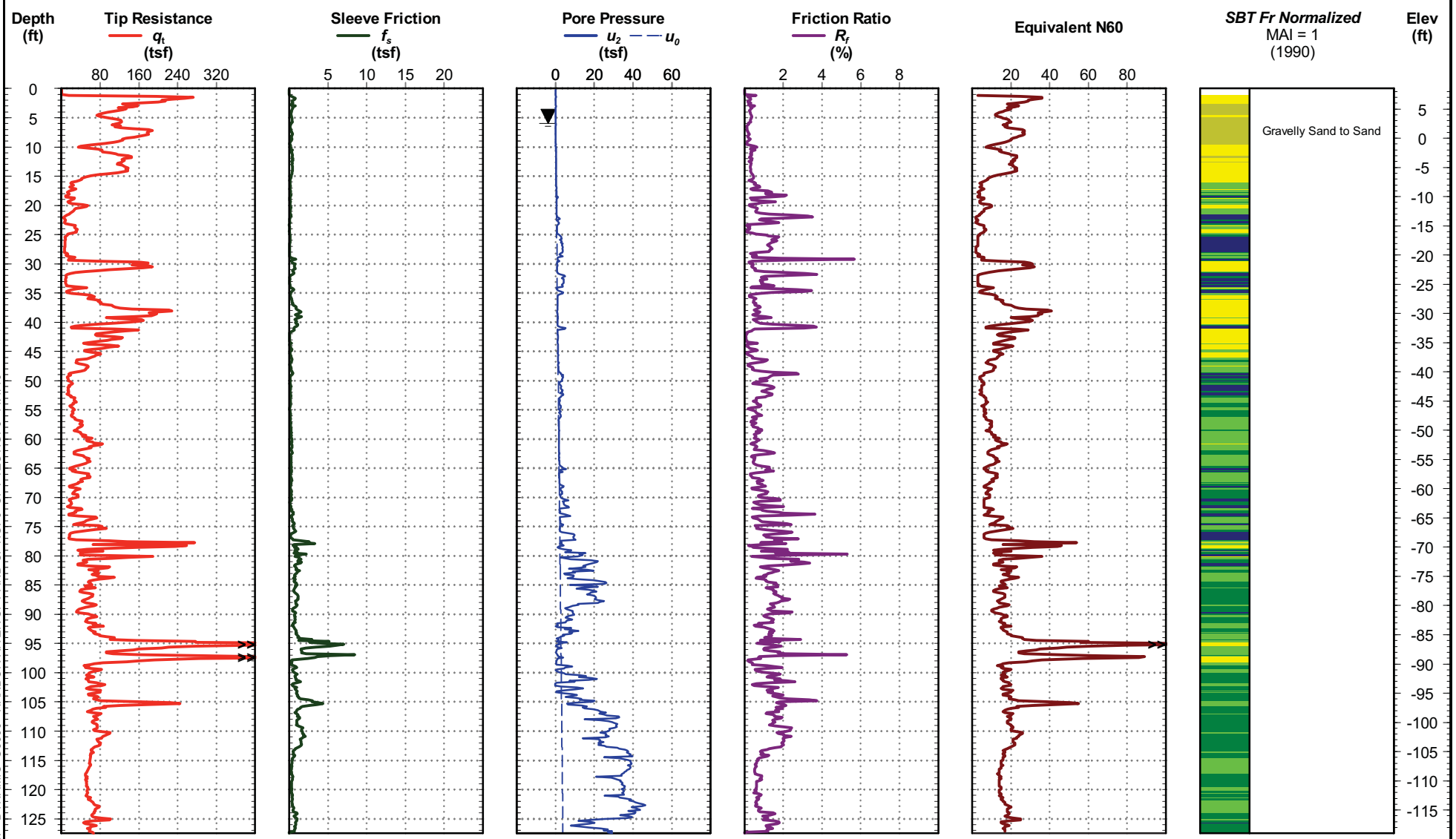
Cone Penetration Test

CPT-1

Date: Aug. 26, 2014
Estimated Water Depth: 6 ft
Rig/Operator: Conetec

Station: 13+72
Offset: 7.0'-LT
Elevation: 8.5

Total Depth: 127.5 ft
Termination Criteria: Target Depth
Cone Size:



CPT REPORT - DYNAMIC G5396 - HARBOR RIVER SPT AND CPT.GPJ CPT TEST.GPJ 11/1/16

CPT-1

Electronic File Name: 14-54074_CP01.cor

F&ME CONSULTANTS

US 21 Bridge Replacement over Harbor River
Beaufort County, South Carolina
Project Number :P026862

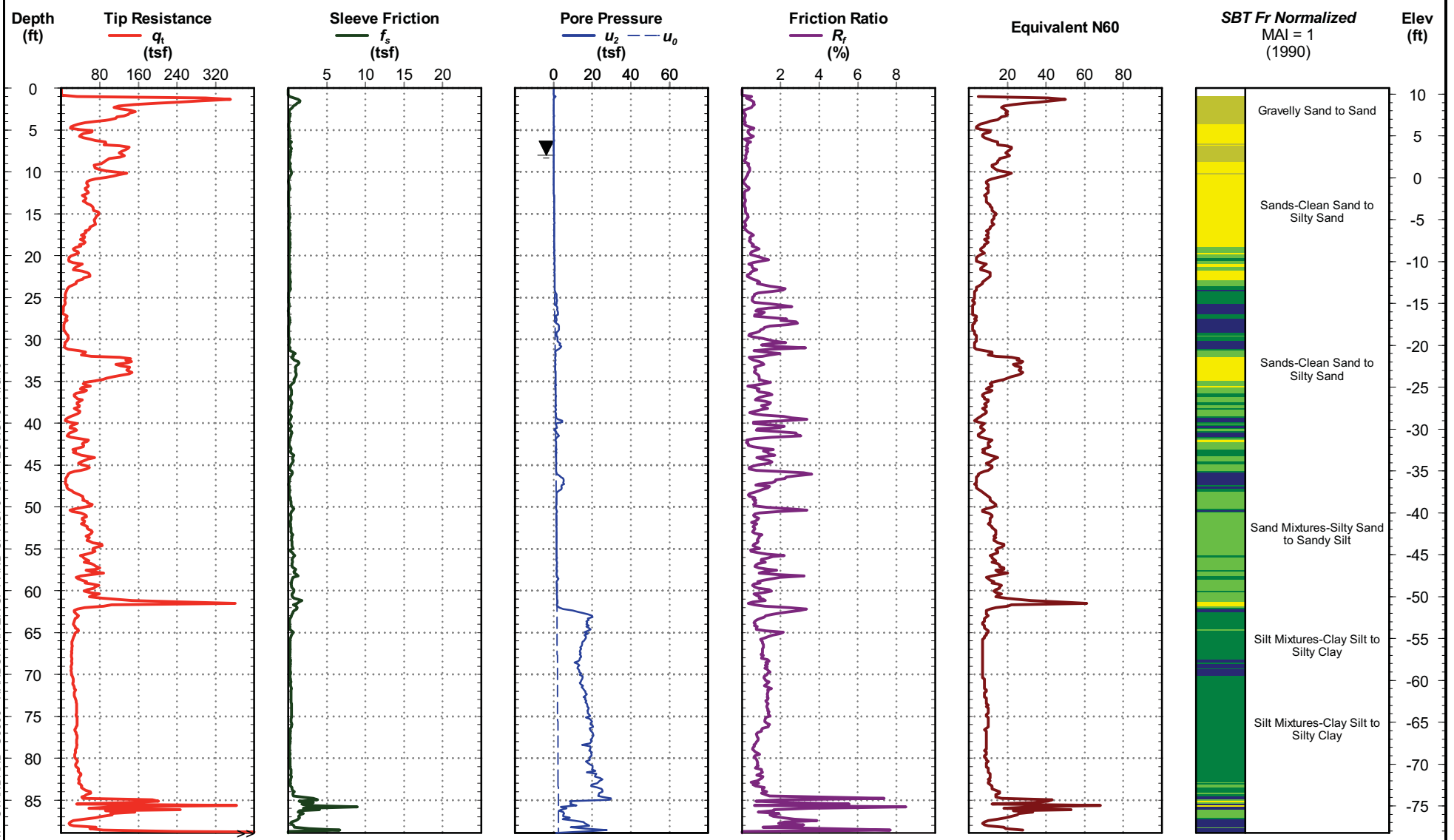
Cone Penetration Test

SCPT-2

Date: Aug. 25, 2014
Estimated Water Depth: 8 ft
Rig/Operator: Conetec

Station: 62+99
Offset: 27.1'-RT
Elevation: 10.7

Total Depth: 88.9 ft
Termination Criteria: Maximum Reaction Force
Cone Size:



CPT REPORT - STANDARD G5396 - HARBOR RIVER SPT AND CPT.GPJ CPT TEST.GPJ 11/3/16

SCPT-2

Electronic File Name: 14-54074_SP02.cor

F&ME CONSULTANTS

US 21 Bridge Replacement over Harbor River
Beaufort County, South Carolina
Project Number :P026862

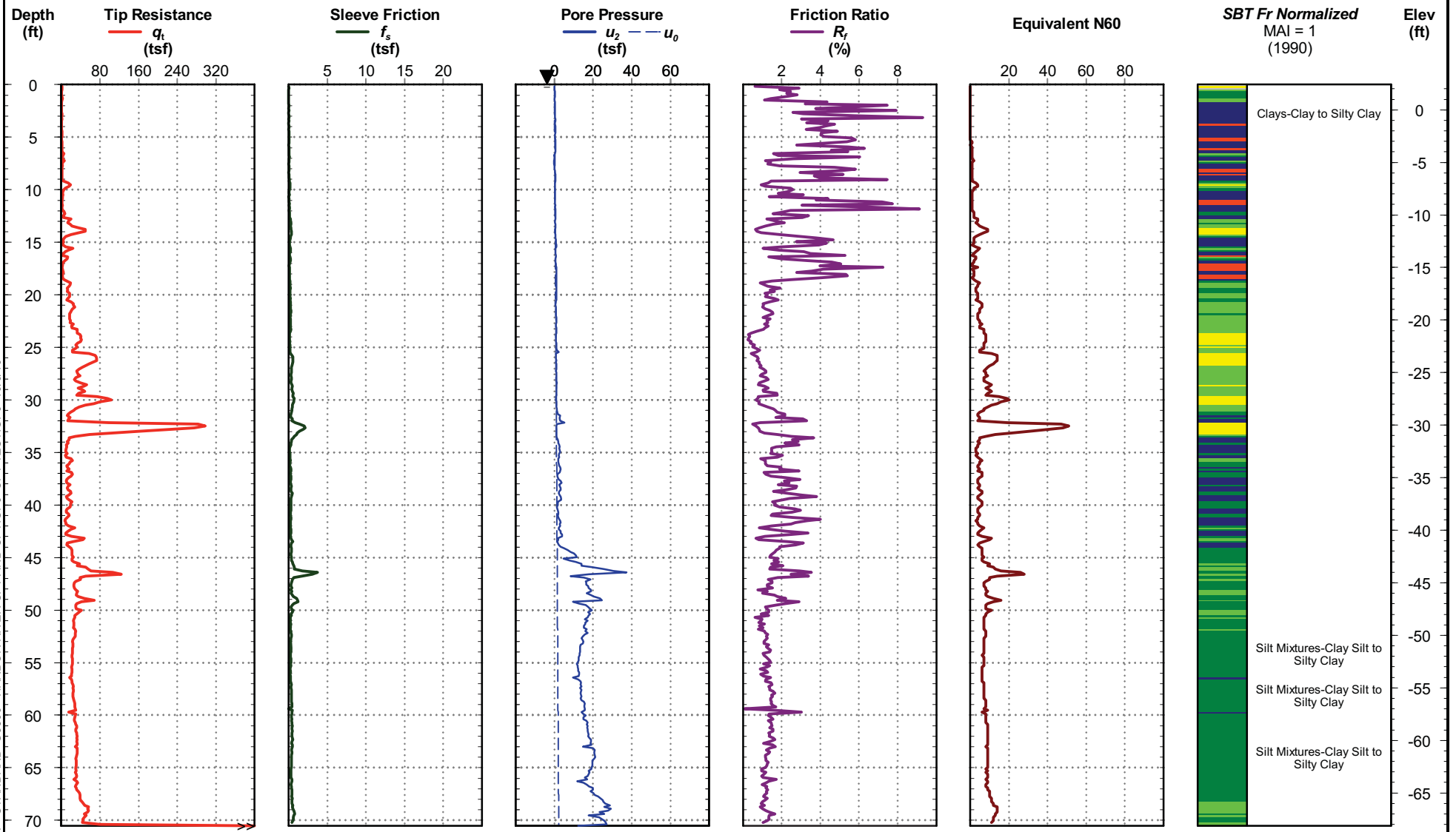
Cone Penetration Test

CPT-3

Date: Sep. 23, 2015
Estimated Water Depth: 0 ft
Rig/Operator: M.A.D.

Station: 42+42
Offset: 96.4'-LT
Elevation: 2.4

Total Depth: 70.5 ft
Termination Criteria: Maximum Reaction Force
Cone Size:



CPT REPORT - STANDARD G5396 - HARBOR RIVER SPT AND CPT.GPJ CPT TEST.GPJ 10/6/16

CPT-3

Electronic File Name: Habor River Hwy 21 CPT-03.cpt

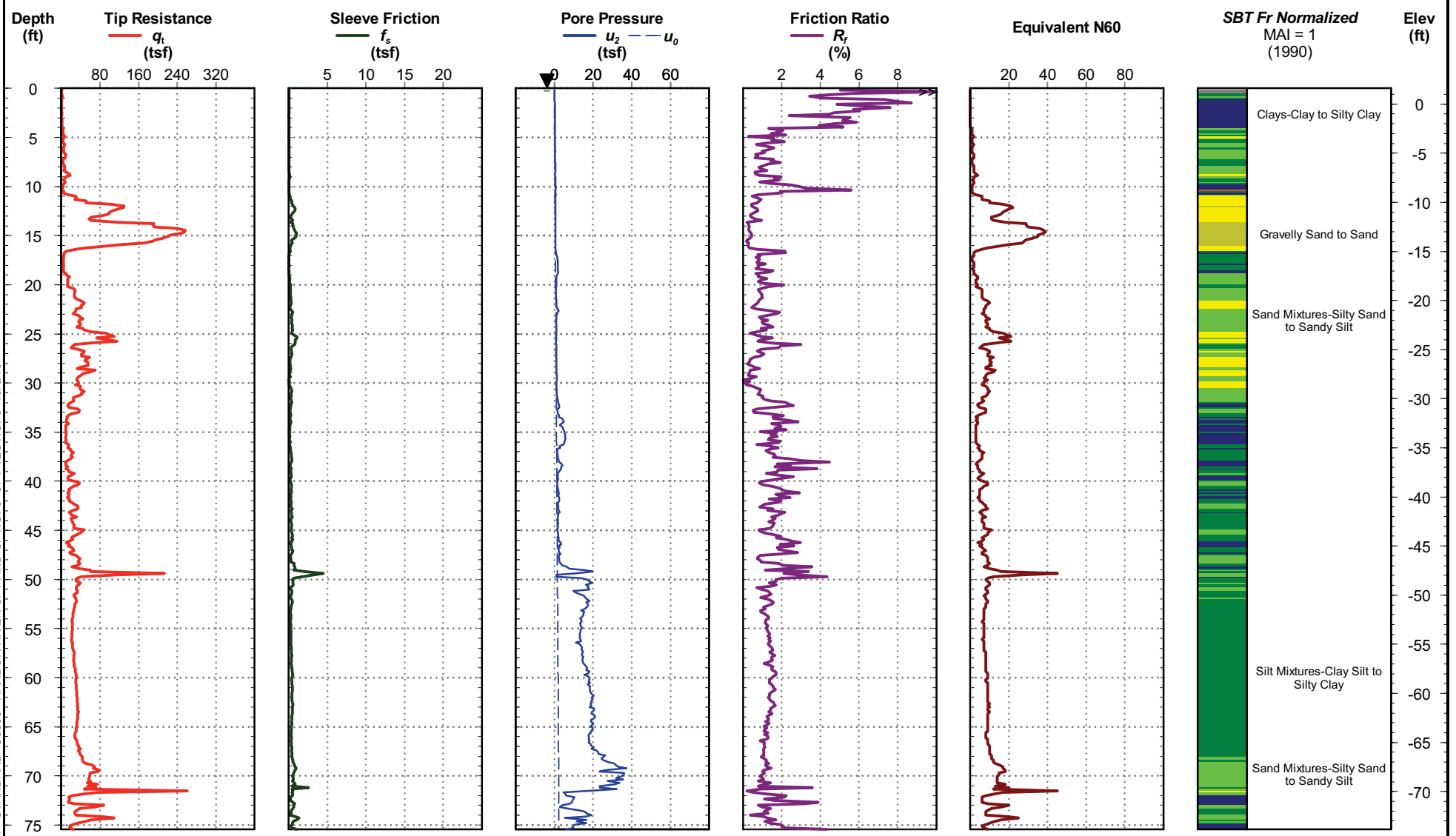
F&ME CONSULTANTS

US 21 Bridge Replacement over Harbor River
Beaufort County, South Carolina
Project Number :P026862

Cone Penetration Test

CPT-4

Date:	Sep. 23, 2015	**Station:**	49+36	**Total Depth:**	75.5 ft
Estimated Water Depth:	0 ft	**Offset:**	76.2'-LT	**Termination Criteria:**	Maximum Reaction Force
Rig/Operator:	M.A.D.	**Elevation:**	1.6	**Cone Size:**	



CPT REPORT - STANDARD G5396 - HARBOR RIVER SPT AND CPT.GPJ CPT TEST.GPJ 10/6/16

CPT-4

Electronic File Name: Habor River Hwy 21 CPT-04.cpt

F&ME CONSULTANTS

US 21 Bridge Replacement over Harbor River
Beaufort County, South Carolina
Project Number :P026862

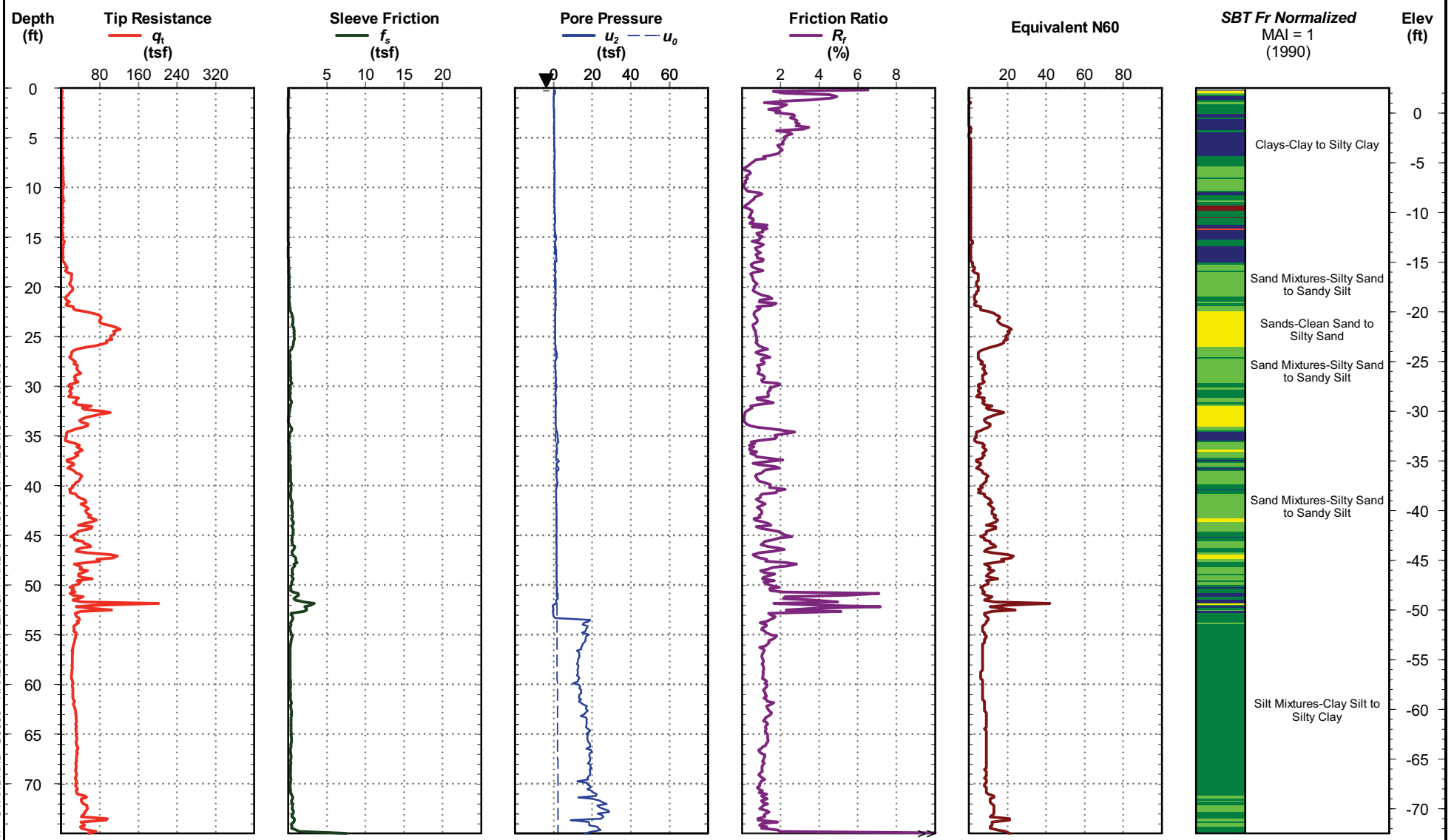
Cone Penetration Test

CPT-5

Date: Sep. 24, 2015
Estimated Water Depth: 0 ft
Rig/Operator: M.A.D.

Station: 60+88
Offset: 78.7'-LT
Elevation: 2.5

Total Depth: 75.0 ft
Termination Criteria: Maximum Reaction Force
Cone Size:



CPT-5

Electronic File Name: Habor River Hwy 21 CPT-05.cpt

CPT REPORT - STANDARD G5396 - HARBOR RIVER SPT AND CPT.GPJ CPT TEST.GPJ 10/6/16

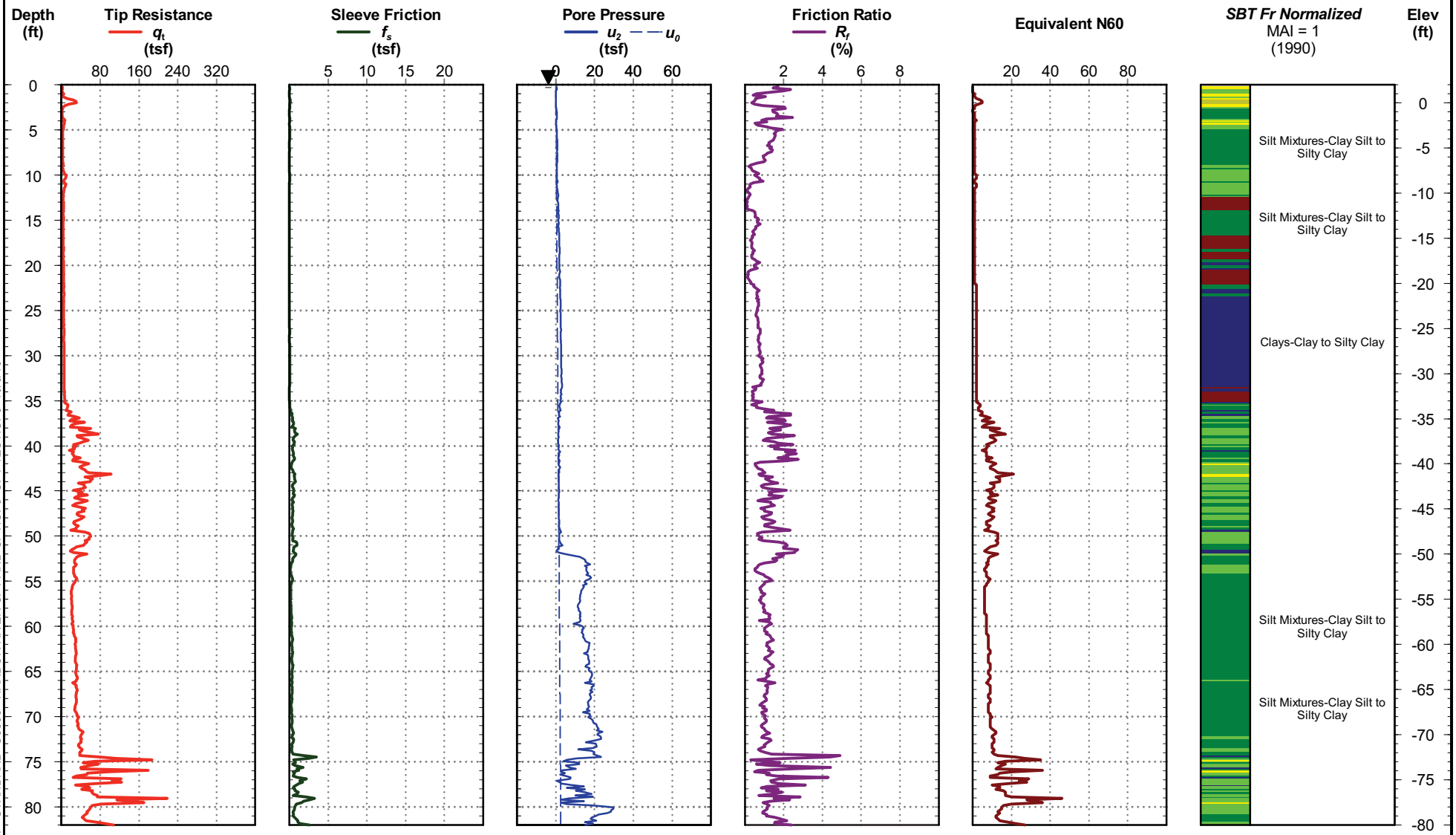
F&ME CONSULTANTS

US 21 Bridge Replacement over Harbor River
Beaufort County, South Carolina
Project Number :P026862

Cone Penetration Test

CPT-6

Date:	Sep. 24, 2015	**Station:**	69+12	**Total Depth:**	82.0 ft
Estimated Water Depth:	0 ft	**Offset:**	41.6'-LT	**Termination Criteria:**	Maximum Reaction Force
Rig/Operator:	M.A.D.	**Elevation:**	2.0	**Cone Size:**	



CPT-6

Electronic File Name: Habor River Hwy 21 CPT-06.cpt

CPT REPORT - STANDARD G5396 - HARBOR RIVER SPT AND CPT.GPJ CPT TEST.GPJ 10/6/16

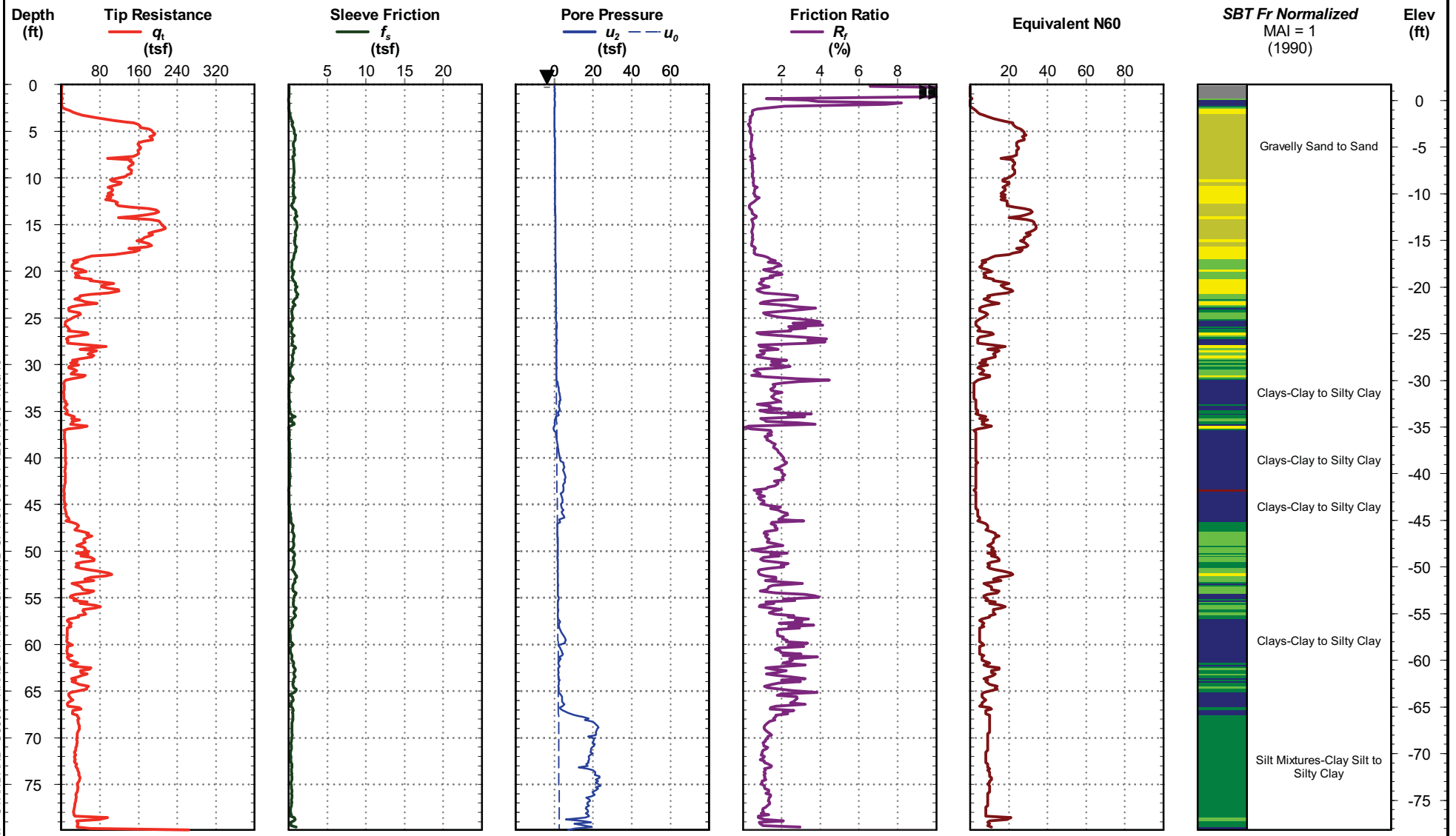
F&ME CONSULTANTS

US 21 Bridge Replacement over Harbor River
Beaufort County, South Carolina
Project Number :P026862

Cone Penetration Test

CPT-7

Date:	Sep. 22, 2015	**Station:**	100+84	**Total Depth:**	79.9 ft
Estimated Water Depth:	0 ft	**Offset:**	1.9'-LT	**Termination Criteria:**	Maximum Reaction Force
Rig/Operator:	M.A.D.	**Elevation:**	1.7	**Cone Size:**	



CPT-7

Electronic File Name: Habor River Hwy 21 CPT-07.cpt

CPT REPORT - STANDARD G5396 - HARBOR RIVER SPT AND CPT.GPJ CPT TEST.GPJ 10/6/16

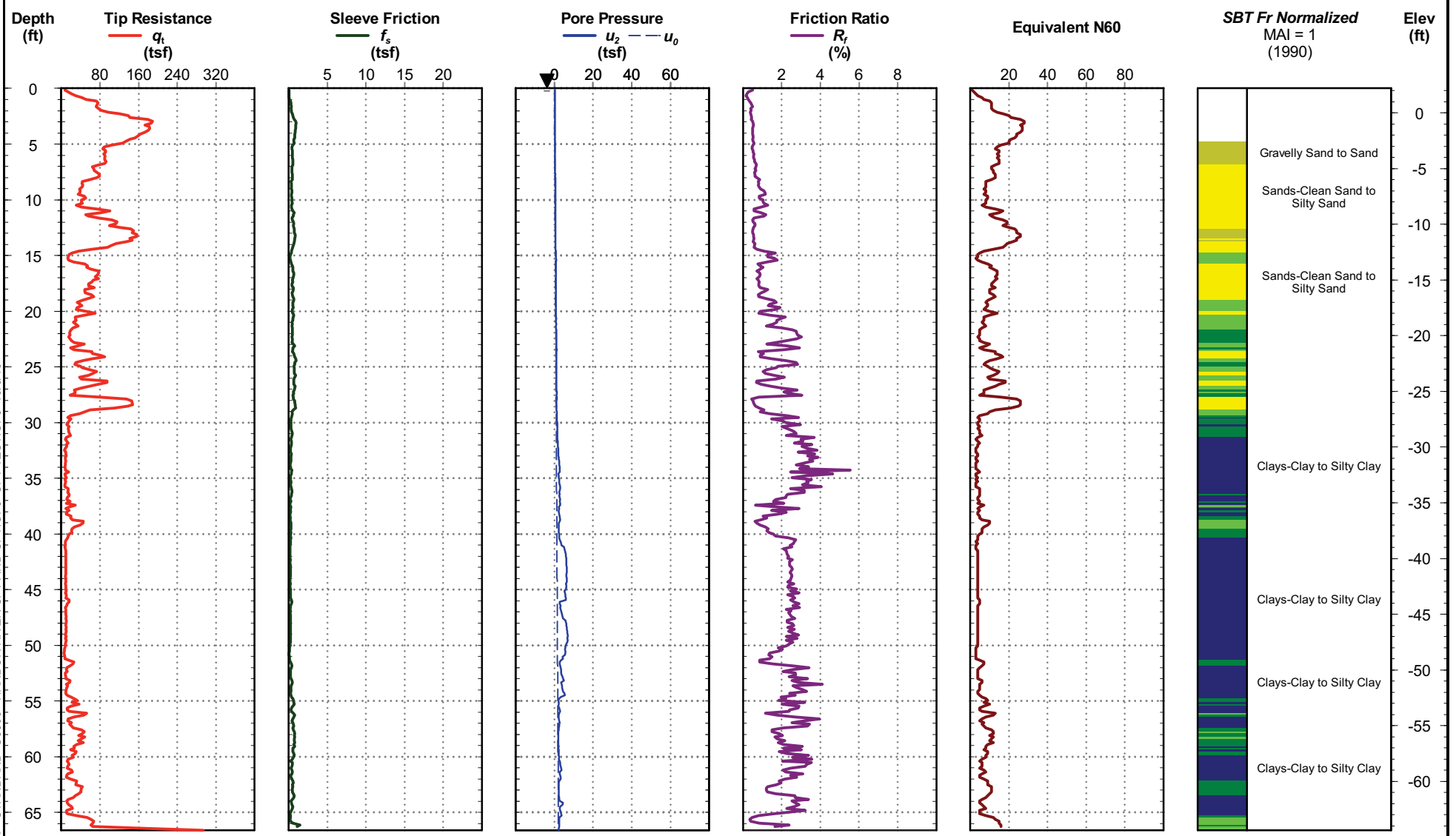
F&ME CONSULTANTS

US 21 Bridge Replacement over Harbor River
Beaufort County, South Carolina
Project Number :P026862

Cone Penetration Test

CPT-8

Date:	Sep. 22, 2015	**Station:**	103+87	**Total Depth:**	66.6 ft
Estimated Water Depth:	0 ft	**Offset:**	15.3'-RT	**Termination Criteria:**	Maximum Reaction Force
Rig/Operator:	M.A.D.	**Elevation:**	2.2	**Cone Size:**	



CPT REPORT - STANDARD G5396 - HARBOR RIVER SPT AND CPT.GPJ CPT TEST.GPJ 10/6/16

CPT-8

Electronic File Name: Habor River Hwy 21 CPT-08.cpt

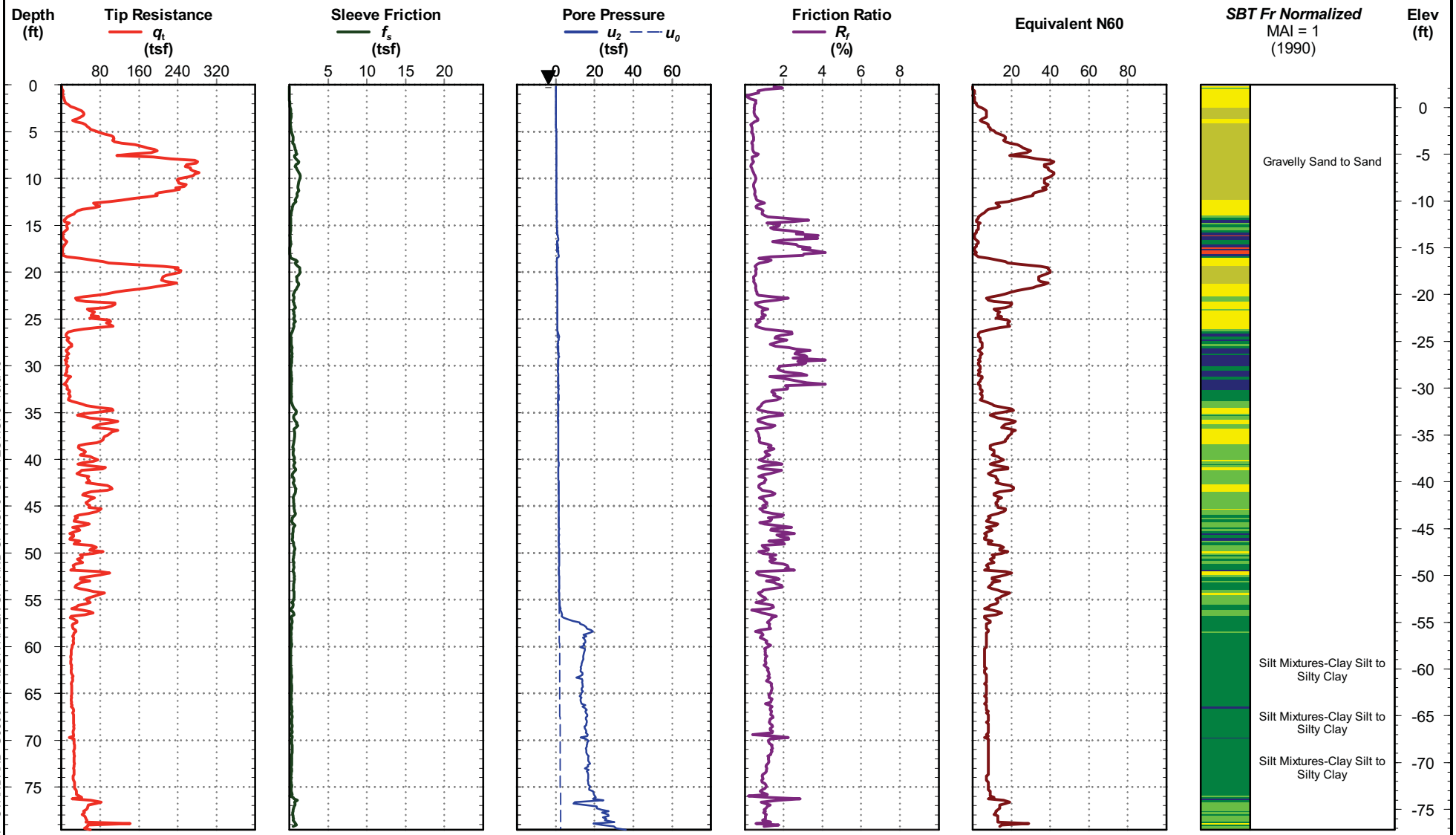
F&ME CONSULTANTS

US 21 Bridge Replacement over Harbor River
Beaufort County, South Carolina
Project Number :P026862

Cone Penetration Test

CPT-9

Date:	Sep. 22, 2015	**Station:**	116+53	**Total Depth:**	79.6 ft
Estimated Water Depth:	0 ft	**Offset:**	42.4'-LT	**Termination Criteria:**	Maximum Reaction Force
Rig/Operator:	M.A.D.	**Elevation:**	2.4	**Cone Size:**	



CPT REPORT - STANDARD G5396 - HARBOR RIVER SPT AND CPT.GPJ CPT TEST.GPJ 10/6/16

CPT-9

Electronic File Name: Habor River Hwy 21 CPT-09.cpt

F&ME CONSULTANTS

US 21 Bridge Replacement over Harbor River
Beaufort County, South Carolina
Project Number :P026862

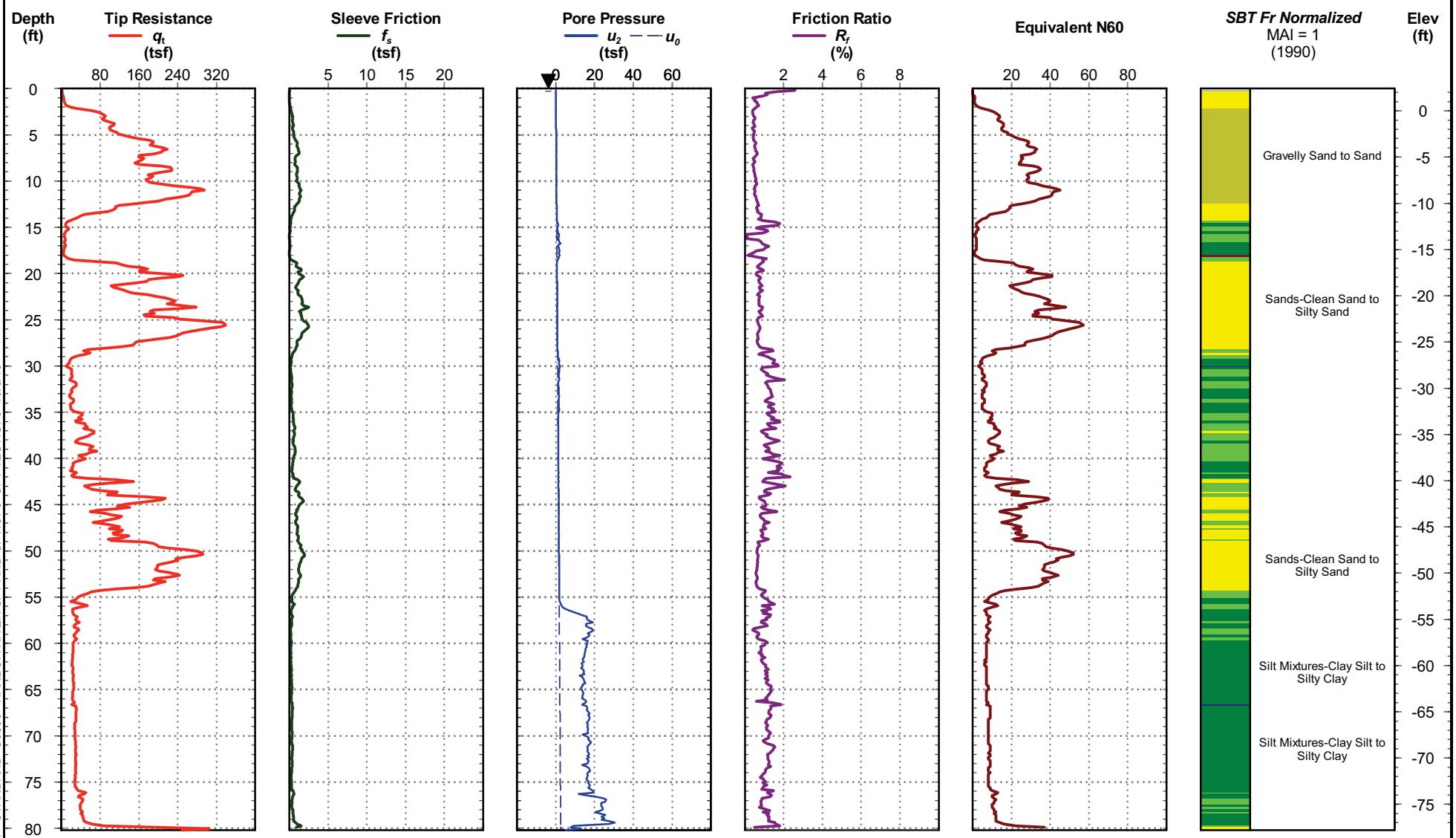
Cone Penetration Test

CPT-10

Date: Sep. 23, 2015
Estimated Water Depth: 0 ft
Rig/Operator: M.A.D.

Station: 120+07
Offset: 49.3'-LT
Elevation: 2.4

Total Depth: 80.2 ft
Termination Criteria: Maximum Reaction Force
Cone Size:



CPT REPORT - STANDARD G5396 - HARBOR RIVER SPT AND CPT.GPJ CPT TEST.GPJ 10/6/16

CPT-10

Electronic File Name: Habor River Hwy 21 CPT-10.cpt

F&ME CONSULTANTS

US 21 Bridge Replacement over Harbor River
Beaufort County, South Carolina
Project Number :P026862

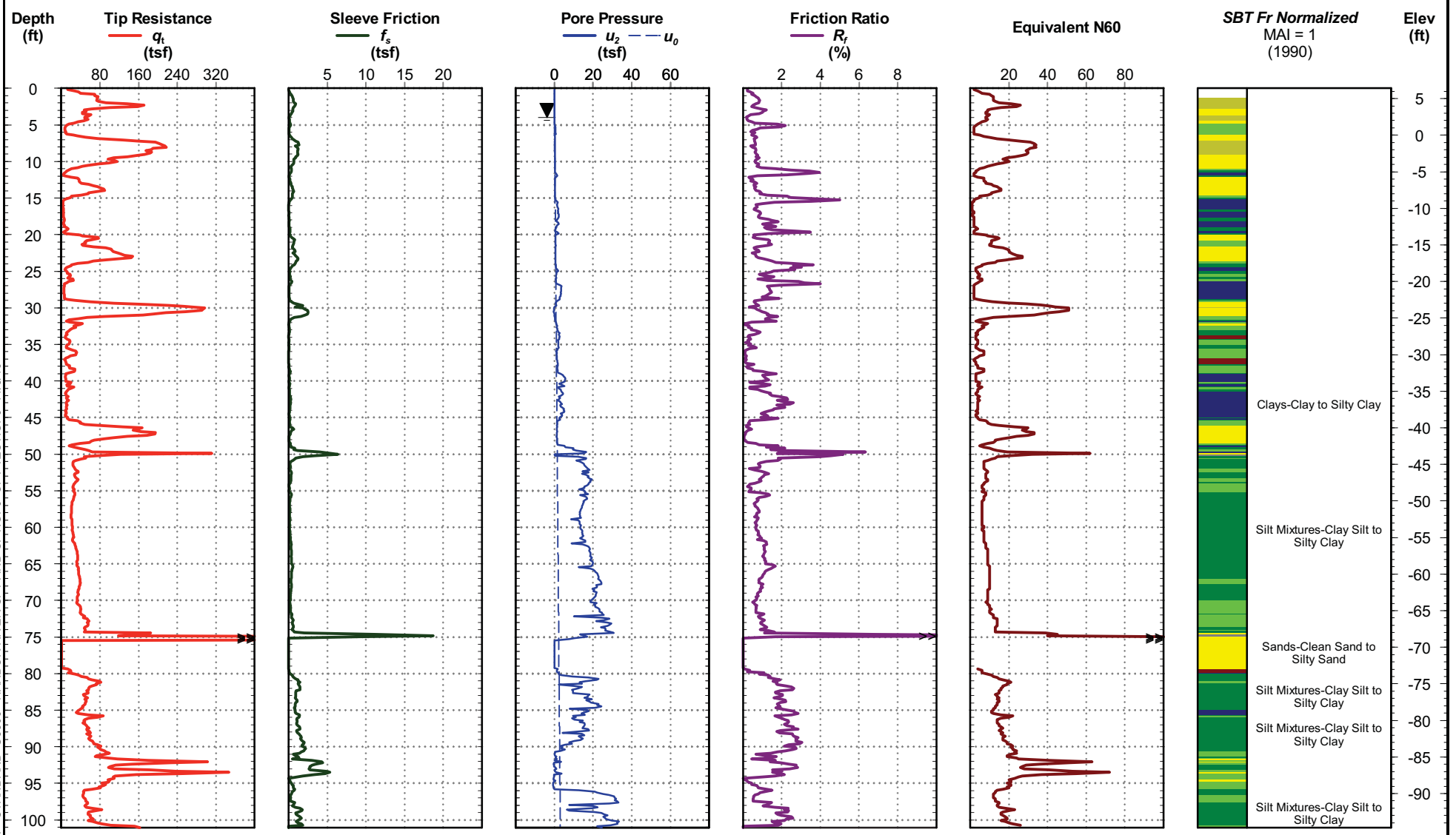
Cone Penetration Test

SCPT-11

Date: Nov. 18, 2015
Estimated Water Depth: 4 ft
Rig/Operator: Conetec

Station: 40+89
Offset: 292.5'-RT
Elevation: 6.4

Total Depth: 101.1 ft
Termination Criteria: Maximum Reaction Force
Cone Size:



CPT REPORT - STANDARD G5396 - HARBOR RIVER SPT AND CPT.GPJ CPT TEST.GPJ 11/3/16

SCPT-11

Electronic File Name: 15-54107_SP SCPT-11.cor

GEOVision
geophysical services

HARBOR RIVER

BOREHOLE GEOPHYSICS

BEAUFORT, SOUTH CAROLINA

BOREHOLE SB-1

August 24, 2016
Report 16248-01 rev 0

HARBOR RIVER

BOREHOLE GEOPHYSICS

BEAUFORT, SOUTH CAROLINA

BOREHOLE SB-1

Prepared for

F&ME Consultants, Inc.
3112 Devine St., #B
Columbia, South Carolina 29205
(803) 254-4540

Prepared by

GEO*Vision* Geophysical Services
1124 Olympic Drive
Corona, California 92881
(951) 549-1234
Project 16248

August 24, 2016
Report 16248-01 rev 0

TABLE OF CONTENTS

TABLE OF CONTENTS **3**

TABLE OF FIGURES **4**

TABLE OF TABLES **4**

APPENDICES **5**

INTRODUCTION **6**

SCOPE OF WORK **6**

INSTRUMENTATION **7**

Suspension Velocity Instrumentation 7
Caliper / Natural Gamma Instrumentation 10
Elog / Natural Gamma Instrumentation 11

MEASUREMENT PROCEDURES **13**

Suspension Velocity Measurement Procedures 13
Caliper / Natural Gamma Measurement Procedures 13
Elog / Natural Gamma Measurement Procedures 15

DATA ANALYSIS **18**

Suspension Velocity Analysis 18
Caliper / Natural Gamma 20
Elog / Natural Gamma Analysis 20

RESULTS **21**

Suspension Velocity Results 21
Caliper / Natural Gamma Results 21
Elog / Natural Gamma Results 22

SUMMARY **23**

Discussion of Suspension Velocity Results 23
Discussion of Caliper / Natural Gamma Results 23
Discussion of Elog / Natural Gamma Results 24
Suspension Velocity Data Reliability 25
Quality Assurance 25

Table of Figures

Figure 1: Concept illustration of P-S logging system 27
Figure 2: Example of filtered (1400 Hz lowpass) suspension record 28
Figure 3. Example of unfiltered suspension record 29
Figure 4: Boring SB-1, Suspension R1-R2 P- and S_H-wave velocities 30

Table of Tables

Table 1. Boring locations and logging dates 26
Table 2. Logging dates and depth ranges 26
Table 3. Boring SB-1, Suspension R1-R2 depths and P- and S_H-wave velocities 31

APPENDICES

APPENDIX A **SUSPENSION VELOCITY MEASUREMENT QUALITY ASSURANCE SUSPENSION SOURCE TO RECEIVER ANALYSIS RESULTS**

APPENDIX B **ELOG, MECHANICAL CALIPER, AND NATURAL GAMMA LOGS**

APPENDIX C **GEOPHYSICAL LOGGING SYSTEMS - NIST TRACEABLE CALIBRATION RECORDS**

INTRODUCTION

Borehole geophysical measurements were collected in one (1) boring at Harbor River in Beaufort, South Carolina. Data acquisition was performed on July 18th, 2016 by Jonathan Jordan of **GEO***Vision*. Data analysis and report preparation were performed by Emily Feldman and Victor Gonzalez and reviewed by John Diehl of **GEO***Vision*. The work was performed for F&ME Consultants, Inc. with Mike Miller serving as the point of contact.

This report describes the field measurements, data analysis, and results of this work.

SCOPE OF WORK

This report presents the results of borehole geophysical measurements collected on July 18th, 2016 as detailed in Table 1.

Robertson Geologging (RG) ELOG and 3-Arm Mechanical Caliper (CAL) probes were used to collect long and short normal resistivity, single point resistance, self-potential, and borehole diameter, respectively. Both probes also acquired natural gamma (NG). The probes acquire data at up to 0.05 foot sample rate.

Measurement procedures followed these ASTM standards:

- ASTM D5753-05 (Re-approved 2010), “Planning and Conducting Boring Geophysical Logging”
- ASTM D6274-98 (Re-approved 2004), “Conducting Boring Geophysical Logging – Gamma”

Data were combined and plotted as profiles of the preceding parameters versus depth.

INSTRUMENTATION

Suspension Velocity Instrumentation

Suspension velocity measurements were performed using the suspension PS logging system, manufactured by OYO Corporation, and their subsidiary, Robertson Geologging. This system directly determines the average velocity of a 3.3-foot high segment of the soil column surrounding the boring of interest by measuring the elapsed time between arrivals of a wave propagating upward through the soil column. The receivers that detect the wave, and the source that generates the wave, are moved as a unit in the boring producing relatively constant amplitude signals at all depths.

The suspension system probe consists of a combined reversible polarity solenoid horizontal shear-wave source (S_H) and compressional-wave source (P), joined to two biaxial receivers by a flexible isolation cylinder, as shown in Figure 1. The separation of the two receivers is 3.3 feet, allowing average wave velocity in the region between the receivers to be determined by inversion of the wave travel time between the two receivers. The total length of the probe as used in these surveys is approximately 22 feet, with the center point of the receiver pair 12.5 feet above the bottom end of the probe.

The probe receives control signals from, and sends the digitized receiver signals to, instrumentation on the surface via an armored conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data using a sheave of known circumference fitted with a digital rotary encoder.

The entire probe is suspended in the boring by the cable, therefore, source motion is not coupled directly to the boring walls; rather, the source motion creates a horizontally propagating impulsive pressure wave in the fluid filling the boring and surrounding the source. This pressure wave is converted to P and S_H-waves in the surrounding soil and rock as it passes through the casing and grout annulus and impinges upon the wall of the boring. These waves propagate through the soil and rock surrounding the boring, in turn causing a pressure wave to be generated in the fluid

surrounding the receivers as the soil waves pass their location. Separation of the P and S_H-waves at the receivers is performed using the following steps:

1. Orientation of the horizontal receivers is maintained parallel to the axis of the source, maximizing the amplitude of the recorded S_H -wave signals.
2. At each depth, S_H-wave signals are recorded with the source actuated in opposite directions, producing S_H-wave signals of opposite polarity, providing a characteristic S_H-wave signature distinct from the P-wave signal.
3. The 6.3 foot separation of source and receiver 1 permits the P-wave signal to pass and damp significantly before the slower S_H-wave signal arrives at the receiver.
4. In saturated soils, the received P-wave signal is typically of much higher frequency than the received S_H-wave signal, permitting additional separation of the two signals by low pass filtering.
5. Direct arrival of the original pressure pulse in the fluid is not detected at the receivers because the wavelength of the pressure pulse in fluid is significantly greater than the dimension of the fluid annulus surrounding the probe (feet versus inches scale), preventing significant energy transmission through the fluid medium.

In operation, a distinct, repeatable pattern of impulses is generated at each depth as follows:

1. The source is fired in one direction producing dominantly horizontal shear with some vertical compression, and the signals from the horizontal receivers situated parallel to the axis of motion of the source are recorded.
2. The source is fired again in the opposite direction and the horizontal receiver signals are recorded.
3. The source is fired again and the vertical receiver signals are recorded. The repeated source pattern facilitates the picking of the P and S_H-wave arrivals; reversal of the source changes the polarity of the S_H-wave pattern but not the P-wave pattern.

The data from each receiver during each source activation is recorded as a different channel on the recording system. The Suspension PS system has six channels (two simultaneous recording channels), each with a 1024 sample record. The recorded data are displayed as six channels with a common time scale. Data are stored on disk for further processing.

Review of the displayed data on the recorder or computer screen allows the operator to set the gains, filters, delay time, pulse length (energy), and sample rate to optimize the quality of the data before recording. Verification of the calibration of the Suspension PS digital recorder is performed every twelve months using a NIST traceable frequency source and counter, as presented in Appendix C.

Caliper / Natural Gamma Instrumentation

Caliper and natural gamma data were collected using a mechanical 3-arm caliper probe (CAL) manufactured by Robertson Geologging, Ltd. The probe is 6.82 feet long, and 1.5 inches in diameter. As configured, the probe can measure boring diameters between 1.6 and 12 inches.

This probe is useful in the following studies:

- Measurement of boring diameter and volume
- Location of hard and soft formations
- Location of fissures, caving, pinching and casing damage
- Bed boundary identification
- Strata correlation between borings

The probe receives control signals from, and sends the digitized measurement values to, a Robertson Micrologger II (MLII) on the surface via an armored cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth using a sheave of known circumference fitted with a digital rotary encoder. Probe and depth data are transmitted by USB link from the MLII unit to a laptop computer where it is displayed and stored.

The caliper consists of three arms, each with a toothed quadrant at their base, pivoted in the lower probe body. A toothed rack engages with each quadrant, constraining the arms to move together. Linear movement of the rack is coupled to opening and closing of the arms. Springs hold the arms open in the operating position. A motor drive retracts the arms, allowing the probe to be lowered into the boring. The rack is coupled to a potentiometer which converts movement into a voltage sensed by the probe's microprocessor.

Natural gamma measurements rely on small quantities of radioactive material contained in soil and rocks to emit gamma radiation as they decay. Trace amounts of uranium and thorium are present

in a few minerals. Feldspar, mica and clays will include traces of a radioactive isotope of potassium. The radiation is detected by scintillation - the production of a tiny flash of light when gamma rays strike a crystal of sodium iodide. The light is converted into an electrical pulse by a photomultiplier tube. Pulses above a threshold value of 60 KeV are counted by the probe's microprocessor. The measurement is useful because the radioactive elements are concentrated in certain soil and rock types, e.g., clay or shale, and depleted in others, e.g., sandstone or coal.

Elog / Natural Gamma Instrumentation

Elog and natural gamma data were collected using an electric log probe (ELOG), manufactured by Robertson Geologging, Ltd. This probe measures Single Point Resistance (SPR), short normal (16 inch) resistivity, long normal (64 inch) resistivity, Spontaneous Potential (SP) and natural gamma. The ELGX probe is 8.20 feet long, and 1.73 inches in diameter. The addition of an insulated bridle cable makes the functional length of the tool 41 feet.

This probe is useful in the following studies:

- Bed boundary identification
- Strata correlation between borings
- Strata geometry and type (shale indication)

The probe receives control signals from, and sends the digitized measurement values to, a Robertson Micrologger II (MLII) on the surface via an armored cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth using a sheave of known circumference fitted with a digital rotary encoder. The probe and depth data are transmitted by USB link from the MLII unit to a laptop computer where it is displayed and stored.

The resistivity section of the probe operates by driving an alternating current into the formation from the central SPR/DRIVE electrode. The current returns via the logging cable armor. However, to ensure adequate penetration of the formation, a 10 meter (32.8 feet) insulated bridle cable is

attached between the probe and cablehead, making the functional length of the probe 41 feet. The bridle is comprised of 10 meters of insulated cable with a remote, or reference, electrode located at the top. Voltages are measured between the 16 inch and 64 inch electrodes and the remote earth connection at surface, as noted below:

- Single Point Resistance (SPR): The current flowing to the cable armor is measured along with the voltage at the SPR electrode. The voltage divided by current gives resistance.

- Spontaneous Potential (SP): This is the DC bias of the 16 inch electrode with respect to the voltage return at the surface (ground stake).

Data quality depends on good grounding at the surface. This is achieved with a metal stake driven into the ground near the borehole.

Natural gamma measurements rely on small quantities of radioactive material contained in soil and rocks to emit gamma radiation as they decay. Trace amounts of uranium and thorium are present in a few minerals. Feldspar, mica and clays will include traces of a radioactive isotope of potassium. The radiation is detected by scintillation - the production of a tiny flash of light when gamma rays strike a crystal of sodium iodide. The light is converted into an electrical pulse by a photomultiplier tube. Pulses above a threshold value of 60 KeV are counted by the probe's microprocessor. The measurement is useful because the radioactive elements are concentrated in certain soil and rock types, e.g., clay or shale, and depleted in others, e.g., sandstone or coal.

MEASUREMENT PROCEDURES

Suspension Velocity Measurement Procedures

Boring SB-1 was logged uncased from 80 feet below ground surface, and filled with water. Measurements followed the **GEO***Vision* Procedure for P-S Suspension Seismic Velocity Logging, revision 1.5. Prior to each logging run, the probe was positioned with the top of the probe even with a stationary reference point. The electronic depth counter was set to the distance between the mid-point of the receiver and the top of the probe, minus the height of the stationary reference point, if any, verified with a tape measure, and recorded on the field logs. The probe was lowered to the bottom of the boring, stopping at 1.6 foot intervals to collect data, as summarized in Table 2.

At each measurement depth the measurement sequence of two opposite horizontal records and one vertical record was performed, and the gains were adjusted as required. The data from each depth were viewed on the computer display, checked, and recorded on disk before moving to the next depth.

Upon completion of the measurements, the probe zero depth indication at the depth reference point was verified prior to removal from the boring.

Caliper / Natural Gamma Measurement Procedures

Measurement procedures followed these ASTM standards:

- ASTM D5753-05 (Reapproved 2010), “Planning and Conducting Borehole Geophysical Logging”
- ASTM D6167-11, “Conducting Borehole Geophysical Logging – Mechanical - Caliper”
- ASTM D6274-10, “Conducting Borehole Geophysical Logging – Gamma”

The CAL probe does not require a fluid filled boring for proper operation. Prior to logging, measurement depths were referenced to ground level. This was done by placing the top of the probe even with a fixed reference point, such as top of casing or drill mud bucket. Then the electronic depth counter was set to the probe length minus the height of the reference point. Once verified with a tape measure, these calculations were recorded on a field log. Offset distances between probe tip and measurement points are corrected by the acquisition software. The probe was then lowered to the bottom of the boring, the caliper arms opened via software control, the software recorder turned on and data were acquired on ascent. The probe was returned to the surface at approximately 10-15 feet/minute, collecting data continuously at 0.05-foot spacing, as summarized in Table 2.

Prior to use, caliper tool operation was verified using **GEO***Vision* verification plate S/N 203. Plate S/N 203 is a circular aluminum plate with a series of four machined annular slots in the top surface for fitting the tips of the caliper arms. The slots have outside diameters from 2.1 to 8.0 inches. Methodically, the nose of the probe is centered through the central hole of the verification plate. The caliper probe arms are opened under program control, and a log recorded as the tips of the arms are sequentially placed in the four slots on the plate. The measured dimensions, as displayed on the computer screen, are recorded and compared to the verification plate know diameters.

If the verification records do not fall within +/- 0.05 inches of the verification plate values, the caliper tool is re-adjusted using the four point verification plate and the verification log repeated. As with the verification, the tips of the caliper arms are placed in the holes marked with the known diameter. During re-adjustment, the value of the current point, as stamped on the jig, is entered via the control computer. The system counts for 15 seconds to make an average of the response. The procedure is repeated for the remaining openings. The computation and generation of the adjustment file is entirely automatic. The adjustment file is simply the set of coefficients of a quadratic curve which fits the four data points.

Natural gamma was not calibrated in the field, as it is a qualitative measurement, not a quantitative value, and is used only to assist in picking transitions between stratigraphic units, as described in ASTM D6274-10, “Conducting Borehole Geophysical Logging – Gamma”.

Upon completion of the measurements, the probe zero depth indication at the depth reference point was verified prior to removal from the boring.

Natural gamma was not calibrated in the field, as it is a qualitative measurement, not a quantitative value, and is used only to assist in picking transitions between stratigraphic units, as described in ASTM D6274-10, “Conducting Borehole Geophysical Logging – Gamma”.

Upon completion of the measurements, the probe zero depth indication at the depth reference point was verified prior to removal from the boring.

Elog / Natural Gamma Measurement Procedures

Measurement procedures followed these ASTM standards:

- ASTM D5753-05 (Re-approved 2010), “Planning and Conducting Boring Geophysical Logging”
- ASTM D6274-10, “Conducting Boring Geophysical Logging – Gamma”

The ELOG probe requires a fluid filled boring for proper operation. Prior to logging, measurement depths were referenced to ground level. This was done by placing the top of the probe even with a fixed reference point, such as top of casing or drill mud bucket. Then the electronic depth counter was set to the probe length minus the height of the reference point. Once verified with a tape measure, these calculations were recorded on a field log. Offset distances between probe tip and measurement points are corrected by the acquisition software.

The probe is connected to the logging cable using a 32.8 foot long insulating cable section or “bridle”. The probe head was insulated by wrapping all exposed metal of the cable head and probe

with self-amalgamating insulation tape. The 32.8 foot insulating yoke was checked for any damage, and repaired with self-amalgamating insulation tape as needed. The functional length of the probe with the bridle cable is 41 feet.

Prior to logging, measurement depths were referenced to ground level. This was done by positioning the probe with the top of the yoke even with a fixed reference point, such as top of casing or drill mud bucket. Then the electronic depth counter was set to the probe and bridle length (41 feet) minus the height of the reference point. Once verified with a tape measure, these calculations were recorded on a field log. Offset distances between probe tip and measurement points are corrected by the acquisition software. The probe was then lowered to the bottom of the boring, the software recorder turned on and data were acquired on ascent.. The probe was then returned to the surface at approximately 10 feet/minute, collecting data continuously at 0.05 foot spacing, until the yoke electrode cleared the surface of the borehole fluid or the probe entered the surface casing, as summarized in Table 2.

The reference ground stake was driven firmly into the ground near the borehole and connected to the ground socket on the winch junction box.

This probe was not calibrated in the field, as it is used to provide qualitative measurements, not quantitative values, and is used only to assist in picking transitions between stratigraphic units, as described in ASTM D5753-05 (Reapproved 2010), Planning and Conducting Boring Geophysical Surveys. A functional test was performed prior to use by applying fixed resistance values across the probe electrodes, as well as a 100 millivolt signal across the SP electrodes, and recording the resultant output of the system.

Natural gamma was not calibrated in the field, as it is a qualitative measurement, not a quantitative value, and is used only to assist in picking transitions between stratigraphic units, as described in ASTM D6274-10, Conducting Boring Geophysical Logging - Gamma.

Upon completion of the measurements, the probe zero depth indication at the depth reference point was verified prior to removal from the boring.

DATA ANALYSIS

Suspension Velocity Analysis

Using the proprietary OYO program PSLOG.EXE version 1.0, the recorded digital waveforms were analyzed to locate the most prominent first minima, first maxima, or first break on the vertical axis records, indicating the arrival of P-wave energy. The difference in travel time between receiver 1 and receiver 2 (R1-R2) arrivals was used to calculate the P-wave velocity for that 1.0 meter segment of the soil column. When observable, P-wave arrivals on the horizontal axis records were used to verify the velocities determined from the vertical axis data. The time picks were then transferred into a Microsoft Excel® template (version 2003 SP2) to complete the velocity calculations based upon the arrival time picks made in PSLOG. The Microsoft Excel® analysis files are included on the data disk that accompanies this report.

The P-wave velocity over the 6.3-foot interval from source to receiver 1 (S-R1) was also picked using PSLOG, and calculated and plotted in Microsoft Excel®, for quality assurance of the velocity derived from the travel time between receivers. In this analysis, the depth values as recorded were increased by 4.8 feet to correspond to the mid-point of the 6.3-foot S-R1 interval. Travel times were obtained by picking the first break of the P-wave signal at receiver 1 and subtracting 4 milliseconds, the calculated and experimentally verified delay from source trigger pulse (beginning of record) to source impact. This delay corresponds to the duration of acceleration of the solenoid before impact.

As with the P-wave records, the recorded digital waveforms were analyzed to locate clear S_H-wave pulses, as indicated by the presence of opposite polarity pulses on each pair of horizontal records. Ideally, the S_H-wave signals from the 'normal' and 'reverse' source pulses are very nearly inverted images of each other. Digital Fast Fourier Transform – Inverse Fast Fourier Transform (FFT – IFFT) lowpass filtering was used to remove the higher frequency P-wave signal from the S_H-wave signal. Different filter cutoffs were used to separate P- and S_H-waves at different depths, ranging from 600 Hz in the slowest zones to 4000 Hz in the regions of highest velocity. At each depth, the

filter frequency was selected to be at least twice the fundamental frequency of the S_H-wave signal being filtered.

Generally, the first maxima were picked for the 'normal' signals and the first minima for the 'reverse' signals, although other points on the waveform were used if the first pulse was distorted. The absolute arrival time of the 'normal' and 'reverse' signals may vary by +/- 0.2 milliseconds, due to differences in the actuation time of the solenoid source caused by constant mechanical bias in the source or by boring inclination. This variation does not affect the R1-R2 velocity determinations, as the differential time is measured between arrivals of waves created by the same source actuation. The final velocity value is the average of the values obtained from the 'normal' and 'reverse' source actuations.

As with the P-wave data, S_H-wave velocity calculated from the travel time over the 6.3-foot interval from source to receiver 1 was calculated and plotted for verification of the velocity derived from the travel time between receivers. In this analysis, the depth values were increased by 4.8 feet to correspond to the mid-point of the 6.3-foot S-R1 interval. Travel times were obtained by picking the first break of the S_H-wave signal at the near receiver and subtracting 4 milliseconds, the calculated and experimentally verified delay from the beginning of the record at the source trigger pulse to source impact.

These data and analysis were reviewed by John Diehl as a component of **GEO***Vision*'s in-house data validation program.

Figure 2 shows an example of R1 - R2 measurements on a sample filtered suspension record. In Figure 2, the time difference over the 3.3 foot interval of 1.88 milliseconds for the horizontal signals is equivalent to an S_H-wave velocity of 1745 feet/second. Whenever possible, time differences were determined from several phase points on the S_H-waveform records to verify the data obtained from the first arrival of the S_H-wave pulse. Figure 3 displays the same record before filtering of the S_H-waveform record with a 1400 Hz FFT - IFFT digital lowpass filter, illustrating

the presence of higher frequency P-wave energy at the beginning of the record, and distortion of the lower frequency S_H-wave by residual P-wave signal.

Caliper / Natural Gamma

CAL and NG data do not require analysis; however depths to identifiable boring log features, such as distinct natural gamma transitions, were compared to verify consistent depth readings on all logs. Using WellCAD software version 5.1, CAL and NG data were combined with other line log data and converted to LAS 2.0 and PDF formats.

Elog / Natural Gamma Analysis

ELOG and NG data do not require analysis; however depths to identifiable boring log features, such as distinct natural gamma transitions, were compared to verify consistent depth readings on all logs. Using WellCAD software version 5.1, ELOG and NG data were combined with other line log data and converted to LAS 2.0 and PDF formats.

RESULTS

Suspension Velocity Results

Suspension R1-R2 P- and S_H-wave velocities for Boring SB-1 are plotted in Figure 5. The suspension velocity data presented in this figure are also presented in Table 3. The Microsoft Excel® analysis file is included in the electronic data that accompanies this report.

P- and S_H-wave velocity data from R1-R2 analysis and quality assurance analysis of S-R1 data are plotted together in Figure A-1 to aid in visual comparison. It should be noted that R1-R2 data are an average velocity over a 3.3-foot segment of the soil column; S-R1 data are an average over 6.3 feet, creating a significant smoothing relative to the R1-R2 plots. The S-R1 velocity data displayed in this figure are also presented in Table A-1 and included in the Microsoft Excel® analysis file that accompanies this report. The Microsoft Excel® analysis file includes Poisson's Ratio calculations, tabulated data and plots.

Caliper / Natural Gamma Results

Caliper (CAL) data are presented on combination line log plots with ELOG and NG data (Appendix B). All logs are scaled to the API 5-inch (1 inch = 20 feet) standard. Depths on all figures and tables are referenced to ground surface. LAS 2.0 data and Acrobat files of the plots are included in the boring specific sub-directories in the data directory that accompanies this report.

Elog / Natural Gamma Results

ELOG data are presented on combination line log plots with CAL and NG data (Appendix B). All logs are scaled to the API 5-inch (1 inch = 20 feet) standard. Depths on all figures and tables are referenced to ground surface. LAS 2.0 data and Acrobat files of the plots are included in the boring specific sub-directories in the data directory that accompanies this report.

SUMMARY

Discussion of Suspension Velocity Results

Suspension PS velocity data are ideally collected in an uncased fluid filled boring, drilled with rotary mud (rotary wash) methods, as found in the case of this boring.

Suspension PS velocity data quality is judged based upon 5 criteria.

- Consistent data between receiver to receiver (R1 – R2) and source to receiver (S – R1) data.
- Consistency between data from adjacent depth intervals.
- Consistent relationship between P-wave and S_H -wave (excluding transition to saturated soils)
- Clarity of P-wave and S_H-wave onset, as well as damping of later oscillations.
- Consistency of profile between adjacent borings, if available.

Good correspondence between the shapes of the P- and S_H-wave velocity curves are observed for this data set. The raw data was of excellent quality, obviating the need for any filtering or other post processing. The velocities derived from S-R1 and R1-R2 data are in good agreement for this borehole, providing verification of the higher resolution R1-R2 data.

There is an interesting drop in both P- and S-wave velocities at about 294 feet below ground surface (bgs). The P-wave velocity drops below water velocity, indicating possibly a thin unsaturated zone. Low Vs velocities continue down to about 400 feet bgs.

Discussion of Caliper / Natural Gamma Results

The caliper log for boring SB-1 shows fairly consistent 6” gauge below the casing to about 248’, where the gauge narrows to 5”, likely due to a change in bit size. The gauge narrows again to 4” at about 452’ bgs. The caliper log terminated at 475’ due to collapse of the hole. This was the final log to be run.

There were no significant variations in the Natural Gamma log, but notable correspondence between minor features, particularly the events at about 285’ and 400’.

Discussion of Elog / Natural Gamma Results

Elog data were acquired in this borehole to full depth, including long- and short-normal resistance, single-point resistance (SPR), and self-potential (SP). ELog data correlate well with other line logs, further assisting identification of lithologic variability with depth.

Natural Gamma data collected with this probe is not presented, as it is of lower vertical resolution than that collected with the CAL probe. However, the data correlates very well with the Caliper NG, and confirms the accuracy of the results.

Suspension Velocity Data Reliability

P- and S_H-wave velocity measurement using the Suspension Method gives average velocities over a 3.3-foot interval of depth. This high resolution results in the scatter of values shown in the graphs. Individual measurements are very reliable with estimated precision of +/- 5%. Standardized field procedures and quality assurance checks contribute to the reliability of these data.

Quality Assurance

These borehole geophysical measurements were performed using industry-standard or better methods for measurements and analyses. All work was performed under **GEO***Vision* quality assurance procedures, which include:

- Use of NIST-traceable calibrations, where applicable, for field and laboratory instrumentation
- Use of standard field data logs
- Independent review of calculations and results by a registered professional engineer, geologist, or geophysicist.

Table 1. Boring locations and logging dates

BORING DESIGNATION	DATES LOGGED	LOCATION[1]		ELEVATION (FEET)
		NORTHING	EASTING	
SB-1	7/18/2016	209678.36	2164427.494	6.4

(1) Coordinates provided by F&ME

Table 2. Logging dates and depth ranges

BORING NUMBER	TOOL AND RUN NUMBER	DEPTH RANGE (FEET)*	CASED OR UNCASED	SAMPLE INTERVAL (FEET)	DATE LOGGED
SB-1	SUSPENSION DOWN01	78.85 – 501.75	UNCASED	1.6	7/18/2016
SB-1	ELOG UP01	515.19 – 77.29	UNCASED	0.05	7/18/2016
SB-1	CALIPER UP01	474.69 – 46.69	UNCASED	0.05	7/18/2016

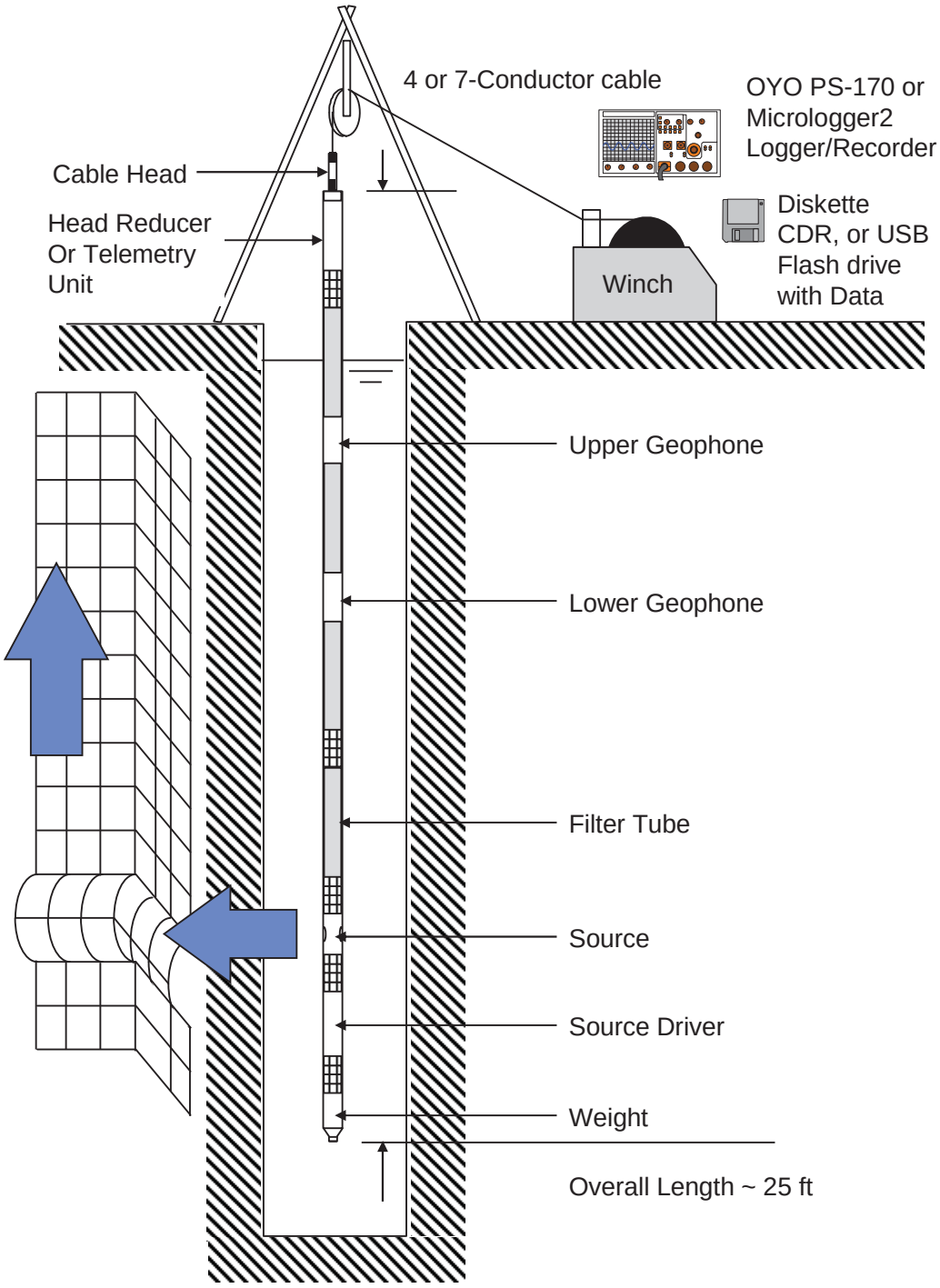


Figure 1: Concept illustration of P-S logging system

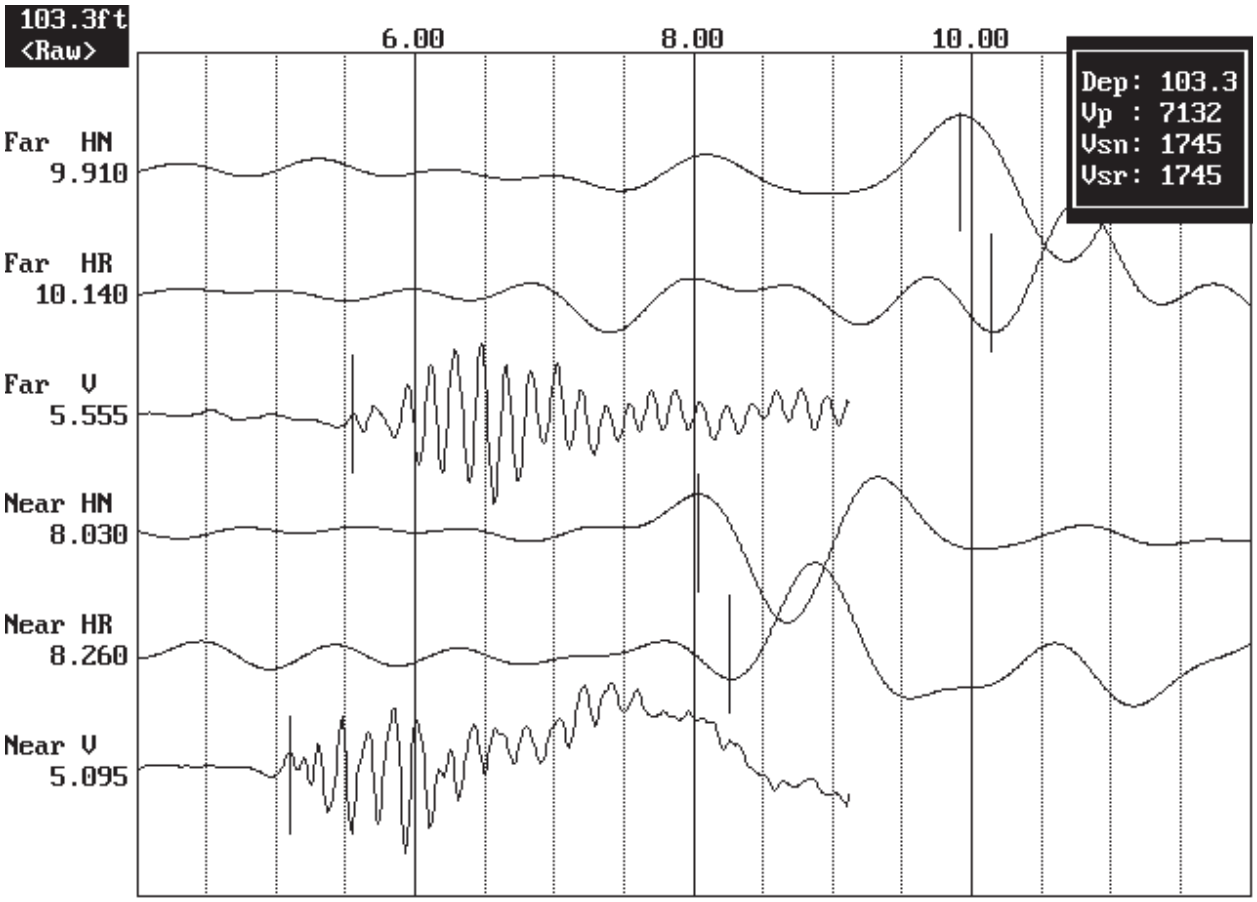


Figure 2: Example of filtered (1400 Hz lowpass) suspension record

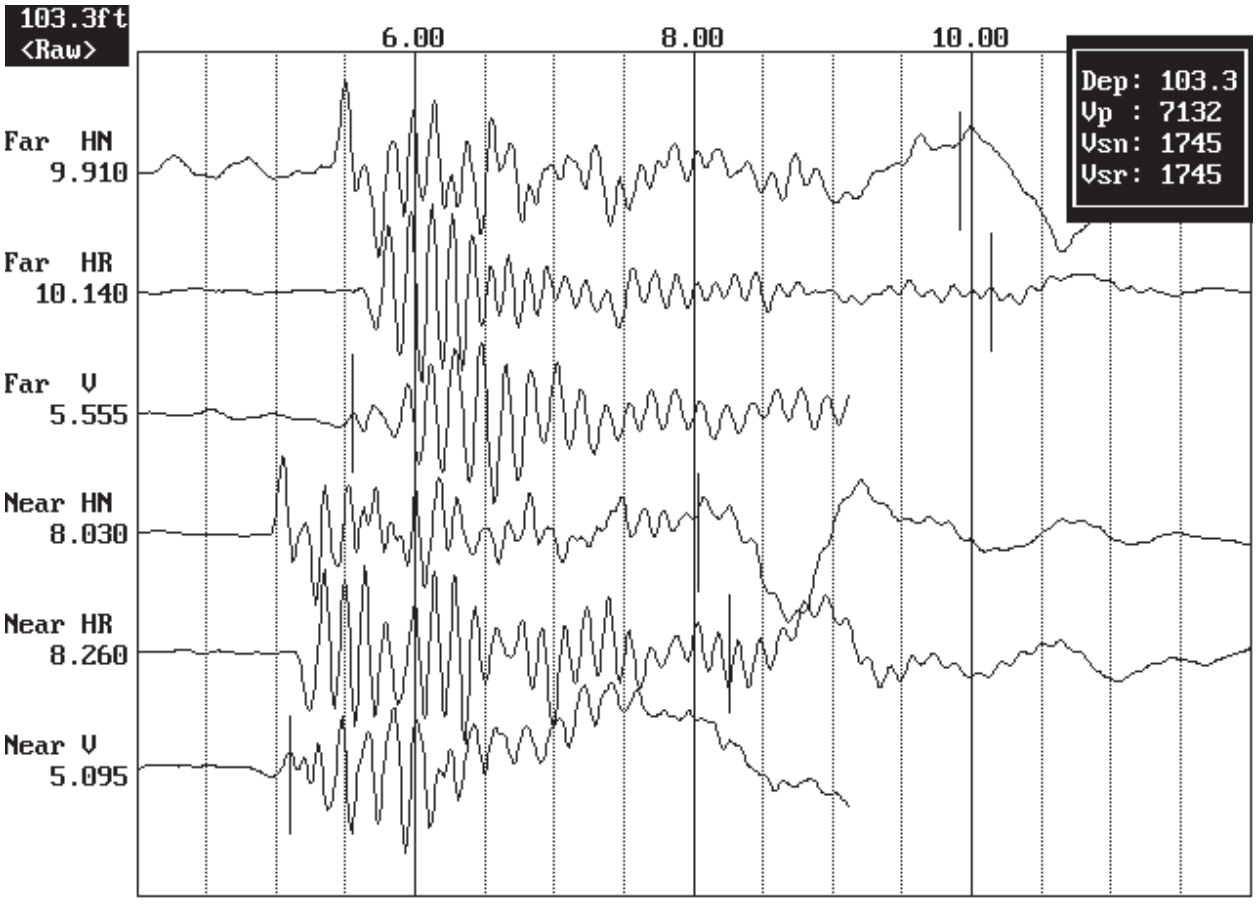


Figure 3. Example of unfiltered suspension record

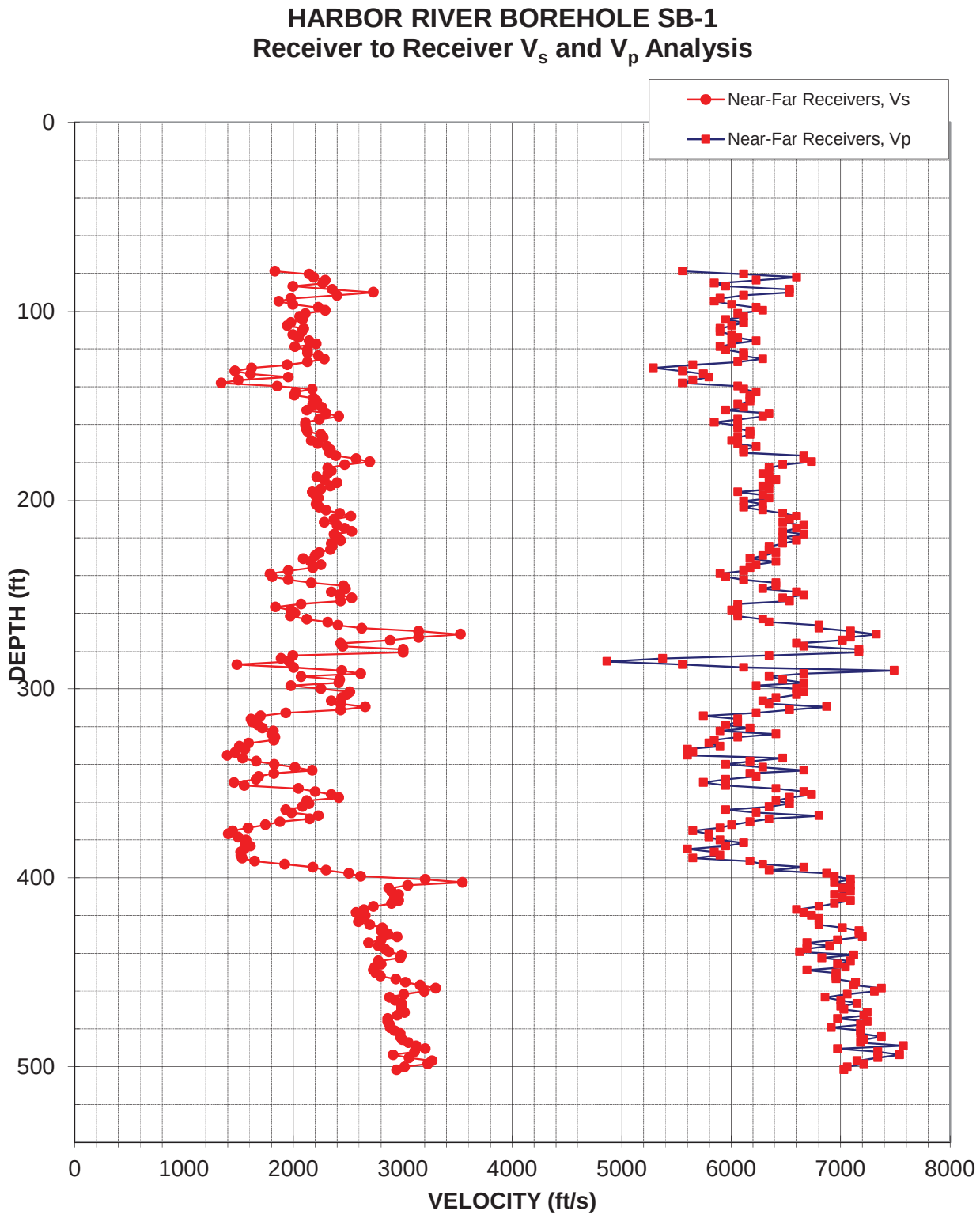


Figure 4: Boring SB-1, Suspension R1-R2 P- and S_H-wave velocities

Table 3. Boring SB-1, Suspension R1-R2 depths and P- and S_H-wave velocities

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio Based on Receiver-to-Receiver Travel Time Data - Borehole SB-1

American Units				Metric Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio	Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V_s	V_p			V_s	V_p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
78.9	1830	5560	0.44	24.0	560	1690	0.44
80.5	2140	6120	0.43	24.5	650	1860	0.43
82.1	2190	6600	0.44	25.0	670	2010	0.44
83.7	2290	6230	0.42	25.5	700	1900	0.42
85.3	2270	5850	0.41	26.0	690	1780	0.41
86.9	2000	5950	0.44	26.5	610	1810	0.44
88.5	2360	6540	0.43	27.0	720	1990	0.43
90.1	2730	6540	0.39	27.5	830	1990	0.39
91.7	2400	6120	0.41	27.9	730	1860	0.41
93.3	1980	5900	0.44	28.4	600	1800	0.44
94.9	1870	5850	0.44	28.9	570	1780	0.44
96.5	2000	6010	0.44	29.4	610	1830	0.44
98.1	2230	6230	0.43	29.9	680	1900	0.43
99.7	2290	6290	0.42	30.4	700	1920	0.42
101.3	2110	6060	0.43	30.9	640	1850	0.43
102.9	2060	6120	0.44	31.4	630	1860	0.44
104.5	2080	5950	0.43	31.8	640	1810	0.43
106.1	1980	6120	0.44	32.3	600	1860	0.44
107.7	1940	6010	0.44	32.8	590	1830	0.44
109.3	2100	5900	0.43	33.3	640	1800	0.43
110.9	2080	5900	0.43	33.8	630	1800	0.43
112.5	2000	6010	0.44	34.3	610	1830	0.44
114.1	2040	6060	0.44	34.8	620	1850	0.44
115.7	2140	6230	0.43	35.3	650	1900	0.43
117.3	2210	6010	0.42	35.8	670	1830	0.42
118.9	2010	5900	0.43	36.2	610	1800	0.43
120.5	2130	5950	0.43	36.7	650	1810	0.43
122.1	2130	6120	0.43	37.2	650	1860	0.43
123.7	2230	6120	0.42	37.7	680	1860	0.42
125.3	2280	6290	0.42	38.2	700	1920	0.42
126.9	2130	6060	0.43	38.7	650	1850	0.43
128.5	1940	5650	0.43	39.2	590	1720	0.43
130.1	1620	5290	0.45	39.7	490	1610	0.45
131.7	1470	5560	0.46	40.1	450	1690	0.46
133.3	1610	5750	0.46	40.6	490	1750	0.46
134.9	1960	5800	0.44	41.1	600	1770	0.44
136.5	1500	5650	0.46	41.6	460	1720	0.46

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio Based on Receiver-to-Receiver Travel Time Data - Borehole SB-1

American Units				Metric Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio	Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V_s	V_p			V_s	V_p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
138.1	1340	5560	0.47	42.1	410	1690	0.47
139.7	1850	6060	0.45	42.6	560	1850	0.45
141.3	2170	6120	0.43	43.1	660	1860	0.43
142.9	2020	6230	0.44	43.6	620	1900	0.44
144.5	2010	6170	0.44	44.1	610	1880	0.44
146.1	2190	6170	0.43	44.5	670	1880	0.43
147.7	2210	6170	0.43	45.0	680	1880	0.43
149.3	2180	6060	0.43	45.5	660	1850	0.43
150.9	2260	6120	0.42	46.0	690	1860	0.42
152.5	2120	5950	0.43	46.5	650	1810	0.43
154.1	2300	6350	0.42	47.0	700	1940	0.42
155.7	2420	6290	0.41	47.5	740	1920	0.41
157.3	2240	6060	0.42	48.0	680	1850	0.42
158.9	2110	5850	0.43	48.4	640	1780	0.43
160.5	2110	6060	0.43	48.9	640	1850	0.43
162.1	2120	6060	0.43	49.4	650	1850	0.43
163.8	2130	6170	0.43	49.9	650	1880	0.43
165.4	2250	6170	0.42	50.4	690	1880	0.42
167.0	2280	6060	0.42	50.9	690	1850	0.42
168.6	2160	6010	0.43	51.4	660	1830	0.43
170.2	2220	6060	0.42	51.9	680	1850	0.42
171.8	2310	6230	0.42	52.4	700	1900	0.42
173.4	2340	6120	0.41	52.8	710	1860	0.41
175.0	2330	6120	0.42	53.3	710	1860	0.42
176.6	2390	6670	0.43	53.8	730	2030	0.43
178.2	2570	6670	0.41	54.3	780	2030	0.41
179.8	2700	6730	0.40	54.8	820	2050	0.40
181.4	2470	6470	0.41	55.3	750	1970	0.41
183.0	2310	6350	0.42	55.8	710	1940	0.42
184.6	2350	6350	0.42	56.3	720	1940	0.42
186.2	2310	6290	0.42	56.7	710	1920	0.42
187.8	2210	6350	0.43	57.2	680	1940	0.43
189.4	2280	6410	0.43	57.7	700	1950	0.43
191.0	2400	6350	0.42	58.2	730	1940	0.42
192.6	2340	6290	0.42	58.7	710	1920	0.42
194.2	2250	6350	0.43	59.2	690	1940	0.43
195.8	2170	6060	0.43	59.7	660	1850	0.43
197.4	2200	6290	0.43	60.2	670	1920	0.43
199.0	2230	6350	0.43	60.7	680	1940	0.43
200.6	2210	6120	0.42	61.1	680	1860	0.42

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Receiver-to-Receiver Travel Time Data - Borehole SB-1

American Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V_s	V_p	
(ft)	(ft/s)	(ft/s)	
202.2	2210	6290	0.43
203.8	2240	6120	0.42
205.4	2300	6290	0.42
207.0	2420	6470	0.42
208.6	2530	6600	0.41
210.2	2370	6540	0.42
211.8	2280	6470	0.43
213.4	2400	6670	0.43
215.0	2470	6600	0.42
216.6	2530	6470	0.41
218.2	2370	6670	0.43
219.8	2410	6470	0.42
221.4	2430	6600	0.42
223.0	2350	6470	0.42
224.6	2360	6350	0.42
226.2	2340	6350	0.42
227.8	2240	6410	0.43
229.4	2200	6290	0.43
231.0	2090	6170	0.44
232.6	2160	6410	0.44
234.2	2250	6230	0.42
235.8	2180	6170	0.43
237.4	1960	6120	0.44
239.0	1790	5900	0.45
240.6	1810	5950	0.45
242.2	1960	6120	0.44
243.8	2160	6410	0.44
245.4	2460	6410	0.41
247.0	2480	6290	0.41
248.7	2350	6600	0.43
250.3	2420	6670	0.42
251.9	2530	6470	0.41
253.5	2430	6540	0.42
255.1	2070	6060	0.43
256.7	1840	6060	0.45
258.3	1980	6010	0.44
259.9	2010	6060	0.44
261.5	1970	6060	0.44
263.1	2120	6290	0.44
264.7	2310	6350	0.42

Metric Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V_s	V_p	
(m)	(m/s)	(m/s)	
61.6	670	1920	0.43
62.1	680	1860	0.42
62.6	700	1920	0.42
63.1	740	1970	0.42
63.6	770	2010	0.41
64.1	720	1990	0.42
64.6	700	1970	0.43
65.0	730	2030	0.43
65.5	750	2010	0.42
66.0	770	1970	0.41
66.5	720	2030	0.43
67.0	730	1970	0.42
67.5	740	2010	0.42
68.0	720	1970	0.42
68.5	720	1940	0.42
69.0	710	1940	0.42
69.4	680	1950	0.43
69.9	670	1920	0.43
70.4	640	1880	0.44
70.9	660	1950	0.44
71.4	690	1900	0.42
71.9	660	1880	0.43
72.4	600	1860	0.44
72.9	540	1800	0.45
73.3	550	1810	0.45
73.8	600	1860	0.44
74.3	660	1950	0.44
74.8	750	1950	0.41
75.3	760	1920	0.41
75.8	720	2010	0.43
76.3	740	2030	0.42
76.8	770	1970	0.41
77.3	740	1990	0.42
77.7	630	1850	0.43
78.2	560	1850	0.45
78.7	600	1830	0.44
79.2	610	1850	0.44
79.7	600	1850	0.44
80.2	650	1920	0.44
80.7	710	1940	0.42

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Receiver-to-Receiver Travel Time Data - Borehole SB-1

American Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V_s	V_p	
(ft)	(ft/s)	(ft/s)	
266.3	2410	6800	0.43
267.9	2620	6800	0.41
269.5	3140	7090	0.38
271.1	3530	7330	0.35
272.7	3140	7090	0.38
274.3	2890	7020	0.40
275.9	2430	6600	0.42
277.5	2450	6670	0.42
279.1	3000	7170	0.39
280.7	3000	7170	0.39
282.3	2000	6350	0.45
283.9	1890	5380	0.43
285.5	1960	4870	0.40
287.1	1480	5560	0.46
288.7	2000	6120	0.44
290.3	2440	7490	0.44
291.9	2610	6670	0.41
293.5	2070	6350	0.44
295.1	2420	6470	0.42
296.7	2420	6670	0.42
298.3	1980	6230	0.44
299.9	2250	6600	0.43
301.5	2520	6670	0.42
303.1	2490	6600	0.42
304.7	2440	6410	0.42
306.3	2350	6290	0.42
307.9	2430	6350	0.41
309.5	2660	6870	0.41
311.1	2430	6540	0.42
312.7	1930	6230	0.45
314.3	1700	5750	0.45
315.9	1610	6060	0.46
317.5	1630	6060	0.46
319.1	1680	5950	0.46
320.7	1720	6170	0.46
322.3	1820	5900	0.45
323.9	1800	6410	0.46
325.5	1830	6060	0.45
327.1	1820	5850	0.45
328.7	1590	5800	0.46

Metric Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V_s	V_p	
(m)	(m/s)	(m/s)	
81.2	730	2070	0.43
81.6	800	2070	0.41
82.1	960	2160	0.38
82.6	1080	2230	0.35
83.1	960	2160	0.38
83.6	880	2140	0.40
84.1	740	2010	0.42
84.6	750	2030	0.42
85.1	920	2180	0.39
85.6	920	2180	0.39
86.0	610	1940	0.45
86.5	580	1640	0.43
87.0	600	1480	0.40
87.5	450	1690	0.46
88.0	610	1860	0.44
88.5	740	2280	0.44
89.0	800	2030	0.41
89.5	630	1940	0.44
89.9	740	1970	0.42
90.4	740	2030	0.42
90.9	600	1900	0.44
91.4	690	2010	0.43
91.9	770	2030	0.42
92.4	760	2010	0.42
92.9	740	1950	0.42
93.4	720	1920	0.42
93.9	740	1940	0.41
94.3	810	2090	0.41
94.8	740	1990	0.42
95.3	590	1900	0.45
95.8	520	1750	0.45
96.3	490	1850	0.46
96.8	500	1850	0.46
97.3	510	1810	0.46
97.8	520	1880	0.46
98.2	550	1800	0.45
98.7	550	1950	0.46
99.2	560	1850	0.45
99.7	560	1780	0.45
100.2	480	1770	0.46

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio Based on Receiver-to-Receiver Travel Time Data - Borehole SB-1

American Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V_s	V_p	
(ft)	(ft/s)	(ft/s)	
330.3	1510	5900	0.47
331.9	1560	5600	0.46
333.6	1470	5650	0.46
335.2	1390	5600	0.47
336.8	1540	6470	0.47
338.4	1660	6170	0.46
340.0	1830	5950	0.45
341.6	2010	6290	0.44
343.2	2170	6670	0.44
344.8	1820	6170	0.45
346.4	1680	6230	0.46
348.0	1660	5950	0.46
349.6	1460	5750	0.47
351.2	1550	5950	0.46
352.8	2040	6410	0.44
354.4	2200	6670	0.44
356.0	2350	6730	0.43
357.6	2420	6540	0.42
359.2	2120	6410	0.44
360.8	2140	6540	0.44
362.4	2080	6350	0.44
364.0	1930	5950	0.44
365.6	1980	6230	0.44
367.2	2230	6800	0.44
368.8	2150	6350	0.44
370.4	1880	6170	0.45
372.0	1750	6010	0.45
373.6	1590	5900	0.46
375.2	1450	5650	0.46
376.8	1410	5800	0.47
378.4	1490	5800	0.46
380.0	1570	5900	0.46
381.6	1560	6120	0.47
383.2	1610	5950	0.46
384.8	1550	5600	0.46
386.4	1520	5850	0.46
388.0	1520	5900	0.46
389.6	1530	5650	0.46
391.2	1650	6170	0.46
392.8	1920	6290	0.45

Metric Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V_s	V_p	
(m)	(m/s)	(m/s)	
100.7	460	1800	0.47
101.2	470	1710	0.46
101.7	450	1720	0.46
102.2	430	1710	0.47
102.6	470	1970	0.47
103.1	510	1880	0.46
103.6	560	1810	0.45
104.1	610	1920	0.44
104.6	660	2030	0.44
105.1	560	1880	0.45
105.6	510	1900	0.46
106.1	510	1810	0.46
106.5	440	1750	0.47
107.0	470	1810	0.46
107.5	620	1950	0.44
108.0	670	2030	0.44
108.5	720	2050	0.43
109.0	740	1990	0.42
109.5	650	1950	0.44
110.0	650	1990	0.44
110.5	640	1940	0.44
110.9	590	1810	0.44
111.4	600	1900	0.44
111.9	680	2070	0.44
112.4	660	1940	0.44
112.9	570	1880	0.45
113.4	530	1830	0.45
113.9	480	1800	0.46
114.4	440	1720	0.46
114.8	430	1770	0.47
115.3	460	1770	0.46
115.8	480	1800	0.46
116.3	480	1860	0.47
116.8	490	1810	0.46
117.3	470	1710	0.46
117.8	460	1780	0.46
118.3	460	1800	0.46
118.8	470	1720	0.46
119.2	500	1880	0.46
119.7	590	1920	0.45

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Receiver-to-Receiver Travel Time Data - Borehole SB-1

American Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V_s	V_p	
(ft)	(ft/s)	(ft/s)	
394.4	2180	6670	0.44
396.0	2300	6350	0.42
397.6	2510	6870	0.42
399.2	2610	6940	0.42
400.8	3210	7090	0.37
402.4	3550	6940	0.32
404.0	3040	7090	0.39
405.6	2870	7020	0.40
407.2	2900	7090	0.40
408.8	2960	6940	0.39
410.4	2920	7020	0.39
412.0	2960	7090	0.39
413.6	2900	6940	0.39
415.2	2730	6800	0.40
416.8	2650	6600	0.40
418.5	2570	6670	0.41
420.1	2660	6730	0.41
421.7	2610	6800	0.41
423.3	2590	6800	0.41
424.9	2700	6800	0.41
426.5	2810	7020	0.40
428.1	2800	7170	0.41
429.7	2860	7170	0.41
431.3	2950	7200	0.40
432.9	2800	6970	0.40
434.5	2690	6690	0.40
436.1	2780	6900	0.40
437.7	2840	6690	0.39
439.3	2870	6630	0.38
440.9	2990	7120	0.39
442.5	2980	6830	0.38
444.1	2780	7090	0.41
445.7	2800	6970	0.40
447.3	2740	7050	0.41
448.9	2730	6690	0.40
450.5	2750	6960	0.41
452.1	2800	6960	0.40
453.7	2940	6960	0.39
455.3	3020	7140	0.39
456.9	3160	7120	0.38

Metric Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V_s	V_p	
(m)	(m/s)	(m/s)	
120.2	660	2030	0.44
120.7	700	1940	0.42
121.2	760	2090	0.42
121.7	800	2120	0.42
122.2	980	2160	0.37
122.7	1080	2120	0.32
123.1	930	2160	0.39
123.6	880	2140	0.40
124.1	880	2160	0.40
124.6	900	2120	0.39
125.1	890	2140	0.39
125.6	900	2160	0.39
126.1	880	2120	0.39
126.6	830	2070	0.40
127.1	810	2010	0.40
127.5	780	2030	0.41
128.0	810	2050	0.41
128.5	800	2070	0.41
129.0	790	2070	0.41
129.5	820	2070	0.41
130.0	860	2140	0.40
130.5	850	2180	0.41
131.0	870	2180	0.41
131.5	900	2190	0.40
131.9	850	2130	0.40
132.4	820	2040	0.40
132.9	850	2100	0.40
133.4	860	2040	0.39
133.9	880	2020	0.38
134.4	910	2170	0.39
134.9	910	2080	0.38
135.4	850	2160	0.41
135.8	850	2130	0.40
136.3	840	2150	0.41
136.8	830	2040	0.40
137.3	840	2120	0.41
137.8	850	2120	0.40
138.3	900	2120	0.39
138.8	920	2180	0.39
139.3	960	2170	0.38

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Receiver-to-Receiver Travel Time Data - Borehole SB-1

American Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V_s	V_p	
(ft)	(ft/s)	(ft/s)	
458.5	3300	7370	0.37
460.1	3200	7310	0.38
461.7	3010	7060	0.39
463.3	2880	6860	0.39
464.9	2930	7000	0.39
466.5	2990	7150	0.39
468.1	2990	7000	0.39
469.7	2990	7030	0.39
471.3	3020	7250	0.40
472.9	2950	7220	0.40
474.5	2860	6970	0.40
476.1	2860	7250	0.41
477.7	2880	7180	0.40
479.3	2890	6920	0.39
480.9	2920	7180	0.40
482.5	2980	7180	0.40
484.1	2980	7370	0.40
485.7	3000	7220	0.40
487.3	3050	7180	0.39
488.9	3120	7580	0.40
490.5	3210	6970	0.37
492.1	3110	7340	0.39
493.7	2910	7540	0.41
495.3	3060	7340	0.40
496.9	3270	7150	0.37
498.5	3230	7220	0.37
500.1	3020	7060	0.39
501.8	2940	7030	0.39

Metric Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V_s	V_p	
(m)	(m/s)	(m/s)	
139.8	1010	2250	0.37
140.2	970	2230	0.38
140.7	920	2150	0.39
141.2	880	2090	0.39
141.7	890	2130	0.39
142.2	910	2180	0.39
142.7	910	2130	0.39
143.2	910	2140	0.39
143.7	920	2210	0.40
144.1	900	2200	0.40
144.6	870	2130	0.40
145.1	870	2210	0.41
145.6	880	2190	0.40
146.1	880	2110	0.39
146.6	890	2190	0.40
147.1	910	2190	0.40
147.6	910	2250	0.40
148.1	910	2200	0.40
148.5	930	2190	0.39
149.0	950	2310	0.40
149.5	980	2130	0.37
150.0	950	2240	0.39
150.5	890	2300	0.41
151.0	930	2240	0.40
151.5	1000	2180	0.37
152.0	980	2200	0.37
152.4	920	2150	0.39
152.9	900	2140	0.39

APPENDIX A

SUSPENSION VELOCITY MEASUREMENT QUALITY ASSURANCE SUSPENSION SOURCE TO RECEIVER ANALYSIS RESULTS

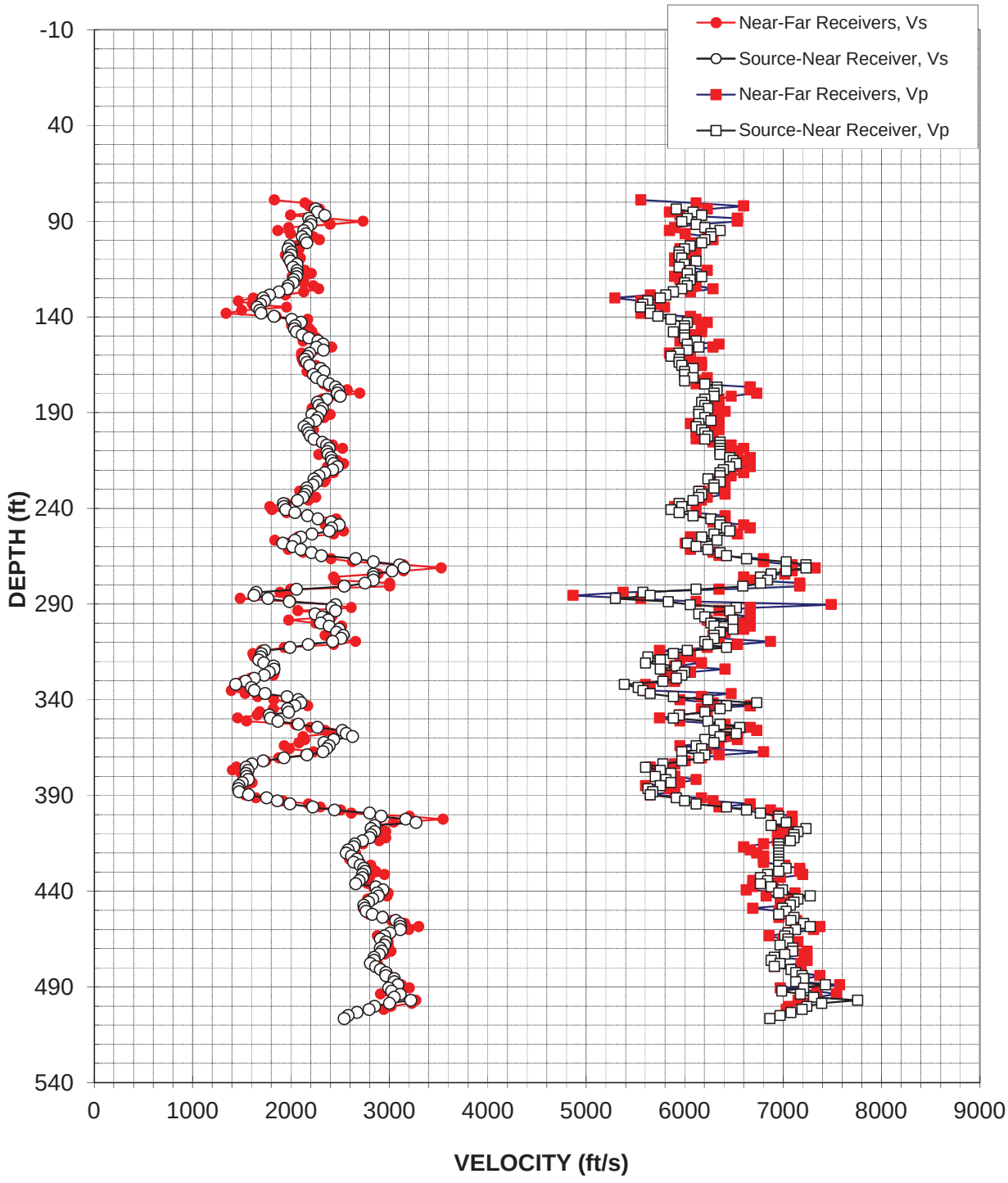


Figure A-1: Boring SB-1, Suspension S-R1 P- and S_H-wave velocities

Table A-1. Boring SB-1, S - R1 quality assurance analysis P- and S_H-wave data

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio Based on Source-to-Receiver Travel Time Data - Borehole SB-1

American Units				Metric Units			
Depth at Midpoint Between Source and Near Receiver	Velocity V_s	Velocity V_p	Poisson's Ratio	Depth at Midpoint Between Source and Near Receiver	Velocity V_s	Velocity V_p	Poisson's Ratio
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
83.7	2250	5920	0.42	25.5	690	1800	0.42
85.3	2270	6090	0.42	26.0	690	1860	0.42
86.9	2340	6180	0.42	26.5	710	1880	0.42
88.5	2180	6030	0.42	27.0	670	1840	0.42
90.1	2210	5970	0.42	27.5	670	1820	0.42
91.7	2200	6120	0.43	27.9	670	1860	0.43
93.3	2170	6210	0.43	28.4	660	1890	0.43
94.9	2130	6360	0.44	28.9	650	1940	0.44
96.5	2150	6270	0.43	29.4	660	1910	0.43
98.1	2120	6270	0.44	29.9	650	1910	0.44
99.7	2150	6210	0.43	30.4	650	1890	0.43
101.3	2160	6180	0.43	30.9	660	1880	0.43
102.9	1980	6060	0.44	31.4	600	1850	0.44
104.5	1970	6000	0.44	31.9	600	1830	0.44
106.1	2000	5940	0.44	32.3	610	1810	0.44
107.7	2000	5940	0.44	32.8	610	1810	0.44
109.3	1980	5970	0.44	33.3	600	1820	0.44
110.9	2000	6120	0.44	33.8	610	1860	0.44
112.5	2060	6000	0.43	34.3	630	1830	0.43
114.1	2020	5940	0.43	34.8	620	1810	0.43
115.7	2060	6060	0.43	35.3	630	1850	0.43
117.3	2060	6030	0.43	35.8	630	1840	0.43
118.9	2060	6180	0.44	36.2	630	1880	0.44
120.5	2030	6060	0.44	36.7	620	1850	0.44
122.1	2020	6000	0.44	37.2	620	1830	0.44
123.7	1970	6030	0.44	37.7	600	1840	0.44
125.3	1970	5970	0.44	38.2	600	1820	0.44
126.9	1880	5890	0.44	38.7	570	1790	0.44
128.5	1780	5810	0.45	39.2	540	1770	0.45
130.1	1720	5750	0.45	39.7	520	1750	0.45
131.7	1730	5630	0.45	40.2	530	1720	0.45
133.3	1690	5580	0.45	40.6	520	1700	0.45
134.9	1660	5550	0.45	41.1	510	1690	0.45
136.5	1680	5650	0.45	41.6	510	1720	0.45
138.1	1700	5650	0.45	42.1	520	1720	0.45
139.7	1830	5730	0.44	42.6	560	1750	0.44
141.3	2010	5860	0.43	43.1	610	1790	0.43
143.0	2100	6030	0.43	43.6	640	1840	0.43
144.6	2050	6000	0.43	44.1	620	1830	0.43

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Source-to-Receiver Travel Time Data - Borehole SB-1

American Units				Metric Units			
Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio	Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio
	V_s	V_p			V_s	V_p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
146.2	2040	6000	0.43	44.5	620	1830	0.43
147.8	2060	5890	0.43	45.0	630	1790	0.43
149.4	2120	6000	0.43	45.5	650	1830	0.43
151.0	2180	6000	0.42	46.0	670	1830	0.42
152.6	2280	6120	0.42	46.5	690	1860	0.42
154.2	2330	6030	0.41	47.0	710	1840	0.41
155.8	2260	6150	0.42	47.5	690	1870	0.42
157.4	2330	6030	0.41	48.0	710	1840	0.41
159.0	2190	5940	0.42	48.5	670	1810	0.42
160.6	2170	5860	0.42	48.9	660	1790	0.42
162.2	2140	5940	0.43	49.4	650	1810	0.43
163.8	2160	5940	0.42	49.9	660	1810	0.42
165.4	2190	5970	0.42	50.4	670	1820	0.42
167.0	2300	6090	0.42	50.9	700	1860	0.42
168.6	2340	6000	0.41	51.4	710	1830	0.41
170.2	2230	6000	0.42	51.9	680	1830	0.42
171.8	2260	6090	0.42	52.4	690	1860	0.42
173.4	2330	6000	0.41	52.8	710	1830	0.41
175.0	2390	6210	0.41	53.3	730	1890	0.41
176.6	2450	6330	0.41	53.8	750	1930	0.41
178.2	2480	6330	0.41	54.3	760	1930	0.41
179.8	2470	6300	0.41	54.8	750	1920	0.41
181.4	2500	6300	0.41	55.3	760	1920	0.41
183.0	2360	6210	0.42	55.8	720	1890	0.42
184.6	2270	6180	0.42	56.3	690	1880	0.42
186.2	2290	6210	0.42	56.8	700	1890	0.42
187.8	2320	6240	0.42	57.2	710	1900	0.42
189.4	2300	6150	0.42	57.7	700	1870	0.42
191.0	2210	6150	0.43	58.2	670	1870	0.43
192.6	2270	6210	0.42	58.7	690	1890	0.42
194.2	2250	6270	0.43	59.2	690	1910	0.43
195.8	2180	6150	0.43	59.7	660	1870	0.43
197.4	2130	6120	0.43	60.2	650	1860	0.43
199.0	2170	6180	0.43	60.7	660	1880	0.43
200.6	2180	6210	0.43	61.1	670	1890	0.43
202.2	2200	6240	0.43	61.6	670	1900	0.43
203.8	2240	6210	0.43	62.1	680	1890	0.43
205.4	2320	6360	0.42	62.6	710	1940	0.42
207.0	2360	6360	0.42	63.1	720	1940	0.42
208.6	2390	6360	0.42	63.6	730	1940	0.42

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Source-to-Receiver Travel Time Data - Borehole SB-1

American Units				Metric Units			
Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio	Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio
	V_s	V_p			V_s	V_p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
210.2	2370	6360	0.42	64.1	720	1940	0.42
211.8	2380	6360	0.42	64.6	730	1940	0.42
213.4	2410	6460	0.42	65.1	730	1970	0.42
215.0	2420	6490	0.42	65.5	740	1980	0.42
216.6	2430	6530	0.42	66.0	740	1990	0.42
218.2	2470	6460	0.41	66.5	750	1970	0.41
219.8	2430	6390	0.42	67.0	740	1950	0.42
221.4	2340	6360	0.42	67.5	710	1940	0.42
223.0	2290	6360	0.43	68.0	700	1940	0.43
224.6	2240	6240	0.43	68.5	680	1900	0.43
226.3	2260	6360	0.43	69.0	690	1940	0.43
227.9	2220	6300	0.43	69.4	680	1920	0.43
229.5	2160	6300	0.43	69.9	660	1920	0.43
231.1	2160	6150	0.43	70.4	660	1870	0.43
232.7	2140	6180	0.43	70.9	650	1880	0.43
234.3	2120	6150	0.43	71.4	650	1870	0.43
235.9	2070	6090	0.43	71.9	630	1860	0.43
237.5	1920	5940	0.44	72.4	590	1810	0.44
239.1	1930	5970	0.44	72.9	590	1820	0.44
240.7	1950	5860	0.44	73.4	590	1790	0.44
242.3	2040	5940	0.43	73.8	620	1810	0.43
243.9	2170	6090	0.43	74.3	660	1860	0.43
245.5	2270	6270	0.42	74.8	690	1910	0.42
247.1	2410	6360	0.42	75.3	730	1940	0.42
248.7	2490	6360	0.41	75.8	760	1940	0.41
250.3	2420	6430	0.42	76.3	740	1960	0.42
251.9	2390	6460	0.42	76.8	730	1970	0.42
253.5	2210	6300	0.43	77.3	670	1920	0.43
255.1	2100	6180	0.43	77.7	640	1880	0.43
256.7	2040	6330	0.44	78.2	620	1930	0.44
258.3	1920	6030	0.44	78.7	580	1840	0.44
259.9	2020	6120	0.44	79.2	610	1860	0.44
261.5	2100	6240	0.44	79.7	640	1900	0.44
263.1	2210	6360	0.43	80.2	670	1940	0.43
264.7	2310	6430	0.43	80.7	700	1960	0.43
266.3	2660	6630	0.40	81.2	810	2020	0.40
267.9	2840	7030	0.40	81.7	870	2140	0.40
269.5	3100	7230	0.39	82.1	950	2210	0.39
271.1	3150	7230	0.38	82.6	960	2210	0.38
272.7	3030	7030	0.39	83.1	920	2140	0.39

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Source-to-Receiver Travel Time Data - Borehole SB-1

American Units				Metric Units			
Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio	Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio
	V_s	V_p			V_s	V_p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
274.3	2840	6880	0.40	83.6	870	2100	0.40
275.9	2840	6770	0.39	84.1	870	2060	0.39
277.5	2840	6840	0.40	84.6	870	2090	0.40
279.1	2750	6770	0.40	85.1	840	2060	0.40
280.7	2540	6590	0.41	85.6	770	2010	0.41
282.3	2060	6120	0.44	86.1	630	1860	0.44
283.9	1650	5580	0.45	86.5	500	1700	0.45
285.5	1630	5650	0.45	87.0	500	1720	0.45
287.1	1770	5300	0.44	87.5	540	1610	0.44
288.7	1980	5830	0.43	88.0	600	1780	0.43
290.3	2450	6060	0.40	88.5	750	1850	0.40
291.9	2420	6530	0.42	89.0	740	1990	0.42
293.5	2450	6460	0.42	89.5	750	1970	0.42
295.1	2240	6150	0.42	90.0	680	1870	0.42
296.7	2320	6210	0.42	90.4	710	1890	0.42
298.3	2380	6490	0.42	90.9	730	1980	0.42
299.9	2300	6270	0.42	91.4	700	1910	0.42
301.5	2390	6300	0.42	91.9	730	1920	0.42
303.1	2490	6490	0.41	92.4	760	1980	0.41
304.7	2460	6360	0.41	92.9	750	1940	0.41
306.3	2530	6300	0.40	93.4	770	1920	0.40
307.9	2510	6300	0.41	93.9	770	1920	0.41
309.5	2430	6210	0.41	94.4	740	1890	0.41
311.2	2180	6240	0.43	94.8	660	1900	0.43
312.8	1990	6430	0.45	95.3	610	1960	0.45
314.4	1730	6030	0.45	95.8	530	1840	0.45
316.0	1700	5890	0.45	96.3	520	1790	0.45
317.6	1690	5630	0.45	96.8	520	1720	0.45
319.2	1670	5750	0.45	97.3	510	1750	0.45
320.8	1720	5600	0.45	97.8	530	1710	0.45
322.4	1820	5920	0.45	98.3	560	1800	0.45
324.0	1830	5750	0.44	98.7	560	1750	0.44
325.6	1780	6000	0.45	99.2	540	1830	0.45
327.2	1730	5970	0.45	99.7	530	1820	0.45
328.8	1630	5920	0.46	100.2	500	1800	0.46
330.4	1540	5780	0.46	100.7	470	1760	0.46
332.0	1440	5390	0.46	101.2	440	1640	0.46
333.6	1600	5530	0.45	101.7	490	1690	0.45
335.2	1630	5580	0.45	102.2	500	1700	0.45
336.8	1740	5650	0.45	102.7	530	1720	0.45

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Source-to-Receiver Travel Time Data - Borehole SB-1

American Units				Metric Units			
Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio	Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio
	V_s	V_p			V_s	V_p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
338.4	1960	5890	0.44	103.1	600	1790	0.44
340.0	2080	6240	0.44	103.6	630	1900	0.44
341.6	2100	6730	0.45	104.1	640	2050	0.45
343.2	2040	6430	0.44	104.6	620	1960	0.44
344.8	1970	6360	0.45	105.1	600	1940	0.45
346.4	1980	6210	0.44	105.6	600	1890	0.44
348.0	1780	5940	0.45	106.1	540	1810	0.45
349.6	1790	5890	0.45	106.6	550	1790	0.45
351.2	1870	6240	0.45	107.0	570	1900	0.45
352.8	2080	6360	0.44	107.5	630	1940	0.44
354.4	2270	6560	0.43	108.0	690	2000	0.43
356.0	2520	6300	0.40	108.5	770	1920	0.40
357.6	2560	6530	0.41	109.0	780	1990	0.41
359.2	2630	6360	0.40	109.5	800	1940	0.40
360.8	2430	6210	0.41	110.0	740	1890	0.41
362.4	2340	6300	0.42	110.5	710	1920	0.42
364.0	2390	6120	0.41	111.0	730	1860	0.41
365.6	2360	6180	0.41	111.4	720	1880	0.41
367.2	2330	5970	0.41	111.9	710	1820	0.41
368.8	2160	6210	0.43	112.4	660	1890	0.43
370.4	1930	6150	0.45	112.9	590	1870	0.45
372.0	1720	5970	0.45	113.4	520	1820	0.45
373.6	1600	5780	0.46	113.9	490	1760	0.46
375.2	1550	5600	0.46	114.4	470	1710	0.46
376.8	1560	5750	0.46	114.9	480	1750	0.46
378.4	1540	5860	0.46	115.3	470	1790	0.46
380.0	1550	5700	0.46	115.8	470	1740	0.46
381.6	1570	5810	0.46	116.3	480	1770	0.46
383.2	1510	5860	0.46	116.8	460	1790	0.46
384.8	1470	5750	0.46	117.3	450	1750	0.46
386.4	1470	5630	0.46	117.8	450	1720	0.46
388.0	1470	5680	0.46	118.3	450	1730	0.46
389.6	1570	5650	0.46	118.8	480	1720	0.46
391.2	1750	5920	0.45	119.3	530	1800	0.45
392.8	1860	6000	0.45	119.7	570	1830	0.45
394.4	1990	6120	0.44	120.2	610	1860	0.44
396.1	2220	6430	0.43	120.7	680	1960	0.43
397.7	2440	6630	0.42	121.2	740	2020	0.42
399.3	2800	6770	0.40	121.7	850	2060	0.40
400.9	2920	6960	0.39	122.2	890	2120	0.39

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Source-to-Receiver Travel Time Data - Borehole SB-1

American Units				Metric Units			
Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio	Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio
	V_s	V_p			V_s	V_p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
402.5	3170	6960	0.37	122.7	960	2120	0.37
404.1	3270	7030	0.36	123.2	1000	2140	0.36
405.7	2850	6880	0.40	123.6	870	2100	0.40
407.3	2810	7230	0.41	124.1	860	2210	0.41
408.9	2850	7150	0.41	124.6	870	2180	0.41
410.5	2810	7110	0.41	125.1	860	2170	0.41
412.1	2800	7110	0.41	125.6	850	2170	0.41
413.7	2730	7070	0.41	126.1	830	2160	0.41
415.3	2650	6960	0.42	126.6	810	2120	0.42
416.9	2640	6960	0.42	127.1	800	2120	0.42
418.5	2580	6960	0.42	127.6	790	2120	0.42
420.1	2560	6960	0.42	128.0	780	2120	0.42
421.7	2620	6960	0.42	128.5	800	2120	0.42
423.3	2670	6960	0.41	129.0	810	2120	0.41
424.9	2640	6960	0.42	129.5	800	2120	0.42
426.5	2710	6960	0.41	130.0	820	2120	0.41
428.1	2740	7030	0.41	130.5	840	2140	0.41
429.7	2750	6960	0.41	131.0	840	2120	0.41
431.3	2730	6840	0.41	131.5	830	2090	0.41
432.9	2730	6770	0.40	131.9	830	2060	0.40
434.5	2690	6840	0.41	132.4	820	2090	0.41
436.1	2660	6770	0.41	132.9	810	2060	0.41
437.7	2860	6880	0.40	133.4	870	2100	0.40
439.3	2940	6990	0.39	133.9	900	2130	0.39
440.9	2880	6960	0.40	134.4	880	2120	0.40
442.5	2890	7280	0.41	134.9	880	2220	0.41
444.1	2830	7150	0.41	135.4	860	2180	0.41
445.7	2790	7110	0.41	135.9	850	2170	0.41
447.3	2740	7070	0.41	136.3	840	2160	0.41
448.9	2750	6990	0.41	136.8	840	2130	0.41
450.5	2760	7030	0.41	137.3	840	2140	0.41
452.1	2830	6960	0.40	137.8	860	2120	0.40
453.7	2930	7110	0.40	138.3	890	2170	0.40
455.3	3070	7080	0.38	138.8	930	2160	0.38
456.9	3110	7210	0.39	139.3	950	2200	0.39
458.5	3110	7280	0.39	139.8	950	2220	0.39
460.1	3110	7130	0.38	140.2	950	2170	0.38
461.7	3010	7050	0.39	140.7	920	2150	0.39
463.3	2950	7020	0.39	141.2	900	2140	0.39
464.9	2910	7050	0.40	141.7	890	2150	0.40

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Source-to-Receiver Travel Time Data - Borehole SB-1

American Units			
Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio
	V_s	V_p	
(ft)	(ft/s)	(ft/s)	
466.5	2960	7050	0.39
468.1	2950	6970	0.39
469.7	2910	7100	0.40
471.3	2920	7100	0.40
472.9	2900	7020	0.40
474.5	2850	6910	0.40
476.1	2840	6880	0.40
477.7	2810	6970	0.40
479.3	2860	6910	0.40
481.0	2910	7080	0.40
482.6	2960	7130	0.40
484.2	2960	7190	0.40
485.8	3050	7210	0.39
487.4	3050	7130	0.39
489.0	3090	7430	0.40
490.6	2990	7210	0.40
492.2	3020	6990	0.38
493.8	3110	7180	0.38
495.4	3050	7310	0.39
497.0	3220	7760	0.40
498.6	3000	7390	0.40
500.2	2850	7240	0.41
501.8	2790	7190	0.41
503.4	2670	7080	0.42
505.0	2580	6970	0.42
506.6	2540	6870	0.42

Metric Units			
Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio
	V_s	V_p	
(m)	(m/s)	(m/s)	
142.2	900	2150	0.39
142.7	900	2120	0.39
143.2	890	2160	0.40
143.7	890	2160	0.40
144.2	880	2140	0.40
144.6	870	2110	0.40
145.1	870	2100	0.40
145.6	860	2120	0.40
146.1	870	2110	0.40
146.6	890	2160	0.40
147.1	900	2170	0.40
147.6	900	2190	0.40
148.1	930	2200	0.39
148.5	930	2170	0.39
149.0	940	2260	0.40
149.5	910	2200	0.40
150.0	920	2130	0.38
150.5	950	2190	0.38
151.0	930	2230	0.39
151.5	980	2360	0.40
152.0	910	2250	0.40
152.5	870	2210	0.41
152.9	850	2190	0.41
153.4	810	2160	0.42
153.9	790	2120	0.42
154.4	770	2090	0.42

APPENDIX B

ELOG, MECHANICAL CALIPER, AND NATURAL GAMMA LOGS

GEOVision
geophysical services

CO F&ME
WELL SB-1
FLD
CTY
STE SC
API No

COMPANY F&ME
WELL ID SB-1
FIELD
COUNTRY USA STATE SC

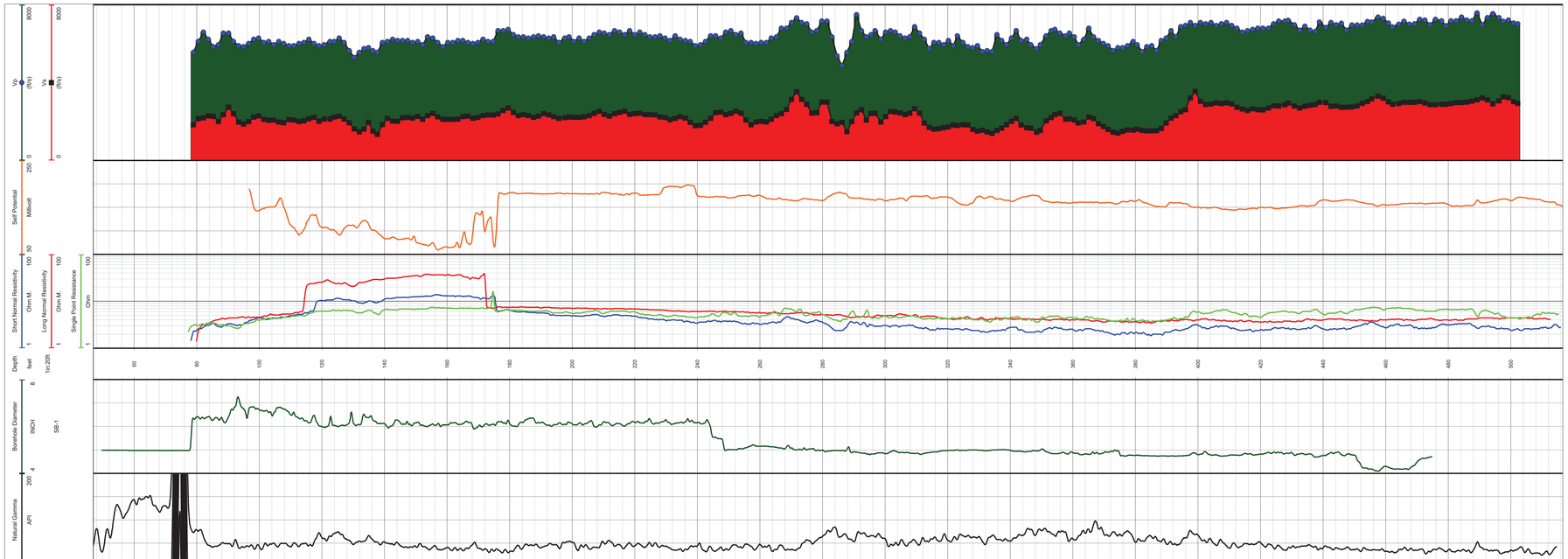
LOCATION
LAT LONG

OTHER SERVICES
ELOG
CAL
NG
PSL

PERMANENT DATUM	NA	ELEVATION NA	K.B.
LOG MEAS. FROM	TOC		D.F.
DRILLING MEAS. FROM	NA		G.L.

DATE	July 18, 2016	July 18, 2016	July 20, 2016	FLUID IN HOLE	MUD
RUN No	1	1	1	SALINITY	
TYPE LOG	ELOG NG	PSL	CAL NG	DENSITY	
DEPTH-DRILLER	518	518	518	LEVEL	
DEPTH-LOGGER	516	515	476		
LOG DEEPEST	516	503	476		
LOG SHALLOW	79	79	50		
OPERATING RIG TIME					
RECORDED BY	JJ	JJ	JJ		
WITNESSED BY					

RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO



APPENDIX C

BORING GEOPHYSICAL LOGGING SYSTEMS - NIST TRACEABLE CALIBRATION RECORDS

MICRO PRECISION CALIBRATION, INC
2165 N. Glassell St.,
Orange, CA 92865
714-901-5659

Certificate of Calibration

Date: Jul 14, 2016 **Cert No.** 222200812421163

Customer:
GEOVISION
1124 OLYMPIC DRIVE
CORONA CA 92881

Work Order #: N/A

MPC Control #:	BG9698	Serial Number:	15014
Asset ID:	15014	Department:	N/A
Gage Type:	LOGGER	Performed By:	TYLER MCKEEN
Manufacturer:	OYO	Received Condition:	IN TOLERANCE
Model Number:	03331-0000	Returned Condition:	IN TOLERANCE
Size:	N/A	Cal. Date:	July 14, 2016
Temp/RH:	72.0°F / 54.0%	Cal. Interval:	12 MONTHS
		Cal. Due Date:	July 14, 2017

Calibration Notes:
See attached data sheet for calculations. (1 Page)

Calibrated IAW customer supplied data form Rev 2.1
Frequency measurement uncertainty = 0.0005 Hz
Unit calibrated with Laptop Panasonic Model CF-29,s/n: 4FKSA41798
Calibrated To 4:1 Accuracy Ratio

Standards Used to Calibrate Equipment

I.D.	Description.	Model	Serial	Manufacturer	Cal. Due Date	Traceability #
BD7715	UNIVERSAL COUNTER	53131A	3416A05377	HEWLETT PACKARD	Aug 26, 2016	222008122635161
T1100	UNIVERSAL COUNTER	53131A	3546A09912	HEWLETT PACKARD	Feb 2, 2017	222008122827657
AM4000	WAVEFORM GENERATOR	33250A	MY40000703	AGILENT	Jul 8, 2017	222200812420653

Procedures Used in this Event

Procedure Name	Description
GEOVISION SEISMIC	Suspension PS Seismic Logger/Recorder Calibration Procedure

Calibrating Technician: TYLER MCKEEN

QC Approval: JIM WILLIAMS

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA's Publication and NIST Technical Note 1297, 1994 Edition. Services rendered comply with ISO 17025:2005, ANSI/NCSL Z540-1, MPC Quality Manual, MPC CSD and with customer purchase order instructions.

Calibration cycles and resulting due dates were submitted/approved by the customer. Any number of factors may cause an instrument to drift out of tolerance before the next scheduled calibration. Recalibration cycles should be based on frequency of use, environmental conditions and customer's established systematic accuracy. The information on this report, pertains only to the instrument identified.

All standards are traceable to SI through the National Institute of Standards and Technology (NIST) and/or recognized national or international standards laboratories. Services rendered include proper manufacturer's service instruction and are warranted for no less than thirty (30) days. This report may not be reproduced in part or in a whole without the prior written approval of the issuing MPC lab.

BG 9698 15014

GEOVision geophysical services

SUSPENSION PS SEISMIC LOGGER/RECORDER CALIBRATION DATA FORM

INSTRUMENT DATA

System mfg.:	O/O	Model no.:	3331
Serial no.:	15014	Calibration date:	07/14/2016
By:	Emily Feldman	Due date:	07/14/2017
Counter mfg.:	Hewlett Packard	Model no.:	5313A
Serial no.:	3546A09912	Calibration date:	02/02/16
By:	Micro Precision	Due date:	02/02/17
Signal generator mfg.:	Agilent	Model no.:	~~07~~ 33250A
Serial no.:	MY40000703	Calibration date:	07/08/16
By:	Micro Precision	Due date:	07/08/17
Laptop controller mfg.:	Panasonic RG3	Model no.:	CF-29 Toughbook
Serial no.:	4FKSA41798	Calibration date:	N/A

SYSTEM SETTINGS:

Gain:	x10
Filter	open
Range:	200 - 5 µs
Delay:	4 msec
Stack (1 std)	1
System date = correct date and time	Yes, 12:25, 7/14/16

PROCEDURE:

Set sine wave frequency to target frequency with amplitude of approximately 0.25 volt peak
Note actual frequency on data form.
Set sample period and record data file to disk. Note file name on data form.
Pick duration of 9 cycles using PSLOG.EXE program, note duration on data form, and save as .sps file. Calculate average frequency for each channel pair and note on data form.

Average frequency must be within +/- 1% of actual frequency at all data points.

Maximum error ((AVG-ACT)/ACT*100)% As found 0.22% As left 0.22%

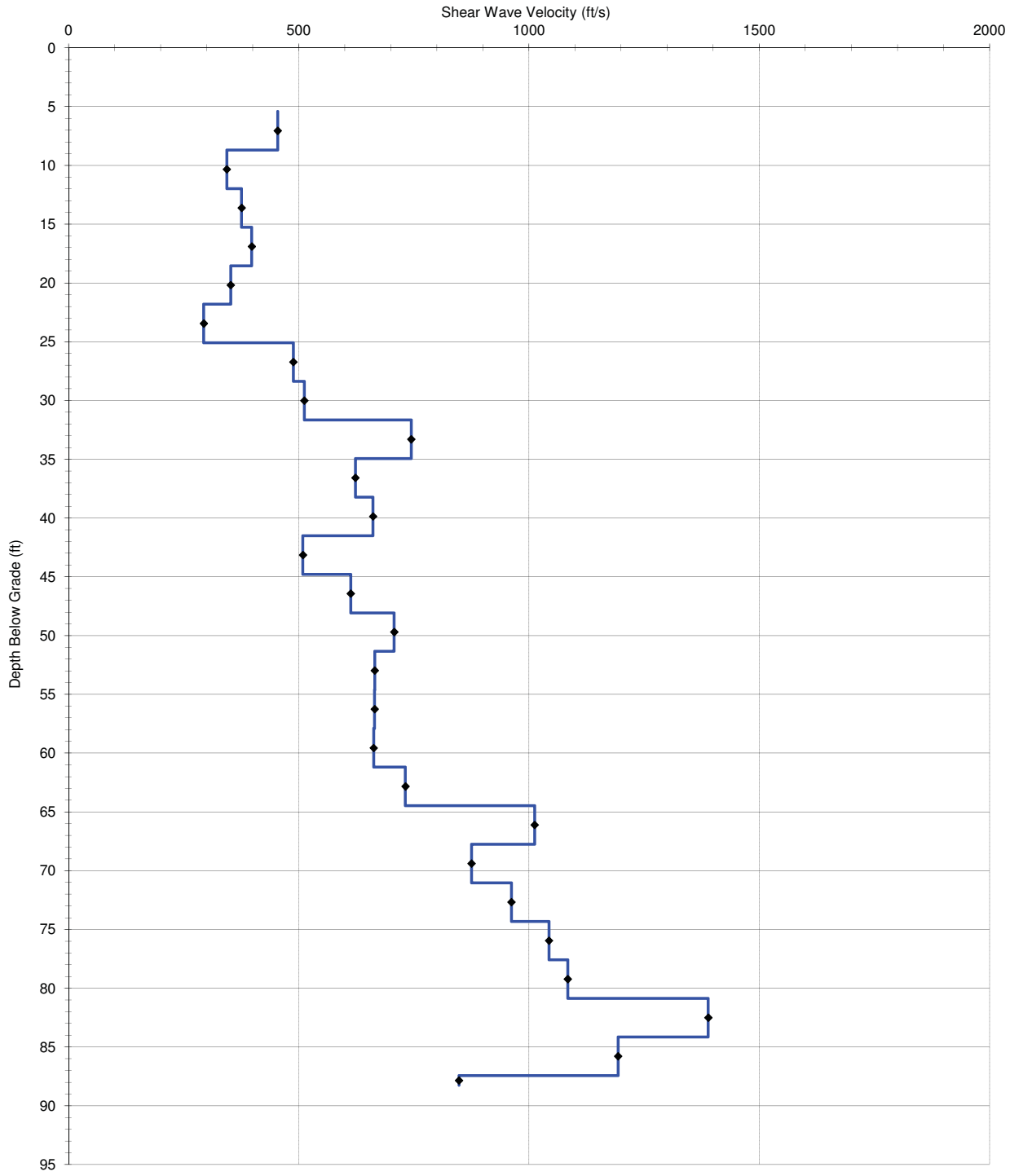
Target Frequency (Hz)	Actual Frequency (Hz)	Sample Period (microS)	File Name Cal2-	Time for 9 cycles Hn (msec)	Average Frequency Hn (Hz)	Time for 9 cycles Hr (msec)	Average Frequency Hr (Hz)	Time for 9 cycles V (msec)	Average Frequency V (Hz)
50.00	50.00	200	001	180	50.00	180	50.00	179.8	50.05
100.0	100.0	100	002	89.9	99.9	89.9	99.9	90.1	99.9
200.0	200.0	50	003	44.95	200.2	45	200.0	45	200.0
500.0	500.0	20	004	18.02	499.5	K:0	~~48.0~~ 500.0	17.98	500.6
1000	1,000	10	005	9.01	998.9	8.98	1002.2	9	1000
2000	2,000	5	006	4.505	1998	4.50	2000	4.495	2002

Calibrated by: Tyler McKean 7/14/16
Name Date Signature

Witnessed by: Emily Feldman 7/14/16
Name Date Signature

Suspension PS Seismic Recorder/Logger Calibration Data Form Rev 2.1 February 7, 2012

Shear Wave Velocity- SCPT-2
US 21 Replacement Bridge Over Harbor River
14-54074
August 25th , 2014



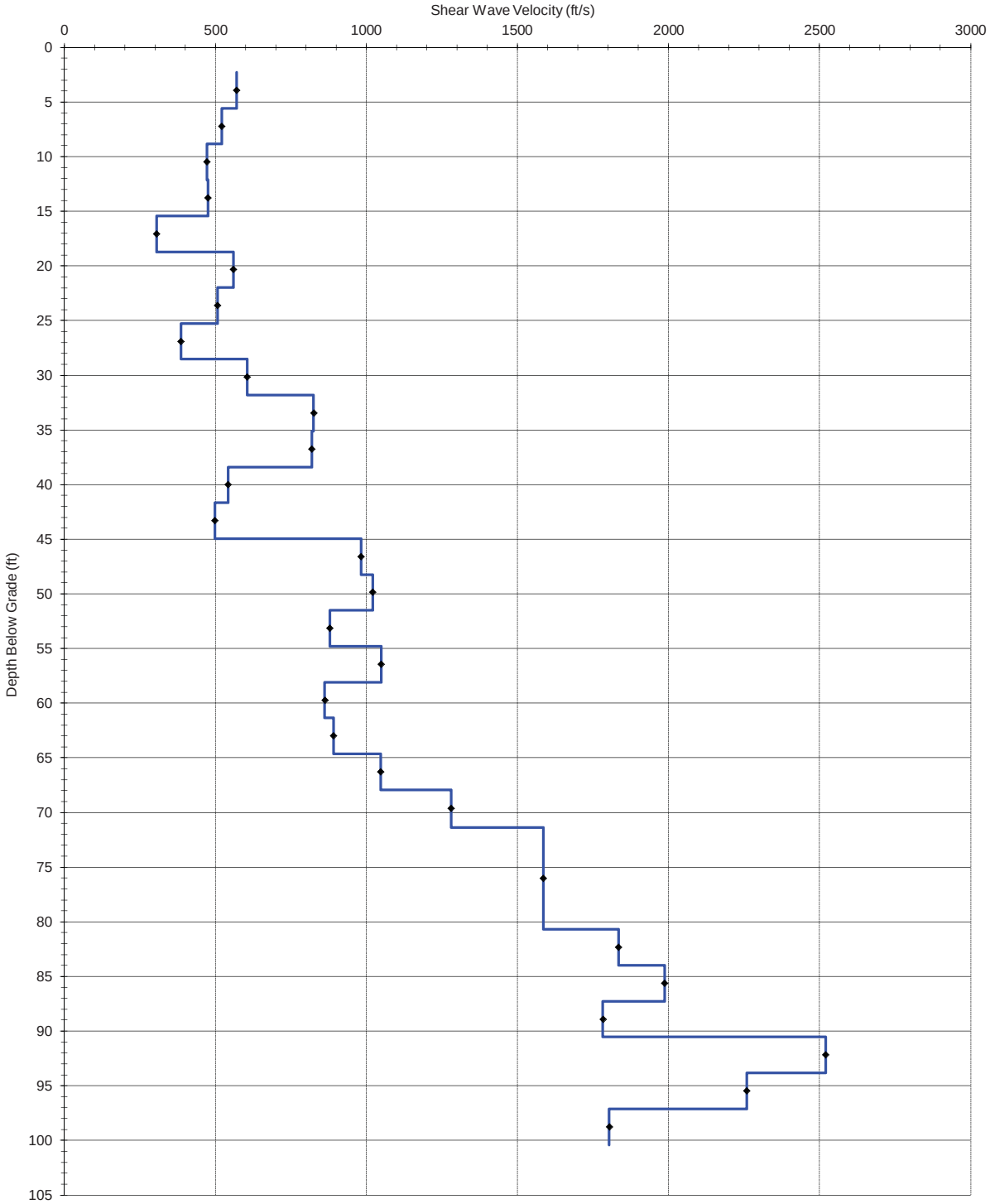
ConeTec Shear Wave Velocity Data Reduction Sheet

Hole: SCPT-2
Location: US 21 Replacement Bridge Over Harbor River
Cone: AD184
Date: 25-Aug-14
Source: Beam

Source Depth	0.00 m
Source Offset	2.15 m

Tip Depth (m)	Geophone Depth(m)	Travel Path (m)	Interval time (ms)	Velocity (m/s)	Velocity (ft/s)	Interval Depth (m)	Interval Depth (ft)
0.00							
1.85	1.65	2.71					
2.85	2.65	3.41	5.07	138.5	454.4	2.15	7.05
3.85	3.65	4.24	7.86	104.8	343.7	3.15	10.33
4.85	4.65	5.12	7.74	114.6	375.9	4.15	13.61
5.85	5.65	6.05	7.61	121.3	397.9	5.15	16.90
6.85	6.65	6.99	8.78	107.5	352.5	6.15	20.18
7.85	7.65	7.95	10.69	89.5	293.8	7.15	23.46
8.85	8.65	8.91	6.50	148.8	488.2	8.15	26.74
9.85	9.65	9.89	6.24	156.1	512.0	9.15	30.02
10.85	10.65	10.86	4.31	226.9	744.3	10.15	33.30
11.85	11.65	11.85	5.17	189.9	623.0	11.15	36.58
12.85	12.65	12.83	4.89	201.5	661.2	12.15	39.86
13.85	13.65	13.82	6.36	155.1	509.0	13.15	43.14
14.85	14.65	14.81	5.29	186.9	613.1	14.15	46.42
15.85	15.65	15.80	4.59	215.6	707.2	15.15	49.70
16.85	16.65	16.79	4.89	202.8	665.4	16.15	52.98
17.85	17.65	17.78	4.90	202.6	664.7	17.15	56.27
18.85	18.65	18.77	4.92	202.0	662.7	18.15	59.55
19.85	19.65	19.77	4.46	223.0	731.6	19.15	62.83
20.85	20.65	20.76	3.22	308.6	1012.3	20.15	66.11
21.85	21.65	21.76	3.73	266.7	875.1	21.15	69.39
22.85	22.65	22.75	3.39	293.2	962.0	22.15	72.67
23.85	23.65	23.75	3.13	318.1	1043.5	23.15	75.95
24.85	24.65	24.74	3.01	330.4	1084.0	24.15	79.23
25.85	25.65	25.74	2.35	423.4	1389.2	25.15	82.51
26.85	26.65	26.74	2.74	363.8	1193.5	26.15	85.79
27.10	26.90	26.99	0.96	258.5	848.0	26.78	87.84

Shear Wave Velocity- SCPT-11
US 21 Replacement Bridge Over Harbor River
15-54107
November 18th , 2015



Job No:	15-54107
Client:	F&ME
Project:	Harbor River
Sounding ID:	SCPT-11
Date:	11/18/2015

Seismic Source:	Beam
Source Offset (ft):	4.75
Source Depth (ft):	0.00
Geophone Offset (ft):	0.66

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)
2.95	2.30	5.28			
6.23	5.58	7.33	2.05	3.59	571
9.51	8.86	10.05	2.73	5.23	521
12.80	12.14	13.04	2.98	6.32	472
16.08	15.42	16.13	3.10	6.52	475
19.36	18.70	19.29	3.16	10.35	305
22.64	21.98	22.49	3.19	5.71	559
25.92	25.26	25.71	3.22	6.34	507
29.20	28.54	28.94	3.23	8.38	386
32.48	31.82	32.18	3.24	5.36	605
35.76	35.10	35.42	3.25	3.94	825
39.04	38.39	38.68	3.25	3.97	820
42.32	41.67	41.94	3.26	6.00	543
45.60	44.95	45.20	3.26	6.55	498
48.88	48.23	48.46	3.26	3.32	982
52.17	51.51	51.73	3.27	3.20	1020
55.45	54.79	55.00	3.27	3.72	879
58.73	58.07	58.26	3.27	3.12	1049
62.01	61.35	61.53	3.27	3.79	862
65.29	64.63	64.81	3.27	3.67	892
68.57	67.91	68.08	3.27	3.12	1047
72.01	71.36	71.52	3.44	2.69	1280
81.36	80.71	80.85	9.33	5.89	1585
84.65	83.99	84.12	3.28	1.79	1834
87.93	87.27	87.40	3.28	1.65	1987
91.21	90.55	90.68	3.28	1.84	1783
94.49	93.83	93.95	3.28	1.30	2520
97.77	97.11	97.23	3.28	1.45	2260
101.05	100.39	100.51	3.28	1.82	1804

APPENDIX B
Laboratory Testing

US-21 BRIDGE REPLACEMENT OVER HARBOR RIVER
BEAUFORT COUNTY, SOUTH CAROLINA
F&ME PROJECT NO.: G5396.00

FINAL LABORATORY ANALYSIS SUMMARY

BORING NUMBER	SAMPLE DEPTH (ft)	% MOISTURE	% GRAVEL	% SAND	% FINES (SILT/CLAY)	LL	PL	PI	USCS	AASHTO Class	% ORGANICS	pH	Resistivity (Ohm-cm)	Sulfate (mg/kg)	Chloride (mg/kg)	Carbonate (% Calcite Equivalent)
B-1	4.0-6.0	--	--	--	--	--	--	--	--	--	1.15	--	--	--	--	--
	6.0-8.0	--	--	--	--	--	--	--	--	--	1.07	--	--	--	--	--
	8.0-10.0	19.3	16.7	76.0	7.3	NP	NP	NP	SP-SM	A-1-b	--	--	--	--	--	--
	12.0-14.0	19.2	8.4	83.7	8.0	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	14.0-16.0	--	--	--	--	--	--	--	--	--	0.31	--	--	--	--	--
	18.0-20.0	27.4	0.0	96.7	3.3	NP	NP	NP	SP	A-3	--	--	--	--	--	--
	28.5-30.0	34.7	0.2	92.4	7.4	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	43.5-45.0	33.8	0.4	88.6	11.0	NP	NP	NP	SP-SM	A-2-4	--	--	--	--	--	--
	48.5-50.0	59.0	0.0	66.8	33.2	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
B-2	4.0-6.0	--	--	--	--	--	--	--	--	--	0.56	--	--	--	--	--
	6.0-8.0	28.7	0.0	95.1	4.9	NP	NP	NP	SP	A-3	--	--	--	--	--	--
	8.0-10.0	27.9	0.0	97.5	2.5	NP	NP	NP	SP	A-3	--	--	--	--	--	--
	10.0-12.0	--	--	--	--	--	--	--	--	--	0.45	--	--	--	--	--
	18.0-20.0	26.5	0.0	93.7	6.3	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	23.5-25.0	--	--	--	--	--	--	--	--	--	1.25	--	--	--	--	--
	28.5-30.0	30.3	0.3	85.7	14.0	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	38.5-40.0	29.3	0.1	91.1	8.8	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	53.5-55.0	28.4	0.3	89.7	10.0	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
B-3	0.0-2.0	36.9	0.2	62.3	37.5	NP	NP	NP	SM	A-4(0)	--	--	--	--	--	--
	4.0-6.0	--	--	--	--	--	--	--	--	--	3.55	--	--	--	--	--
	6.0-8.0	151.6	0.0	1.5	98.5	74	49	25	MH	A-7-5(36)	--	--	--	--	--	--
	13.5-15.0	26.1	0.0	92.3	7.7	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	18.5-20.0	--	--	--	--	--	--	--	--	--	--	7.9	200	126	5080	--
	23.5-25.0	29.3	15.8	59.7	24.5	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	28.5-30.0	101.1	0.0	3.4	96.6	58	31	27	MH	A-7-5(32)	--	--	--	--	--	--
	38.5-40.0	30.2	3.7	85.8	10.4	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
B-4	2.0-4.0	52.5	4.9	63.2	31.9	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	4.0-6.0	--	--	--	--	--	--	--	--	--	2.68	--	--	--	--	--
	8.0-10.0	32.9	1.2	72.9	26.0	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	13.5-15.0	31.8	0.0	84.9	15.1	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	23.5-25.0	27.8	1.1	76.9	22.0	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	33.5-35.0	35.8	1.6	76.8	21.6	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	38.5-40.0	--	--	--	--	--	--	--	--	--	--	8.0	180	559	8350	--
	48.5-50.0	31.8	0.6	82.4	17.0	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	63.5-65.0	64.5	0.0	46.9	53.1	71	35	36	MH	A-7-5(16)	--	--	--	--	--	--
B-5	2.0-4.0	27.9	0.0	93.4	6.6	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	6.0-8.0	24.1	0.0	85.3	14.6	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	8.0-10.0	--	--	--	--	--	--	--	--	--	0.27	--	--	--	--	--
	13.5-15.0	36.1	0.3	79.9	19.7	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	23.5-25.0	26.8	0.1	89.4	10.5	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	28.5-30.0	--	--	--	--	--	--	--	--	--	--	8.2	9.5	488	8360	--
	33.5-35.0	39.0	0.0	67.2	32.8	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	43.5-45.0	33.4	0.0	79.1	20.9	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	53.5-55.0	38.9	0.8	73.2	26.0	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
B-6	2.0-4.0	--	--	--	--	--	--	--	--	--	0.53	--	--	--	--	--
	4.0-6.0	28.4	0.0	82.8	17.2	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	8.0-10.0	24.6	0.0	84.3	15.7	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	13.5-15.0	34.8	0.3	73.6	26.1	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	23.5-25.0	24.8	0.0	86.3	13.7	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	28.5-30.0	28.8	0.0	89.0	11.0	NP	NP	NP	SP-SM	A-2-4	--	--	--	--	--	--
	38.5-40.0	27.5	0.0	81.7	18.3	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	58.5-60.0	--	--	--	--	--	--	--	--	--	--	7.7	85	763	16000	--

US-21 BRIDGE REPLACEMENT OVER HARBOR RIVER
BEAUFORT COUNTY, SOUTH CAROLINA
F&ME PROJECT NO.: G5396.00

FINAL LABORATORY ANALYSIS SUMMARY

BORING NUMBER	SAMPLE DEPTH (ft)	% MOISTURE	% GRAVEL	% SAND	% FINES (SILT/CLAY)	LL	PL	PI	USCS	AASHTO Class	% ORGANICS	pH	Resistivity (Ohm-cm)	Sulfate (mg/kg)	Chloride (mg/kg)	Carbonate (% Calcite Equivalent)
B-7	4.0-6.0	24.2	4.0	83.2	12.8	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	8.0-10.0	33.1	3.0	78.8	18.2	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	13.5-15.0	31.3	0.3	80.9	18.9	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	18.5-20.0	24.2	4.0	85.1	10.8	NP	NP	NP	SP-SM	A-2-4	--	--	--	--	--	--
	28.5-30.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8
	43.5-45.0	38.0	0.0	82.1	17.9	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
B-8	4.0-6.0	24.0	1.0	87.2	11.9	NP	NP	NP	SP-SM	A-2-4	--	--	--	--	--	--
	18.5-20.0	73.8	0.0	32.5	67.5	34	20	14	CL	A-6(8)	--	--	--	--	--	--
	23.5-25.0	54.5	0.2	64.8	34.9	30	19	11	SC	A-2-6(0)	--	--	--	--	--	--
	28.5-30.0	38.8	1.0	77.0	22.0	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	33.5-35.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16
	43.5-45.0	27.3	0.0	93.5	6.5	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	48.5-50.0	37.1	0.0	91.8	8.2	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
B-9	2.0-4.0	22.6	8.4	83.8	7.7	NP	NP	NP	SP-SM	A-1-b	--	--	--	--	--	--
	4.0-6.0	21.9	2.2	90.7	7.2	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	8.0-10.0	25.6	0.1	89.6	10.3	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	13.5-15.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5
	28.5-30.0	88.5	0.2	20.7	79.1	58	30	28	CH	A-7-5(24)	--	--	--	--	--	--
	43.5-45.0	25.6	1.2	91.4	7.5	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
B-10	3.5-5.5	50.0	0.0	58.9	41.1	26	17	9	SC	A-4(1)	--	--	--	--	--	--
	7.5-9.5	24.1	0.0	92.1	7.9	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	25.0-26.5	58.3	0.0	42.8	57.2	33	26	7	ML	A-4(2)	--	--	--	--	--	--
	30.5-32.0	--	--	--	--	--	--	--	--	--	--	7.1	62	2400	8400	--
	46.0-47.5	21.9	7.0	87.0	6.0	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	56.5-58.0	58.1	2.8	66.2	31.0	39	27	12	SM	A-2-6(0)	--	--	--	--	--	--
	86.5-88.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	460
B-11	26.0-28.0	33.7	0.0	81.8	18.1	22	NP	NP	SM	A-2-4	--	--	--	--	--	--
	28.0-30.0	57.6	0.5	47.4	52.1	26	17	9	CL	A-4(2)	--	--	--	--	--	--
	30.0-32.0	30.5	0.2	84.5	15.3	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	36.5-38.0	93.7	0.0	12.1	87.9	58	35	23	MH	A-7-5(25)	--	--	--	--	--	--
	68.5-70.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	451
	83.0-84.5	45.3	0.3	53.7	46.0	31	NP	NP	SM	A-4(0)	--	--	--	--	--	--
	92.5-94.0	--	--	--	--	--	--	--	--	--	--	7.0	101	2000	5700	--
B-12	37.0-39.0	32.9	1.3	74.9	23.8	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	45.5-47.0	24.6	6.4	83.2	10.4	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	61.0-62.5	81.2	0.0	52.0	48.0	51	NP	NP	SM	A-5(0)	--	--	--	--	--	--
	80.0-81.5	61.8	0.0	53.4	46.6	44	31	13	SM	A-7-5(4)	--	--	--	--	--	--
	96.5-98.0	33.7	0.9	49.3	49.7	30	NP	NP	SM	A-4(0)	--	--	--	--	--	--
	115.5-117.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	493
B-13	32.0-34.0	34.6	4.4	72.8	22.8	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	42.5-44.0	63.6	0.0	35.8	64.2	41	20	21	CL	A-7-6(11)	--	--	--	--	--	--
	52.5-54.0	78.3	2.1	32.6	65.3	23	NP	NP	ML	A-4(0)	--	--	--	--	--	--
	58.0-59.5	--	--	--	--	--	--	--	--	--	--	7.2	76	1700	7600	--
	63.5-65.0	73.8	0.2	55.9	43.9	67	29	38	SC	A-7-6(11)	--	--	--	--	--	--
	94.5-96.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	460
	99.5-101.0	37.3	4.2	45.6	50.2	30	24	6	ML	A-4(1)	--	--	--	--	--	--
B-14	8.0-10.0	32.4	0.0	86.2	13.8	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	23.5-25.0	38.6	0.0	82.4	17.6	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	28.5-30.0	50.9	0.3	56.0	43.7	31	24	7	SM	A-4(1)	--	--	--	--	--	--
	33.5-35.0	--	--	--	--	--	--	--	--	--	--	7.4	71	1600	6900	--
	38.5-40.0	56.1	0.0	48.0	52.0	47	36	11	ML	A-7-5(4)	--	--	--	--	--	--
	48.5-50.0	46.2	0.0	69.8	30.1	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	72.5-74.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	40

US-21 BRIDGE REPLACEMENT OVER HARBOR RIVER
BEAUFORT COUNTY, SOUTH CAROLINA
F&ME PROJECT NO.: G5396.00

FINAL LABORATORY ANALYSIS SUMMARY

BORING NUMBER	SAMPLE DEPTH (ft)	% MOISTURE	% GRAVEL	% SAND	% FINES (SILT/CLAY)	LL	PL	PI	USCS	AASHTO Class	% ORGANICS	pH	Resistivity (Ohm-cm)	Sulfate (mg/kg)	Chloride (mg/kg)	Carbonate (% Calcite Equivalent)
B-15	4.0-6.0	26.2	0.0	91.8	8.2	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	6.0-8.0	23.5	0.0	94.9	5.1	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	13.5-15.0	23.8	0.0	94.5	5.5	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	--
	18.5-20.0	33.2	0.2	82.3	17.5	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	38.5-40.0	--	--	--	--	--	--	--	--	--	4.15	--	--	--	--	--
	43.5-45.0	31.6	0.6	78.7	20.7	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	58.5-60.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8
B-16	6.0-8.0	24.5	0.0	97.9	2.1	NP	NP	NP	SP	A-3	--	--	--	--	--	--
	13.5-15.0	24.3	0.0	97.9	2.1	NP	NP	NP	SP	A-3	--	--	--	--	--	--
	23.5-25.0	37.4	0.0	86.1	13.9	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	38.5-40.0	56.7	0.0	53.4	46.6	36	21	15	SC	A-6(4)	--	--	--	--	--	--
	48.5-50.0	84.8	0.0	9.0	91.0	75	35	40	MH	A-7-5(25)	--	--	--	--	--	--
	53.5-55.0	--	--	--	--	--	--	--	--	--	7.22	--	--	--	--	--
	78.5-80.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15
TS-1	6.0-8.0	25.9	0.3	85.8	13.9	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	16.0-18.0	52.2	0.0	50.3	49.7	25	21	4	SC-SM	A-4(0)	--	--	--	--	--	--
	22.0-24.0	26.7	0.0	83.7	16.3	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	26.0-28.0	65.5	0.0	34.4	65.6	42	27	15	ML	A-7-6(9)	--	--	--	--	--	--
	32.0-34.0	40.2	1.0	70.7	28.3	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	44.0-46.0	24.0	3.7	84.1	12.2	NP	NP	NP	SM	A-2-4	--	--	--	--	--	--
	46.0-48.0	20.1	10.1	80.1	9.8	NP	NP	NP	SP-SM	A-1-b	--	--	--	--	--	--
	56.0-58.0	62.4	0.0	35.8	64.2	44	39	5	ML	A-5(4)	--	--	--	--	--	--
	72.0-74.0	61.7	0.6	32.1	67.4	55	32	23	MH	A-7-5(16)	--	--	--	--	--	--
	76.0-78.0	44.5	2.0	33.3	64.7	31	23	8	ML	A-4(4)	--	--	--	--	--	--
	80.0-82.0	42.6	0.0	50.9	49.1	NP	NP	NP	SM	A-4(0)	--	--	--	--	--	--
	104.0-106.0	33.4	0.0	43.2	56.8	NP	NP	NP	ML	A-4(0)	--	--	--	--	--	--
	120.0-122.0	35.4	0.2	44.5	55.3	NP	NP	NP	ML	A-4(0)	--	--	--	--	--	--
SB-1	18.0-20.0	--	--	--	--	--	--	--	--	--	1.92	--	--	--	--	--
	36.0-38.0	--	--	--	--	--	--	--	--	--	1.42	--	--	--	--	--
	44.0-46.0	55.4	0.6	67.5	31.9	42	20	22	SC	A-2-7(2)	--	--	--	--	--	--
	93.5-95.0	44.7	2.2	56.5	41.3	NP	NP	NP	SM	A-4(0)	--	--	--	--	--	--
	138.5-140.0	68.0	0.0	13.7	86.3	63	29	34	CH	A-7-6(33)	--	--	--	--	--	--
	168.5-170.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	509
	178.5-180.0	32.9	0.2	56.3	43.5	NP	NP	NP	SM	A-4(0)	--	--	--	--	--	--
	198.5-200.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	443
	238.5-240.0	34.4	0.0	12.2	87.8	40	23	17	CL	A-6(16)	--	--	--	--	--	--
	255.0-257.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	361
	275.0-277.0	30.1	0.0	28.7	71.3	32	30	2	ML	A-4(1)	--	--	--	--	--	--
	303.0-308.0	30.3	23.6	23.2	53.3	37	34	3	ML	A-4(1)	--	--	--	--	--	--
	308.0-313.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	320
	338.0-343.0	25.9	0.6	16.5	82.9	40	26	14	ML	A-6(12)	--	--	--	--	--	--
	358.0-363.0	17.4	8.6	26.8	64.6	33	24	9	ML	A-4(4)	--	--	--	--	--	--
	373.0-378.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	222
	381.0-385.0	38.3	0.0	5.3	94.7	63	38	25	MH	A-7-5(31)	--	--	--	--	--	--
H_20 - River West	--	--	--	--	--	--	--	--	--	--	--	6.8	27	22,715 mg/L	16,596 mg/L	--
H_20 - River East	--	--	--	--	--	--	--	--	--	--	--	6.9	26	23,227 mg/L	16,396 mg/L	--

US-21 Bridge Replacement over Harbor River
BEAUFORT COUNTY, SOUTH CAROLINA
F&ME PROJECT NO.: G5396.00

FINAL LABORATORY ANALYSIS SUMMARY

BORING NUMBER	SAMPLE DEPTH (ft)	% MOISTURE	% GRAVEL	% SAND	% FINES (SILT/CLAY)	LL	PL	PI	USCS	AASHTO Class	CU Triaxial Shear				UC Strength (psi)	Standard Proctor		Direct Shear (φ)	Consolidation	Resonant Column
											φ	C (psf)	φ'	C' (psi)		Optimum Moisture Content (%)	Maximum Dry Density (pcf)			
AP-1	16.0-18.0	63.0	0.0	39.0	61.0	65	21	44	CH	A-7-6(24)	--	--	29.0	0.878	--	--	--	--	See Results	--
	18.0-20.0	86.3	0.2	26.5	73.3	111	34	77	CH	A-7-5(60)	--	--	38.0	0.5	--	--	--	--	See Results	--
AP-2	16.0-18.0	56.0	2.1	48.0	49.9	66	22	44	SC	A-7-6(17)	--	--	31.5	0.435	--	--	--	--	See Results	--
	18.0-20.0	69.3	0.0	36.5	63.5	81	27	54	CH	A-7-6(33)	--	--	18.5	1.85	--	--	--	--	See Results	--
AP-3	25.0-27.0	83.0	0.1	20.4	79.5	85	27	58	CH	A-7-6(50)	--	--	26.0	1.5	--	--	--	--	See Results	--
	27.0-29.0	78.8	0.1	18.5	81.4	74	25	49	CH	A-7-6(43)	--	--	7.2	2.95	--	--	--	--	See Results	--
AP-4	38.0-40.0	69.0	0.0	28.7	71.3	71	24	47	CH	A-7-6(34)	--	--	--	--	--	--	--	--	See Results	--
	40.0-42.0	33.8	0.2	78.4	21.5	NP	NP	NP	SM	A-2-4	13.0	4.1	24.0	4.1	--	--	--	--	--	--
	70.0-72.0	58.8	0.0	48.0	52.0	NP	NP	NP	ML	A-4(0)	34.0	0.0	--	--	--	--	--	--	--	--
AP-5	6.0-10.0	21.6	0.0	97.0	3.0	NP	NP	NP	SP	A-3	--	--	--	--	--	--	--	32.1	--	--
	30.0-32.0	26.6	0.0	97.1	2.9	NP	NP	NP	SP	A-3	--	--	--	--	--	--	--	27.9	--	--
SB-1	130.0-133.0	38.0	0.0	33.7	66.3	42	30	12	ML	A-7-5(8)	--	--	--	--	--	--	--	--	--	See Results
	145.0-148.0	33.1	0.2	42.5	57.3	38	25	13	ML	A-6(6)	--	--	40.7	1.05	--	--	--	--	--	--
	200.0-203.0	32.0	0.1	47.8	52.1	43	27	16	ML	A-7-6(6)	--	--	--	--	--	--	--	--	--	See Results
	230.0-233.0	32.6	1.0	21.3	77.7	48	30	18	ML	A-7-5(15)			29.2	16.5	--	--	--	--	--	--
	250.0-255.0	29.0	--	--	--	--	--	--	--	--	--	--	--	--	143.5	--	--	--	--	--
	257.0-260.0	31.6	0.0	34.9	65.1	76	21	55	CH	A-7-6(34)	--	--	--	--	--	--	--	--	--	See Results
	298.0-303.0	31.7	--	--	--	--	--	--	--	--	--	--	--	--	166.5	--	--	--	--	--
	323.0-328.0	22.3	--	--	--	--	--	--	--	--	--	--	--	--	85.9	--	--	--	--	--
	358.0-363.0	26.8	--	--	--	--	--	--	--	--	--	--	--	--	236.4	--	--	--	--	--
	378.0-381.0	39.3	0.0	12.2	87.8	133	29	104	CH	A-7-6(104)	--	--	--	--	--	--	--	--	--	See Results
	381.0-385.0	32.3	--	--	--	--	--	--	--	--	--	--	--	--	233.5	--	--	--	--	--
BS-1	0.0-5.0	5.3	11.4	81.0	7.6	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	17.3	100.3	34.4	--	--
BS-2	0.0-5.0	5.6	5.4	86.2	8.3	NP	NP	NP	SP-SM	A-3	--	--	--	--	--	16.6	100.8	32.6	--	--
BS-3	0.0-5.0	1.3	0.1	98.2	1.7	NP	NP	NP	SP	A-3	--	--	--	--	--	18.1	97.8	33.5	--	--
BS-4	0.0-5.0	2.6	0.6	96.6	2.9	NP	NP	NP	SP	A-3	--	--	--	--	--	15.8	94.6	31.0	--	--

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	14-1273	**DATE SAMPLE RECEIVED:**	9/3/2014
DESCRIPTION OF SOIL:	Various		
TESTED BY:	KB	**DATE OF TESTING:**	9/3/2014
		DATE OF WEIGHING:	9/4/2014

BORING NO.	B-1	B-1	B-1	B-1	B-1
SAMPLE NO.	14-1273C	14-1273F	14-1273I	14-1273L	14-1273O
SAMPLE DEPTH	8.0'--10.0'	12.0'-14.0'	18.0'-20.0'	28.5'-30.0'	43.5'-45.0'
WATER CONTENT, W%	19.3	19.2	27.4	34.7	33.8

BORING NO.	B-1				
SAMPLE NO.	14-1273R				
SAMPLE DEPTH	48.5'-50.0'				
WATER CONTENT, W%	59.0				

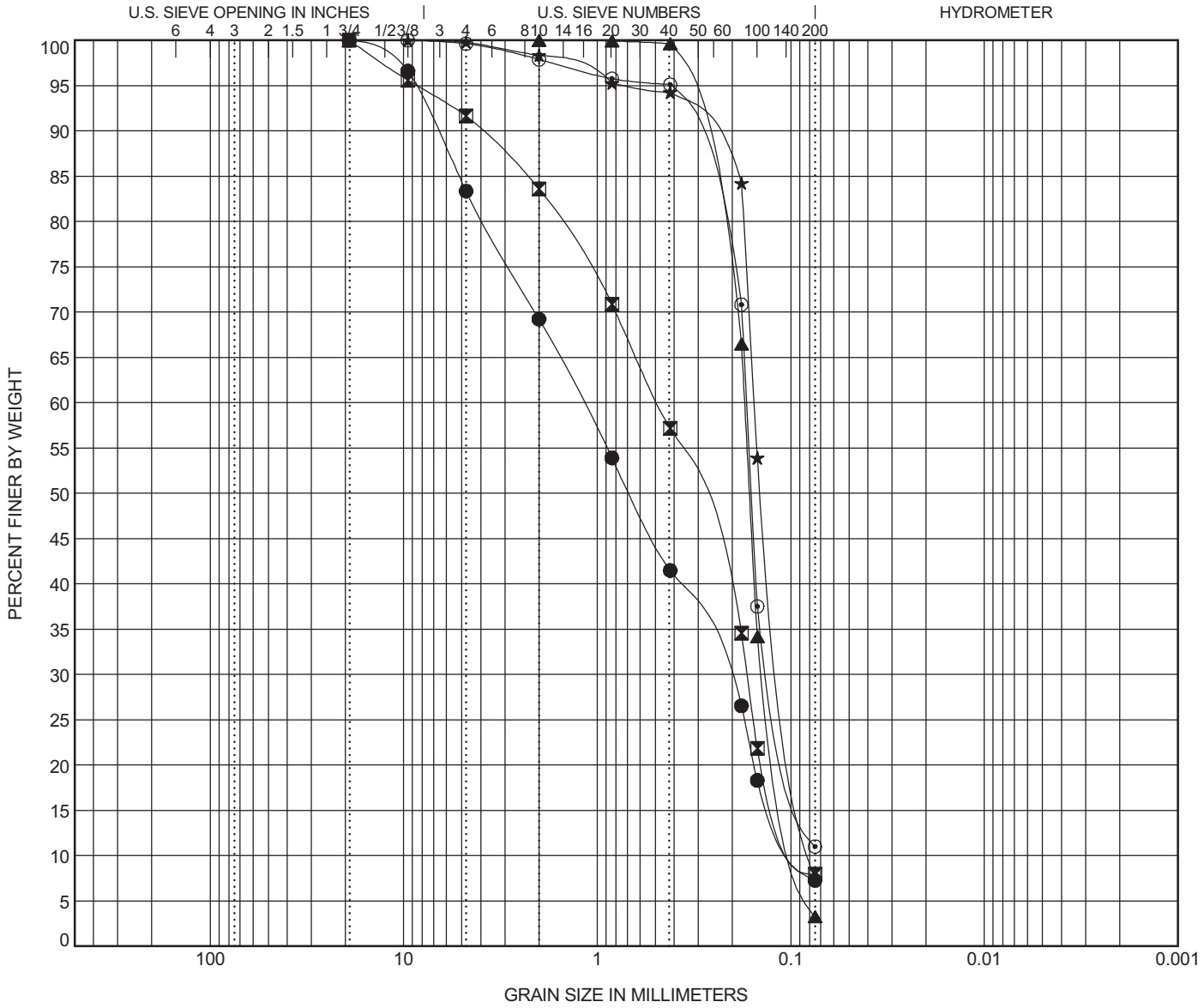
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-1**	**10.0**	**Poorly Graded F/C SAND (SP-SM) with Silt and Gravel A-1-b**	**NP**	**NP**	**NP**	**0.46**	**13.35**
⊠	**B-1**	**14.0**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**0.70**	**5.84**
▲	**B-1**	**20.0**	**Poorly Graded Fine SAND (SP) A-3**	**NP**	**NP**	**NP**	**1.22**	**1.99**
★	**B-1**	**30.0**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**0.91**	**1.99**
⊙	**B-1**	**45.0**	**Poorly Graded Fine SAND (SP-SM) with Silt A-2-4**	**NP**	**NP**	**NP**	**1.22**	**2.32**

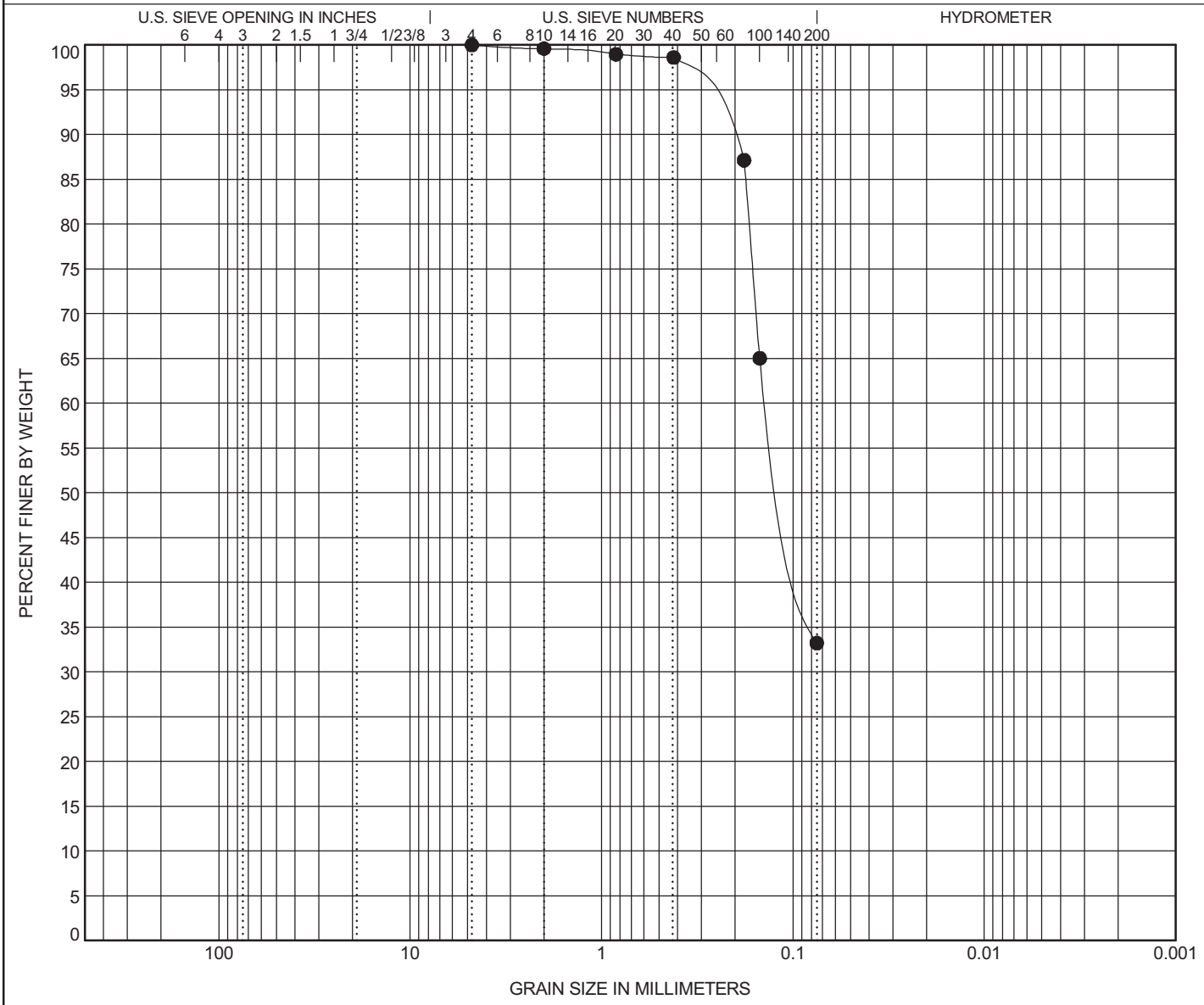
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-1**	**10.0**	**19.1**	**8.741**	**0.675**	**0.089**	**16.7**	**76.0**	**7.3**	
⊠	**B-1**	**14.0**	**19.1**	**8.544**	**0.321**	**0.083**	**8.4**	**83.7**	**8.0**	
▲	**B-1**	**20.0**	**2**	**0.373**	**0.163**	**0.087**	**0.0**	**96.7**	**3.3**	
★	**B-1**	**30.0**	**9.52**	**0.69**	**0.141**	**0.078**	**0.2**	**92.4**	**7.4**	
⊙	**B-1**	**45.0**	**9.52**	**0.418**	**0.16**		**0.4**	**88.6**	**11.0**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-1**	**50.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		

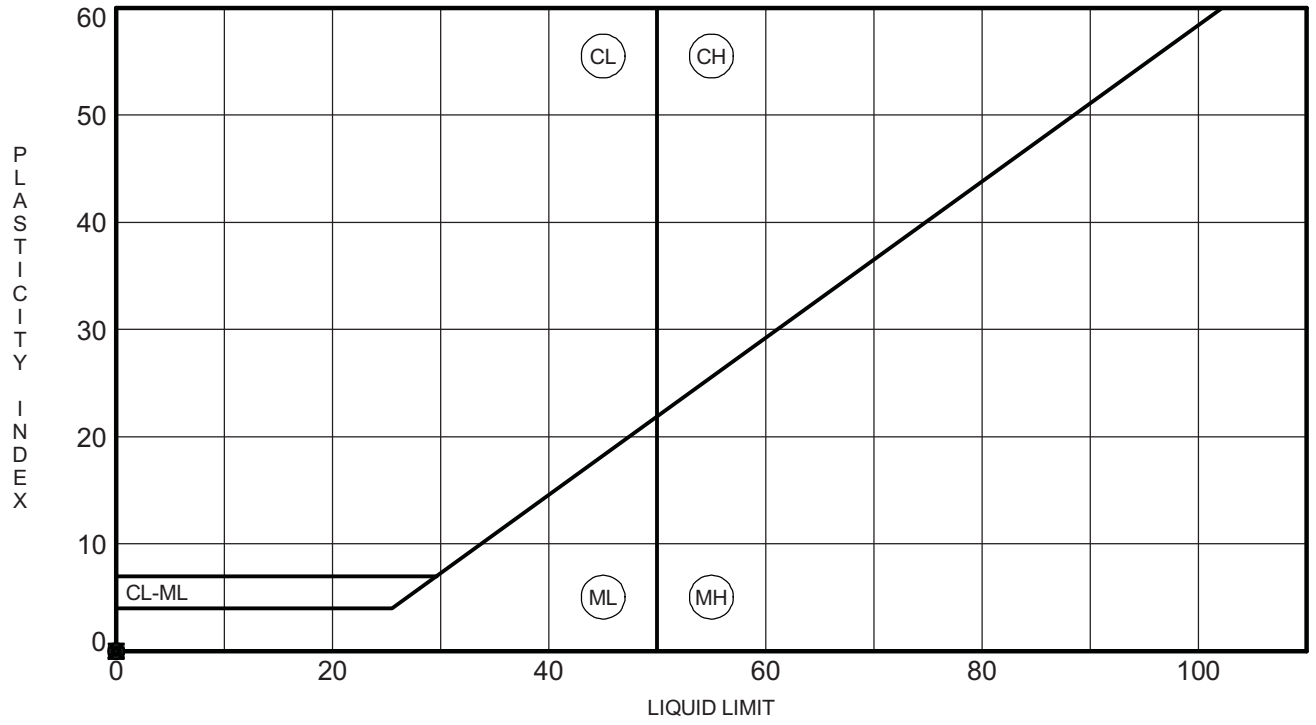
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-1**	**50.0**	**4.76**	**0.322**	**0.108**		**0.0**	**66.8**	**33.2**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-1**	**10.0**	**NP**	**NP**	**NP**	**7**	**Poorly Graded F/C SAND (SP-SM) with Silt and Gravel A-1-b**
⊠	**B-1**	**14.0**	**NP**	**NP**	**NP**	**8**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**
▲	**B-1**	**20.0**	**NP**	**NP**	**NP**	**3**	**Poorly Graded Fine SAND (SP) A-3**
★	**B-1**	**30.0**	**NP**	**NP**	**NP**	**7**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**
⊙	**B-1**	**45.0**	**NP**	**NP**	**NP**	**11**	**Poorly Graded Fine SAND (SP-SM) with Silt A-2-4**
✿	**B-1**	**50.0**	**NP**	**NP**	**NP**	**33**	**Silty Fine SAND (SM) A-2-4**

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

ORGANIC IMPURITIES DETERMINATION
(AASHTO T267)

PROJECT: US 21 Bridge Replacement over Harbor River

PROJECT NO.: G5396

SAMPLE NUMBER: 14-1273

DATE SAMPLE RECEIVED: 9/4/2014

DESCRIPTION OF SOIL: Various

TESTED BY: JH

DATE OF TESTING: 9/8/2014

DATE OF WEIGHING: 9/8/2014

BORING NO.	B-1	B-1	B-1		
SAMPLE NO.	14-1273S	14-1273T	14-1273U		
SAMPLE DEPTH	4.0'-6.0'	6.0'-8.0'	14.0'-16.0'		
WT. OF CRUCIBLE + DRY SOIL (BEFORE IGNITION) (GRAMS)	171.13	173.78	149.23		
WT. OF CRUCIBLE + DRY SOIL (AFTER IGNITION) (GRAMS)	170.71	173.37	149.11		
WT. OF CRUCIBLE (GRAMS)	134.66	135.55	110.79		
WT. OF DRY SOIL (BEFORE IGNITION) (GRAMS)	36.47	38.23	38.44		
WT. OF DRY SOIL (AFTER IGNITION) (GRAMS)	36.05	37.82	38.32		
IGNITION LOSS (GRAMS)	0.42	0.41	0.12		
ORGANIC IMPURITIES %	1.15	1.07	0.31		

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	14-1328	**DATE SAMPLE RECEIVED:**	9/4/2014
DESCRIPTION OF SOIL:	Various		
TESTED BY:	KB	**DATE OF TESTING:**	9/5/2014
		DATE OF WEIGHING:	9/8/2014

BORING NO.	B-2	B-2	B-2	B-2	B-2
SAMPLE NO.	14-1328F	14-1328I	14-1328L	14-1328O	14-1328R
SAMPLE DEPTH	6.0'-8.0'	8.0'-10.0'	18.0'-20.0'	28.5'-30.0'	38.5'-40.0'
WATER CONTENT, W%	28.7	27.9	26.5	30.3	29.3

BORING NO.	B-2				
SAMPLE NO.	14-1328U				
SAMPLE DEPTH	53.5'-55.0'				
WATER CONTENT, W%	28.4				

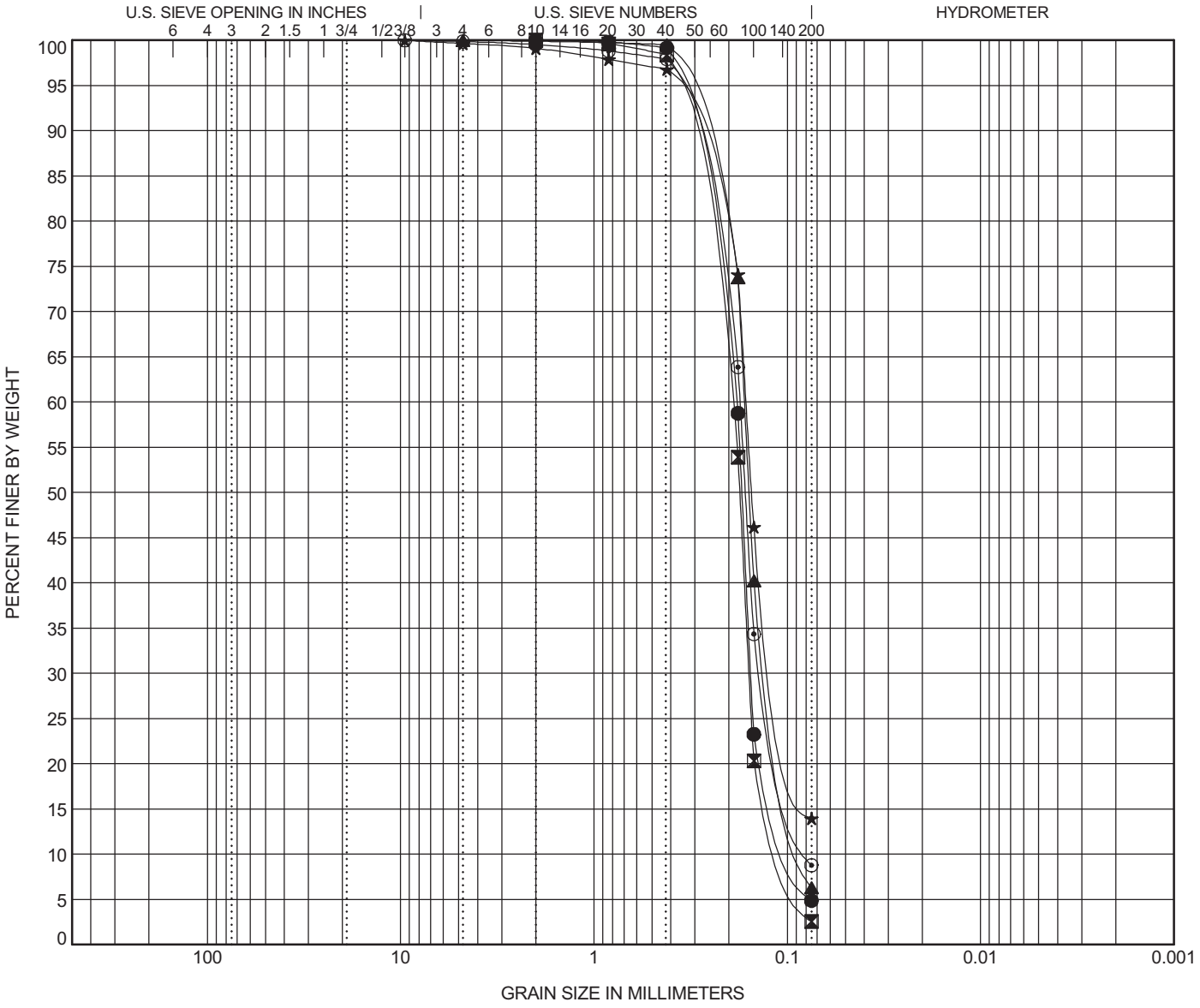
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-2	8.0	Poorly Graded Fine SAND (SP) A-3	NP	NP	NP	1.42	2.03
⊠	B-2	10.0	Poorly Graded Fine SAND (SP) A-3	NP	NP	NP	1.22	2.02
▲	B-2	20.0	Poorly Graded Fine SAND (SP-SM) with Silt A-3	NP	NP	NP	1.09	2.06
★	B-2	30.0	Silty Fine SAND (SM) A-2-4	NP	NP	NP		
⊙	B-2	40.0	Poorly Graded Fine SAND (SP-SM) with Silt A-3	NP	NP	NP	1.29	2.27

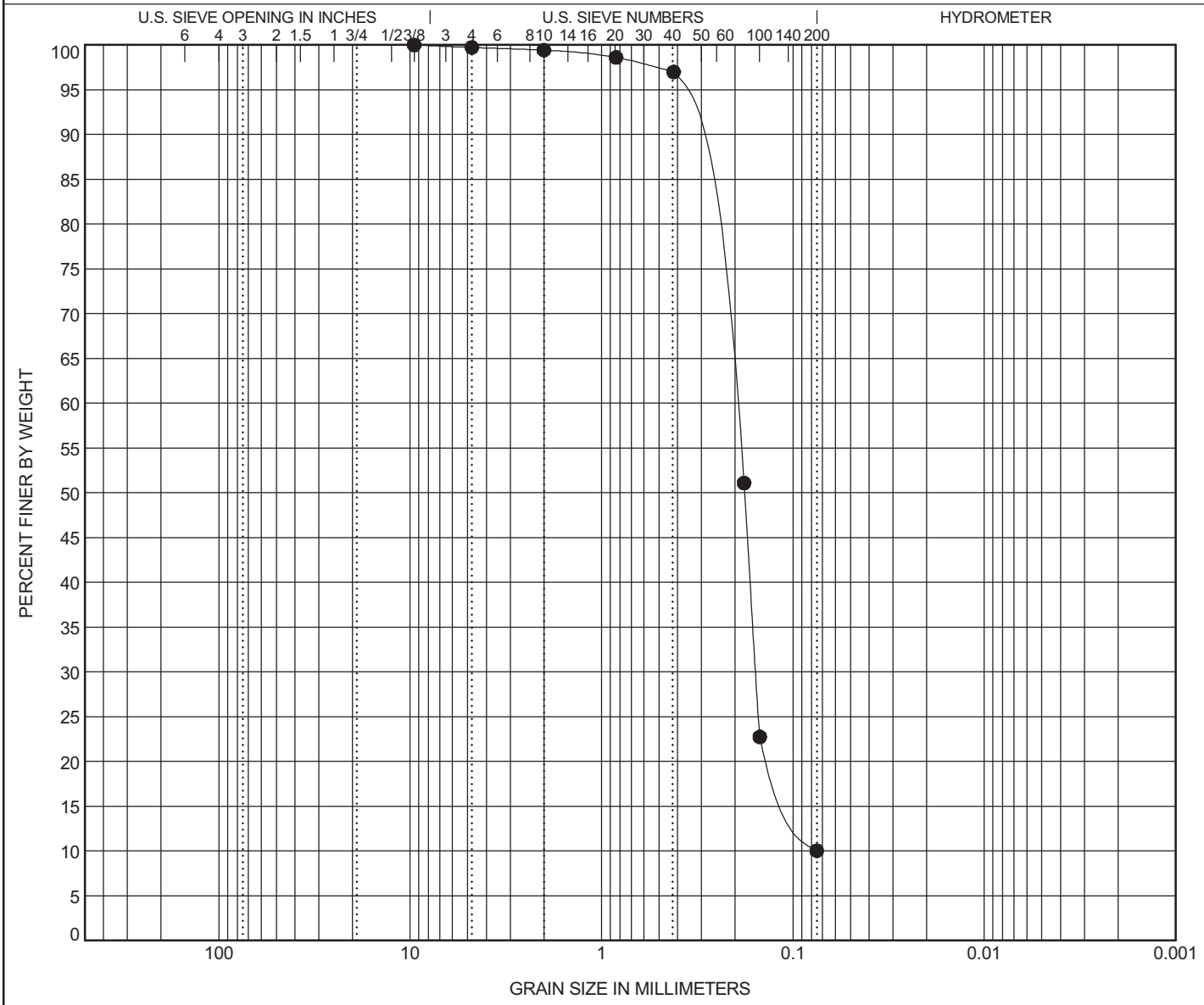
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	B-2	8.0	2	0.385	0.172	0.091	0.0	95.1	4.9	
⊠	B-2	10.0	2	0.394	0.176	0.1	0.0	97.5	2.5	
▲	B-2	20.0	4.76	0.362	0.157	0.081	0.0	93.7	6.3	
★	B-2	30.0	9.52	0.393	0.153		0.3	85.7	14.0	
⊙	B-2	40.0	9.52	0.39	0.165	0.077	0.1	91.1	8.8	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

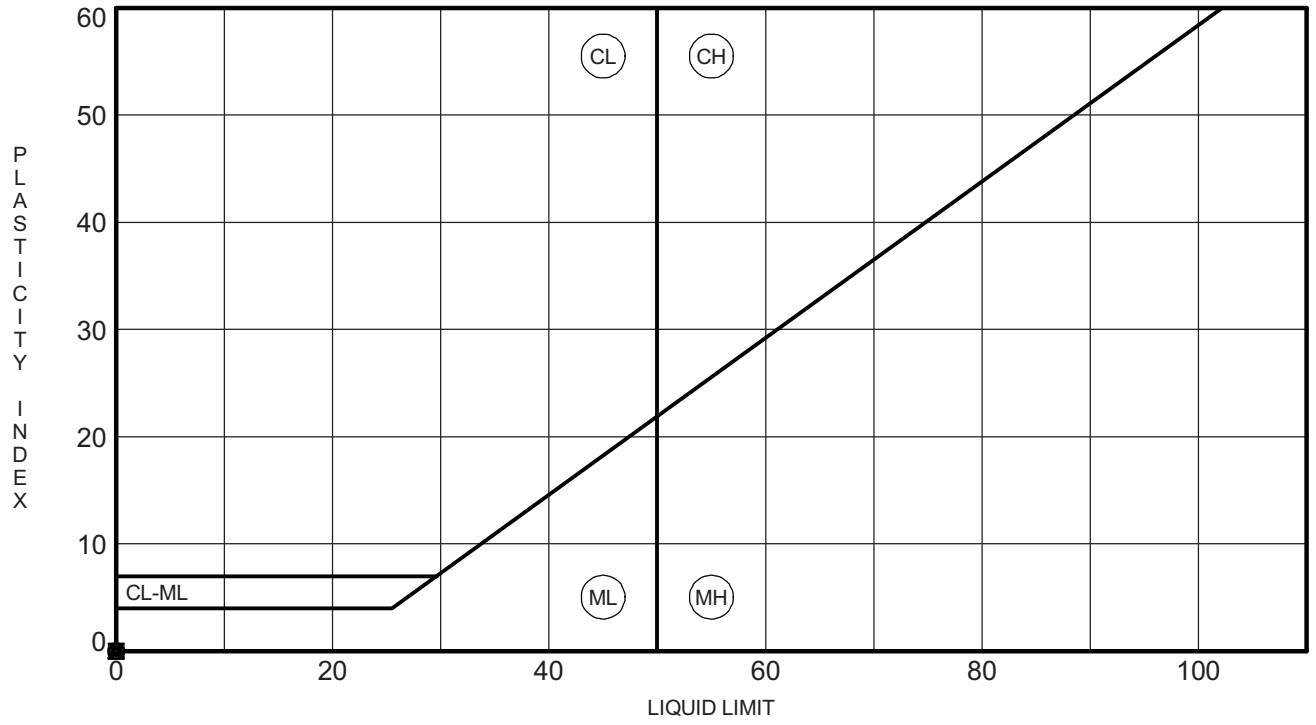
BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● **B-2**	**55.0**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**1.54**	**2.83**

BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **B-2**	**55.0**	**9.52**	**0.405**	**0.179**		**0.3**	**89.7**	**10.0**	

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-2**	**8.0**	**NP**	**NP**	**NP**	**5**	**Poorly Graded Fine SAND (SP) A-3**
⊠	**B-2**	**10.0**	**NP**	**NP**	**NP**	**3**	**Poorly Graded Fine SAND (SP) A-3**
▲	**B-2**	**20.0**	**NP**	**NP**	**NP**	**6**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**
★	**B-2**	**30.0**	**NP**	**NP**	**NP**	**14**	**Silty Fine SAND (SM) A-2-4**
⊙	**B-2**	**40.0**	**NP**	**NP**	**NP**	**9**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**
✿	**B-2**	**55.0**	**NP**	**NP**	**NP**	**10**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**

ATTERBERG LIMITS G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

ORGANIC IMPURITIES DETERMINATION
(AASHTO T267)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	14-1328	**DATE SAMPLE RECEIVED:**	9/4/2014
DESCRIPTION OF SOIL:	Various		
TESTED BY:	JH	**DATE OF TESTING:**	9/8/2014
		DATE OF WEIGHING:	9/8/2014

BORING NO.	B-2	B-2	B-2		
SAMPLE NO.	14-1328A	14-1328B	14-1328C		
SAMPLE DEPTH	4.0'-6.0'	10.0'-12.0'	23.5'-25.0'		
WT. OF CRUCIBLE + DRY SOIL (BEFORE IGNITION) (GRAMS)	171.92	171.93	172.55		
WT. OF CRUCIBLE + DRY SOIL (AFTER IGNITION) (GRAMS)	171.71	171.75	172.09		
WT. OF CRUCIBLE (GRAMS)	134.66	132.08	135.70		
WT. OF DRY SOIL (BEFORE IGNITION) (GRAMS)	37.26	39.85	36.85		
WT. OF DRY SOIL (AFTER IGNITION) (GRAMS)	37.05	39.67	36.39		
IGNITION LOSS (GRAMS)	0.21	0.18	0.46		
ORGANIC IMPURITIES %	0.56	0.45	1.25		

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396.00
SAMPLE NUMBER:	15-1436	**DATE SAMPLE RECEIVED:**	10/1/2015
DESCRIPTION OF SOIL:	Various		
TESTED BY:	MM	**DATE OF TESTING:**	10/1/2015
		DATE OF WEIGHING:	10/2/2015

BORING NO.	B-3	B-3	B-3	B-3	B-3
SAMPLE NO.	15-1436C	15-1436G	15-1436J	15-1436Q	15-1436T
SAMPLE DEPTH	0.0-2.0'	6.0-8.0'	13.5-15.0'	23.5-25.0'	28.5-30.0'
WATER CONTENT, W%	36.9	151.6	26.1	29.3	101.1

BORING NO.	B-3				
SAMPLE NO.	15-1436W				
SAMPLE DEPTH	38.5-40.0'				
WATER CONTENT, W%	30.2				

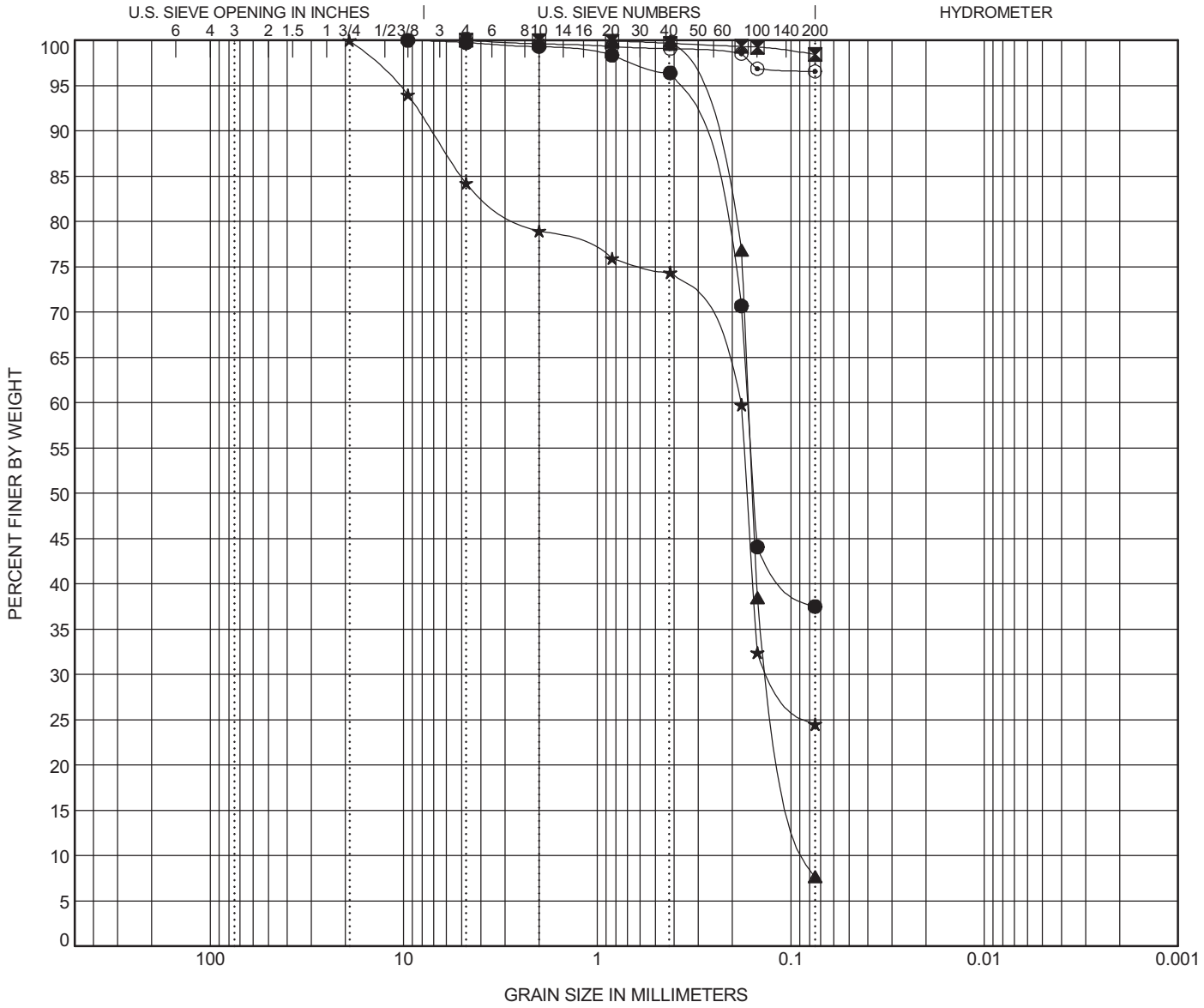
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

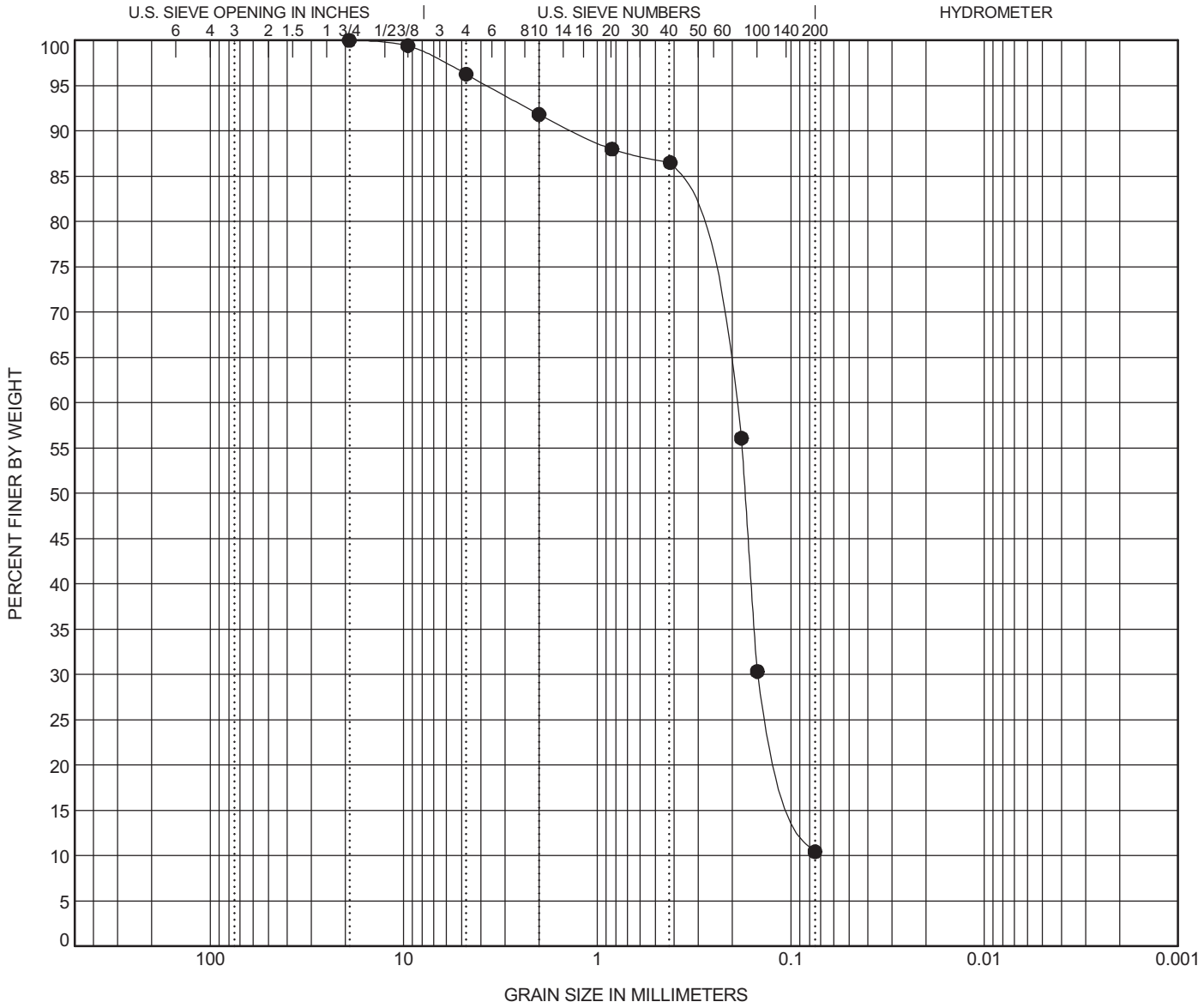
	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-3	2.0	Silty Fine SAND (SM) A-4(0)	NP	NP	NP		
⊠	B-3	8.0	Elastic SILT (MH) A-7-5(36)	74	49	25		
▲	B-3	15.0	Poorly Graded Fine SAND (SP-SM) with Silt A-3	NP	NP	NP	1.16	2.10
★	B-3	25.0	Silty Fine SAND (SM) with Gravel A-2-4	NP	NP	NP		
⊙	B-3	30.0	Elastic SILT (MH) A-7-5(32)	58	31	27		

	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	B-3	2.0	9.52	0.401	0.155		0.2	62.3	37.5	
⊠	B-3	8.0	4.76				0.0	1.5	98.5	
▲	B-3	15.0	0.84	0.35	0.158	0.079	0.0	92.3	7.7	
★	B-3	25.0	19.1	10.692	0.168		15.8	59.7	24.5	
⊙	B-3	30.0	4.76				0.0	3.4	96.6	

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-3**	**40.0**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**1.46**	**2.72**

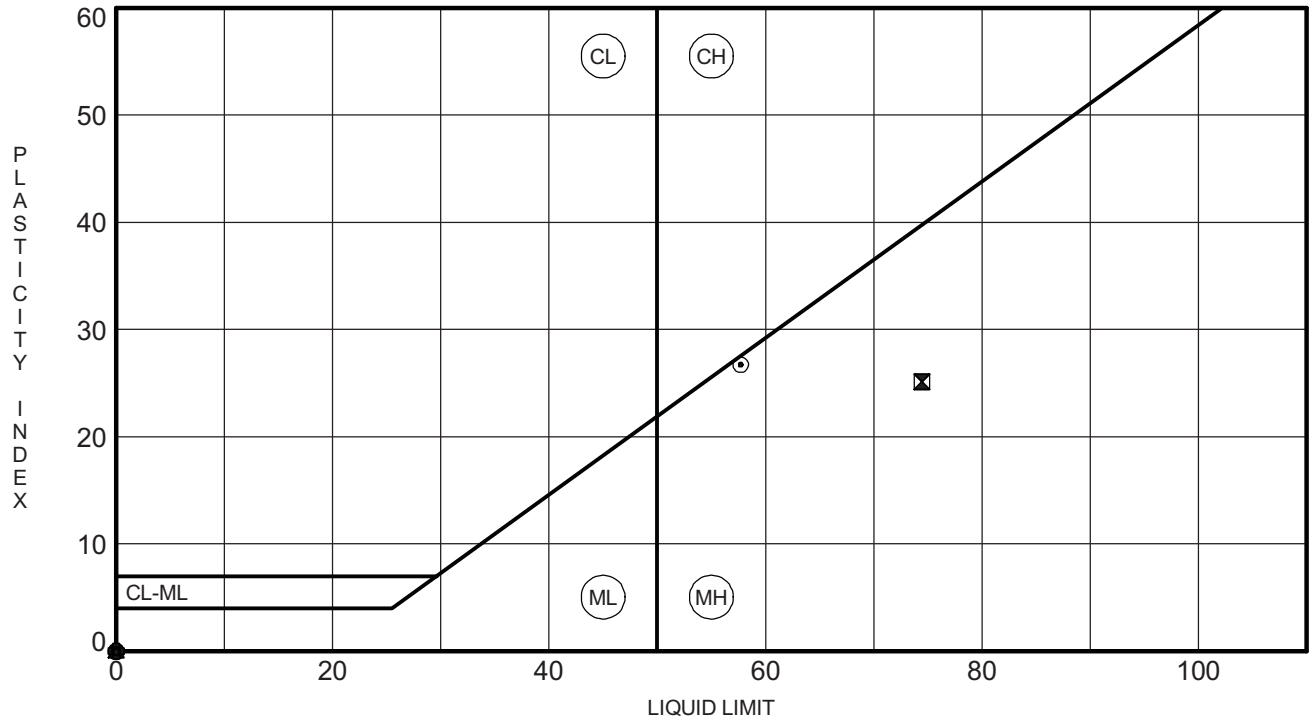
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-3**	**40.0**	**19.1**	**3.709**	**0.172**		**3.7**	**85.8**	**10.4**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-3**	**2.0**	**NP**	**NP**	**NP**	**38**	**Silty Fine SAND (SM) A-4(0)**
⊠	**B-3**	**8.0**	**74**	**49**	**25**	**98**	**Elastic SILT (MH) A-7-5(36)**
▲	**B-3**	**15.0**	**NP**	**NP**	**NP**	**8**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**
★	**B-3**	**25.0**	**NP**	**NP**	**NP**	**25**	**Silty Fine SAND (SM) with Gravel A-2-4**
⊙	**B-3**	**30.0**	**58**	**31**	**27**	**97**	**Elastic SILT (MH) A-7-5(32)**
✿	**B-3**	**40.0**	**NP**	**NP**	**NP**	**10**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

ORGANIC IMPURITIES DETERMINATION
(AASHTO T267)

PROJECT: US 21 Bridge Replacement over Harbor River **PROJECT NO.:** G5396.00

SAMPLE NUMBER: 15-1436D **DATE SAMPLE RECEIVED:**

DESCRIPTION OF SOIL:

TESTED BY: JH **DATE OF TESTING:** 10/13/2015

DATE OF WEIGHING: 10/14/2015

BORING NO.	B-3				
SAMPLE NO.	15-1436D				
SAMPLE DEPTH	4.0'-6.0'				
WT. OF CRUCIBLE + DRY SOIL (BEFORE IGNITION) (GRAMS)	174.66				
WT. OF CRUCIBLE + DRY SOIL (AFTER IGNITION) (GRAMS)	173.24				
WT. OF CRUCIBLE (GRAMS)	134.66				
WT. OF DRY SOIL (BEFORE IGNITION) (GRAMS)	40.00				
WT. OF DRY SOIL (AFTER IGNITION) (GRAMS)	38.58				
IGNITION LOSS (GRAMS)	1.42				
ORGANIC IMPURITIES %	3.55				

Determining pH of Soil for Use in Corrosion Testing
AASHTO T 289

PROJECT TITLE	F&ME/HARBOR RIVER/SC	SAMPLE ID	B-3 15-1436M
PROJECT NO.	1524908.09	SAMPLE TYPE	Bag
REMARKS	F&ME Project No. G5396	SAMPLE DEPTH	18.5 - 20.0'

SAMPLE PREPARATION

Sieved through the #10 Sieve	YES
Air Dry	YES
Type of Water	DISTILLED

Trial	pH	Temperature
1	7.90	20.0
2	7.88	20.1
3	7.89	20.2
AVERAGE	7.89	20.1

Description SILTY SAND; dark gray, sea shells.

USCS (SM)

TECH	TJ
DATE	10/13/15
CHECK	
REVIEW	
APPROVE	

Determining Minimum Laboratory Soil Resistivity
AASHTO T 288

PROJECT TITLE	F&ME/HARBOR RIVER/SC	SAMPLE ID	B-3	15-1436N
PROJECT NO.	1524908.09	SAMPLE TYPE	Bag	
REMARKS	F&ME Project No. G5396	SAMPLE DEPTH	18.5 - 20.0'	

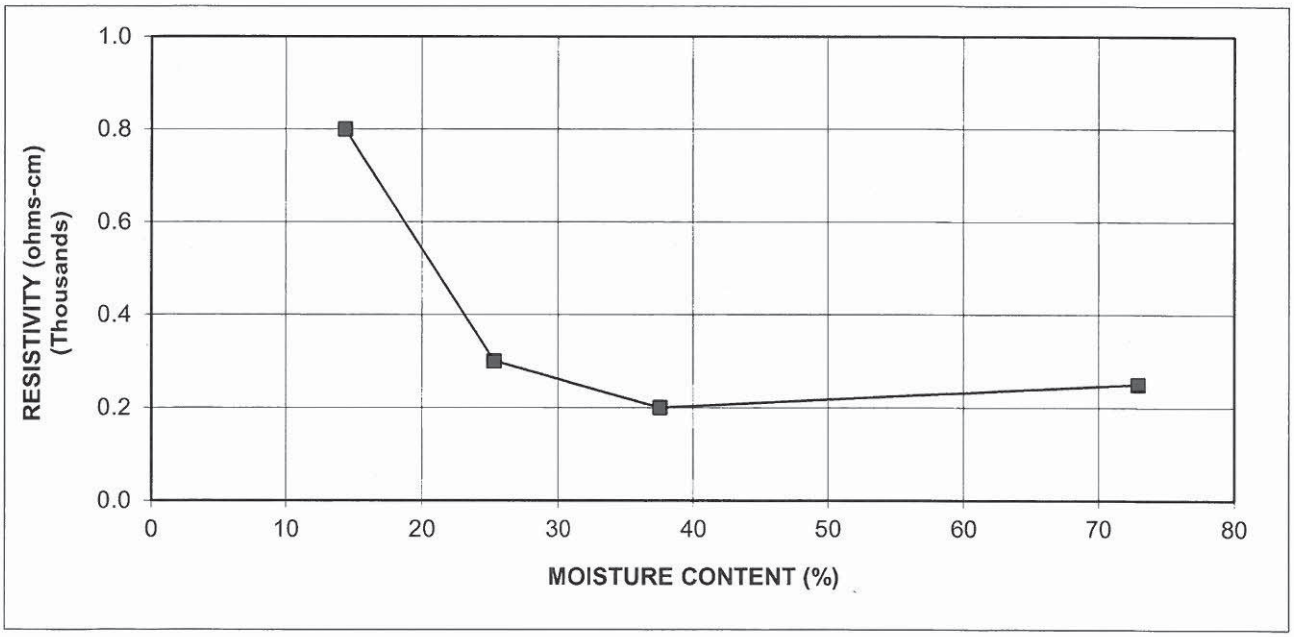
SAMPLE PREPARATION	Sieved through the #10 Sieve	Yes
TEST APPARATUS	Miller Soilbox and Nilsson 400 Soil Resistance Meter.	

Identification: Lowest resistivity

SPECIMEN (Point)	1	2	3	4
RESISTIVITY (ohms-cm)	800	300	200	250

MOISTURE CONTENT

WET WEIGHT & TARE	89.43	106.77	116.52	195.83
DRY WEIGHT & TARE	84.60	95.73	98.93	135.24
TARE WEIGHT	51.00	52.02	52.10	52.15
WEIGHT OF MOISTURE (gm)	4.83	11.04	17.59	60.59
WEIGHT OF DRY SOIL (gm)	33.60	43.71	46.83	83.09
MOISTURE CONTENT (%)	14.38	25.26	37.56	72.92



Description: SILTY SAND; dark gray, sea shells.

USCS: (SM)

TECH	TJ
DATE	10/13/15
CHECK	
REVIEW	
APPROVE	

ACL

ADVANCED CHEMISTRY LABS, INC.

Phone: (770) 409-1444
Fax: (770) 409-1844
e-mail: acl@acl-labs.net

3039 Amwiler Road • Suite 100 • Atlanta, GA 30360
P.O. Box 88610 • Atlanta, GA 30356
www.acl-labs.com

Client: Golder Associates, Inc.
3730 Chamblee Tucker Road
Atlanta, GA 30341-0000

Client Proj #: 1524908
ACL Project #: 68442
Date Received: 10/13/2015
Date Reported: 10/30/2015

Contact: Mr. Henry Mock

Sample ID: B-3 18.5-20'

Matrix: Soil

ACL #: 307835

Date/Time Sampled: 10/13/2015 11:15

Analyte (Method)	Result	PQL	Units	DF	Prep Date/Time	Analysis Date/Time	Analyst
Sol. Chloride (9252A)*	5080	500	mg/kg	50	10/16/2015 8:30	10/16/2015 8:30	MM
Sol. Sulfate (9038)*	126	50	mg/kg	5	10/19/2015 10:20	10/19/2015 10:20	MM

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396.00
SAMPLE NUMBER:	15-1437	**DATE SAMPLE RECEIVED:**	10/1/2015
DESCRIPTION OF SOIL:	Various		
TESTED BY:	MM	**DATE OF TESTING:**	10/1/2015
		DATE OF WEIGHING:	10/2/2015

BORING NO.	B-4	B-4	B-4	B-4	B-4
SAMPLE NO.	15-1437C	15-1437G	15-1437J	15-1437M	15-1437P
SAMPLE DEPTH	2.0-4.0'	8.0-10.0'	13.5-15.0'	23.5-25.0'	33.5-35.0'
WATER CONTENT, W%	52.5	32.9	31.8	27.8	35.8

BORING NO.	B-4	B-4			
SAMPLE NO.	15-1437W	15-1437Z			
SAMPLE DEPTH	48.5-50.0'	63.5-65.0'			
WATER CONTENT, W%	31.8	64.5			

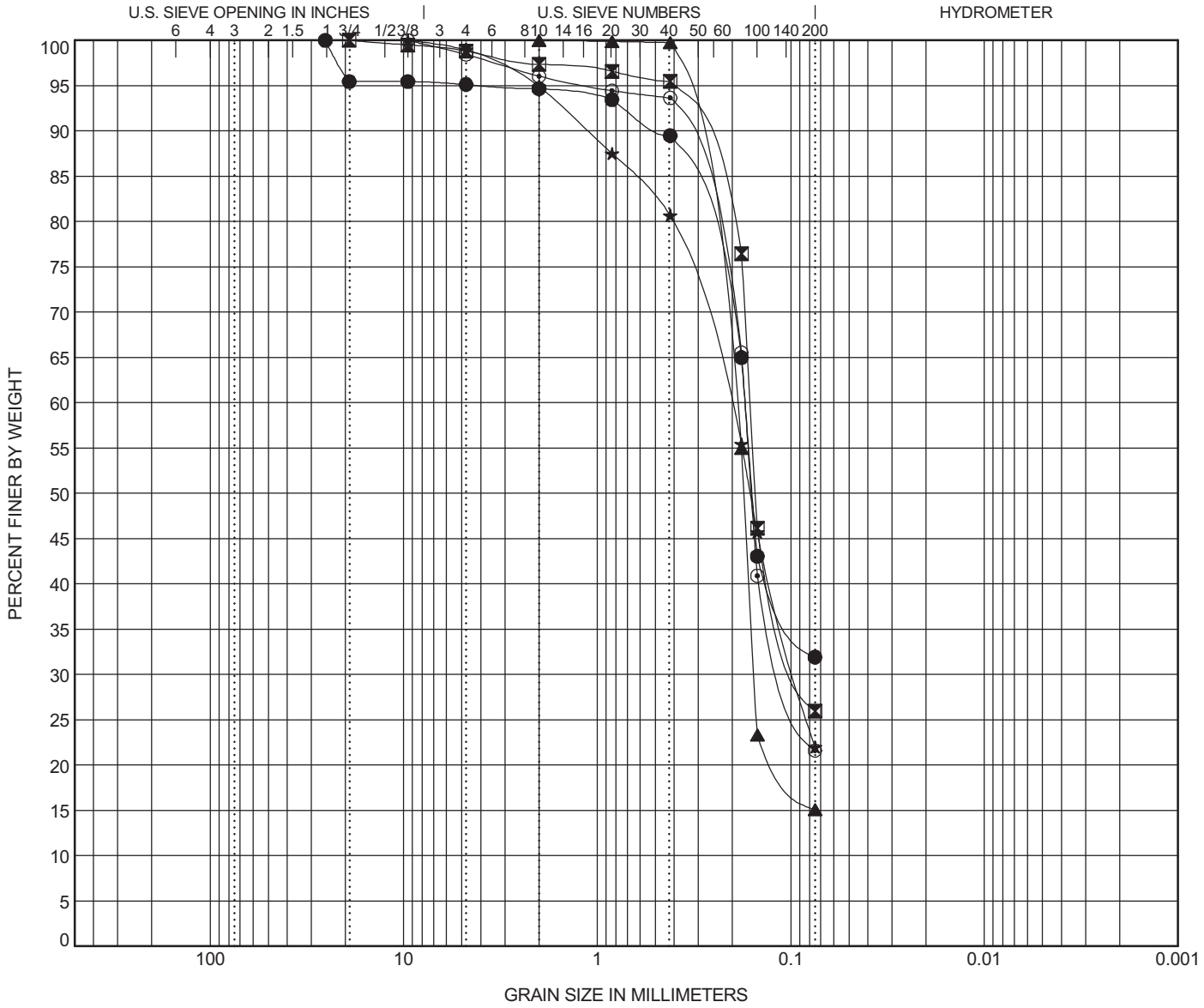
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● B-4	4.0	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
⊠ B-4	10.0	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
▲ B-4	15.0	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
★ B-4	25.0	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
⊙ B-4	35.0	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		

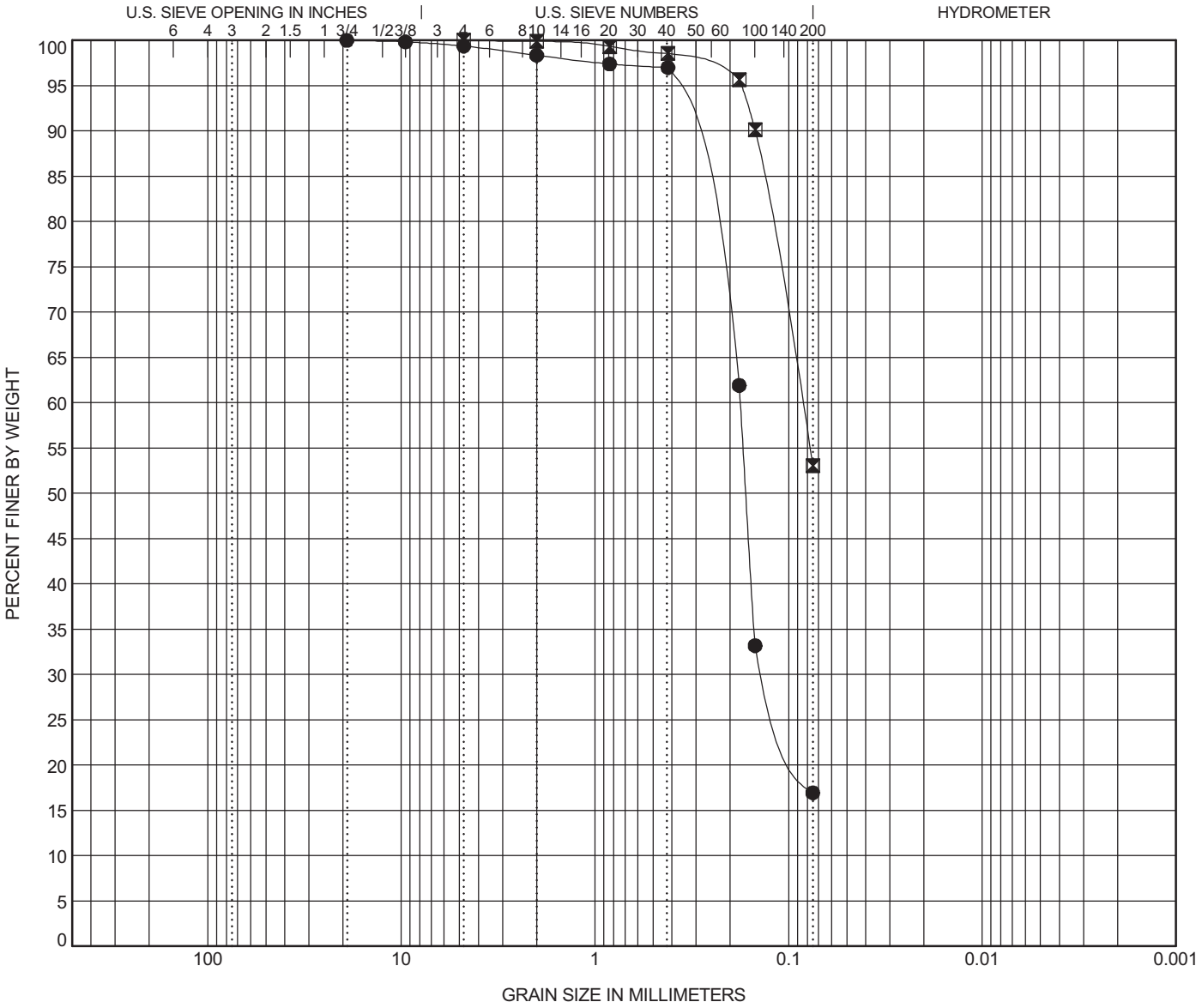
BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
● B-4	4.0	**25.4**	**3.699**	**0.158**		**4.9**	**63.2**	**31.9**	
⊠ B-4	10.0	**19.1**	**0.411**	**0.153**		**1.2**	**72.9**	**26.0**	
▲ B-4	15.0	**2**	**0.384**	**0.175**		**0.0**	**84.9**	**15.1**	
★ B-4	25.0	**9.52**	**2.034**	**0.162**		**1.1**	**76.9**	**22.0**	
⊙ B-4	35.0	**9.52**	**1.13**	**0.16**		**1.6**	**76.8**	**21.6**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-4**	**50.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
⊠	**B-4**	**65.0**	**Sandy Elastic SILT (MH) A-7-5(16)**	**71**	**35**	**36**		

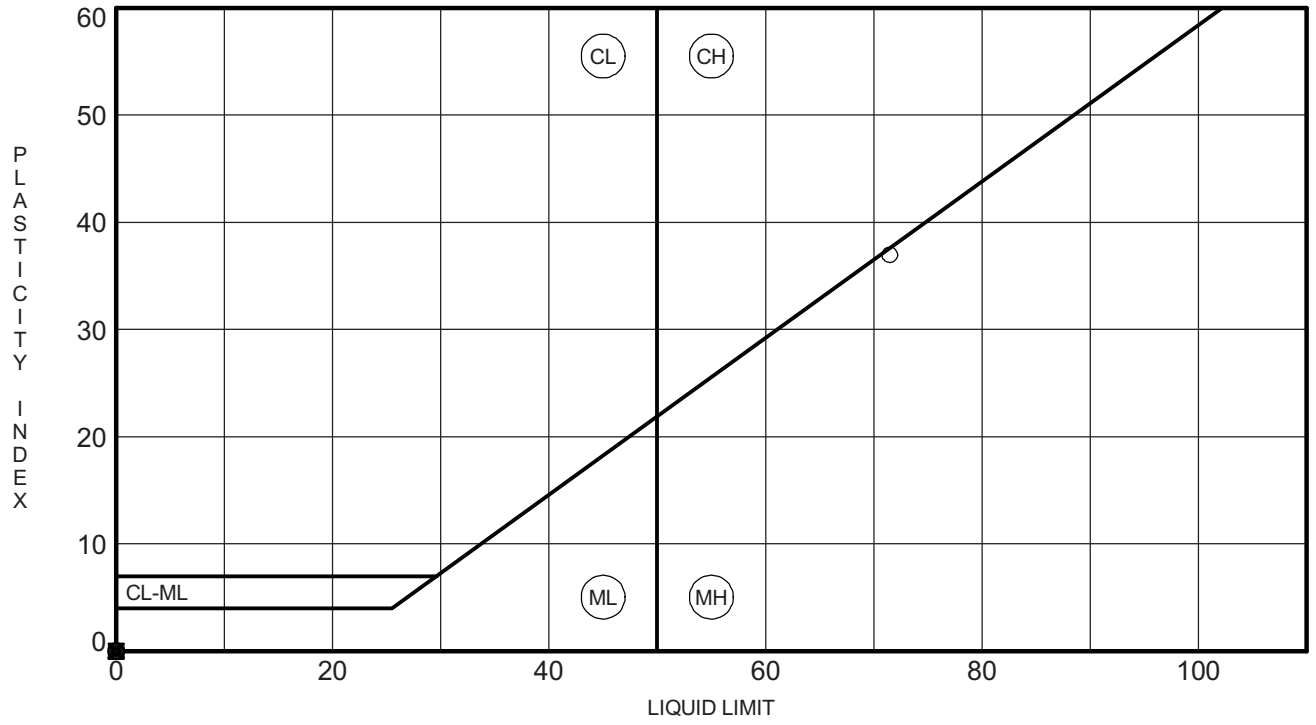
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-4**	**50.0**	**19.1**	**0.4**	**0.166**		**0.6**	**82.4**	**17.0**	
⊠	**B-4**	**65.0**	**4.76**	**0.176**			**0.0**	**46.9**	**53.1**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-4**	**4.0**	**NP**	**NP**	**NP**	**32**	**Silty Fine SAND (SM) A-2-4**
⊠	**B-4**	**10.0**	**NP**	**NP**	**NP**	**26**	**Silty Fine SAND (SM) A-2-4**
▲	**B-4**	**15.0**	**NP**	**NP**	**NP**	**15**	**Silty Fine SAND (SM) A-2-4**
★	**B-4**	**25.0**	**NP**	**NP**	**NP**	**22**	**Silty Fine SAND (SM) A-2-4**
⊙	**B-4**	**35.0**	**NP**	**NP**	**NP**	**22**	**Silty Fine SAND (SM) A-2-4**
✿	**B-4**	**50.0**	**NP**	**NP**	**NP**	**17**	**Silty Fine SAND (SM) A-2-4**
○	**B-4**	**65.0**	**71**	**35**	**36**	**53**	**Sandy Elastic SILT (MH) A-7-5(16)**

ATTERBERG LIMITS G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

ORGANIC IMPURITIES DETERMINATION
(AASHTO T267)

PROJECT: US 21 Bridge Replacement over Harbor River **PROJECT NO.:** G5396.00

SAMPLE NUMBER: 15-1437D **DATE SAMPLE RECEIVED:**

DESCRIPTION OF SOIL:

TESTED BY: JH **DATE OF TESTING:** 10/13/2015

DATE OF WEIGHING: 10/14/2015

BORING NO.	B-4				
SAMPLE NO.	15-1437D				
SAMPLE DEPTH	4.0'-6.0'				
WT. OF CRUCIBLE + DRY SOIL (BEFORE IGNITION) (GRAMS)	172.08				
WT. OF CRUCIBLE + DRY SOIL (AFTER IGNITION) (GRAMS)	171.01				
WT. OF CRUCIBLE (GRAMS)	132.08				
WT. OF DRY SOIL (BEFORE IGNITION) (GRAMS)	40.00				
WT. OF DRY SOIL (AFTER IGNITION) (GRAMS)	38.93				
IGNITION LOSS (GRAMS)	1.07				
ORGANIC IMPURITIES %	2.68				

Determining pH of Soil for Use in Corrosion Testing
AASHTO T 289

PROJECT TITLE	F&ME/HARBOR RIVER/SC	SAMPLE ID	B-4 15-1437S
PROJECT NO.	1524908.09	SAMPLE TYPE	Bag
REMARKS	F&ME Project No. G5396	SAMPLE DEPTH	38.5 - 40.0'

SAMPLE PREPARATION

Sieved through the #10 Sieve	YES
Air Dry	YES
Type of Water	DISTILLED

Trial	pH	Temperature
1	8.03	20.1
2	8.04	20.2
3	8.04	20.2
AVERAGE	8.04	20.2

Description CLAYEY SAND; olive brown.

USCS (SC)

TECH	TJ
DATE	10/13/15
CHECK	
REVIEW	
APPROVE	

Determining Minimum Laboratory Soil Resistivity
AASHTO T 288

PROJECT TITLE	F&ME/HARBOR RIVER/SC	SAMPLE ID	B-4 15-1437T
PROJECT NO.	1524908.09	SAMPLE TYPE	Bag
REMARKS	F&ME Project No. G5396	SAMPLE DEPTH	38.5 - 40.0'

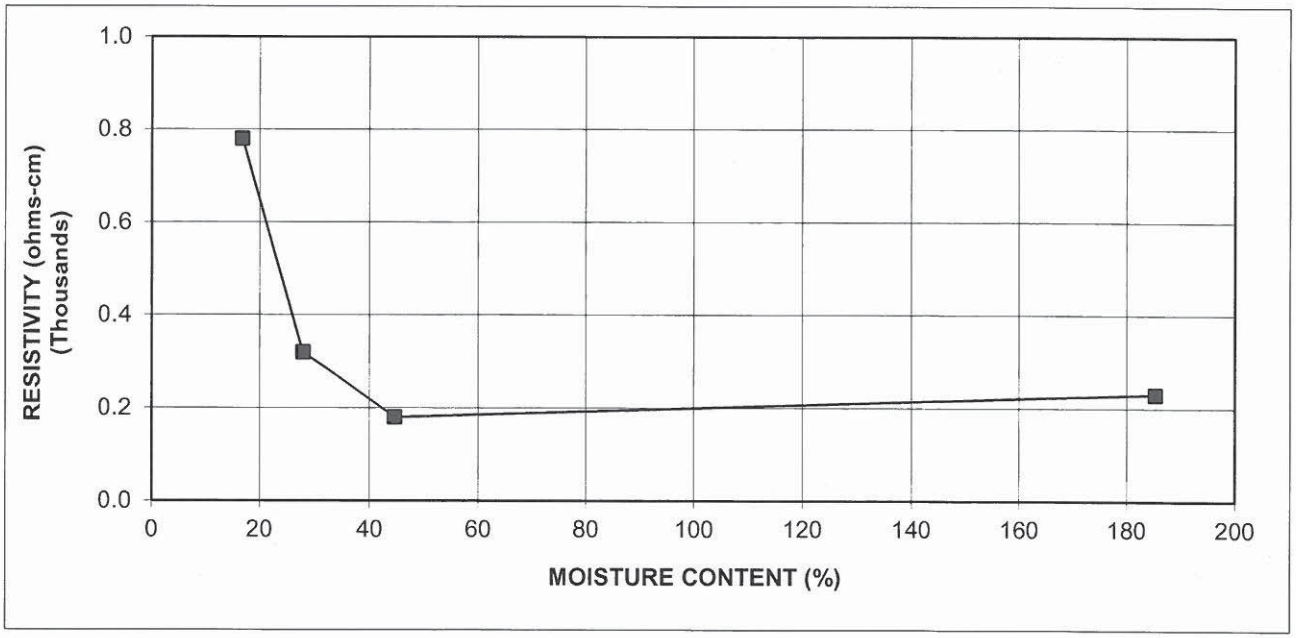
SAMPLE PREPARATION — Sieved through the #10 Sieve: Yes
TEST APPARATUS — Miller Soilbox and Nilsson 400 Soil Resistance Meter.

Identification: Lowest resistivity

SPECIMEN (Point)	1	2	3	4
RESISTIVITY (ohms-cm)	780	320	180	230

MOISTURE CONTENT

WET WEIGHT & TARE	89.28	100.21	117.14	258.52
DRY WEIGHT & TARE	83.76	89.62	97.00	123.87
TARE WEIGHT	50.92	51.73	51.88	51.22
WEIGHT OF MOISTURE (gm)	5.52	10.59	20.14	134.65
WEIGHT OF DRY SOIL (gm)	32.84	37.89	45.12	72.65
MOISTURE CONTENT (%)	16.81	27.95	44.64	185.34



Description: CLAYEY SAND; olive brown.

USCS: (SC)

TECH	TJ
DATE	10/13/15
CHECK	
REVIEW	
APPROVE	

ACL

ADVANCED CHEMISTRY LABS, INC.

Phone: (770) 409-1444
Fax: (770) 409-1844
e-mail: acl@acl-labs.net

3039 Amwiler Road • Suite 100 • Atlanta, GA 30360
P.O. Box 88610 • Atlanta, GA 30356
www.acl-labs.com

Client: Golder Associates, Inc.
3730 Chamblee Tucker Road
Atlanta, GA 30341-0000

Client Proj #: 1524908
ACL Project #: 68442
Date Received: 10/13/2015
Date Reported: 10/30/2015

Contact: Mr. Henry Mock

Sample ID: B-4 38.5-40'

Matrix: Soil

ACL #: 307836

Date/Time Sampled: 10/13/2015 11:15

Analyte (Method)	Result	PQL	Units	DF	Prep Date/Time	Analysis Date/Time	Analyst
Sol. Chloride (9252A)*	8350	500	mg/kg	50	10/16/2015 8:30	10/16/2015 8:30	MM
Sol. Sulfate (9038)*	559	200	mg/kg	20	10/19/2015 10:20	10/19/2015 10:20	MM

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396.00
SAMPLE NUMBER:	15-1438	**DATE SAMPLE RECEIVED:**	10/1/2015
DESCRIPTION OF SOIL:	Various		
TESTED BY:	MM	**DATE OF TESTING:**	10/1/2015
		DATE OF WEIGHING:	10/2/2015

BORING NO.	B-5	B-5	B-5	B-5	B-5
SAMPLE NO.	15-1438C	15-1438F	15-1438J	15-1438M	15-1438T
SAMPLE DEPTH	2.0-4.0'	6.0-8.0'	13.5-15.0'	23.5-25.0'	33.5-35.0'
WATER CONTENT, W%	27.9	24.1	36.1	26.8	39.0

BORING NO.	B-5	B-5			
SAMPLE NO.	15-1438W	15-1438Z			
SAMPLE DEPTH	43.5-45.0'	53.5-55.0'			
WATER CONTENT, W%	33.4	38.9			

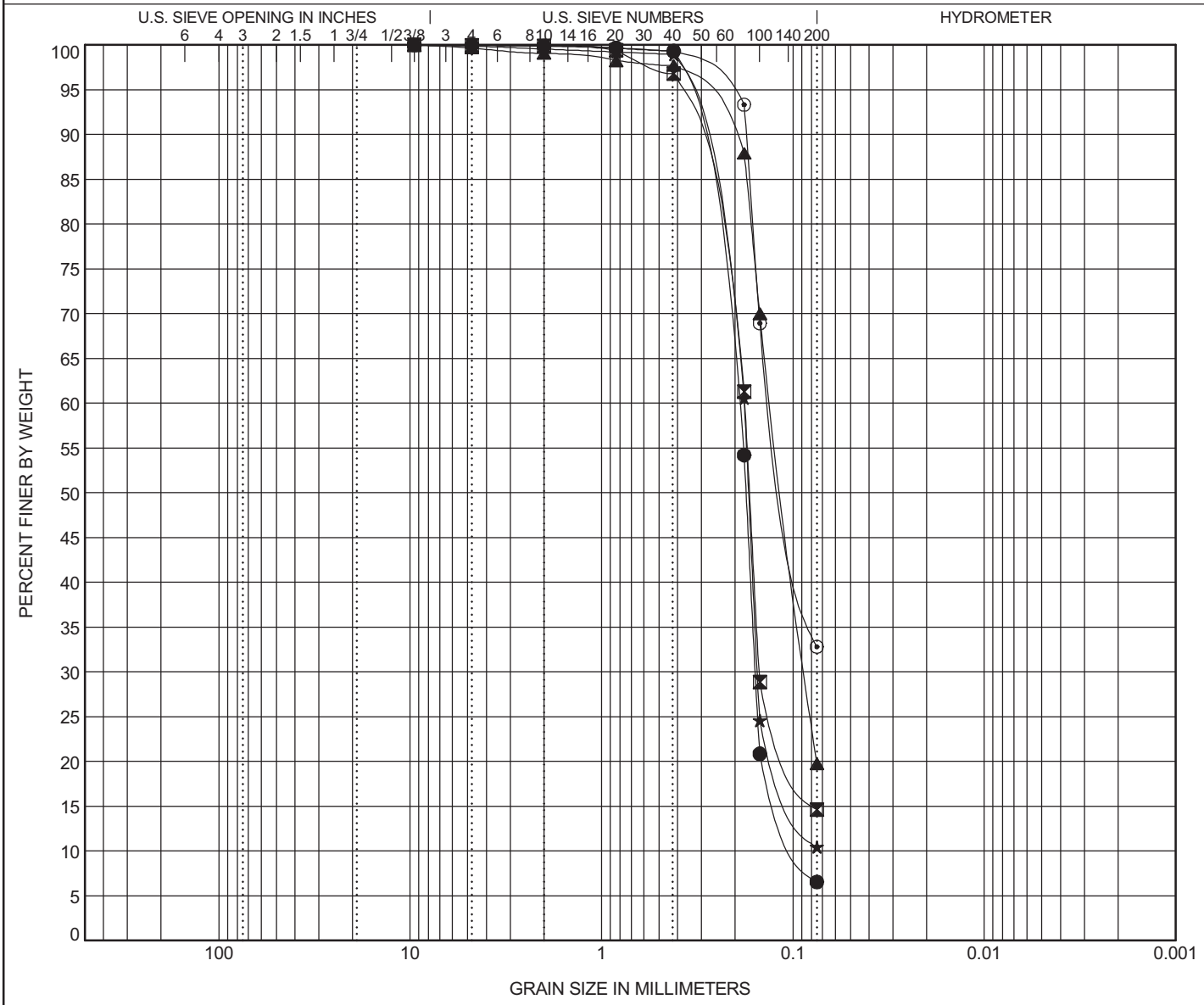
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-5	4.0	Poorly Graded Fine SAND (SP-SM) with Silt A-3	NP	NP	NP	1.39	2.27
⊠	B-5	8.0	Silty Fine SAND (SM) A-2-4	NP	NP	NP		
▲	B-5	15.0	Silty Fine SAND (SM) A-2-4	NP	NP	NP		
★	B-5	25.0	Poorly Graded Fine SAND (SP-SM) with Silt A-3	NP	NP	NP	1.79	2.45
⊙	B-5	35.0	Silty Fine SAND (SM) A-2-4	NP	NP	NP		

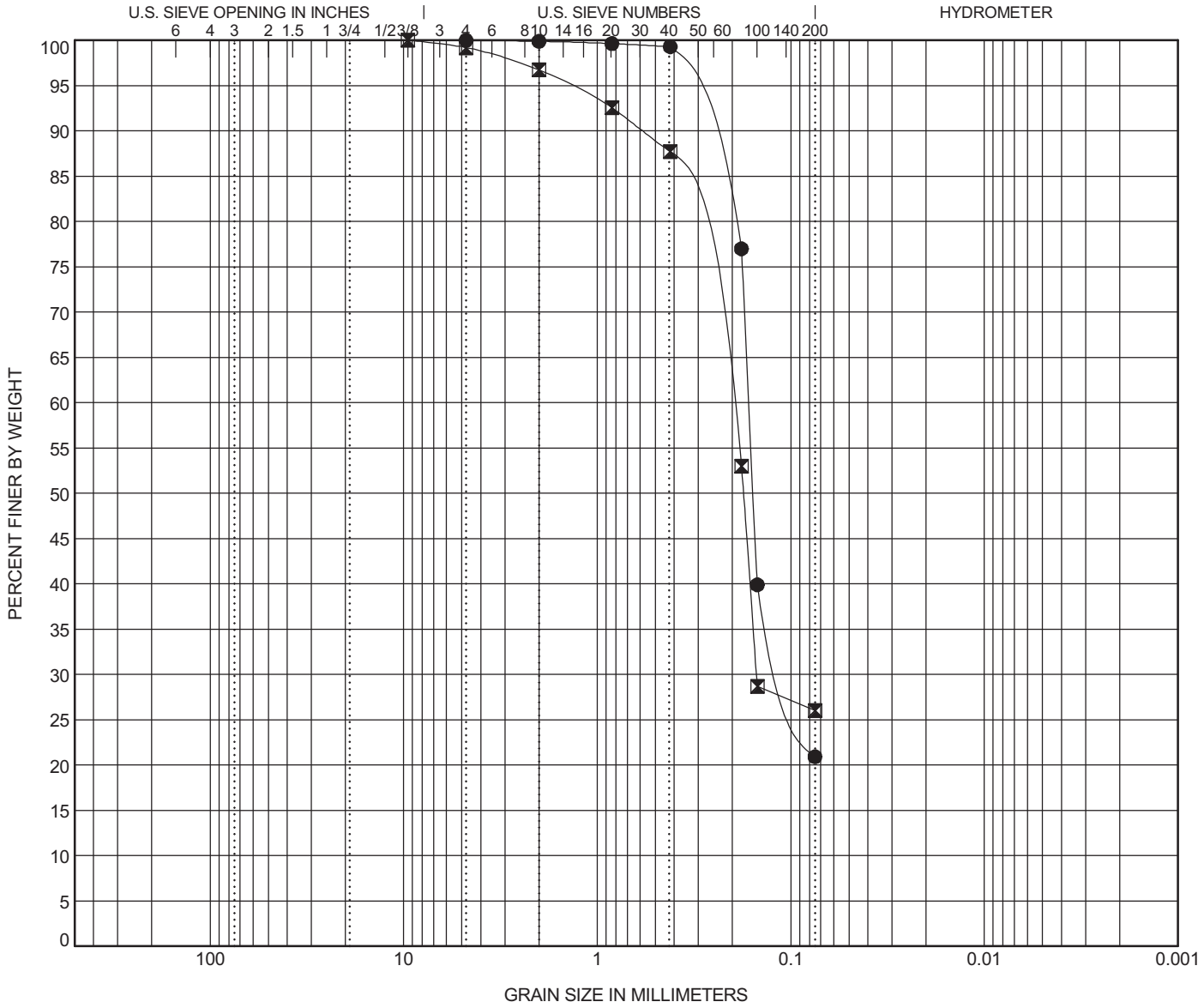
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	B-5	4.0	9.52	0.387	0.176	0.088	0.0	93.4	6.6	
⊠	B-5	8.0	9.52	0.402	0.169		0.0	85.3	14.6	
▲	B-5	15.0	9.52	0.332	0.113		0.3	79.9	19.7	
★	B-5	25.0	9.52	0.385	0.17		0.1	89.4	10.5	
⊙	B-5	35.0	4.76	0.227	0.104		0.0	67.2	32.8	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-5**	**45.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
⊠	**B-5**	**55.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		

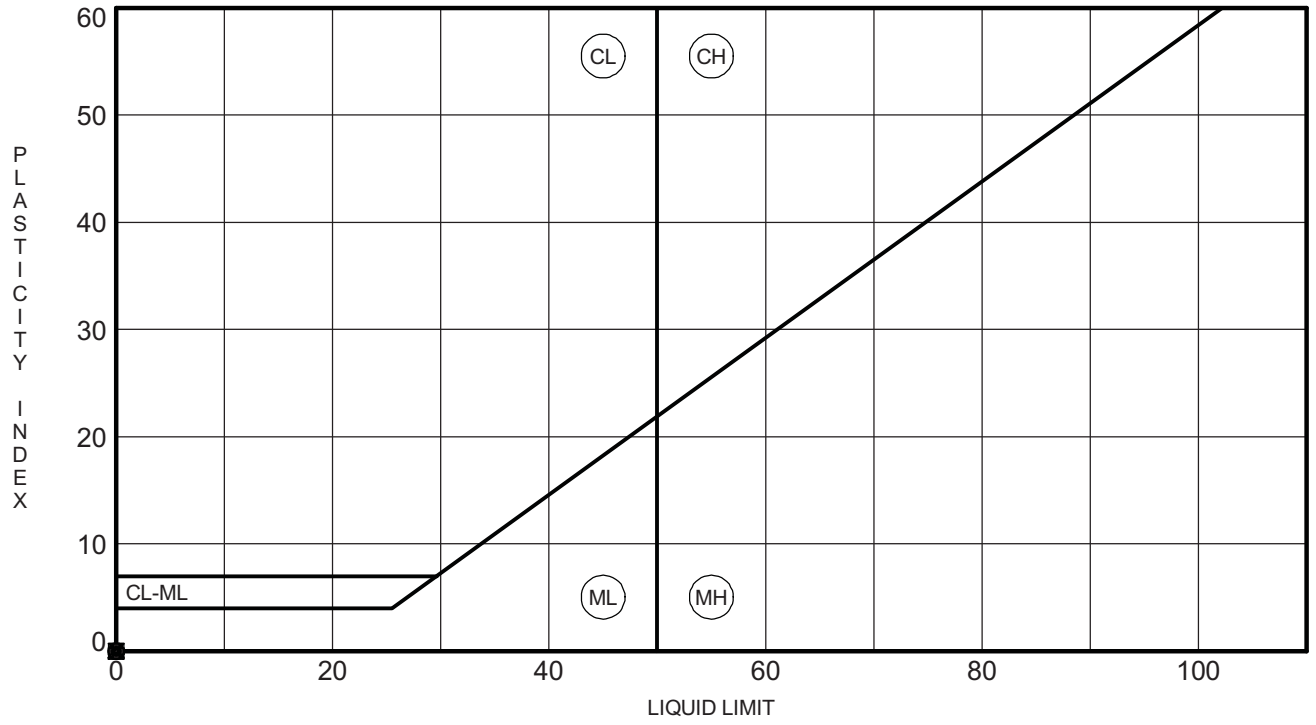
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-5**	**45.0**	**4.76**	**0.357**	**0.157**		**0.0**	**79.1**	**20.9**	
⊠	**B-5**	**55.0**	**9.52**	**1.393**	**0.176**		**0.8**	**73.2**	**26.0**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-5**	**4.0**	**NP**	**NP**	**NP**	**7**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**
⊠	**B-5**	**8.0**	**NP**	**NP**	**NP**	**15**	**Silty Fine SAND (SM) A-2-4**
▲	**B-5**	**15.0**	**NP**	**NP**	**NP**	**20**	**Silty Fine SAND (SM) A-2-4**
★	**B-5**	**25.0**	**NP**	**NP**	**NP**	**10**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**
⊙	**B-5**	**35.0**	**NP**	**NP**	**NP**	**33**	**Silty Fine SAND (SM) A-2-4**
✿	**B-5**	**45.0**	**NP**	**NP**	**NP**	**21**	**Silty Fine SAND (SM) A-2-4**
○	**B-5**	**55.0**	**NP**	**NP**	**NP**	**26**	**Silty Fine SAND (SM) A-2-4**

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

ORGANIC IMPURITIES DETERMINATION
(AASHTO T267)

PROJECT: US 21 Bridge Replacement over Harbor River **PROJECT NO.:** G5396.00

SAMPLE NUMBER: 15-1438G **DATE SAMPLE RECEIVED:**

DESCRIPTION OF SOIL:

TESTED BY: JH **DATE OF TESTING:** 10/13/2015

DATE OF WEIGHING: 10/14/2015

BORING NO.	B-5				
SAMPLE NO.	15-1438G				
SAMPLE DEPTH	8.0'-10.0'				
WT. OF CRUCIBLE + DRY SOIL (BEFORE IGNITION) (GRAMS)	169.97				
WT. OF CRUCIBLE + DRY SOIL (AFTER IGNITION) (GRAMS)	169.86				
WT. OF CRUCIBLE (GRAMS)	129.97				
WT. OF DRY SOIL (BEFORE IGNITION) (GRAMS)	40.00				
WT. OF DRY SOIL (AFTER IGNITION) (GRAMS)	39.89				
IGNITION LOSS (GRAMS)	0.11				
ORGANIC IMPURITIES %	0.27				

Determining pH of Soil for Use in Corrosion Testing
AASHTO T 289

PROJECT TITLE	F&ME/HARBOR RIVER/SC	SAMPLE ID	B-5 15-1438P
PROJECT NO.	1524908.09	SAMPLE TYPE	Bag
REMARKS	F&ME Project No. G5396	SAMPLE DEPTH	28.5 - 30.0'

SAMPLE PREPARATION

Sieved through the #10 Sieve	YES
Air Dry	YES
Type of Water	DISTILLED

Trial	pH	Temperature
1	8.20	20.1
2	8.19	20.2
3	8.21	20.2
AVERAGE	8.20	20.2

Description SILTY CLAY; olive brown.

USCS (CL)

TECH	TJ
DATE	10/13/15
CHECK	
REVIEW	
APPROVE	

Determining Minimum Laboratory Soil Resistivity
AASHTO T 288

PROJECT TITLE	F&ME/HARBOR RIVER/SC	SAMPLE ID	B-5 15-1438Q
PROJECT NO.	1524908.09	SAMPLE TYPE	Bag
REMARKS	F&ME Project No. G5396	SAMPLE DEPTH	28.5 - 30.0'

SAMPLE PREPARATION — Sieved through the #10 Sieve: Yes

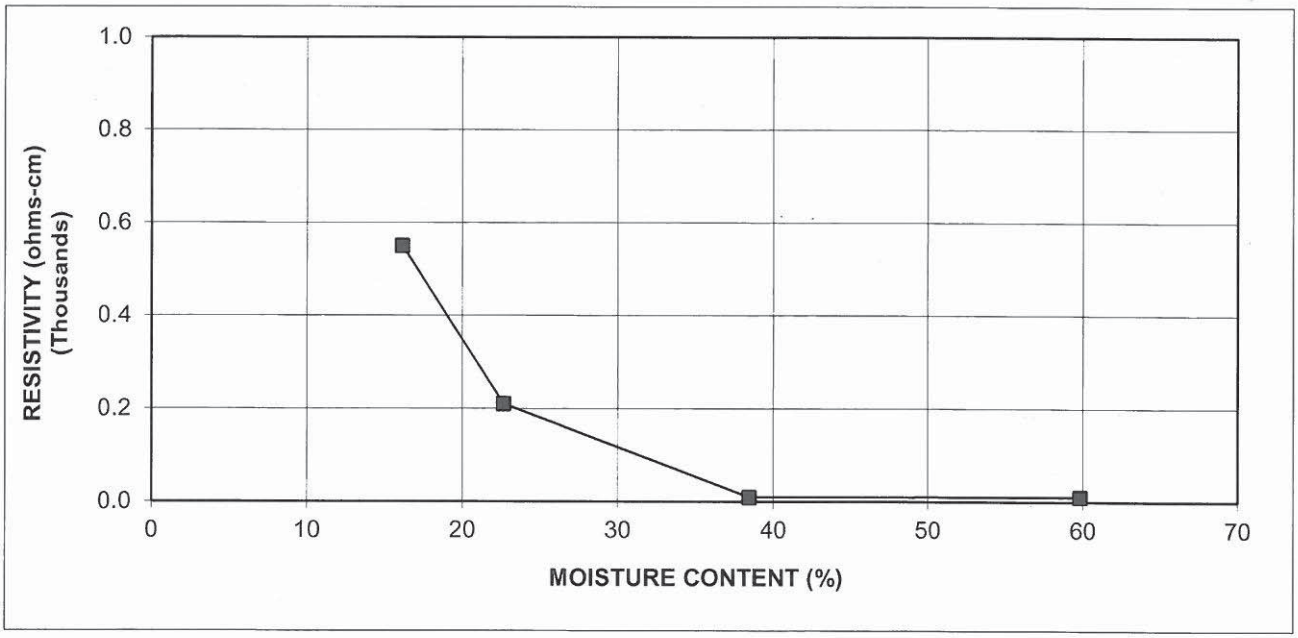
TEST APPARATUS — Miller Soilbox and Nilsson 400 Soil Resistance Meter.

Identification: Lowest resistivity

SPECIMEN (Point)	1	2	3	4
RESISTIVITY (ohms-cm)	550	210	9.5	10.0

MOISTURE CONTENT

WET WEIGHT & TARE	108.40	132.51	131.98	358.88
DRY WEIGHT & TARE	100.56	117.40	109.63	244.07
TARE WEIGHT	51.87	50.72	51.50	52.16
WEIGHT OF MOISTURE (gm)	7.84	15.11	22.35	114.81
WEIGHT OF DRY SOIL (gm)	48.69	66.68	58.13	191.91
MOISTURE CONTENT (%)	16.10	22.66	38.45	59.82



Description: SILTY CLAY; olive brown.

USCS: (CL)

TECH	TJ
DATE	10/13/15
CHECK	
REVIEW	
APPROVE	

ACL

ADVANCED CHEMISTRY LABS, INC.

Phone: (770) 409-1444
Fax: (770) 409-1844
e-mail: acl@acl-labs.net

3039 Amwiler Road • Suite 100 • Atlanta, GA 30360
P.O. Box 88610 • Atlanta, GA 30356
www.acl-labs.com

Client: Golder Associates, Inc.
3730 Chamblee Tucker Road
Atlanta, GA 30341-0000

Client Proj #: 1524908
ACL Project #: 68442
Date Received: 10/13/2015
Date Reported: 10/30/2015

Contact: Mr. Henry Mock

Sample ID: B-5 28.5-30'

Matrix: Soil

ACL #: 307837

Date/Time Sampled: 10/13/2015 11:15

Analyte (Method)	Result	PQL	Units	DF	Prep Date/Time	Analysis Date/Time	Analyst
Sol. Chloride (9252A)*	8360	500	mg/kg	50	10/16/2015 8:30	10/16/2015 8:30	MM
Sol. Sulfate (9038)*	488	200	mg/kg	20	10/19/2015 10:20	10/19/2015 10:20	MM

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396.00
SAMPLE NUMBER:	15-1439	**DATE SAMPLE RECEIVED:**	10/1/2015
DESCRIPTION OF SOIL:	Various		
TESTED BY:	MM	**DATE OF TESTING:**	10/1/2015
		DATE OF WEIGHING:	10/2/2015

BORING NO.	B-6	B-6	B-6	B-6	B-6
SAMPLE NO.	15-1439D	15-1439G	15-1439J	15-1439M	15-1439P
SAMPLE DEPTH	4.0-6.0'	8.0-10.0'	13.5-15.0'	23.5-25.0'	28.5-30.0'
WATER CONTENT, W%	28.4	24.6	34.8	24.8	28.8

BORING NO.	B-6				
SAMPLE NO.	15-1439S				
SAMPLE DEPTH	38.5-40.0'				
WATER CONTENT, W%	27.5				

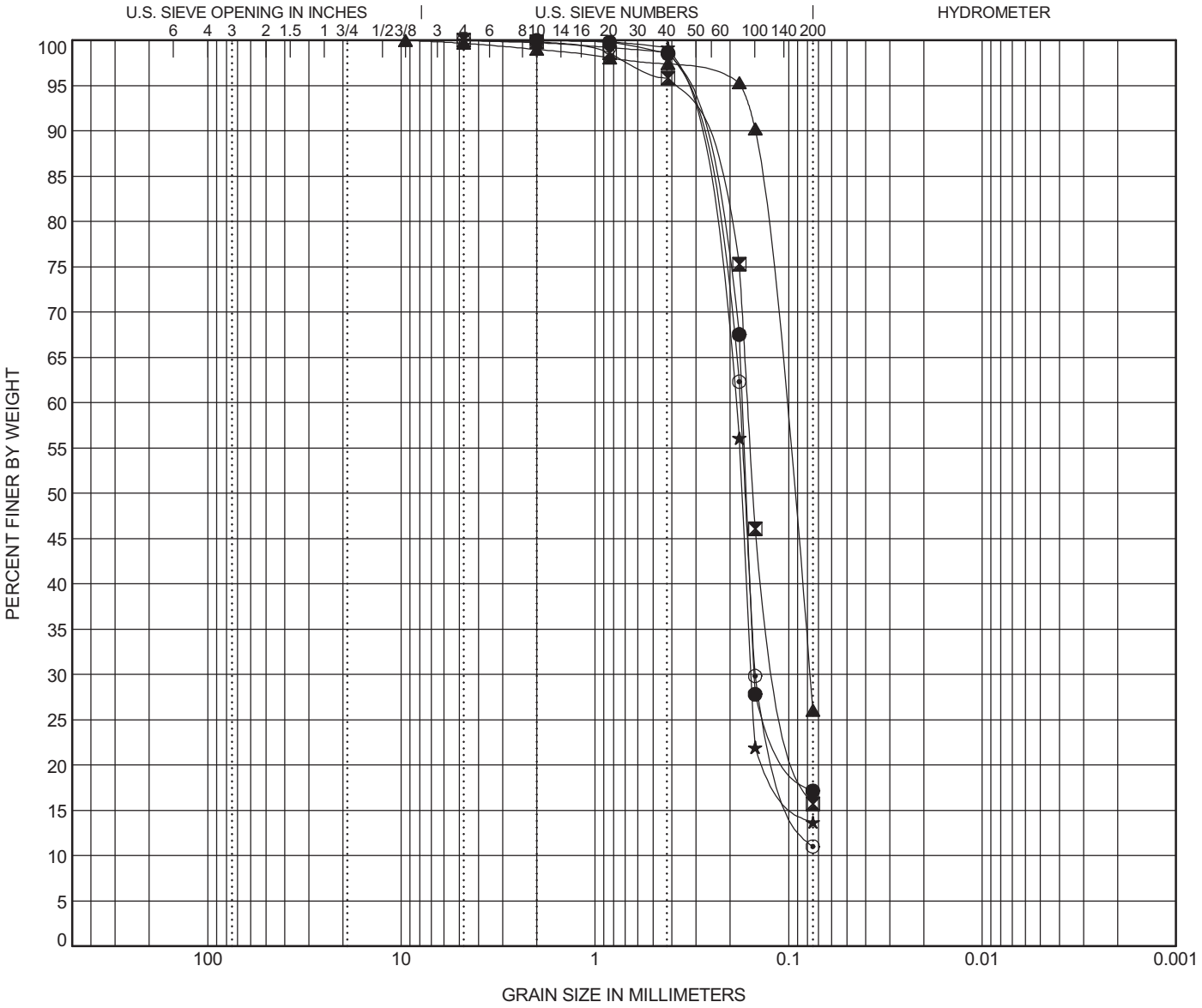
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

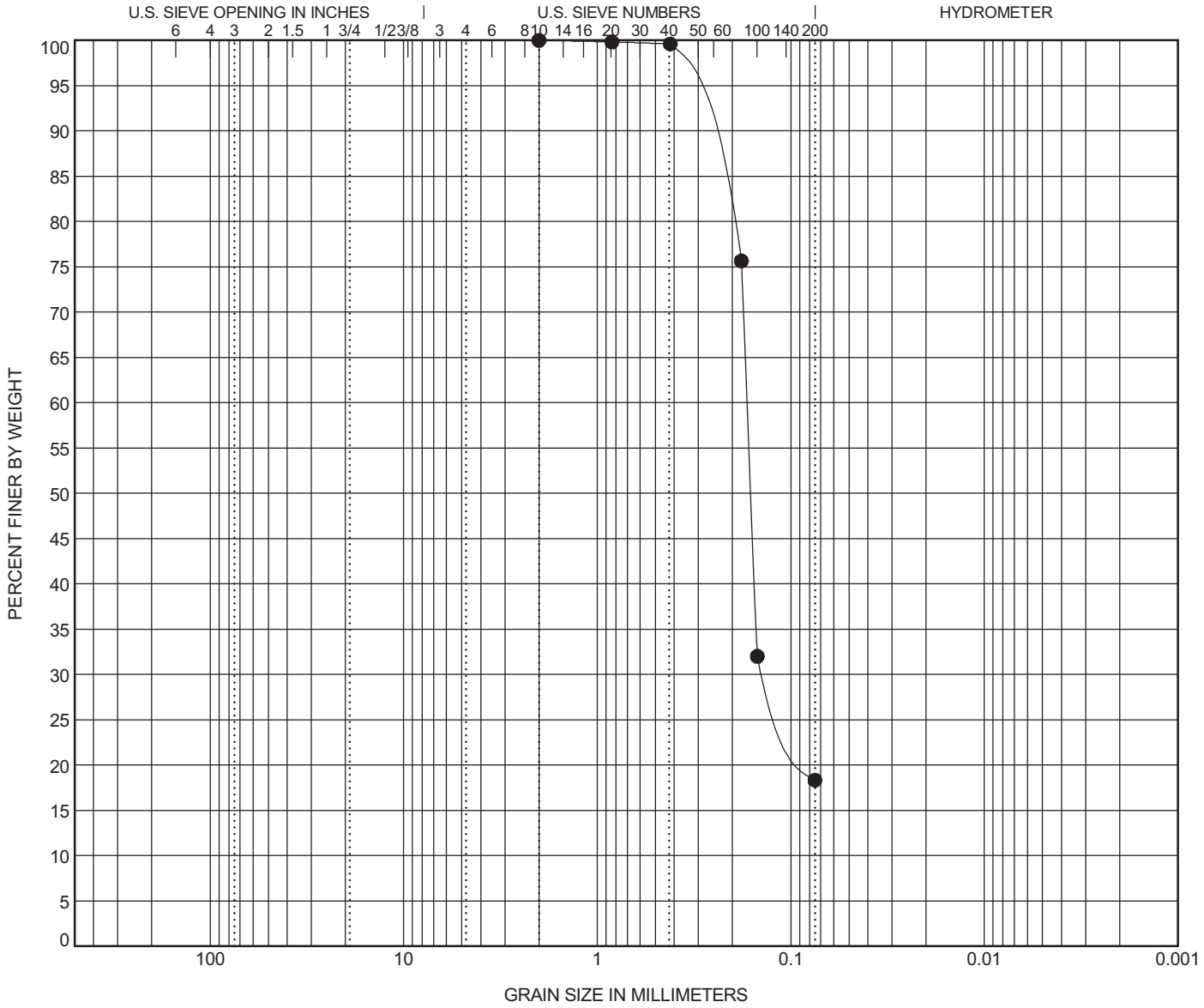
	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-6**	**6.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
⊠	**B-6**	**10.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
▲	**B-6**	**15.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
★	**B-6**	**25.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
⊙	**B-6**	**30.0**	**Poorly Graded Fine SAND (SP-SM) with Silt A-2-4**	**NP**	**NP**	**NP**	**1.73**	**2.46**

	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-6**	**6.0**	**2**	**0.381**	**0.166**		**0.0**	**82.8**	**17.2**	
⊠	**B-6**	**10.0**	**4.76**	**0.405**	**0.153**		**0.0**	**84.3**	**15.7**	
▲	**B-6**	**15.0**	**9.52**	**0.178**	**0.097**		**0.3**	**73.6**	**26.1**	
★	**B-6**	**25.0**	**4.76**	**0.387**	**0.174**		**0.0**	**86.3**	**13.7**	
⊙	**B-6**	**30.0**	**4.76**	**0.385**	**0.168**		**0.0**	**89.0**	**11.0**	

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● **B-6**	**40.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		

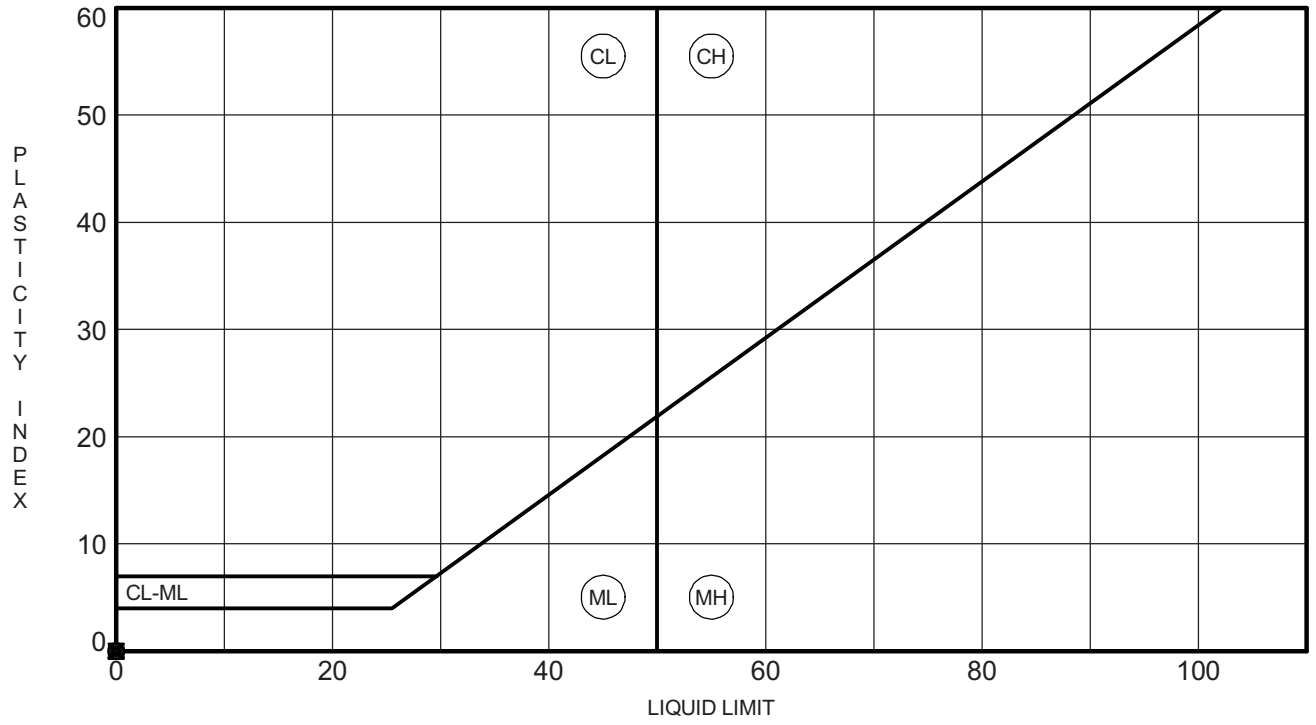
BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **B-6**	**40.0**	**2**	**0.357**	**0.161**		**0.0**	**81.7**	**18.3**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-6**	**6.0**	**NP**	**NP**	**NP**	**17**	**Silty Fine SAND (SM) A-2-4**
⊠	**B-6**	**10.0**	**NP**	**NP**	**NP**	**16**	**Silty Fine SAND (SM) A-2-4**
▲	**B-6**	**15.0**	**NP**	**NP**	**NP**	**26**	**Silty Fine SAND (SM) A-2-4**
★	**B-6**	**25.0**	**NP**	**NP**	**NP**	**14**	**Silty Fine SAND (SM) A-2-4**
⊙	**B-6**	**30.0**	**NP**	**NP**	**NP**	**11**	**Poorly Graded Fine SAND (SP-SM) with Silt A-2-4**
✿	**B-6**	**40.0**	**NP**	**NP**	**NP**	**18**	**Silty Fine SAND (SM) A-2-4**

ATTERBERG LIMITS G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

ORGANIC IMPURITIES DETERMINATION
(AASHTO T267)

PROJECT: US 21 Bridge Replacement over Harbor River **PROJECT NO.:** G5396.00

SAMPLE NUMBER: 15-1439A **DATE SAMPLE RECEIVED:**

DESCRIPTION OF SOIL:

TESTED BY: JH **DATE OF TESTING:** 10/13/2015

DATE OF WEIGHING: 10/14/2015

BORING NO.	B-6				
SAMPLE NO.	15-1439A				
SAMPLE DEPTH	2.0'-4.0'				
WT. OF CRUCIBLE + DRY SOIL (BEFORE IGNITION) (GRAMS)	150.80				
WT. OF CRUCIBLE + DRY SOIL (AFTER IGNITION) (GRAMS)	150.59				
WT. OF CRUCIBLE (GRAMS)	110.80				
WT. OF DRY SOIL (BEFORE IGNITION) (GRAMS)	40.00				
WT. OF DRY SOIL (AFTER IGNITION) (GRAMS)	39.79				
IGNITION LOSS (GRAMS)	0.21				
ORGANIC IMPURITIES %	0.53				

Determining pH of Soil for Use in Corrosion Testing
AASHTO T 289

PROJECT TITLE	F&ME/HARBOR RIVER/SC	SAMPLE ID	B-6 15-1439V
PROJECT NO.	1524908.09	SAMPLE TYPE	Bag
REMARKS	F&ME Project No. G5396	SAMPLE DEPTH	58.5 - 60.0'

SAMPLE PREPARATION

Sieved through the #10 Sieve	YES
Air Dry	YES
Type of Water	DISTILLED

Trial	pH	Temperature
1	7.66	20.1
2	7.67	20.1
3	7.64	20.1
AVERAGE	7.66	20.1

Description	SILTY CLAY; grayish brown.
USCS	(CL)

TECH	TJ
DATE	10/13/15
CHECK	
REVIEW	
APPROVE	

Determining Minimum Laboratory Soil Resistivity
AASHTO T 288

PROJECT TITLE	F&ME/HARBOR RIVER/SC	SAMPLE ID	B-6	15-1439W
PROJECT NO.	1524908.09	SAMPLE TYPE	Bag	
REMARKS	F&ME Project No. G5396	SAMPLE DEPTH	58.5 - 60.0'	

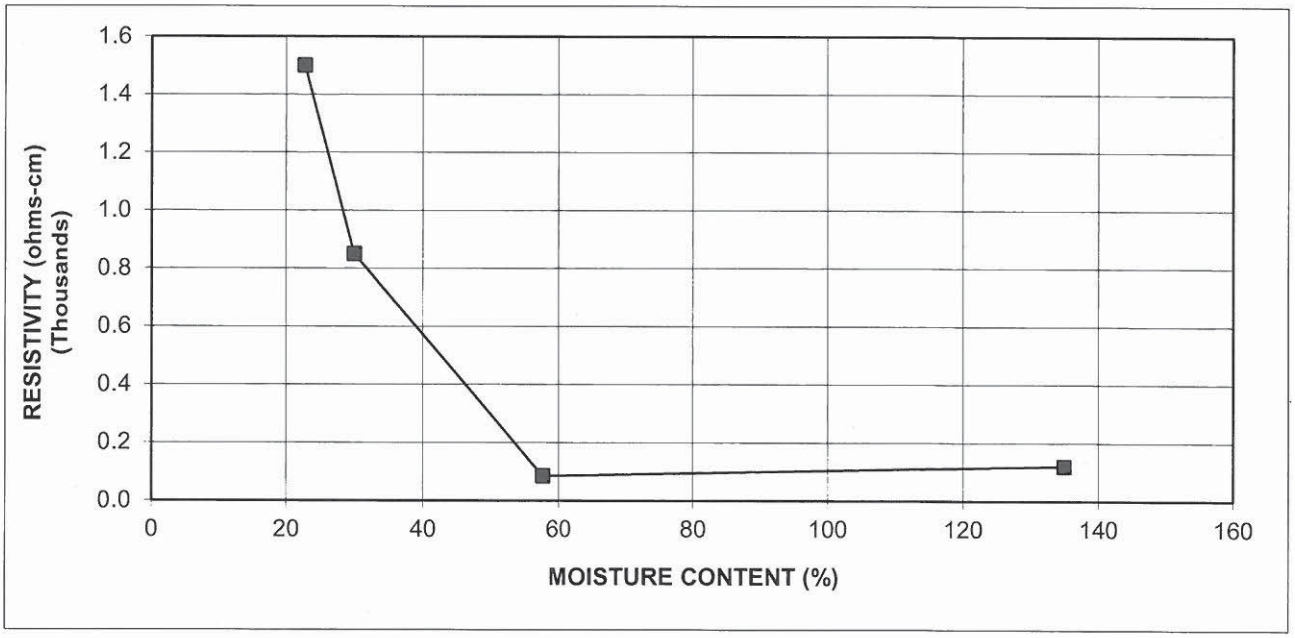
SAMPLE PREPARATION — Sieved through the #10 Sieve: Yes
TEST APPARATUS — Miller Soilbox and Nilsson 400 Soil Resistance Meter.

Identification: Lowest resistivity

SPECIMEN (Point)	1	2	3	4
RESISTIVITY (ohms-cm)	1,500	850	85	120

MOISTURE CONTENT

WET WEIGHT & TARE	110.92	145.08	179.10	321.03
DRY WEIGHT & TARE	99.29	121.54	132.64	166.52
TARE WEIGHT	48.19	43.00	52.04	52.01
WEIGHT OF MOISTURE (gm)	11.63	23.54	46.46	154.51
WEIGHT OF DRY SOIL (gm)	51.10	78.54	80.60	114.51
MOISTURE CONTENT (%)	22.76	29.97	57.64	134.93



Description: SILTY CLAY; grayish brown.

USCS: (CL)

TECH	TJ
DATE	10/13/15
CHECK	
REVIEW	
APPROVE	

ACL

ADVANCED CHEMISTRY LABS, INC.

Phone: (770) 409-1444
Fax: (770) 409-1844
e-mail: acl@acl-labs.net

3039 Amwiler Road • Suite 100 • Atlanta, GA 30360
P.O. Box 88610 • Atlanta, GA 30356
www.acl-labs.com

Client: Golder Associates, Inc.
3730 Chamblee Tucker Road
Atlanta, GA 30341-0000

Client Proj #: 1524908
ACL Project #: 68442
Date Received: 10/13/2015
Date Reported: 10/30/2015

Contact: Mr. Henry Mock

Sample ID: B-6 58.5-60'

Matrix: Soil

ACL #: 307838

Date/Time Sampled: 10/13/2015 11:15

Analyte (Method)	Result	PQL	Units	DF	Prep Date/Time	Analysis Date/Time	Analyst
Sol. Chloride (9252A)*	16000	1000	mg/kg	100	10/16/2015 8:30	10/16/2015 8:30	MM
Sol. Sulfate (9038)*	763	200	mg/kg	20	10/19/2015 10:20	10/19/2015 10:20	MM

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1197	**DATE SAMPLE RECEIVED:**	7/21/2016
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MB	**DATE OF TESTING:**	7/25/2016
		DATE OF WEIGHING:	7/26/2016

BORING NO.	B-7	B-7	B-7	B-7	B-7
SAMPLE NO.	16-1197C	16-1197F	16-1197I	16-1197L	16-1197O
SAMPLE DEPTH	4.0-6.0'	8.0-10.0'	13.5-15.0'	18.5-20.0'	43.5-45.0'
WATER CONTENT, W%	24.2	33.1	31.3	24.2	38.0

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

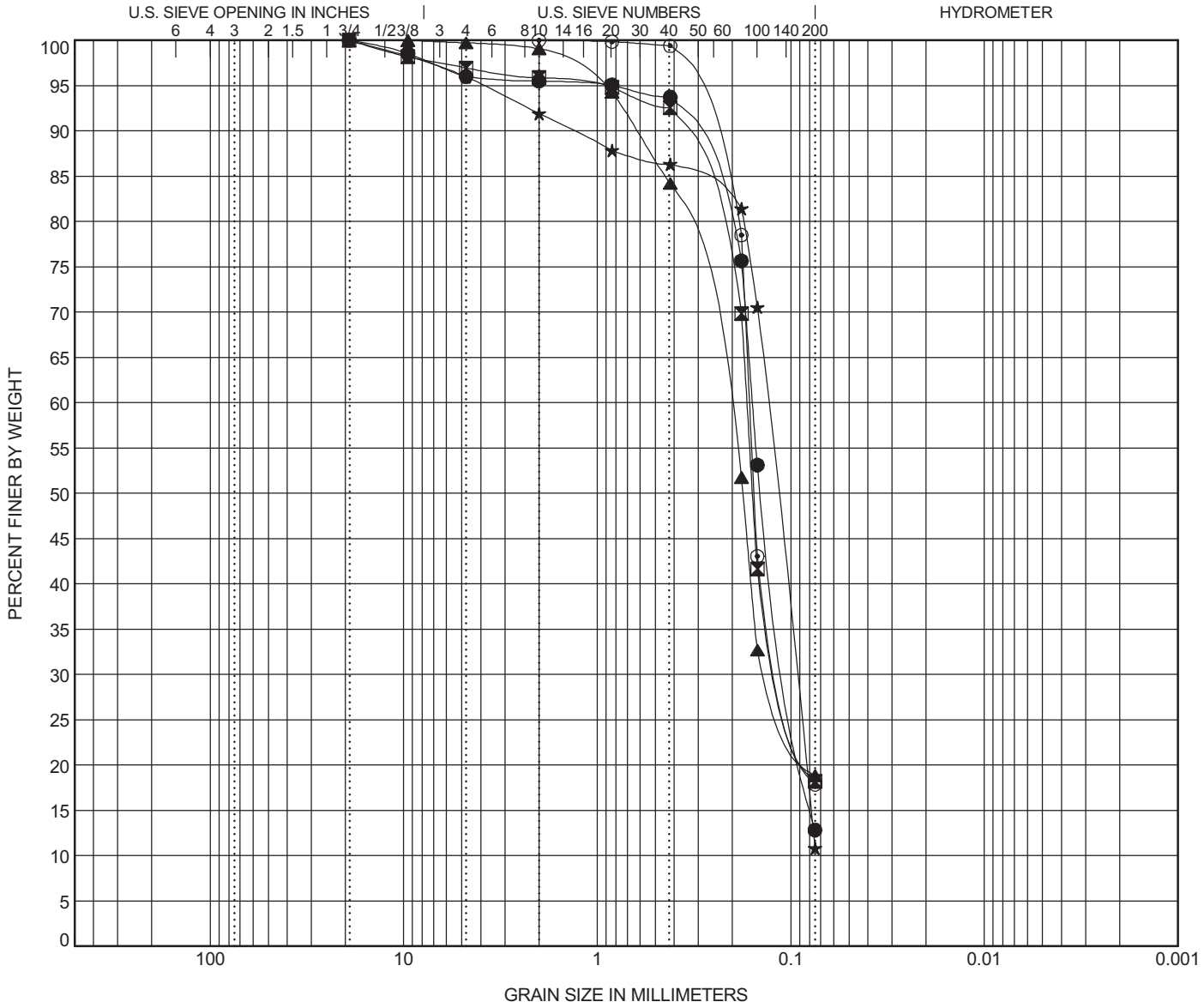
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-7	6.0	Silty Fine SAND (SM) A-2-4	NP	NP	NP		
⊠	B-7	10.0	Silty Fine SAND (SM) A-2-4	NP	NP	NP		
▲	B-7	15.0	Silty F/M SAND (SM) A-2-4	NP	NP	NP		
★	B-7	20.0	Poorly Graded F/C SAND (SP-SM) with Silt A-2-4	NP	NP	NP	0.89	1.78
⊙	B-7	45.0	Silty Fine SAND (SM) A-2-4	NP	NP	NP		

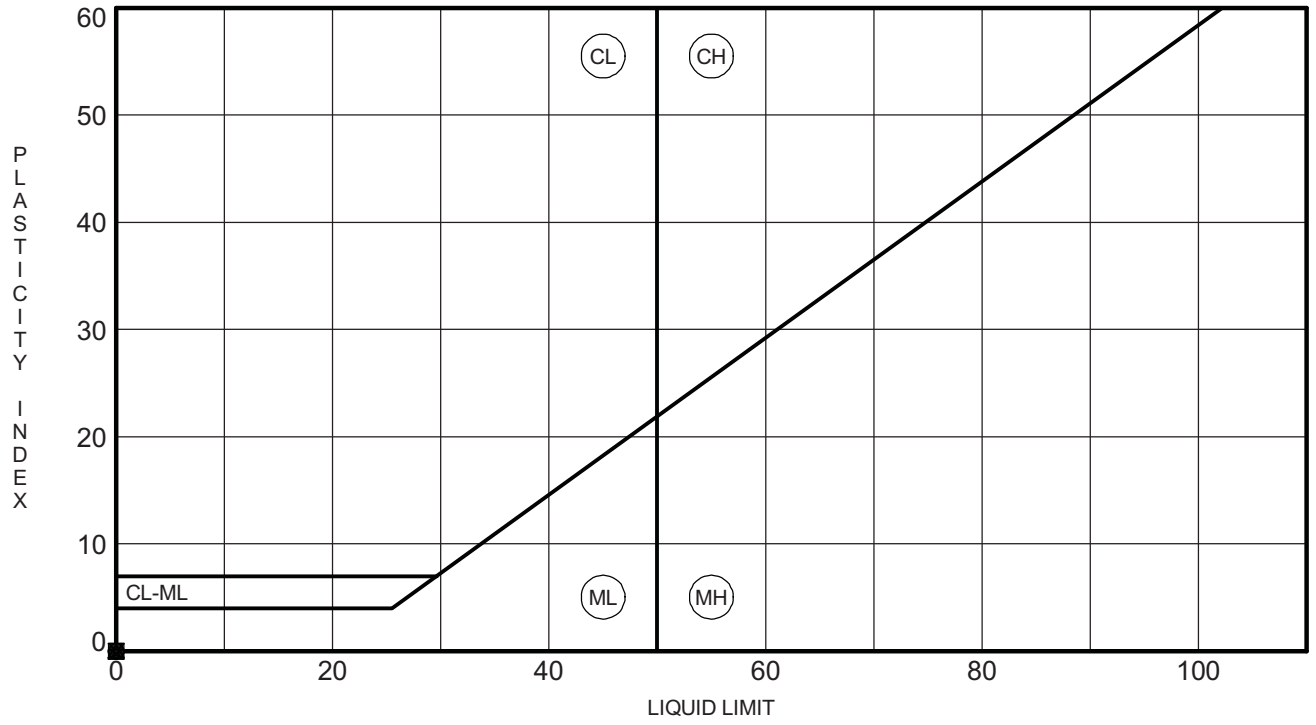
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	B-7	6.0	19.1	0.801	0.141		4.0	83.2	12.8	
⊠	B-7	10.0	19.1	0.954	0.158		3.0	78.8	18.2	
▲	B-7	15.0	9.52	0.957	0.177		0.3	80.9	18.9	
★	B-7	20.0	19.1	3.859	0.118		4.0	85.1	10.8	
⊙	B-7	45.0	2	0.351	0.155		0.0	82.1	17.9	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-7**	**6.0**	**NP**	**NP**	**NP**	**13**	**Silty Fine SAND (SM) A-2-4**
⊠	**B-7**	**10.0**	**NP**	**NP**	**NP**	**18**	**Silty Fine SAND (SM) A-2-4**
▲	**B-7**	**15.0**	**NP**	**NP**	**NP**	**19**	**Silty F/M SAND (SM) A-2-4**
★	**B-7**	**20.0**	**NP**	**NP**	**NP**	**11**	**Poorly Graded F/C SAND (SP-SM) with Silt A-2-4**
⊙	**B-7**	**45.0**	**NP**	**NP**	**NP**	**18**	**Silty Fine SAND (SM) A-2-4**

Client:	FME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	08/23/16
Tested By:	jbr
Checked By:	jdt

Rapid Determination of Carbonate Content of Soils by ASTM D4373

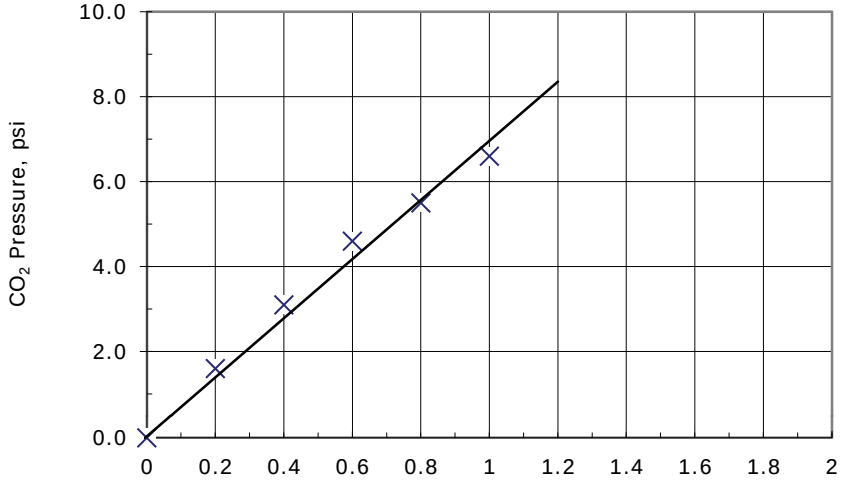
Boring ID	Sample ID	Depth, ft	*CO_2 Pressure, psi	Weight of Sample used, g	Weight $CaCO_3$, grams	Calcite Equivalent, %
B-7	16-1197P	28.5-30	0.20	2.00	0.08	8

Notes: Calcium Carbonate content precise to +/- 1.5%

*CO_2 Pressure is based on the weight of sample as indicated in the table.

The reported Calcite Equivalent (%) is based on one gram

Figure 1: Calibration Curve



Weight Calcium Carbonate, g

% Calcite Equivalent = Weight x 100

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1242	**DATE SAMPLE RECEIVED:**	7/29/2016
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	JH	**DATE OF TESTING:**	8/1/2016
		DATE OF WEIGHING:	8/2/2016

BORING NO.	B-8	B-8	B-8	B-8	B-8
SAMPLE NO.	16-1242C	16-1242S	16-1242F	16-1242I	16-1242M
SAMPLE DEPTH	4.0-6.0'	18.5-20.0'	23.5-25.0'	28.5-30.0'	43.5-45.0'
WATER CONTENT, W%	24.0	73.8	54.5	38.8	27.3

BORING NO.	B-8				
SAMPLE NO.	16-1242P				
SAMPLE DEPTH	48.5-50.0'				
WATER CONTENT, W%	37.1				

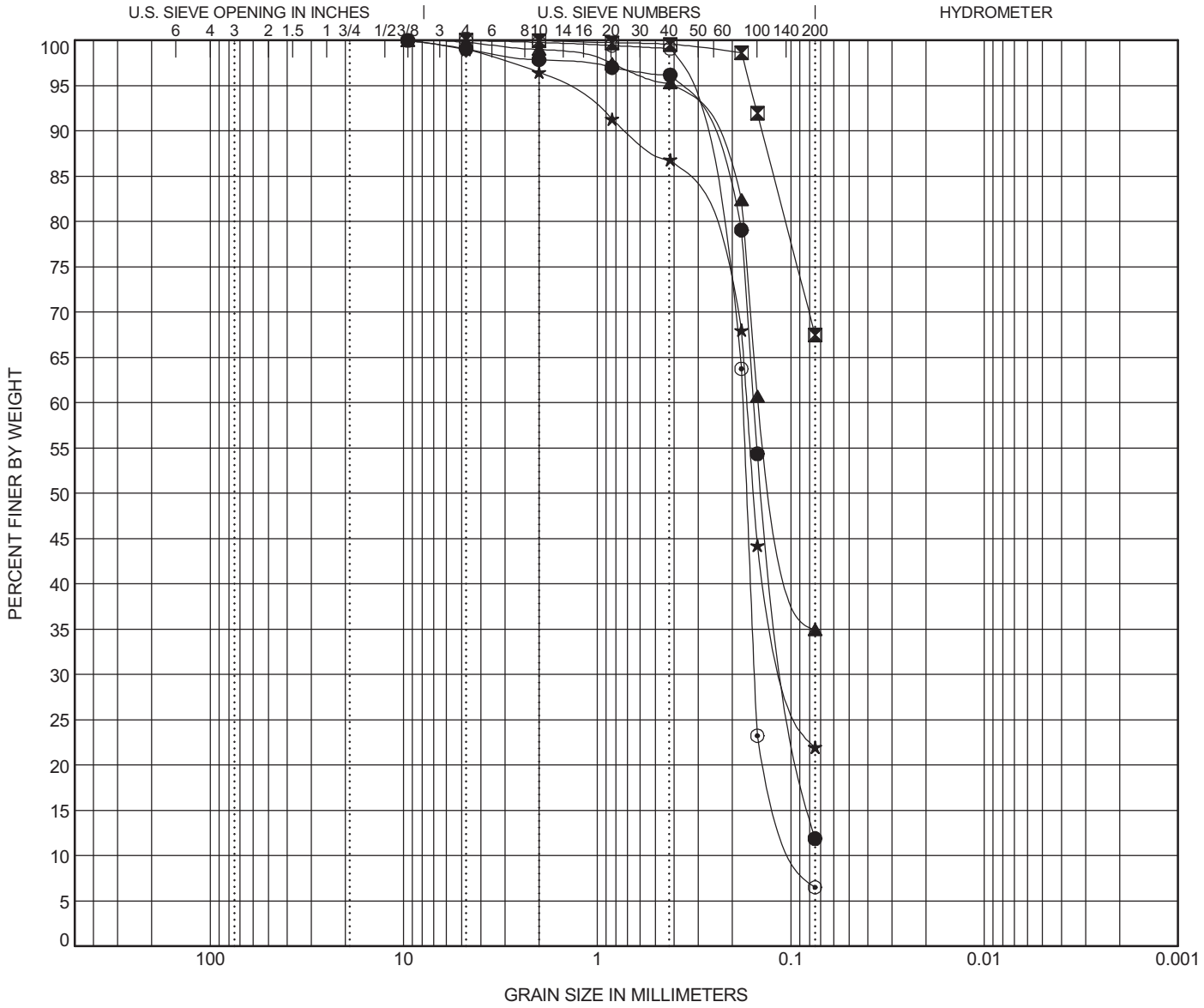
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

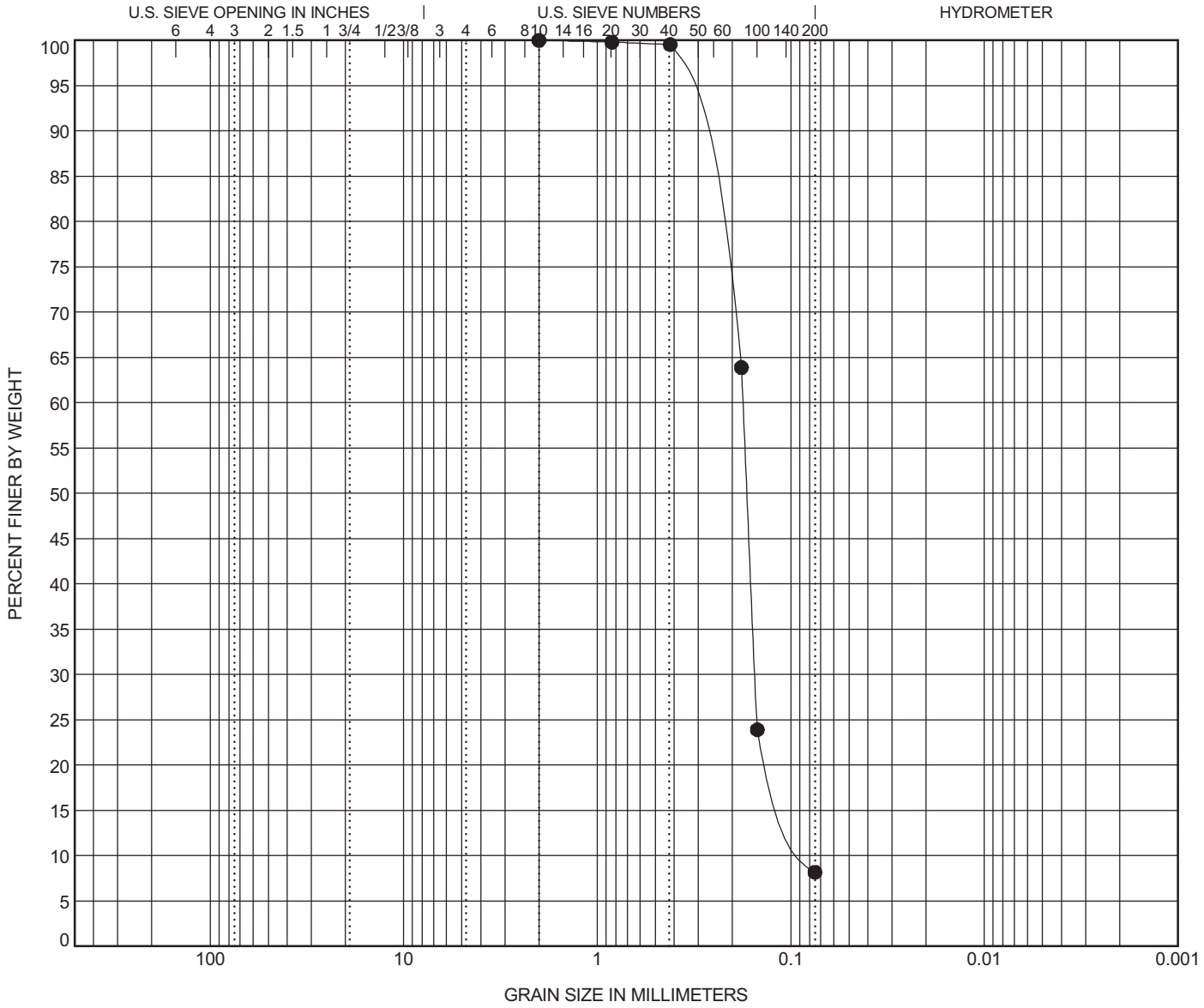
	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-8	6.0	Poorly Graded F/M SAND (SP-SM) with Silt A-2-4	NP	NP	NP	0.89	2.14
⊠	B-8	20.0	Sandy Lean CLAY (CL) A-6(8)	34	20	14		
▲	B-8	25.0	Clayey F/M SAND (SC) A-2-6(0)	30	19	11		
★	B-8	30.0	Silty F/M SAND (SM) A-2-4	NP	NP	NP		
⊙	B-8	45.0	Poorly Graded F/M SAND (SP-SM) with Silt A-3	NP	NP	NP	1.54	2.04

	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	B-8	6.0	9.52	0.396	0.139		1.0	87.2	11.9	
⊠	B-8	20.0	4.76	0.162			0.0	32.5	67.5	
▲	B-8	25.0	9.52	0.412	0.112		0.2	64.8	34.9	
★	B-8	30.0	9.52	1.559	0.156		1.0	77.0	22.0	
⊙	B-8	45.0	4.76	0.381	0.169	0.087	0.0	93.5	6.5	

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-8**	**50.0**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**1.64**	**2.18**

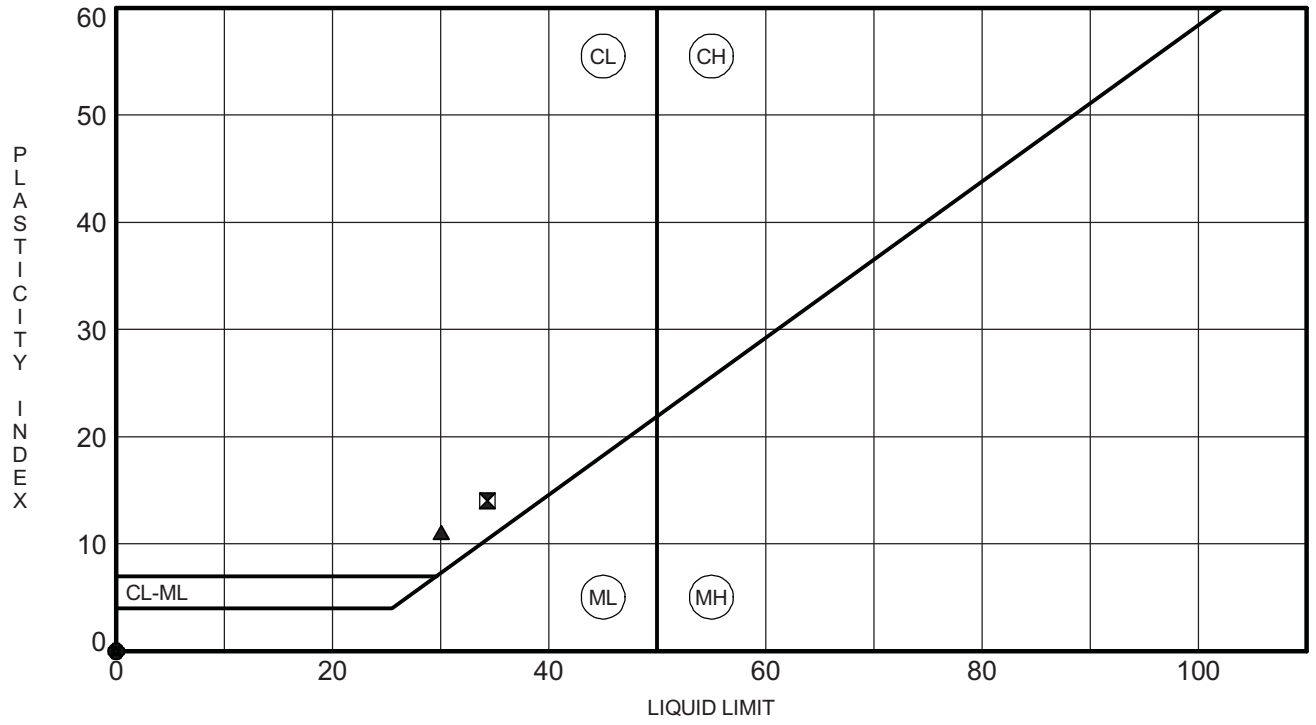
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-8**	**50.0**	**2**	**0.377**	**0.169**	**0.081**	**0.0**	**91.8**	**8.2**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-8**	**6.0**	**NP**	**NP**	**NP**	**12**	**Poorly Graded F/M SAND (SP-SM) with Silt A-2-4**
⊠	**B-8**	**20.0**	**34**	**20**	**14**	**68**	**Sandy Lean CLAY (CL) A-6(8)**
▲	**B-8**	**25.0**	**30**	**19**	**11**	**35**	**Clayey F/M SAND (SC) A-2-6(0)**
★	**B-8**	**30.0**	**NP**	**NP**	**NP**	**22**	**Silty F/M SAND (SM) A-2-4**
⊙	**B-8**	**45.0**	**NP**	**NP**	**NP**	**7**	**Poorly Graded F/M SAND (SP-SM) with Silt A-3**
✿	**B-8**	**50.0**	**NP**	**NP**	**NP**	**8**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**

ATTERBERG LIMITS G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

Client:	FME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	08/23/16
Tested By:	jbr
Checked By:	jdt

Rapid Determination of Carbonate Content of Soils by ASTM D4373

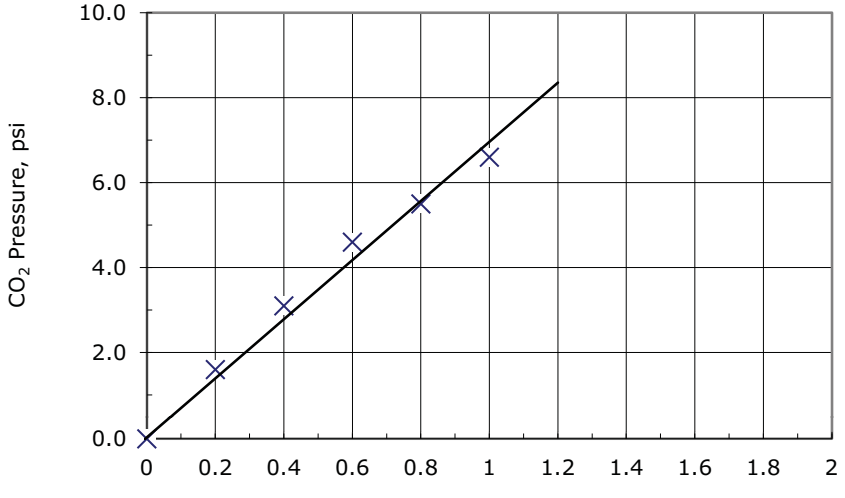
Boring ID	Sample ID	Depth, ft	*CO_2 Pressure, psi	Weight of Sample used, g	Weight $CaCO_3$, grams	Calcite Equivalent, %
B-8	16-1242J	33.5-35	0.20	1.00	0.16	16

Notes: Calcium Carbonate content precise to +/- 1.5%

*CO_2 Pressure is based on the weight of sample as indicated in the table.

The reported Calcite Equivalent (%) is based on one gram

Figure 1: Calibration Curve



% Calcite Equivalent = Weight x 100

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1243	**DATE SAMPLE RECEIVED:**	7/29/2016
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MB	**DATE OF TESTING:**	8/1/2016
		DATE OF WEIGHING:	8/2/2016

BORING NO.	B-9	B-9	B-9	B-9	B-9
SAMPLE NO.	16-1243F	16-1243I	16-1243L	16-1243C	16-1243P
SAMPLE DEPTH	2.0-4.0'	4.0-6.0'	8.0-10.0'	28.5-30.0'	43.5-45.0'
WATER CONTENT, W%	22.6	21.9	25.6	88.5	25.6

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

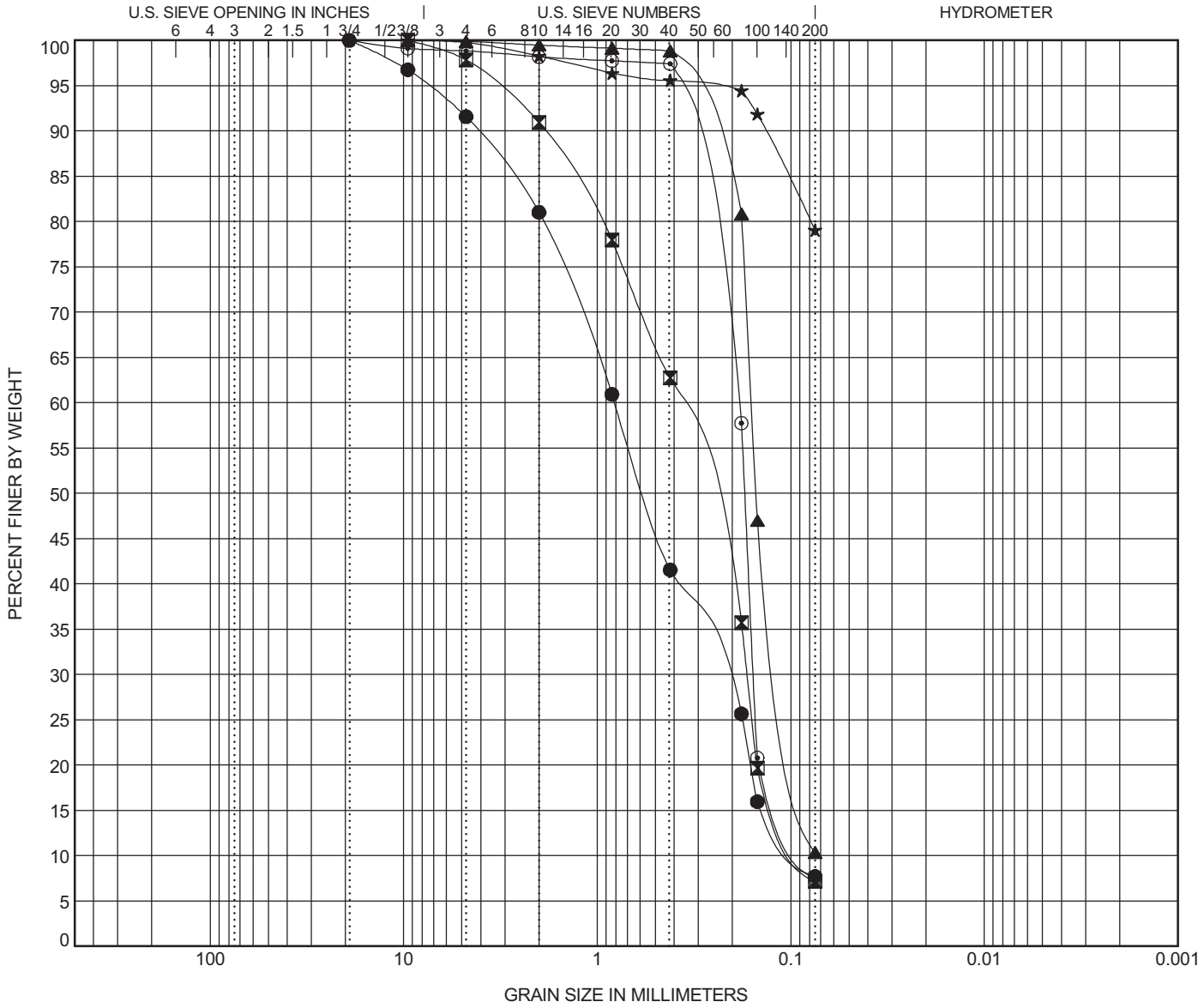
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-9**	**4.0**	**Poorly Graded F/C SAND (SP-SM) with Silt A-1-b**	**NP**	**NP**	**NP**	**0.70**	**8.97**
⊠	**B-9**	**6.0**	**Poorly Graded F/C SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**0.84**	**4.40**
▲	**B-9**	**10.0**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**0.98**	**2.15**
★	**B-9**	**30.0**	**Fat CLAY with Fine Sand (CH) A-7-5(24)**	**58**	**30**	**28**		
⊙	**B-9**	**45.0**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**1.51**	**2.21**

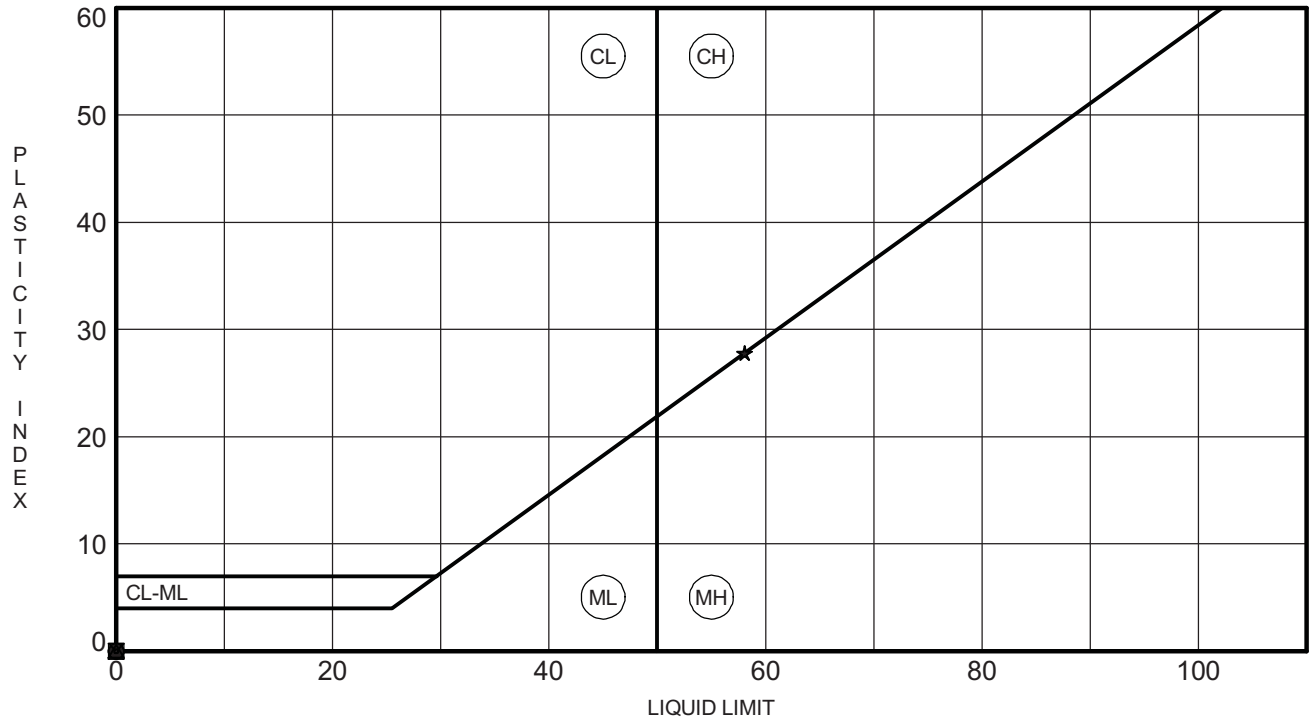
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-9**	**4.0**	**19.1**	**7.521**	**0.568**	**0.091**	**8.4**	**83.8**	**7.7**	
⊠	**B-9**	**6.0**	**9.52**	**3.326**	**0.282**	**0.088**	**2.2**	**90.7**	**7.2**	
▲	**B-9**	**10.0**	**9.52**	**0.35**	**0.152**		**0.1**	**89.6**	**10.3**	
★	**B-9**	**30.0**	**9.52**	**0.27**			**0.2**	**20.7**	**79.1**	
⊙	**B-9**	**45.0**	**19.1**	**0.399**	**0.173**	**0.085**	**1.2**	**91.4**	**7.5**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-9**	**4.0**	**NP**	**NP**	**NP**	**8**	**Poorly Graded F/C SAND (SP-SM) with Silt A-1-b**
⊠	**B-9**	**6.0**	**NP**	**NP**	**NP**	**7**	**Poorly Graded F/C SAND (SP-SM) with Silt A-3**
▲	**B-9**	**10.0**	**NP**	**NP**	**NP**	**10**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**
★	**B-9**	**30.0**	**58**	**30**	**28**	**79**	**Fat CLAY with Fine Sand (CH) A-7-5(24)**
⊙	**B-9**	**45.0**	**NP**	**NP**	**NP**	**7**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**

ATTERBERG LIMITS G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

Client:	FME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	08/23/16
Tested By:	jbr
Checked By:	jdt

Rapid Determination of Carbonate Content of Soils by ASTM D4373

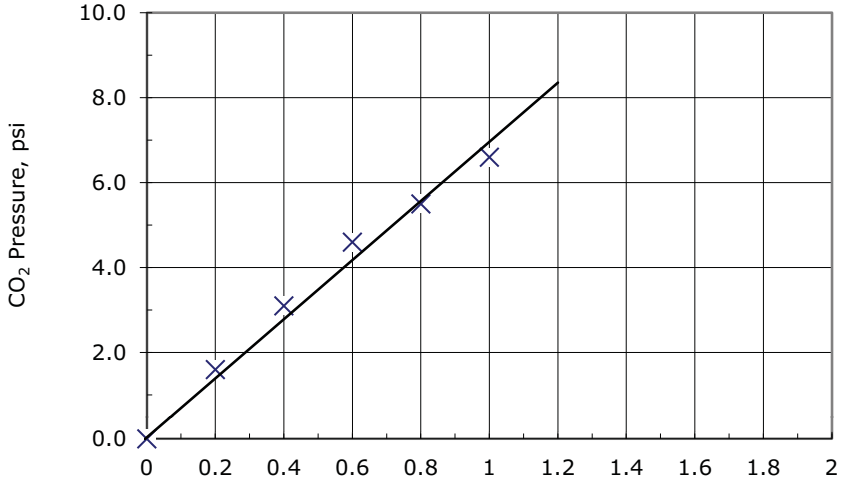
Boring ID	Sample ID	Depth, ft	*CO_2 Pressure, psi	Weight of Sample used, g	Weight $CaCO_3$, grams	Calcite Equivalent, %
B-9	16-1243M	13.5-15	0.30	5.00	0.05	5

Notes: Calcium Carbonate content precise to +/- 1.5%

*CO_2 Pressure is based on the weight of sample as indicated in the table.

The reported Calcite Equivalent (%) is based on one gram

Figure 1: Calibration Curve



% Calcite Equivalent = Weight x 100

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1110	**DATE SAMPLE RECEIVED:**	7/5/2016
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MB	**DATE OF TESTING:**	7/12/2016
		DATE OF WEIGHING:	7/13/2016

BORING NO.	B-10	B-10	B-10	B-10	B-10
SAMPLE NO.	16-1110C	16-1110F	16-1110I	16-1110L	16-1110O
SAMPLE DEPTH	3.5-5.5'	7.5-9.5'	25.0-26.5'	46.0-47.5'	56.5-58.0'
WATER CONTENT, W%	50.0	24.1	58.3	21.9	58.1

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

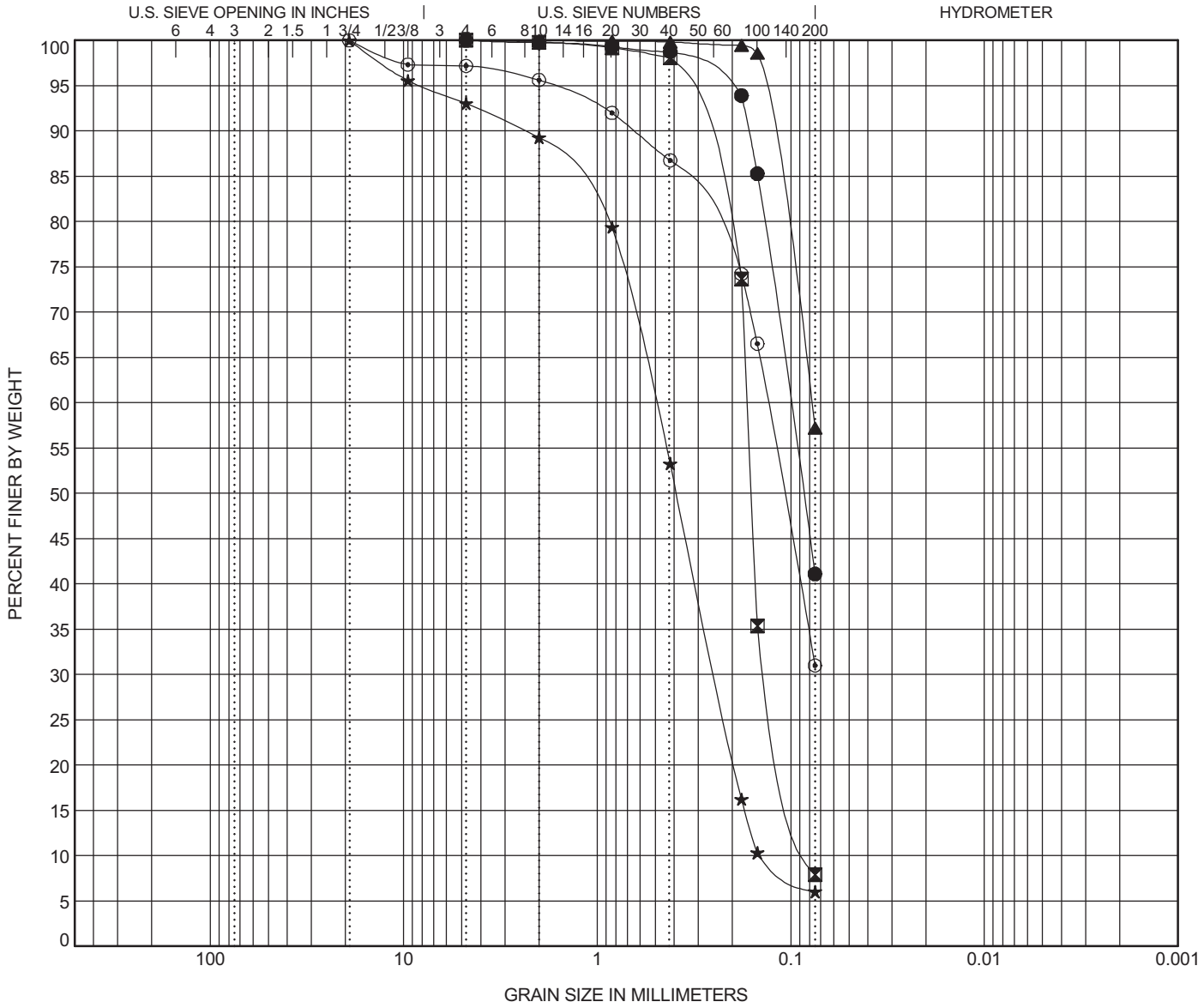
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-10**	**5.5**	**Clayey Fine SAND (SC) A-4(1)**	**26**	**17**	**9**		
⊠	**B-10**	**9.5**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**1.28**	**2.13**
▲	**B-10**	**26.5**	**Sandy SILT (ML) A-4(2)**	**33**	**26**	**7**		
★	**B-10**	**47.5**	**Poorly Graded F/C SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**0.86**	**3.56**
⊙	**B-10**	**58.0**	**Silty F/M SAND (SM) A-2-6(0)**	**39**	**27**	**12**		

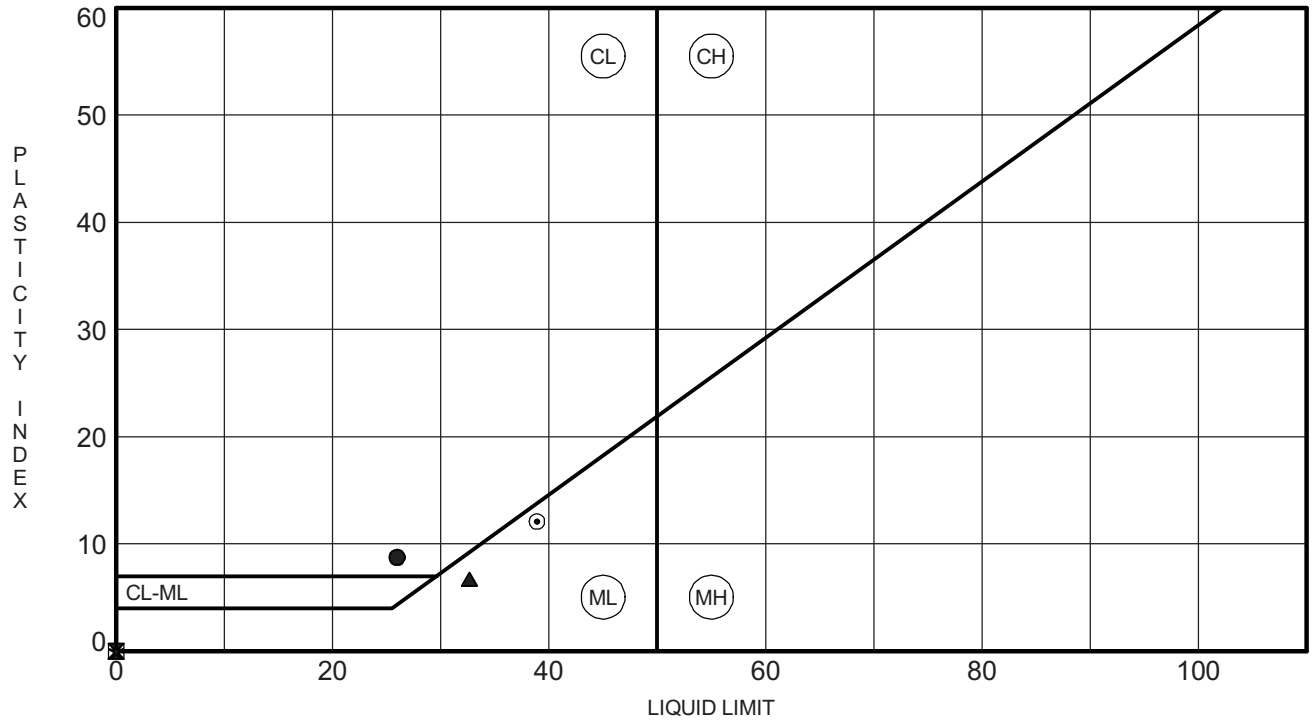
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-10**	**5.5**	**4.76**	**0.217**	**0.086**		**0.0**	**58.9**	**41.1**	
⊠	**B-10**	**9.5**	**4.76**	**0.377**	**0.16**	**0.079**	**0.0**	**92.1**	**7.9**	
▲	**B-10**	**26.5**	**2**	**0.14**			**0.0**	**42.8**	**57.2**	
★	**B-10**	**47.5**	**19.1**	**8.124**	**0.39**	**0.141**	**7.0**	**87.0**	**6.0**	
⊙	**B-10**	**58.0**	**19.1**	**1.721**	**0.108**		**2.8**	**66.2**	**31.0**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-10**	**5.5**	**26**	**17**	**9**	**41**	**Clayey Fine SAND (SC) A-4(1)**
⊠	**B-10**	**9.5**	**NP**	**NP**	**NP**	**8**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**
▲	**B-10**	**26.5**	**33**	**26**	**7**	**57**	**Sandy SILT (ML) A-4(2)**
★	**B-10**	**47.5**	**NP**	**NP**	**NP**	**6**	**Poorly Graded F/C SAND (SP-SM) with Silt A-3**
⊙	**B-10**	**58.0**	**39**	**27**	**12**	**31**	**Silty F/M SAND (SM) A-2-6(0)**

ATTERBERG LIMITS G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	---	Sample Type:	---	Tested By:	GA
Sample ID:	---	Test Date:	08/09/16	Checked By:	mcm
Depth :	---	Test Id:	386279		

pH of Soil by ASTM D4972

Boring ID	Sample ID	Depth	Visual Description	pH of Soil in Distilled Water	pH of Soil in Calcium Chloride
B-10	---	30.5-32 ft	Moist, dark gray silty sand	7.1	6.8

Notes: Sample Preparation: screened through #10 sieve

Method A, pH meter used

Client:	F&ME Consultants
Project:	US-21 Replacement Bridge over Harbor River
Location:	---
GTX#:	305005
Test Date:	08/09/16
Tested By:	jm
Checked By:	mcm

Laboratory Measurement of Soil Resistivity Using the Wenner Four-Electrode Method by ASTM G57 (Laboratory Measurement)

Boring ID	Sample ID	Depth, ft.	Sample Description	Electrical Resistivity, ohm-cm	Electrical Conductivity, $(ohm\text{-}cm)^{-1}$
B-10	---	30.5-32	Moist, dark gray silty sand	62	1.61E-02

Notes: Test Equipment: Nilsson Model 400 Soil Resistance Meter, MC Miller Soil Box
Water added to sample to create a thick slurry prior to testing (saturated condition).
Electrical Conductivity is calculated as inverse of Electrical Resistivity (per ASTM G57)
Test conducted in standard laboratory atmosphere: 68-73 F

Project Name: US-21 REP. BRIDGE OVER HARBOR
Project Number: 305005
Lab Number: L1623916
Report Date: 08/08/16

SAMPLE RESULTS

Lab ID: L1623916-01
Client ID: B-10 / 30.5-32.0 FT
Sample Location: Not Specified
Matrix: Soil
Date Collected: 08/01/16 11:51
Date Received: 08/02/16
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	56.7		%	0.100	NA	1	-	08/03/16 02:46	121,2540G	VB
Chloride	8400		mg/kg	170	--	10	-	08/05/16 18:53	1,9251	
Sulfate	2400		mg/kg	880	--	5	-	08/04/16 11:30	1,9038	AW

Client:	FME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	08/23/16
Tested By:	jbr
Checked By:	jdt

Rapid Determination of Carbonate Content of Soils by ASTM D4373

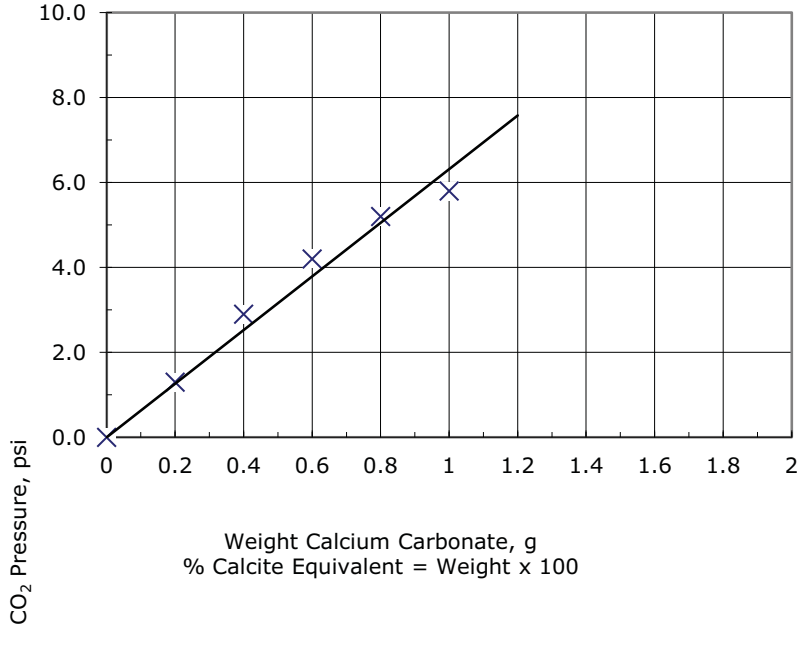
Boring ID	Sample ID	Depth, ft	*CO_2 Pressure, psi	Weight of Sample used, g	Weight $CaCO_3$, grams	Calcite Equivalent, %
B-10	---	86.5-88	5.60	1.00	4.60	460

Notes: Calcium Carbonate content precise to +/- 1.5%

*CO_2 Pressure is based on the weight of sample as indicated in the table.

The reported Calcite Equivalent (%) is based on one gram

Figure 1: Calibration Curve



F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1111	**DATE SAMPLE RECEIVED:**	7/5/2016
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MB	**DATE OF TESTING:**	7/12/2016
		DATE OF WEIGHING:	7/13/2016

BORING NO.	B-11	B-11	B-11	B-11	B-11
SAMPLE NO.	16-1111C	16-1111F	16-1111I	16-1111L	16-1111O
SAMPLE DEPTH	26.0-28.0'	28.0.-30.0'	30.0-32.0'	36.5-38.0'	83.0-84.5'
WATER CONTENT, W%	33.7	57.6	30.5	93.7	45.3

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

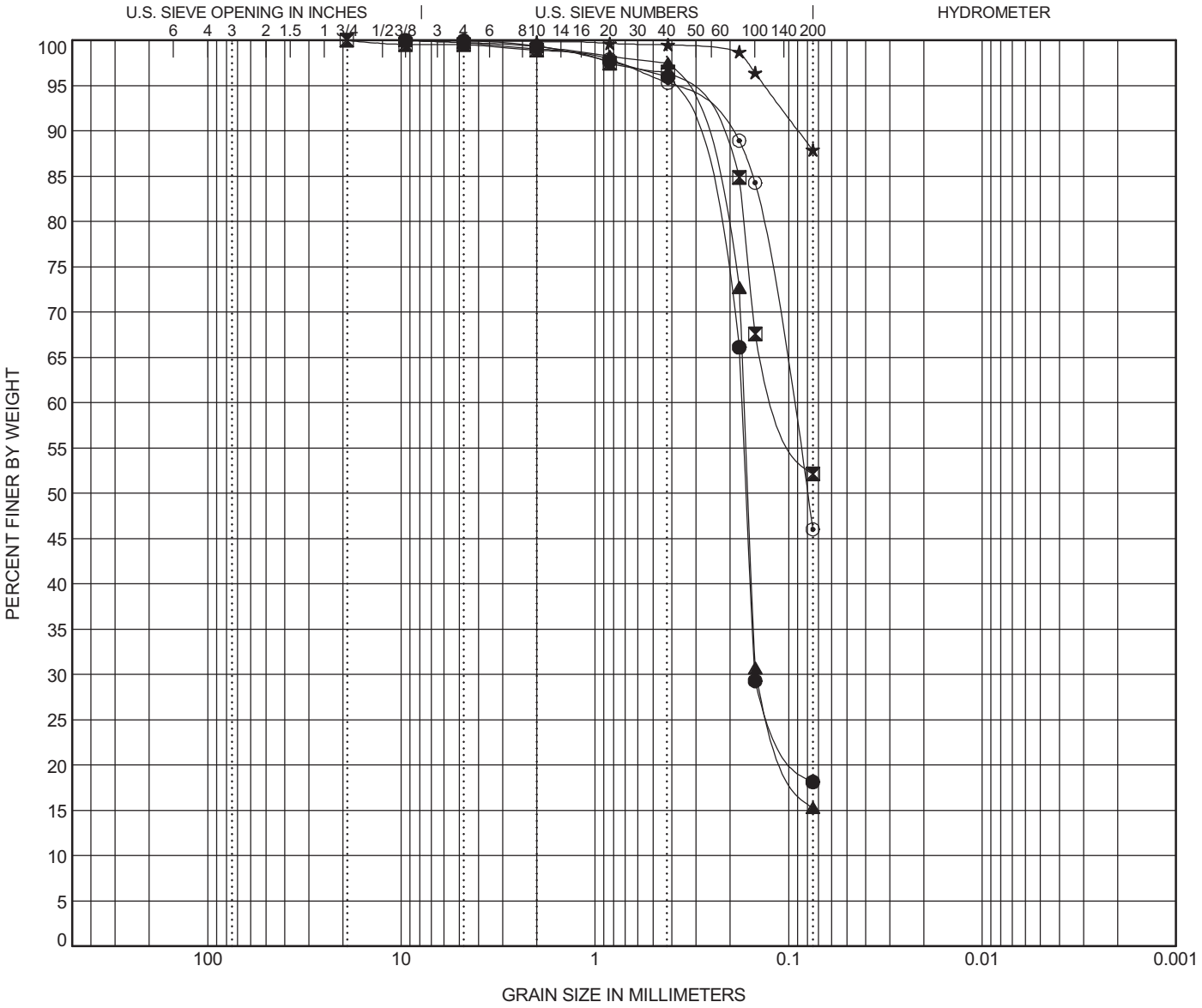
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-11**	**28.0**	**Silty Fine SAND (SM) A-2-4**	**22**	**NP**	**NP**		
⊠	**B-11**	**30.0**	**Sandy Lean CLAY (CL) A-4(2)**	**26**	**17**	**9**		
▲	**B-11**	**32.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
★	**B-11**	**38.0**	**Elastic SILT (MH) A-7-5(25)**	**58**	**35**	**23**		
⊙	**B-11**	**84.5**	**Silty Fine SAND (SM) A-4(0)**	**31**	**NP**	**NP**		

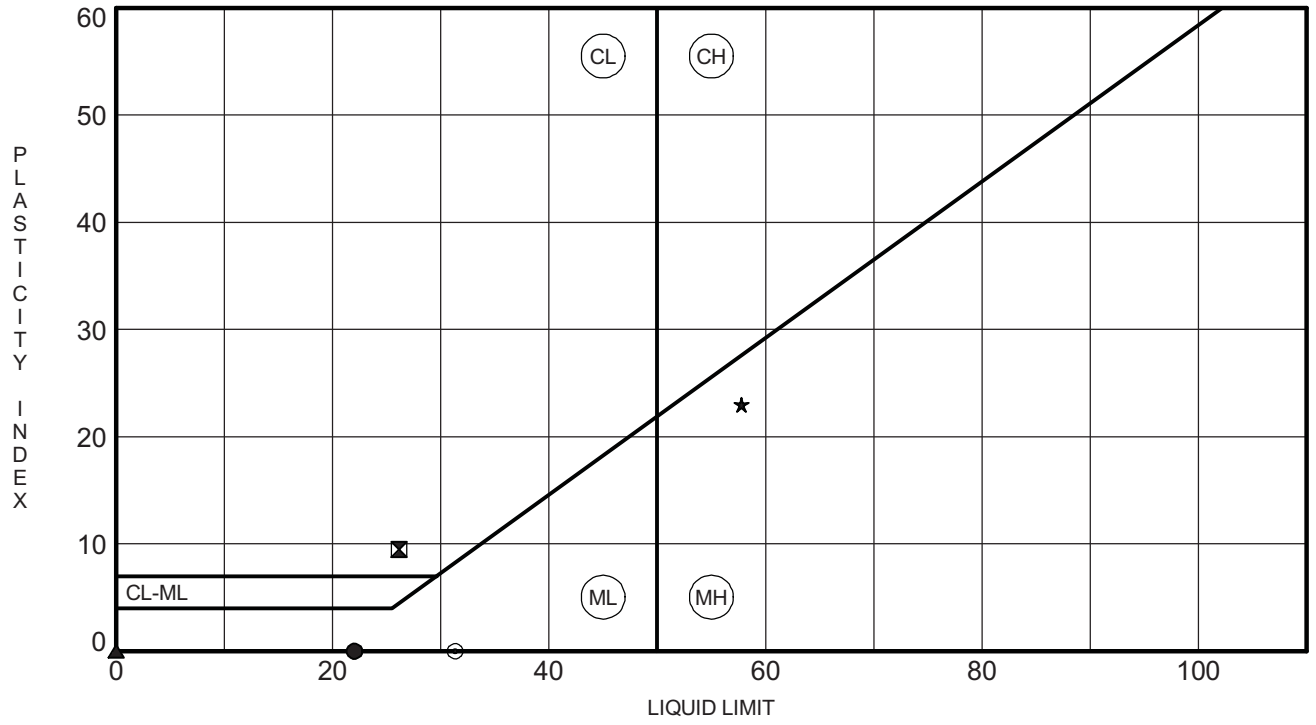
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-11**	**28.0**	**9.52**	**0.409**	**0.166**		**0.0**	**81.8**	**18.1**	
⊠	**B-11**	**30.0**	**19.1**	**0.376**			**0.5**	**47.4**	**52.1**	
▲	**B-11**	**32.0**	**9.52**	**0.386**	**0.162**		**0.2**	**84.5**	**15.3**	
★	**B-11**	**38.0**	**9.52**	**0.133**			**0.0**	**12.1**	**87.9**	
⊙	**B-11**	**84.5**	**9.52**	**0.402**	**0.081**		**0.3**	**53.7**	**46.0**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-11**	**28.0**	**22**	**NP**	**NP**	**18**	**Silty Fine SAND (SM) A-2-4**
⊠	**B-11**	**30.0**	**26**	**17**	**9**	**52**	**Sandy Lean CLAY (CL) A-4(2)**
▲	**B-11**	**32.0**	**NP**	**NP**	**NP**	**15**	**Silty Fine SAND (SM) A-2-4**
★	**B-11**	**38.0**	**58**	**35**	**23**	**88**	**Elastic SILT (MH) A-7-5(25)**
⊙	**B-11**	**84.5**	**31**	**NP**	**NP**	**46**	**Silty Fine SAND (SM) A-4(0)**

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	---	Sample Type:	---	Tested By:	GA
Sample ID:	---	Test Date:	08/09/16	Checked By:	mcm
Depth :	---	Test Id:	386279		

pH of Soil by ASTM D4972

Boring ID	Sample ID	Depth	Visual Description	pH of Soil in Distilled Water	pH of Soil in Calcium Chloride
B-11	---	92.5-94 ft	Moist, dark olive clay with sand	7.0	6.8

Notes: Sample Preparation: screened through #10 sieve

Method A, pH meter used

Client:	F&ME Consultants
Project:	US-21 Replacement Bridge over Harbor River
Location:	---
GTX#:	305005
Test Date:	08/09/16
Tested By:	jm
Checked By:	mcm

Laboratory Measurement of Soil Resistivity Using the Wenner Four-Electrode Method by ASTM G57 (Laboratory Measurement)

Boring ID	Sample ID	Depth, ft.	Sample Description	Electrical Resistivity, ohm-cm	Electrical Conductivity, $(ohm\text{-}cm)^{-1}$
B-11	---	92.5-94	Moist, olive clay with sand	101	9.91E-03

Notes: Test Equipment: Nilsson Model 400 Soil Resistance Meter, MC Miller Soil Box
Water added to sample to create a thick slurry prior to testing (saturated condition).
Electrical Conductivity is calculated as inverse of Electrical Resistivity (per ASTM G57)
Test conducted in standard laboratory atmosphere: 68-73 F

Project Name: US-21 REP. BRIDGE OVER HARBOR
Project Number: 305005
Lab Number: L1623916
Report Date: 08/08/16

SAMPLE RESULTS

Lab ID: L1623916-02
Client ID: B-11 / 92.5-94.0 FT
Sample Location: Not Specified
Matrix: Soil
Date Collected: 08/01/16 11:59
Date Received: 08/02/16
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	62.2		%	0.100	NA	1	-	08/03/16 02:46	121,2540G	VB
Chloride	5700		mg/kg	140	--	10	-	08/05/16 17:53	1,9251	
Sulfate	2000		mg/kg	800	--	5	-	08/04/16 11:30	1,9038	AW

Client:	FME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	08/23/16
Tested By:	jbr
Checked By:	jdt

Rapid Determination of Carbonate Content of Soils by ASTM D4373

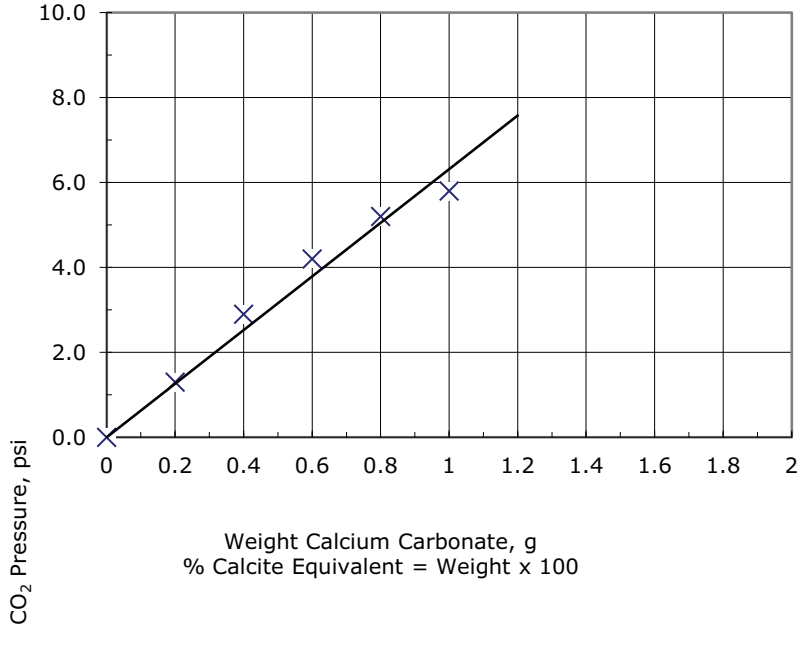
Boring ID	Sample ID	Depth, ft	*CO_2 Pressure, psi	Weight of Sample used, g	Weight $CaCO_3$, grams	Calcite Equivalent, %
B-11	---	68.5-70	5.50	1.00	4.51	451

Notes: Calcium Carbonate content precise to +/- 1.5%

*CO_2 Pressure is based on the weight of sample as indicated in the table.

The reported Calcite Equivalent (%) is based on one gram

Figure 1: Calibration Curve



F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1182	**DATE SAMPLE RECEIVED:**	7/15/2016
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MB	**DATE OF TESTING:**	7/20/2016
		DATE OF WEIGHING:	7/21/2016

BORING NO.	B-12	B-12	B-12	B-12	B-12
SAMPLE NO.	16-1182C	16-1182F	16-1182I	16-1182L	16-1182O
SAMPLE DEPTH	37.0-39.0'	45.5-47.0'	61.0-62.5'	80.0-81.5'	96.5-98.0'
WATER CONTENT, W%	32.9	24.6	81.2	61.8	33.7

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

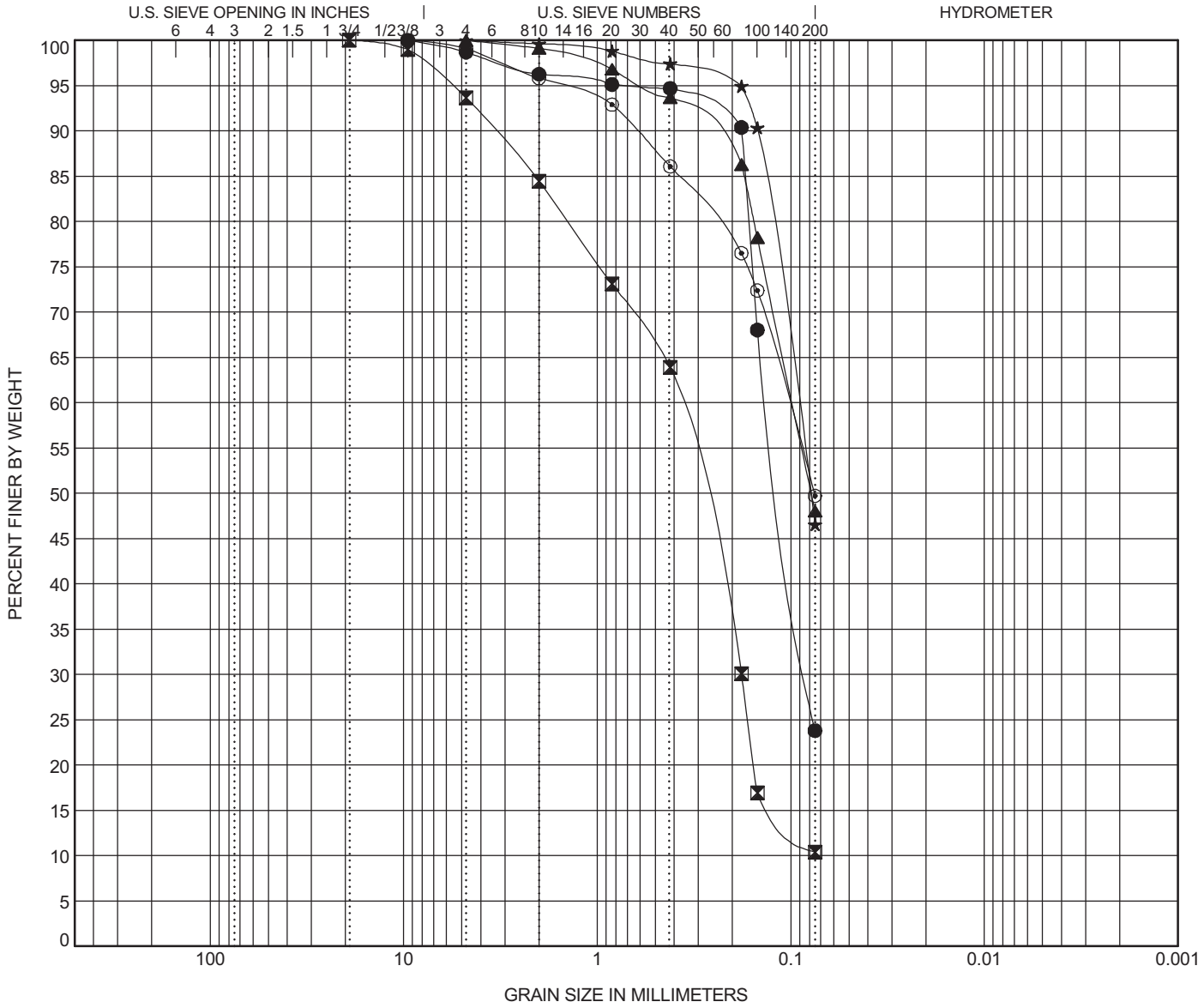
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-12**	**39.0**	**Silty F/M SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
⊠	**B-12**	**47.0**	**Poorly Graded F/C SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**1.18**	**5.30**
▲	**B-12**	**62.5**	**Silty F/M SAND (SM) A-5(0)**	**51**	**NP**	**NP**		
★	**B-12**	**81.5**	**Silty Fine SAND (SM) A-7-5(4)**	**44**	**31**	**13**		
⊙	**B-12**	**98.0**	**Silty F/M SAND (SM) A-4(0)**	**30**	**NP**	**NP**		

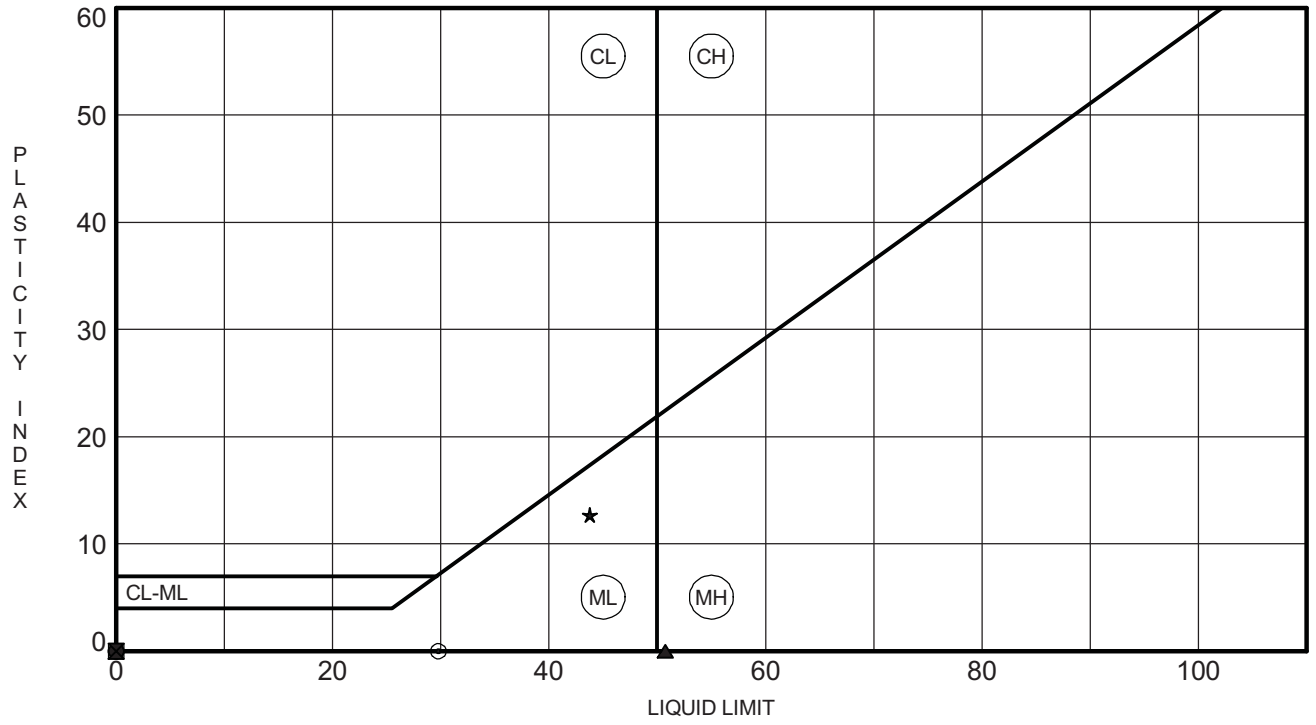
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-12**	**39.0**	**9.52**	**0.672**	**0.113**		**1.3**	**74.9**	**23.8**	
⊠	**B-12**	**47.0**	**19.1**	**5.662**	**0.296**		**6.4**	**83.2**	**10.4**	
▲	**B-12**	**62.5**	**4.76**	**0.561**	**0.078**		**0.0**	**52.0**	**48.0**	
★	**B-12**	**81.5**	**4.76**	**0.184**	**0.079**		**0.0**	**53.4**	**46.6**	
⊙	**B-12**	**98.0**	**9.52**	**1.56**	**0.076**		**0.9**	**49.3**	**49.7**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-12**	**39.0**	**NP**	**NP**	**NP**	**24**	**Silty F/M SAND (SM) A-2-4**
⊠	**B-12**	**47.0**	**NP**	**NP**	**NP**	**10**	**Poorly Graded F/C SAND (SP-SM) with Silt A-3**
▲	**B-12**	**62.5**	**51**	**NP**	**NP**	**48**	**Silty F/M SAND (SM) A-5(0)**
★	**B-12**	**81.5**	**44**	**31**	**13**	**47**	**Silty Fine SAND (SM) A-7-5(4)**
⊙	**B-12**	**98.0**	**30**	**NP**	**NP**	**50**	**Silty F/M SAND (SM) A-4(0)**

Client:	FME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	08/23/16
Tested By:	jbr
Checked By:	jdt

Rapid Determination of Carbonate Content of Soils by ASTM D4373

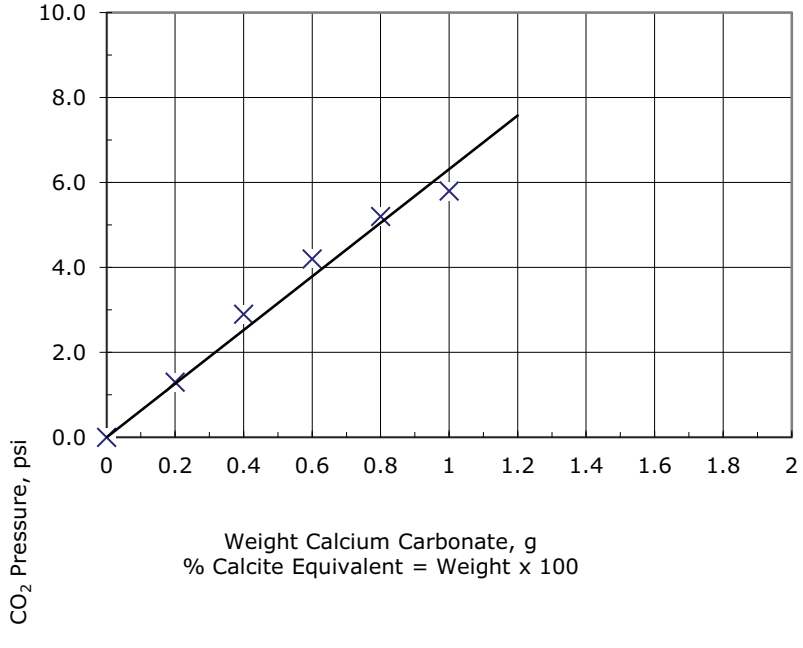
Boring ID	Sample ID	Depth, ft	*CO_2 Pressure, psi	Weight of Sample used, g	Weight $CaCO_3$, grams	Calcite Equivalent, %
B-12	---	115.5-117	6.00	1.00	4.93	493

Notes: Calcium Carbonate content precise to +/- 1.5%

*CO_2 Pressure is based on the weight of sample as indicated in the table.

The reported Calcite Equivalent (%) is based on one gram

Figure 1: Calibration Curve



F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1039	**DATE SAMPLE RECEIVED:**	7/6/2016
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MB	**DATE OF TESTING:**	7/6/2016
		DATE OF WEIGHING:	7/7/2016

BORING NO.	B-13	B-13	B-13	B-13	B-13
SAMPLE NO.	16-1039C	16-1039F	16-1039I	16-1039L	16-1039O
SAMPLE DEPTH	32.0-34.0'	42.5-44.0'	52.5-54.0'	63.5-65.0'	99.5-101.0'
WATER CONTENT, W%	34.6	63.6	78.3	73.8	37.3

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

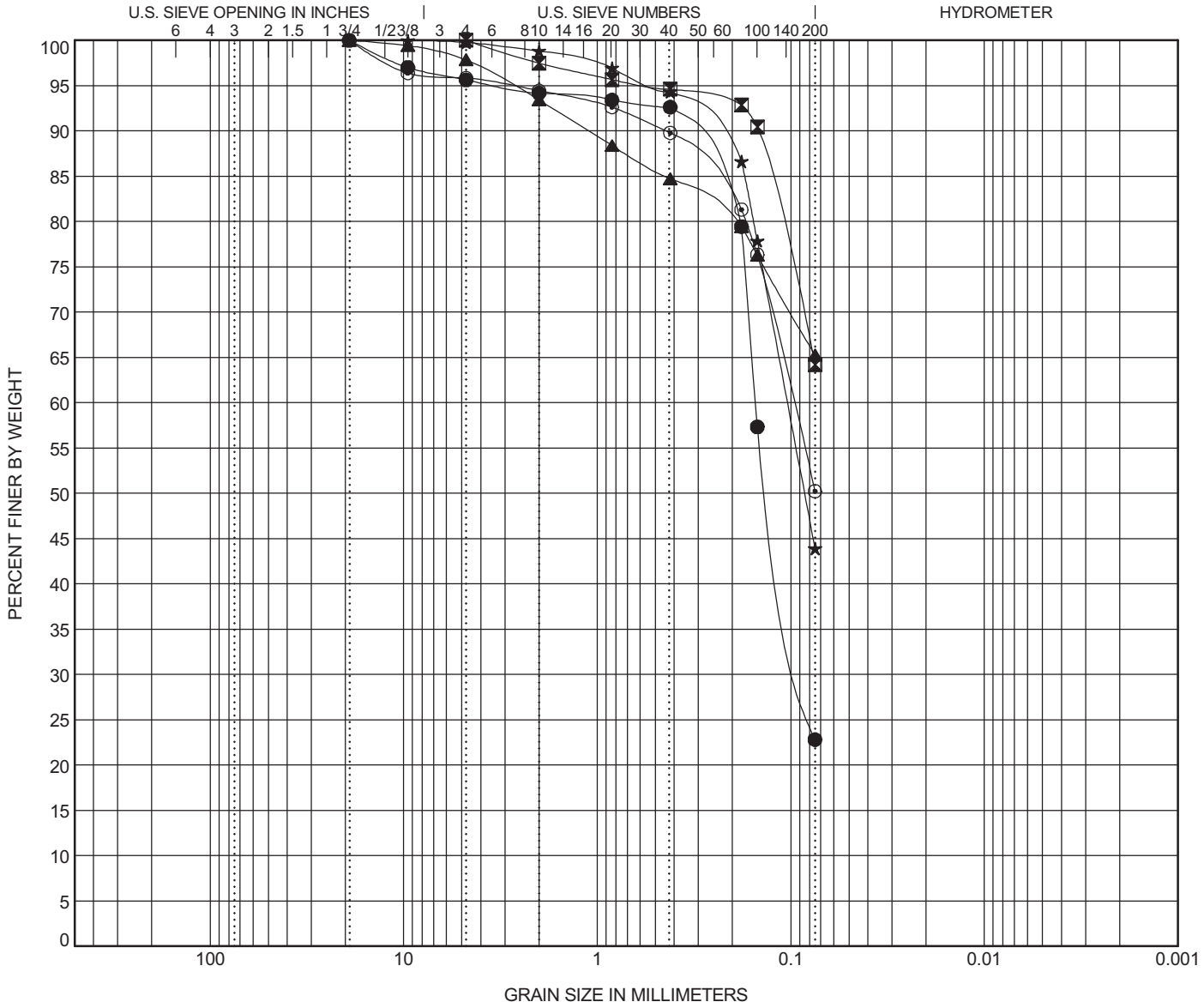
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-13**	**34.0**	**Silty F/M SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
⊠	**B-13**	**44.0**	**Sandy Lean CLAY (CL) A-7-6(11)**	**41**	**20**	**21**		
▲	**B-13**	**54.0**	**Sandy SILT (ML) A-4(0)**	**23**	**NP**	**NP**		
★	**B-13**	**65.0**	**Clayey F/M SAND (SC) A-7-6(11)**	**67**	**29**	**38**		
⊙	**B-13**	**101.0**	**Sandy SILT (ML) A-4(1)**	**30**	**24**	**6**		

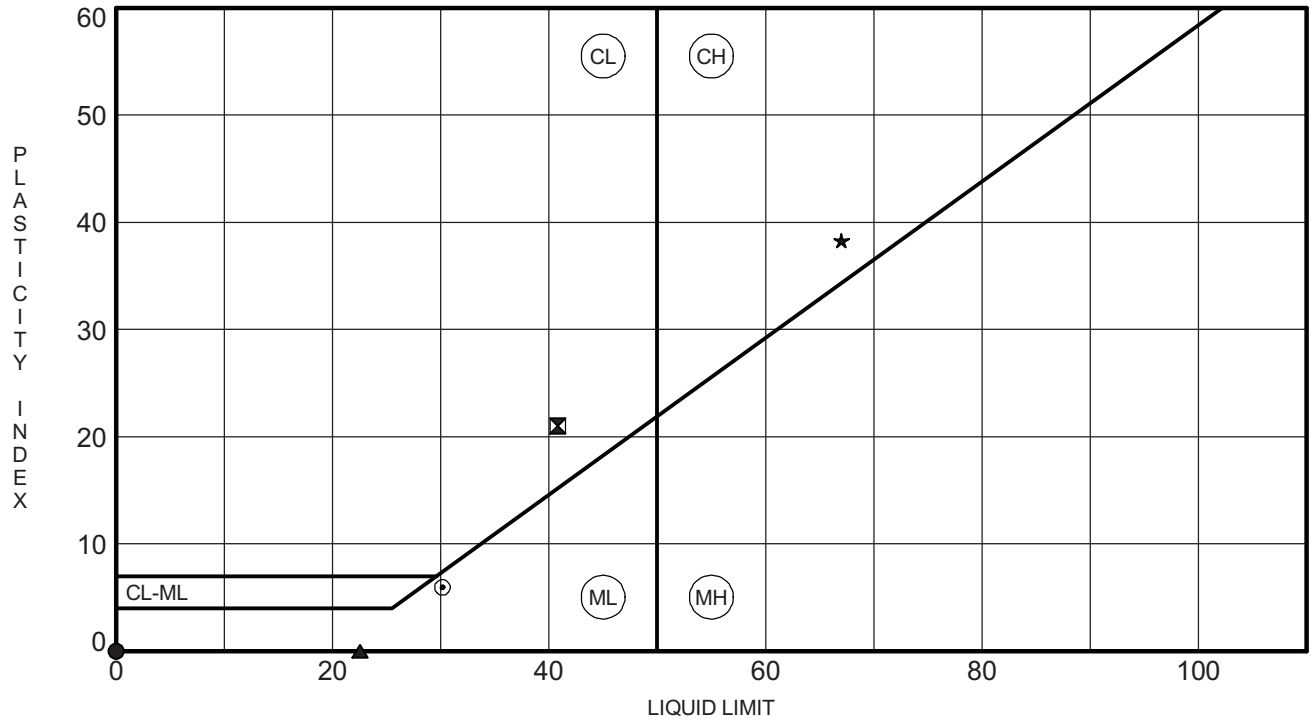
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-13**	**34.0**	**19.1**	**3.252**	**0.129**		**4.4**	**72.8**	**22.8**	
⊠	**B-13**	**44.0**	**4.76**	**0.54**			**0.0**	**35.8**	**64.2**	
▲	**B-13**	**54.0**	**19.1**	**2.717**			**2.1**	**32.6**	**65.3**	
★	**B-13**	**65.0**	**9.52**	**0.501**	**0.085**		**0.2**	**55.9**	**43.9**	
⊙	**B-13**	**101.0**	**19.1**	**2.809**			**4.2**	**45.6**	**50.2**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-13**	**34.0**	**NP**	**NP**	**NP**	**23**	**Silty F/M SAND (SM) A-2-4**
⊠	**B-13**	**44.0**	**41**	**20**	**21**	**64**	**Sandy Lean CLAY (CL) A-7-6(11)**
▲	**B-13**	**54.0**	**23**	**NP**	**NP**	**65**	**Sandy SILT (ML) A-4(0)**
★	**B-13**	**65.0**	**67**	**29**	**38**	**44**	**Clayey F/M SAND (SC) A-7-6(11)**
⊙	**B-13**	**101.0**	**30**	**24**	**6**	**50**	**Sandy SILT (ML) A-4(1)**

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	---	Sample Type:	---	Tested By:	GA
Sample ID:	---	Test Date:	08/09/16	Checked By:	mcm
Depth :	---	Test Id:	386279		

pH of Soil by ASTM D4972

Boring ID	Sample ID	Depth	Visual Description	pH of Soil in Distilled Water	pH of Soil in Calcium Chloride
B-13	---	58-59.5 ft	Moist, dark olive silty sand	7.2	7.0

Notes: Sample Preparation: screened through #10 sieve

Method A, pH meter used

Client:	F&ME Consultants
Project:	US-21 Replacement Bridge over Harbor River
Location:	---
GTX#:	305005
Test Date:	08/09/16
Tested By:	jm
Checked By:	mcm

Laboratory Measurement of Soil Resistivity Using the Wenner Four-Electrode Method by ASTM G57 (Laboratory Measurement)

Boring ID	Sample ID	Depth, ft.	Sample Description	Electrical Resistivity, ohm-cm	Electrical Conductivity, $(ohm\text{-}cm)^{-1}$
B-13	---	58-59.5	Moist, dark olive silty sand	76	1.31E-02

Notes: Test Equipment: Nilsson Model 400 Soil Resistance Meter, MC Miller Soil Box
Water added to sample to create a thick slurry prior to testing (saturated condition).
Electrical Conductivity is calculated as inverse of Electrical Resistivity (per ASTM G57)
Test conducted in standard laboratory atmosphere: 68-73 F

Project Name: US-21 REP. BRIDGE OVER HARBOR
Project Number: 305005
Lab Number: L1623916
Report Date: 08/08/16

SAMPLE RESULTS

Lab ID: L1623916-03
Client ID: B-13 / 58.0-59.5 FT
Sample Location: Not Specified
Matrix: Soil
Date Collected: 08/01/16 12:04
Date Received: 08/02/16
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	67.4		%	0.100	NA	1	-	08/03/16 02:46	121,2540G	VB
Chloride	7600		mg/kg	140	--	10	-	08/05/16 17:55	1,9251	
Sulfate	1700		mg/kg	740	--	5	-	08/04/16 11:30	1,9038	AW

Client:	FME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	08/23/16
Tested By:	jbr
Checked By:	jdt

Rapid Determination of Carbonate Content of Soils by ASTM D4373

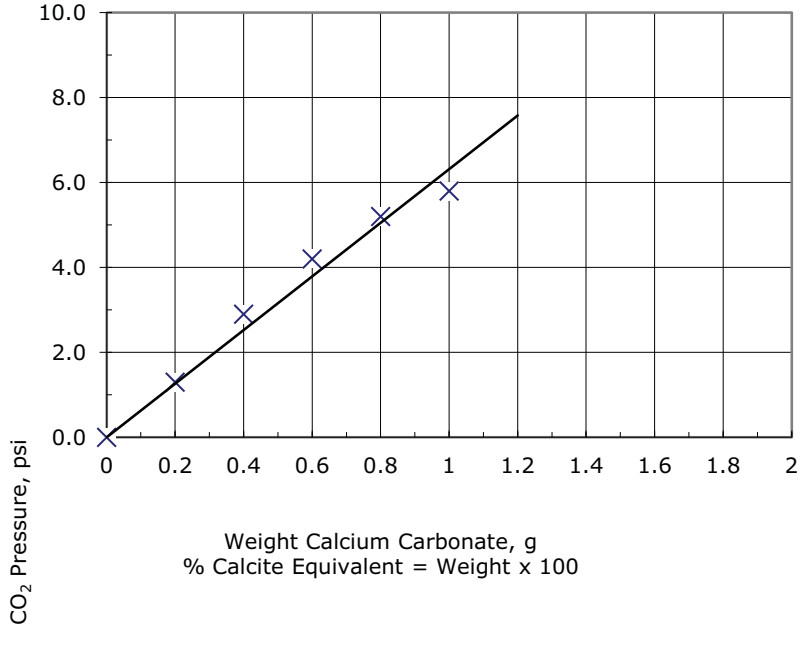
Boring ID	Sample ID	Depth, ft	*CO_2 Pressure, psi	Weight of Sample used, g	Weight $CaCO_3$, grams	Calcite Equivalent, %
B-13	---	94.5-96	5.60	1.00	4.60	460

Notes: Calcium Carbonate content precise to +/- 1.5%

*CO_2 Pressure is based on the weight of sample as indicated in the table.

The reported Calcite Equivalent (%) is based on one gram

Figure 1: Calibration Curve



F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1008	**DATE SAMPLE RECEIVED:**	7/6/2016
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MB	**DATE OF TESTING:**	7/6/2016
		DATE OF WEIGHING:	7/7/2016

BORING NO.	B-14	B-14	B-14	B-14	B-14
SAMPLE NO.	16-1008C	16-1008F	16-1008I	16-1008L	16-1008O
SAMPLE DEPTH	8.0-10.0'	23.5-25.0'	28.5-30.0'	38.5-40.0'	48.5-50.0'
WATER CONTENT, W%	32.4	38.6	50.9	56.1	46.2

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

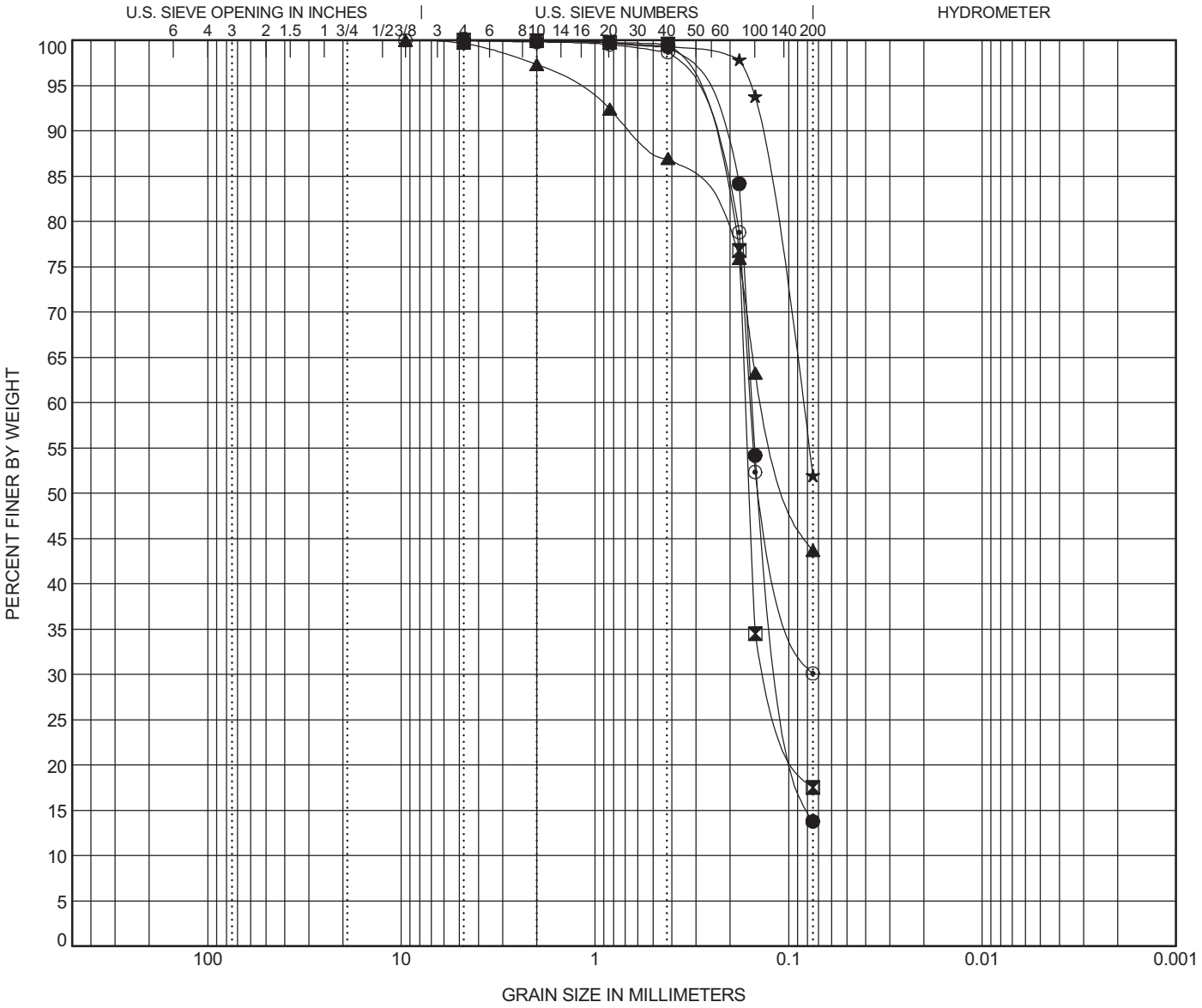
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-14**	**10.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
⊠	**B-14**	**25.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
▲	**B-14**	**30.0**	**Silty F/M SAND (SM) A-4(1)**	**31**	**24**	**7**		
★	**B-14**	**40.0**	**Sandy SILT (ML) A-7-5(4)**	**47**	**36**	**11**		
⊙	**B-14**	**50.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		

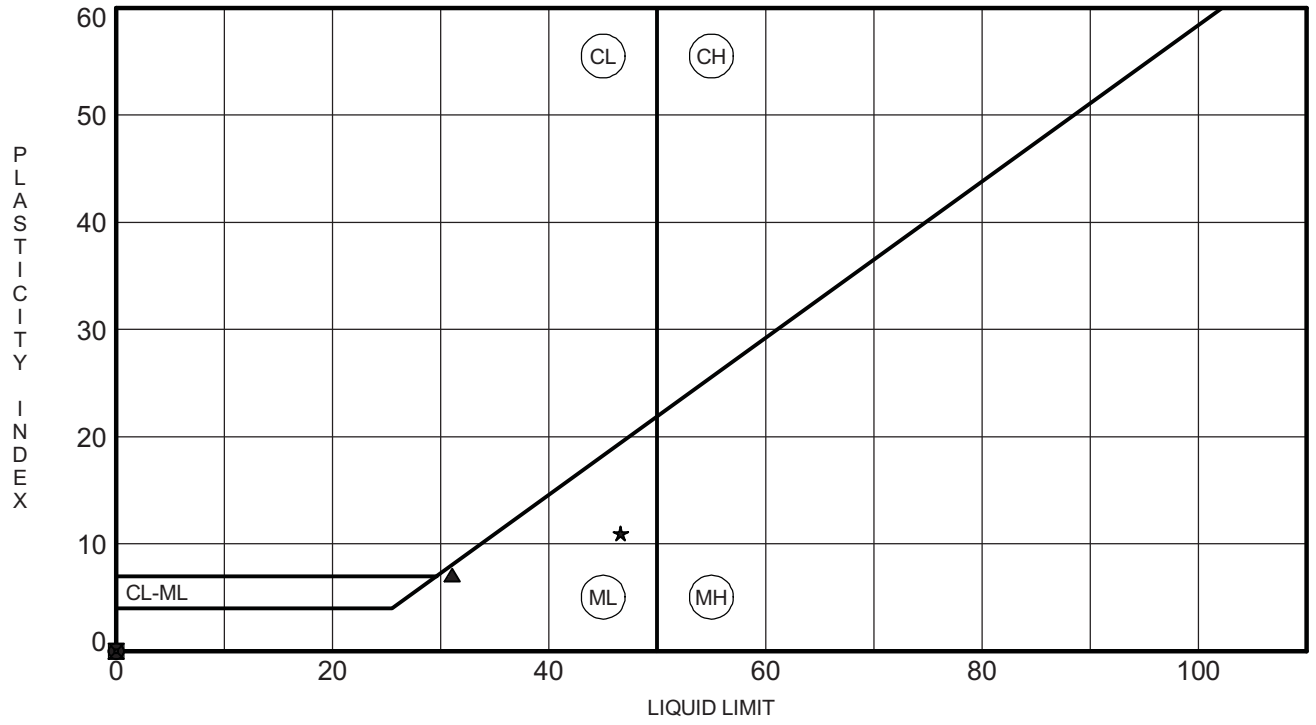
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-14**	**10.0**	**4.76**	**0.328**	**0.139**		**0.0**	**86.2**	**13.8**	
⊠	**B-14**	**25.0**	**4.76**	**0.354**	**0.16**		**0.0**	**82.4**	**17.6**	
▲	**B-14**	**30.0**	**9.52**	**1.321**	**0.094**		**0.3**	**56.0**	**43.7**	
★	**B-14**	**40.0**	**4.76**	**0.157**			**0.0**	**48.0**	**52.0**	
⊙	**B-14**	**50.0**	**9.52**	**0.359**	**0.139**		**0.0**	**69.8**	**30.1**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-14**	**10.0**	**NP**	**NP**	**NP**	**14**	**Silty Fine SAND (SM) A-2-4**
⊠	**B-14**	**25.0**	**NP**	**NP**	**NP**	**18**	**Silty Fine SAND (SM) A-2-4**
▲	**B-14**	**30.0**	**31**	**24**	**7**	**44**	**Silty F/M SAND (SM) A-4(1)**
★	**B-14**	**40.0**	**47**	**36**	**11**	**52**	**Sandy SILT (ML) A-7-5(4)**
⊙	**B-14**	**50.0**	**NP**	**NP**	**NP**	**30**	**Silty Fine SAND (SM) A-2-4**

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	---	Sample Type:	---	Tested By:	GA
Sample ID:	---	Test Date:	08/09/16	Checked By:	mcm
Depth :	---	Test Id:	386279		

pH of Soil by ASTM D4972

Boring ID	Sample ID	Depth	Visual Description	pH of Soil in Distilled Water	pH of Soil in Calcium Chloride
B-14	---	33.5-35 ft	Moist, olive gray clay with sand	7.4	7.1

Notes: Sample Preparation: screened through #10 sieve

Method A, pH meter used

Client:	F&ME Consultants
Project:	US-21 Replacement Bridge over Harbor River
Location:	---
GTX#:	305005
Test Date:	08/09/16
Tested By:	jm
Checked By:	mcm

Laboratory Measurement of Soil Resistivity Using the Wenner Four-Electrode Method by ASTM G57 (Laboratory Measurement)

Boring ID	Sample ID	Depth, ft.	Sample Description	Electrical Resistivity, ohm-cm	Electrical Conductivity, $(ohm\text{-}cm)^{-1}$
B-14	---	33.5-35	Moist, olive gray clay with sand	71	1.40E-02

Notes: Test Equipment: Nilsson Model 400 Soil Resistance Meter, MC Miller Soil Box
Water added to sample to create a thick slurry prior to testing (saturated condition).
Electrical Conductivity is calculated as inverse of Electrical Resistivity (per ASTM G57)
Test conducted in standard laboratory atmosphere: 68-73 F

Project Name: US-21 REP. BRIDGE OVER HARBOR
Project Number: 305005
Lab Number: L1623916
Report Date: 08/08/16

SAMPLE RESULTS

Lab ID: L1623916-04
Client ID: B-14 / 33.5-35.0 FT
Sample Location: Not Specified
Matrix: Soil
Date Collected: 08/01/16 12:11
Date Received: 08/02/16
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	73.8		%	0.100	NA	1	-	08/03/16 02:46	121,2540G	VB
Chloride	6900		mg/kg	130	--	10	-	08/05/16 17:59	1,9251	
Sulfate	1600		mg/kg	660	--	4.9	-	08/04/16 11:30	1,9038	AW

Client:	FME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	08/23/16
Tested By:	jbr
Checked By:	jdt

Rapid Determination of Carbonate Content of Soils by ASTM D4373

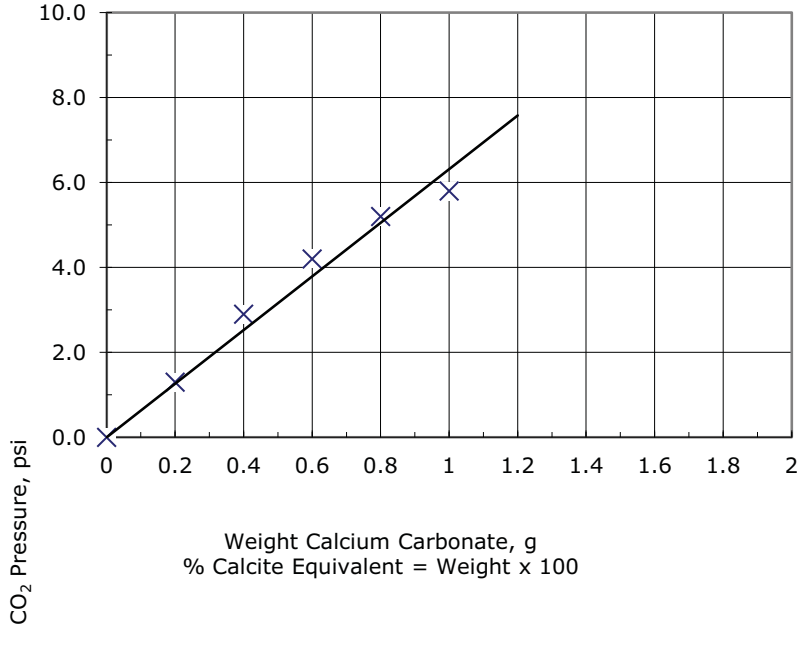
Boring ID	Sample ID	Depth, ft	*CO_2 Pressure, psi	Weight of Sample used, g	Weight $CaCO_3$, grams	Calcite Equivalent, %
B-14	---	72.5-74	4.90	10.00	0.40	40

Notes: Calcium Carbonate content precise to +/- 1.5%

*CO_2 Pressure is based on the weight of sample as indicated in the table.

The reported Calcite Equivalent (%) is based on one gram

Figure 1: Calibration Curve



F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1285	**DATE SAMPLE RECEIVED:**	8/5/2016
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MB	**DATE OF TESTING:**	8/9/2016
		DATE OF WEIGHING:	8/10/2016

BORING NO.	B-15	B-15	B-15	B-15	B-15
SAMPLE NO.	16-1285C	16-1285F	16-1285I	16-1285L	16-1285P
SAMPLE DEPTH	4.0-6.0'	6.0-8.0'	13.5-15.0'	18.5-20.0'	43.5-45.0'
WATER CONTENT, W%	26.2	23.5	23.8	33.2	31.6

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

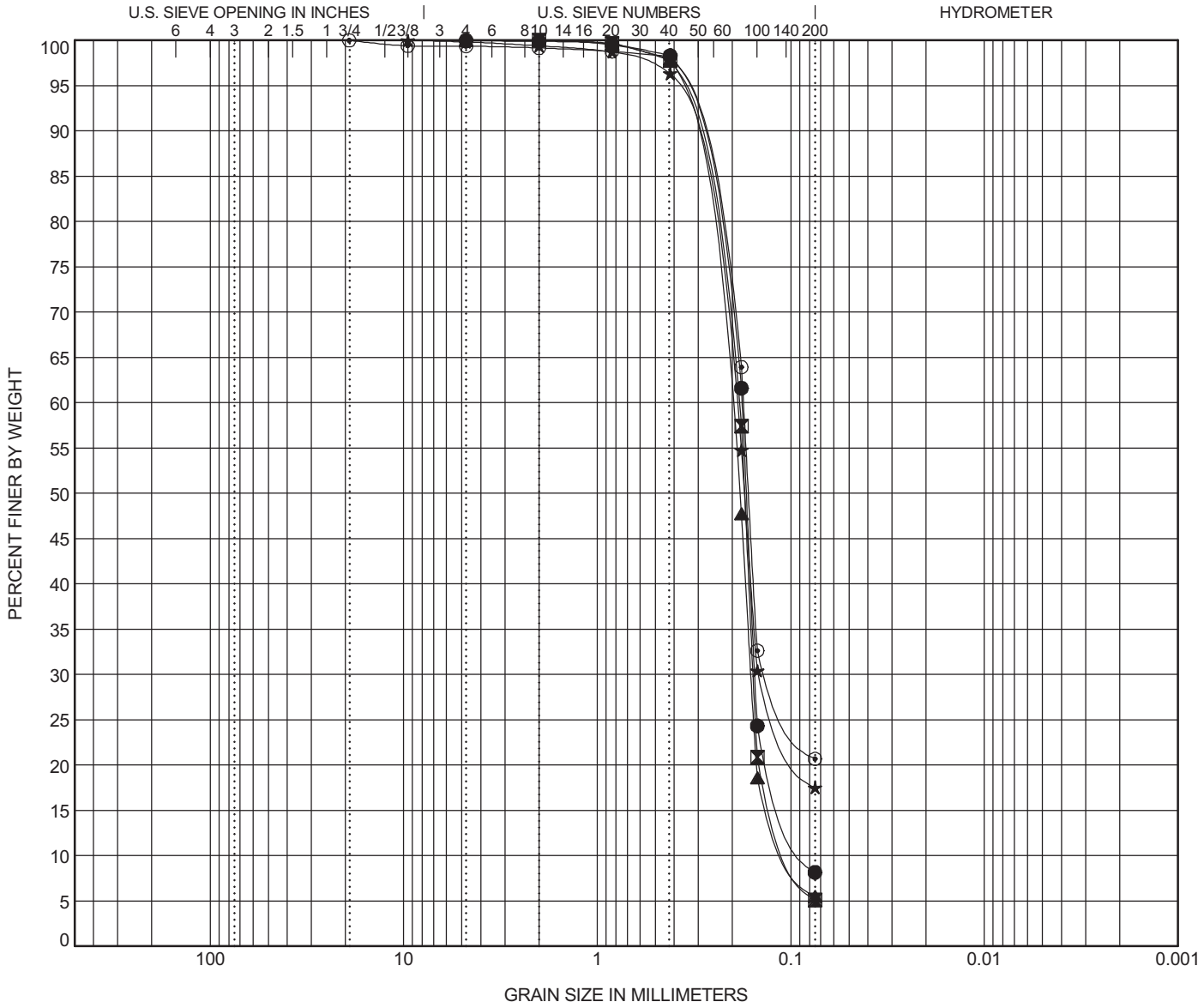
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-15**	**6.0**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**1.62**	**2.20**
⊠	**B-15**	**8.0**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**1.38**	**2.05**
▲	**B-15**	**15.0**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**1.23**	**2.33**
★	**B-15**	**20.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
⊙	**B-15**	**45.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		

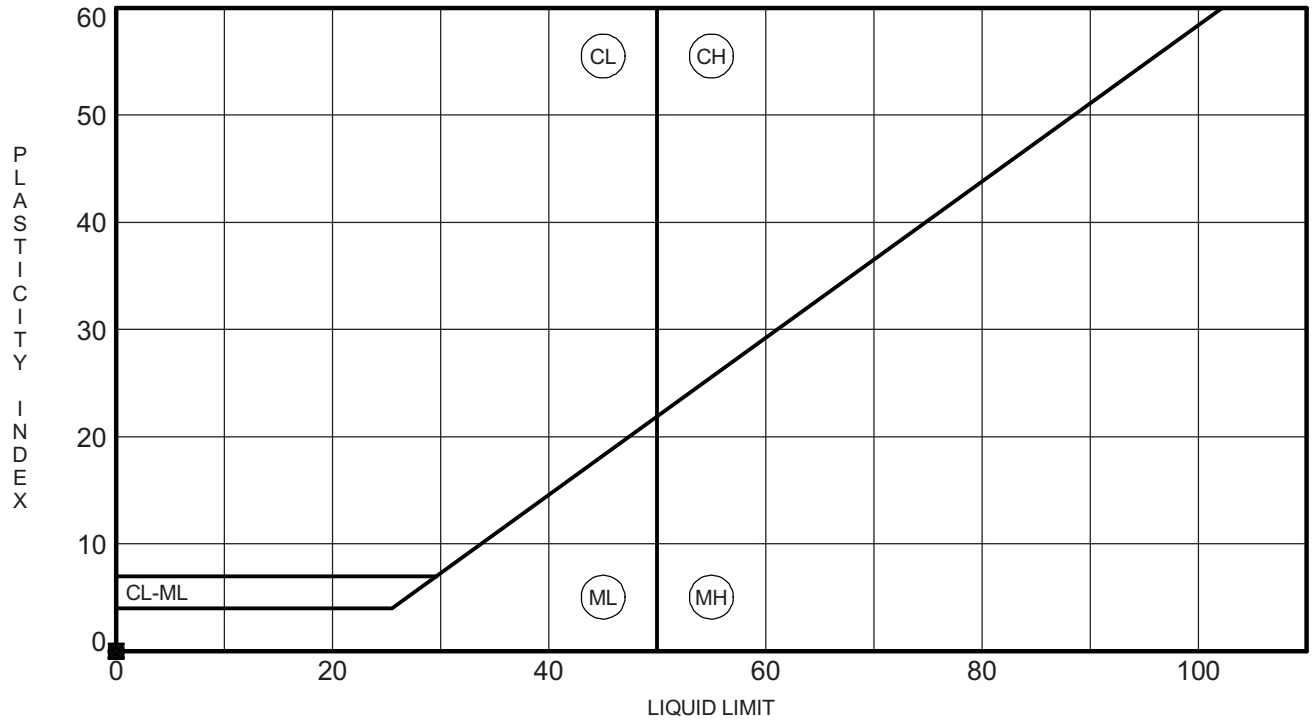
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-15**	**6.0**	**4.76**	**0.389**	**0.17**	**0.081**	**0.0**	**91.8**	**8.2**	
⊠	**B-15**	**8.0**	**2**	**0.396**	**0.173**	**0.093**	**0.0**	**94.9**	**5.1**	
▲	**B-15**	**15.0**	**4.76**	**0.4**	**0.187**	**0.095**	**0.0**	**94.5**	**5.5**	
★	**B-15**	**20.0**	**9.52**	**0.409**	**0.173**		**0.2**	**82.3**	**17.5**	
⊙	**B-15**	**45.0**	**19.1**	**0.388**	**0.165**		**0.6**	**78.7**	**20.7**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-15**	**6.0**	**NP**	**NP**	**NP**	**8**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**
⊠	**B-15**	**8.0**	**NP**	**NP**	**NP**	**5**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**
▲	**B-15**	**15.0**	**NP**	**NP**	**NP**	**6**	**Poorly Graded Fine SAND (SP-SM) with Silt A-3**
★	**B-15**	**20.0**	**NP**	**NP**	**NP**	**18**	**Silty Fine SAND (SM) A-2-4**
⊙	**B-15**	**45.0**	**NP**	**NP**	**NP**	**21**	**Silty Fine SAND (SM) A-2-4**

ATTERBERG LIMITS G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

ORGANIC IMPURITIES DETERMINATION
(AASHTO T267)

PROJECT: US 21 Bridge Replacement over Harbor River

PROJECT NO.: G5396

SAMPLE NUMBER: 16-1285

DATE SAMPLE RECEIVED: 8/8/2016

DESCRIPTION OF SOIL:

TESTED BY: MB

DATE OF TESTING: 8/10/2016

DATE OF WEIGHING: 8/10/2016

BORING NO.	B-15				
SAMPLE NO.	16-1285M				
SAMPLE DEPTH	38.5-40.0'				
WT. OF CRUCIBLE + DRY SOIL (BEFORE IGNITION) (GRAMS)	177.48				
WT. OF CRUCIBLE + DRY SOIL (AFTER IGNITION) (GRAMS)	175.82				
WT. OF CRUCIBLE (GRAMS)	137.48				
WT. OF DRY SOIL (BEFORE IGNITION) (GRAMS)	40.00				
WT. OF DRY SOIL (AFTER IGNITION) (GRAMS)	38.34				
IGNITION LOSS (GRAMS)	1.66				
ORGANIC IMPURITIES %	4.15				

Client:	FME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	08/23/16
Tested By:	jbr
Checked By:	jdt

Rapid Determination of Carbonate Content of Soils by ASTM D4373

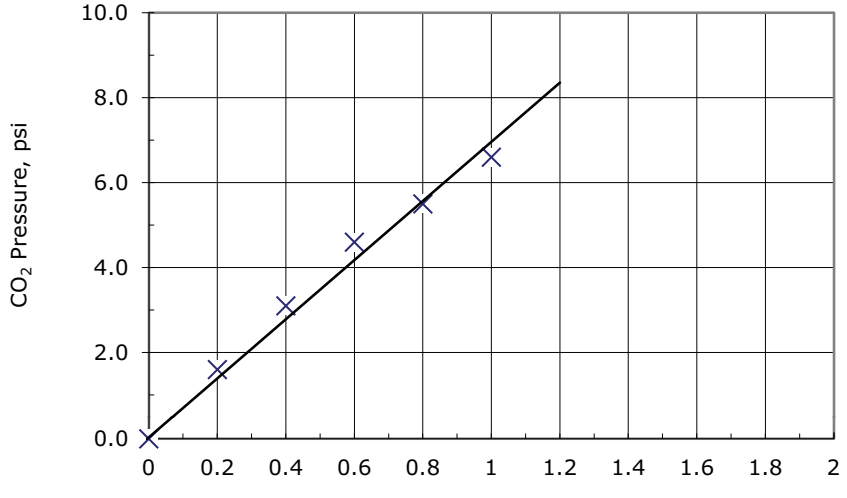
Boring ID	Sample ID	Depth, ft	*CO_2 Pressure, psi	Weight of Sample used, g	Weight $CaCO_3$, grams	Calcite Equivalent, %
B-15	16-1285Q	58.5-60	0.20	2.00	0.08	8

Notes: Calcium Carbonate content precise to +/- 1.5%

*CO_2 Pressure is based on the weight of sample as indicated in the table.

The reported Calcite Equivalent (%) is based on one gram

Figure 1: Calibration Curve



% Calcite Equivalent = Weight x 100

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1286	**DATE SAMPLE RECEIVED:**	8/5/2016
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MB	**DATE OF TESTING:**	8/9/2016
		DATE OF WEIGHING:	8/10/2016

BORING NO.	B-16	B-16	B-16	B-16	B-16
SAMPLE NO.	16-1286C	16-1286F	16-1286I	16-1286L	16-1286O
SAMPLE DEPTH	6.0-8.0'	13.5-15.0'	23.5-25.0'	38.5-40.0'	48.5-50.0'
WATER CONTENT, W%	24.5	24.3	37.4	56.7	84.8

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

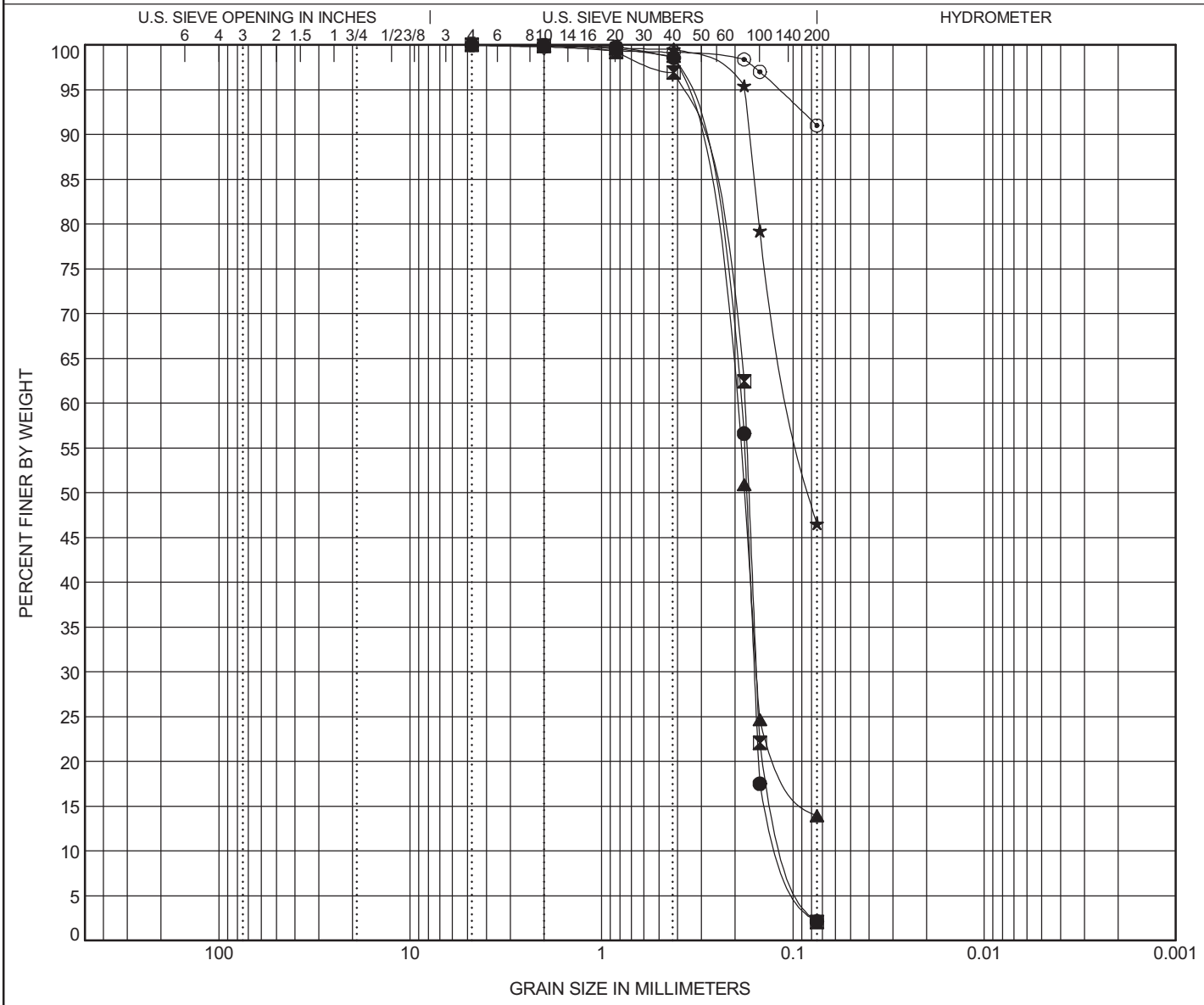
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-16**	**8.0**	**Poorly Graded Fine SAND (SP) A-3**	**NP**	**NP**	**NP**	**1.22**	**1.81**
⊠	**B-16**	**15.0**	**Poorly Graded Fine SAND (SP) A-3**	**NP**	**NP**	**NP**	**1.37**	**1.81**
▲	**B-16**	**25.0**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
★	**B-16**	**40.0**	**Clayey Fine SAND (SC) A-6(4)**	**36**	**21**	**15**		
⊙	**B-16**	**50.0**	**Elastic SILT (MH) A-7-5(25)**	**75**	**35**	**40**		

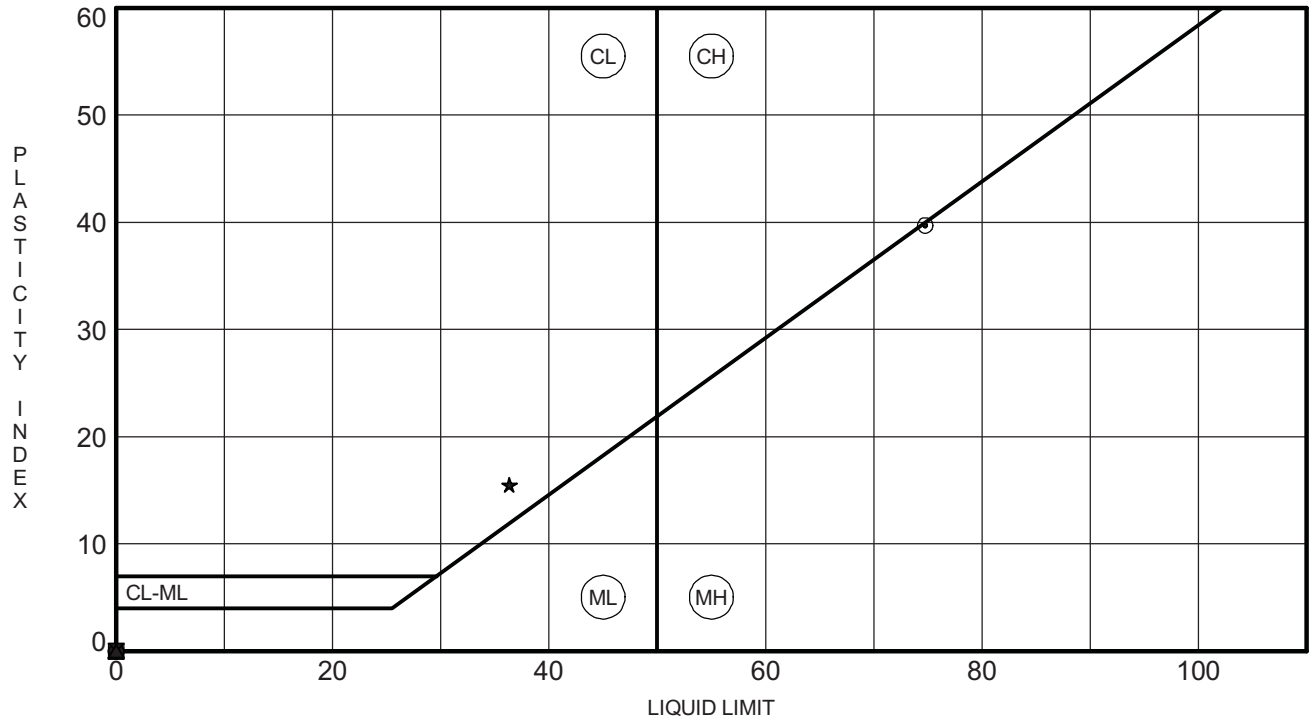
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-16**	**8.0**	**4.76**	**0.391**	**0.174**	**0.107**	**0.0**	**97.9**	**2.1**	
⊠	**B-16**	**15.0**	**4.76**	**0.4**	**0.17**	**0.098**	**0.0**	**97.9**	**2.1**	
▲	**B-16**	**25.0**	**4.76**	**0.393**	**0.179**		**0.0**	**86.1**	**13.9**	
★	**B-16**	**40.0**	**4.76**	**0.179**	**0.081**		**0.0**	**53.4**	**46.6**	
⊙	**B-16**	**50.0**	**4.76**	**0.118**			**0.0**	**9.0**	**91.0**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-16**	**8.0**	**NP**	**NP**	**NP**	**2**	**Poorly Graded Fine SAND (SP) A-3**
⊠	**B-16**	**15.0**	**NP**	**NP**	**NP**	**2**	**Poorly Graded Fine SAND (SP) A-3**
▲	**B-16**	**25.0**	**NP**	**NP**	**NP**	**14**	**Silty Fine SAND (SM) A-2-4**
★	**B-16**	**40.0**	**36**	**21**	**15**	**47**	**Clayey Fine SAND (SC) A-6(4)**
⊙	**B-16**	**50.0**	**75**	**35**	**40**	**91**	**Elastic SILT (MH) A-7-5(25)**

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

ORGANIC IMPURITIES DETERMINATION
(AASHTO T267)

PROJECT: US 21 Bridge Replacement over Harbor River

PROJECT NO.: G5396

SAMPLE NUMBER: 16-1286

DATE SAMPLE RECEIVED: 8/8/2016

DESCRIPTION OF SOIL:

TESTED BY: MB

DATE OF TESTING: 8/10/2016

DATE OF WEIGHING: 8/10/2016

BORING NO.	B-16				
SAMPLE NO.	16-1286P				
SAMPLE DEPTH	53.5-55.0'				
WT. OF CRUCIBLE + DRY SOIL (BEFORE IGNITION) (GRAMS)	139.63				
WT. OF CRUCIBLE + DRY SOIL (AFTER IGNITION) (GRAMS)	136.74				
WT. OF CRUCIBLE (GRAMS)	99.63				
WT. OF DRY SOIL (BEFORE IGNITION) (GRAMS)	40.00				
WT. OF DRY SOIL (AFTER IGNITION) (GRAMS)	37.11				
IGNITION LOSS (GRAMS)	2.89				
ORGANIC IMPURITIES %	7.22				

Client:	FME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	08/23/16
Tested By:	jbr
Checked By:	jdt

Rapid Determination of Carbonate Content of Soils by ASTM D4373

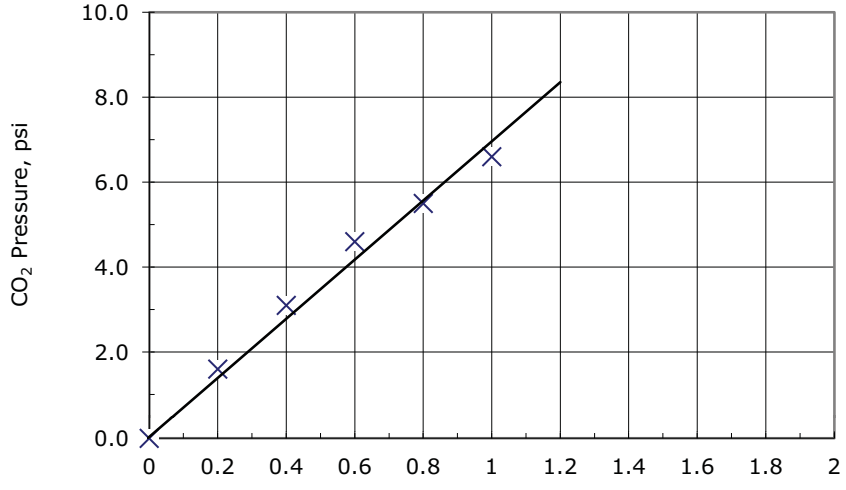
Boring ID	Sample ID	Depth, ft	*CO_2 Pressure, psi	Weight of Sample used, g	Weight $CaCO_3$, grams	Calcite Equivalent, %
B-16	16-1286Q	78.5-80	1.80	10.00	0.15	15

Notes: Calcium Carbonate content precise to +/- 1.5%

*CO_2 Pressure is based on the weight of sample as indicated in the table.

The reported Calcite Equivalent (%) is based on one gram

Figure 1: Calibration Curve



% Calcite Equivalent = Weight x 100

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	15-1799	**DATE SAMPLE RECEIVED:**	12/3/2015
DESCRIPTION OF SOIL:	Various		
TESTED BY:	MB	**DATE OF TESTING:**	12/3/2015
		DATE OF WEIGHING:	12/4/2015

BORING NO.	TS-1	TS-1	TS-1	TS-1	TS-1
SAMPLE NO.	15-1799C	15-1799F	15-1799I	15-1799L	15-1799O
SAMPLE DEPTH	6.0-8.0'	16.0-18.0'	22.0-24.0'	26.0-28.0'	32.0-34.0'
WATER CONTENT, W%	25.9	52.2	26.7	65.5	40.2

BORING NO.	TS-1	TS-1	TS-1	TS-1	TS-1
SAMPLE NO.	15-1799R	15-1799U	15-1799X	15-1799AA	15-1799DD
SAMPLE DEPTH	44.0-46.0'	46.0-48.0'	56.0-58.0'	72.0-74.0'	76.0-78.0'
WATER CONTENT, W%	24.0	20.1	62.4	61.7	44.5

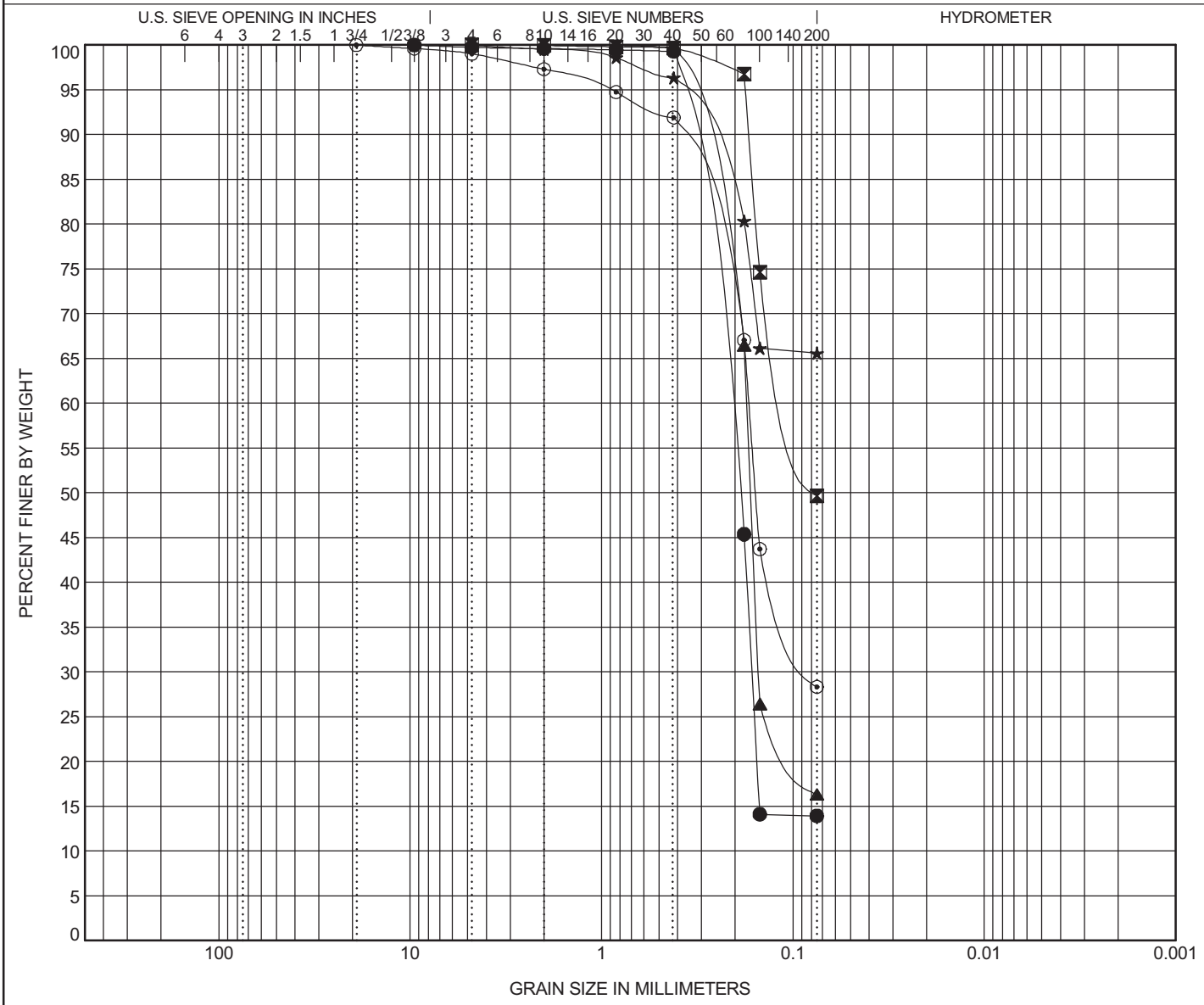
BORING NO.	TS-1	TS-1	TS-1		
SAMPLE NO.	15-1799GG	15-1799JJ	15-1799MM		
SAMPLE DEPTH	80.0-82.0'	104.0-106.0'	120.0-122.0'		
WATER CONTENT, W%	42.6	33.4	35.4		

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	TS-1	8.0	Silty Fine SAND (SM) A-2-4	NP	NP	NP		
⊠	TS-1	18.0	Silty, Clayey Fine SAND (SC-SM) A-4(0)	25	21	4		
▲	TS-1	24.0	Silty Fine SAND (SM) A-2-4	NP	NP	NP		
★	TS-1	28.0	Sandy SILT (ML) A-7-6(9)	42	27	15		
⊙	TS-1	34.0	Silty Fine SAND (SM) A-2-4	NP	NP	NP		

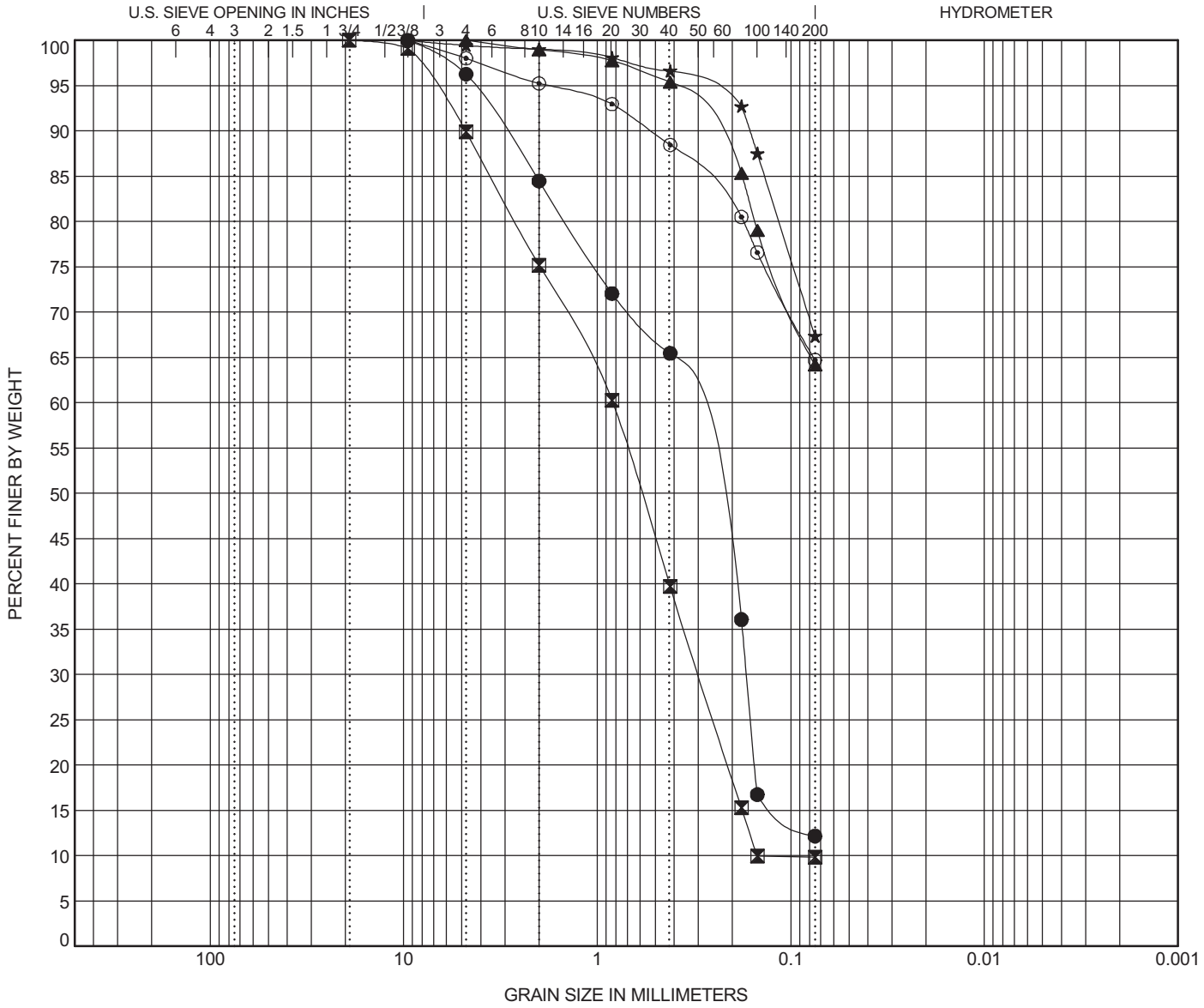
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	TS-1	8.0	9.52	0.393	0.194		0.3	85.8	13.9	
⊠	TS-1	18.0	4.76	0.177	0.076		0.0	50.3	49.7	
▲	TS-1	24.0	2	0.372	0.167		0.0	83.7	16.3	
★	TS-1	28.0	4.76	0.391			0.0	34.4	65.6	
⊙	TS-1	34.0	19.1	0.915	0.157		1.0	70.7	28.3	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	TS-1	46.0	Silty F/C SAND (SM) A-2-4	NP	NP	NP	1.48	6.62
⊠	TS-1	48.0	Poorly Graded F/C SAND (SP-SM)with Silt A-1-b	NP	NP	NP	0.72	5.57
▲	TS-1	58.0	Sandy SILT (ML) A-5(4)	44	39	5		
★	TS-1	74.0	Sandy Elastic SILT (MH) A-7-5(16)	55	32	23		
⊙	TS-1	78.0	Sandy SILT (ML) A-4(4)	31	23	8		

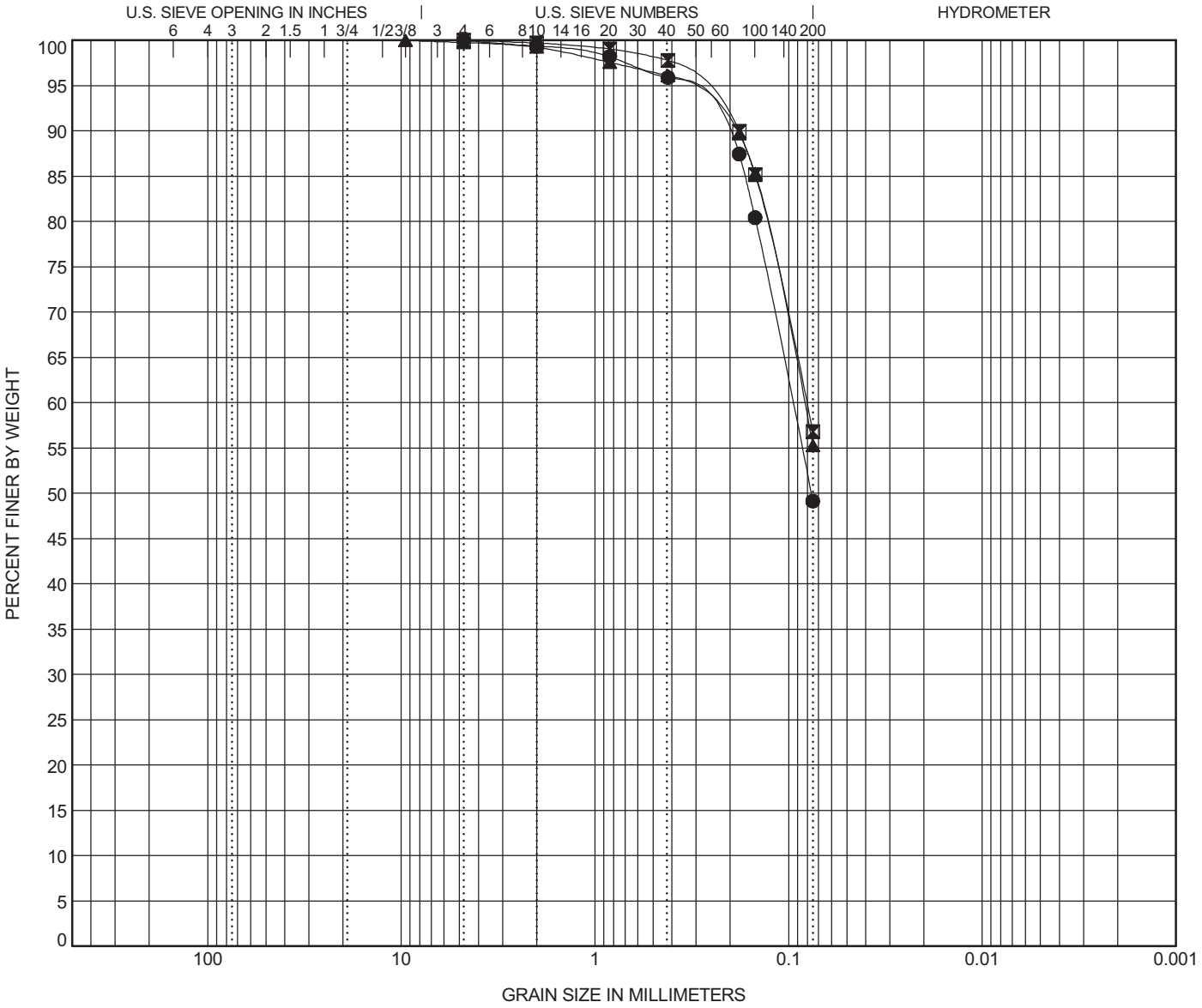
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	TS-1	46.0	9.52	4.333	0.269		3.7	84.1	12.2	
⊠	TS-1	48.0	19.1	6.971	0.594	0.149	10.1	80.1	9.8	
▲	TS-1	58.0	4.76	0.406			0.0	35.8	64.2	
★	TS-1	74.0	9.52	0.293			0.6	32.1	67.4	
⊙	TS-1	78.0	9.52	1.814			2.0	33.3	64.7	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**TS-1**	**82.0**	**Silty Fine SAND (SM) A-4(0)**	**NP**	**NP**	**NP**		
⊠	**TS-1**	**106.0**	**Sandy SILT (ML) A-4(0)**	**NP**	**NP**	**NP**		
▲	**TS-1**	**122.0**	**Sandy SILT (ML) A-4(0)**	**NP**	**NP**	**NP**		

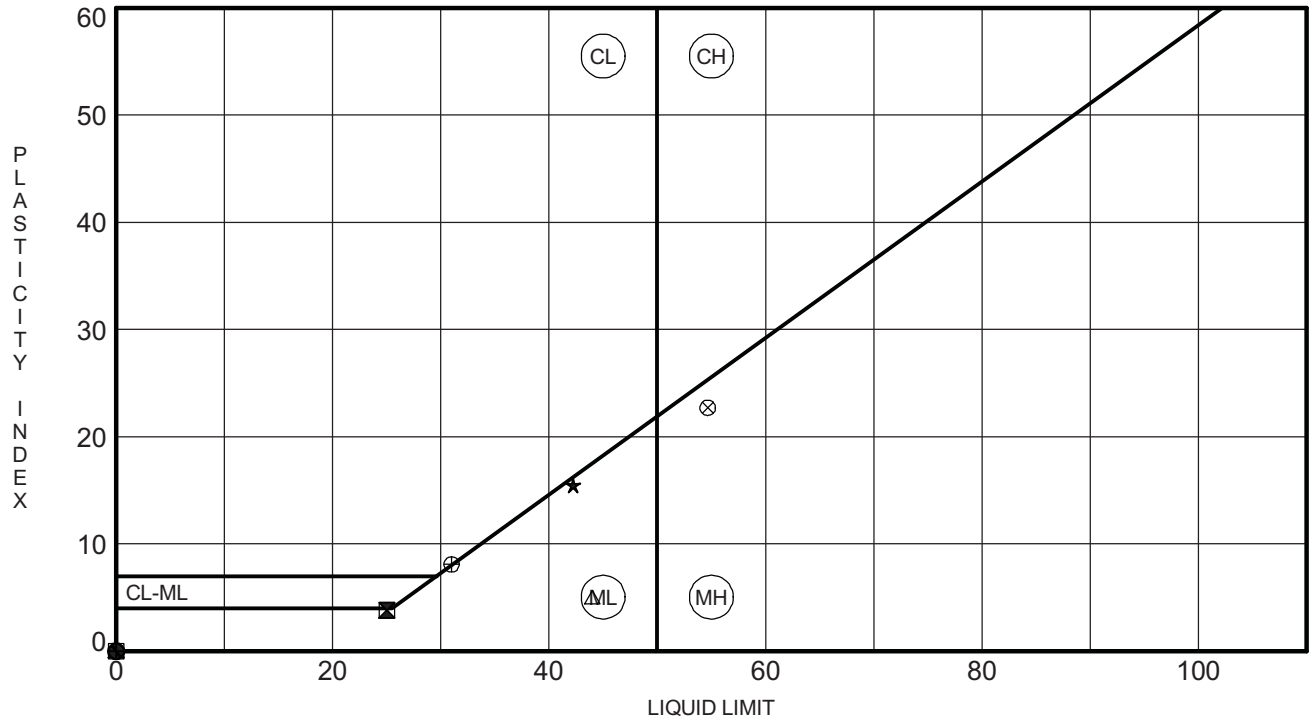
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**TS-1**	**82.0**	**4.76**	**0.384**	**0.076**		**0.0**	**50.9**	**49.1**	
⊠	**TS-1**	**106.0**	**4.76**	**0.31**			**0.0**	**43.2**	**56.8**	
▲	**TS-1**	**122.0**	**9.52**	**0.362**			**0.2**	**44.5**	**55.3**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	TS-1	8.0	NP	NP	NP	14	Silty Fine SAND (SM) A-2-4
⊠	TS-1	18.0	25	21	4	50	Silty, Clayey Fine SAND (SC-SM) A-4(0)
▲	TS-1	24.0	NP	NP	NP	16	Silty Fine SAND (SM) A-2-4
★	TS-1	28.0	42	27	15	66	Sandy SILT (ML) A-7-6(9)
⊙	TS-1	34.0	NP	NP	NP	28	Silty Fine SAND (SM) A-2-4
✿	TS-1	46.0	NP	NP	NP	12	Silty F/C SAND (SM) A-2-4
○	TS-1	48.0	NP	NP	NP	10	Poorly Graded F/C SAND (SP-SM)with Silt A-1-b
△	TS-1	58.0	44	39	5	64	Sandy SILT (ML) A-5(4)
⊗	TS-1	74.0	55	32	23	67	Sandy Elastic SILT (MH) A-7-5(16)
⊕	TS-1	78.0	31	23	8	65	Sandy SILT (ML) A-4(4)
□	TS-1	82.0	NP	NP	NP	49	Silty Fine SAND (SM) A-4(0)
⊛	TS-1	106.0	NP	NP	NP	57	Sandy SILT (ML) A-4(0)
◓	TS-1	122.0	NP	NP	NP	55	Sandy SILT (ML) A-4(0)

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1140 & 16-1212	**DATE SAMPLE RECEIVED:**	8/8/2016
DESCRIPTION OF SOIL:	Various		
TESTED BY:	MB	**DATE OF TESTING:**	8/10/2016
		DATE OF WEIGHING:	8/11/2016

BORING NO.	SB-1	SB-1	SB-1	SB-1	SB-1
SAMPLE NO.	16-1140A	16-1140D	16-1140G	16-1140J	16-1140M
SAMPLE DEPTH	44.0-46.0'	93.5-95.0'	138.5-140.0'	178.5-180.0'	238.5-240.0'
WATER CONTENT, W%	55.4	44.7	68.0	32.9	34.4

BORING NO.	SB-1	SB-1	SB-1	SB-1	SB-1
SAMPLE NO.	16-1212A	16-1212D	16-1212G	16-1212J	16-1212M
SAMPLE DEPTH	275.0-277.0'	303.0-308.0'	338.0-343.0'	358.0-363.0'	381.0-385.0'
WATER CONTENT, W%	30.1	30.3	25.9	17.4	38.3

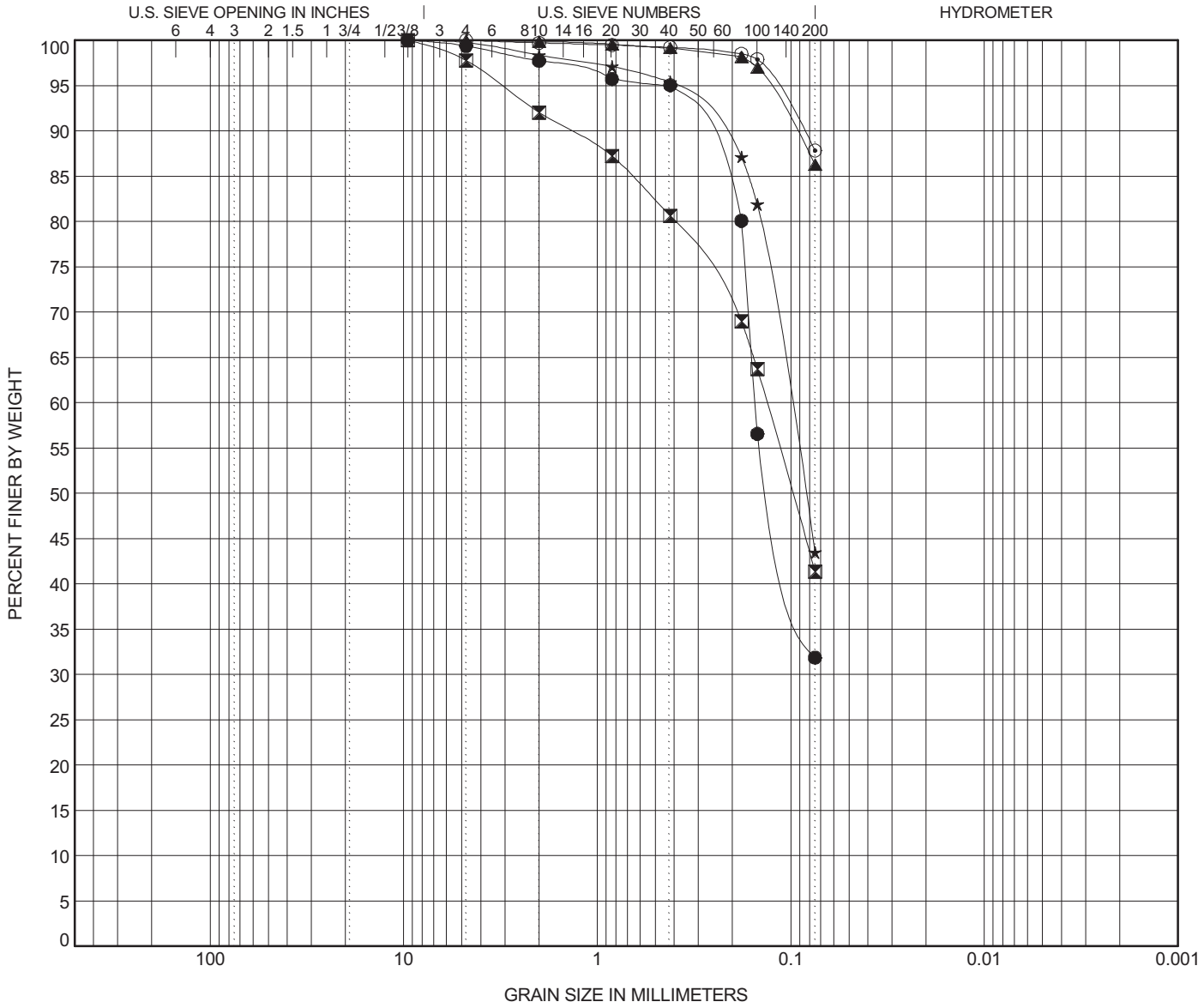
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**SB-1**	**46.0**	**Clayey Fine SAND (SC) A-2-7(2)**	**42**	**20**	**22**		
⊠	**SB-1**	**95.0**	**Silty Fine SAND (SM) A-4(0)**	**NP**	**NP**	**NP**		
▲	**SB-1**	**140.0**	**Fat CLAY (CH) A-7-6(33)**	**63**	**29**	**34**		
★	**SB-1**	**180.0**	**Silty Fine SAND (SM) A-4(0)**	**NP**	**NP**	**NP**		
⊙	**SB-1**	**240.0**	**Lean CLAY (CL) A-6(16)**	**40**	**23**	**17**		

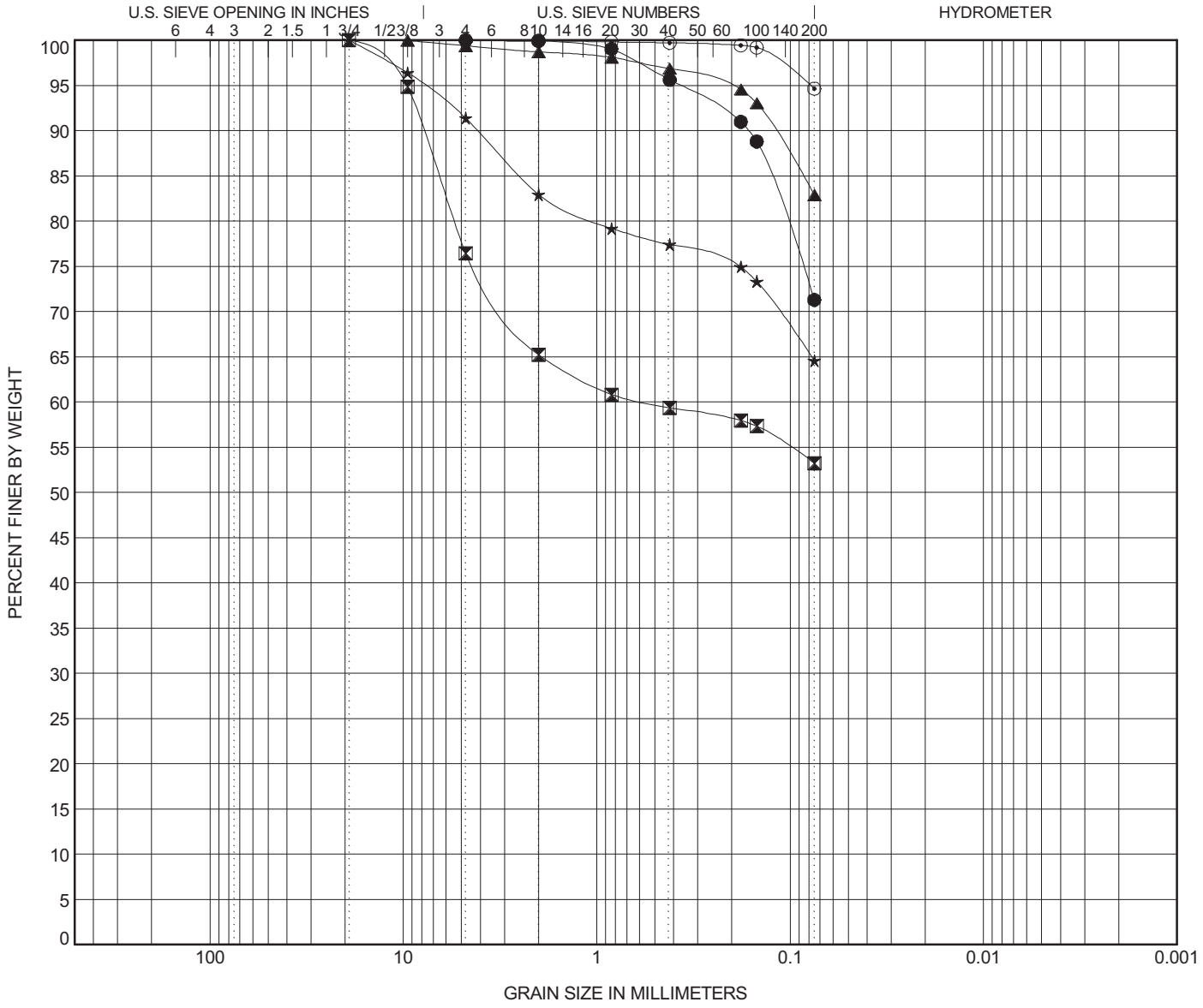
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**SB-1**	**46.0**	**9.52**	**0.419**	**0.124**		**0.6**	**67.5**	**31.9**	
⊠	**SB-1**	**95.0**	**9.52**	**3.117**	**0.098**		**2.2**	**56.5**	**41.3**	
▲	**SB-1**	**140.0**	**4.76**	**0.131**			**0.0**	**13.7**	**86.3**	
★	**SB-1**	**180.0**	**9.52**	**0.402**	**0.084**		**0.2**	**56.3**	**43.5**	
⊙	**SB-1**	**240.0**	**4.76**	**0.122**			**0.0**	**12.2**	**87.8**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 11/2/16

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**SB-1**	**277.0**	**SILT (ML) with Sand A-4(1)**	**32**	**30**	**2**		
⊠	**SB-1**	**308.0**	**Gravelly SILT (ML) with Sand A-4(1)**	**37**	**34**	**3**		
▲	**SB-1**	**343.0**	**SILT (ML) with Sand A-6(12)**	**40**	**26**	**14**		
★	**SB-1**	**363.0**	**Sandy SILT (ML) A-4(4)**	**33**	**24**	**9**		
⊙	**SB-1**	**385.0**	**Elastic SILT (MH) A-7-5(31)**	**63**	**38**	**25**		

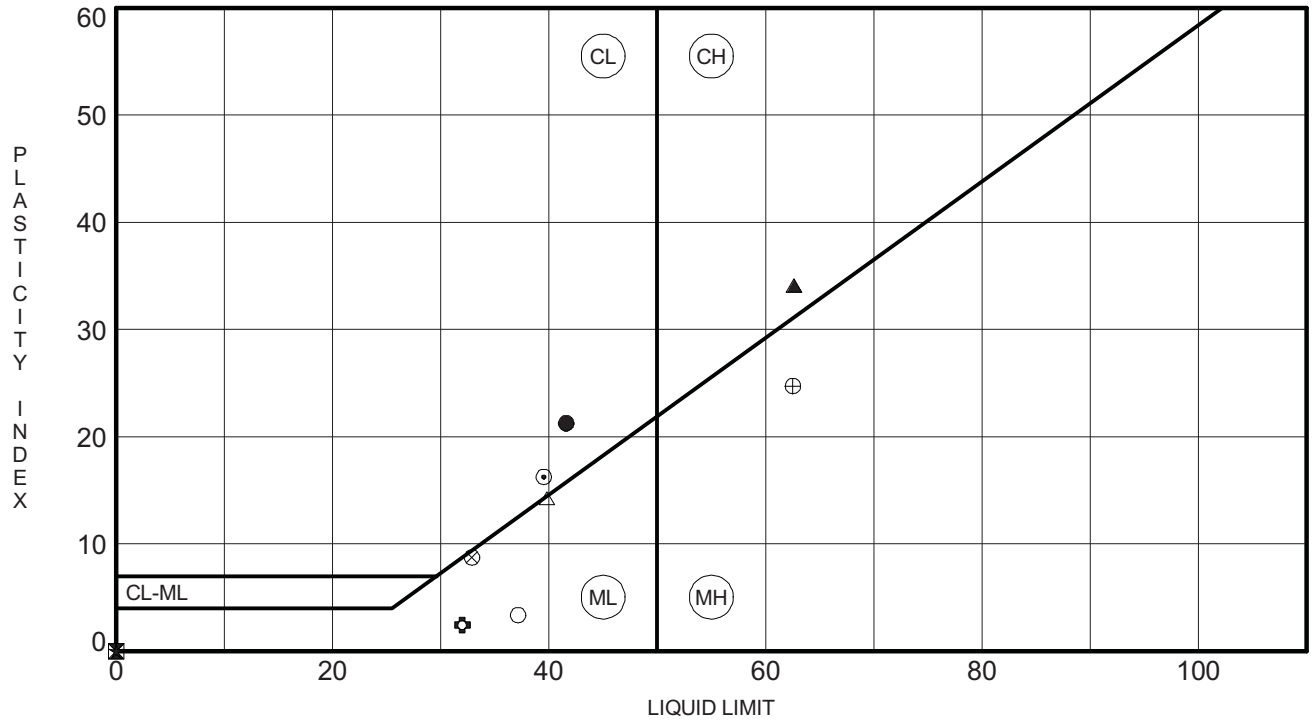
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**SB-1**	**277.0**	**4.76**	**0.374**			**0.0**	**28.7**	**71.3**	
⊠	**SB-1**	**308.0**	**19.1**	**9.69**			**23.6**	**23.2**	**53.3**	
▲	**SB-1**	**343.0**	**9.52**	**0.21**			**0.6**	**16.5**	**82.9**	
★	**SB-1**	**363.0**	**19.1**	**7.814**			**8.6**	**26.8**	**64.6**	
⊙	**SB-1**	**385.0**	**4.76**	**0.079**			**0.0**	**5.3**	**94.7**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 11/2/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	SB-1	46.0	42	20	22	32	Clayey Fine SAND (SC) A-2-7(2)
⊠	SB-1	95.0	NP	NP	NP	41	Silty Fine SAND (SM) A-4(0)
▲	SB-1	140.0	63	29	34	86	Fat CLAY (CH) A-7-6(33)
★	SB-1	180.0	NP	NP	NP	43	Silty Fine SAND (SM) A-4(0)
⊙	SB-1	240.0	40	23	17	88	Lean CLAY (CL) A-6(16)
✿	SB-1	277.0	32	30	2	71	SILT (ML) with Sand A-4(1)
○	SB-1	308.0	37	34	3	53	Gravelly SILT (ML) with Sand A-4(1)
△	SB-1	343.0	40	26	14	83	SILT (ML) with Sand A-6(12)
⊗	SB-1	363.0	33	24	9	65	Sandy SILT (ML) A-4(4)
⊕	SB-1	385.0	63	38	25	95	Elastic SILT (MH) A-7-5(31)

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

ORGANIC IMPURITIES DETERMINATION
(AASHTO T267)

PROJECT:	US 21 Bridge Replacment over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1140	**DATE SAMPLE RECEIVED:**	8/8/2016
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MB	**DATE OF TESTING:**	8/10/2016
		DATE OF WEIGHING:	8/10/2016

BORING NO.	SB-1	SB-1			
SAMPLE NO.	16-1140R/SS-10	16-1140S/SS-19			
SAMPLE DEPTH	18.0-20.0'	36.0-38.0'			
WT. OF CRUCIBLE + DRY SOIL (BEFORE IGNITION) (GRAMS)	169.95	175.57			
WT. OF CRUCIBLE + DRY SOIL (AFTER IGNITION) (GRAMS)	169.18	175.00			
WT. OF CRUCIBLE (GRAMS)	129.95	135.57			
WT. OF DRY SOIL (BEFORE IGNITION) (GRAMS)	40.00	40.00			
WT. OF DRY SOIL (AFTER IGNITION) (GRAMS)	39.23	39.43			
IGNITION LOSS (GRAMS)	0.77	0.57			
ORGANIC IMPURITIES %	1.92	1.42			

Client:	FME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	08/23/16
Tested By:	jbr
Checked By:	jdt

Rapid Determination of Carbonate Content of Soils by ASTM D4373

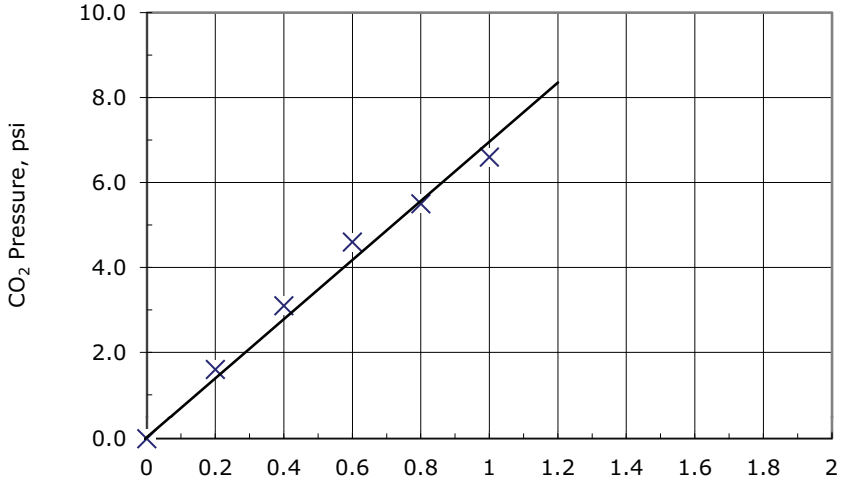
Boring ID	Sample ID	Depth, ft	*CO_2 Pressure, psi	Weight of Sample used, g	Weight $CaCO_3$, grams	Calcite Equivalent, %
SB-1	16-1140P	168.5-170	6.20	1.00	5.09	509
SB-1	16-1140Q	198.5-200	5.40	1.00	4.43	443
SB-1	16-1212U	255-257	4.40	1.00	3.61	361
SB-1	16-1212V	308-313	3.90	1.00	3.20	320
SB-1	16-1212W	373-378	2.70	1.00	2.22	222

Notes: Calcium Carbonate content precise to +/- 1.5%

*CO_2 Pressure is based on the weight of sample as indicated in the table.

The reported Calcite Equivalent (%) is based on one gram

Figure 1: Calibration Curve

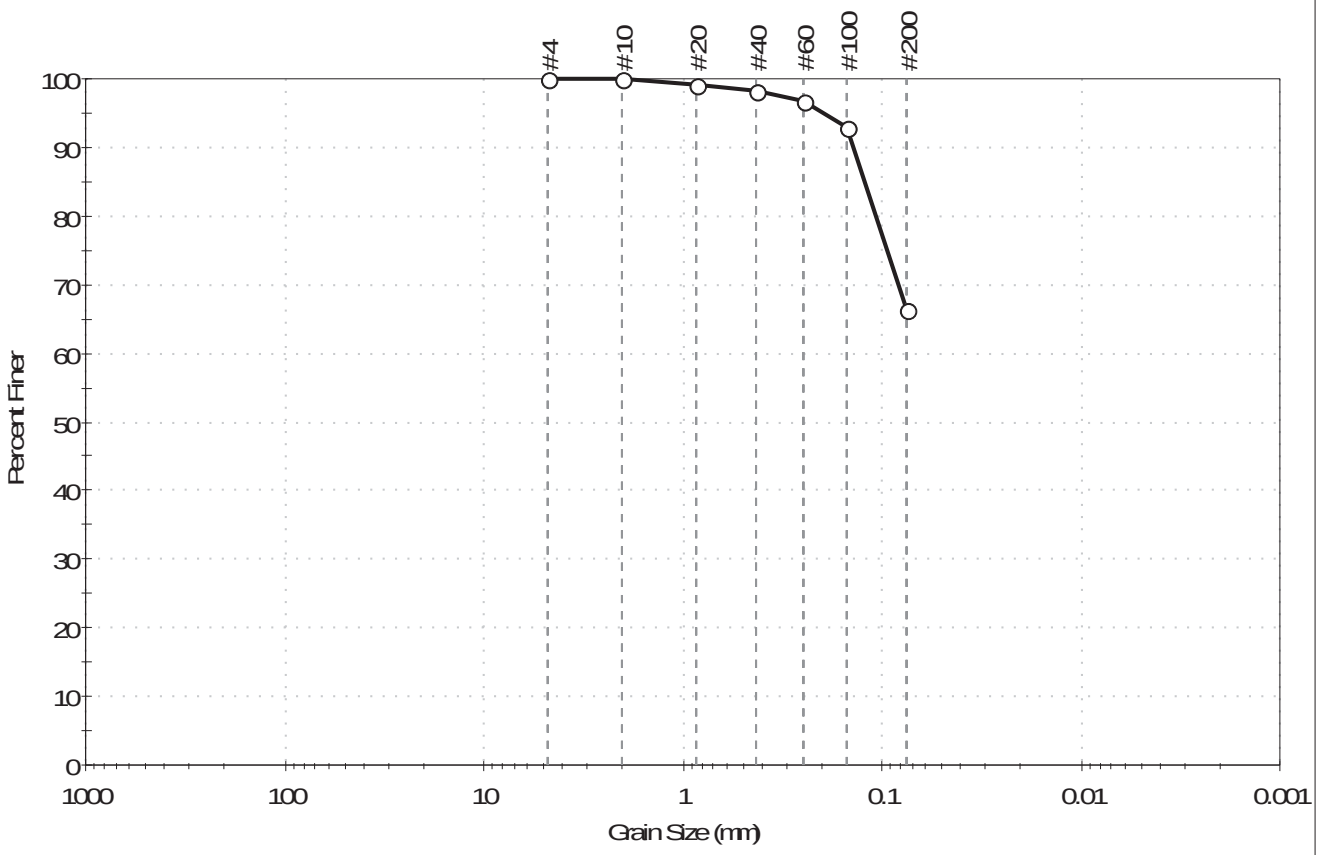


Weight Calcium Carbonate, g

% Calcite Equivalent = Weight x 100

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	SB-1	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-1	Test Date:	11/04/16	Checked By:	mcm
Depth :	130.0-133.5 ft	Test Id:	397424		
Test Comment:	---				
Visual Description:	Moist, olive sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



%Cobble	%Gravel	%Sand	%Silt & Clay Size
—	0.0	33.7	66.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	98		
#60	0.25	97		
#100	0.15	93		
#200	0.075	66		

Coefficients

D_{85} = 0.1220 mm	D_{30} = N/A
D_{60} = N/A	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Sandy Silt (ML)

AASHTO Clayey Soils (A-7-5 (8))

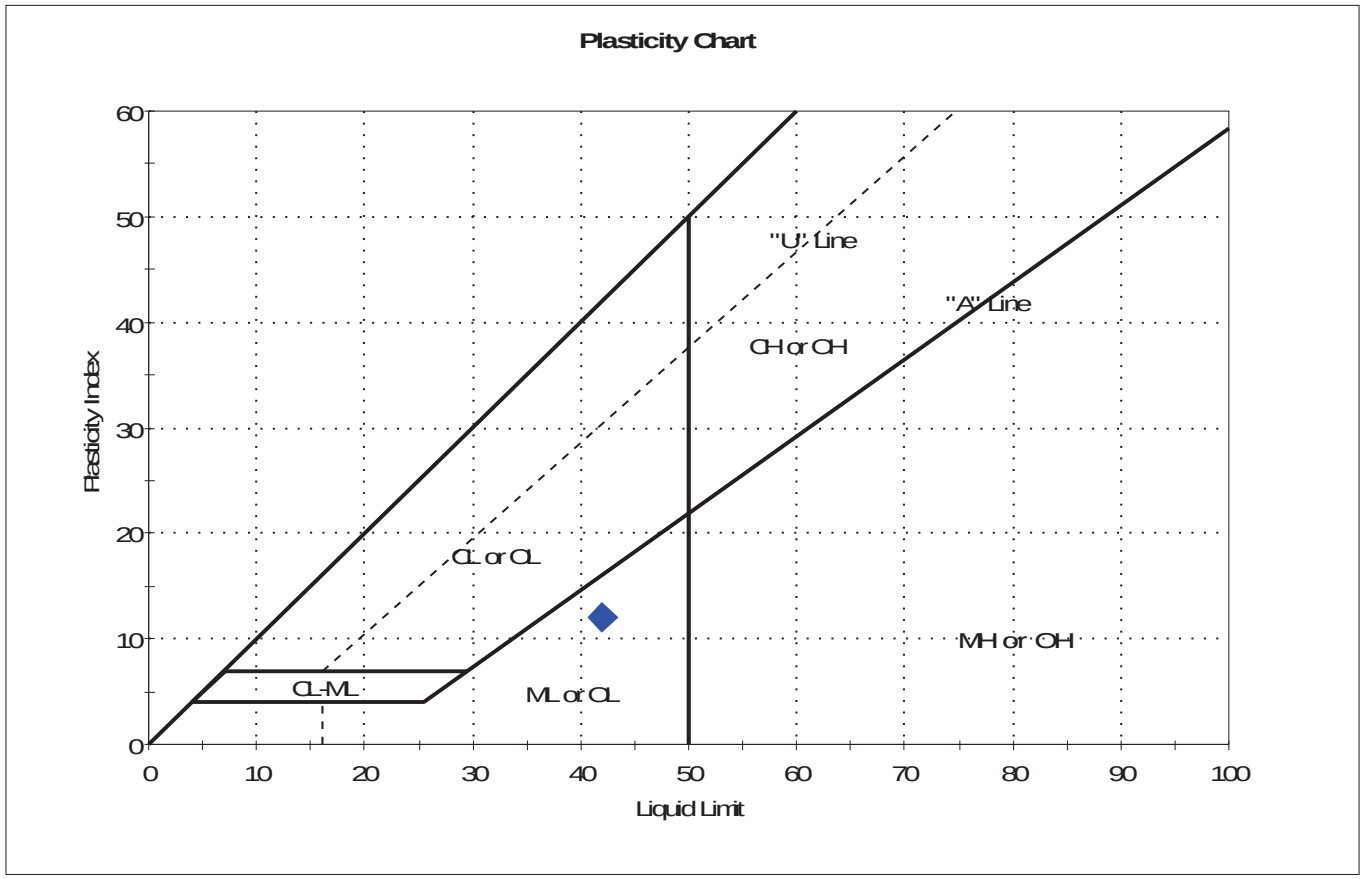
Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	SB-1	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-1	Test Date:	11/04/16	Checked By:	mcm
Depth :	130.0-133.5 ft	Test Id:	397422		
Test Comment:	---				
Visual Description:	Moist, olive sandy silt				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	UD-1	SB-1	130.0-133.5 ft	38	42	30	12	0.6	Sandy Silt (ML)

Sample Prepared using the WET method
2% Retained on #40 Sieve
Dry Strength: HIGH
Dilatancy: SLOW
Toughness: LOW

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	---	Sample Type:	---	Tested By:	jbr
Sample ID:	---	Test Date:	08/30/16	Checked By:	mcm
Depth :	---	Test Id:	387124		

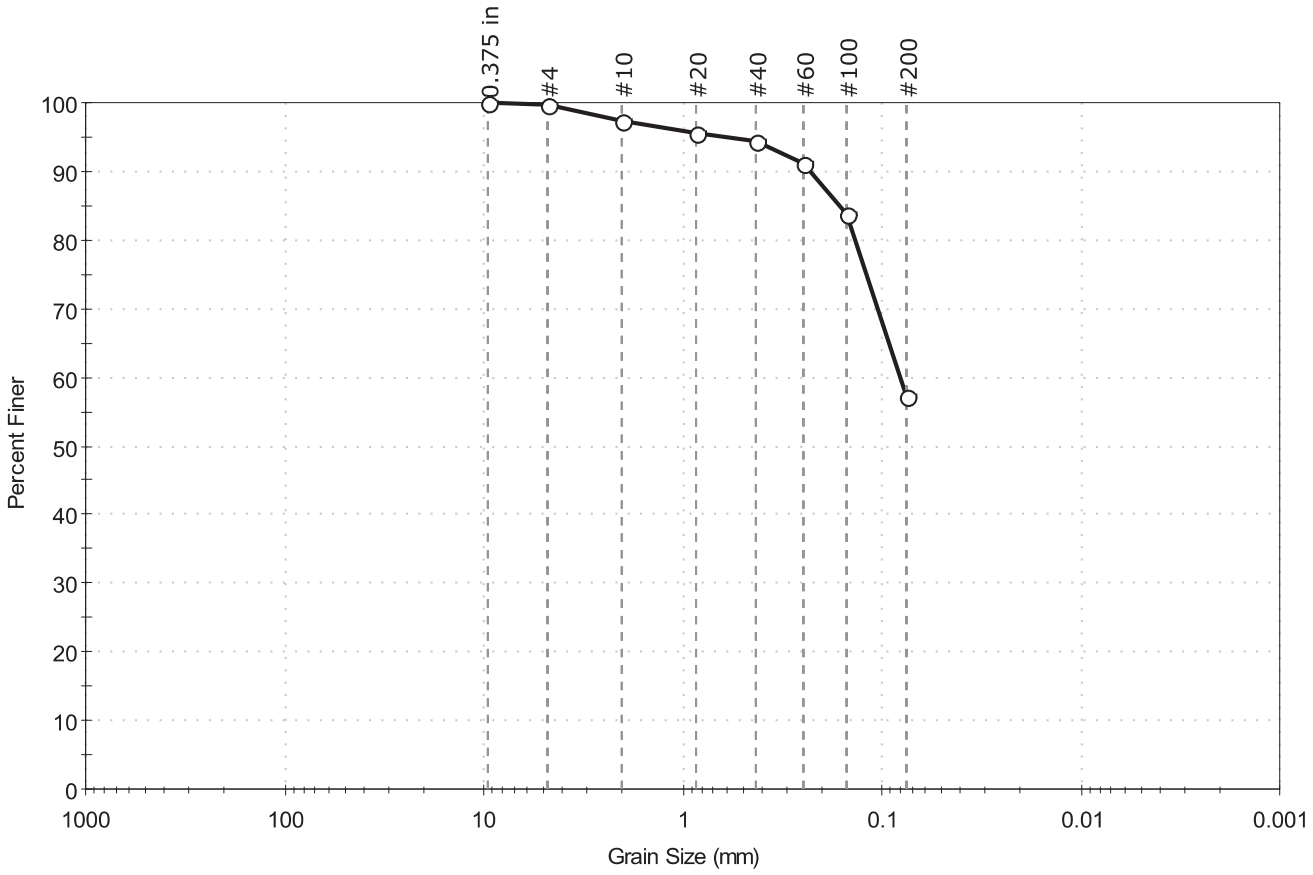
Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
SB-1	UD- 2	145.0-148.0 ft	Moist, olive sandy silt	33.1

Notes: Temperature of Drying : 110º Celsius

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	SB-1	Sample Type:	tube	Tested By:	jbr
Sample ID:	UD-2	Test Date:	08/31/16	Checked By:	mcm
Depth :	145.0-148.0 ft	Test Id:	387107		
Test Comment:	---				
Visual Description:	Moist, olive sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.2	42.5	57.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	97		
#20	0.85	96		
#40	0.42	94		
#60	0.25	91		
#100	0.15	84		
#200	0.075	57		

Coefficients

D_{85} =0.1641 mm	D_{30} =N/A
D_{60} =0.0805 mm	D_{15} =N/A
D_{50} =N/A	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM Sandy Silt (ML)

AASHTO Clayey Soils (A-6 (6))

Sample/Test Description

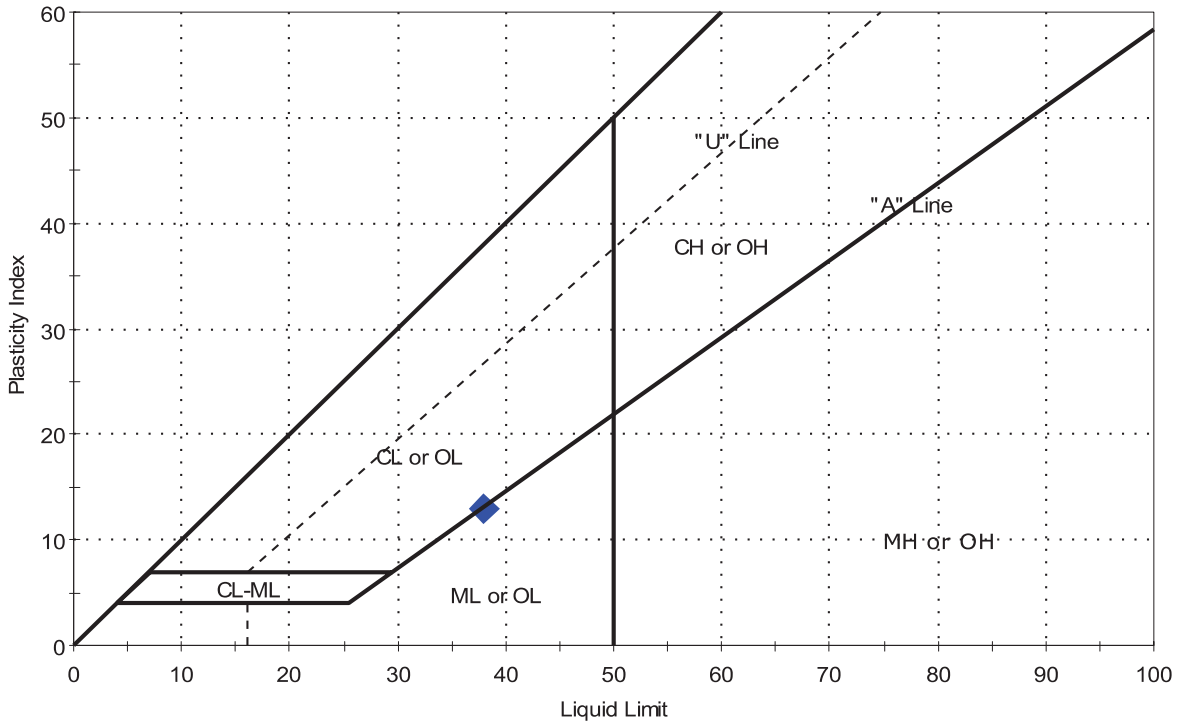
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

printed 9/8/2016 3:36:05 PM

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	SB-1	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-2	Test Date:	08/31/16	Checked By:	mcm
Depth :	145.0-148.0 ft	Test Id:	387115		
Test Comment:	---				
Visual Description:	Moist, olive sandy silt				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



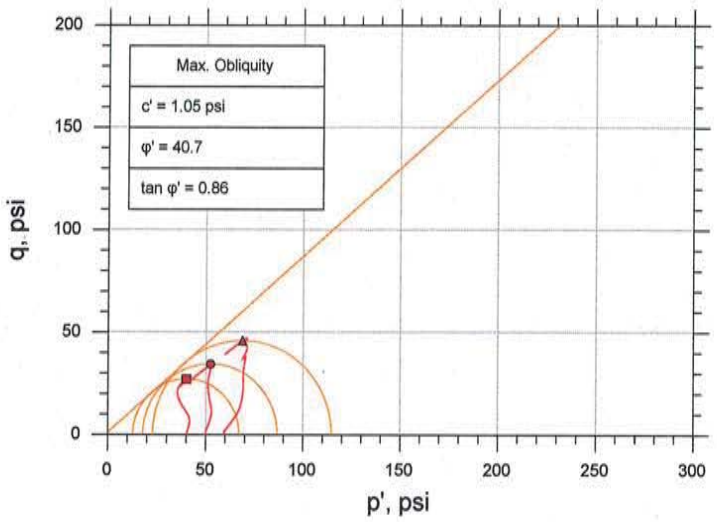
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	UD-2	SB-1	45.0-148. ft	33	38	25	13	0.6	Sandy Silt (ML)

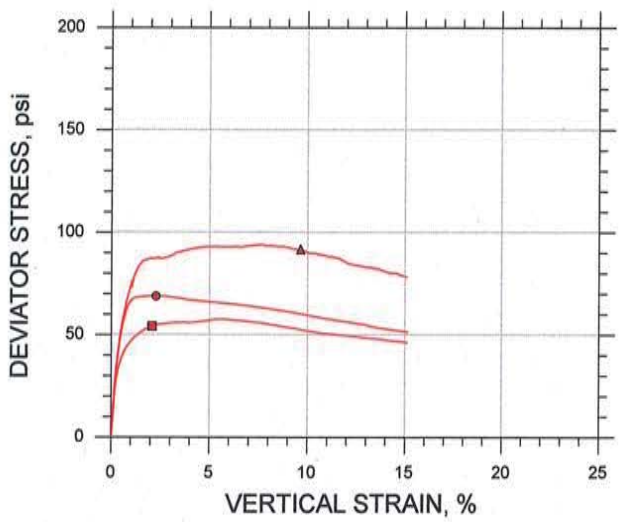
Sample Prepared using the WET method
6% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: RAPID
Toughness: LOW

GeoTesting EXPRESS

Client: F&ME Consultants	
Project Name: US-21 Replacement Bridge	
Project Location: ---	
Project Number: GTX-305005	
Tested By: md	Checked By: mcm
Boring ID: SB-1	
Preparation: intact	
Description: Moist, olive sandy silt	
Classification: Sandy silt	
Group Symbol: ML	
Liquid Limit: 38	Plastic Limit: 25
Plasticity Index: 13	Estimated Specific Gravity: 2.7

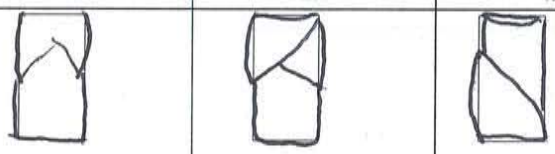
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		■	●	▲	
Sample ID		UD-2	UD-2	UD-2	
Depth, ft		145.0-148.0 ft	145.0-148.0 ft	145.0-148.0 ft	
Test Number		CU-8-1	CU-8-2	CU-8-3	
Initial	Height, in	6.100	5.890	6.200	
	Diameter, in	2.860	2.850	2.850	
	Moisture Content (from Cuttings), %	33.8	33.2	29.9	
	Dry Density, pcf	85.9	88.2	93.1	
	Saturation (Wet Method), %	94.8	98.2	99.7	
	Void Ratio	0.963	0.912	0.810	
Before Shear	Moisture Content, %	33.3	31.2	25.8	
	Dry Density, pcf	88.8	91.5	99.3	
	Cross-sectional Area (Method A), in²	6.273	6.205	6.049	
	Saturation, %	100.0	100.0	100.0	
	Void Ratio	0.898	0.842	0.698	
	Back Pressure, psi	131.0	121.0	33.00	
Vertical Effective Consolidation Stress, psi		39.97	49.98	59.94	
Horizontal Effective Consolidation Stress, psi		40.00	50.00	59.99	
Vertical Strain after Consolidation, %		0.7774	0.7386	0.8643	
Volumetric Strain after Consolidation, %		2.735	3.028	5.571	
Time to 50% Consolidation, min		1.000	0.6400	1.000	
Shear Strength, psi		27.13	34.45	45.85	
Strain at Failure, %		2.08	2.27	9.63	
Strain Rate, %/min		0.01600	0.01600	0.01600	
Deviator Stress at Failure, psi		54.25	68.90	91.70	
Effective Minor Principal Stress at Failure, psi		12.82	17.93	22.91	
Effective Major Principal Stress at Failure, psi		67.07	86.84	114.6	
B-Value		0.96	0.95	1.00	

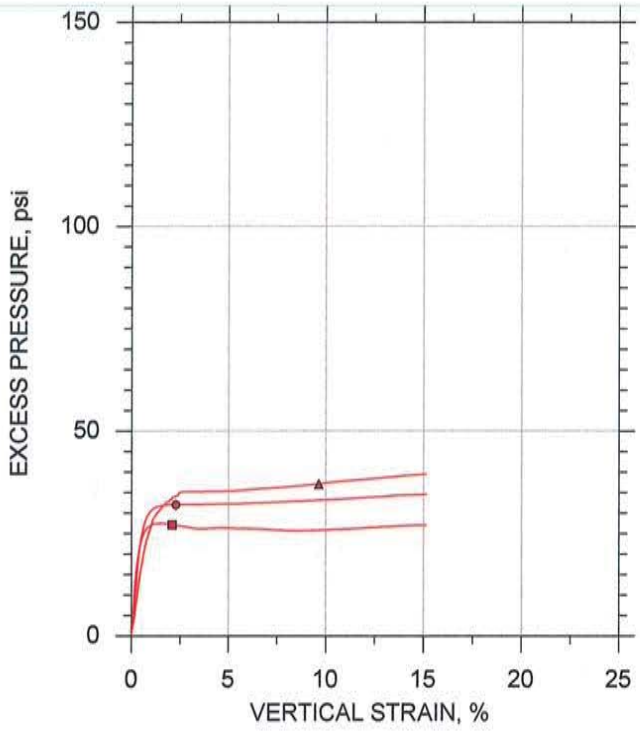
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

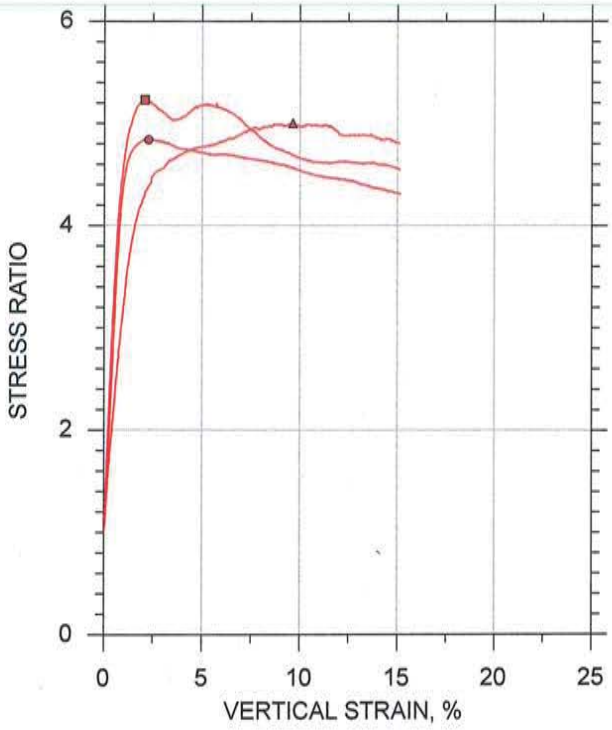


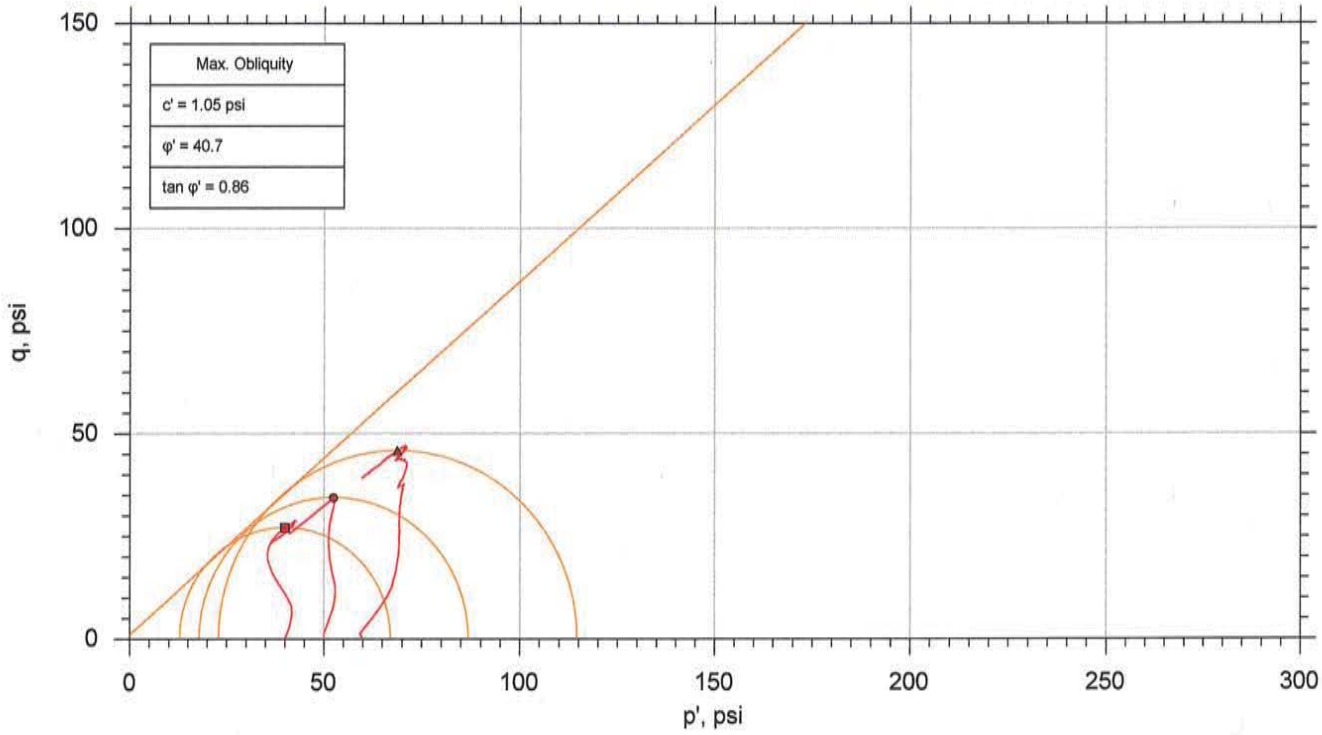
Remarks:

System O

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







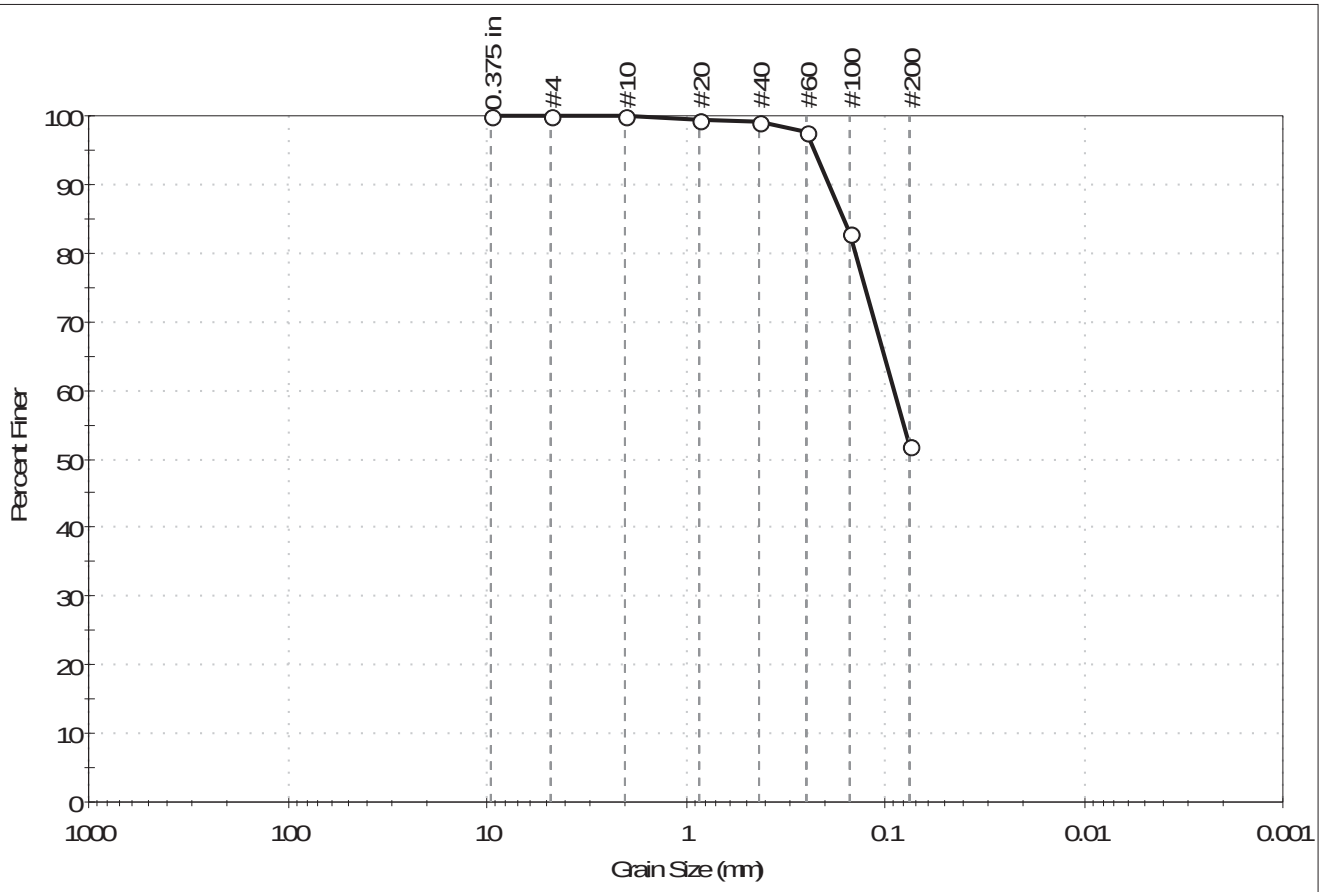
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	UD-2	CU-8-1	145.0-148.0 ft	md	8/28/16	mcm	9/9/16	305005-CU-8-1m.dat
●	UD-2	CU-8-2	145.0-148.0 ft	md	8/28/16	mcm	9/8/16	305005-CU-8-2m.dat
▲	UD-2	CU-8-3	145.0-148.0 ft	md	8/28/16	mm	9/9/16	305005-CU-8-3m.dat

GeoTesting EXPRESS

Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: SB-1	Sample Type: intact	
Description: Moist, olive sandy silt		
Remarks: System O		

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	SB-1	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-4	Test Date:	11/04/16	Checked By:	mcm
Depth :	200.0-203.0 ft	Test Id:	397425		
Test Comment:	---				
Visual Description:	Moist, olive sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



%Cobble	%Gravel	%Sand	%Silt & Clay Size
–	0.1	47.8	52.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	98		
#100	0.15	83		
#200	0.075	52		

Coefficients

D_{85} = 0.1611 mm	D_{30} = N/A
D_{60} = 0.0896 mm	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Sandy Silt (ML)

AASHTO Clayey Soils (A-7-6 (6))

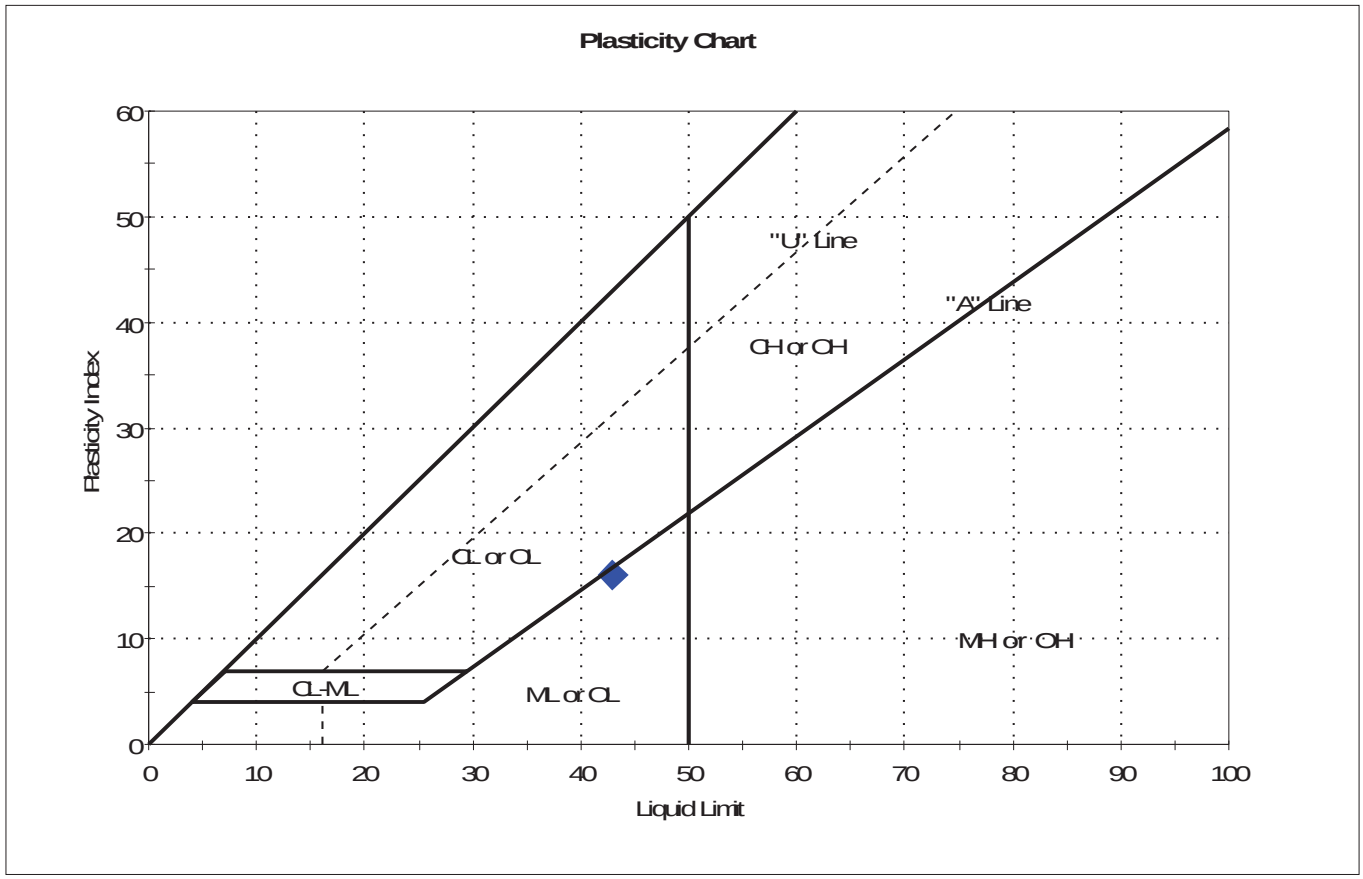
Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	SB-1	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-4	Test Date:	11/04/16	Checked By:	mcm
Depth :	200.0-203.0 ft	Test Id:	397423		
Test Comment:	---				
Visual Description:	Moist, olive sandy silt				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	UD-4	SB-1	00.0-203. ft	32	43	27	16	0.3	Sandy Silt (ML)

Sample Prepared using the WET method
1% Retained on #40 Sieve
Dry Strength: HIGH
Dilatancy: SLOW
Toughness: LOW

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	---	Sample Type:	---	Tested By:	jbr
Sample ID:	---	Test Date:	08/30/16	Checked By:	mcm
Depth :	---	Test Id:	387124		

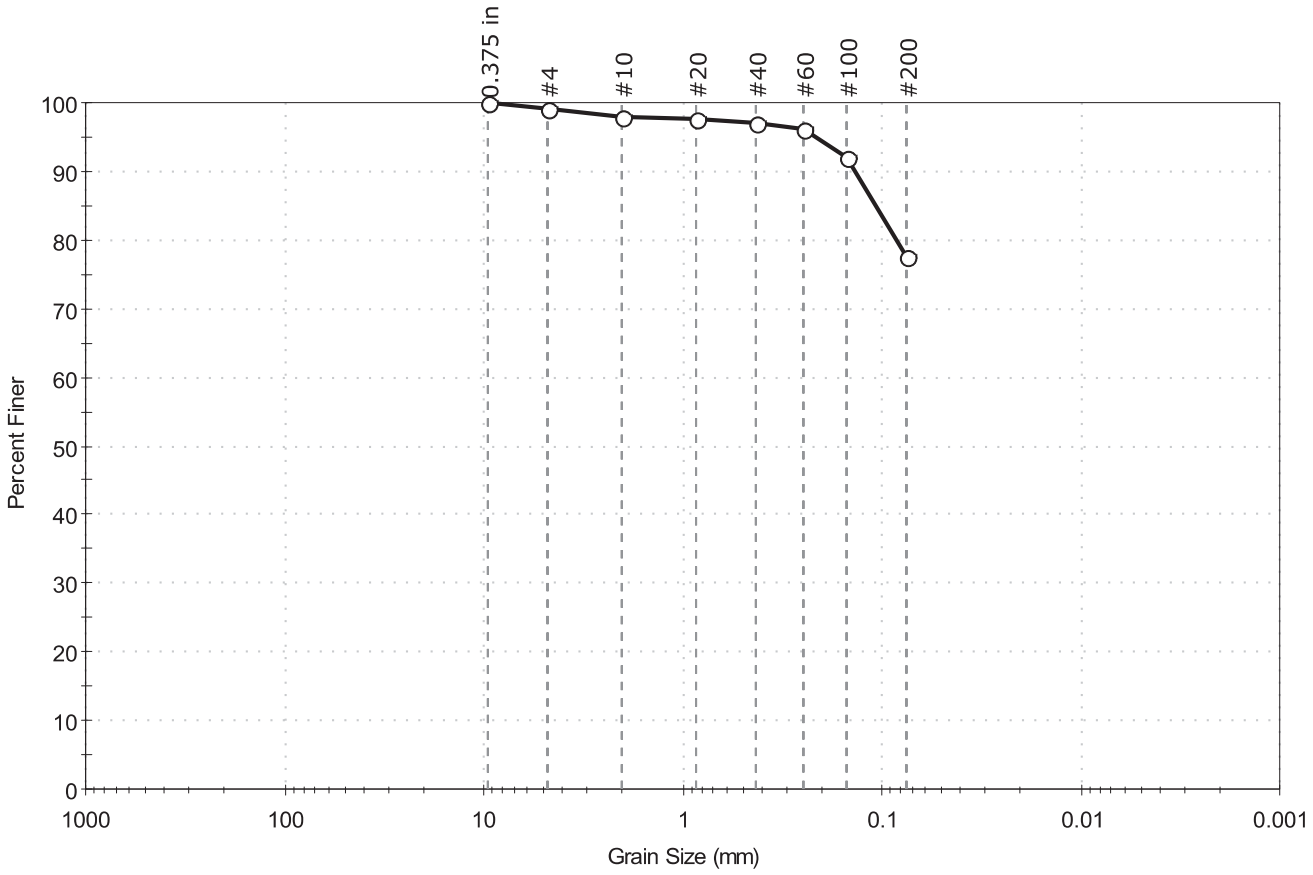
Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
SB-1	UD-5	230.0-233.0 ft	Moist, olive silt with sand	32.6

Notes: Temperature of Drying : 110º Celsius

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	SB-1	Sample Type:	tube	Tested By:	jbr
Sample ID:	UD-5	Test Date:	08/31/16	Checked By:	mcm
Depth :	230.0-233.0 ft	Test Id:	387108		
Test Comment:	---				
Visual Description:	Moist, olive silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.0	21.3	77.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	98		
#20	0.85	98		
#40	0.42	97		
#60	0.25	96		
#100	0.15	92		
#200	0.075	78		

Coefficients

D_{85} =0.1069 mm	D_{30} =N/A
D_{60} =N/A	D_{15} =N/A
D_{50} =N/A	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM Silt with sand (ML)

AASHTO Clayey Soils (A-7-5 (15))

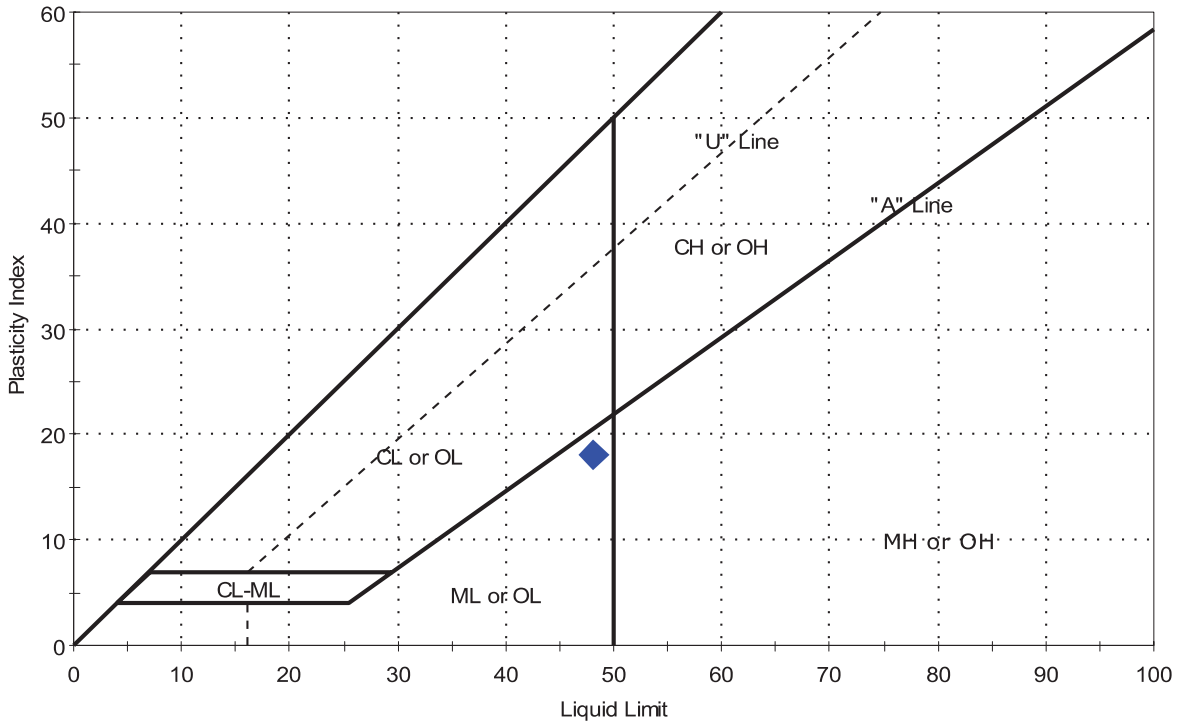
Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	SB-1	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-5	Test Date:	08/31/16	Checked By:	mcm
Depth :	230.0-233.0 ft	Test Id:	387116		
Test Comment:	---				
Visual Description:	Moist, olive silt with sand				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



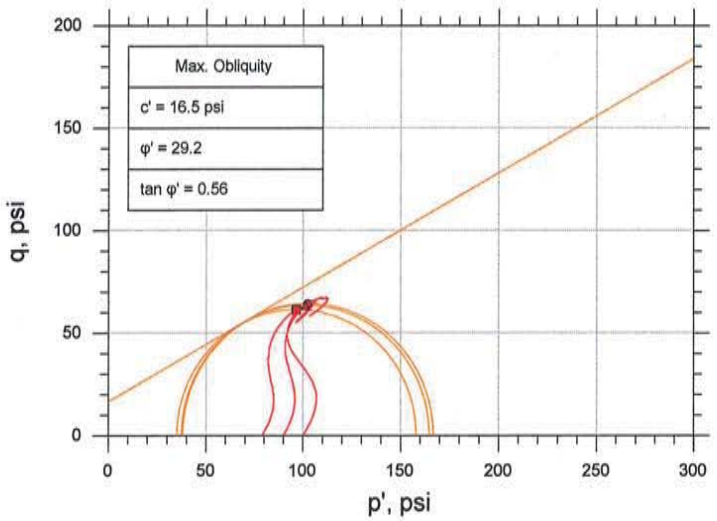
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	UD-5	SB-1	30.0-233. ft	33	48	30	18	0.1	Silt with sand (ML)

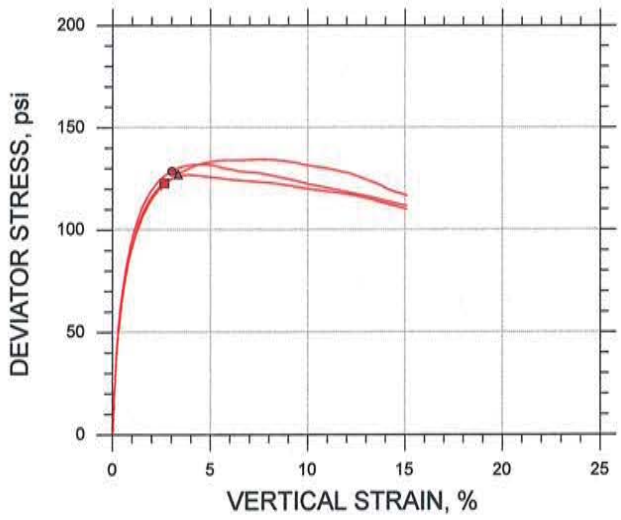
Sample Prepared using the WET method
3% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: RAPID
Toughness: LOW

GeoTesting EXPRESS

Client: F&ME Consultants	
Project Name: US-21 Replacement Bridge	
Project Location: ---	
Project Number: GTX-305005	
Tested By: md	Checked By: mcm
Boring ID: SB-1	
Preparation: intact	
Description: Moist, olive silt with sand	
Classification: Silt with sand	
Group Symbol: ML	
Liquid Limit: 48	Plastic Limit: 30
Plasticity Index: 18	Estimated Specific Gravity: 2.7

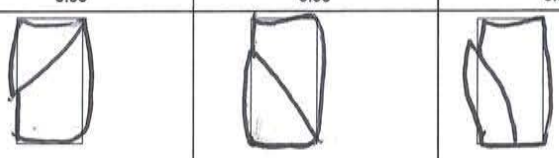
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		■	●	▲
Sample ID		UD-5	UD-5	UD-5
Depth, ft		230.0-233.0 ft	230.0-233.0 ft	230.0-233.0 ft
Test Number		CU-7-1	CU-7-2	CU-7-3
Initial	Height, in	6.150	6.150	6.100
	Diameter, in	2.850	2.840	2.830
	Moisture Content (from Cuttings), %	31.0	29.5	29.4
	Dry Density, pcf	89.8	89.9	90.8
	Saturation (Wet Method), %	95.5	91.2	92.6
	Void Ratio	0.876	0.875	0.857
Before Shear	Moisture Content, %	31.5	29.1	27.8
	Dry Density, pcf	91.1	94.4	96.3
	Cross-sectional Area (Method A), in²	6.371	6.129	6.058
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.849	0.785	0.750
	Back Pressure, psi	141.0	121.0	123.0
Vertical Effective Consolidation Stress, psi		79.96	89.91	99.90
Horizontal Effective Consolidation Stress, psi		80.02	90.00	100.0
Vertical Strain after Consolidation, %		1.201	1.611	2.136
Volumetric Strain after Consolidation, %		1.133	4.820	5.775
Time to 50% Consolidation, min		0.2500	13.39	42.25
Shear Strength, psi		61.43	64.32	63.57
Strain at Failure, %		2.64	3.03	3.35
Strain Rate, %/min		0.01600	0.01600	0.01600
Deviator Stress at Failure, psi		122.9	128.6	127.1
Effective Minor Principal Stress at Failure, psi		35.12	38.10	37.52
Effective Major Principal Stress at Failure, psi		158.0	166.7	164.7
B-Value		0.95	0.95	0.95

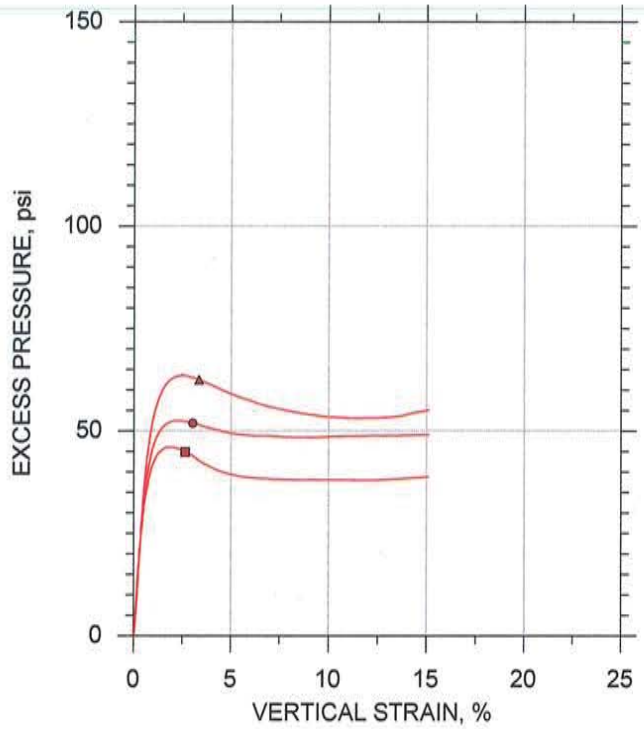
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

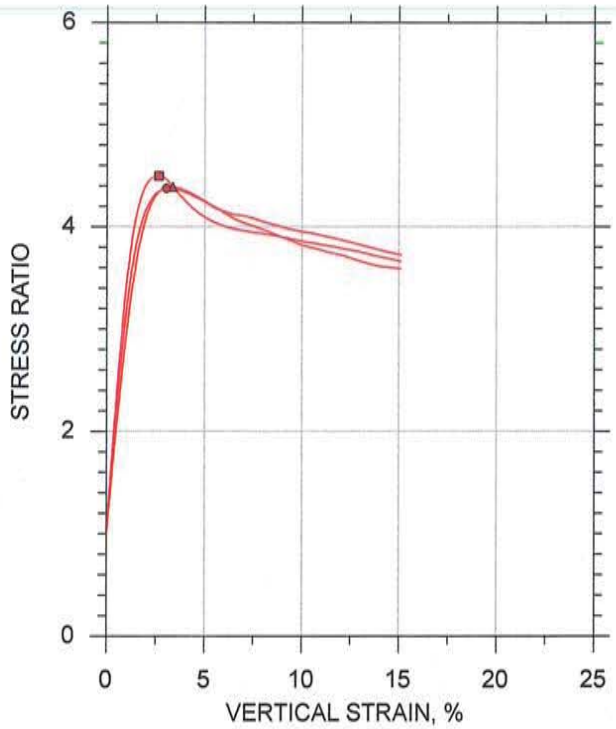


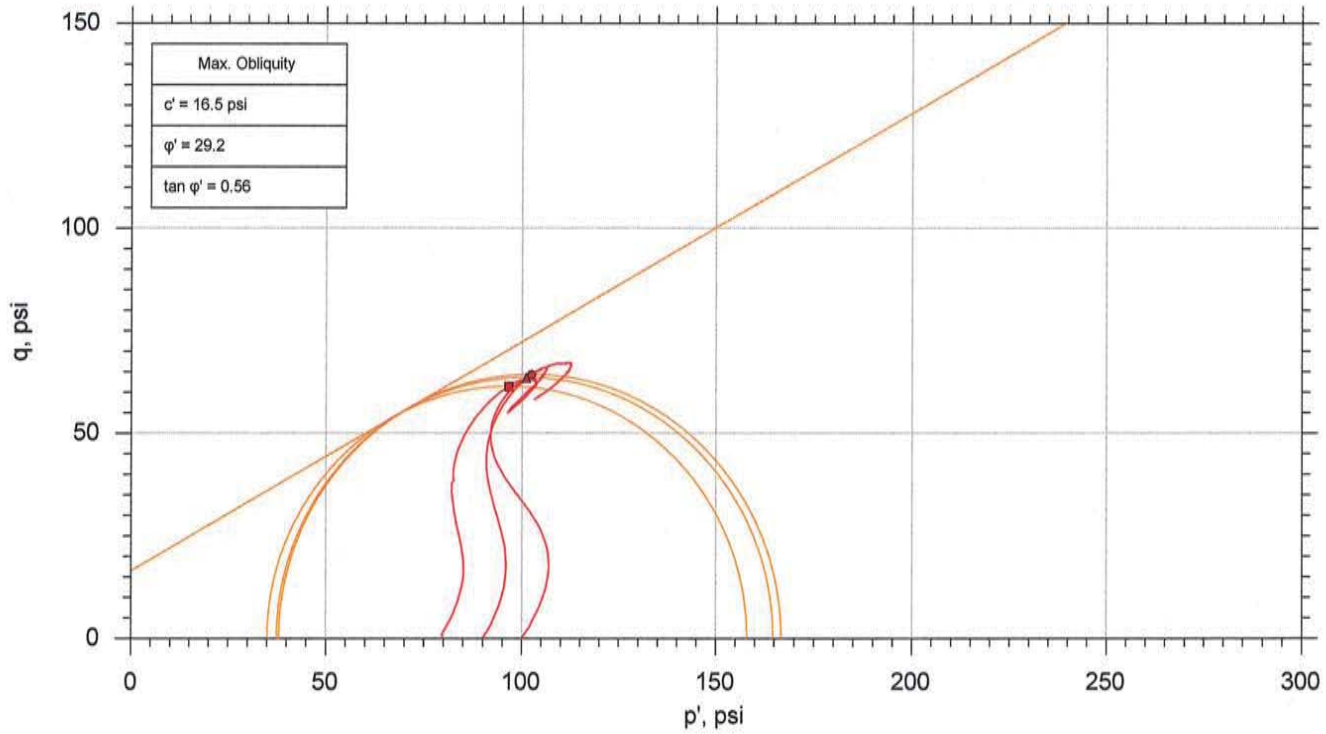
Remarks:

System K

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	UD-5	CU-7-1	230.0-233.0 ft	md	8/28/16	mcm	9/8/16	305005-CU-7-1m.dat
●	UD-5	CU-7-2	230.0-233.0 ft	md	8/26/16	mcm	9/8/16	305005-CU-7-2m.dat
▲	UD-5	CU-7-3	230.0-233.0 ft	md	8/26/16	mcm	9/8/16	305005-CU-7-3m.dat

GeoTesting EXPRESS

Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: SB-1	Sample Type: intact	
Description: Moist, olive silt with sand		
Remarks: System K		

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT: US 21 Bridge Replacement over Harbor River **PROJECT NO.:** G5396

SAMPLE NUMBER: 16-1208D **DATE SAMPLE RECEIVED:**

DESCRIPTION OF SOIL: Sandy Fat Clay (CH) A-7-6(34)

TESTED BY: Fugro **DATE OF TESTING:**

DATE OF WEIGHING:

BORING NO.	SB-1/UD-6				
SAMPLE NO.	16-1208D				
SAMPLE DEPTH	257.0-260.0'				
WATER CONTENT, W%	31.6				

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

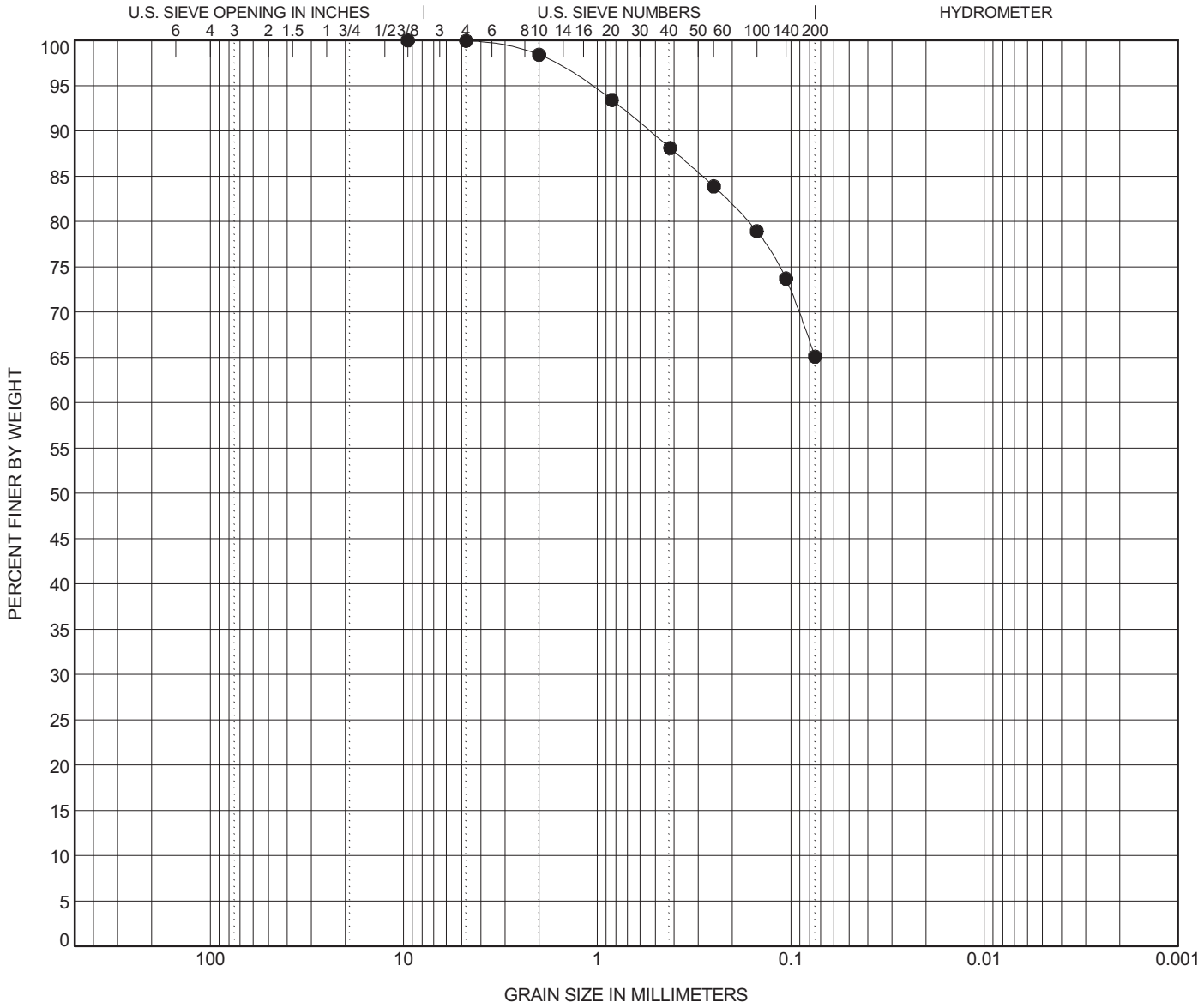
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

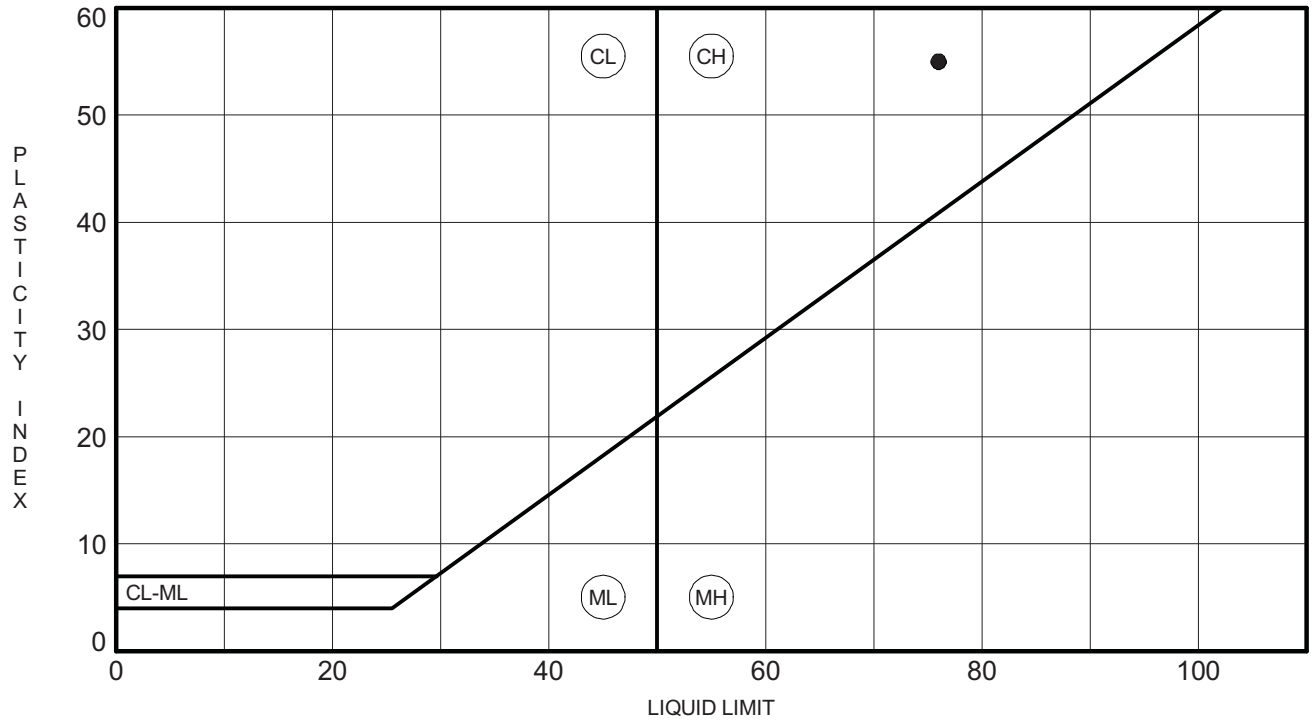
	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**SB-1**	**260.0**	**Sandy Fat CLAY (CH) A-7-6(34)**	**76**	**21**	**55**		

	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**SB-1**	**260.0**	**9.52**	**1.102**			**0.0**	**34.9**	**65.1**	

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**SB-1**	**260.0**	**76**	**21**	**55**	**65**	**Sandy Fat CLAY (CH) A-7-6(34)**

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT: US 21 Bridge Replacement over Harbor River **PROJECT NO.:** G5396

SAMPLE NUMBER: **DATE SAMPLE RECEIVED:**

DESCRIPTION OF SOIL: Fat Clay (CH) A-7-6(104)

TESTED BY: Fugro **DATE OF TESTING:**

DATE OF WEIGHING:

BORING NO.	SB-1/UD-9				
SAMPLE NO.	16-1211D				
SAMPLE DEPTH	378.0-381.0'				
WATER CONTENT, W%	39.3				

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

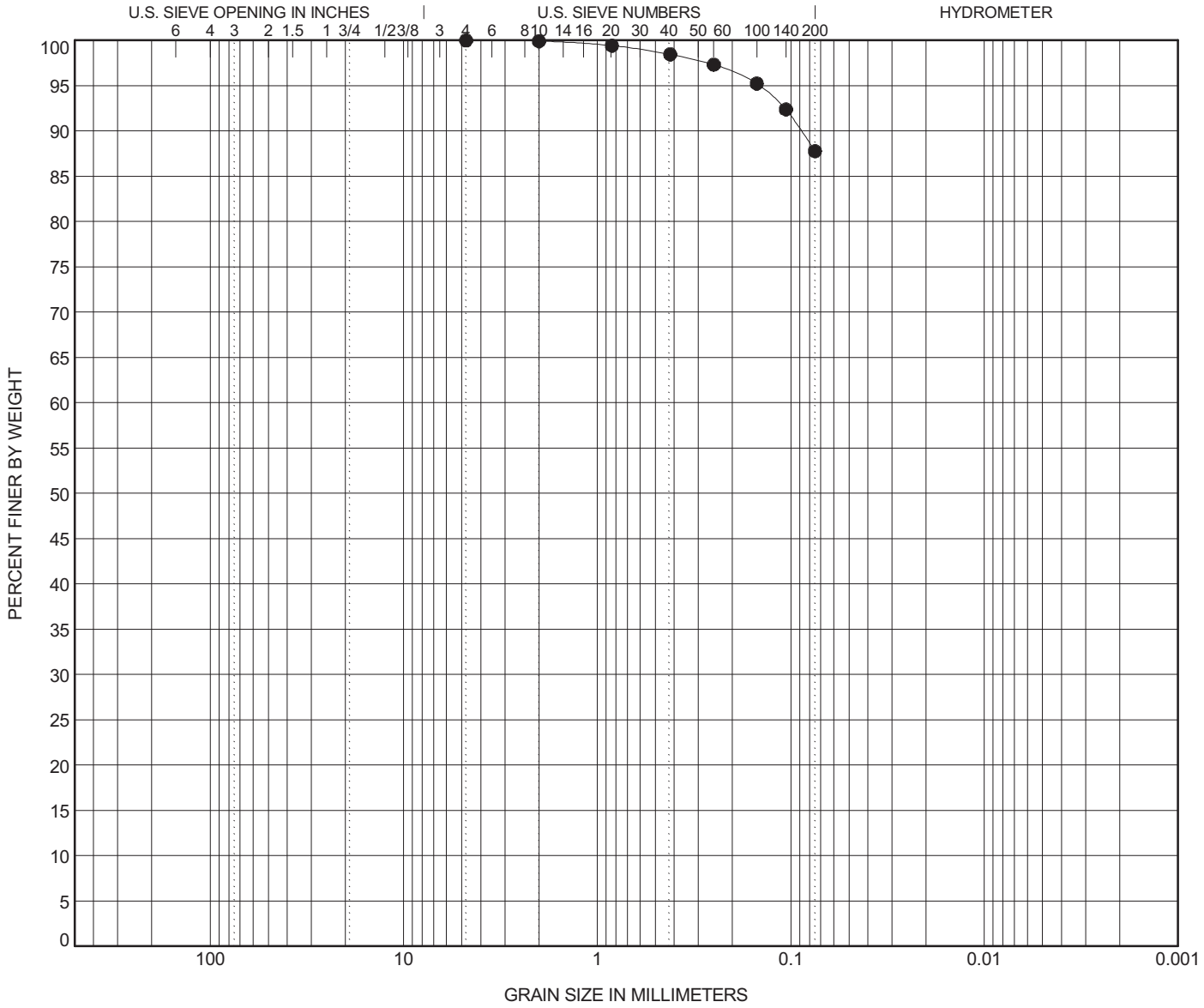
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● **SB-1**	**381.0**	**Fat CLAY (CH) A-7-6(104)**	**133**	**29**	**104**		

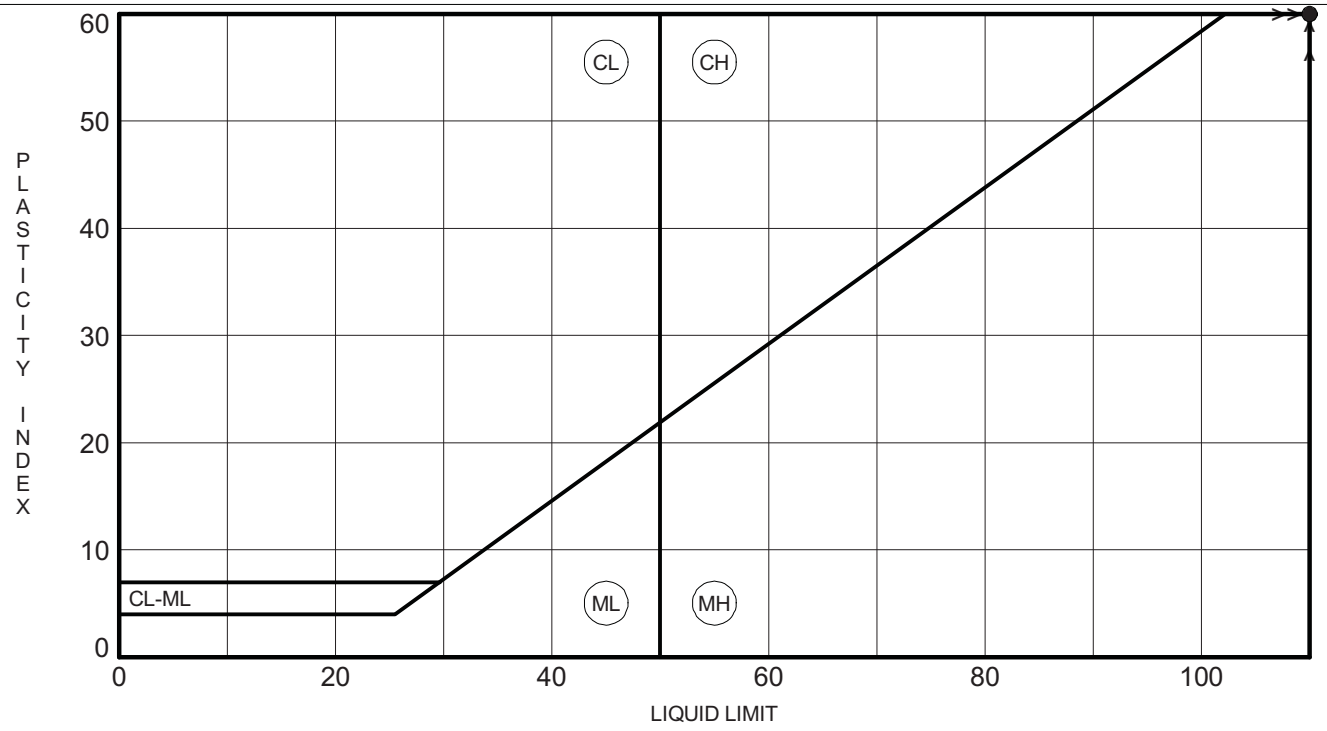
BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **SB-1**	**381.0**	**4.76**	**0.146**			**0.0**	**12.2**	**87.8**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 11/2/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

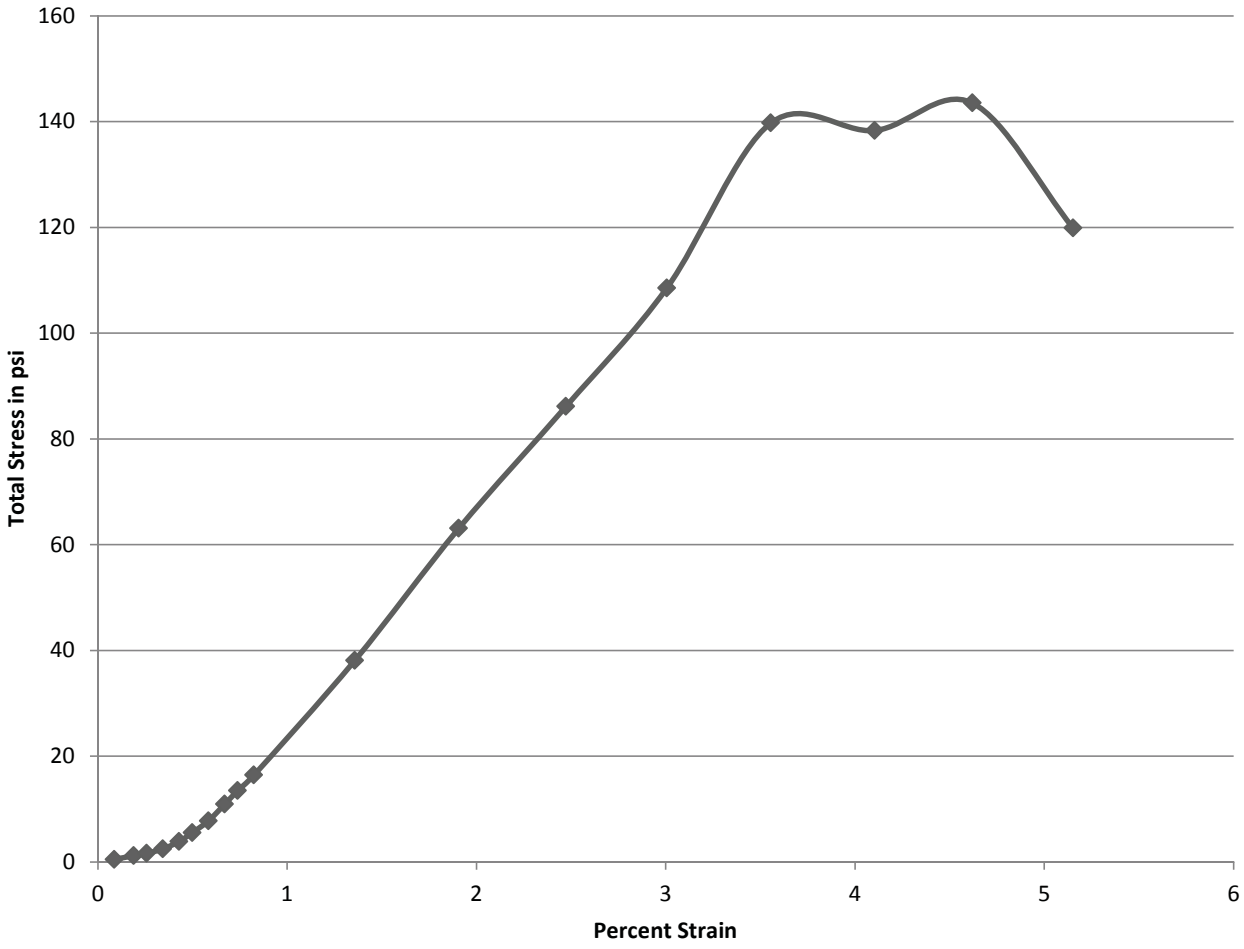
PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**SB-1**	**381.0**	**133**	**29**	**104**	**88**	**Fat CLAY (CH) A-7-6(104)**

UNCONFINED COMPRESSIVE STRENGTH TEST REPORT
ASTM D2166 / AASHTO T208

Stress/Strain Curve - Sample 16-1212P



Average Initial Diameter (Do):	2.328 in.	Sample Volume:	21.142 in^3
Average Initial Height (Lo):	4.967 in.	Sample Volume:	0.012 ft^3
Average Initial Area (Ao):	4.257 in^2	Moist Sample Weight:	1.47 lbs.
In-Situ Moist Unit Weight:	119.7 pcf	In-Situ Dry Unit Weight:	92.8 pcf
Failure Mode:			

Project Name	US-21 Bridge Replacement over Harbor River		
Project Number	G5396.00	Date	8/11/2016
SCDOT File #	P026862	PIN #	
Sample/Location	SB-1 / NQ-1		
Depth/Elevation	250.0' - 255.0'		

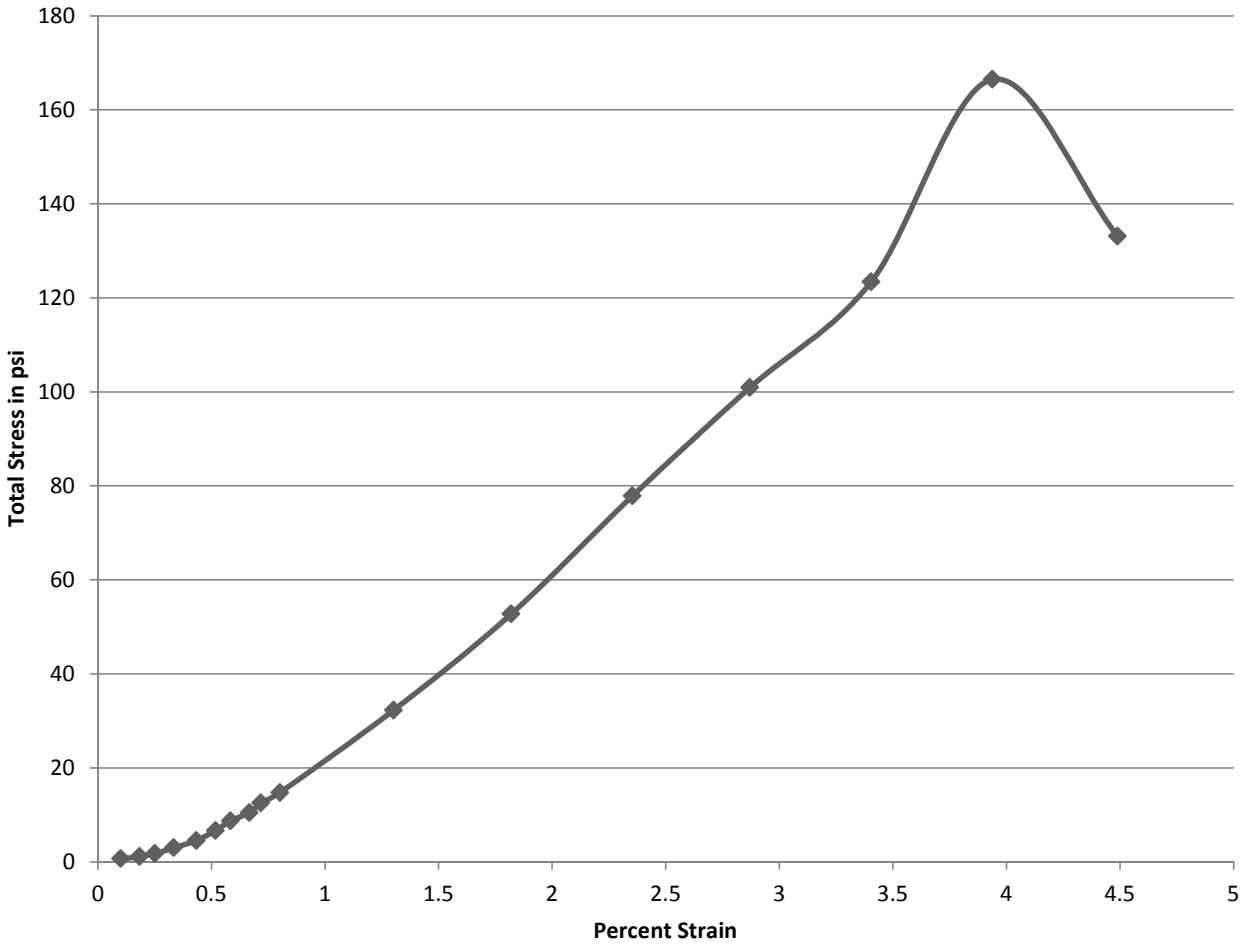
Sample Type : Undisturbed - Shelby Tube
Target Strain Rate : 1% per minute
Description:

PI=	% Fines=
NMC = 29.0%	L/D Ratio = 2.13
$\sigma_{c\text{-}ULT}$ = 143.5	ε_{ULT} = 4.6%

F&ME CONSULTANTS
3112 Devine Street Columbia, SC 29205
Geotechnical · Environmental · Materials

UNCONFINED COMPRESSIVE STRENGTH TEST REPORT
ASTM D2166 / AASHTO T208

Stress/Strain Curve - Sample 16-1212Q



Average Initial Diameter (Do):	2.395 in.	Sample Volume:	23.025 in^3
Average Initial Height (Lo):	5.111 in.	Sample Volume:	0.013 ft^3
Average Initial Area (Ao):	4.505 in^2	Moist Sample Weight:	1.56 lbs.
In-Situ Moist Unit Weight:	116.8 pcf	In-Situ Dry Unit Weight:	88.7 pcf
Failure Mode:			

Project Name	US-21 Bridge Replacement over Harbor River		
Project Number	G5396.00	Date	8/11/2016
SCDOT File #	P026862	PIN #	
Sample/Location	SB-1 / NQ-11		
Depth/Elevation	298.0' - 303.0'		

Sample Type : Undisturbed - Shelby Tube
Target Strain Rate : 1% per minute
Description:

PI=	% Fines=
NMC = 31.7%	L/D Ratio = 2.13
$\sigma_{c\text{-}ULT}$ = 166.5	ε_{ULT} = 3.9%

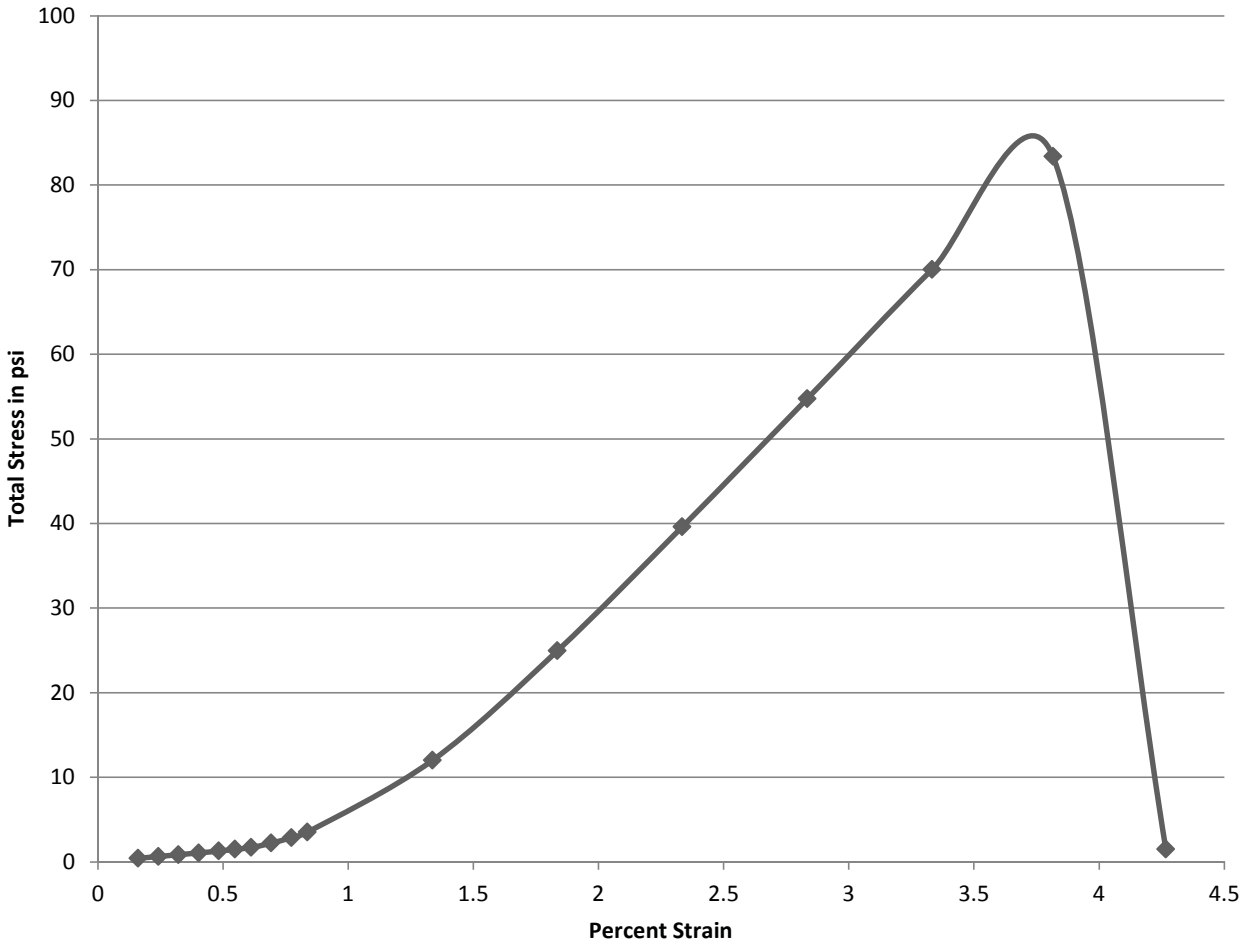
F&ME CONSULTANTS

3112 Devine Street Columbia, SC 29205

Geotechnical · Environmental · Materials

UNCONFINED COMPRESSIVE STRENGTH TEST REPORT
ASTM D2166 / AASHTO T208

Stress/Strain Curve - Sample 16-1212R



Average Initial Diameter (Do):	2.445 in.	Sample Volume:	24.875 in^3
Average Initial Height (Lo):	5.298 in.	Sample Volume:	0.014 ft^3
Average Initial Area (Ao):	4.695 in^2	Moist Sample Weight:	1.63 lbs.
In-Situ Moist Unit Weight:	112.9 pcf	In-Situ Dry Unit Weight:	92.3 pcf
Failure Mode:			

Project Name	US-21 Bridge Replacement over Harbor River		
Project Number	G5396.00	Date	8/11/2016
SCDOT File #	P026862	PIN #	
Sample/Location	SB-1 / NQ-16		
Depth/Elevation	323.0' - 328.0'		

Sample Type : Undisturbed - Shelby Tube
Target Strain Rate : 1% per minute
Description:

PI=	% Fines=
NMC = 22.3%	L/D Ratio = 2.17
$\sigma_{c\text{-}ULT}$ = 85.9	ε_{ULT} = 3.7%

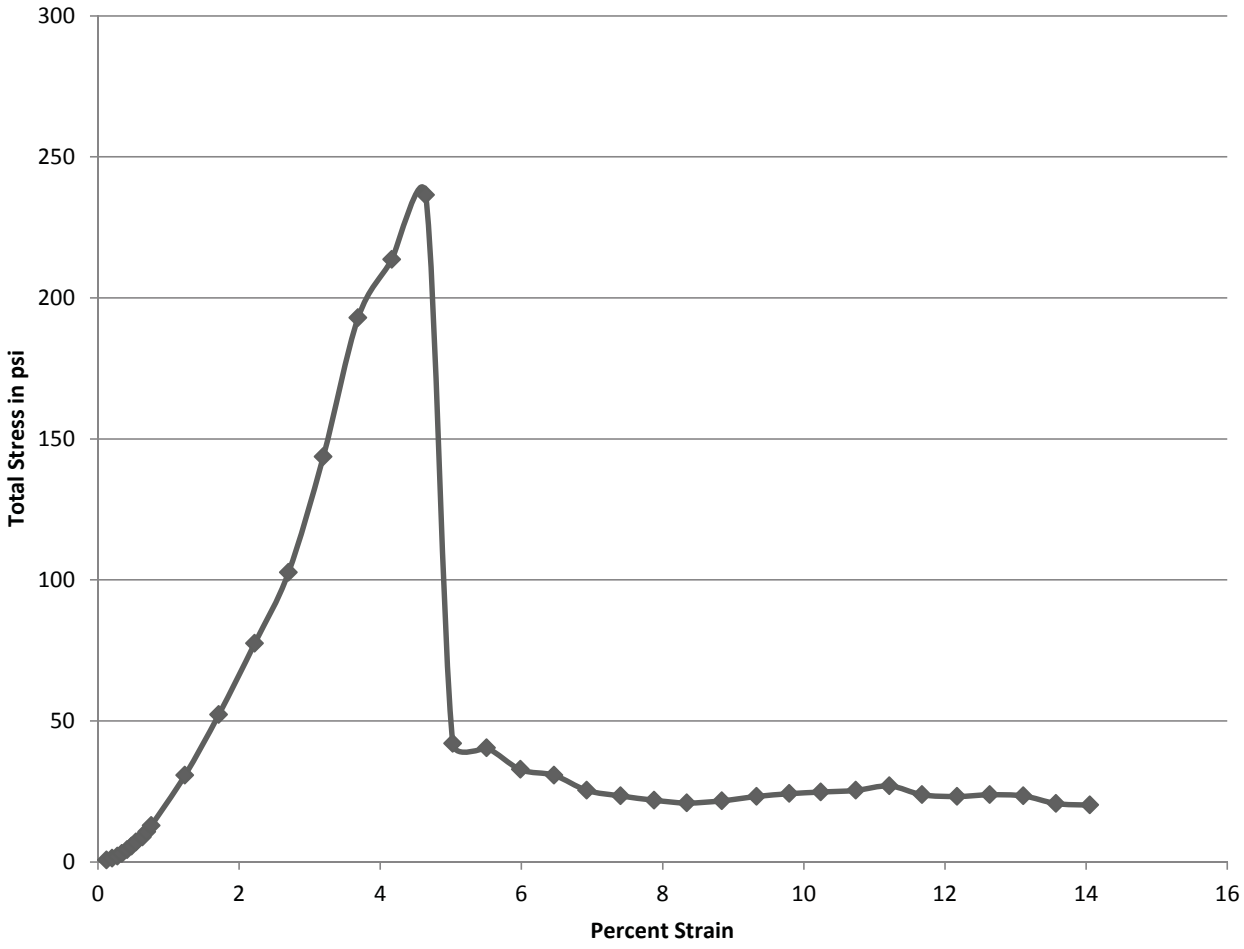
F&ME CONSULTANTS

3112 Devine Street Columbia, SC 29205

Geotechnical · Environmental · Materials

UNCONFINED COMPRESSIVE STRENGTH TEST REPORT
ASTM D2166 / AASHTO T208

Stress/Strain Curve - Sample 16-1212S



Average Initial Diameter (Do):	2.416 in.	Sample Volume:	25.352 in^3
Average Initial Height (Lo):	5.53 in.	Sample Volume:	0.0147 ft^3
Average Initial Area (Ao):	4.584 in^2	Moist Sample Weight:	1.78 lbs.
In-Situ Moist Unit Weight:	121.5 pcf	In-Situ Dry Unit Weight:	95.9 pcf
Failure Mode:			

Project Name	US-21 Bridge Replacement over Harbor River		
Project Number	G5396.00	Date	8/11/2016
SCDOT File #	P026862	PIN #	
Sample/Location	SB-1 / NQ-23		
Depth/Elevation	358.0' - 363.0'		

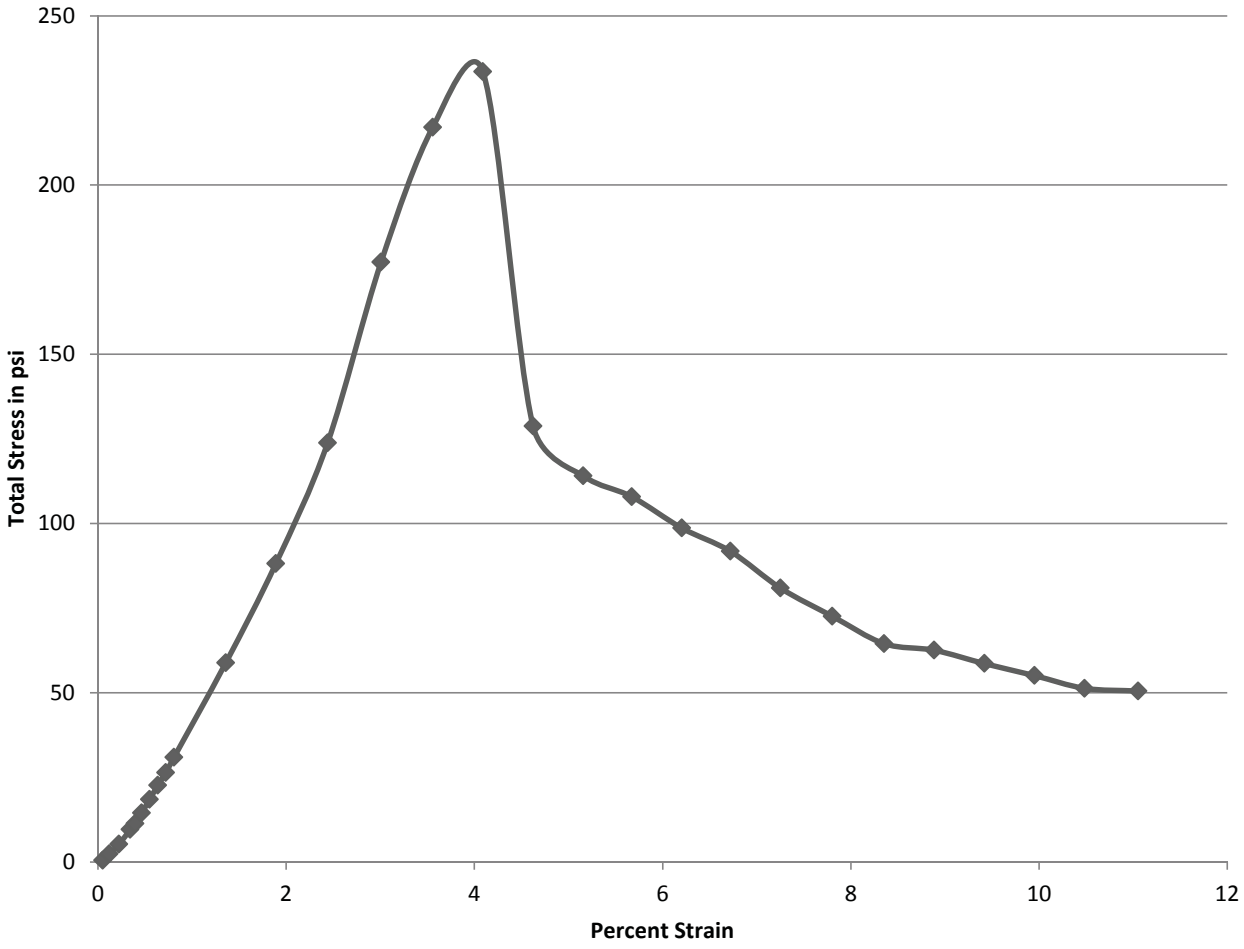
Sample Type : Undisturbed - Shelby Tube
Target Strain Rate : 1% per minute
Description:

PI=	% Fines=
NMC = 26.8%	L/D Ratio = 2.29
$\sigma_{c\text{-}ULT}$ = 236.4	ε_{ULT} = 4.8%

F&ME CONSULTANTS
3112 Devine Street Columbia, SC 29205
Geotechnical · Environmental · Materials

UNCONFINED COMPRESSIVE STRENGTH TEST REPORT
ASTM D2166 / AASHTO T208

Stress/Strain Curve - Sample 16-1212T



Average Initial Diameter (Do):	2.391 in.	Sample Volume:	22.284 in^3
Average Initial Height (Lo):	4.963 in.	Sample Volume:	0.0129 ft^3
Average Initial Area (Ao):	4.490 in^2	Moist Sample Weight:	1.50 lbs.
In-Situ Moist Unit Weight:	116.4 pcf	In-Situ Dry Unit Weight:	88.0 pcf
Failure Mode:			

Project Name	US-21 Bridge Replacement over Harbor River		
Project Number	G5396.00	Date	8/11/2016
SCDOT File #	P026862	PIN #	
Sample/Location	SB-1 / NQ-27		
Depth/Elevation	381.0' - 385.0'		

Sample Type : Undisturbed - Shelby Tube
Target Strain Rate : 1% per minute
Description:

PI=	% Fines=
NMC = 32.3%	L/D Ratio = 2.08
$\sigma_{c\text{-}ULT}$ = 233.5	ε_{ULT} = 4.1%

F&ME CONSULTANTS

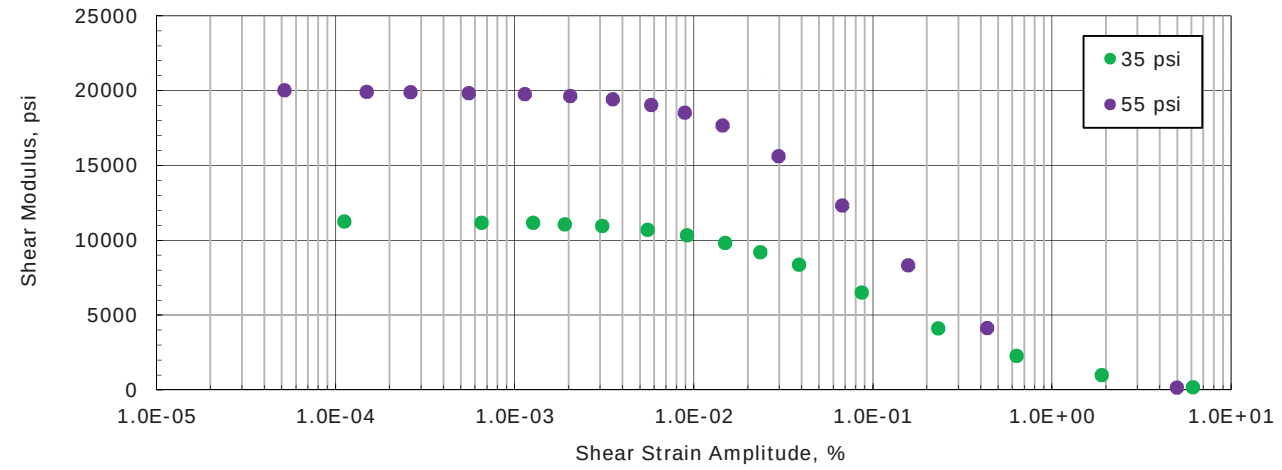
3112 Devine Street Columbia, SC 29205

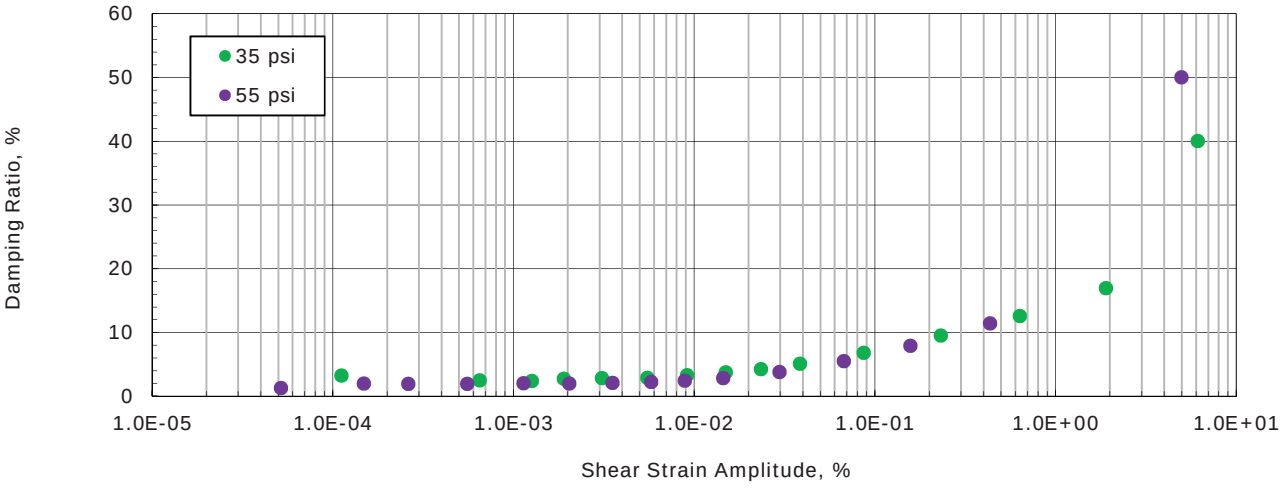
Geotechnical · Environmental · Materials

GeoTesting EXPRESS

Client:	F&ME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	10/28/16, 11/3/16
Tested By:	sg
Checked By:	jdt
Boring ID:	SB-1
Sample ID:	UD-1
Depth, ft:	130.0-133.5
Test Confining Pressure, psi:	**35 55**
Visual Description:	Moist, olive sandy silt
Preparation:	Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.

Modulus and Damping of Soils by Resonant-Column Method by ASTM D4015

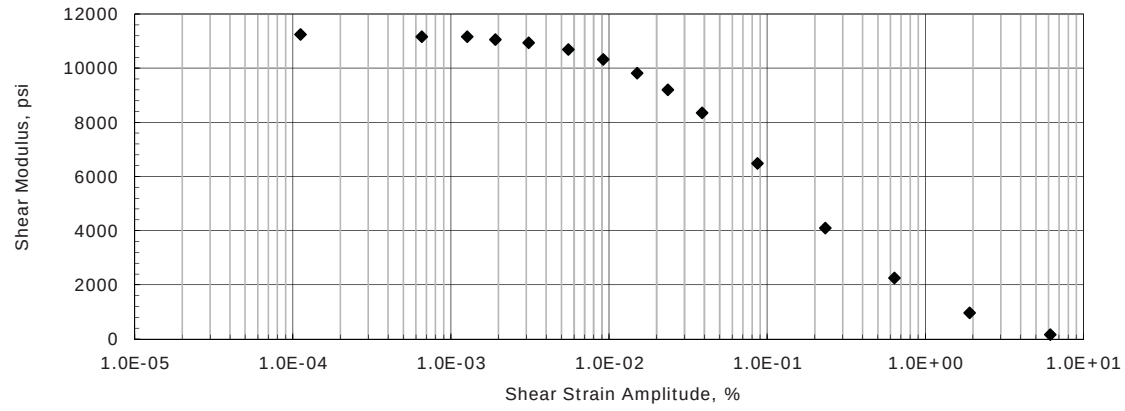


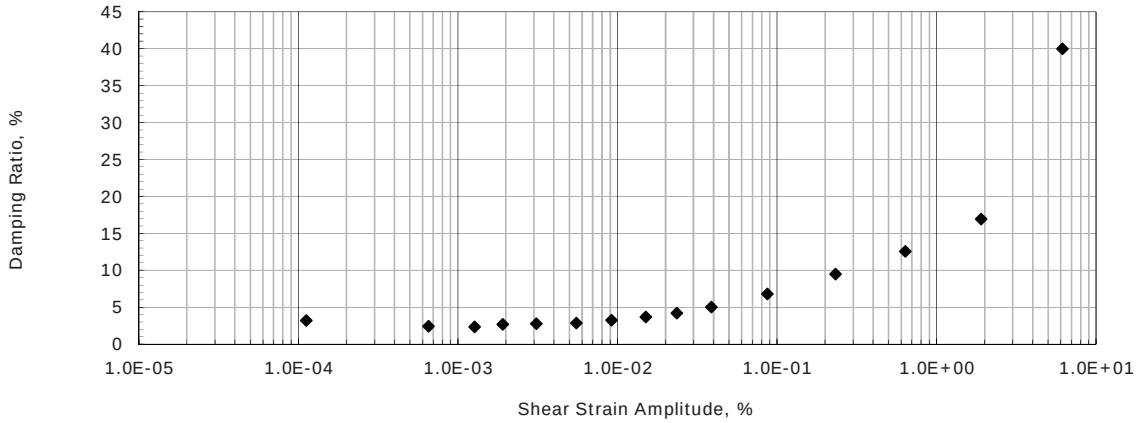


Notes: Data from two tests, each at a different confining pressure, plotted together on the same graph.

Client:	F&ME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	11/03/16
Tested By:	sg
Checked By:	jdt
Boring ID:	SB-1
Sample ID:	UD-1
Depth, ft:	130.0-133.5
Test Confining Pressure, psi:	**35**
Visual Description:	Moist, olive sandy silt
Preparation:	Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.

Modulus and Damping of Soils by Resonant-Column Method by ASTM D4015





Initial Diameter, in:	2.49
Initial Height, in:	5.00
Initial Mass, grams:	699
Initial Moisture Content, %:	38.0
Initial Dry Density, pcf:	79.3
Initial Bulk Density, pcf:	109.4
Initial Degree of Saturation:	92.2
Initial Void Ratio:	1.10

Final Diameter, in:	2.45
Final Height, in:	4.90
Final Mass, grams:	698.39
Final Moisture Content, %:	36.6
Final Dry Density, pcf:	83.7
Final Bulk Density, pcf:	114.4
Final Degree of Saturation:	99.1
Final Void Ratio:	0.99

Notes: Moisture content obtained from sample trimmings

Isotropic stress conditions

GeoTesting EXPRESS

Client:	F&ME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	11/03/16
Tested By:	sg
Checked By:	jdt
Boring ID:	SB-1
Sample ID:	UD-1
Depth, ft:	130.0-133.5
Test Confining Pressure, psi:	**35**
Visual Description:	Moist, olive sandy silt
Test Conditions:	Confining Stress of 35 psi over a range of strains from 0.000112 to 6.15% with a forced sinusoidal vibration.
Preparation:	Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.

Modulus and Damping of Soils by Resonant-Column Method by ASTM D4015

Apparatus Used: Geocomp Corp. quasi-fixed/free boundry condition automated RCTS Test System

Active Mass, g:	2144.75	Torque Calibration Factor, N-m/V:	12.9
Passive Mass, g:	1053.2	Accelerometer Calibration Factor, rad/s^2/V:	3293
Active Inertia, kg-m^2:	1.66E-03		
Passive Inertia, kg-m^2:	0.0012425		

Elapsed Time	Excitation	Frequency	Axial Strain	Volumetric Strain	* Pore Pressure	Effective Confining Stress	Average Strain Amplitude	Shear Modulus, G	Damping Ratio, D
min	%	Hz	%	%	psi	psi	%	psi	%
0.31	0.040	116	2.91E-02	0.029	---	35	1.12E-04	1.12E+04	3.19
0.52	0.100	115	2.91E-02	0.029	---	35	6.53E-04	1.12E+04	2.43
0.62	0.158	115	2.91E-02	0.029	---	35	1.27E-03	1.12E+04	2.32
0.73	0.251	115	2.91E-02	0.029	---	35	1.91E-03	1.11E+04	2.68
0.83	0.398	114	2.91E-02	0.029	---	35	3.09E-03	1.09E+04	2.77
0.93	0.631	113	2.91E-02	0.029	---	35	5.53E-03	1.07E+04	2.86
1.04	1.000	111	2.91E-02	0.029	---	35	9.17E-03	1.03E+04	3.23
1.14	1.586	109	2.91E-02	0.029	---	35	1.50E-02	9.81E+03	3.68
1.24	2.515	106	2.91E-02	0.029	---	35	2.35E-02	9.20E+03	4.20
1.35	3.989	101	2.91E-02	0.029	---	35	3.87E-02	8.35E+03	5.03
1.56	6.338	90	2.91E-02	0.029	---	35	8.69E-02	6.49E+03	6.77
1.87	10.087	72	2.91E-02	0.029	---	35	2.33E-01	4.10E+03	9.48
2.18	16.021	54	2.91E-02	0.029	---	35	6.36E-01	2.25E+03	12.54
2.49	25.446	36	2.91E-02	0.029	---	35	1.91E+00	9.70E+02	16.91
2.80	40.386	20	2.91E-02	0.029	---	35	6.15E+00	1.66E+02	40.01

The Shear Wave Velocity can be determined by the following equation:

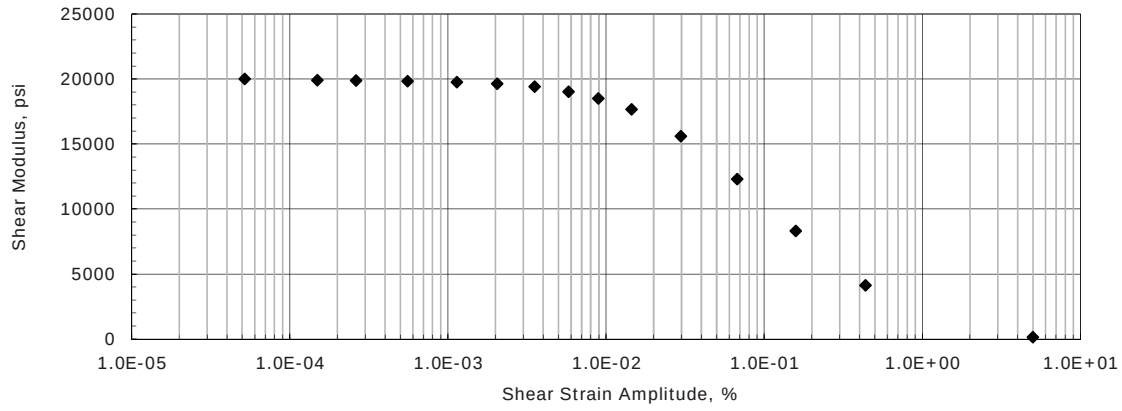
Vs = sqrt(G*g/bulk density)

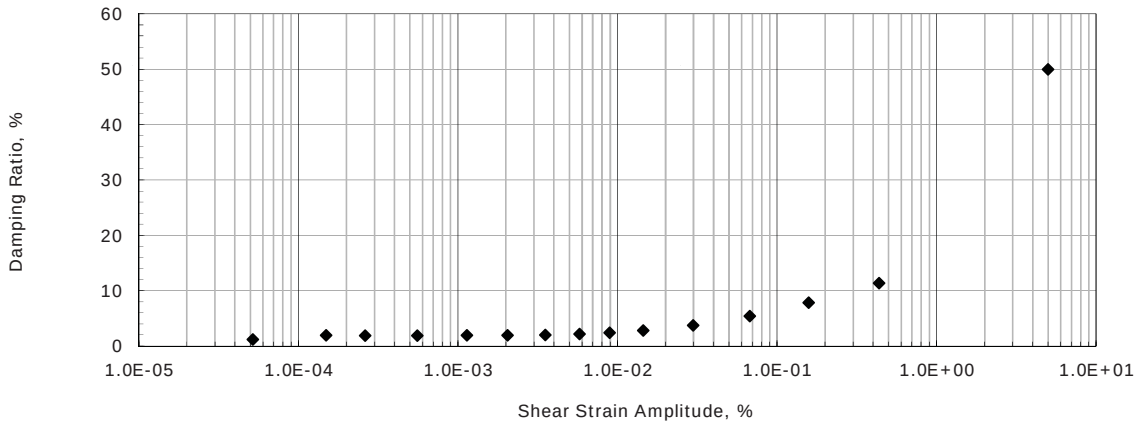
where: Vs = shear wave velocity
G = shear modulus
g = acceleration due to gravity, 9.81 m/sec^2
final bulk density

* Test is run with drainage valve open, but speed of test is such that excess pore pressure could develop, at higher shear strains within specimen.

Client:	F&ME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	10/28/16
Tested By:	sg
Checked By:	jdt
Boring ID:	SB-1
Sample ID:	UD-1
Depth, ft:	130.0-133.5
Test Confining Pressure, psi:	**55**
Visual Description:	Moist, olive sandy silt
Preparation:	Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.

Modulus and Damping of Soils by Resonant-Column Method by ASTM D4015





Initial Diameter, in:	2.85
Initial Height, in:	6.00
Initial Mass, grams:	1106
Initial Moisture Content, %:	40.1
Initial Dry Density, pcf:	78.6
Initial Bulk Density, pcf:	110.1
Initial Degree of Saturation:	95.7
Initial Void Ratio:	1.12

Final Diameter, in:	2.79
Final Height, in:	5.87
Final Mass, grams:	1092
Final Moisture Content, %:	37.1
Final Dry Density, pcf:	83.5
Final Bulk Density, pcf:	114.5
Final Degree of Saturation:	99.9
Final Void Ratio:	0.99

Notes: Moisture content obtained from sample trimmings

Isotropic stress conditions

Client:	F&ME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	10/28/16
Tested By:	sg
Checked By:	jdt
Boring ID:	SB-1
Sample ID:	UD-1
Depth, ft:	130.0-133.5
Test Confining Pressure, psi:	**55**
Visual Description:	Moist, olive sandy silt
Test Conditions:	Confining Stress of 55 psi over a range of strains from 0.0000519 to 4.99% with a forced sinusoidal vibration.
Preparation:	Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.

Modulus and Damping of Soils by Resonant-Column Method by ASTM D4015

Apparatus Used: Geocomp Corp. quasi-fixed/free boundry condition automated RCTS Test System

Active Mass, g:	2144.75	Torque Calibration Factor, N-m/V:	12.9
Passive Mass, g:	1053.2	Accelerometer Calibration Factor, rad/s^2/V:	3293
Active Inertia, kg-m^2:	1.66E-03		
Passive Inertia, kg-m^2:	0.0012425		

Elapsed Time	Excitation	Frequency	Axial Strain	Volumetric Strain	* Pore Pressure	Effective Confining Stress	Average Strain Amplitude	Shear Modulus, G	Damping Ratio, D
min	%	Hz	%	%	psi	psi	%	psi	%
0.31	0.039	172	4.35E-02	0.043	---	54	5.19E-05	2.00E+04	1.22
0.52	0.098	172	4.35E-02	0.043	---	54	1.49E-04	1.99E+04	1.95
0.62	0.156	172	4.35E-02	0.043	---	54	2.62E-04	1.99E+04	1.91
0.73	0.247	171	4.35E-02	0.043	---	54	5.55E-04	1.98E+04	1.89
0.83	0.392	171	4.35E-02	0.043	---	54	1.14E-03	1.98E+04	1.97
0.93	0.621	171	4.35E-02	0.043	---	54	2.05E-03	1.96E+04	1.93
1.04	0.983	170	4.35E-02	0.043	---	54	3.53E-03	1.94E+04	2.02
1.14	1.558	168	4.35E-02	0.043	---	54	5.79E-03	1.90E+04	2.17
1.24	2.470	166	4.35E-02	0.043	---	54	8.91E-03	1.85E+04	2.41
1.35	3.919	163	4.35E-02	0.043	---	54	1.45E-02	1.77E+04	2.81
1.56	6.230	154	4.35E-02	0.043	---	54	2.98E-02	1.56E+04	3.75
1.87	9.925	137	4.35E-02	0.043	---	54	6.75E-02	1.23E+04	5.44
2.28	15.835	114	4.35E-02	0.043	---	54	1.58E-01	8.31E+03	7.87
2.80	25.282	81	4.35E-02	0.043	---	54	4.36E-01	4.13E+03	11.39
3.52	40.388	20	4.35E-02	0.043	---	54	4.99E+00	1.38E+02	49.99

The Shear Wave Velocity can be determined by the following equation:

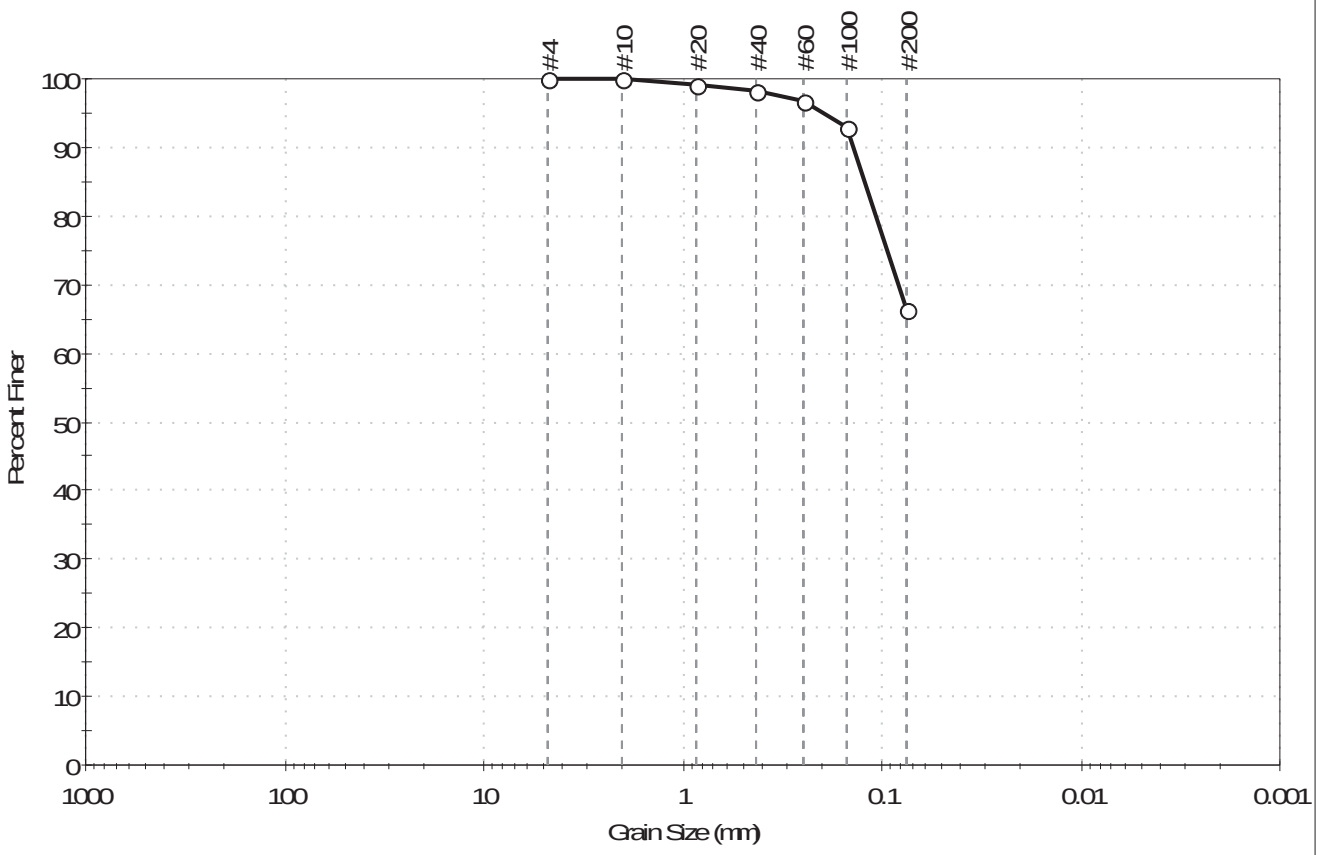
Vs = sqrt(G*g/bulk density)

where: Vs = shear wave velocity
G = shear modulus
g = acceleration due to gravity, 9.81 m/sec^2
final bulk density

* Test is run with drainage valve open, but speed of test is such that excess pore pressure could develop, at higher shear strains within specimen.

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	SB-1	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-1	Test Date:	11/04/16	Checked By:	mcm
Depth :	130.0-133.5 ft	Test Id:	397424		
Test Comment:	---				
Visual Description:	Moist, olive sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



%Cobble	%Gravel	%Sand	%Silt & Clay Size
—	0.0	33.7	66.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	98		
#60	0.25	97		
#100	0.15	93		
#200	0.075	66		

Coefficients

D_{85} = 0.1220 mm	D_{30} = N/A
D_{60} = N/A	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Sandy Silt (ML)

AASHTO Clayey Soils (A-7-5 (8))

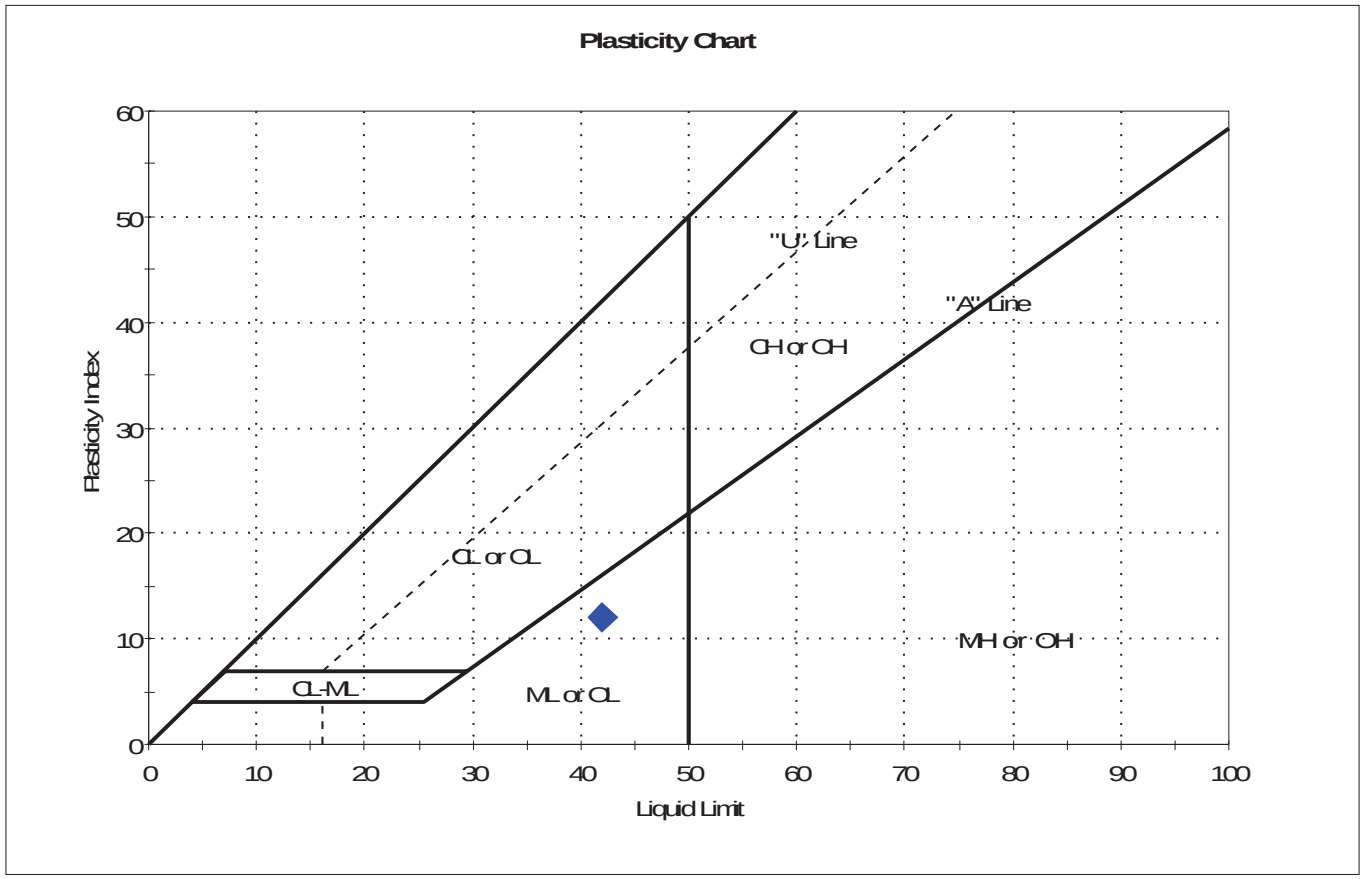
Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	SB-1	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-1	Test Date:	11/04/16	Checked By:	mcm
Depth :	130.0-133.5 ft	Test Id:	397422		
Test Comment:	---				
Visual Description:	Moist, olive sandy silt				
Sample Comment:	---				

Atterberg Limits - ASTM D4318

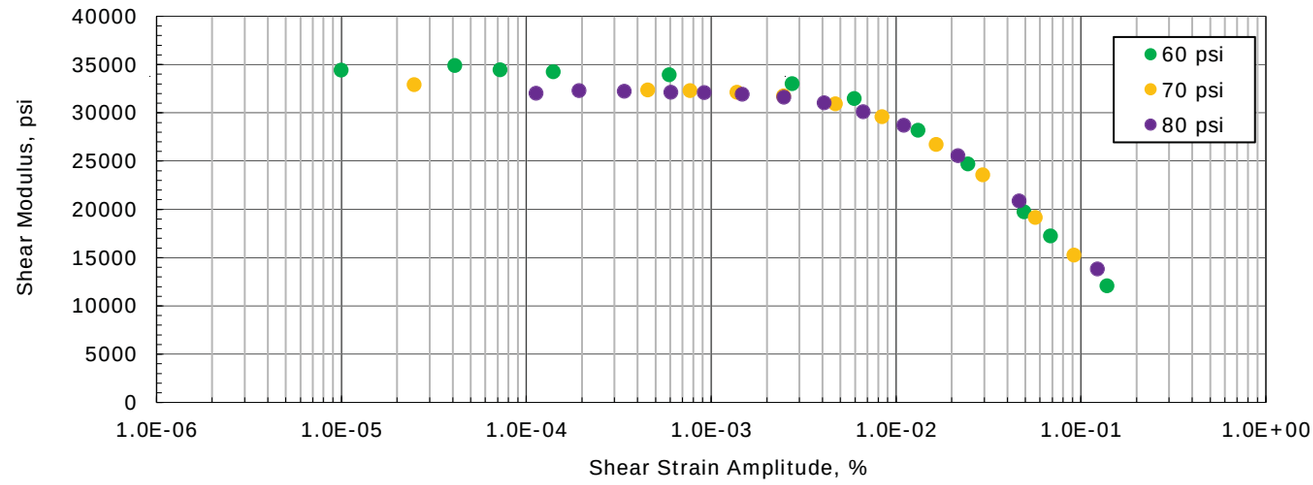


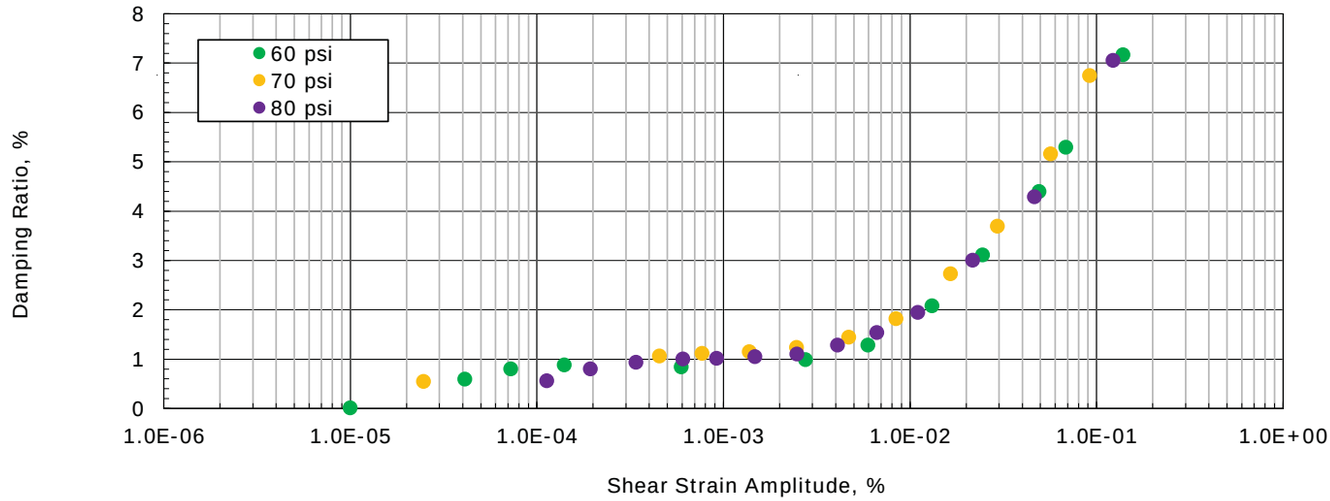
Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	UD-1	SB-1	130.0-133.5 ft	38	42	30	12	0.6	Sandy Silt (ML)

Sample Prepared using the WET method
2% Retained on #40 Sieve
Dry Strength: HIGH
Dilatancy: SLOW
Toughness: LOW

Client:	F&ME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	10/18/16, 10/19/16, 10/25/16
Tested By:	njh
Checked By:	jdt
Boring ID:	SB-1
Sample ID:	UD-4
Depth, ft:	200.0-203.0
Test Confining Pressure, psi:	**60 70 80**
Visual Description:	Moist, olive gray silty clay
Preparation:	Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.

Modulus and Damping of Soils by Resonant-Column Method by ASTM D4015

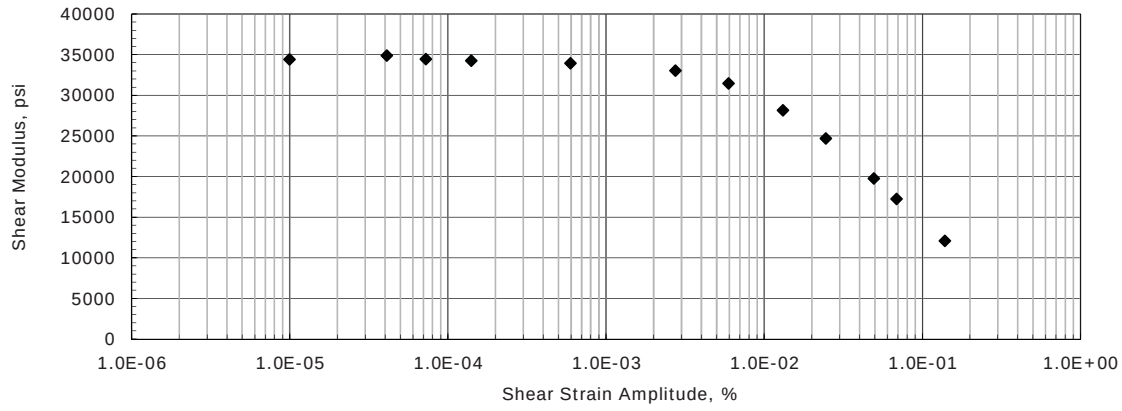


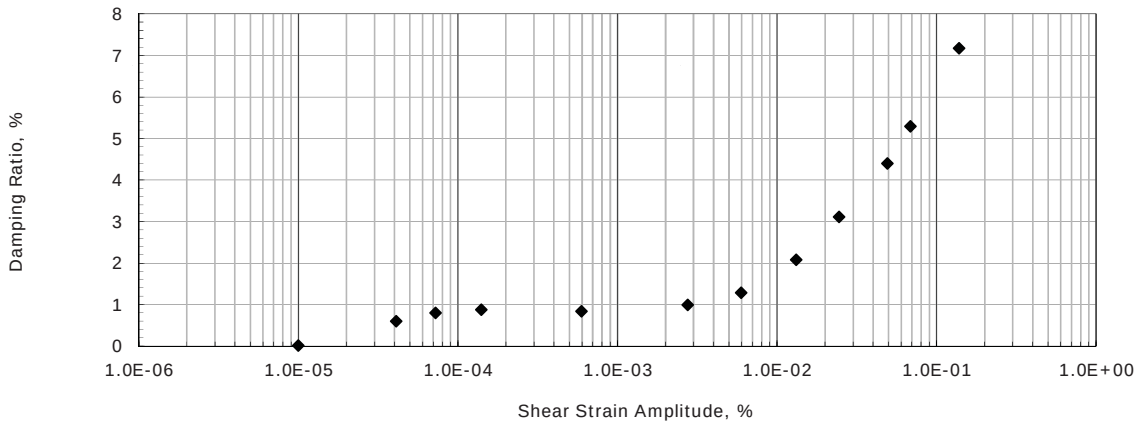


Notes: Data from three tests, each at a different confining pressure, plotted together on the same graph.

Client:	F&ME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	10/18/16
Tested By:	njh
Checked By:	jdt
Boring ID:	SB-1
Sample ID:	UD4
Depth, ft:	200.0-203.0
Test Confining Pressure, psi:	**60**
Visual Description:	Moist, olive gray clay
Preparation:	Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.

Modulus and Damping of Soils by Resonant-Column Method by ASTM D4015





Initial Diameter, in:	2.83
Initial Height, in:	5.80
Initial Mass, grams:	1110
Initial Moisture Content, %:	31.7
Initial Dry Density, pcf:	88.0
Initial Bulk Density, pcf:	115.9
Initial Degree of Saturation:	95.1
Initial Void Ratio:	0.89

Final Diameter, in:	2.81
Final Height, in:	5.73
Final Mass, grams:	1095
Final Moisture Content, %:	27.4
Final Dry Density, pcf:	90.3
Final Bulk Density, pcf:	115.0
Final Degree of Saturation:	86.7
Final Void Ratio:	0.84

Notes: Moisture content obtained from sample trimmings

Isotropic stress conditions

Client:	F&ME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	10/18/16
Tested By:	njh
Checked By:	jdt
Boring ID:	SB-1
Sample ID:	UD4
Depth, ft:	200.0-203.0
Test Confining Pressure, psi:	**60**
Visual Description:	Moist, olive gray clay
Test Conditions:	Confining Stress of 60 psi over a range of strains from 0.00000997 to 7.17% with a forced sinusoidal vibration.
Preparation:	Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.

Modulus and Damping of Soils by Resonant-Column Method by ASTM D4015

Apparatus Used: Geocomp Corp. quasi-fixed/free boundry condition automated RCTS Test System

Active Mass, g:	2144.75	Torque Calibration Factor, N-m/V:	12.9
Passive Mass, g:	1053.2	Accelerometer Calibration Factor, rad/s^2/V:	3293
Active Inertia, kg-m^2:	1.66E-03		
Passive Inertia, kg-m^2:	0.0012425		

Elapsed Time	Excitation	Frequency	Axial Strain	Volumetric Strain	* Pore Pressure	Effective Confining Stress	Average Strain Amplitude	Shear Modulus, G	Damping Ratio, D
min	%	Hz	%	%	psi	psi	%	psi	%
1.97	0.153	225	4.13E-02	0.041	---	60	9.97E-06	3.44E+04	0.01
2.38	0.963	226	4.13E-02	0.041	---	60	4.10E-05	3.49E+04	0.60
2.49	1.525	225	4.13E-02	0.041	---	60	7.23E-05	3.44E+04	0.80
2.59	2.418	225	4.13E-02	0.041	---	60	1.40E-04	3.43E+04	0.88
2.69	3.833	224	4.13E-02	0.041	---	60	5.94E-04	3.39E+04	0.84
2.80	6.078	221	4.13E-02	0.041	---	60	2.75E-03	3.30E+04	0.99
2.90	9.643	217	4.13E-02	0.041	---	60	5.96E-03	3.15E+04	1.28
3.11	15.359	206	4.13E-02	0.041	---	60	1.32E-02	2.82E+04	2.08
3.31	24.442	194	4.13E-02	0.041	---	60	2.45E-02	2.47E+04	3.11
3.62	39.145	175	4.13E-02	0.041	---	60	4.92E-02	1.97E+04	4.39
3.83	62.122	165	4.13E-02	0.041	---	60	6.85E-02	1.72E+04	5.29
4.25	99.226	139	4.13E-02	0.041	---	60	1.38E-01	1.21E+04	7.17

The Shear Wave Velocity can be determined by the following equation:

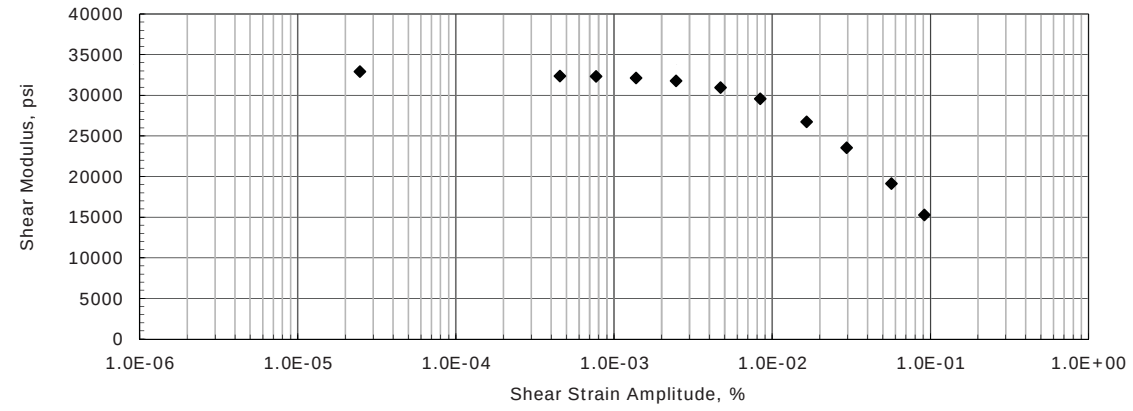
Vs = sqrt(G*g/bulk density)

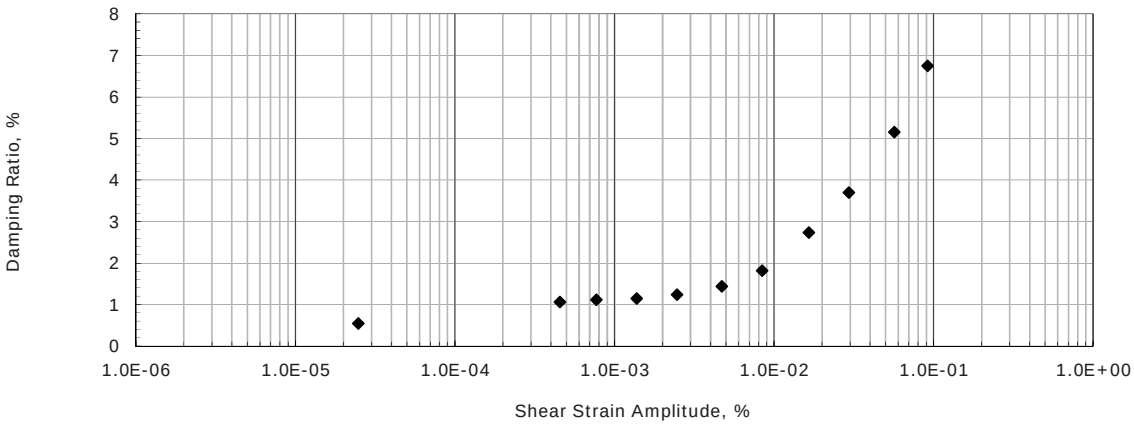
where: Vs = shear wave velocity
G = shear modulus
g = acceleration due to gravity, 9.81 m/sec^2
final bulk density

* Test is run with drainage valve open, but speed of test is such that excess pore pressure could develop, at higher shear strains within specimen.

Client:	F&ME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	10/18/16
Tested By:	njh
Checked By:	jdt
Boring ID:	SB-1
Sample ID:	UD4
Depth, ft:	200.0-203.0
Test Confining Pressure, psi:	**70**
Visual Description:	Moist, olive gray silty clay
Preparation:	Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.

Modulus and Damping of Soils by Resonant-Column Method by ASTM D4015





Initial Diameter, in:	2.84
Initial Height, in:	5.89
Initial Mass, grams:	1132
Initial Moisture Content, %:	31.5
Initial Dry Density, pcf:	87.9
Initial Bulk Density, pcf:	115.6
Initial Degree of Saturation:	94.2
Initial Void Ratio:	0.89

Final Diameter, in:	2.81
Final Height, in:	5.78
Final Mass, grams:	1122
Final Moisture Content, %:	30.1
Final Dry Density, pcf:	91.5
Final Bulk Density, pcf:	119.1
Final Degree of Saturation:	98.3
Final Void Ratio:	0.82

Notes: Moisture content obtained from sample trimmings

Isotropic stress conditions

Client:	F&ME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	10/18/16
Tested By:	njh
Checked By:	jdt
Boring ID:	SB-1
Sample ID:	UD4
Depth, ft:	200.0-203.0
Test Confining Pressure, psi:	**70**
Visual Description:	Moist, olive gray silty clay
Test Conditions:	Confining Stress of 70 psi over a range of strains from 0.0000247 to 6.74% with a forced sinusoidal vibration.
Preparation:	Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.

Modulus and Damping of Soils by Resonant-Column Method by ASTM D4015

Apparatus Used: Geocomp Corp. quasi-fixed/free boundry condition automated RCTS Test System

Active Mass, g:	2144.75	Torque Calibration Factor, N-m/V:	12.9
Passive Mass, g:	1053.2	Accelerometer Calibration Factor, rad/s^2/V:	3293
Active Inertia, kg-m^2:	1.66E-03		
Passive Inertia, kg-m^2:	0.0012425		

Elapsed Time	Excitation	Frequency	Axial Strain	Volumetric Strain	* Pore Pressure	Effective Confining Stress	Average Strain Amplitude	Shear Modulus, G	Damping Ratio, D
min	%	Hz	%	%	psi	psi	%	psi	%
0.73	0.243	219	4.41E-02	0.044	---	70	2.47E-05	3.29E+04	0.55
1.14	1.530	218	4.41E-02	0.044	---	70	4.54E-04	3.24E+04	1.06
1.24	2.424	218	4.41E-02	0.044	---	70	7.70E-04	3.23E+04	1.12
1.35	3.842	218	4.41E-02	0.044	---	70	1.38E-03	3.21E+04	1.15
1.45	6.091	217	4.41E-02	0.044	---	70	2.47E-03	3.18E+04	1.24
1.56	9.657	214	4.41E-02	0.044	---	70	4.70E-03	3.09E+04	1.44
1.66	15.321	210	4.41E-02	0.044	---	70	8.40E-03	2.96E+04	1.82
1.87	24.378	201	4.41E-02	0.044	---	70	1.65E-02	2.67E+04	2.73
2.07	38.803	190	4.41E-02	0.044	---	70	2.95E-02	2.36E+04	3.69
2.38	61.938	172	4.41E-02	0.044	---	70	5.67E-02	1.91E+04	5.16
2.69	98.715	155	4.41E-02	0.044	---	70	9.18E-02	1.53E+04	6.74

The Shear Wave Velocity can be determined by the following equation:

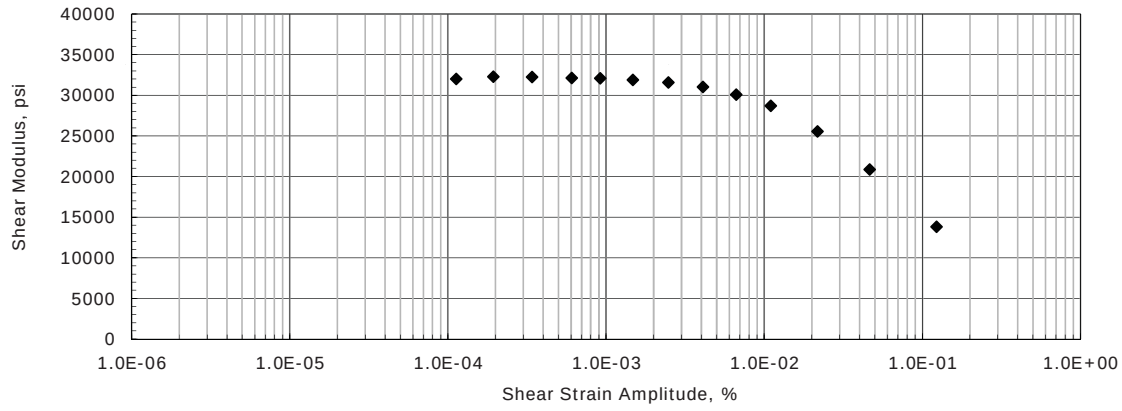
Vs = sqrt(G*g/bulk density)

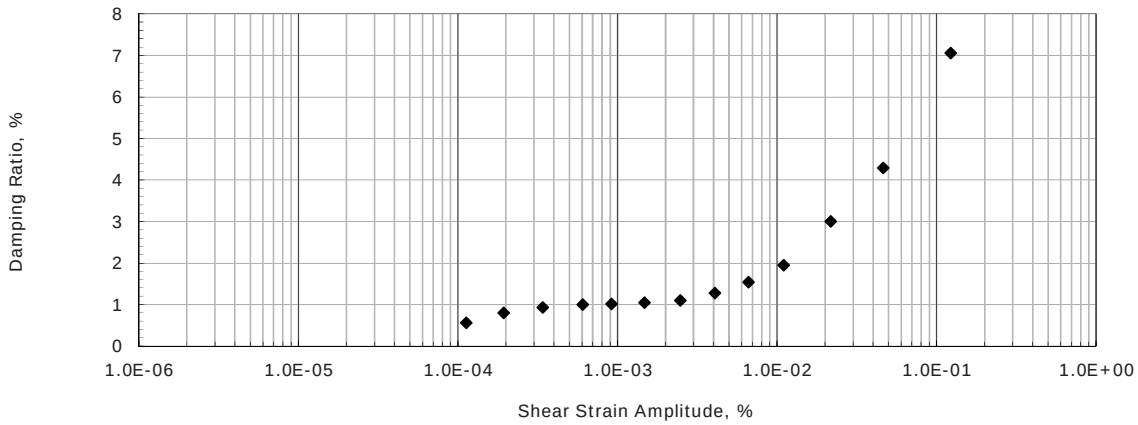
where: Vs = shear wave velocity
G = shear modulus
g = acceleration due to gravity, 9.81 m/sec^2
final bulk density

* Test is run with drainage valve open, but speed of test is such that excess pore pressure could develop, at higher shear strains within specimen.

Client:	F&ME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	10/18/16
Tested By:	njh
Checked By:	jdt
Boring ID:	SB-1
Sample ID:	UD4
Depth, ft:	200.0-203.0
Test Confining Pressure, psi:	**80**
Visual Description:	Moist, olive gray silty clay
Preparation:	Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.

Modulus and Damping of Soils by Resonant-Column Method by ASTM D4015





Initial Diameter, in:	2.83
Initial Height, in:	5.99
Initial Mass, grams:	1130
Initial Moisture Content, %:	31.7
Initial Dry Density, pcf:	86.8
Initial Bulk Density, pcf:	114.3
Initial Degree of Saturation:	92.1
Initial Void Ratio:	0.92

Final Diameter, in:	2.79
Final Height, in:	5.85
Final Mass, grams:	1113
Final Moisture Content, %:	30.6
Final Dry Density, pcf:	91.3
Final Bulk Density, pcf:	119.3
Final Degree of Saturation:	99.5
Final Void Ratio:	0.82

Notes: Moisture content obtained from sample trimmings

Isotropic stress conditions

Client:	F&ME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	10/18/16
Tested By:	njh
Checked By:	jdt
Boring ID:	SB-1
Sample ID:	UD4
Depth, ft:	200.0-203.0
Test Confining Pressure, psi:	**80**
Visual Description:	Moist, olive gray silty clay
Test Conditions:	Confining Stress of 80 psi over a range of strains from 0.000113 to 7.05% with a forced sinusoidal vibration.
Preparation:	Extruded from tube, cut, trimmed and placed into apparatus at the as-received density and moisture content.

Modulus and Damping of Soils by Resonant-Column Method by ASTM D4015

Apparatus Used: Geocomp Corp. quasi-fixed/free boundry condition automated RCTS Test System

Active Mass, g:	2144.75	Torque Calibration Factor, N-m/V:	12.9
Passive Mass, g:	1053.2	Accelerometer Calibration Factor, rad/s^2/V:	3293
Active Inertia, kg-m^2:	1.66E-03		
Passive Inertia, kg-m^2:	0.0012425		

Elapsed Time	Excitation	Frequency	Axial Strain	Volumetric Strain	* Pore Pressure	Effective Confining Stress	Average Strain Amplitude	Shear Modulus, G	Damping Ratio, D
min	%	Hz	%	%	psi	psi	%	psi	%
0.73	0.243	214	5.58E-02	0.056	---	80	1.13E-04	3.20E+04	0.56
0.93	0.611	215	5.58E-02	0.056	---	80	1.93E-04	3.23E+04	0.80
1.04	0.966	215	5.58E-02	0.056	---	80	3.40E-04	3.22E+04	0.93
1.14	1.532	215	5.58E-02	0.056	---	80	6.06E-04	3.21E+04	1.00
1.24	2.428	215	5.58E-02	0.056	---	80	9.19E-04	3.21E+04	1.02
1.35	3.847	214	5.58E-02	0.056	---	80	1.48E-03	3.19E+04	1.04
1.45	6.100	213	5.58E-02	0.056	---	80	2.48E-03	3.16E+04	1.10
1.55	9.672	212	5.58E-02	0.056	---	80	4.09E-03	3.10E+04	1.28
1.66	15.338	209	5.58E-02	0.056	---	80	6.64E-03	3.01E+04	1.54
1.76	24.337	205	5.58E-02	0.056	---	80	1.10E-02	2.87E+04	1.95
1.97	38.749	194	5.58E-02	0.056	---	80	2.17E-02	2.55E+04	3.00
2.28	61.840	177	5.58E-02	0.056	---	80	4.64E-02	2.09E+04	4.29
2.69	98.957	146	5.58E-02	0.056	---	80	1.23E-01	1.38E+04	7.05

The Shear Wave Velocity can be determined by the following equation:

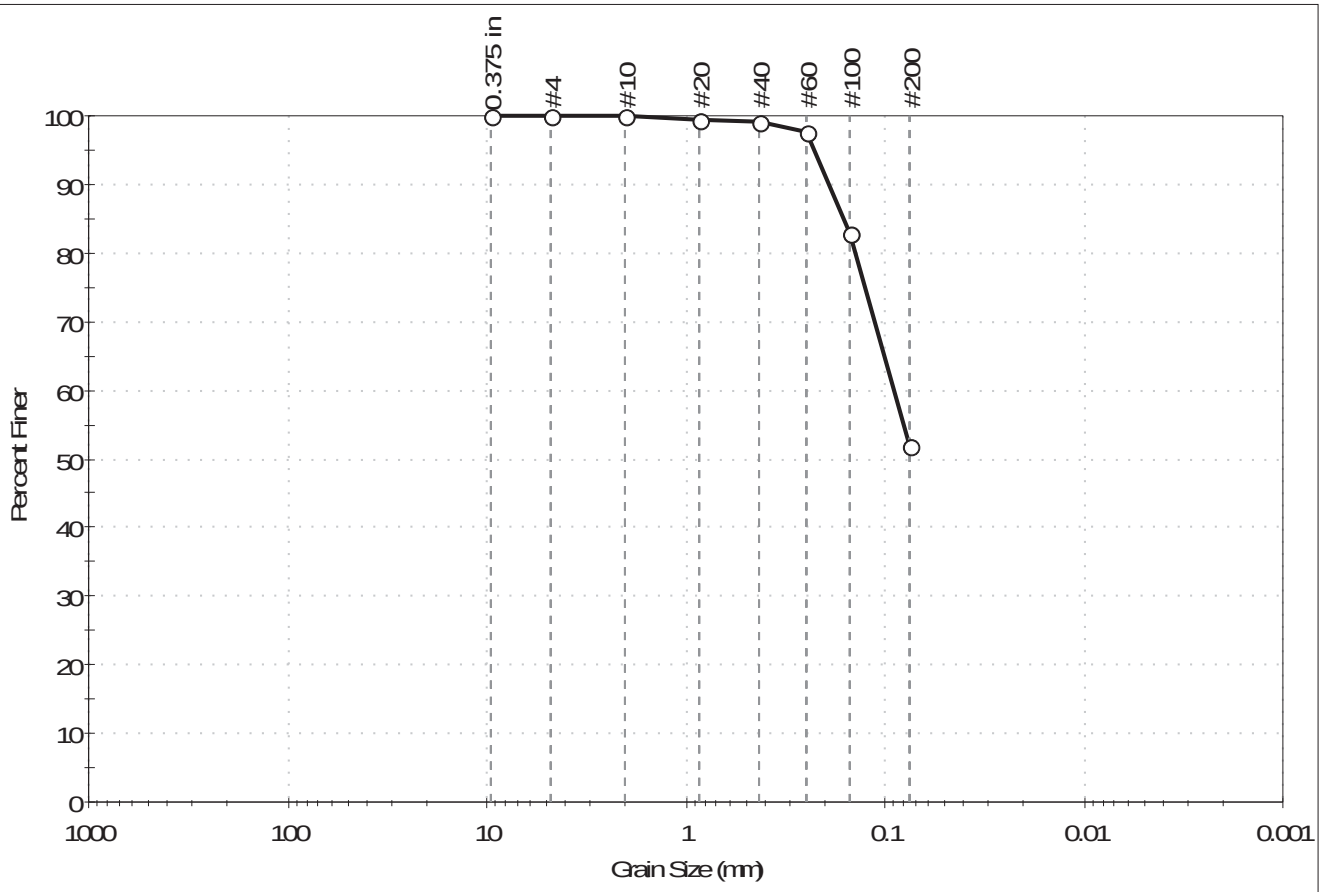
Vs = sqrt(G*g/bulk density)

where: Vs = shear wave velocity
G = shear modulus
g = acceleration due to gravity, 9.81 m/sec^2
final bulk density

* Test is run with drainage valve open, but speed of test is such that excess pore pressure could develop, at higher shear strains within specimen.

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	SB-1	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-4	Test Date:	11/04/16	Checked By:	mcm
Depth :	200.0-203.0 ft	Test Id:	397425		
Test Comment:	---				
Visual Description:	Moist, olive sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



%Cobble	%Gravel	%Sand	%Silt & Clay Size
–	0.1	47.8	52.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	98		
#100	0.15	83		
#200	0.075	52		

Coefficients

D_{85} = 0.1611 mm	D_{30} = N/A
D_{60} = 0.0896 mm	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Sandy Silt (ML)

AASHTO Clayey Soils (A-7-6 (6))

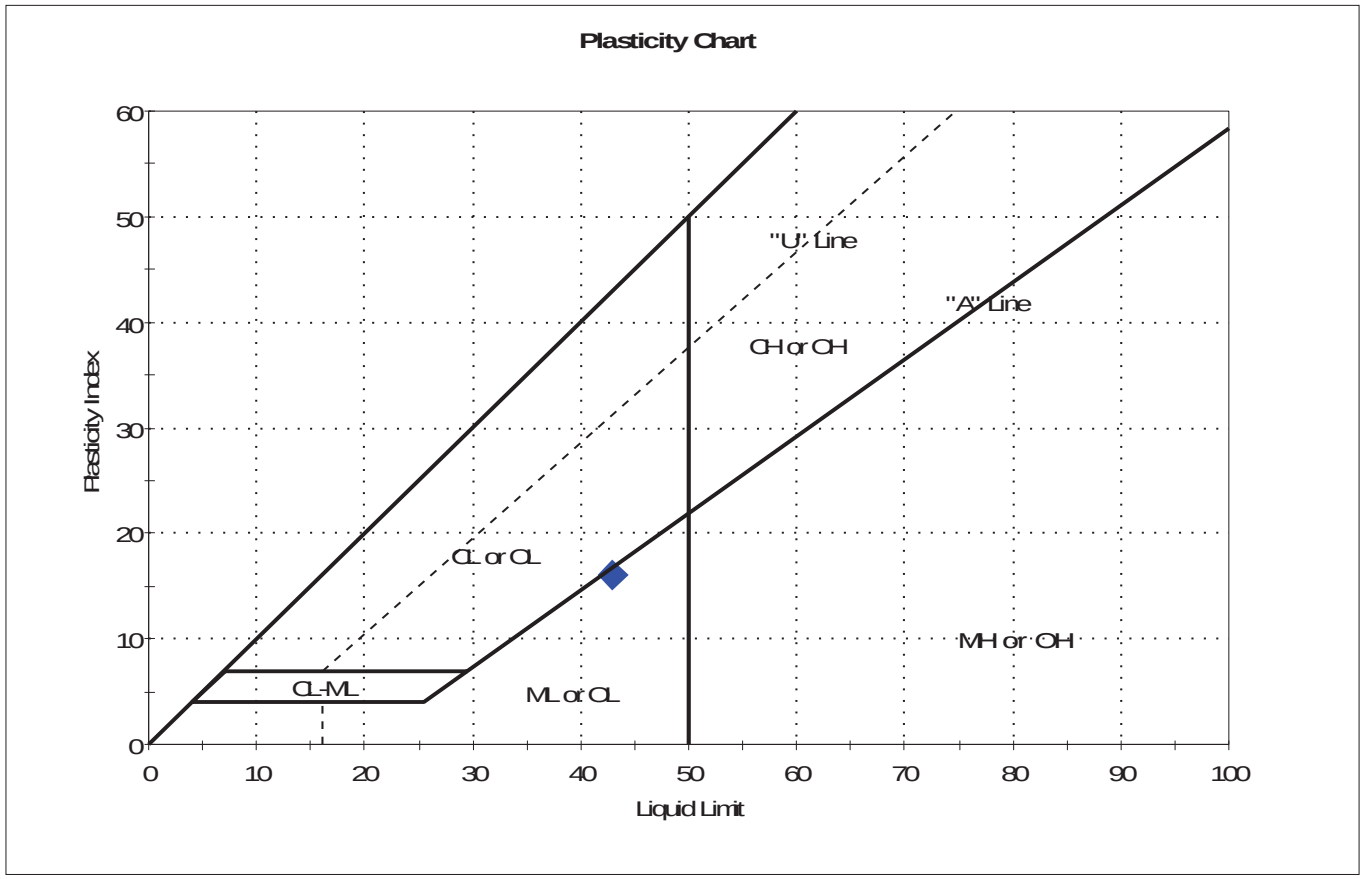
Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

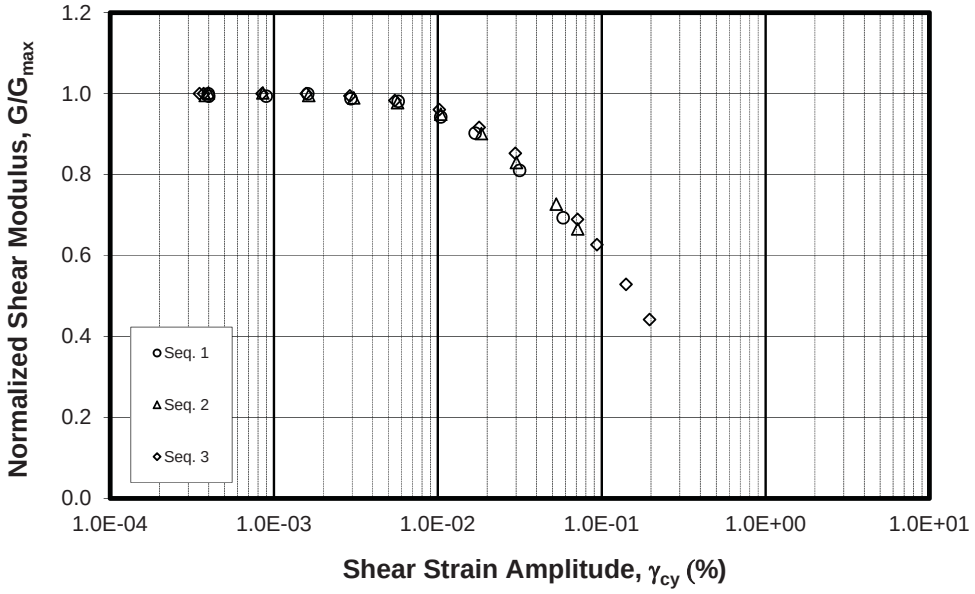
Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	SB-1	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-4	Test Date:	11/04/16	Checked By:	mcm
Depth :	200.0-203.0 ft	Test Id:	397423		
Test Comment:	---				
Visual Description:	Moist, olive sandy silt				
Sample Comment:	---				

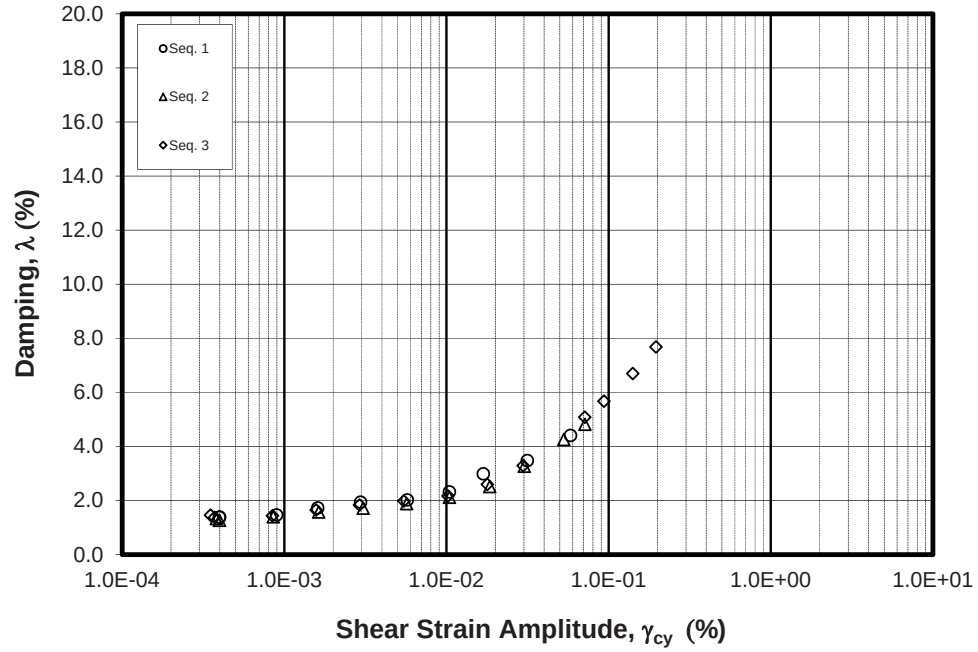
Atterberg Limits - ASTM D4318



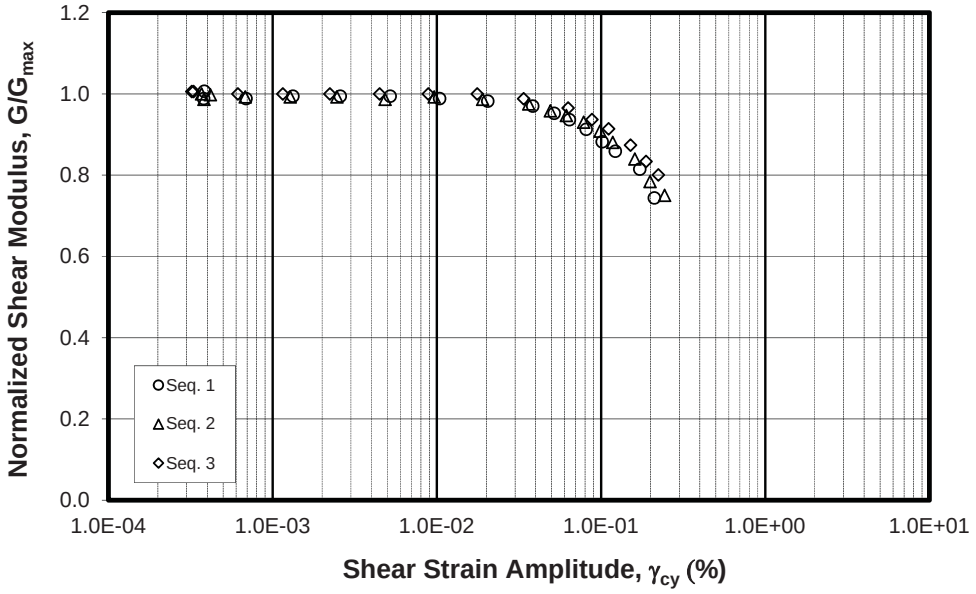
Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	UD-4	SB-1	00.0-203. ft	32	43	27	16	0.3	Sandy Silt (ML)

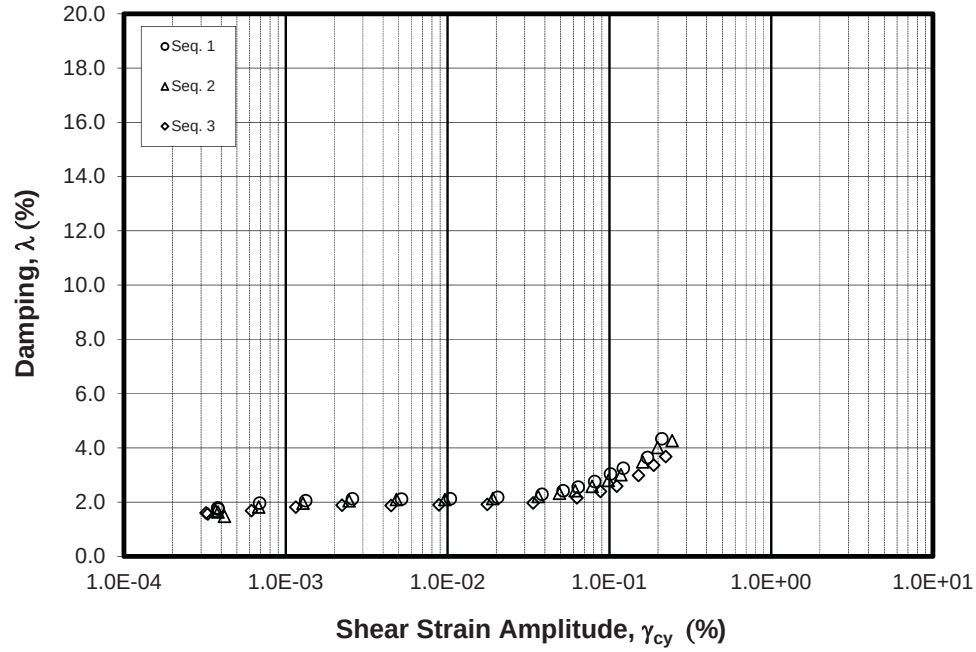
Sample Prepared using the WET method
1% Retained on #40 Sieve
Dry Strength: HIGH
Dilatancy: SLOW
Toughness: LOW



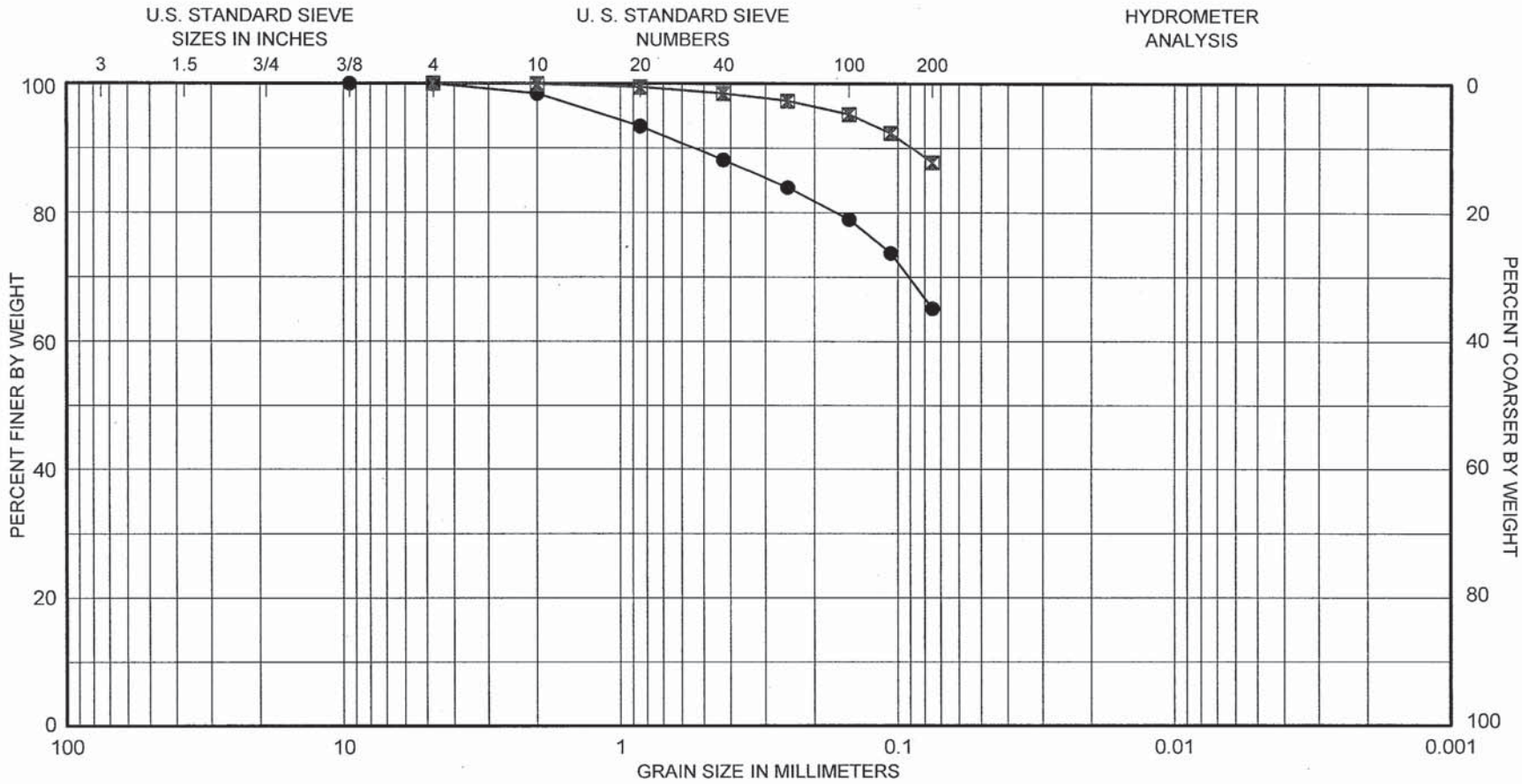


RESONANT COLUMN TEST
Three Stages of Isotropic Consolidation - OCR = 1
Sample: UD-6a Depth: 257.85 ft
Boring SB-1





RESONANT COLUMN TEST
Three Stages of Isotropic Consolidation - OCR = 1
Sample: UD-9a Depth: 380.55 ft
Boring SB-1

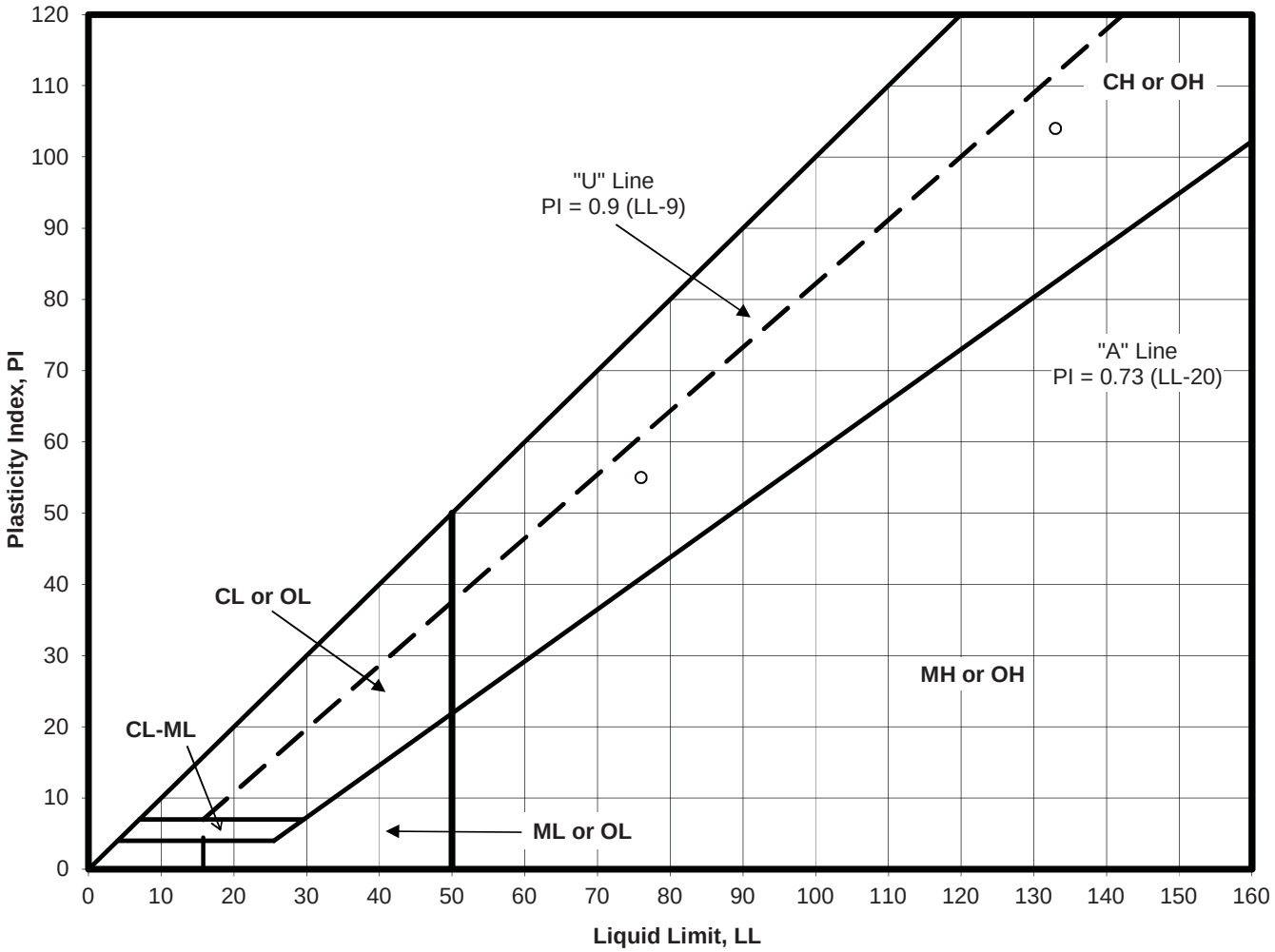


GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	C_c	C_u	D_{50}	D_{90}	CLASSIFICATION
●	SB-1_UD-6a	257.85				0.54	Sandy Clay, greenish gray
⊠	SB-1_UD-9a	380.55				0.09	Clay, olive gray and greenish gray, with san pockets and carbonate nodules
✳							
⊗							

GRAIN SIZE CURVE

PLATE 1



PLASTICITY CHART
Project No. 04.11160019

Sample	LL	PL	PI
SB-1_UD-6a	76	21	55
SB-1_UD-9a	133	29	104

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	---	Sample Type:	---	Tested By:	jbr
Sample ID:	---	Test Date:	08/30/16	Checked By:	mcm
Depth :	---	Test Id:	387124		

Moisture Content of Soil and Rock - ASTM D2216

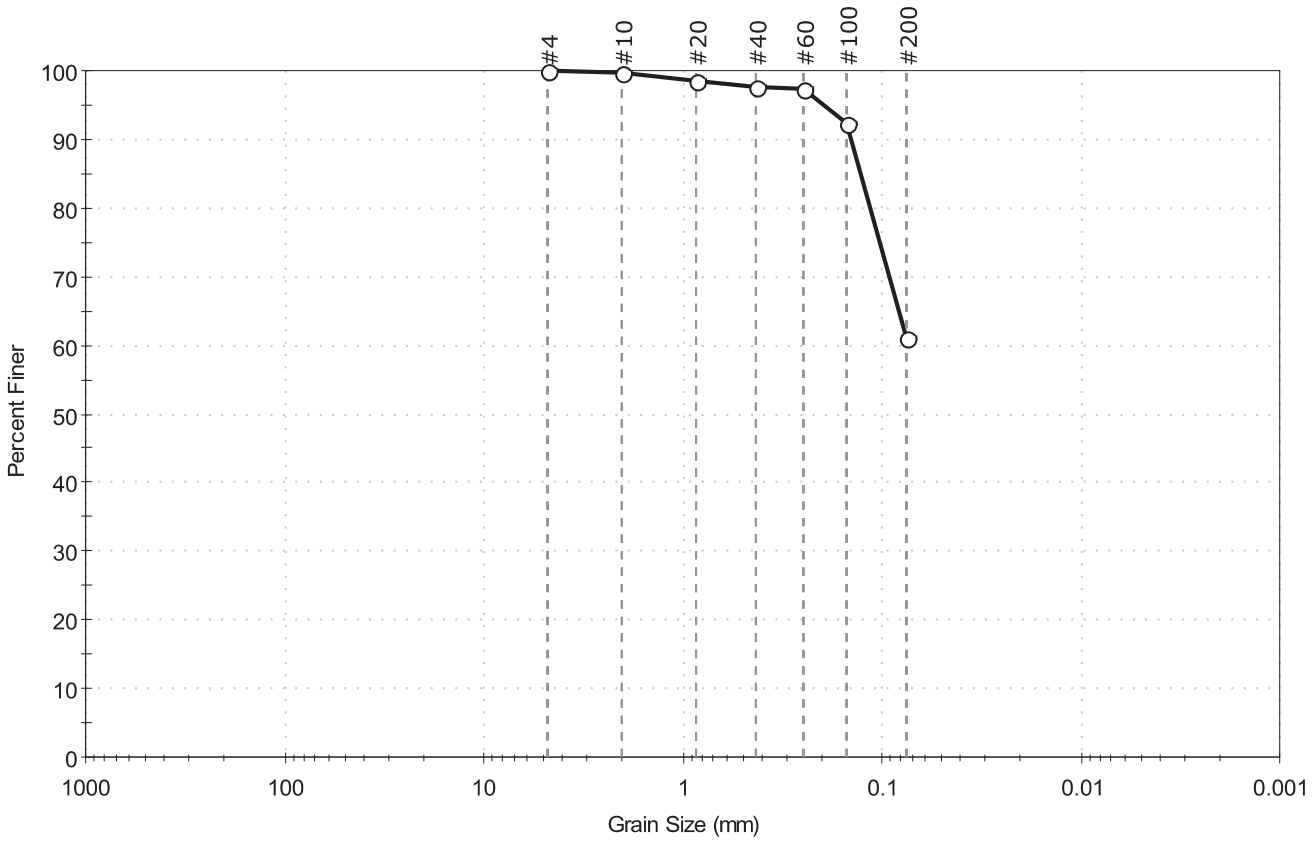
Boring ID	Sample ID	Depth	Description	Moisture Content,%
AP-1	UD-1	16.0-18.0 ft	Moist, olive sandy clay	63.0

Notes: Temperature of Drying : 110º Celsius

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-1	Sample Type:	tube	Tested By:	jbr
Sample ID:	UD-1	Test Date:	08/26/16	Checked By:	mcm
Depth :	16.0-18.0 ft	Test Id:	387101		

Test Comment: ---
Visual Description: Moist, olive sandy clay
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	39.0	61.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	98		
#60	0.25	97		
#100	0.15	92		
#200	0.075	61		

Coefficients

D_{85} = 0.1278 mm	D_{30} = N/A
D_{60} = N/A	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM Sandy Fat clay (CH)

AASHTO Clayey Soils (A-7-6 (24))

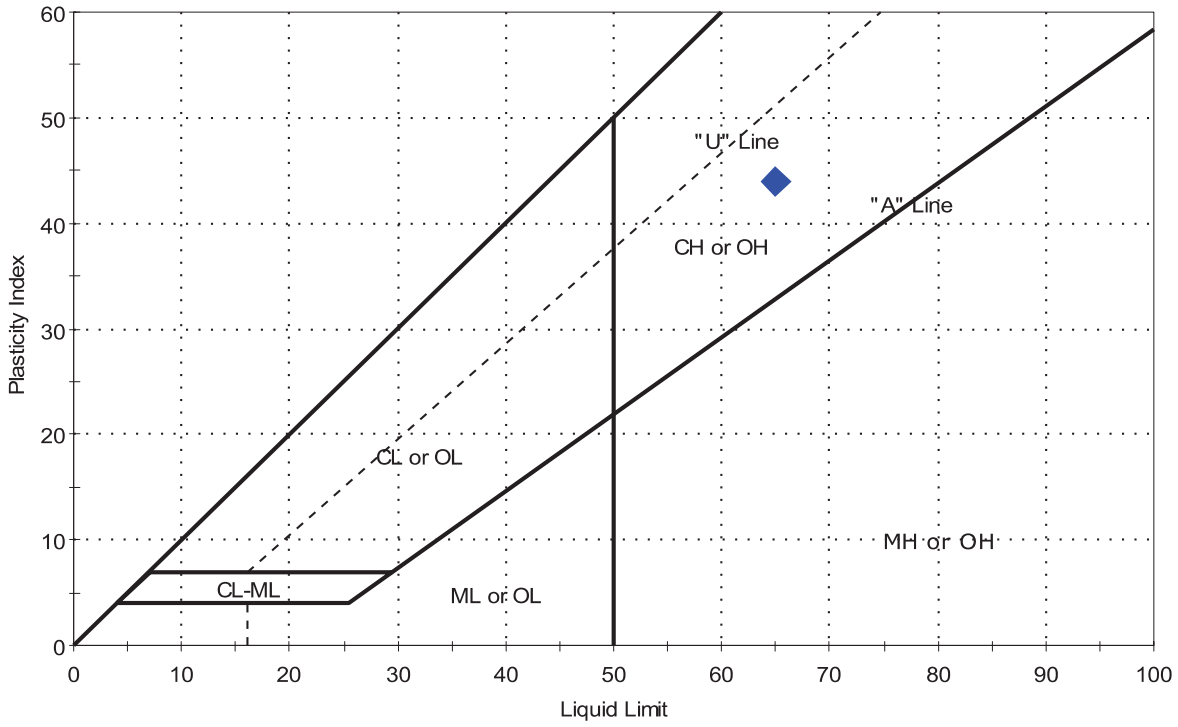
Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-1	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-1	Test Date:	08/31/16	Checked By:	mcm
Depth :	16.0-18.0 ft	Test Id:	387109		
Test Comment:	---				
Visual Description:	Moist, olive sandy clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



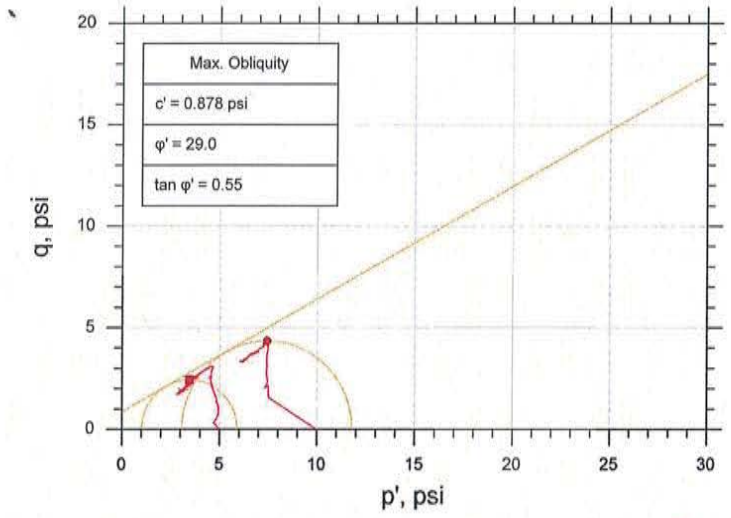
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	UD-1	AP-1	16.0-18.0 ft	63	65	21	44	1	Sandy Fat clay (CH)

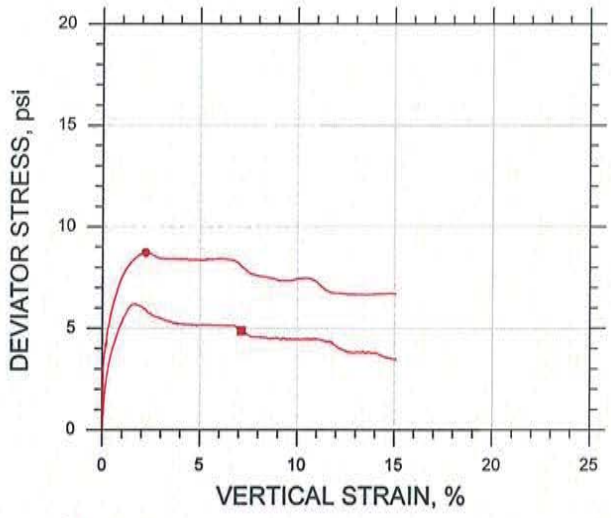
Sample Prepared using the WET method
2% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: NONE
Toughness: MEDIUM

GeoTesting EXPRESS

Client: F&ME Consultants	
Project Name: US 21 Replacement Bridge	
Project Location: ---	
Project Number: GTX-305005	
Tested By: md	Checked By: mcm
Boring ID: AP-1	
Preparation: intact	
Description: Moist, gray clay with sand	
Classification: Fat clay	
Group Symbol: CH	
Liquid Limit: ---	Plastic Limit: ---
Plasticity Index: ---	Estimated Specific Gravity: 2.7

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		■	●		
Sample ID		ST-1	ST-1		
Depth, ft		16.0-18.0 ft	16.0-18.0 ft		
Test Number		CU-5-1	CU-5-2		
Initial	Height, in	4.680	4.500		
	Diameter, in	2.020	2.030		
	Moisture Content (from Cuttings), %	50.2	60.1		
	Dry Density, pcf	66.5	63.3		
	Saturation (Wet Method), %	88.4	97.5		
	Void Ratio	1.53	1.66		
Before Shear	Moisture Content, %	51.2	59.6		
	Dry Density, pcf	70.7	64.6		
	Cross-sectional Area (Method A), in²	3.034	3.180		
	Saturation, %	100.0	100.0		
	Void Ratio	1.38	1.61		
	Back Pressure, psi	51.00	160.8		
Vertical Effective Consolidation Stress, psi		4.947	9.959		
Horizontal Effective Consolidation Stress, psi		4.994	9.982		
Vertical Strain after Consolidation, %		0.5866	0.3451		
Volumetric Strain after Consolidation, %		5.758	2.070		
Time to 50% Consolidation, min		262.4	18.06		
Shear Strength, psi		2.440	4.369		
Strain at Failure, %		7.12	2.18		
Strain Rate, %/min		0.01600	0.01600		
Deviator Stress at Failure, psi		4.880	8.738		
Effective Minor Principal Stress at Failure, psi		1.007	3.054		
Effective Major Principal Stress at Failure, psi		5.887	11.79		
B-Value		0.96	0.95		

Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

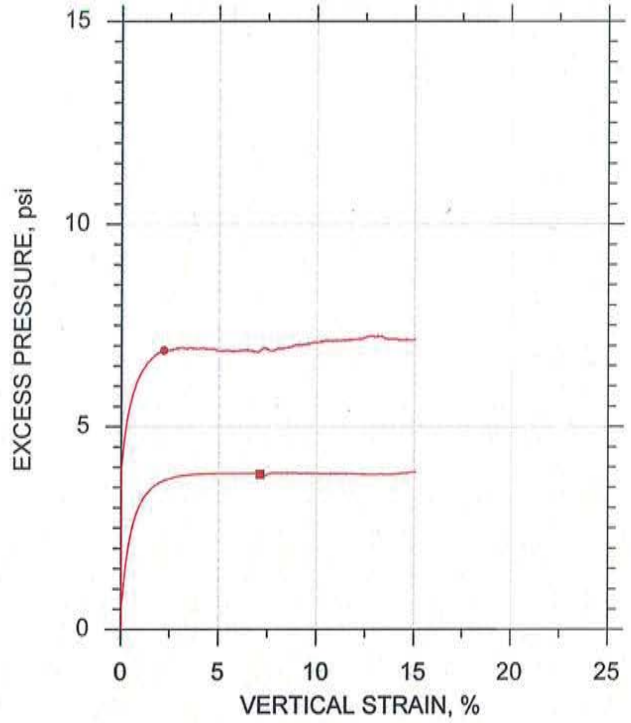


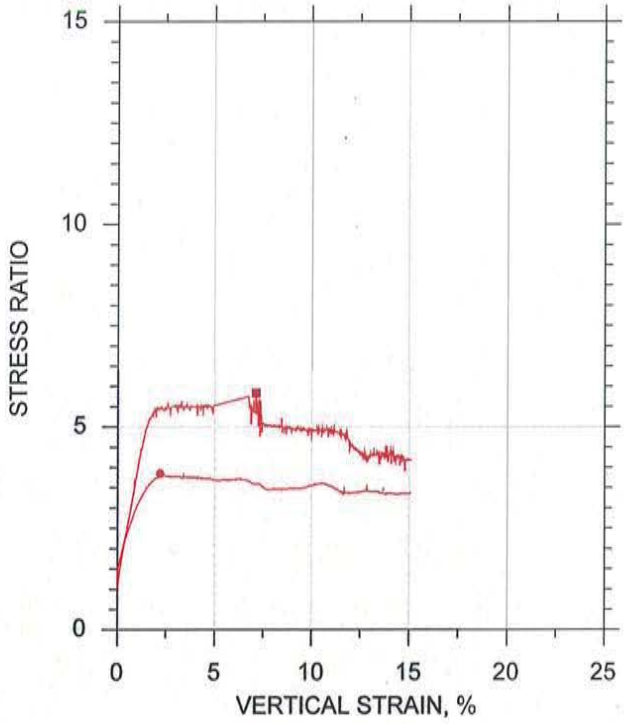


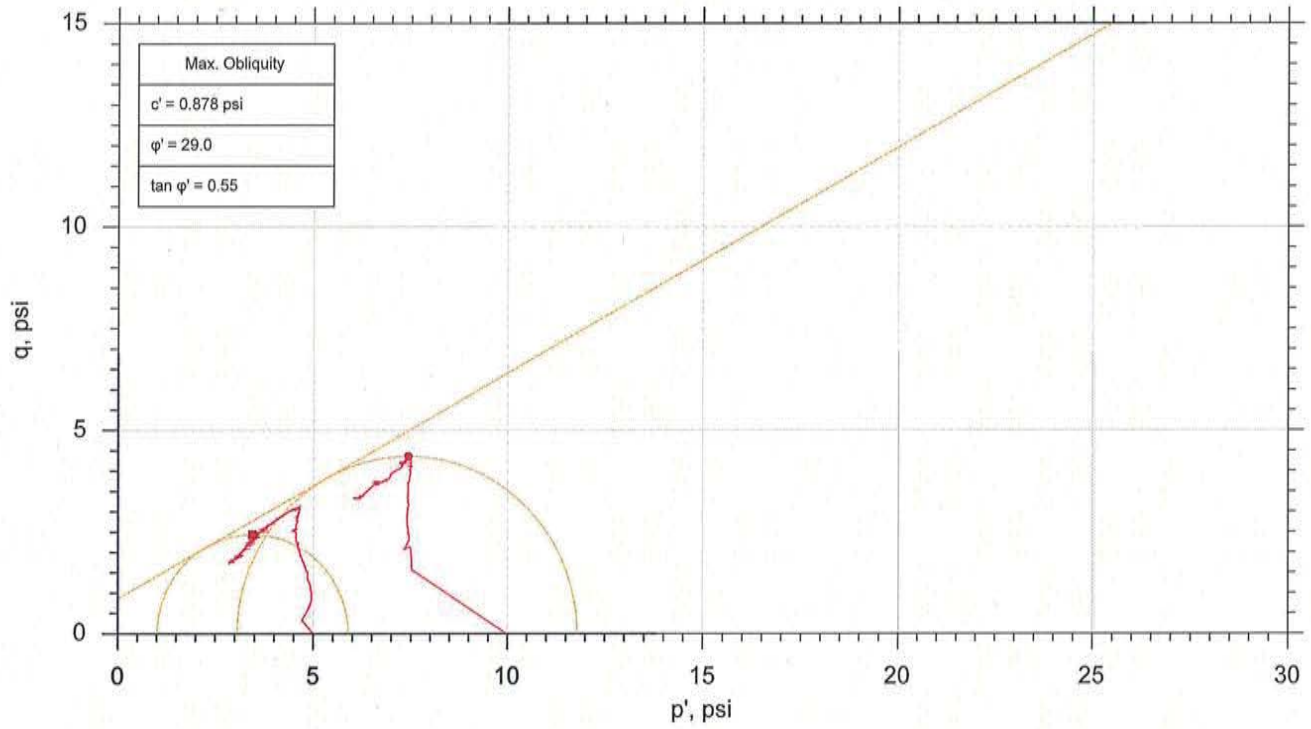
Remarks:

System B

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







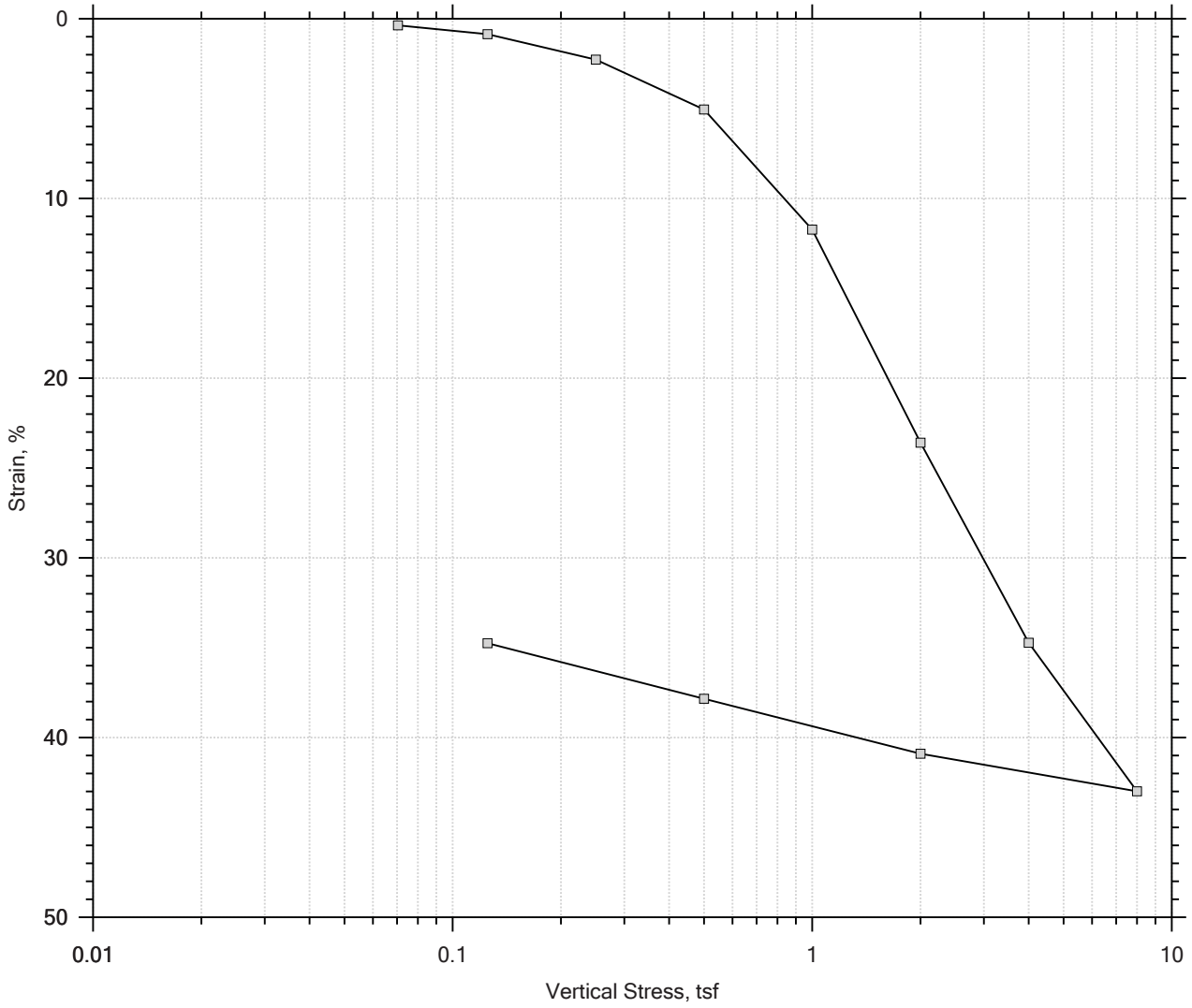
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	ST-1	CU-5-1	16.0-18.0 ft	md	8/24/16	mcm	9/7/16	305005-CU-5-1m.dat
●	ST-1	CU-5-2	16.0-18.0 ft	md	8/24/16	mcm	9/7/16	305005-CU-5-2m.dat

GeoTesting EXPRESS

Project: US 21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Sample Type: intact	
Description: Moist, gray clay with sand		
Remarks: System B		

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report

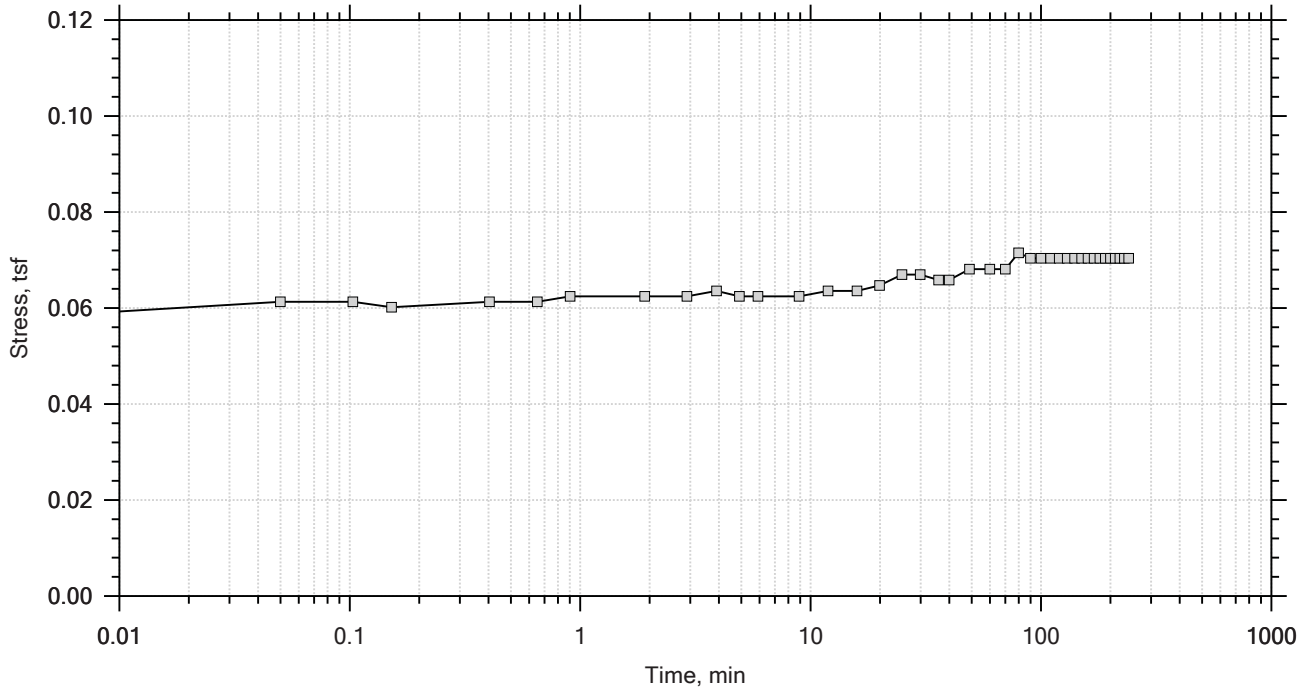


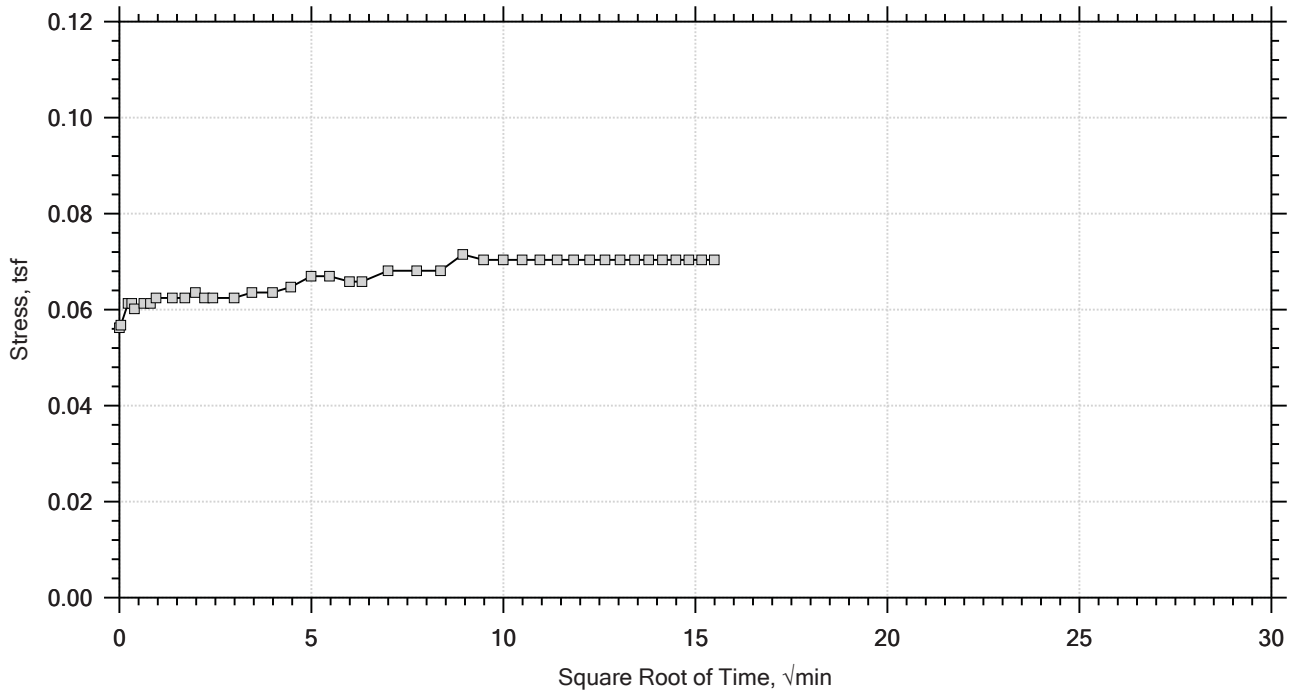
				Before Test	After Test
Current Vertical Effective Stress: ---				Water Content, %	85.59	49.46
Preconsolidation Stress: ---				Dry Unit Weight, pcf	50.811	72.587
Compression Ratio: ---				Saturation, %	99.16	100.00
Diameter: 2.5 in		Height: 1 in		Void Ratio	2.36	1.35
LL: 65	PL: 21	PI: 44	GS: 2.74			

GeoTesting EXPRESS	Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
	Test No.: IP-5	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V, Swell Pressure = 0.0704 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 11
Constant Volume Step
Stress: 0.0704 tsf

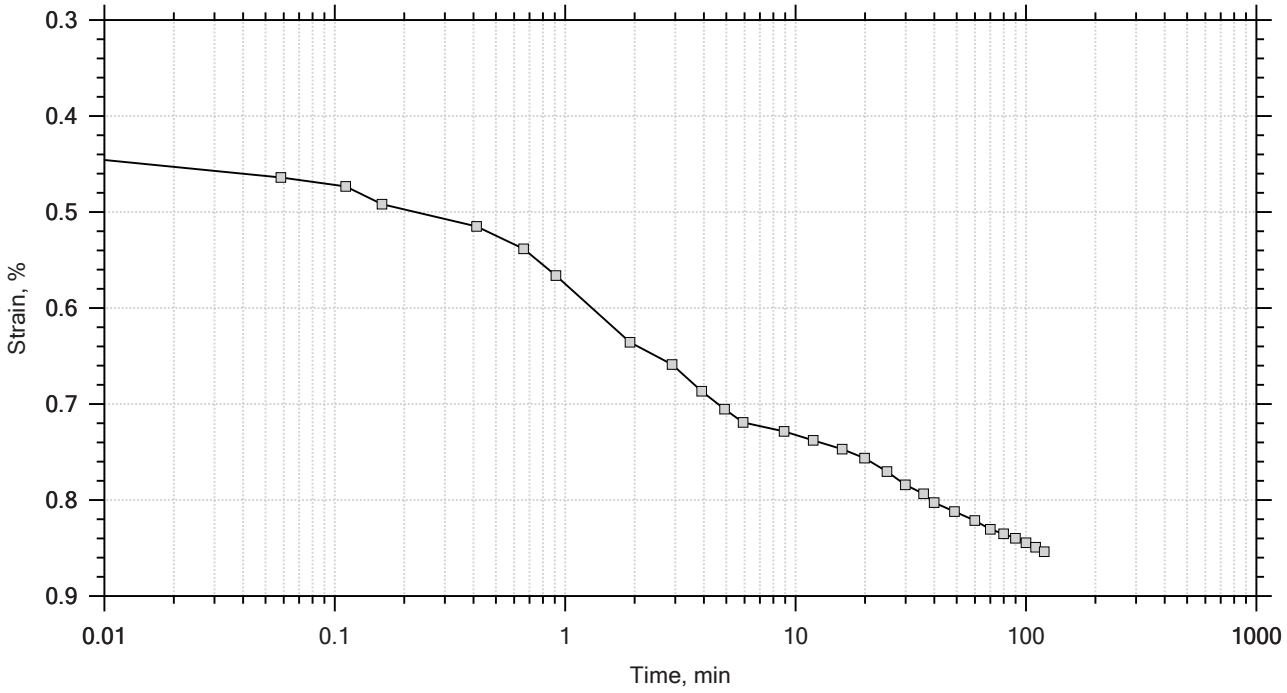


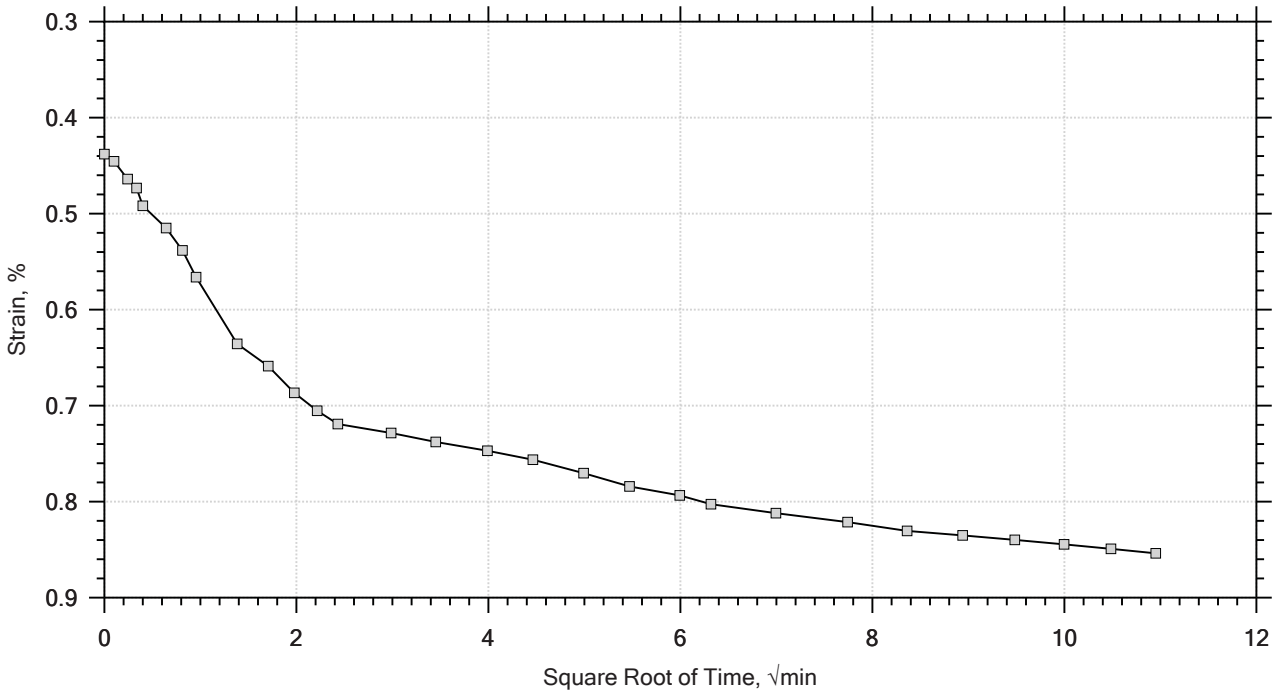


GeoTesting EXPRESS	Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
	Test No.: IP-5	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V, Swell Pressure = 0.0704 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 11
Constant Load Step
Stress: 0.125 tsf

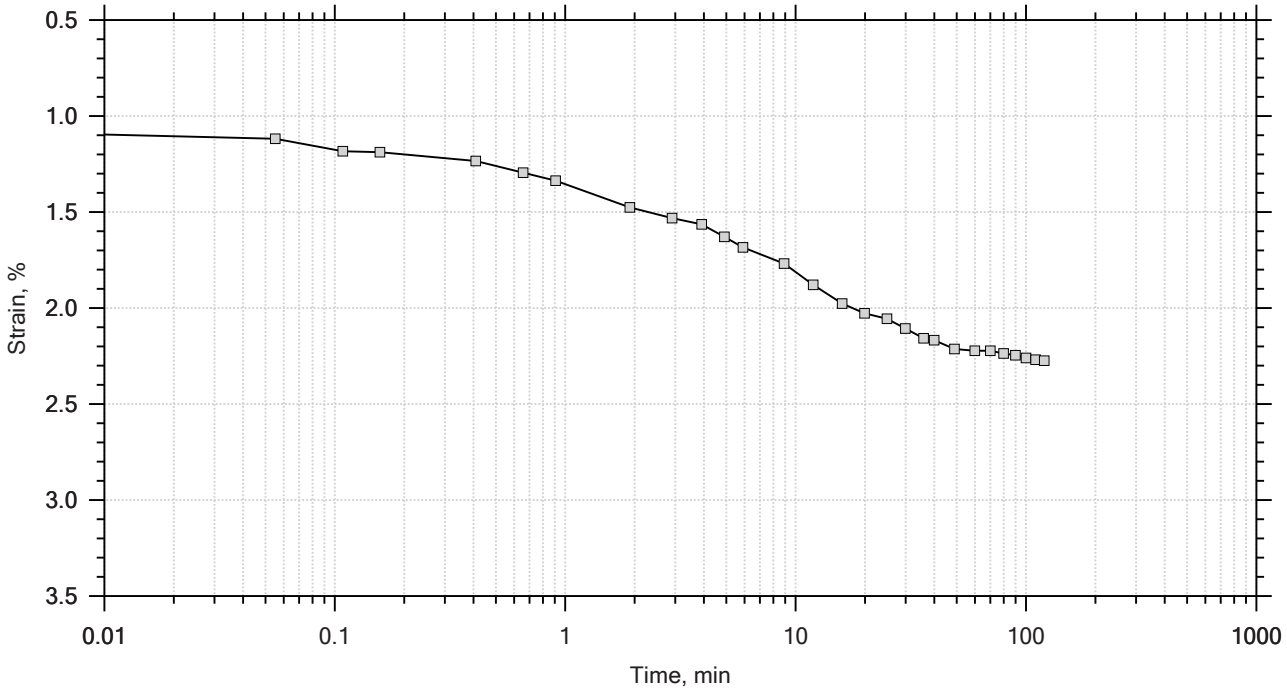


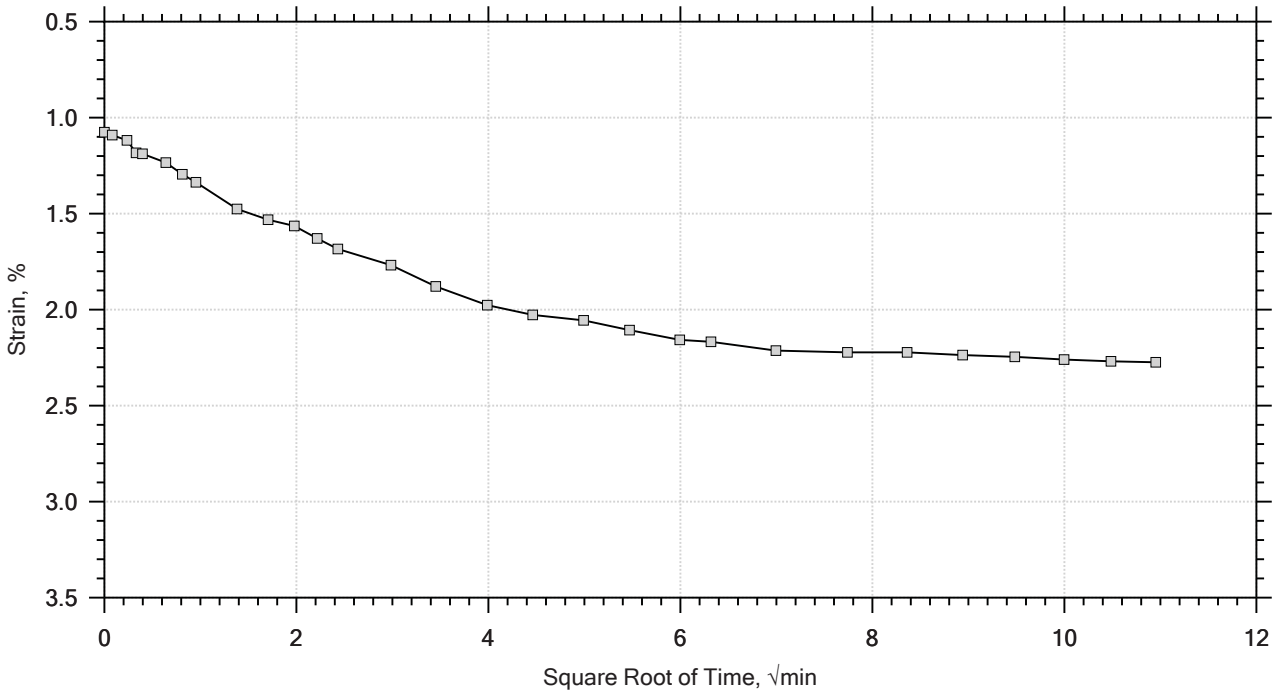


GeoTesting EXPRESS	Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
	Test No.: IP-5	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V, Swell Pressure = 0.0704 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 11
Constant Load Step
Stress: 0.25 tsf

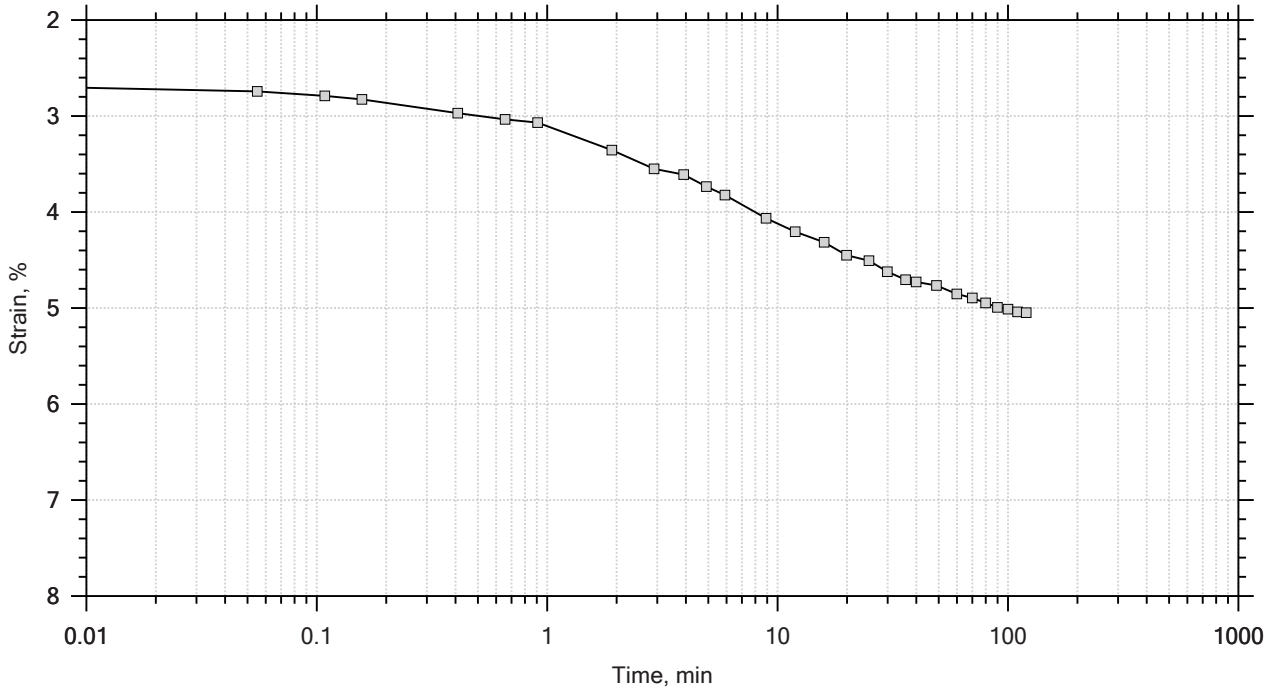


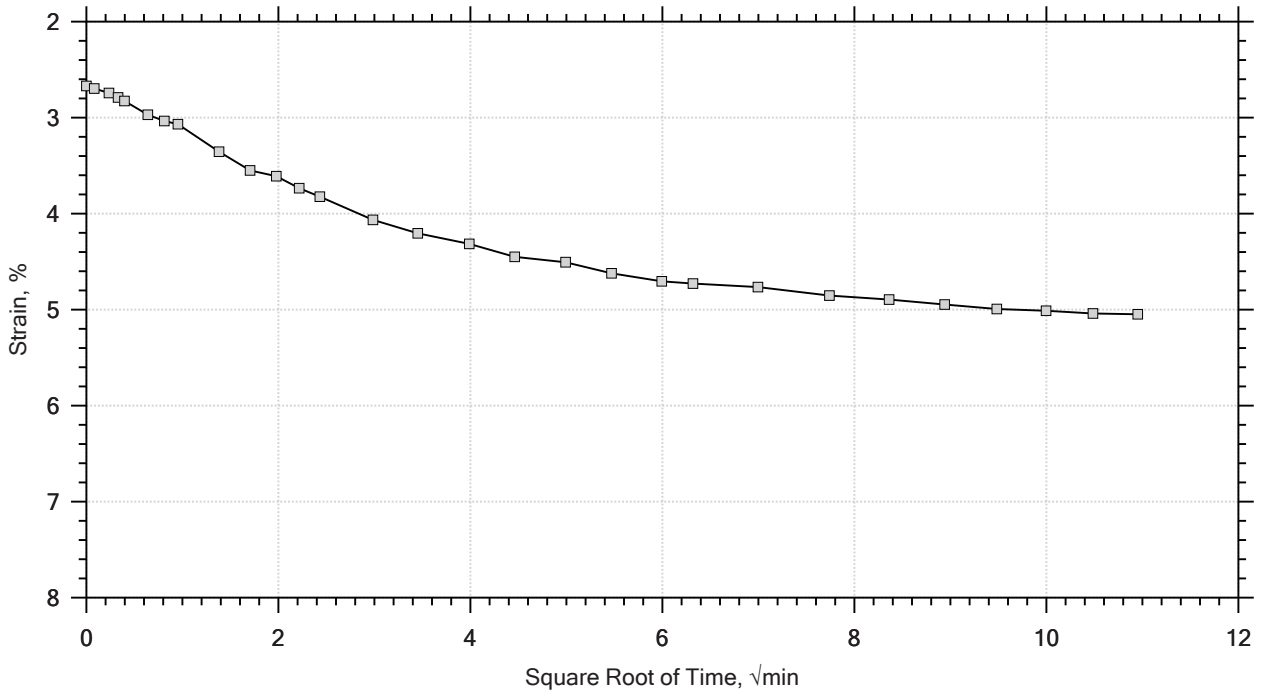


Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
Test No.: IP-5	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System V, Swell Pressure = 0.0704 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 11
Constant Load Step
Stress: 0.5 tsf

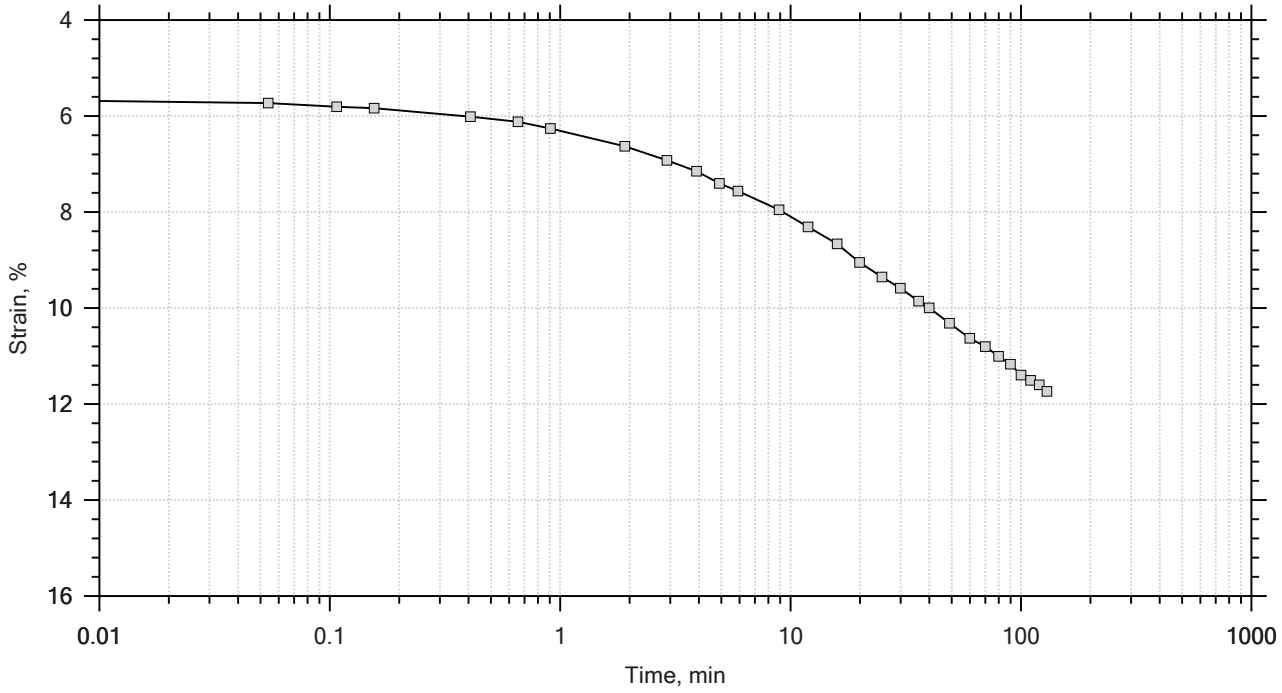


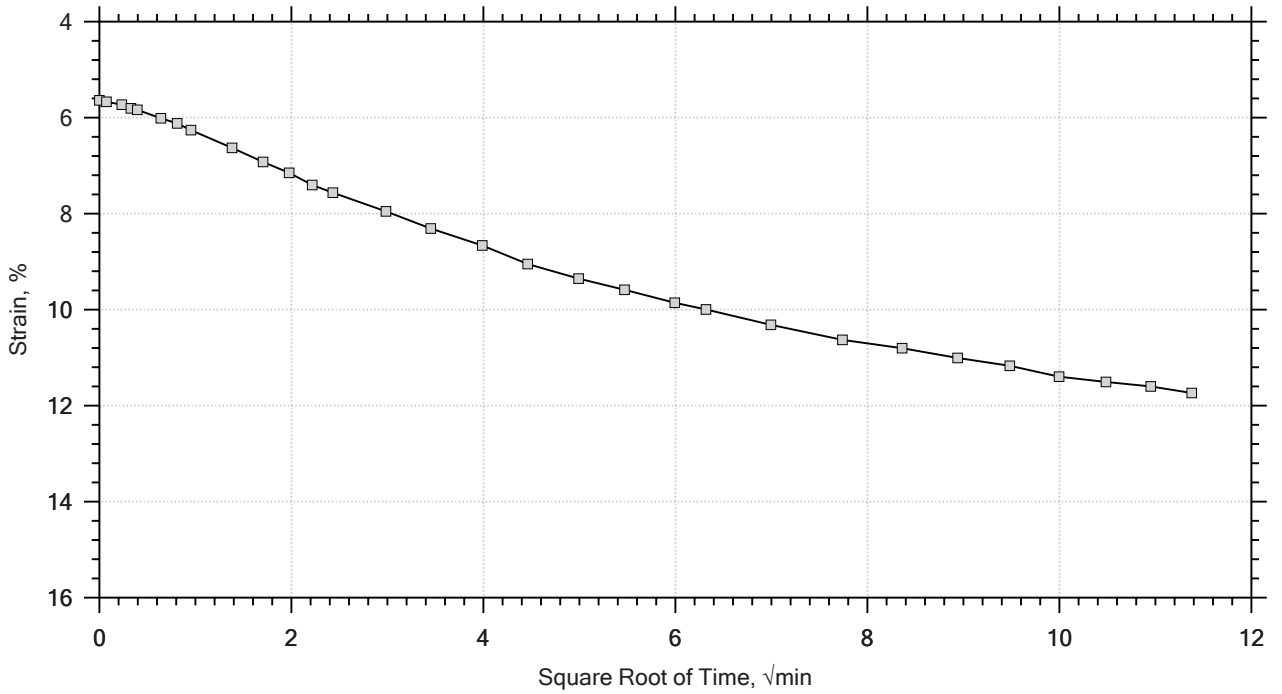


GeoTesting EXPRESS	Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
	Test No.: IP-5	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V, Swell Pressure = 0.0704 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 11
Constant Load Step
Stress: 1 tsf

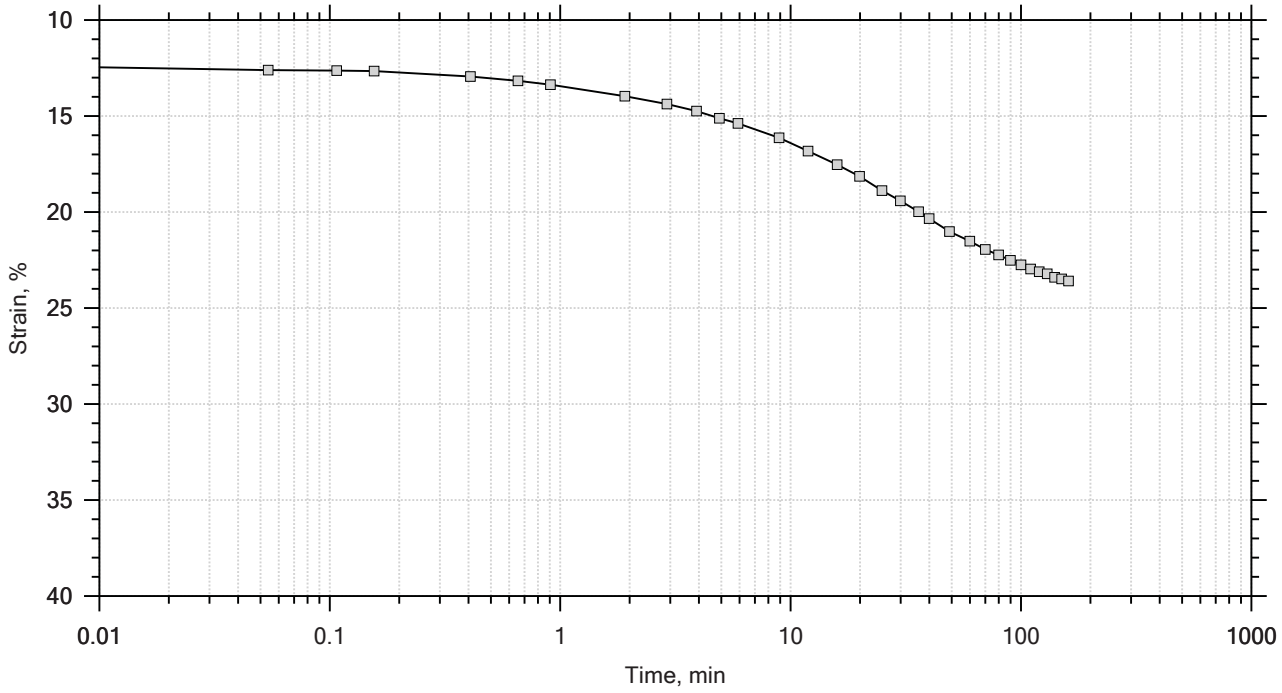


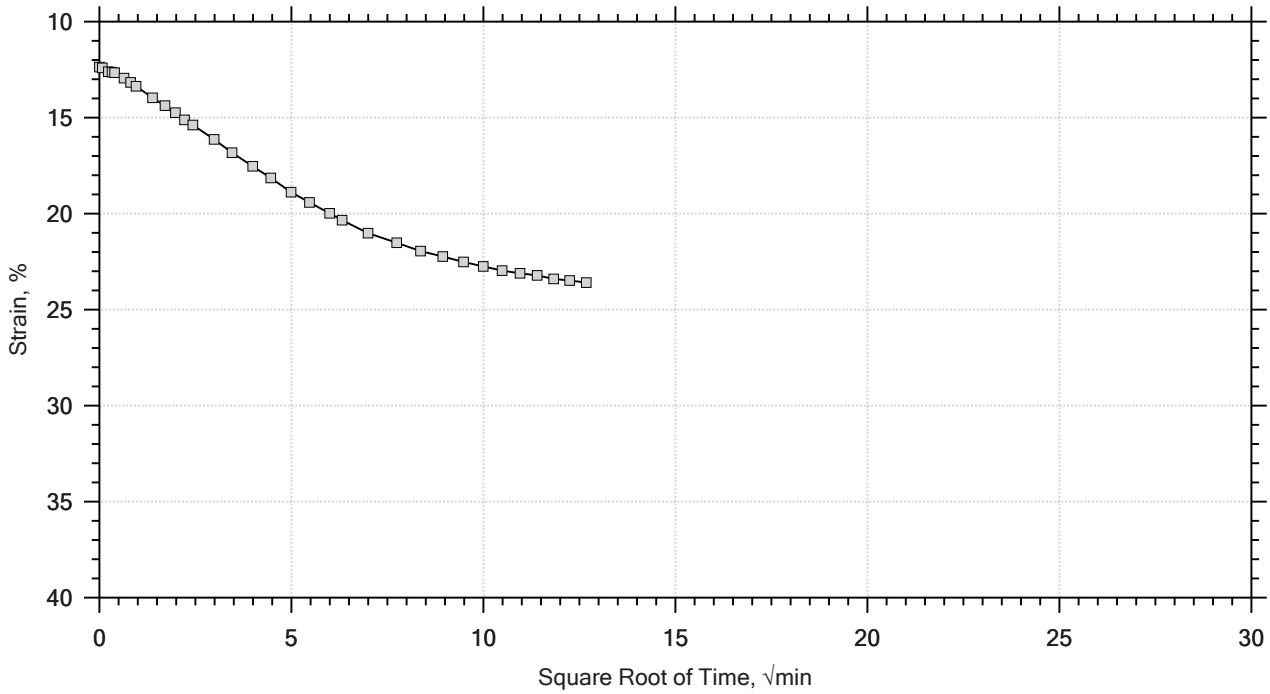


Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
Test No.: IP-5	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System V, Swell Pressure = 0.0704 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 11
Constant Load Step
Stress: 2 tsf

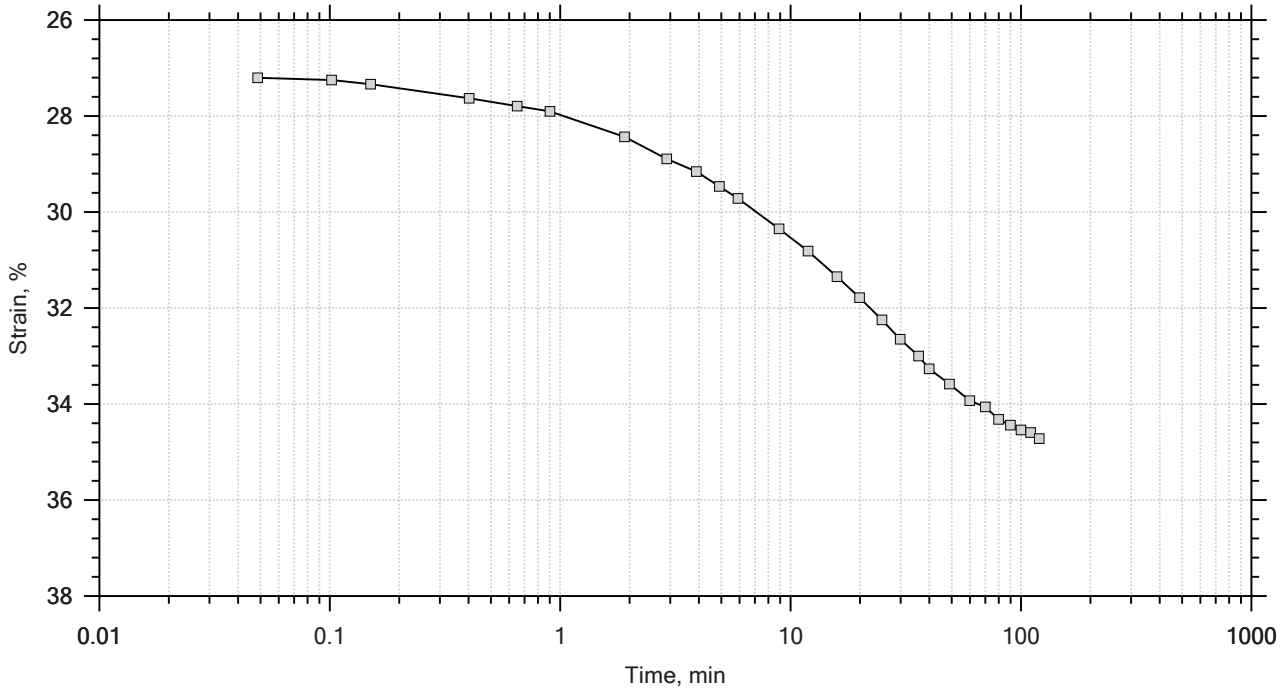


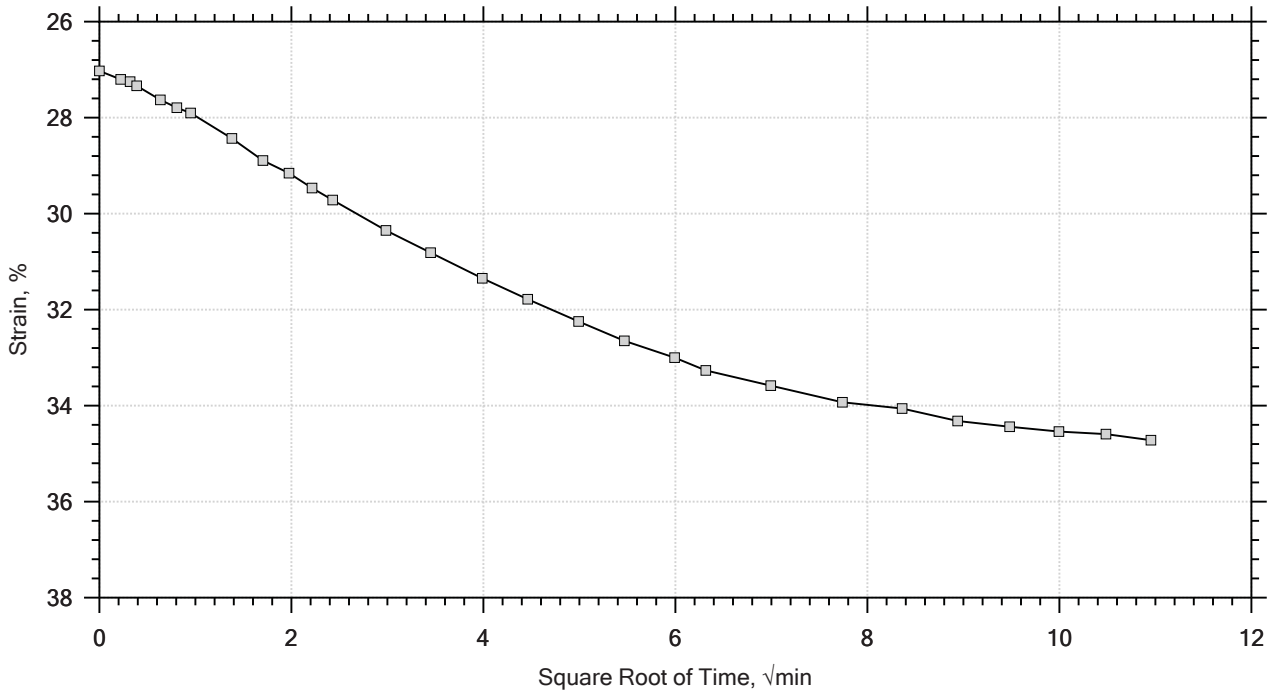


Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
Test No.: IP-5	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System V, Swell Pressure = 0.0704 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 11
Constant Load Step
Stress: 4 tsf

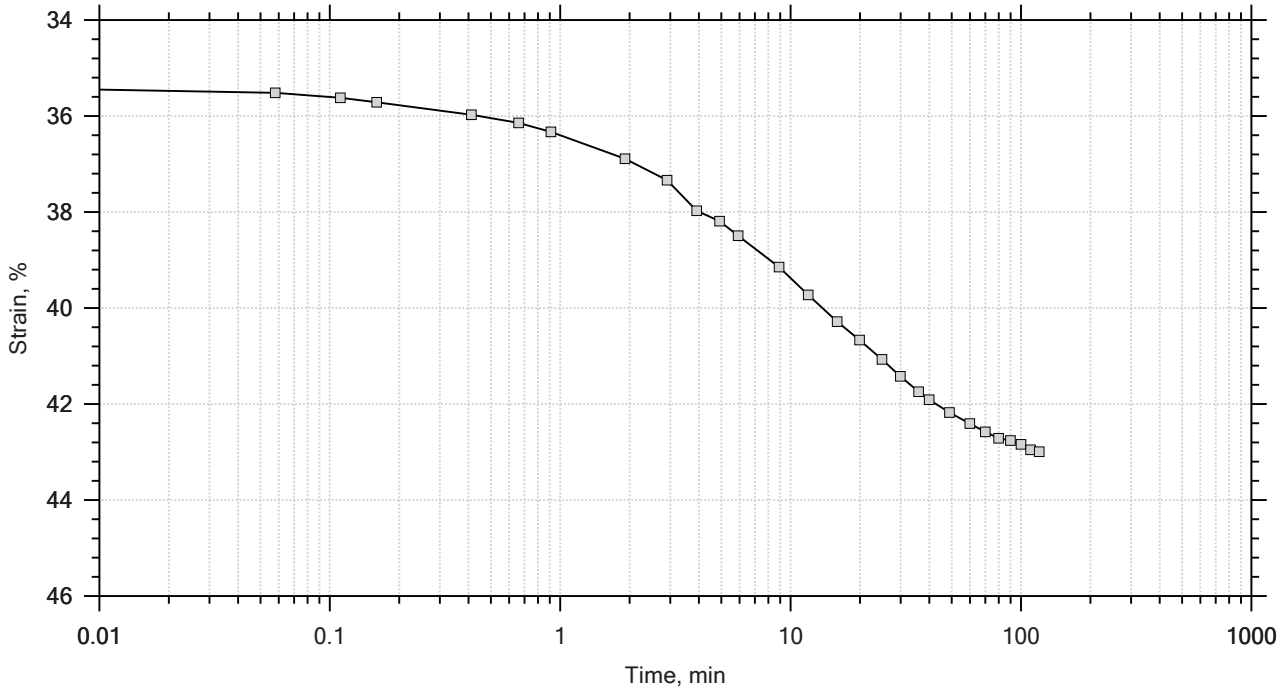


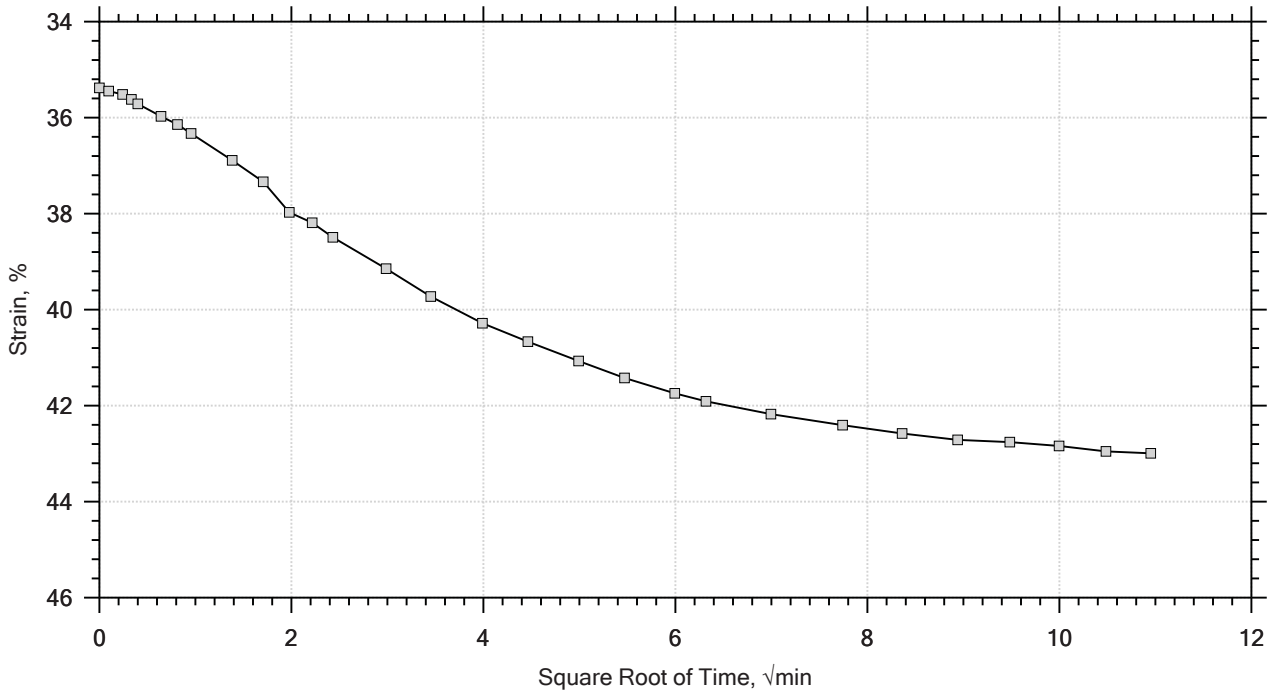


Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
Test No.: IP-5	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System V, Swell Pressure = 0.0704 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 11
Constant Load Step
Stress: 8 tsf

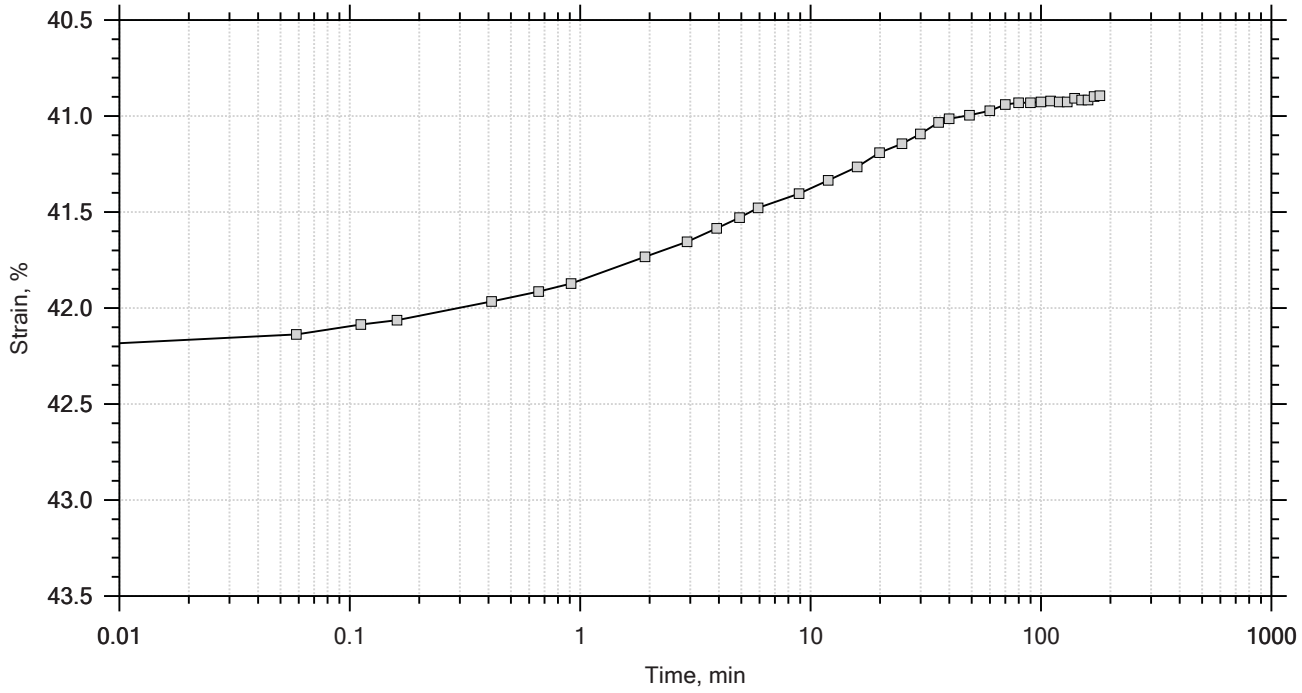


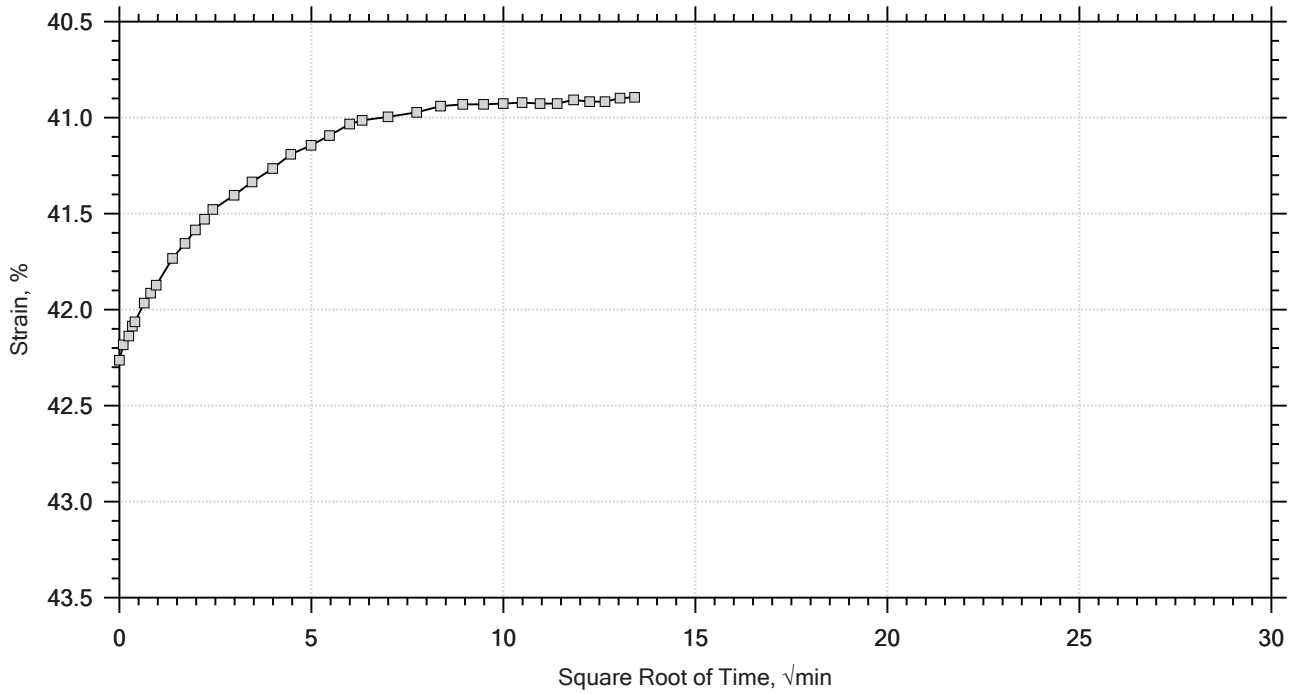


GeoTesting EXPRESS	Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
	Test No.: IP-5	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V, Swell Pressure = 0.0704 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 11
Constant Load Step
Stress: 2 tsf

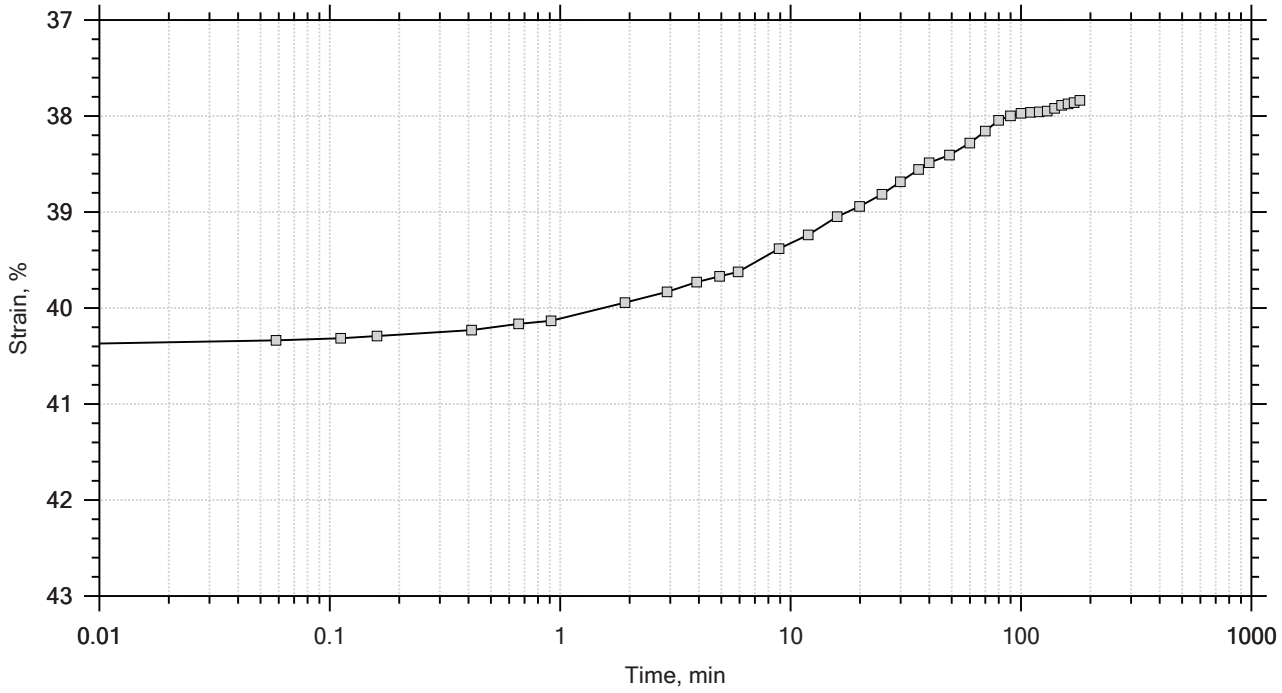


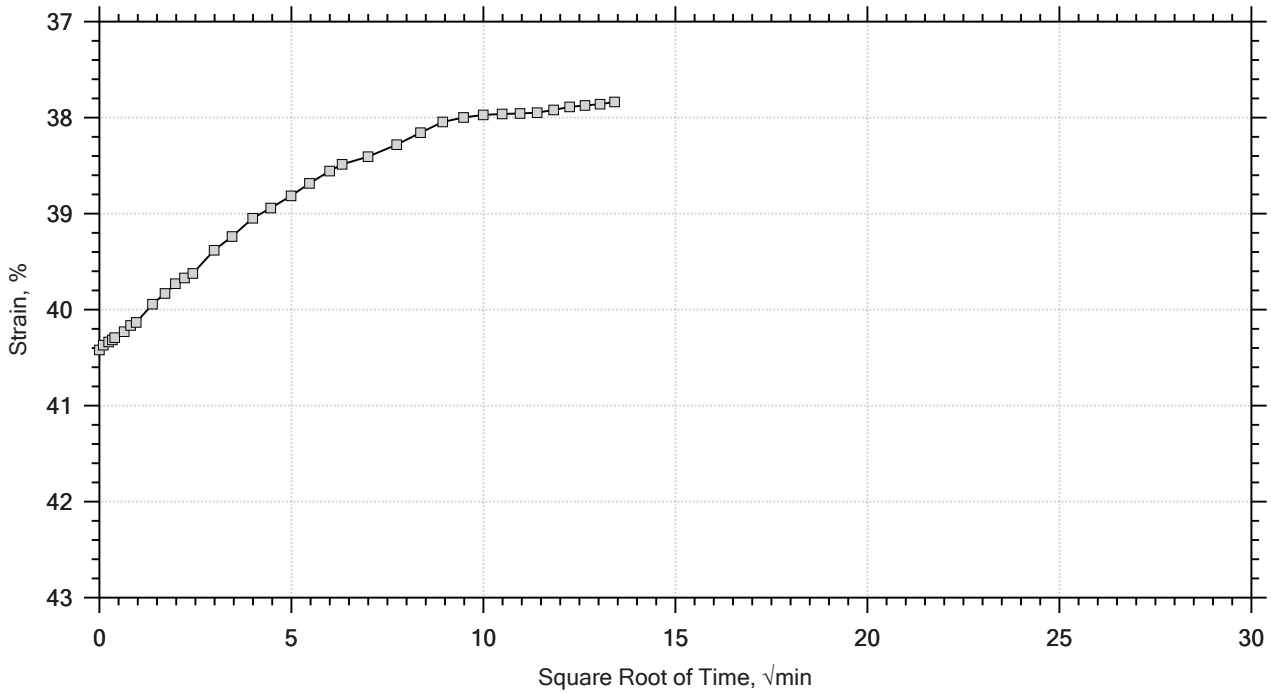


Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
Test No.: IP-5	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System V, Swell Pressure = 0.0704 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 11
Constant Load Step
Stress: 0.5 tsf

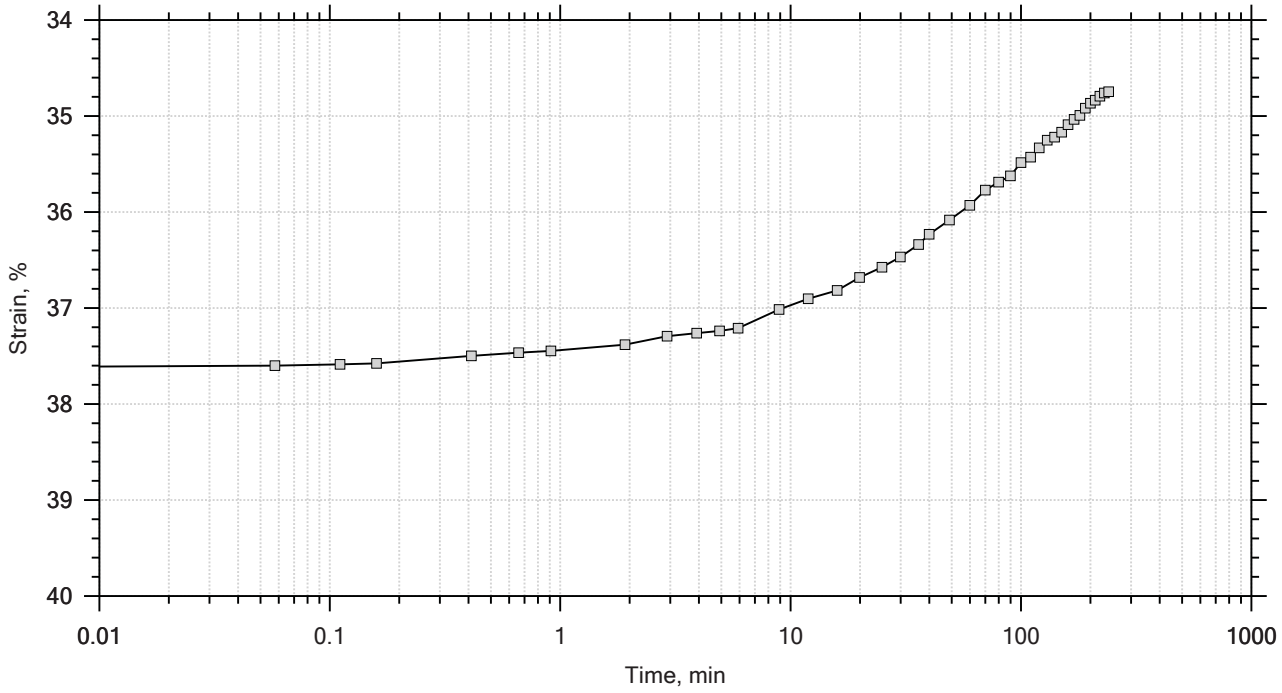


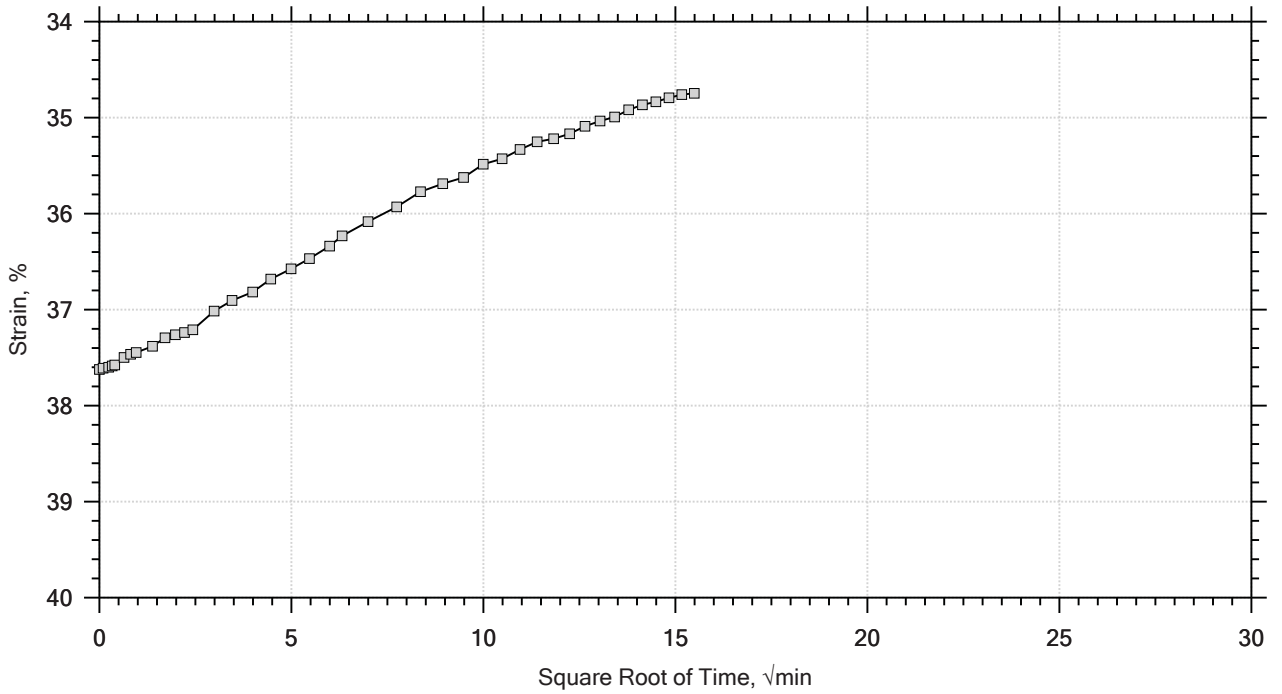


Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
Test No.: IP-5	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System V, Swell Pressure = 0.0704 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 11
Constant Load Step
Stress: 0.125 tsf





Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
Test No.: IP-5	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System V, Swell Pressure = 0.0704 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.74	Liquid Limit: 65
Initial Height: 1.00 in	Initial Void Ratio: 2.36	Plastic Limit: 21
Final Height: 0.70 in	Final Void Ratio: 1.35	Plasticity Index: 44

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	15994	RING		B-295
Mass Container, gm	8.45	110.11	110.11	8.28
Mass Container + Wet Soil, gm	133.6	231.62	207.96	105.89
Mass Container + Dry Soil, gm	78.91	175.58	175.58	73.59
Mass Dry Soil, gm	70.46	65.471	65.471	65.31
Water Content, %	77.62	85.59	49.46	49.46
Void Ratio	---	2.36	1.35	---
Degree of Saturation, %	---	99.16	100.00	---
Dry Unit Weight, pcf	---	50.811	72.587	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS	Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
	Test No.: IP-5	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V, Swell Pressure = 0.0704 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Log of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/s	Mv 1/tsf	k ft/day	Ca %
1	0.0704	0.003665	2.35	0.367	0.000	0.00e+00	5.21e-02	0.00e+00	0.00e+00
2	0.125	0.008537	2.33	0.854	1.818	3.10e-06	8.92e-02	7.45e-04	0.00e+00
3	0.250	0.02273	2.29	2.27	0.000	0.00e+00	1.14e-01	0.00e+00	0.00e+00
4	0.500	0.05048	2.19	5.05	4.388	1.21e-06	1.11e-01	3.61e-04	0.00e+00
5	1.00	0.1173	1.97	11.7	0.000	0.00e+00	1.34e-01	0.00e+00	0.00e+00
6	2.00	0.2359	1.57	23.6	17.652	2.19e-07	1.19e-01	7.00e-05	0.00e+00
7	4.00	0.3472	1.19	34.7	0.000	0.00e+00	5.57e-02	0.00e+00	0.00e+00
8	8.00	0.4299	0.916	43.0	7.643	2.79e-07	2.07e-02	1.56e-05	0.00e+00
9	2.00	0.4089	0.987	40.9	0.000	0.00e+00	3.50e-03	0.00e+00	0.00e+00
10	0.500	0.3784	1.09	37.8	0.000	0.00e+00	2.04e-02	0.00e+00	0.00e+00
11	0.125	0.3475	1.19	34.7	0.000	0.00e+00	8.24e-02	0.00e+00	0.00e+00

GeoTesting EXPRESS	Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
	Test No.: IP-5	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V, Swell Pressure = 0.0704 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Square Root of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv ft²/s	Mv 1/tsf	k ft/day
1	0.0704	0.003665	2.35	0.367	5.902	4.14e-06	5.21e-02	5.82e-04
2	0.125	0.008537	2.33	0.854	13.764	1.76e-06	8.92e-02	4.24e-04
3	0.250	0.02273	2.29	2.27	21.383	1.11e-06	1.14e-01	3.41e-04
4	0.500	0.05048	2.19	5.05	18.440	1.24e-06	1.11e-01	3.70e-04
5	1.00	0.1173	1.97	11.7	55.324	3.72e-07	1.34e-01	1.34e-04
6	2.00	0.2359	1.57	23.6	78.285	2.13e-07	1.19e-01	6.79e-05
7	4.00	0.3472	1.19	34.7	50.153	2.46e-07	5.57e-02	3.69e-05
8	8.00	0.4299	0.916	43.0	32.140	2.85e-07	2.07e-02	1.59e-05
9	2.00	0.4089	0.987	40.9	20.221	4.09e-07	3.50e-03	3.86e-06
10	0.500	0.3784	1.09	37.8	52.762	1.71e-07	2.04e-02	9.40e-06
11	0.125	0.3475	1.19	34.7	233.771	4.26e-08	8.24e-02	9.47e-06

GeoTesting EXPRESS	Project: SU-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/24/16	Depth: 16.0-18.0 ft
	Test No.: IP-5	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V, Swell Pressure = 0.0704 tsf		
	Displacement at End of Increment		

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	---	Sample Type:	---	Tested By:	jbr
Sample ID:	---	Test Date:	08/30/16	Checked By:	mcm
Depth :	---	Test Id:	387124		

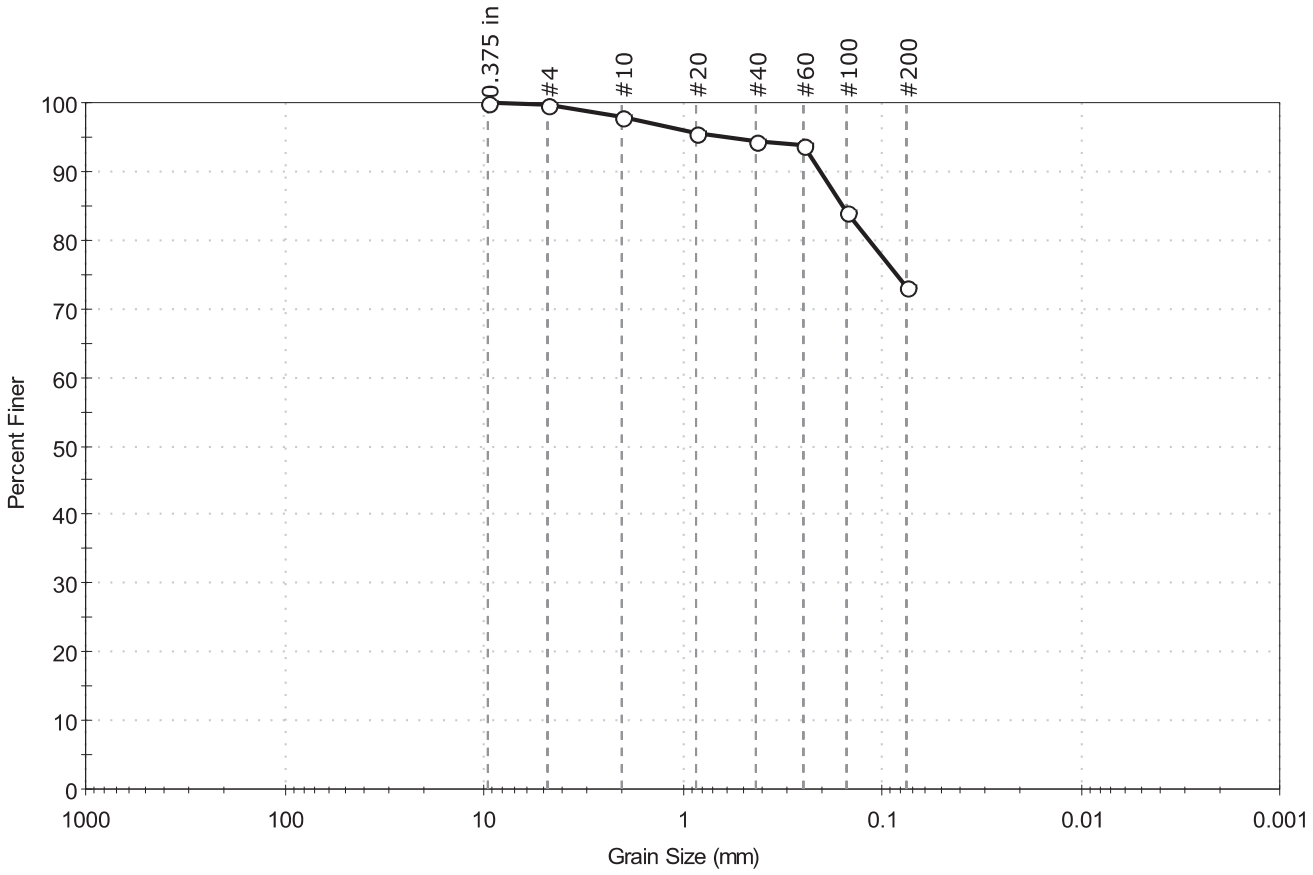
Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
AP-1	UD-2	18.0-20.0 ft	Moist, olive clay with sand	86.3

Notes: Temperature of Drying : 110º Celsius

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-1	Sample Type:	tube	Tested By:	jbr
Sample ID:	UD-2	Test Date:	08/24/16	Checked By:	mcm
Depth :	18.0-20.0 ft	Test Id:	387102		
Test Comment:	---				
Visual Description:	Moist, olive clay with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.2	26.5	73.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	98		
#20	0.85	96		
#40	0.42	94		
#60	0.25	94		
#100	0.15	84		
#200	0.075	73		

Coefficients

D_{85} =0.1582 mm	D_{30} =N/A
D_{60} =N/A	D_{15} =N/A
D_{50} =N/A	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM Fat clay with sand (CH)

AASHTO Clayey Soils (A-7-5 (60))

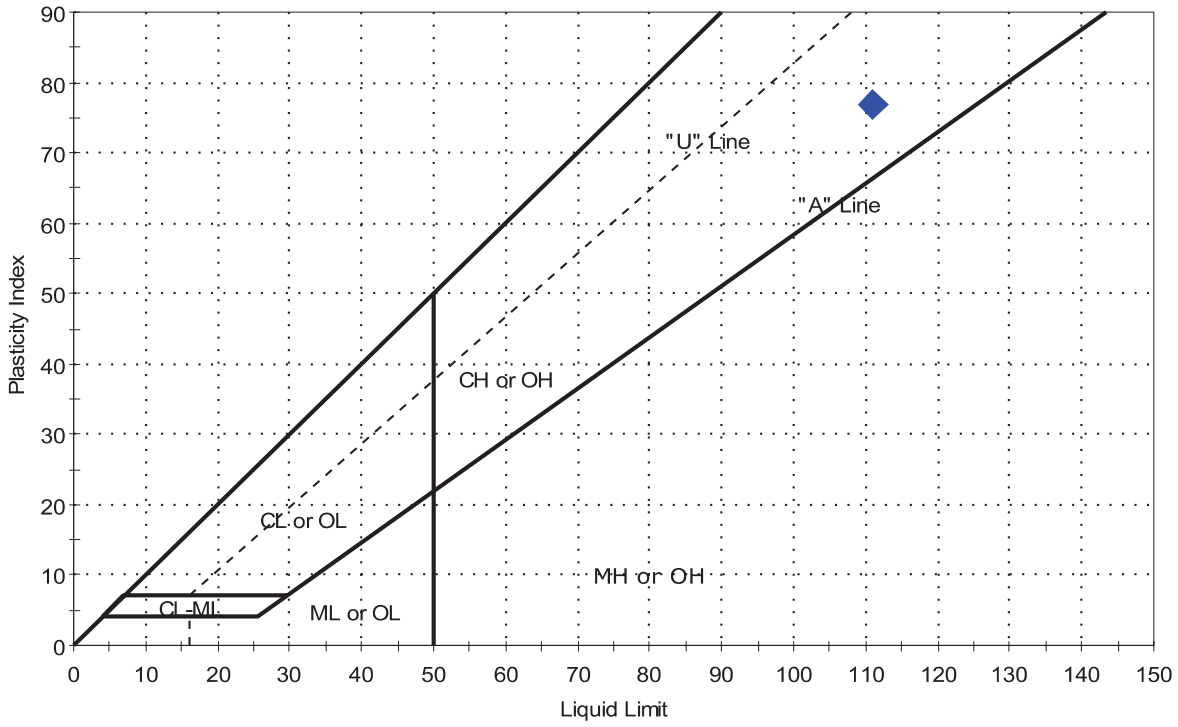
Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-1	Sample Type:	tube	Tested By:	cam
Sample ID:	UD-2	Test Date:	08/26/16	Checked By:	mcm
Depth :	18.0-20.0 ft	Test Id:	387110		
Test Comment:	---				
Visual Description:	Moist, olive clay with sand				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



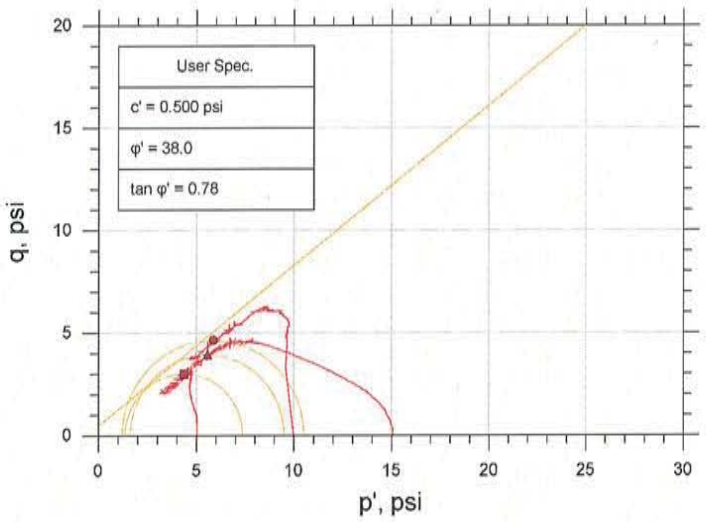
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	UD-2	AP-1	18.0-20.0 ft	86	111	34	77	0.7	Fat clay with sand (CH)

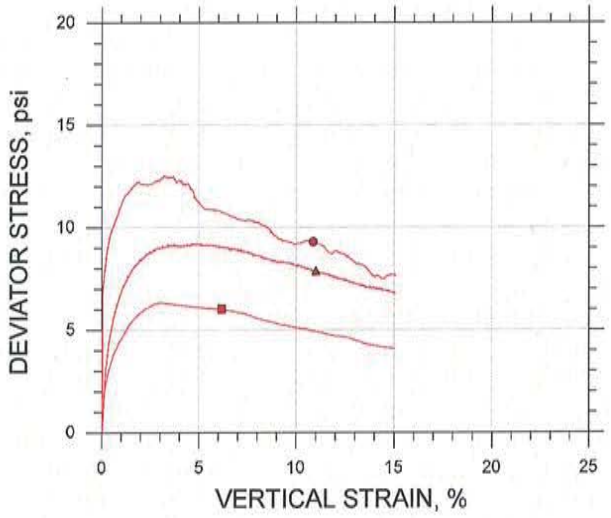
Sample Prepared using the WET method
6% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

GeoTesting EXPRESS

Client: F&ME Consultants	
Project Name: US-21 Replacement Bridge	
Project Location: ---	
Project Number: GTX-305005	
Tested By: md	Checked By: mcm
Boring ID: AP-1	
Preparation: Intact	
Description: Moist, olive clay with sand	
Classification: Fat clay with sand	
Group Symbol: CH	
Liquid Limit: 111	Plastic Limit: 34
Plasticity Index: 77	Estimated Specific Gravity: 2.7

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





		■	●	▲	
Symbol					
Sample ID		ST-2	ST-2	ST-2	
Depth, ft		18.0-20.0 ft	18.0-20.0 ft	18.0-20.0 ft	
Test Number		CU-3-1	CU-3-2	CU-3-3	
Initial	Height, in	4.550	4.540	4.490	
	Diameter, in	2.030	2.030	2.030	
	Moisture Content (from Cuttings), %	71.3	84.8	84.8	
	Dry Density, pcf	55.7	46.4	49.5	
	Saturation (Wet Method), %	95.0	87.0	95.0	
	Void Ratio	2.02	2.63	2.41	
Before Shear	Moisture Content, %	71.0	69.6	66.8	
	Dry Density, pcf	57.8	58.6	60.1	
	Cross-sectional Area (Method A), in²	3.123	2.614	2.723	
	Saturation, %	100.0	100.0	100.0	
	Void Ratio	1.92	1.88	1.80	
	Back Pressure, psi	127.0	29.02	28.99	
Vertical Effective Consolidation Stress, psi		5.008	9.831	14.86	
Horizontal Effective Consolidation Stress, psi		5.009	9.968	15.01	
Vertical Strain after Consolidation, %		0.03924	1.773	2.088	
Volumetric Strain after Consolidation, %		3.576	20.60	17.44	
Time to 50% Consolidation, min		148.8	458.0	342.3	
Shear Strength, psi		3.011	4.650	3.939	
Strain at Failure, %		6.18	10.9	11.0	
Strain Rate, %/min		0.01600	0.01600	0.01600	
Deviator Stress at Failure, psi		6.022	9.300	7.877	
Effective Minor Principal Stress at Failure, psi		1.355	1.207	1.622	
Effective Major Principal Stress at Failure, psi		7.376	10.51	9.499	
B-Value		0.95	0.99	0.95	

Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

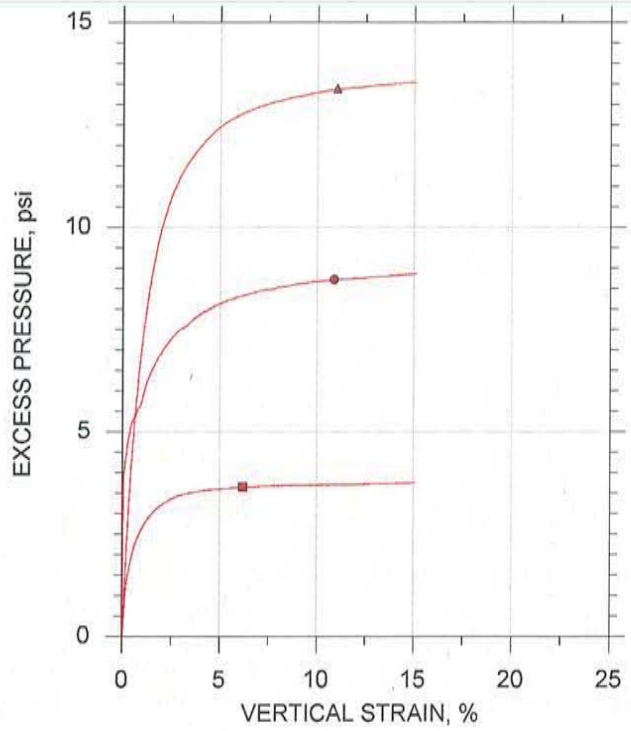


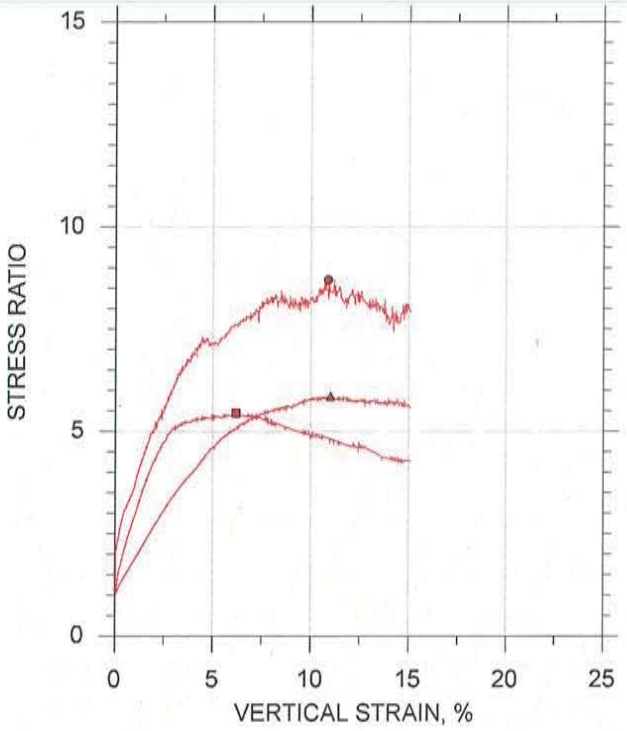


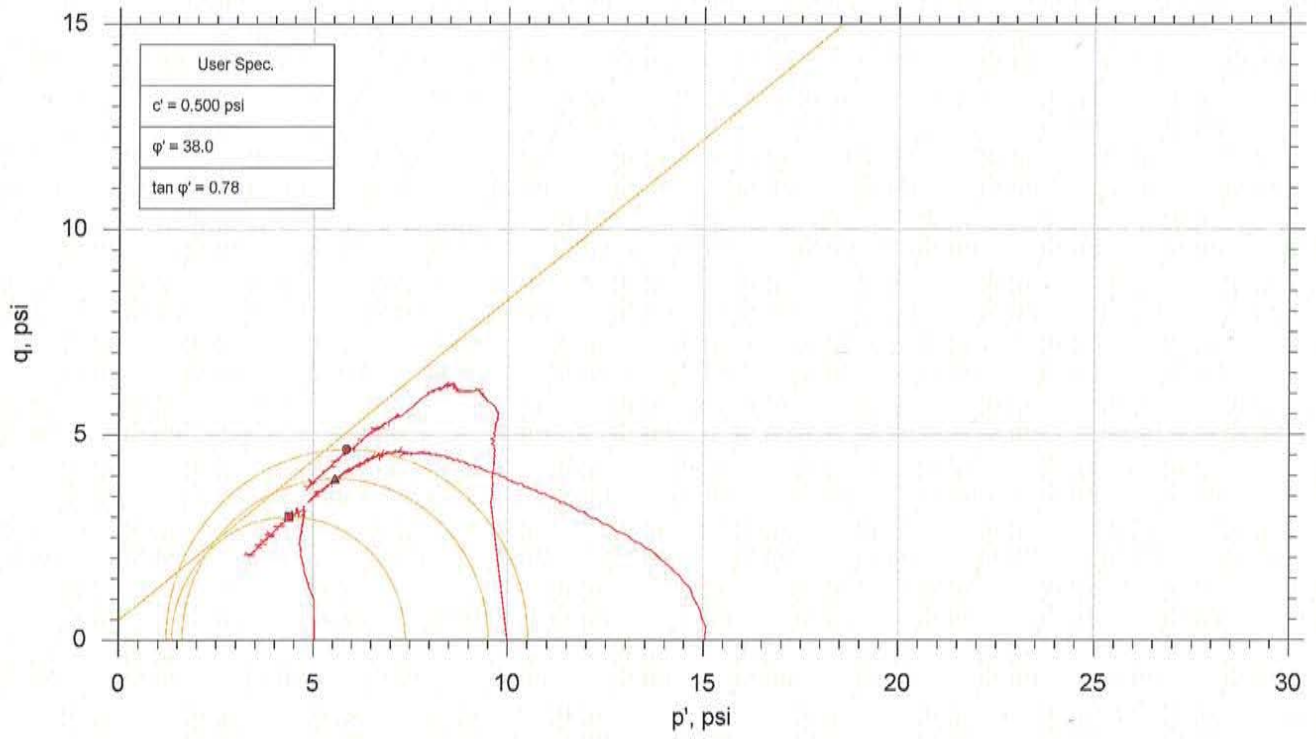
Remarks:

System T. Note CU-2-2 test specimen not used in determining cohesion or friction values.

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







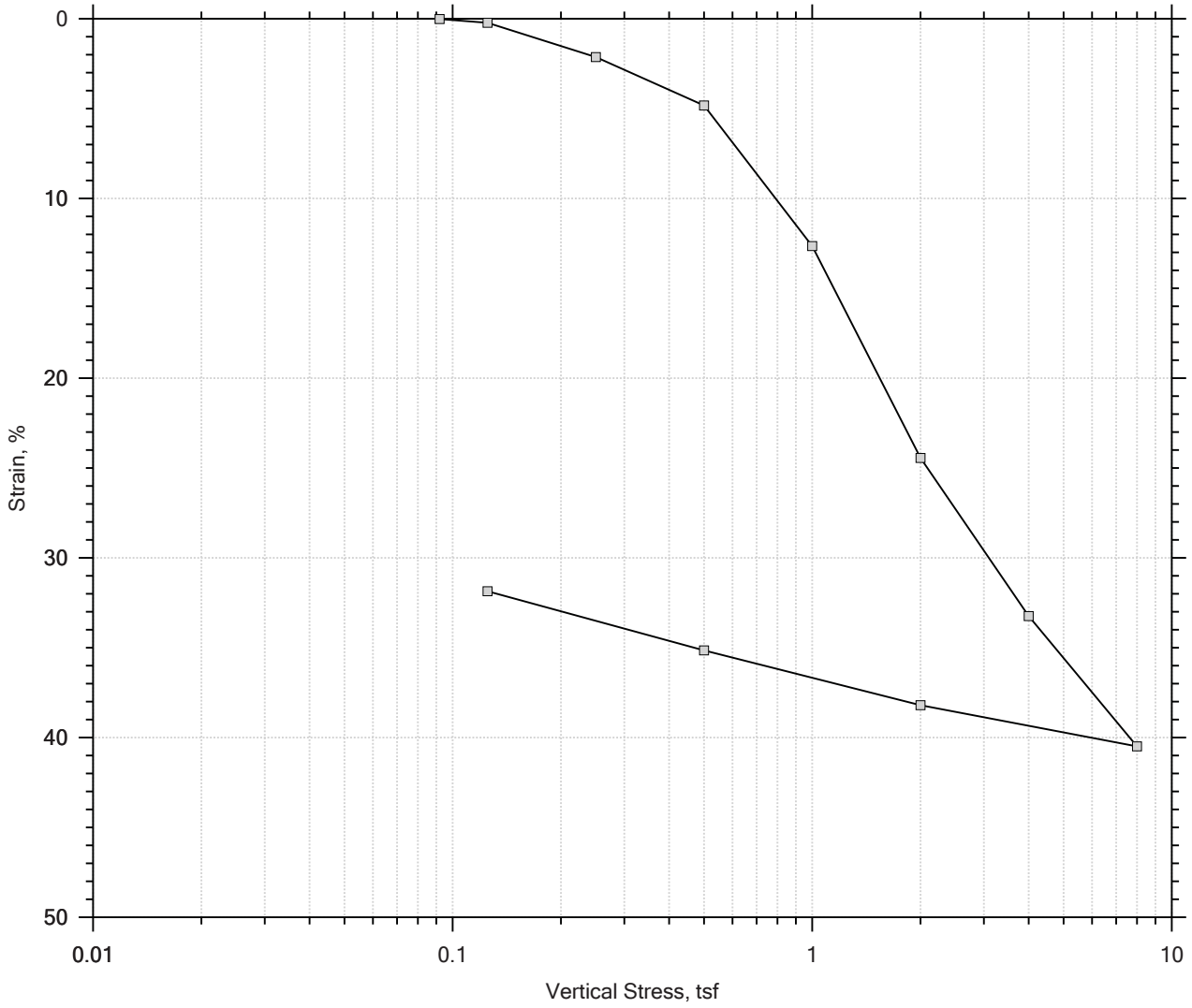
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	ST-2	CU-3-1	18.0-20.0 ft	md	8/22/16	mcm	8/29/16	305005-CU-3-1m.dat
●	ST-2	CU-3-2	18.0-20.0 ft	md	8/22/16	mcm	8/29/16	305005-CU-3-2m.dat
▲	ST-2	CU-3-3	18.0-20.0 ft	md	8/22/16	mcm	8/29/16	305005-CU-3-3m.dat

GeoTesting EXPRESS

Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Sample Type: Intact	
Description: Moist, olive clay with sand		
Remarks: System T. Note CU-2-2 test specimen not used in determining cohesion or friction values.		

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report

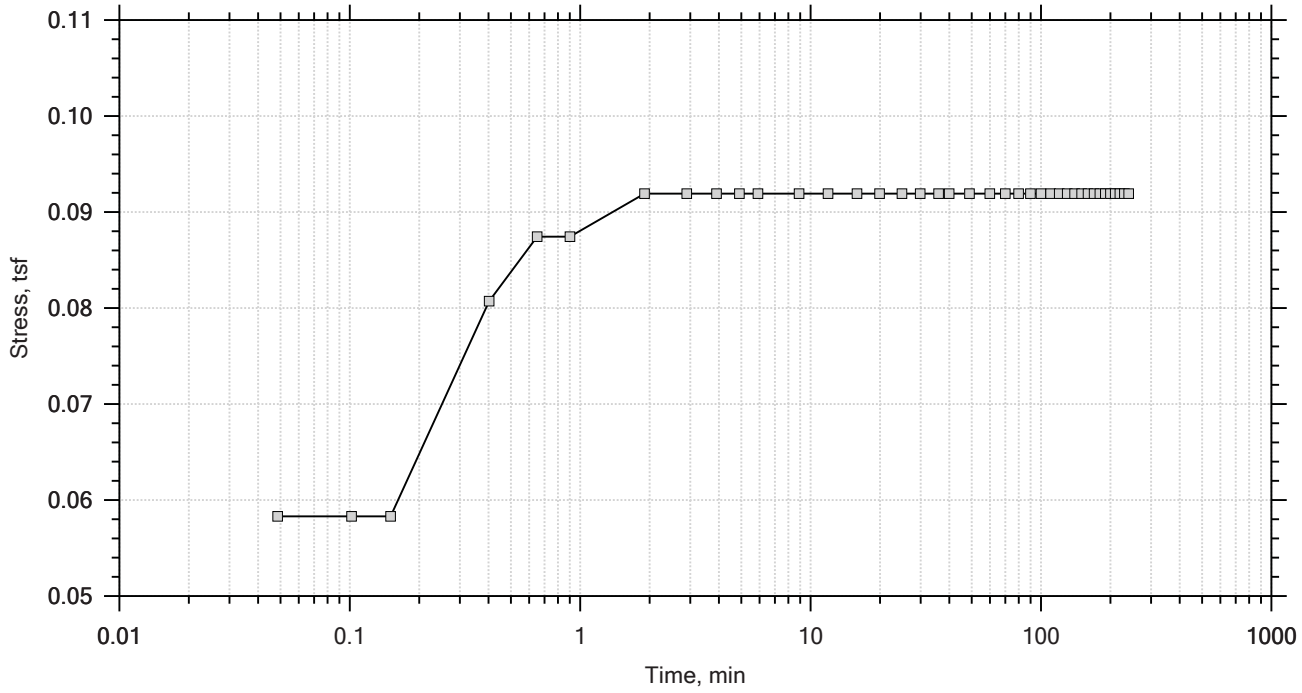


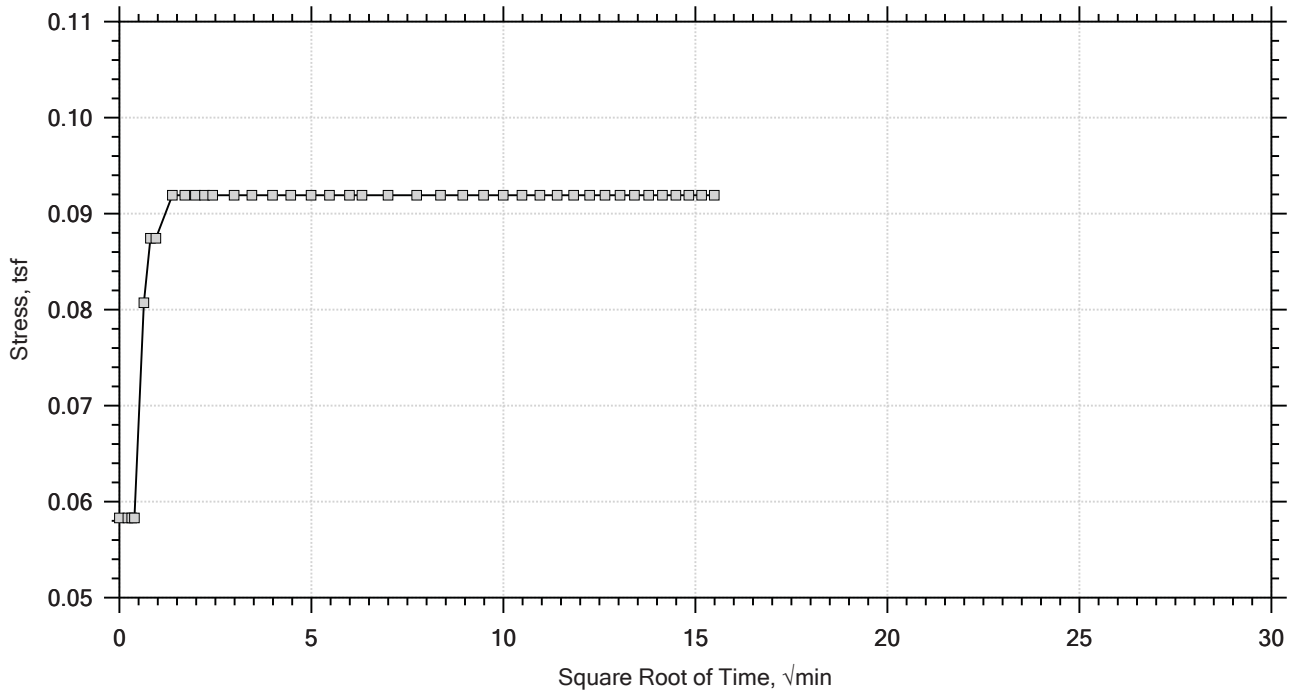
					Before Test	After Test
Current Vertical Effective Stress: ---				Water Content, %	89.14	52.62
Preconsolidation Stress: ---				Dry Unit Weight, pcf	48.913	69.876
Compression Ratio: ---				Saturation, %	98.06	100.00
Diameter: 2.5 in		Height: 1 in		Void Ratio	2.48	1.43
LL: 111	PL: 34	PI: 77	GS: 2.72			

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-3	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System R, Swell Pressure = 0.0919 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 11
Constant Volume Step
Stress: 0.0919 tsf

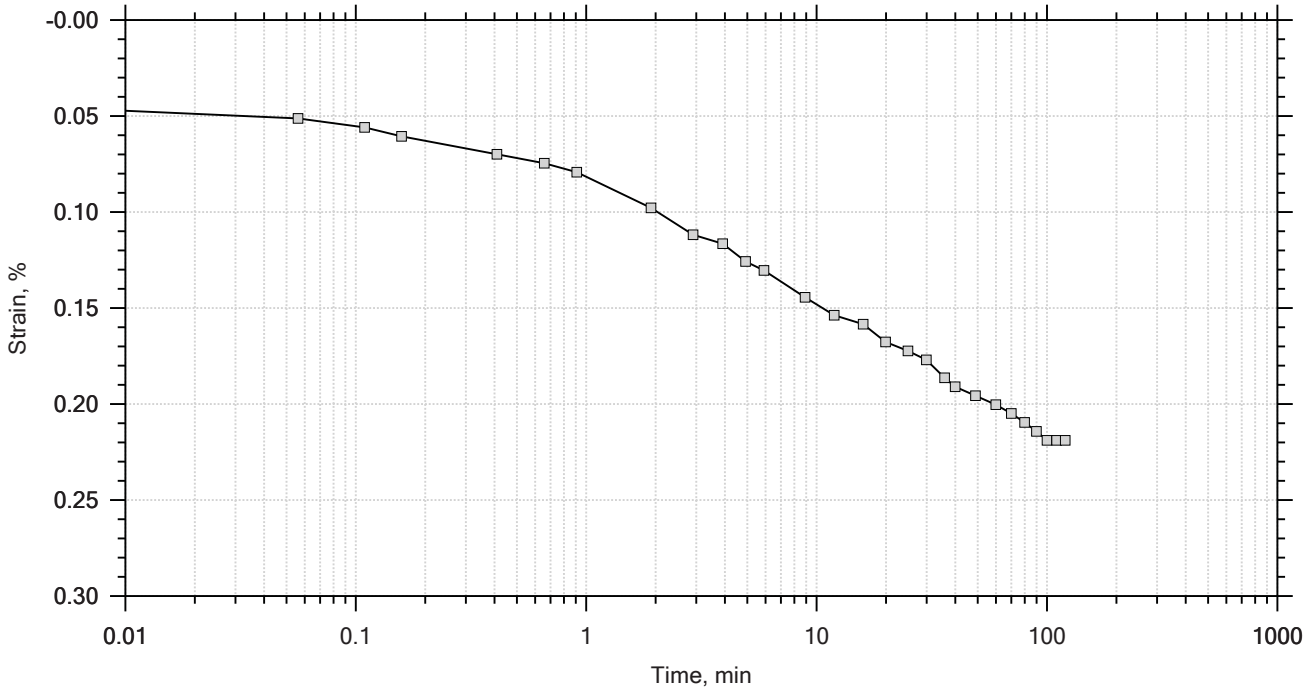


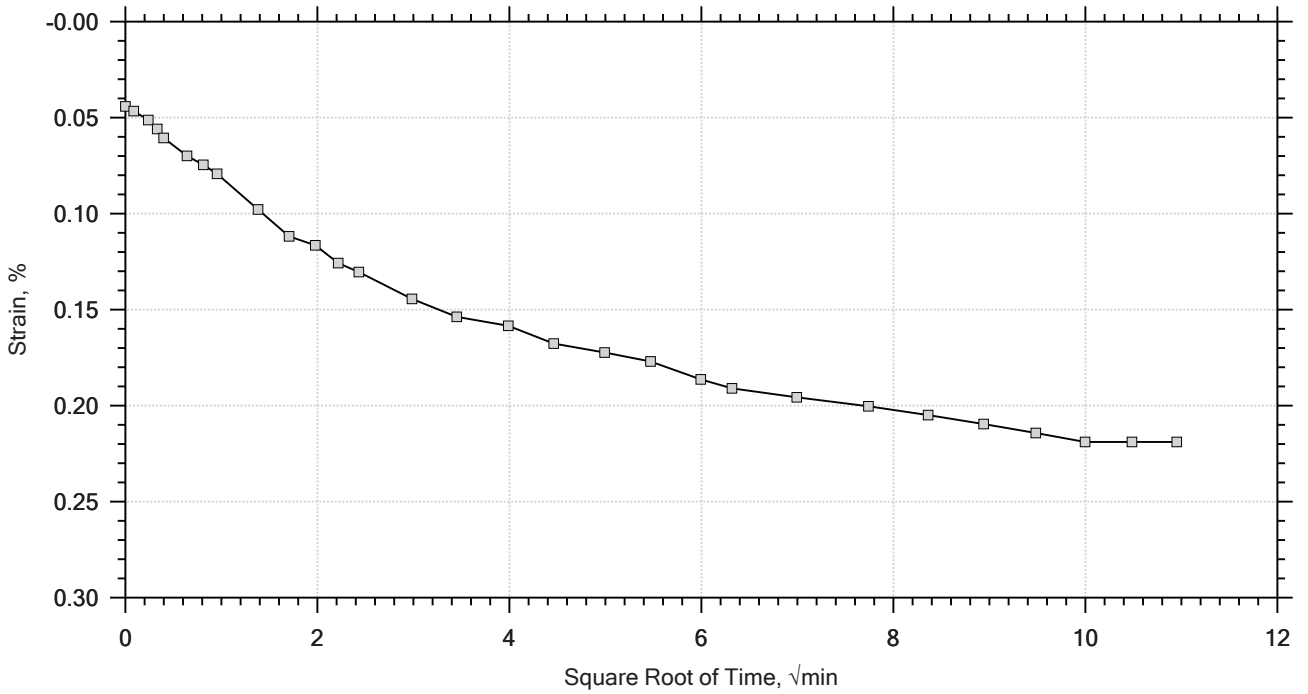


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-3	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System R, Swell Pressure = 0.0919 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 11
Constant Load Step
Stress: 0.125 tsf

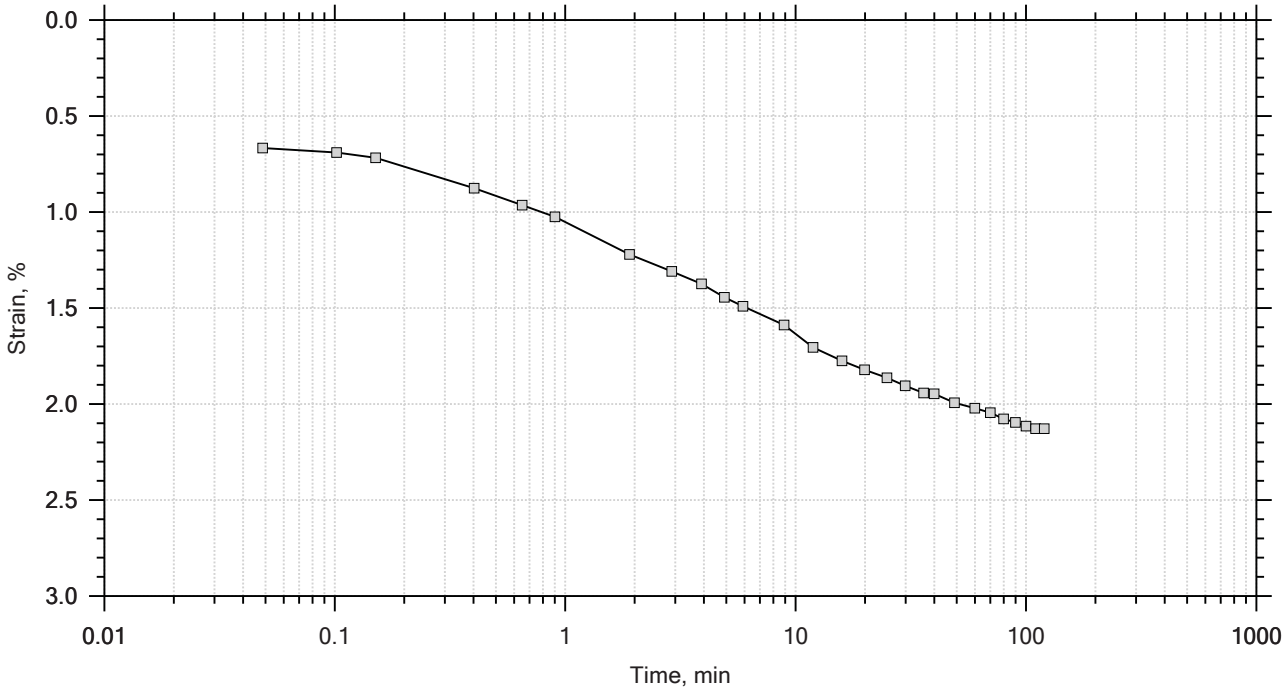


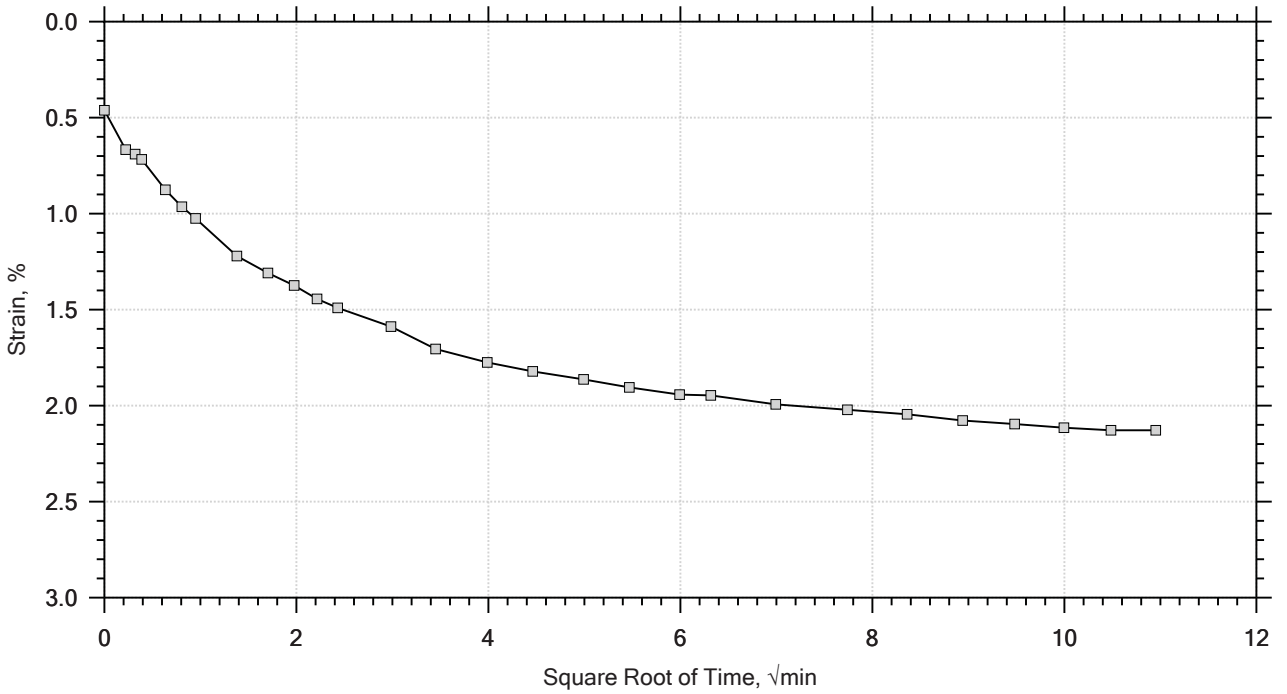


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-3	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System R, Swell Pressure = 0.0919 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 11
Constant Load Step
Stress: 0.25 tsf

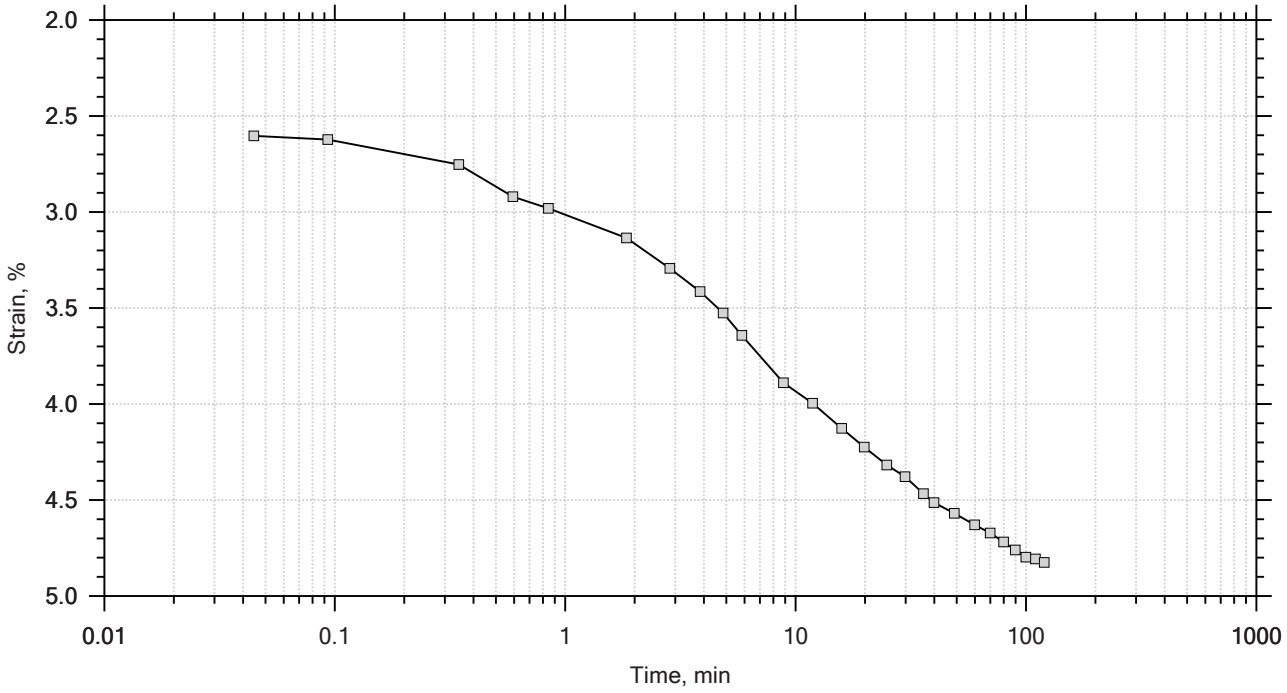


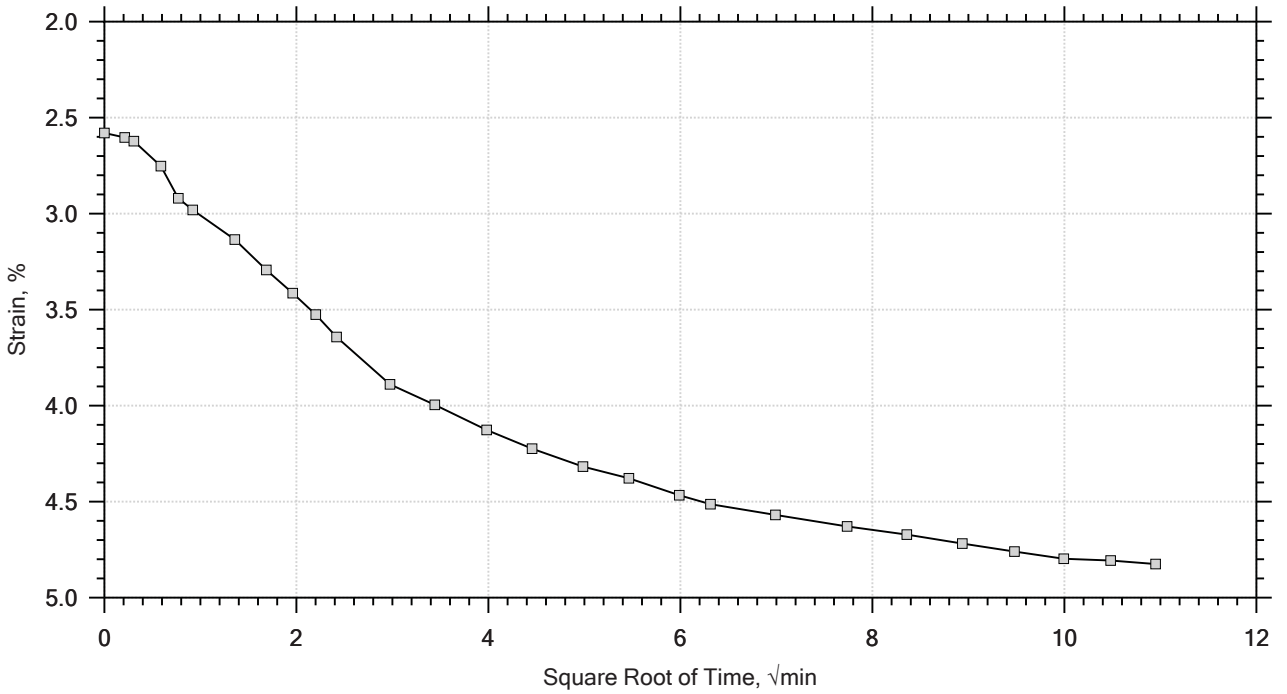


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-3	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System R, Swell Pressure = 0.0919 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 11
Constant Load Step
Stress: 0.5 tsf

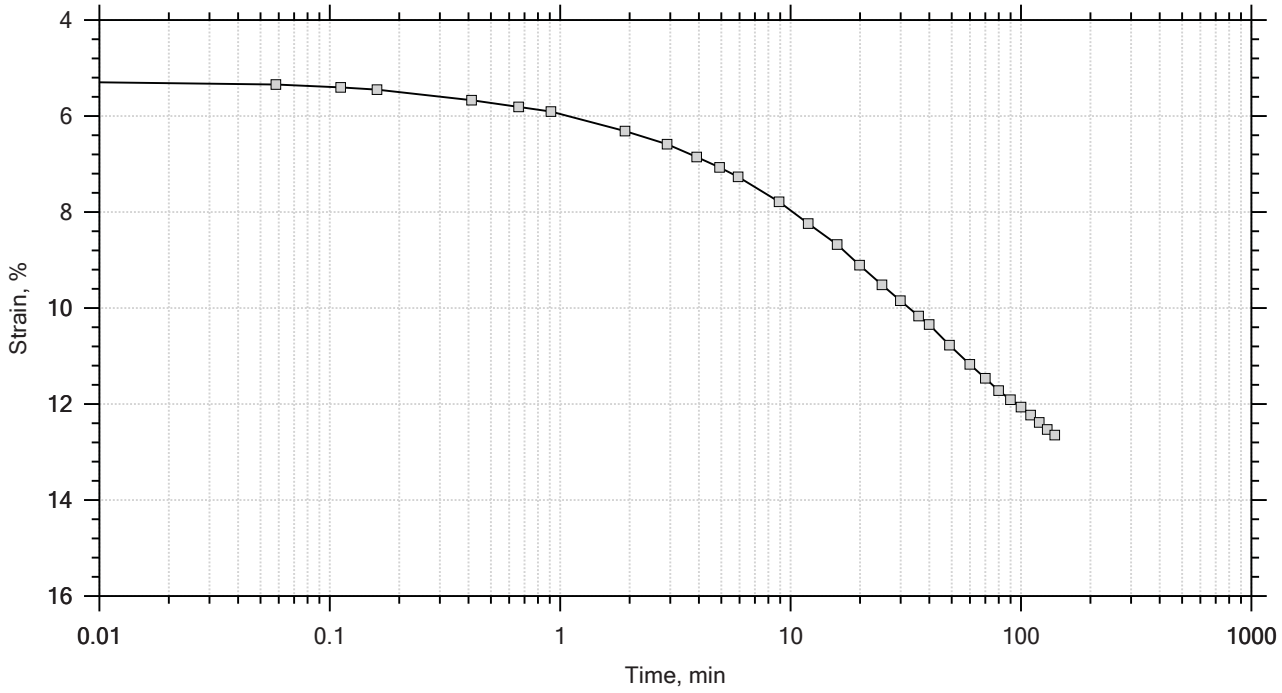


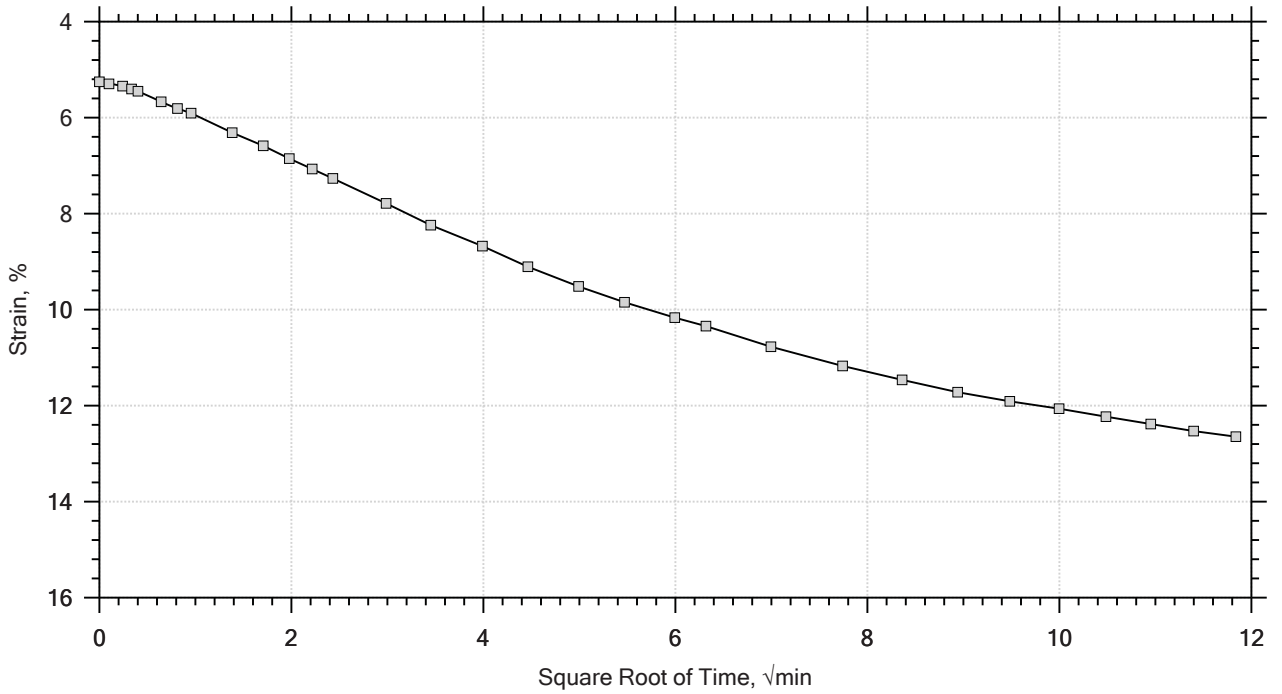


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-3	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System R, Swell Pressure = 0.0919 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 11
Constant Load Step
Stress: 1 tsf

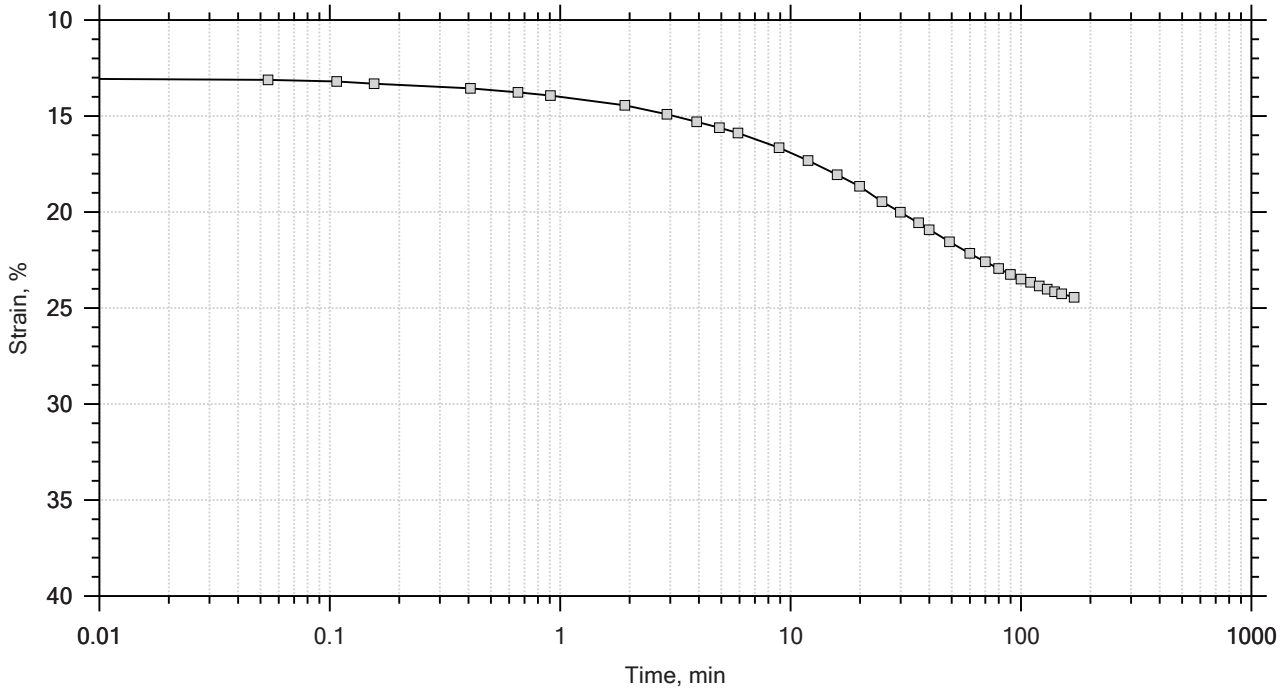


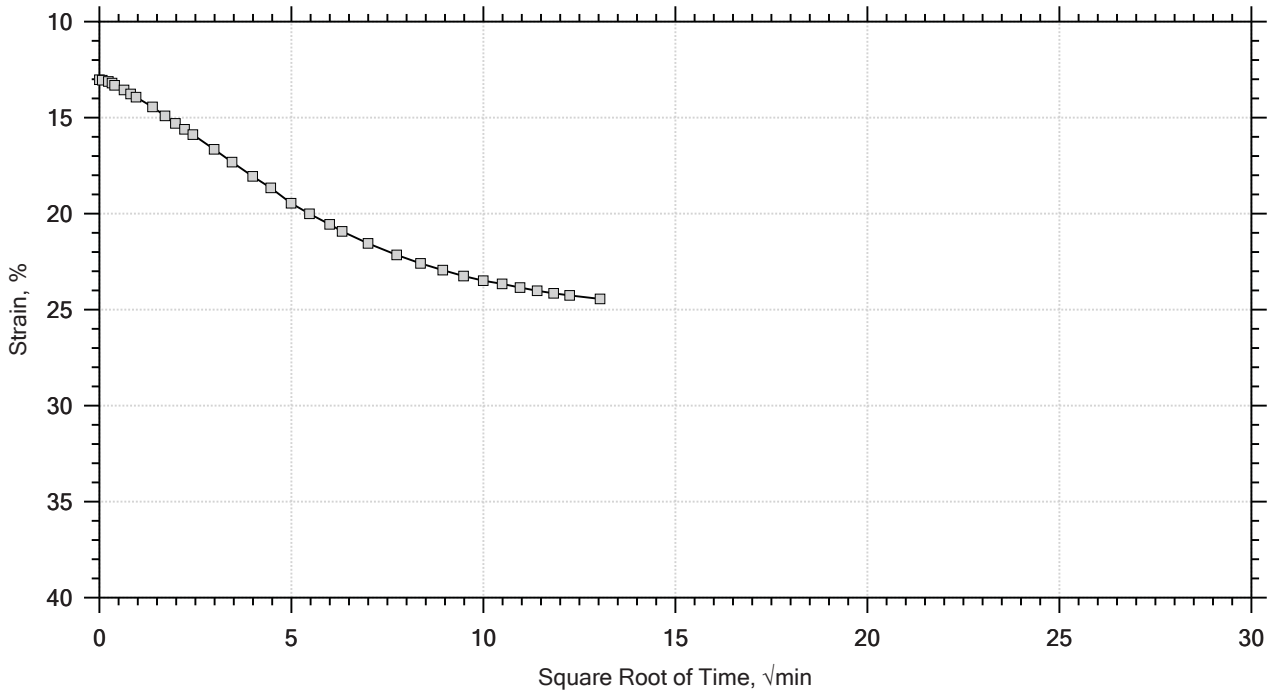


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
Test No.: IP-3	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System R, Swell Pressure = 0.0919 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 11
Constant Load Step
Stress: 2 tsf

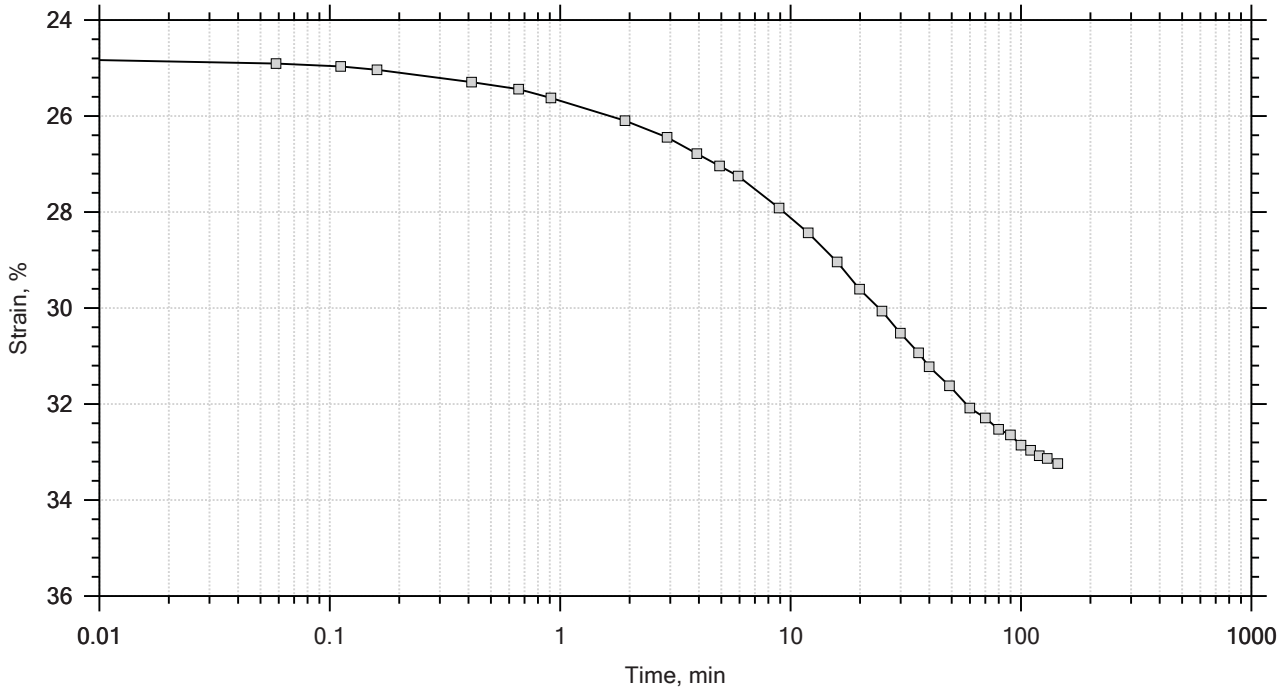


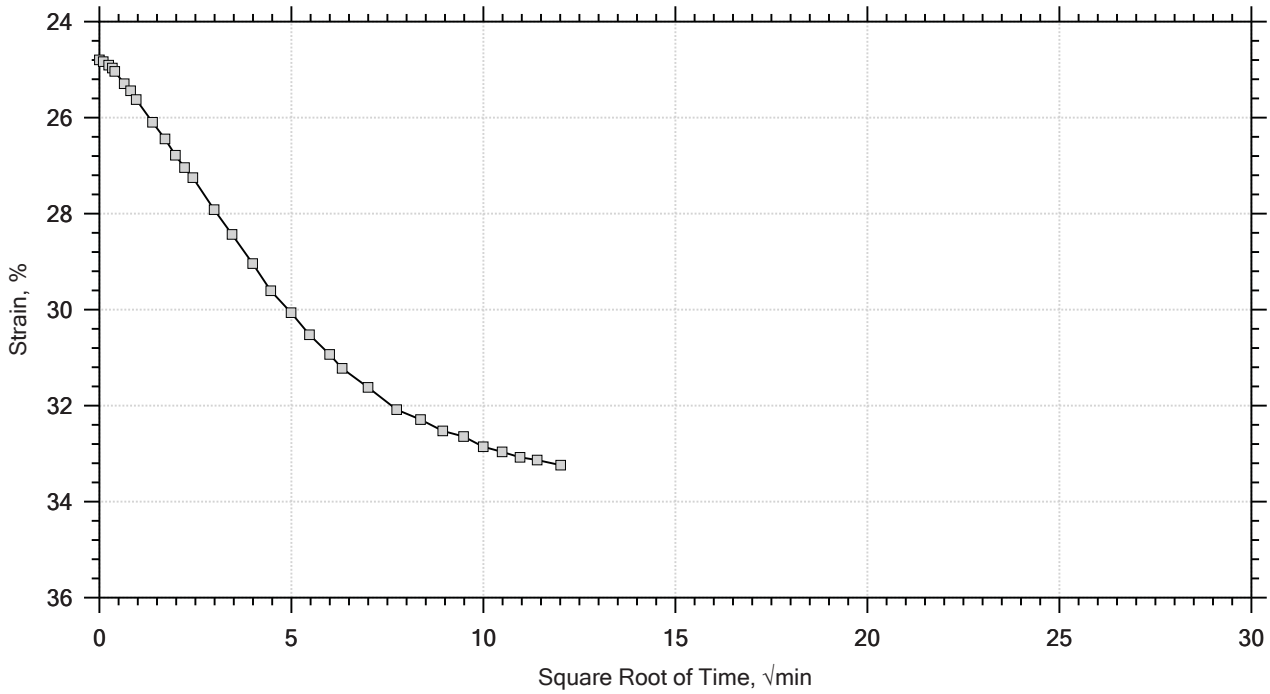


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
Test No.: IP-3	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System R, Swell Pressure = 0.0919 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 11
Constant Load Step
Stress: 4 tsf

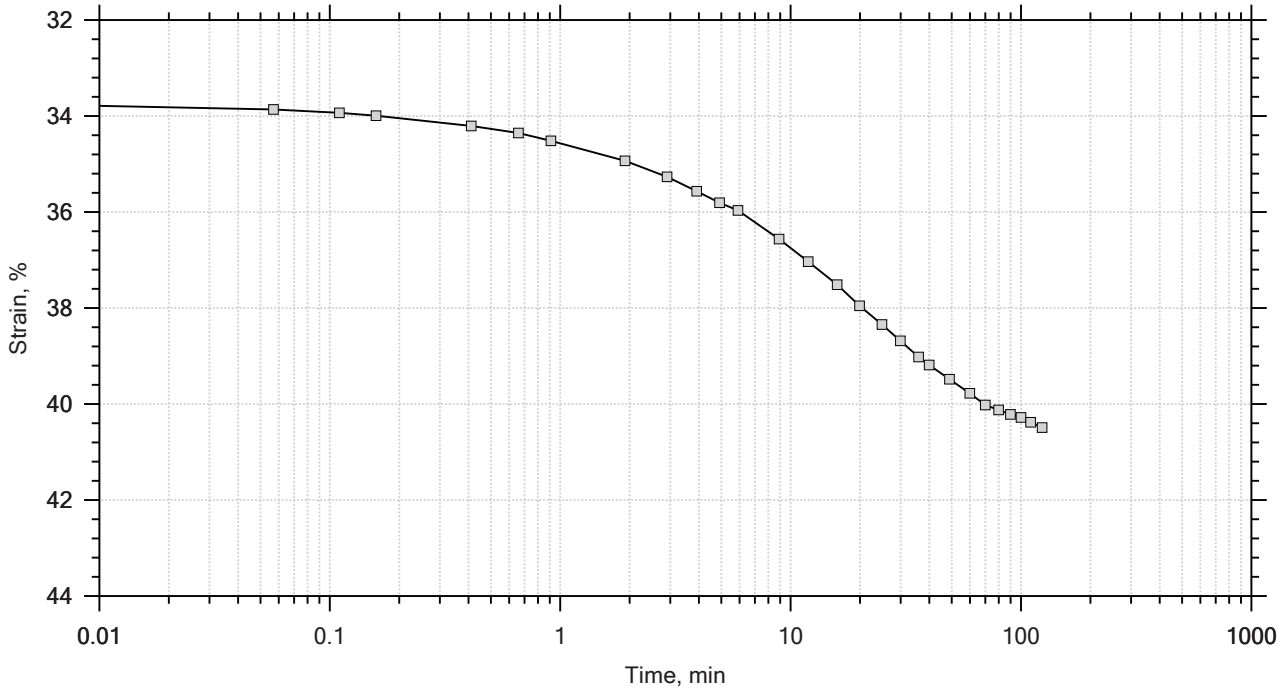


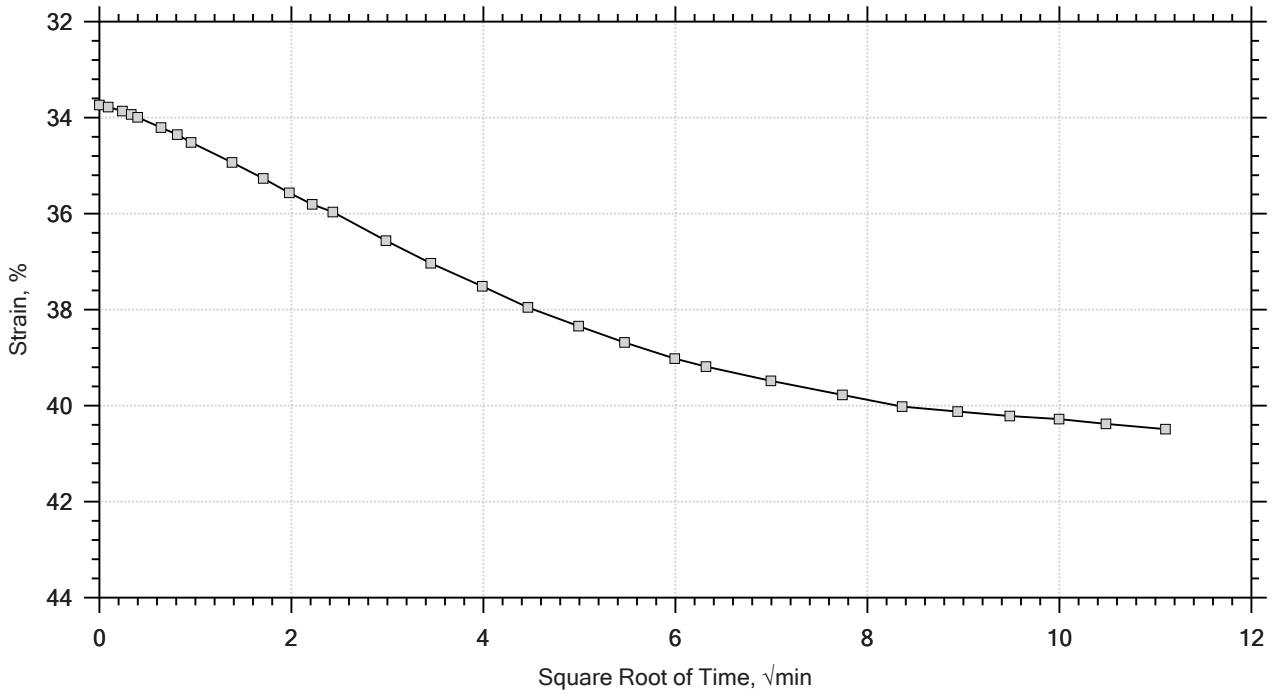


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-3	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System R, Swell Pressure = 0.0919 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 11
Constant Load Step
Stress: 8 tsf

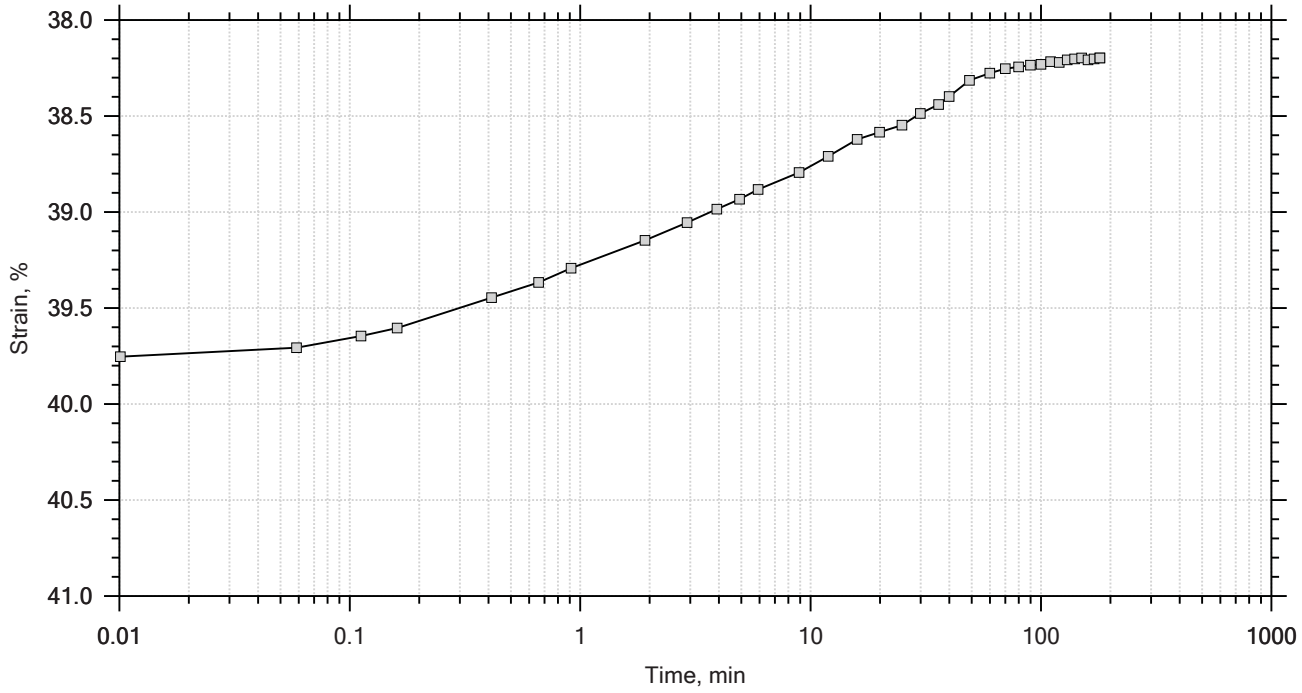


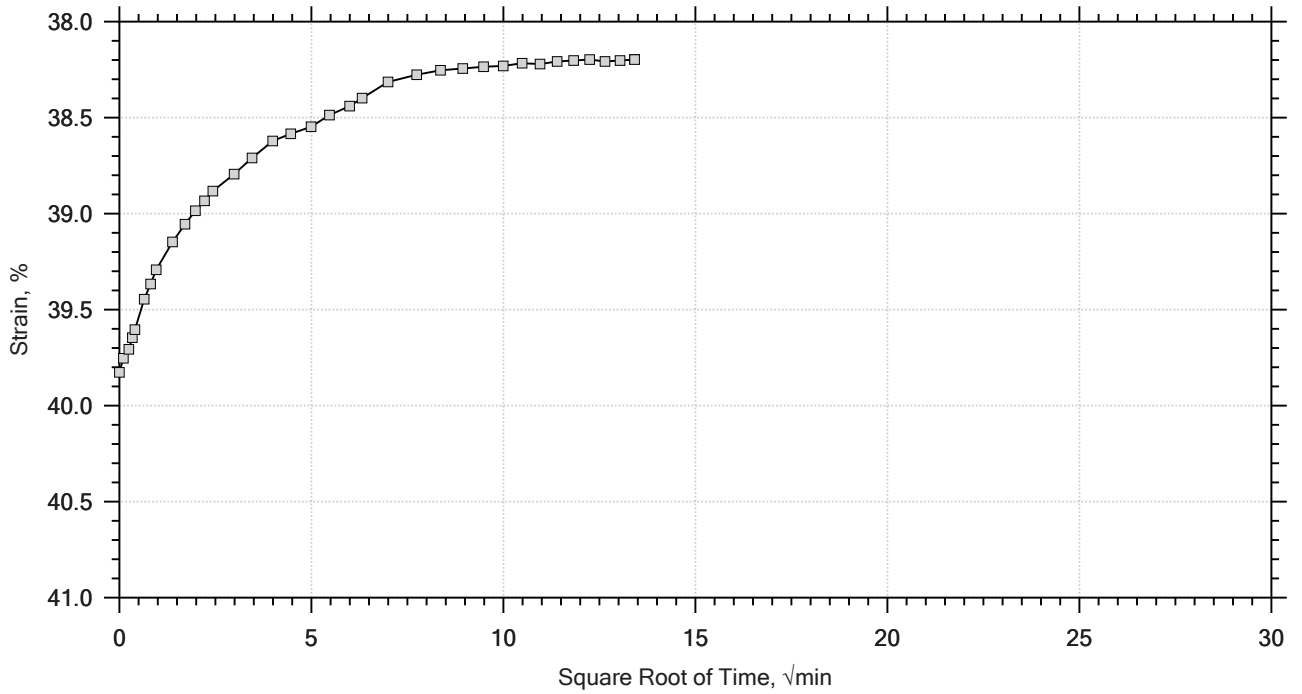


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-3	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System R, Swell Pressure = 0.0919 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 11
Constant Load Step
Stress: 2 tsf

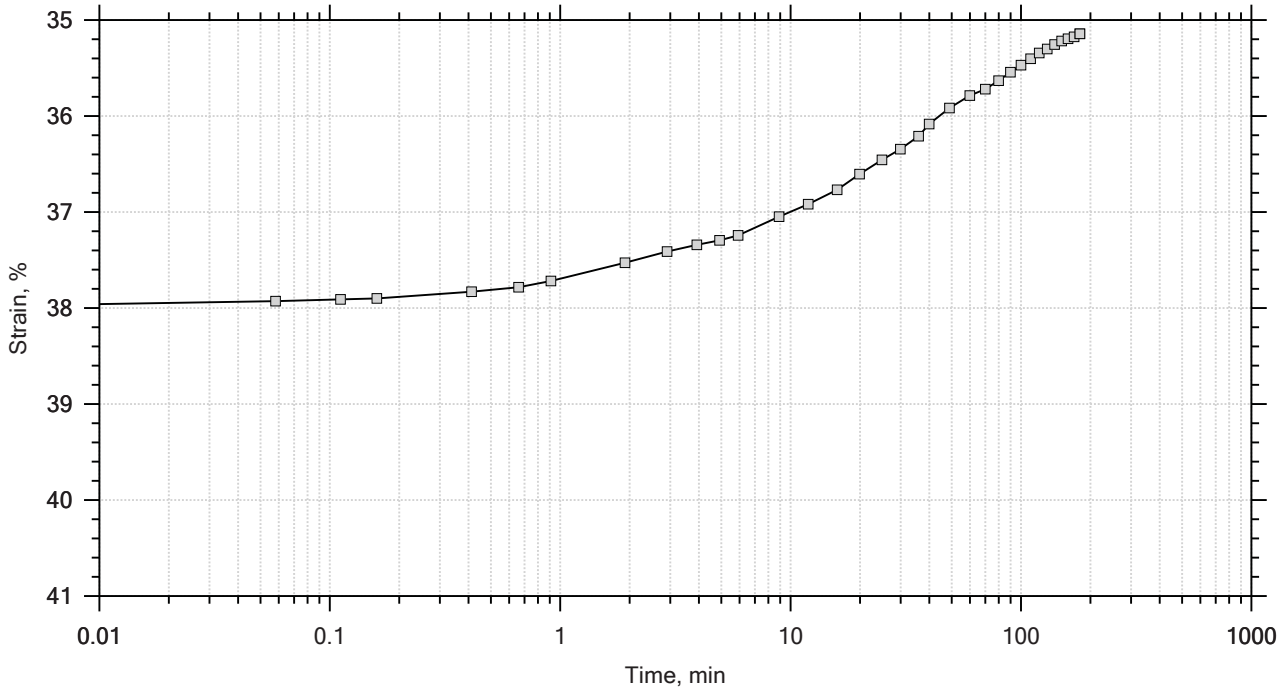


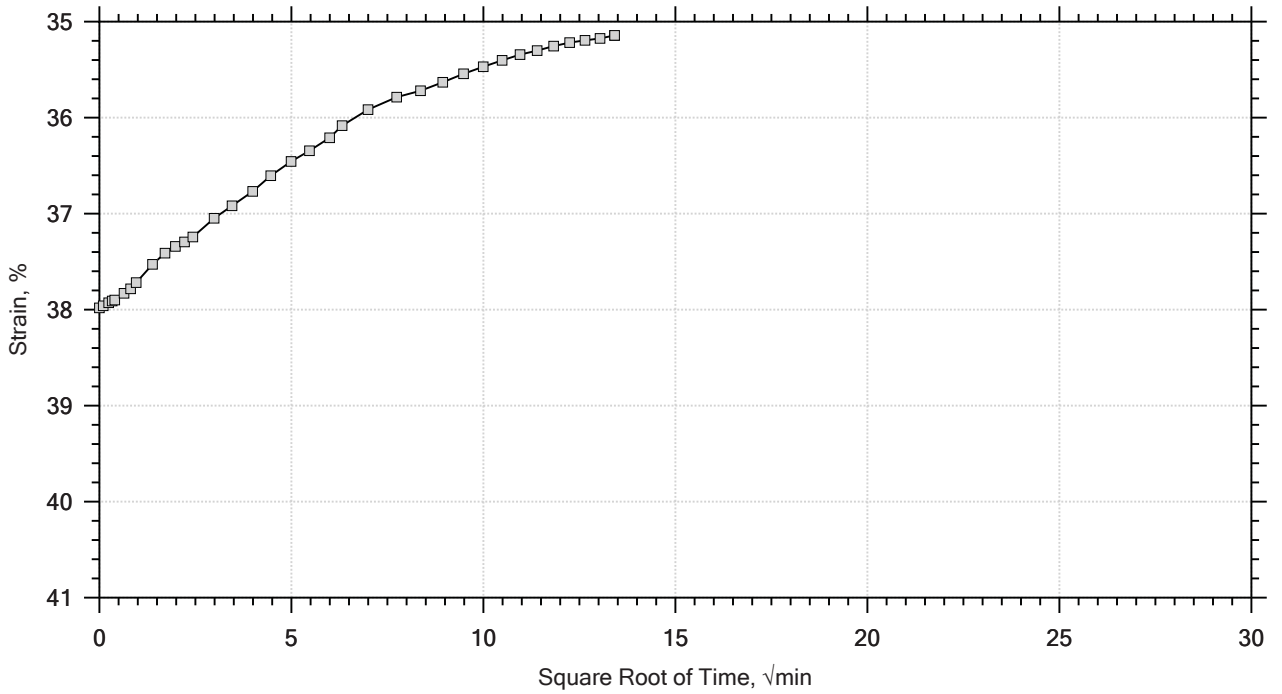


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
Test No.: IP-3	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System R, Swell Pressure = 0.0919 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 11
Constant Load Step
Stress: 0.5 tsf

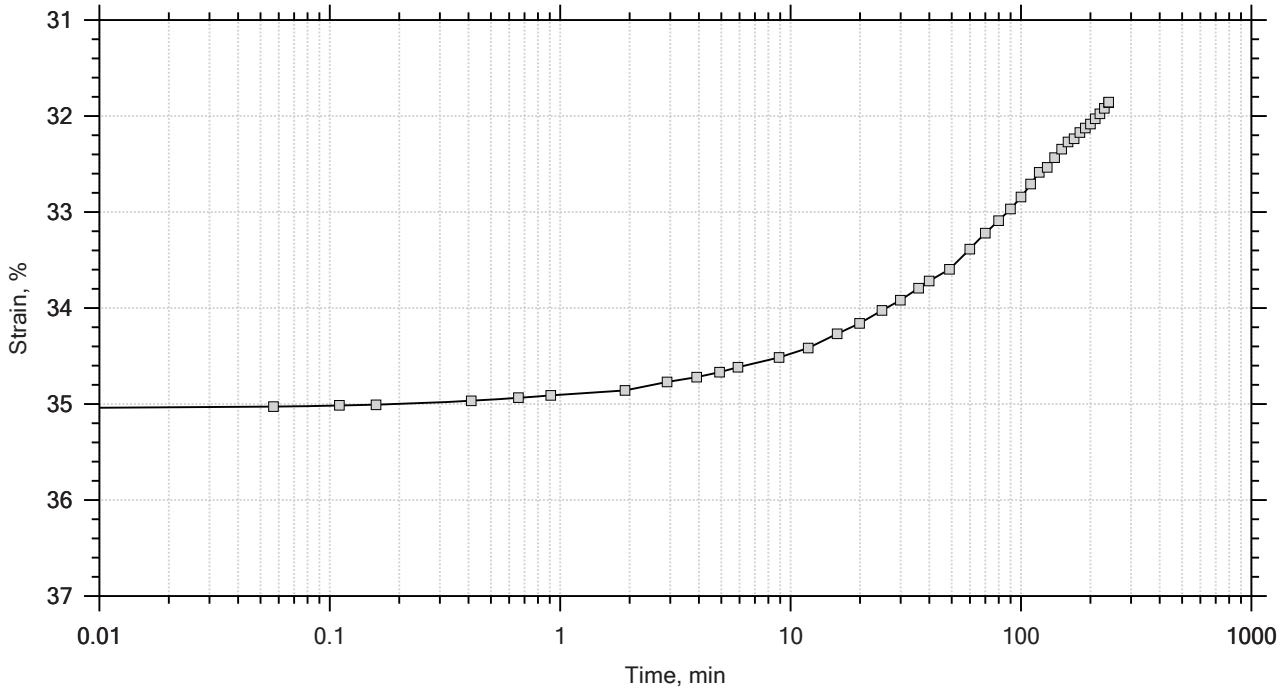


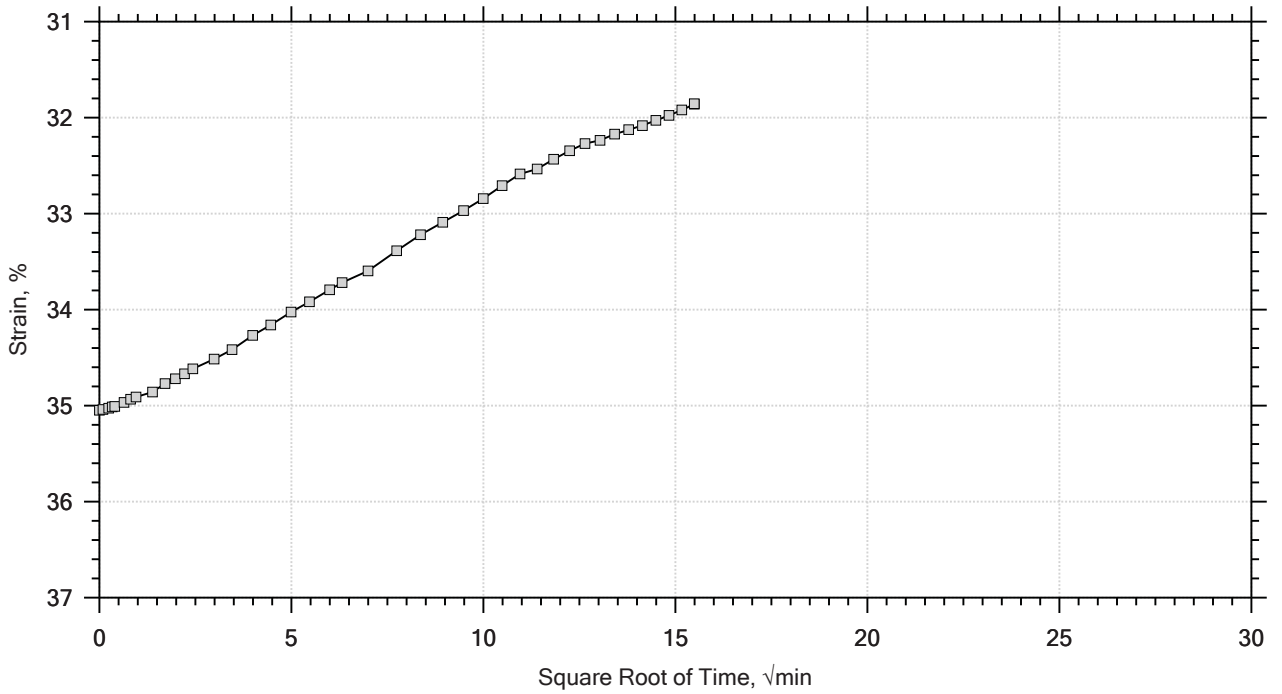


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
Test No.: IP-3	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System R, Swell Pressure = 0.0919 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 11
Constant Load Step
Stress: 0.125 tsf





Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-1	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
Test No.: IP-3	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System R, Swell Pressure = 0.0919 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.72	Liquid Limit: 111
Initial Height: 1.00 in	Initial Void Ratio: 2.48	Plastic Limit: 34
Final Height: 0.70 in	Final Void Ratio: 1.43	Plasticity Index: 77

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	15389	RING		C-1647
Mass Container, gm	8.21	109.02	109.02	8.42
Mass Container + Wet Soil, gm	241.13	228.23	205.21	99.61
Mass Container + Dry Soil, gm	141.82	172.05	172.05	68.17
Mass Dry Soil, gm	133.61	63.026	63.026	59.75
Water Content, %	74.33	89.14	52.62	52.62
Void Ratio	---	2.48	1.43	---
Degree of Saturation, %	---	98.06	100.00	---
Dry Unit Weight, pcf	---	48.913	69.876	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-3	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System R, Swell Pressure = 0.0919 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Log of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/s	Mv 1/tsf	k ft/day	Ca %
1	0.0919	0.0001397	2.48	0.0140	0.000	0.00e+00	1.52e-03	0.00e+00	0.00e+00
2	0.125	0.002189	2.47	0.219	0.000	0.00e+00	6.20e-02	0.00e+00	0.00e+00
3	0.250	0.02128	2.40	2.13	4.360	1.28e-06	1.53e-01	5.26e-04	0.00e+00
4	0.500	0.04825	2.31	4.82	4.805	1.11e-06	1.08e-01	3.22e-04	0.00e+00
5	1.00	0.1264	2.04	12.6	0.000	0.00e+00	1.56e-01	0.00e+00	0.00e+00
6	2.00	0.2444	1.63	24.4	18.156	2.08e-07	1.18e-01	6.63e-05	0.00e+00
7	4.00	0.3324	1.32	33.2	14.875	1.94e-07	4.40e-02	2.30e-05	0.00e+00
8	8.00	0.4049	1.07	40.5	11.940	1.90e-07	1.81e-02	9.30e-06	0.00e+00
9	2.00	0.3820	1.15	38.2	0.000	0.00e+00	3.82e-03	0.00e+00	0.00e+00
10	0.500	0.3514	1.25	35.1	19.511	1.17e-07	2.04e-02	6.44e-06	0.00e+00
11	0.125	0.3185	1.37	31.9	0.000	0.00e+00	8.77e-02	0.00e+00	0.00e+00

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-3	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System R, Swell Pressure = 0.0919 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Square Root of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv ft²/s	Mv 1/tsf	k ft/day
1	0.0919	0.0001397	2.48	0.0140	0.000	0.00e+00	1.52e-03	0.00e+00
2	0.125	0.002189	2.47	0.219	22.890	1.07e-06	6.20e-02	1.79e-04
3	0.250	0.02128	2.40	2.13	15.976	1.50e-06	1.53e-01	6.18e-04
4	0.500	0.04825	2.31	4.82	21.822	1.05e-06	1.08e-01	3.05e-04
5	1.00	0.1264	2.04	12.6	74.186	2.75e-07	1.56e-01	1.16e-04
6	2.00	0.2444	1.63	24.4	85.426	1.91e-07	1.18e-01	6.06e-05
7	4.00	0.3324	1.32	33.2	70.490	1.76e-07	4.40e-02	2.09e-05
8	8.00	0.4049	1.07	40.5	49.359	1.98e-07	1.81e-02	9.69e-06
9	2.00	0.3820	1.15	38.2	19.291	4.68e-07	3.82e-03	4.82e-06
10	0.500	0.3514	1.25	35.1	86.546	1.14e-07	2.04e-02	6.25e-06
11	0.125	0.3185	1.37	31.9	201.559	5.38e-08	8.77e-02	1.27e-05

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-1	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-3	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System R, Swell Pressure = 0.0919 tsf		
	Displacement at End of Increment		

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	---	Sample Type:	---	Tested By:	jbr
Sample ID:	---	Test Date:	08/30/16	Checked By:	mcm
Depth :	---	Test Id:	387124		

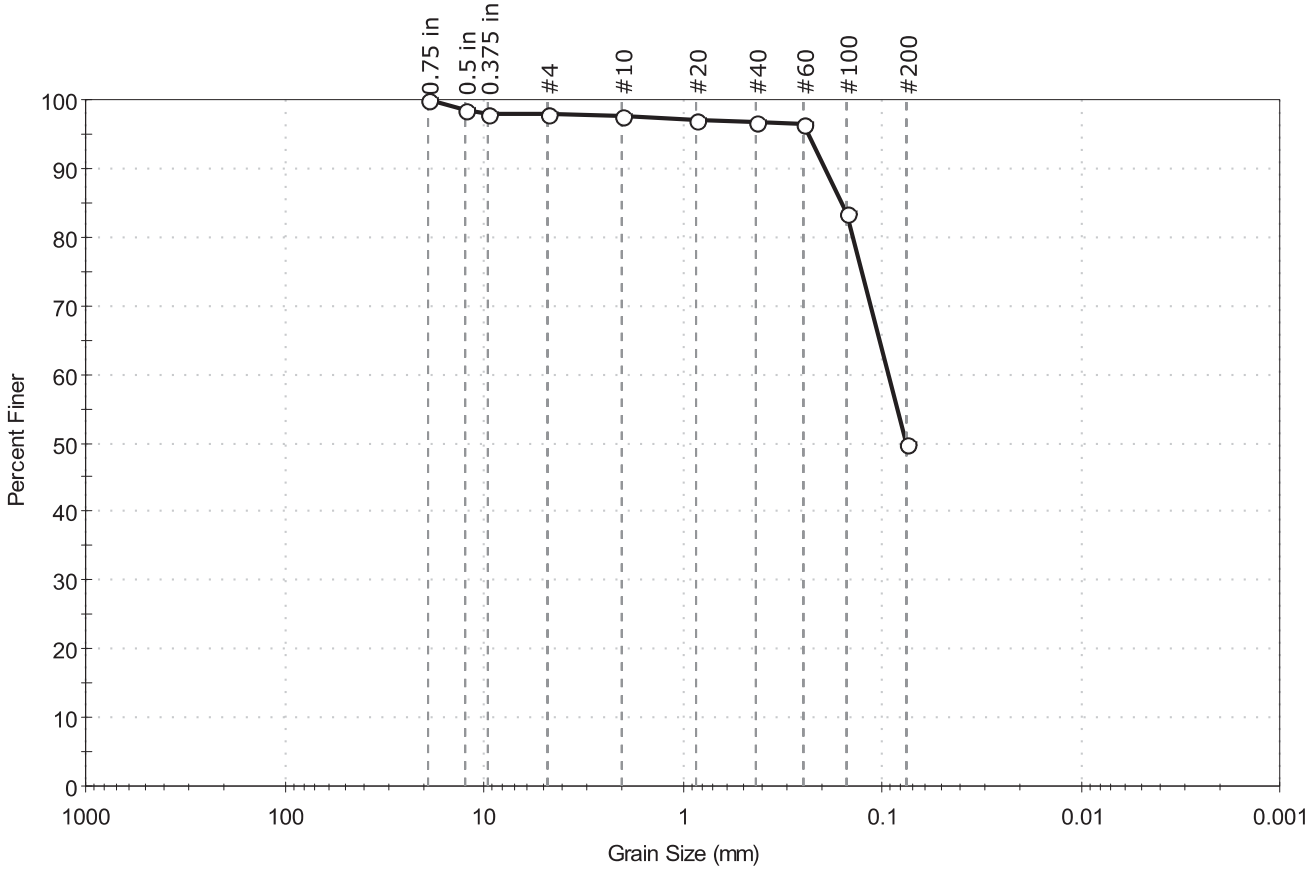
Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
AP-2	UD-1	16.0-18.0 ft	Moist, olive clayey sand	56.0

Notes: Temperature of Drying : 110º Celsius

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-2	Sample Type:	tube	Tested By:	jbr
Sample ID:	UD-1	Test Date:	08/23/16	Checked By:	mcm
Depth :	16.0-18.0 ft	Test Id:	387103		
Test Comment:	---				
Visual Description:	Moist, olive clayey sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	2.1	48.0	49.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	98		
0.375 in	9.50	98		
#4	4.75	98		
#10	2.00	98		
#20	0.85	97		
#40	0.42	97		
#60	0.25	96		
#100	0.15	83		
#200	0.075	50		

Coefficients

D_{85} =0.1600 mm	D_{30} =N/A
D_{60} =0.0925 mm	D_{15} =N/A
D_{50} =0.0752 mm	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM Clayey sand (SC)

AASHTO Clayey Soils (A-7-6 (17))

Sample/Test Description

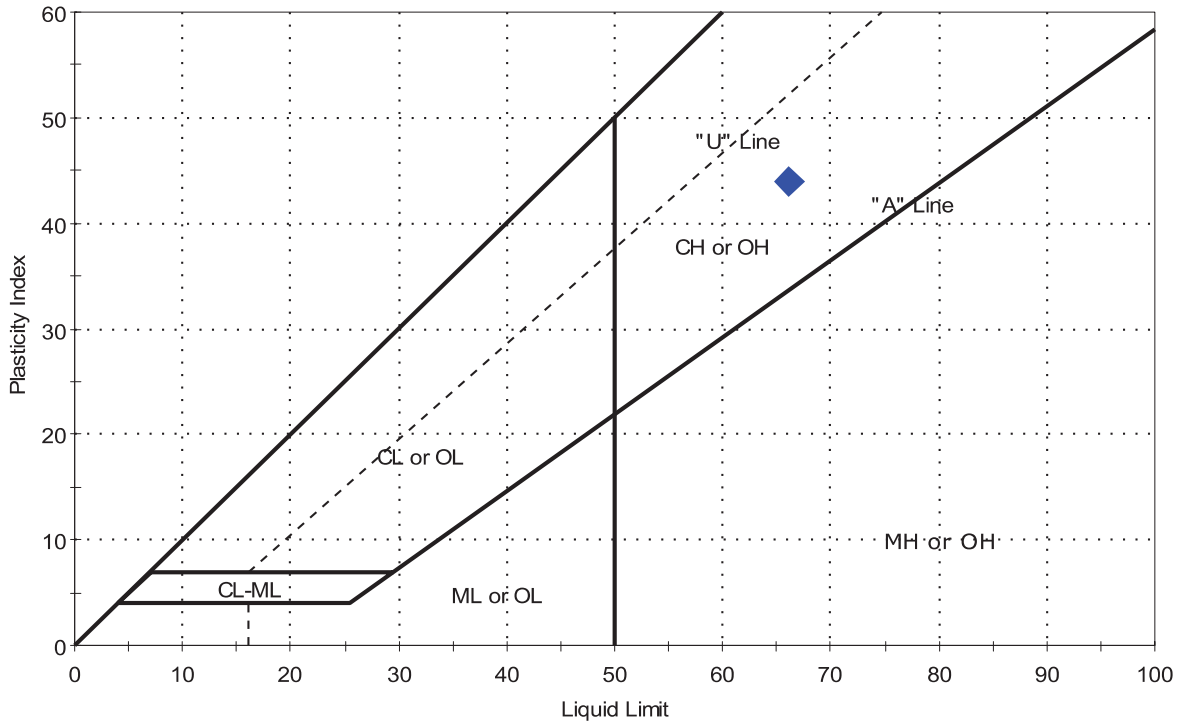
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

printed 9/8/2016 3:35:57 PM

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-2	Sample Type:	tube	Tested By:	cam
Sample ID:	UD-1	Test Date:	08/22/16	Checked By:	mcm
Depth :	16.0-18.0 ft	Test Id:	387111		
Test Comment:	---				
Visual Description:	Moist, olive clayey sand				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



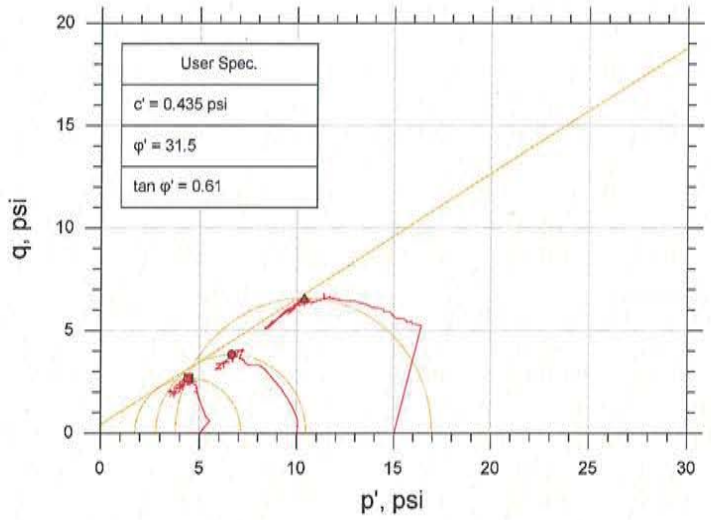
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	UD-1	AP-2	16.0-18.0 ft	56	66	22	44	0.8	Clayey sand (SC)

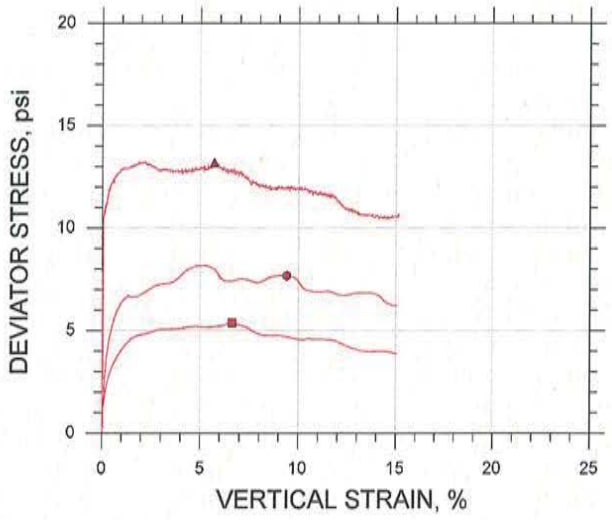
Sample Prepared using the WET method
3% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

GeoTesting EXPRESS

Client: F&ME Consultants	
Project Name: US 21 Replacement Bridge	
Project Location: ---	
Project Number: GTX-305005	
Tested By: md	Checked By: mcm
Boring ID: AP-2	
Preparation: intact	
Description: Moist, olive clayey sand	
Classification: Clayey sand	
Group Symbol: SC	
Liquid Limit: 66	Plastic Limit: 22
Plasticity Index: 44	Estimated Specific Gravity: 2.7

CONSOLIDATED DRAINED TRIAXIAL TEST by ASTM D4767





Symbol		■	●	▲	
Sample ID		ST-1	ST-1	ST-1	
Depth, ft		16.0-18.0 ft	16.0-18.0 ft	16.0-18.0 ft	
Test Number		CU-2-1	CU-2-2	CU-2-3	
Initial	Height, in	4.650	4.720	4.390	
	Diameter, in	2.050	2.030	2.030	
	Moisture Content (from Cuttings), %	72.9	49.2	52.1	
	Dry Density, pcf	56.4	69.3	66.4	
	Saturation (Wet Method), %	99.0	92.7	91.5	
	Void Ratio	1.99	1.43	1.54	
Before Shear	Moisture Content, %	70.4	47.1	47.2	
	Dry Density, pcf	58.1	74.2	74.1	
	Cross-sectional Area (Method A), in²	3.205	3.042	2.998	
	Saturation, %	100.0	100.0	100.0	
	Void Ratio	1.90	1.27	1.28	
	Back Pressure, psi	139.0	150.8	150.9	
Vertical Effective Consolidation Stress, psi		5.002	9.937	14.76	
Horizontal Effective Consolidation Stress, psi		5.002	9.987	14.99	
Vertical Strain after Consolidation, %		0.01752	0.6124	2.957	
Volumetric Strain after Consolidation, %		3.012	6.546	9.651	
Time to 50% Consolidation, min		92.16	45.56	161.3	
Shear Strength, psi		2.690	3.838	6.597	
Strain at Failure, %		6.63	9.40	5.69	
Strain Rate, %/min		0.01600	0.01600	0.01600	
Deviator Stress at Failure, psi		5.381	7.677	13.19	
Effective Minor Principal Stress at Failure, psi		1.747	2.795	3.775	
Effective Major Principal Stress at Failure, psi		7.128	10.47	16.97	
B-Value		0.95	0.95	0.95	

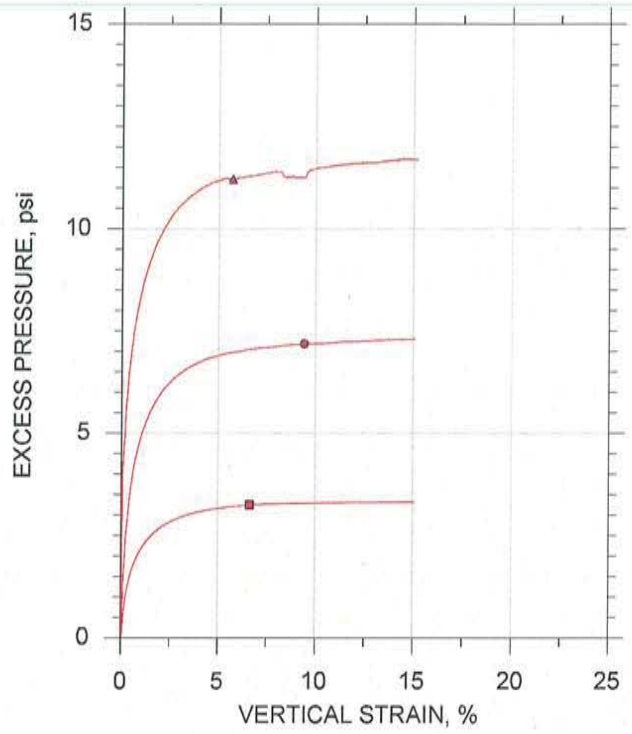
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

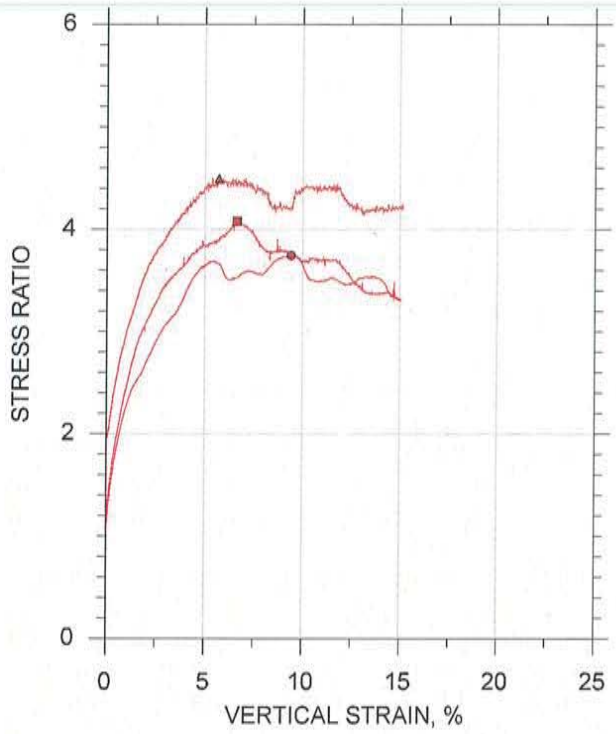


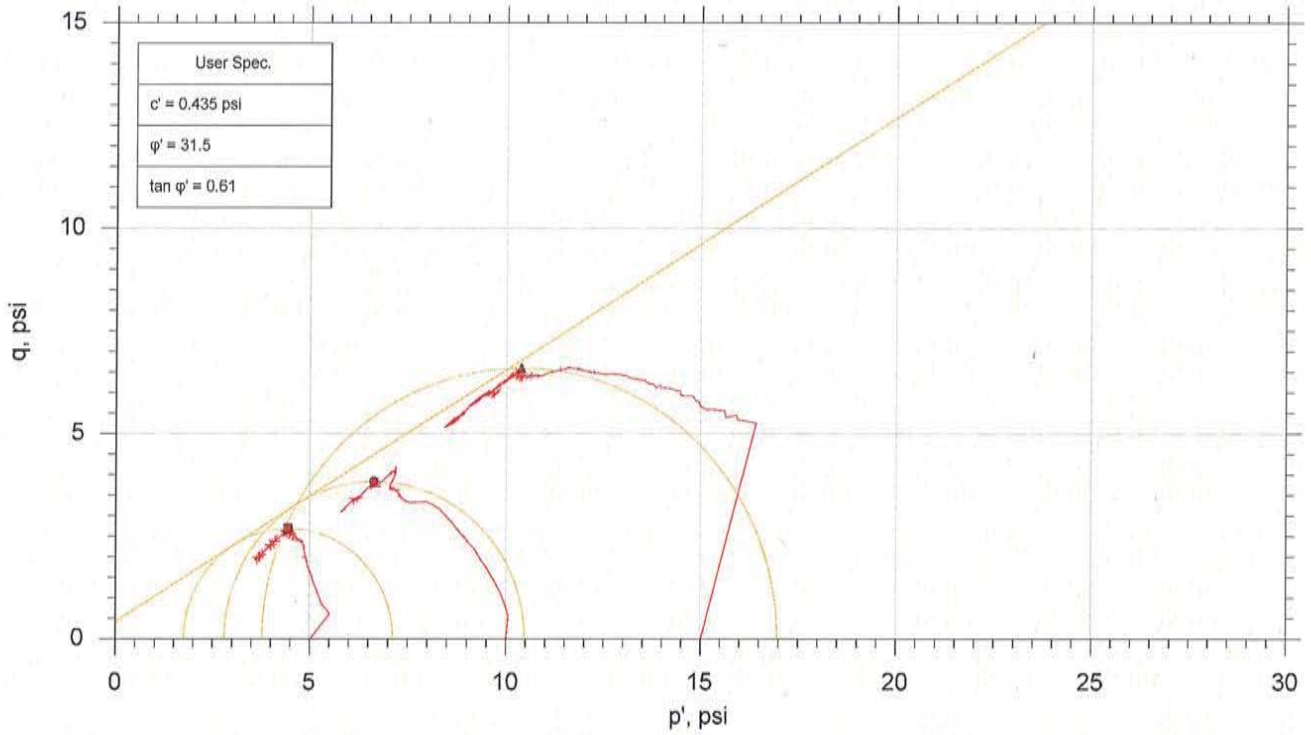
Remarks:

System B. Note CU-2-3 test specimen was not used in determining cohesion or friction values.

CONSOLIDATED DRAINED TRIAXIAL TEST by ASTM D4767







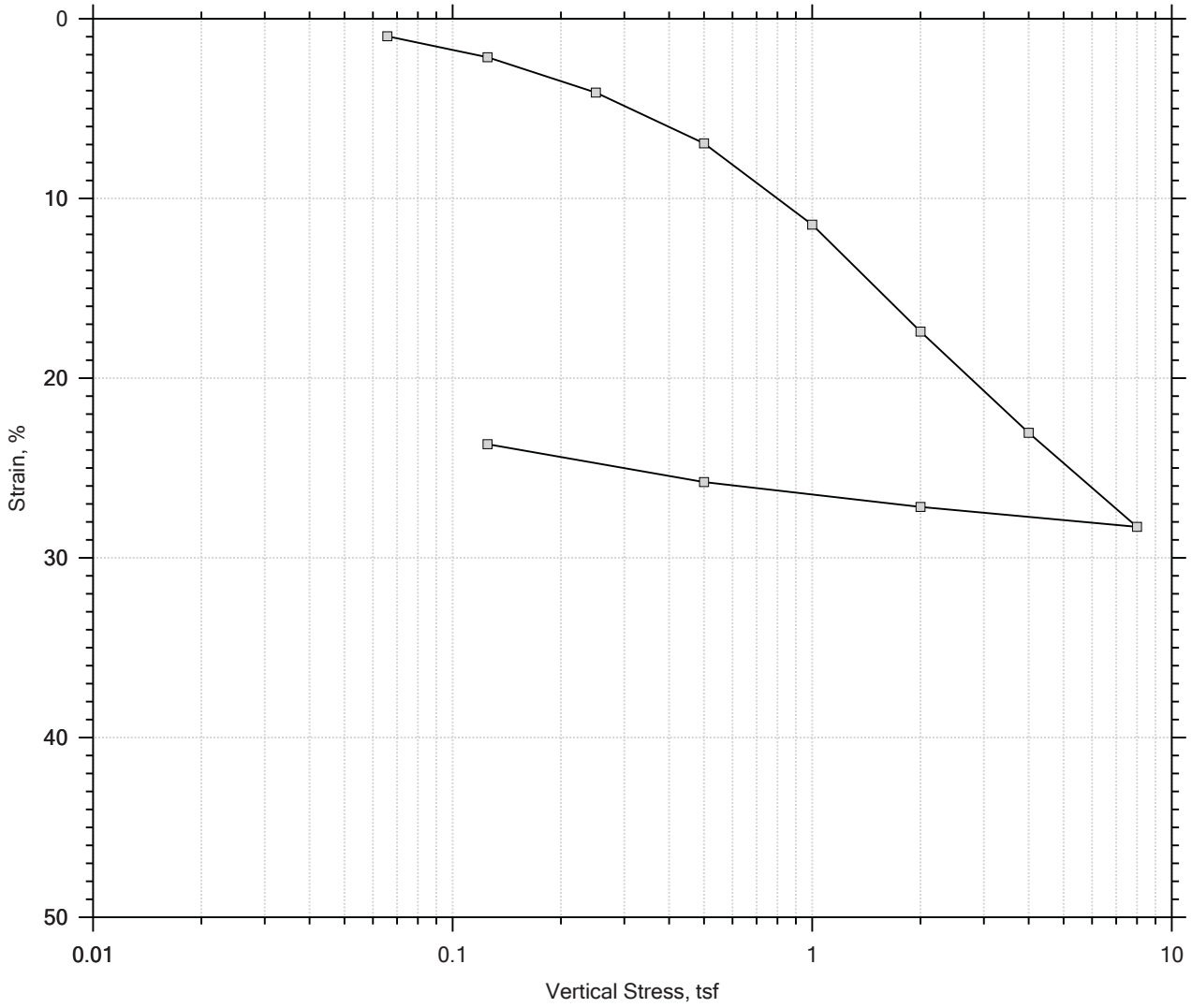
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	ST-1	CU-2-1	16.0-18.0 ft	md	8/19/16	mcm	8/31/16	305005-CU-2-1m.dat
●	ST-1	CU-2-2	16.0-18.0 ft	md	8/18/16	mcm	8/31/16	305005-CU-2-2m.dat
▲	ST-1	CU-2-3	16.0-18.0 ft	md	8/18/16	mcm	8/31/16	305005-CU-2-3m.dat

GeoTesting EXPRESS

Project: US 21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Sample Type: intact	
Description: Moist, olive clayey sand		
Remarks: System B. Note CU-2-3 test specimen was not used in determining cohesion or friction values.		

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report

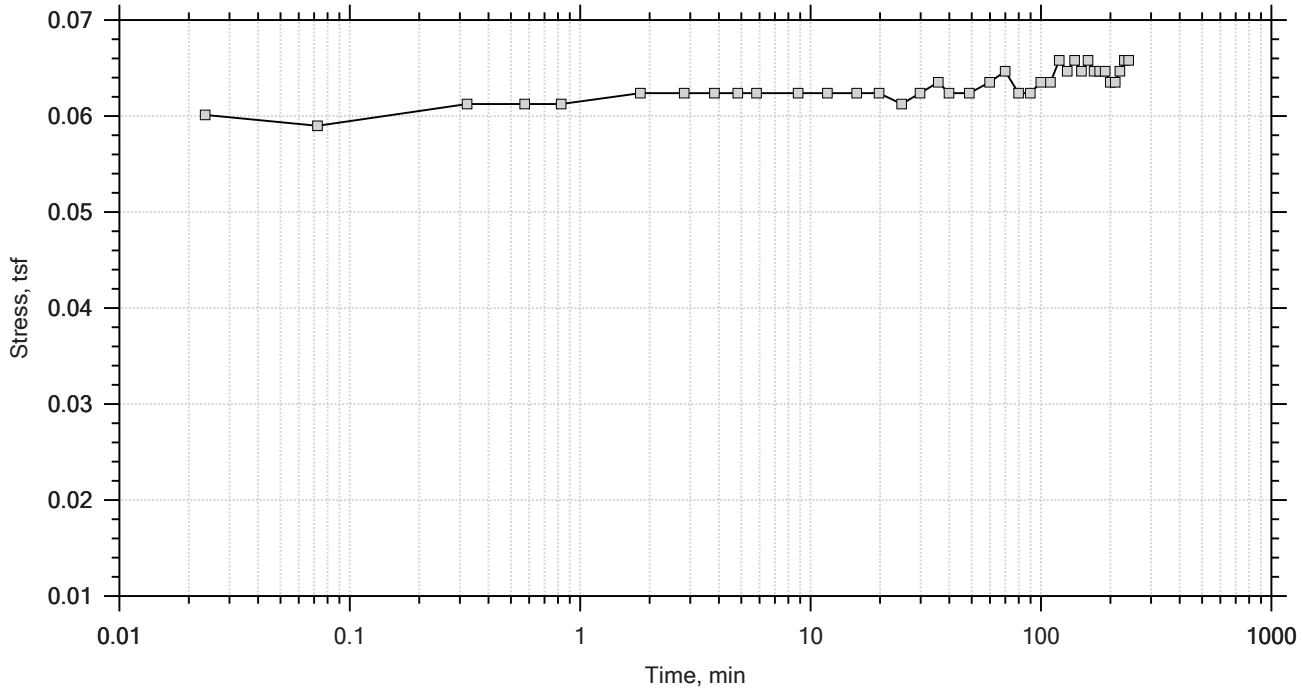


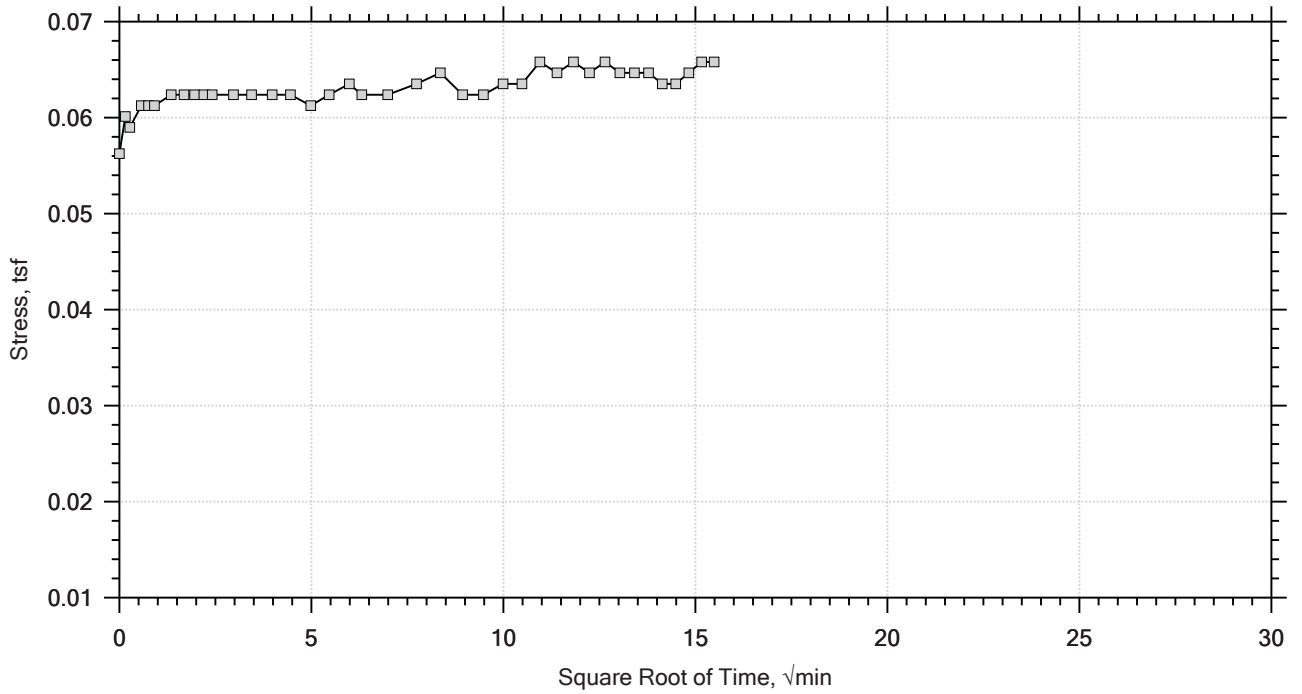
				Before Test	After Test
Current Vertical Effective Stress: ---				Water Content, %	51.80	34.90
Preconsolidation Stress: ---				Dry Unit Weight, pcf	69.92	87.4
Compression Ratio: ---				Saturation, %	98.17	100.00
Diameter: 2.5 in		Height: 1 in		Void Ratio	1.44	0.96
LL: 66	PL: 22	PI: 44	GS: 2.74			

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
	Test No.: IP-2	Sample Type: intact	Elevation: ---
	Description: Moist, olive clayey sand		
	Remarks: System S, Swell Pressure = 0.0658 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 11
Constant Volume Step
Stress: 0.0658 tsf

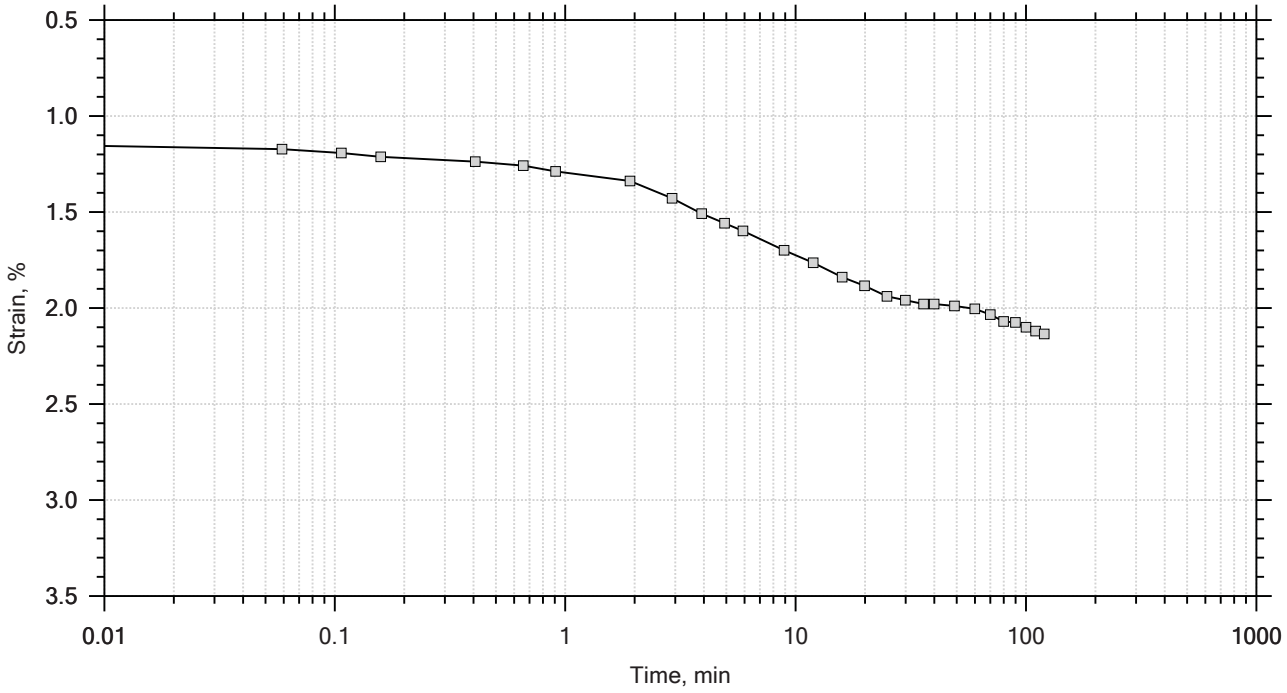


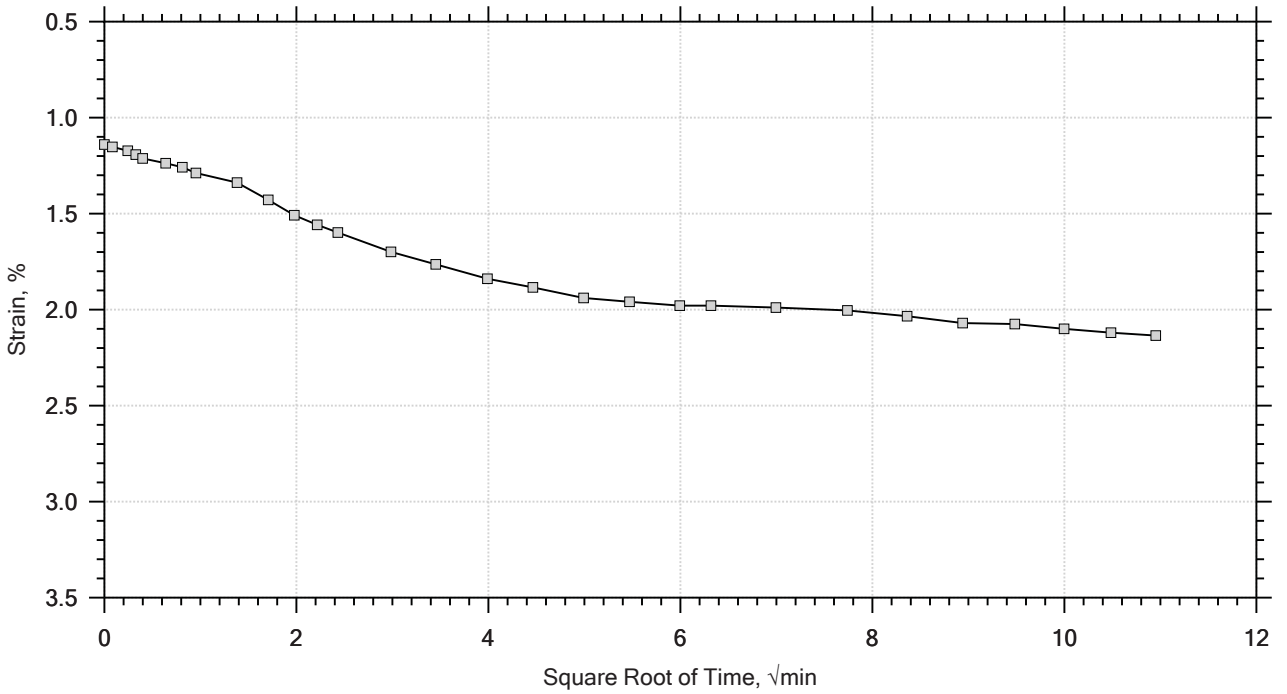


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
Test No.: IP-2	Sample Type: intact	Elevation: ---
Description: Moist, olive clayey sand		
Remarks: System S, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 11
Constant Load Step
Stress: 0.125 tsf

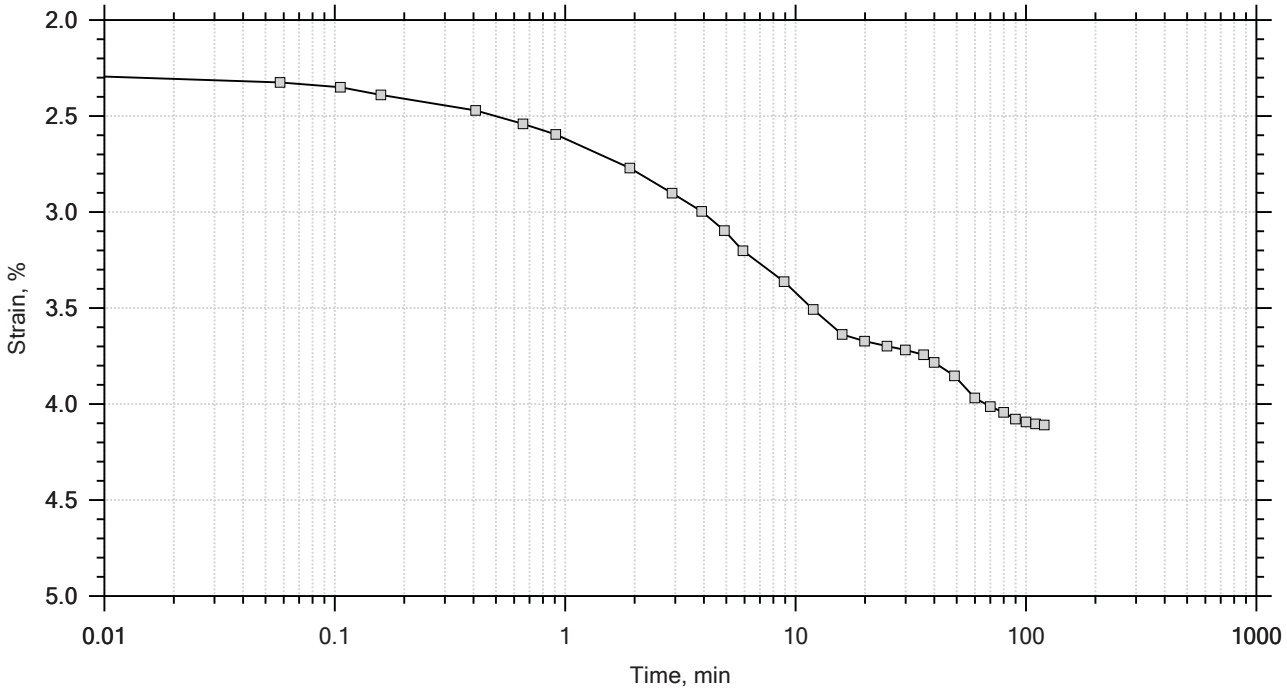


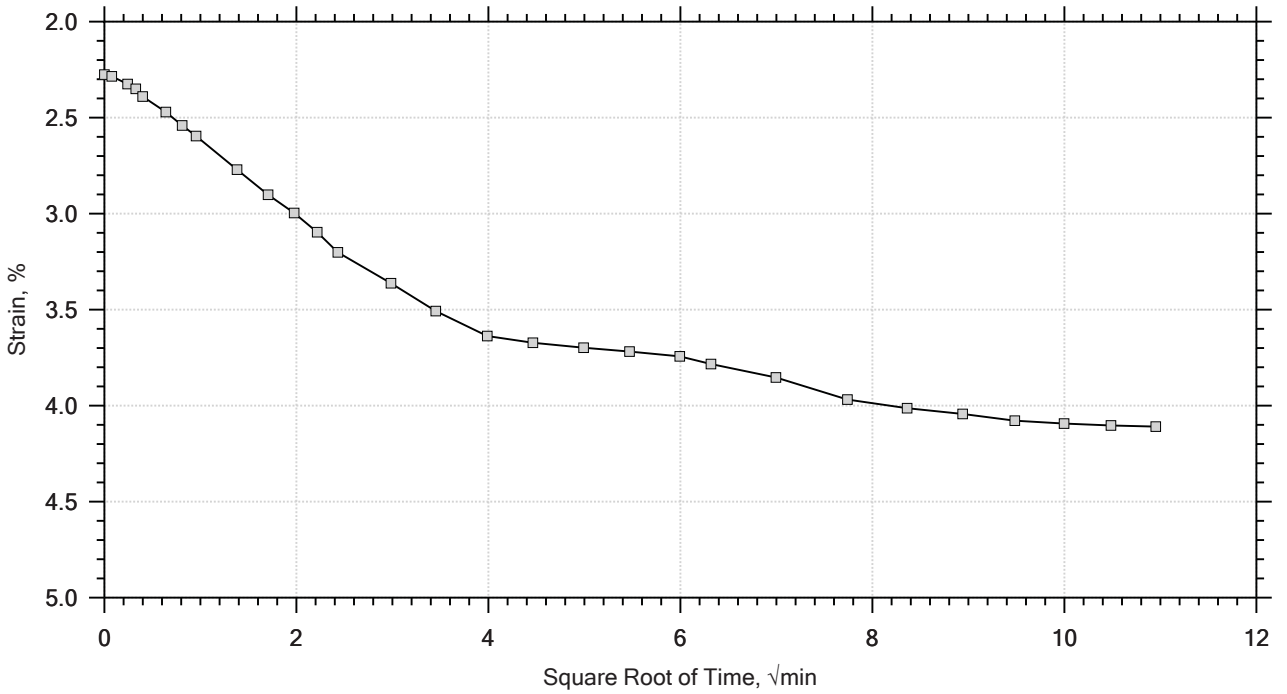


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
Test No.: IP-2	Sample Type: intact	Elevation: ---
Description: Moist, olive clayey sand		
Remarks: System S, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 11
Constant Load Step
Stress: 0.25 tsf

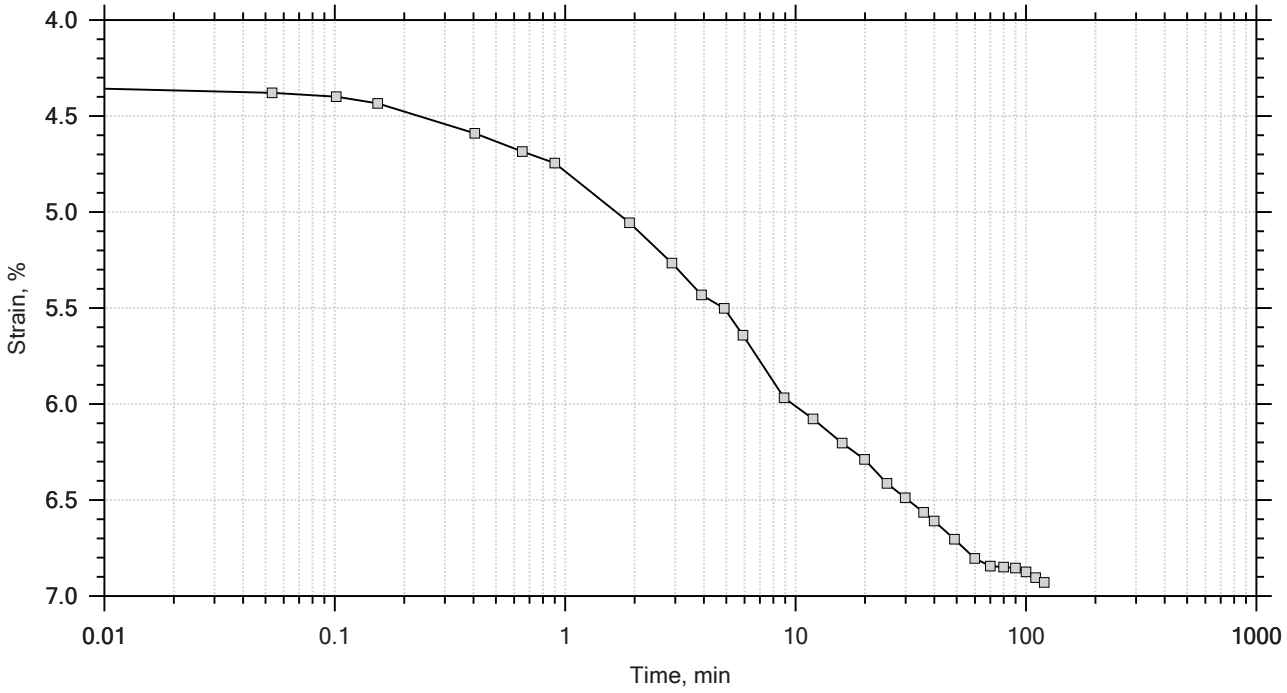


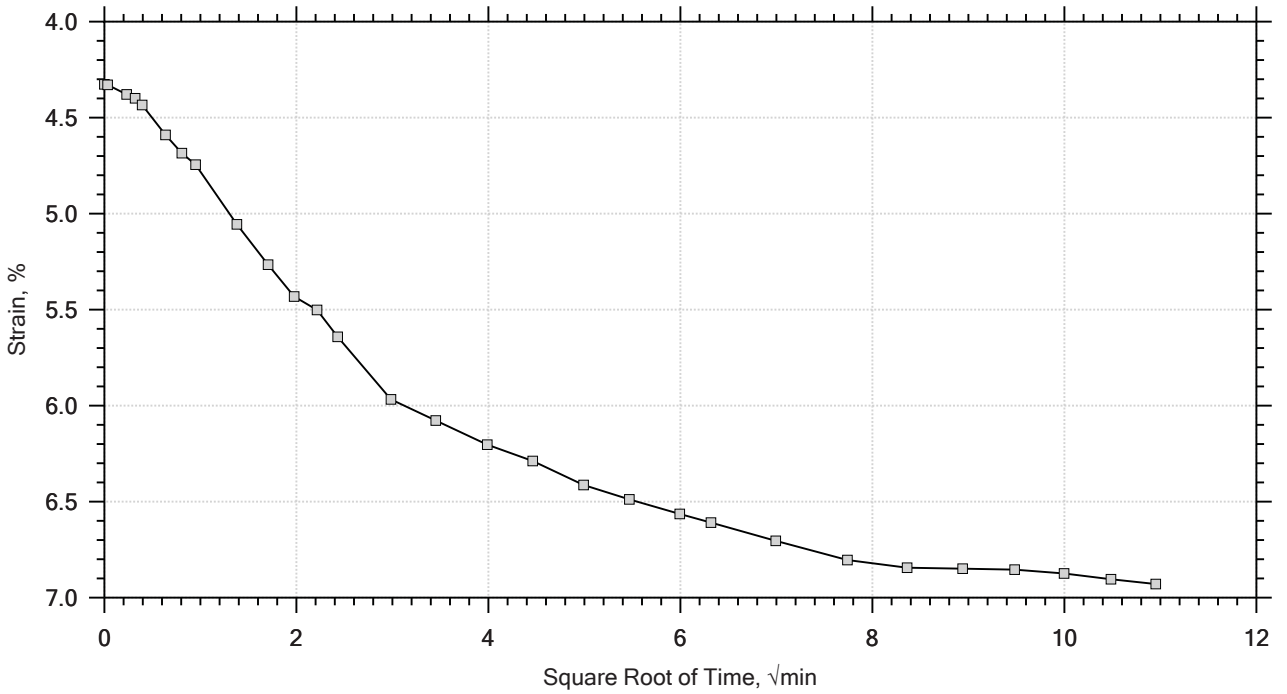


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
	Test No.: IP-2	Sample Type: intact	Elevation: ---
	Description: Moist, olive clayey sand		
	Remarks: System S, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 11
Constant Load Step
Stress: 0.5 tsf

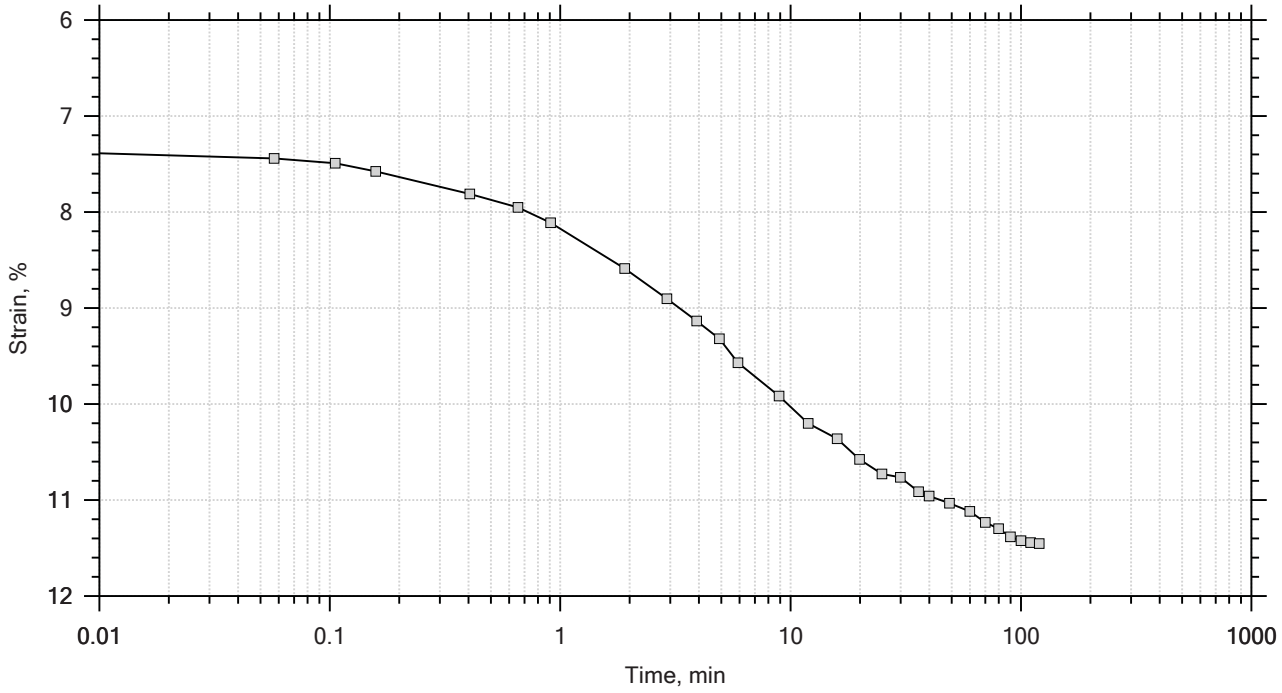


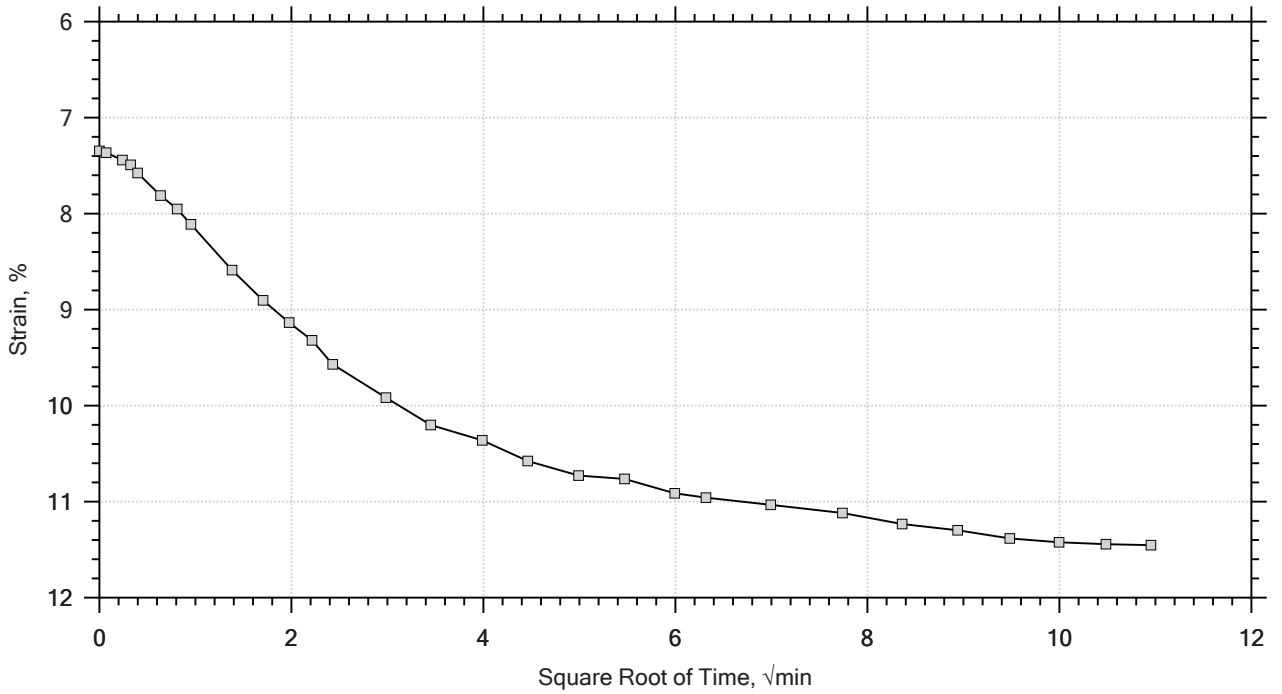


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
	Test No.: IP-2	Sample Type: intact	Elevation: ---
	Description: Moist, olive clayey sand		
	Remarks: System S, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 11
Constant Load Step
Stress: 1 tsf

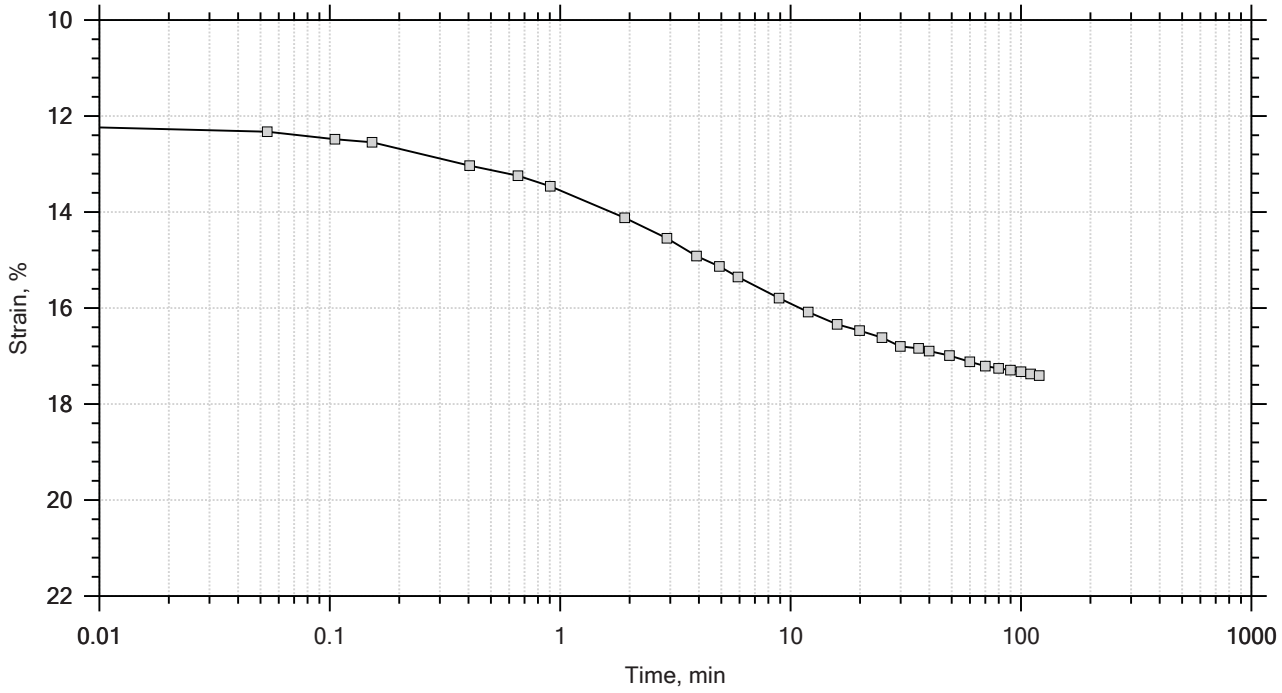


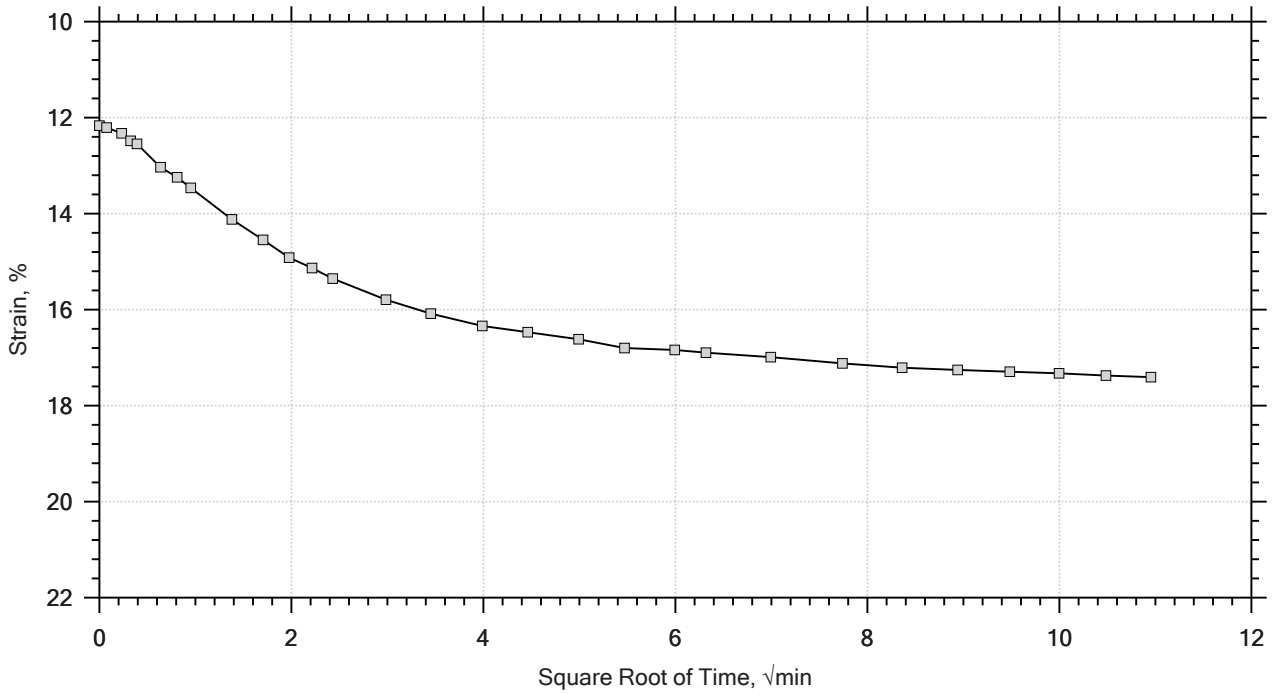


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
	Test No.: IP-2	Sample Type: intact	Elevation: ---
	Description: Moist, olive clayey sand		
	Remarks: System S, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 11
Constant Load Step
Stress: 2 tsf

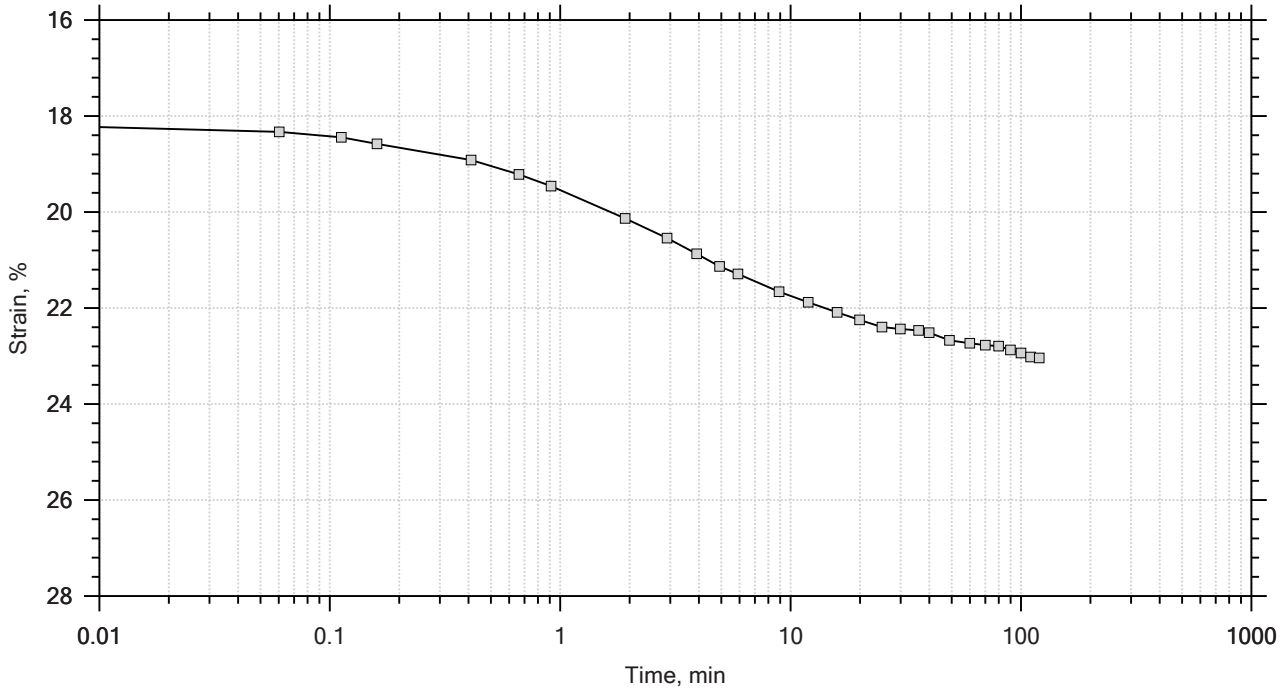


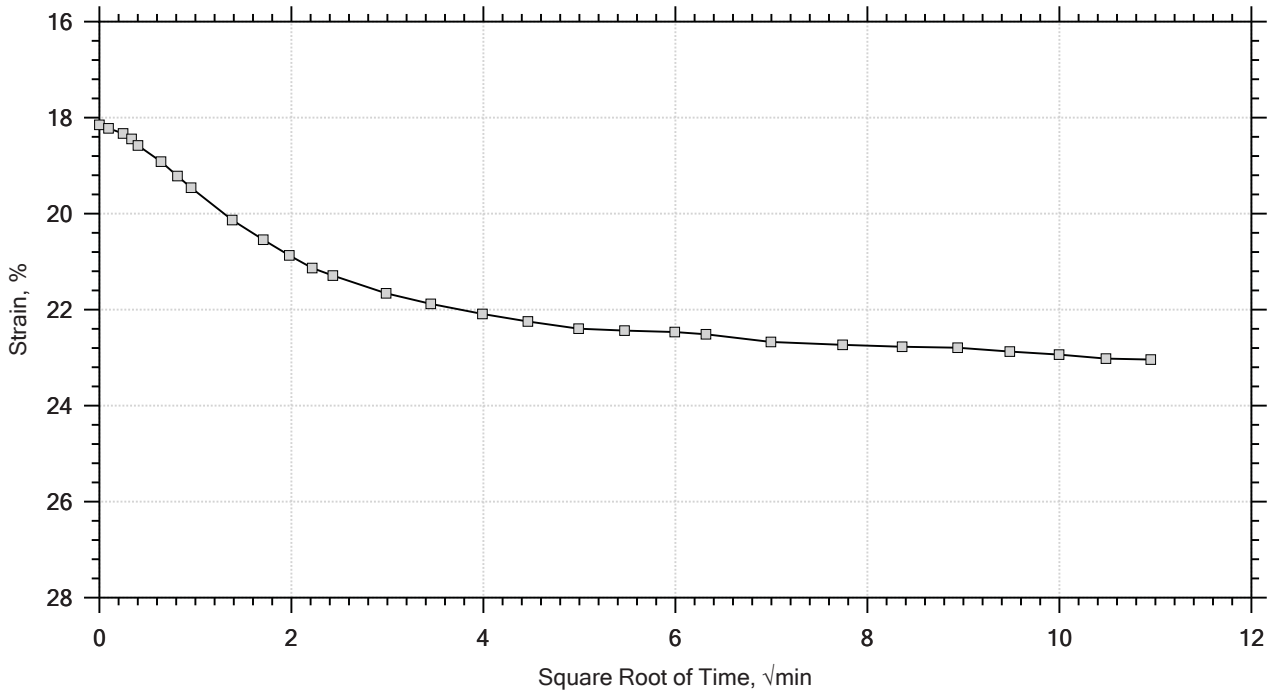


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
	Test No.: IP-2	Sample Type: intact	Elevation: ---
	Description: Moist, olive clayey sand		
	Remarks: System S, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 11
Constant Load Step
Stress: 4 tsf

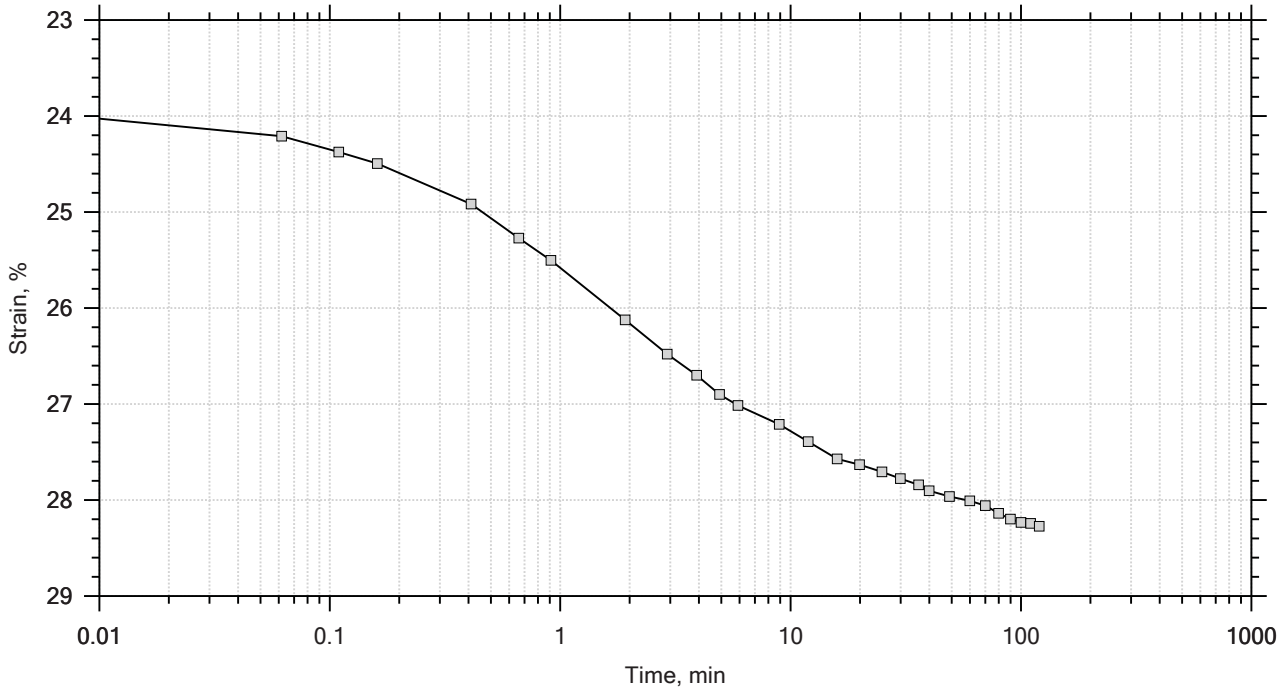


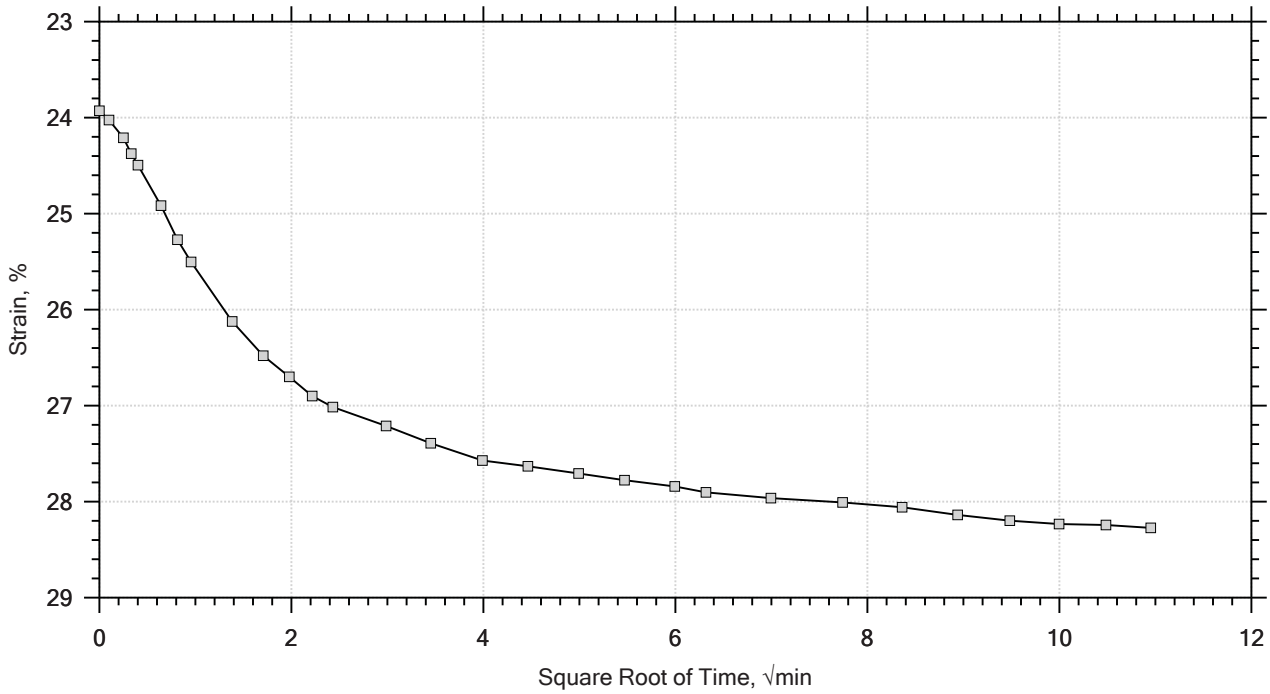


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
	Test No.: IP-2	Sample Type: intact	Elevation: ---
	Description: Moist, olive clayey sand		
	Remarks: System S, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 11
Constant Load Step
Stress: 8 tsf

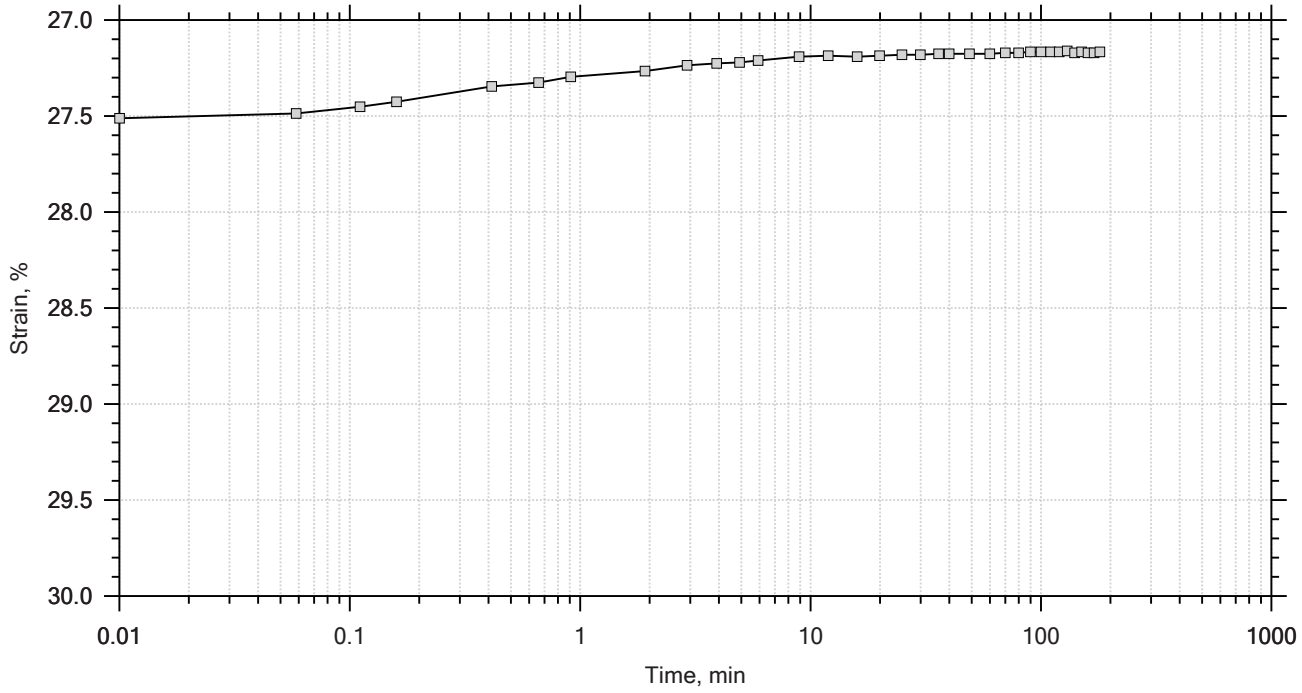


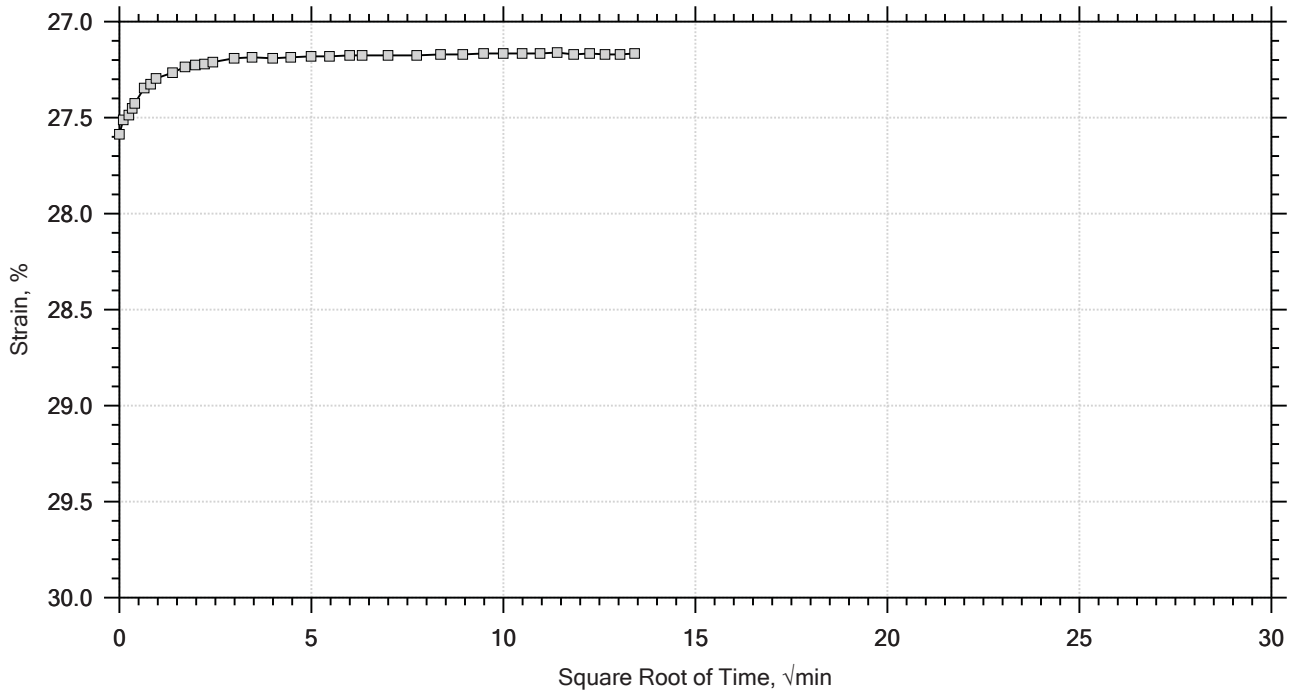


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
	Test No.: IP-2	Sample Type: intact	Elevation: ---
	Description: Moist, olive clayey sand		
	Remarks: System S, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 11
Constant Load Step
Stress: 2 tsf

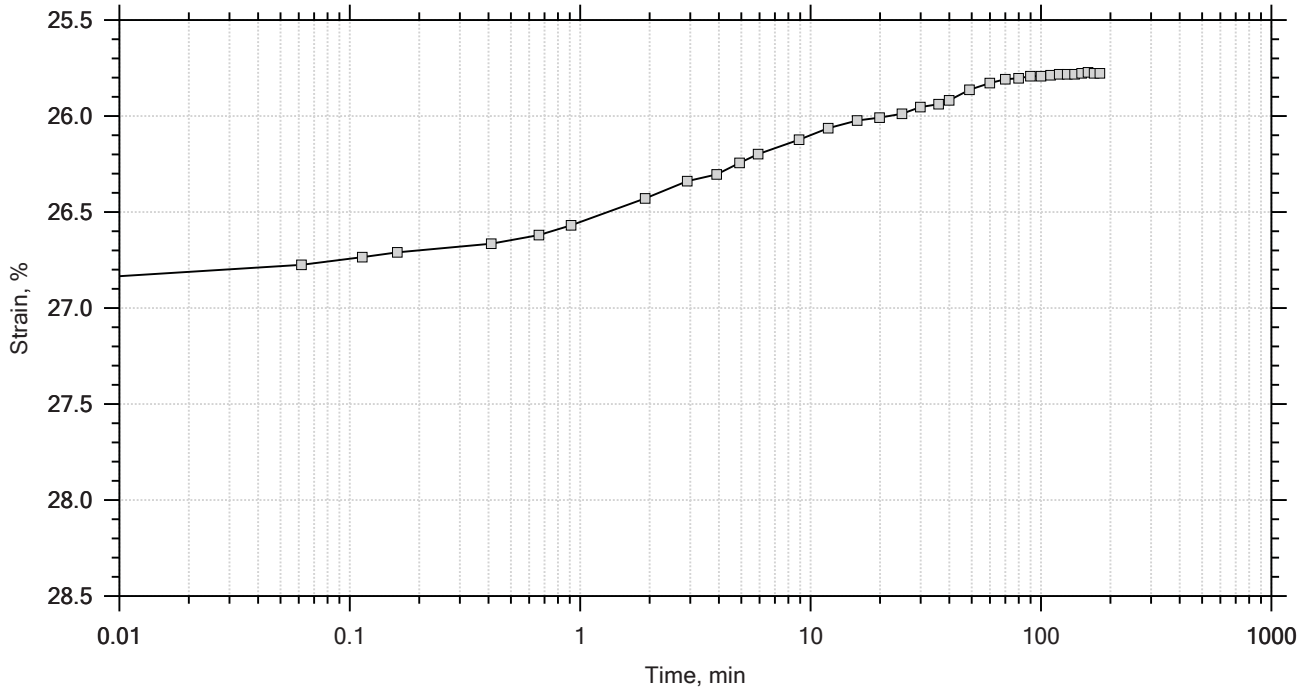


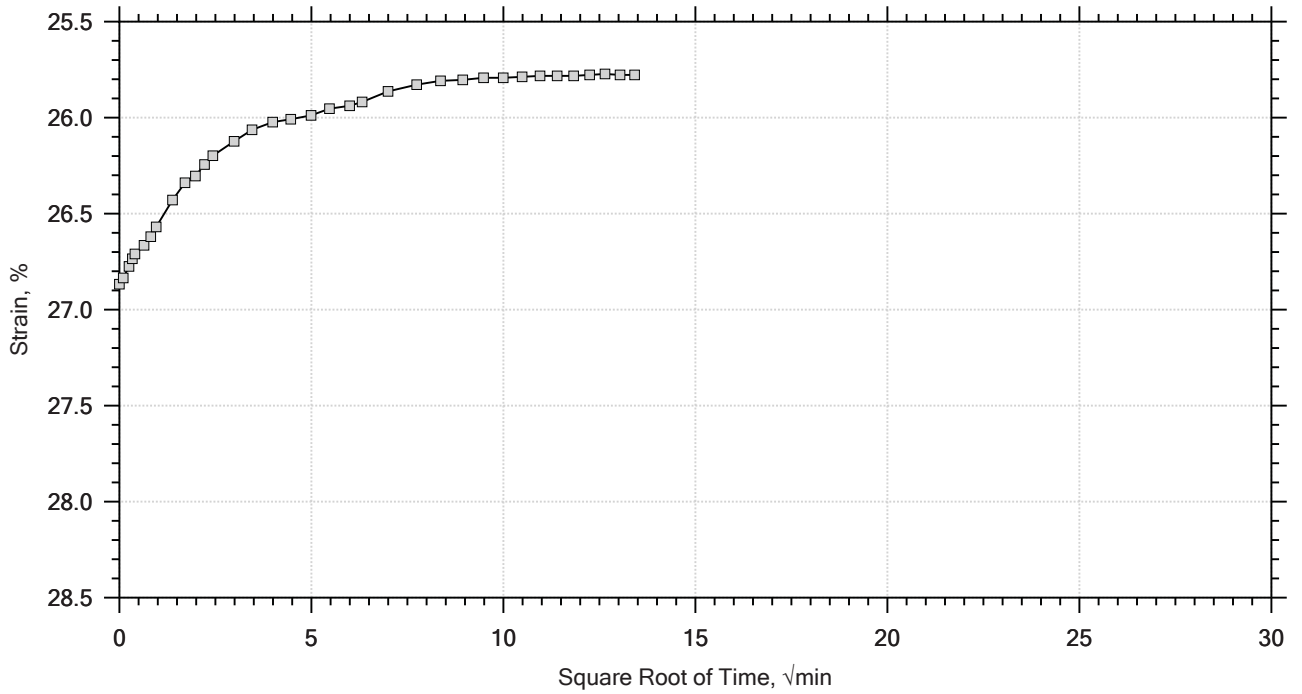


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
Test No.: IP-2	Sample Type: intact	Elevation: ---
Description: Moist, olive clayey sand		
Remarks: System S, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 11
Constant Load Step
Stress: 0.5 tsf

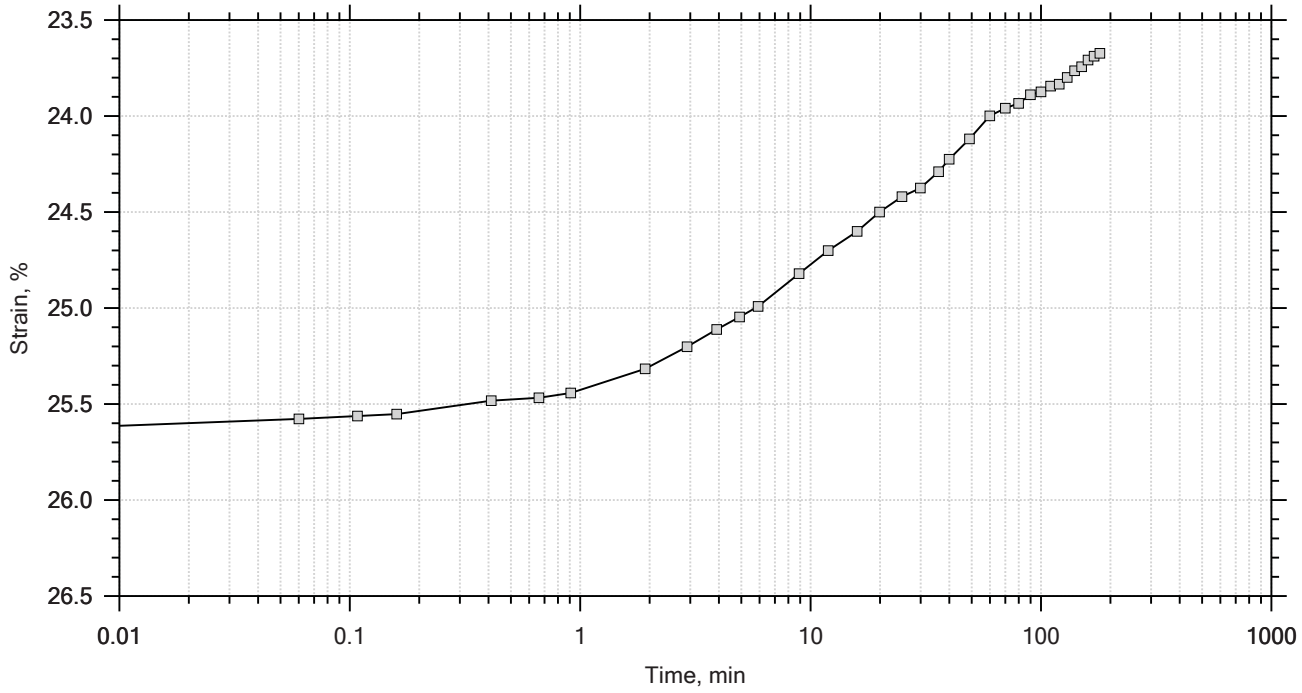


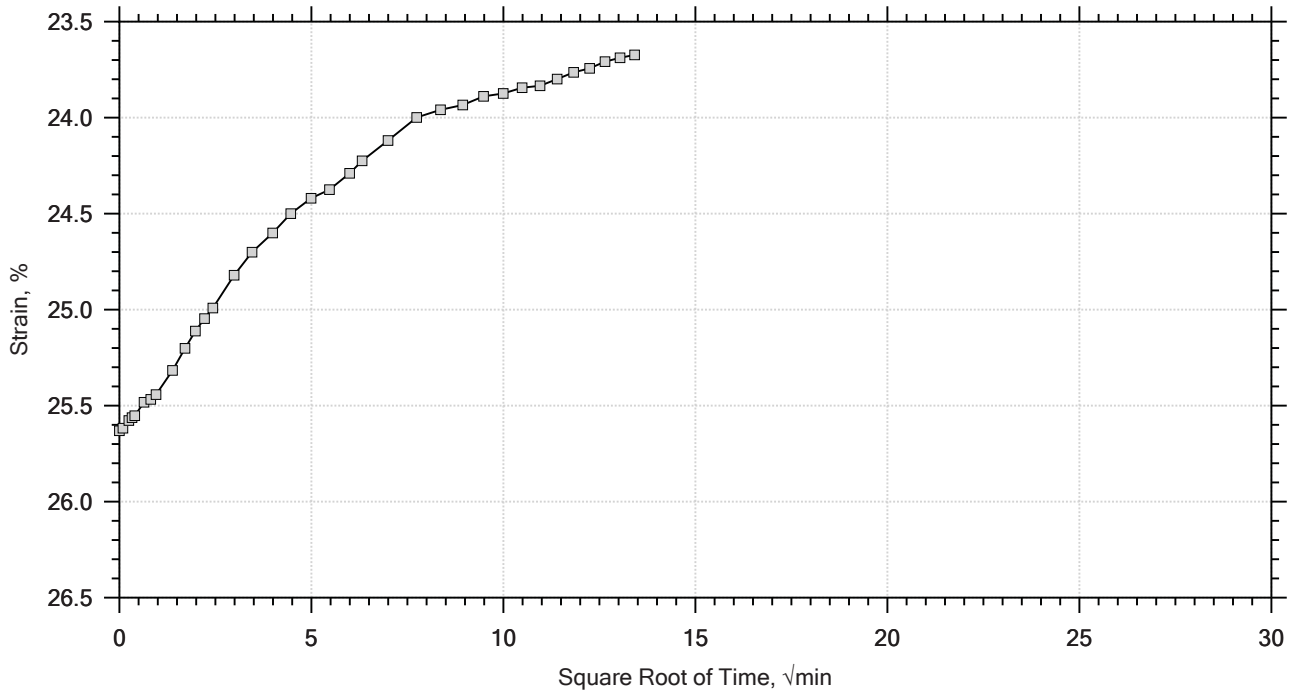


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
Test No.: IP-2	Sample Type: intact	Elevation: ---
Description: Moist, olive clayey sand		
Remarks: System S, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 11
Constant Load Step
Stress: 0.125 tsf





Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
Test No.: IP-2	Sample Type: intact	Elevation: ---
Description: Moist, olive clayey sand		
Remarks: System S, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.74	Liquid Limit: 66
Initial Height: 1.00 in	Initial Void Ratio: 1.44	Plastic Limit: 22
Final Height: 0.80 in	Final Void Ratio: 0.956	Plasticity Index: 44

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	16719	RING		9370
Mass Container, gm	8.86	111.44	111.44	8.57
Mass Container + Wet Soil, gm	211.34	248.2	232.98	128.77
Mass Container + Dry Soil, gm	128.42	201.53	201.53	97.67
Mass Dry Soil, gm	119.56	90.093	90.093	89.1
Water Content, %	69.35	51.80	34.90	34.90
Void Ratio	---	1.44	0.96	---
Degree of Saturation, %	---	98.17	100.00	---
Dry Unit Weight, pcf	---	69.92	87.4	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
	Test No.: IP-2	Sample Type: intact	Elevation: ---
	Description: Moist, olive clayey sand		
	Remarks: System S, Swell Pressure = 0.0658 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Log of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/s	Mv 1/tsf	k ft/day	Ca %
1	0.0658	0.009670	1.42	0.967	0.000	0.00e+00	1.47e-01	0.00e+00	0.00e+00
2	0.125	0.02134	1.39	2.13	5.659	9.76e-07	1.97e-01	5.19e-04	0.00e+00
3	0.250	0.04108	1.34	4.11	0.000	0.00e+00	1.58e-01	0.00e+00	0.00e+00
4	0.500	0.06929	1.28	6.93	4.867	1.05e-06	1.13e-01	3.18e-04	0.00e+00
5	1.00	0.1145	1.16	11.5	3.045	1.54e-06	9.05e-02	3.77e-04	0.00e+00
6	2.00	0.1741	1.02	17.4	2.268	1.84e-06	5.95e-02	2.95e-04	0.00e+00
7	4.00	0.2304	0.881	23.0	2.275	1.59e-06	2.82e-02	1.21e-04	0.00e+00
8	8.00	0.2827	0.753	28.3	1.266	2.49e-06	1.31e-02	8.79e-05	0.00e+00
9	2.00	0.2717	0.781	27.2	0.000	0.00e+00	1.85e-03	0.00e+00	0.00e+00
10	0.500	0.2578	0.814	25.8	2.399	1.28e-06	9.25e-03	3.21e-05	0.00e+00
11	0.125	0.2367	0.866	23.7	0.000	0.00e+00	5.61e-02	0.00e+00	0.00e+00

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
	Test No.: IP-2	Sample Type: intact	Elevation: ---
	Description: Moist, olive clayey sand		
	Remarks: System S, Swell Pressure = 0.0658 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Square Root of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv ft²/s	Mv 1/tsf	k ft/day
1	0.0658	0.009670	1.42	0.967	48.028	5.06e-07	1.47e-01	2.01e-04
2	0.125	0.02134	1.39	2.13	26.995	8.81e-07	1.97e-01	4.69e-04
3	0.250	0.04108	1.34	4.11	19.010	1.21e-06	1.58e-01	5.16e-04
4	0.500	0.06929	1.28	6.93	18.500	1.18e-06	1.13e-01	3.60e-04
5	1.00	0.1145	1.16	11.5	17.554	1.15e-06	9.05e-02	2.81e-04
6	2.00	0.1741	1.02	17.4	11.121	1.62e-06	5.95e-02	2.59e-04
7	4.00	0.2304	0.881	23.0	9.520	1.64e-06	2.82e-02	1.25e-04
8	8.00	0.2827	0.753	28.3	5.535	2.45e-06	1.31e-02	8.65e-05
9	2.00	0.2717	0.781	27.2	2.193	5.84e-06	1.85e-03	2.91e-05
10	0.500	0.2578	0.814	25.8	10.719	1.24e-06	9.25e-03	3.09e-05
11	0.125	0.2367	0.866	23.7	40.735	3.41e-07	5.61e-02	5.17e-05

GeoTesting EXPRESS

Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 08/19/16	Depth: 16.0-18.0 ft
Test No.: IP-2	Sample Type: intact	Elevation: ---
Description: Moist, olive clayey sand		
Remarks: System S, Swell Pressure = 0.0658 tsf		
Displacement at End of Increment		

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	---	Sample Type:	---	Tested By:	jbr
Sample ID:	---	Test Date:	08/30/16	Checked By:	mcm
Depth :	---	Test Id:	387124		

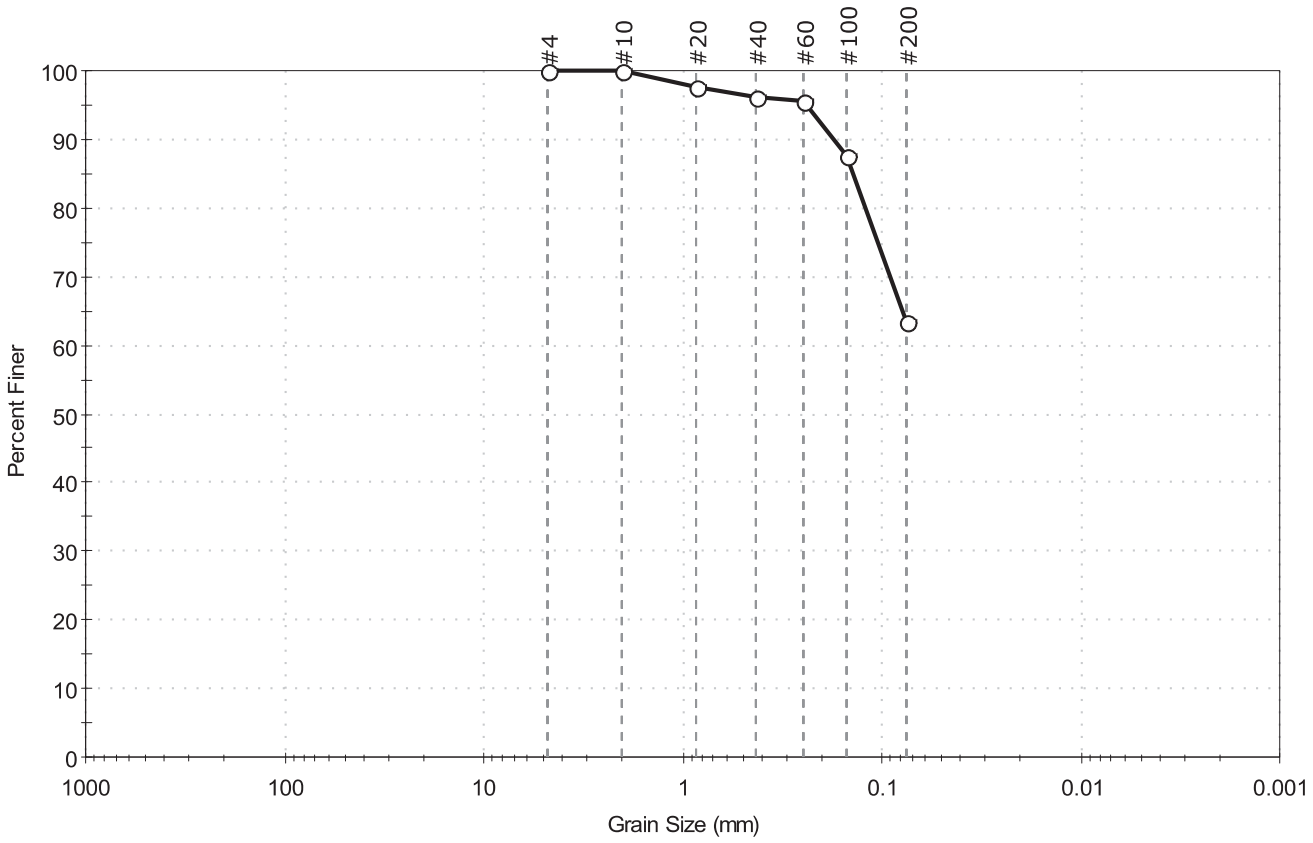
Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
AP-2	UD-2	18.0-20.0 ft	Moist, olive sandy clay	69.3

Notes: Temperature of Drying : 110º Celsius

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-2	Sample Type:	tube	Tested By:	jbr
Sample ID:	UD-2	Test Date:	08/26/16	Checked By:	mcm
Depth :	18.0-20.0 ft	Test Id:	387104		
Test Comment:	---				
Visual Description:	Moist, olive sandy clay				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	36.5	63.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	98		
#40	0.42	96		
#60	0.25	96		
#100	0.15	88		
#200	0.075	64		

Coefficients

D_{85} =0.1387 mm	D_{30} =N/A
D_{60} =N/A	D_{15} =N/A
D_{50} =N/A	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM Sandy Fat clay (CH)

AASHTO Clayey Soils (A-7-6 (33))

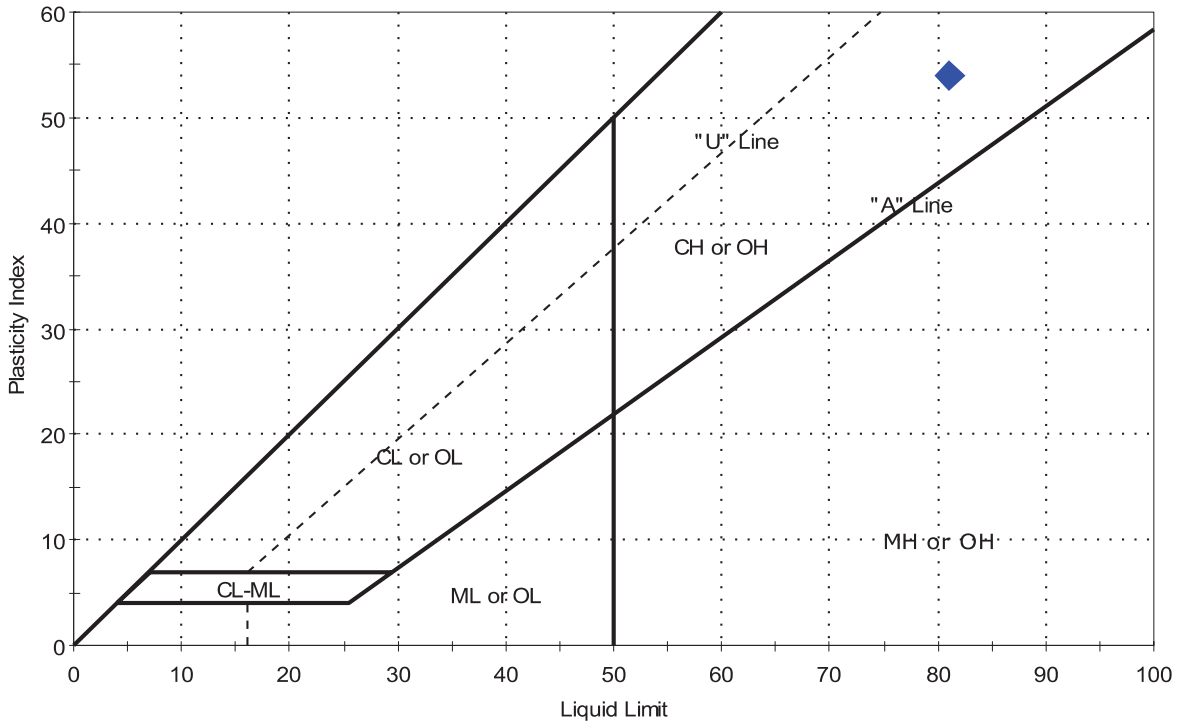
Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-2	Sample Type:	tube	Tested By:	cam
Sample ID:	UD-2	Test Date:	08/29/16	Checked By:	mcm
Depth :	18.0-20.0 ft	Test Id:	387112		
Test Comment:	---				
Visual Description:	Moist, olive sandy clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



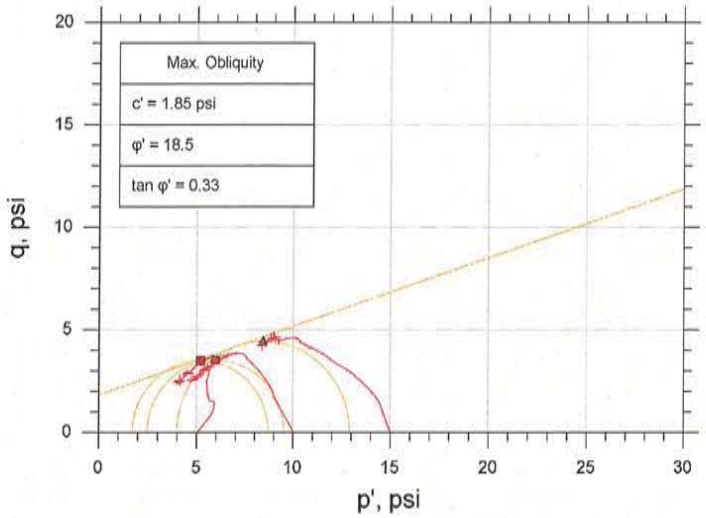
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	UD-2	AP-2	18.0-20.0 ft	69	81	27	54	0.8	Sandy Fat clay (CH)

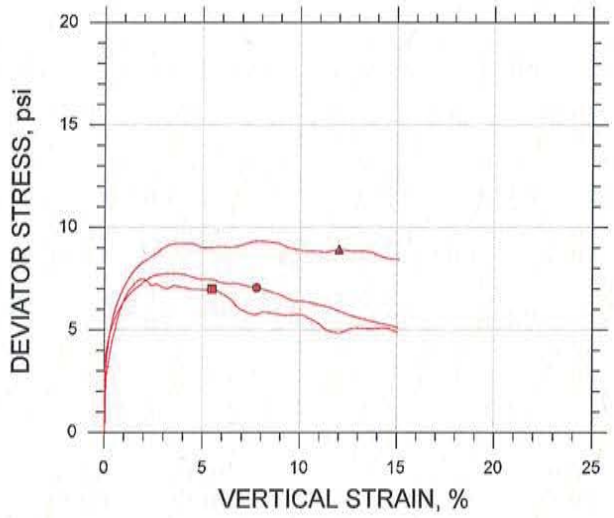
Sample Prepared using the WET method
4% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

GeoTesting EXPRESS

Client: F&ME Consultants	
Project Name: US-21 Replacement Bridge	
Project Location: ---	
Project Number: GTX-305005	
Tested By: md	Checked By: mcm
Boring ID: AP-2	
Preparation: intact	
Description: Moist, olive sandy clay	
Classification: Sandy Fat clay	
Group Symbol: CH	
Liquid Limit: 81	Plastic Limit: 27
Plasticity Index: 54	Estimated Specific Gravity: 2.7

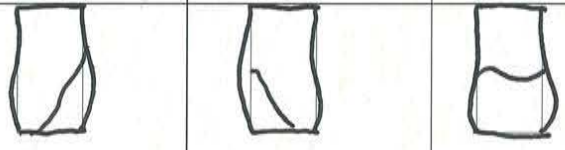
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		■	●	▲	
Sample ID		ST-2	ST-2	ST-2	
Depth, ft		18.0-20.0 ft	18.0-20.0 ft	18.0-20.0 ft	
Test Number		CU-4-1	CU-4-2	CU-4-3	
Initial	Height, in	4.500	4.350	4.380	
	Diameter, in	2.030	2.010	2.030	
	Moisture Content (from Cuttings), %	64.9	70.2	80.2	
	Dry Density, pcf	60.5	54.4	52.1	
	Saturation (Wet Method), %	98.2	90.4	96.8	
	Void Ratio	1.78	2.10	2.24	
Before Shear	Moisture Content, %	63.4	70.4	70.2	
	Dry Density, pcf	62.1	58.1	58.2	
	Cross-sectional Area (Method A), in²	3.153	3.020	3.006	
	Saturation, %	100.0	100.0	100.0	
	Void Ratio	1.71	1.90	1.90	
	Back Pressure, psi	96.99	151.0	150.7	
Vertical Effective Consolidation Stress, psi		5.008	9.886	14.67	
Horizontal Effective Consolidation Stress, psi		5.005	10.00	14.97	
Vertical Strain after Consolidation, %		0.002069	1.405	3.740	
Volumetric Strain after Consolidation, %		2.531	5.704	10.72	
Time to 50% Consolidation, min		72.25	90.25	169.0	
Shear Strength, psi		3.498	3.528	4.459	
Strain at Failure, %		5.48	7.76	12.0	
Strain Rate, %/min		0.01600	0.01600	0.01600	
Deviator Stress at Failure, psi		6.995	7.055	8.918	
Effective Minor Principal Stress at Failure, psi		1.703	2.455	3.977	
Effective Major Principal Stress at Failure, psi		8.698	9.510	12.90	
B-Value		0.95	0.95	0.95	

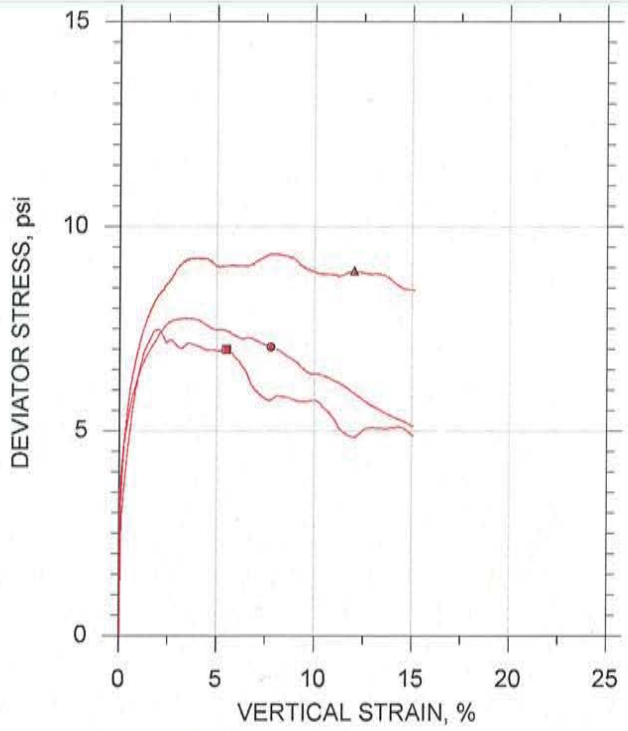
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

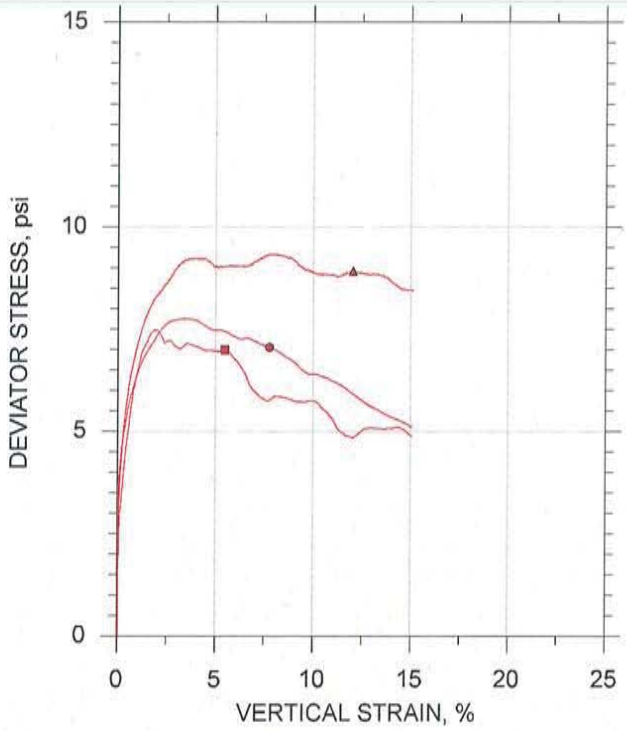


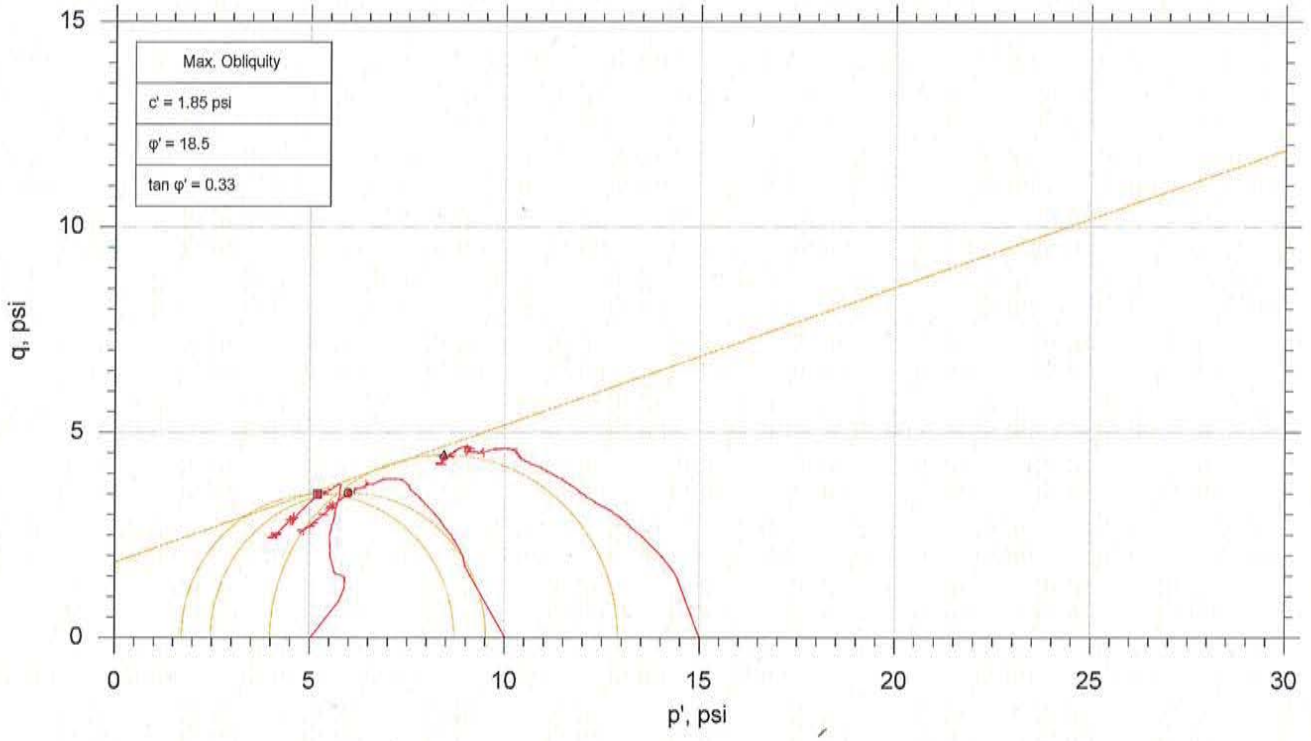
Remarks:

System X. Note CU-1-1 test specimen was not used in determining cohesion or friction values.

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







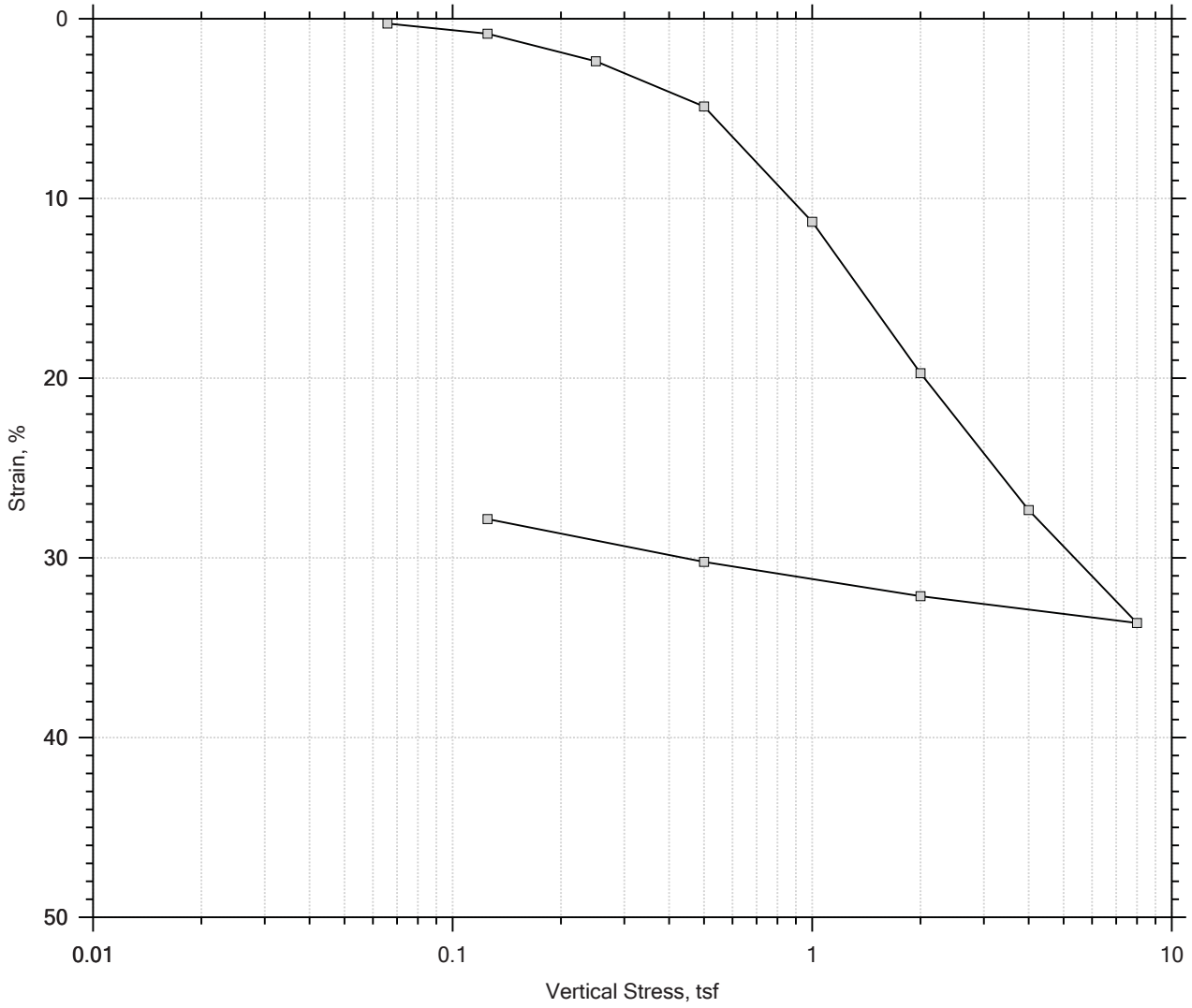
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	ST-2	CU-4-1	18.0-20.0 ft	md	8/23/16	mcm	8/30/16	305005-CU-4-1m.dat
●	ST-2	CU-4-2	18.0-20.0 ft	md	08/23/16	mcm	8/30/16	305005-CU-4-2m.dat
▲	ST-2	CU-4-3	18.0-20.0 ft	md	08/23/16	mcm	8/30/16	305005-CU-4-3m.dat

GeoTesting EXPRESS

Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Sample Type: intact	
Description: Moist, olive sandy clay		
Remarks: System X. Note CU-1-1 test specimen was not used in determining cohesion or friction values.		

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report

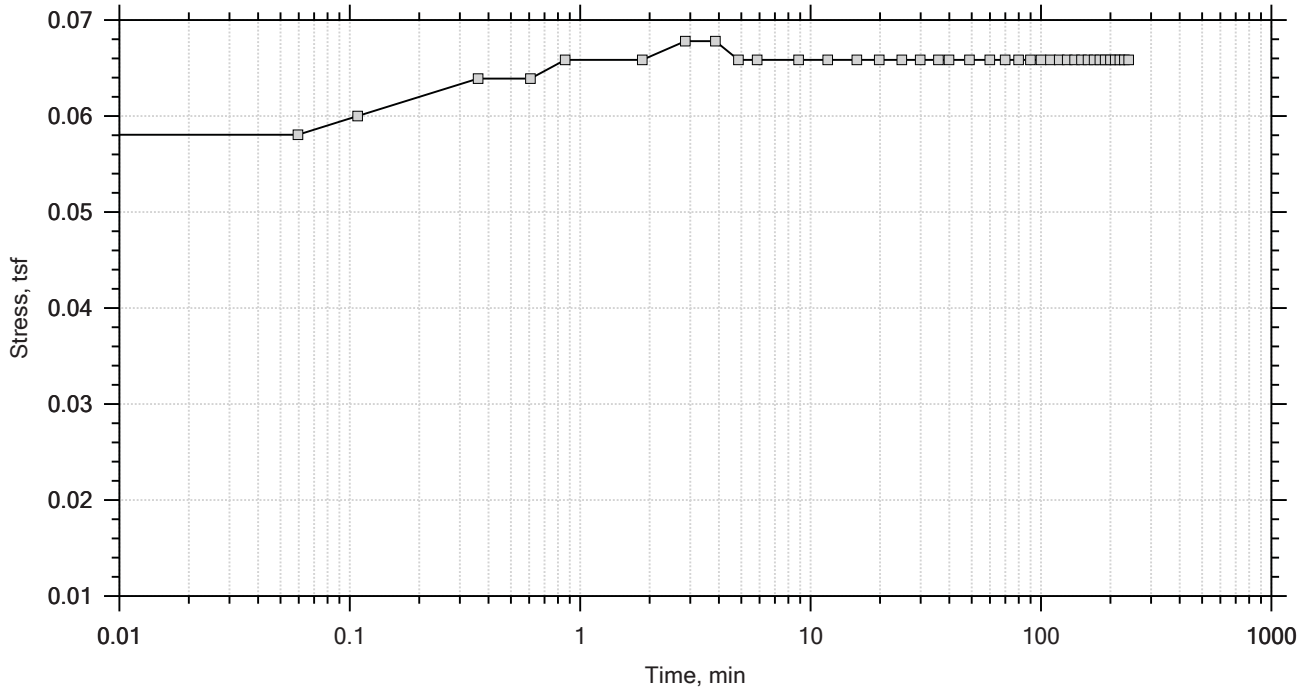


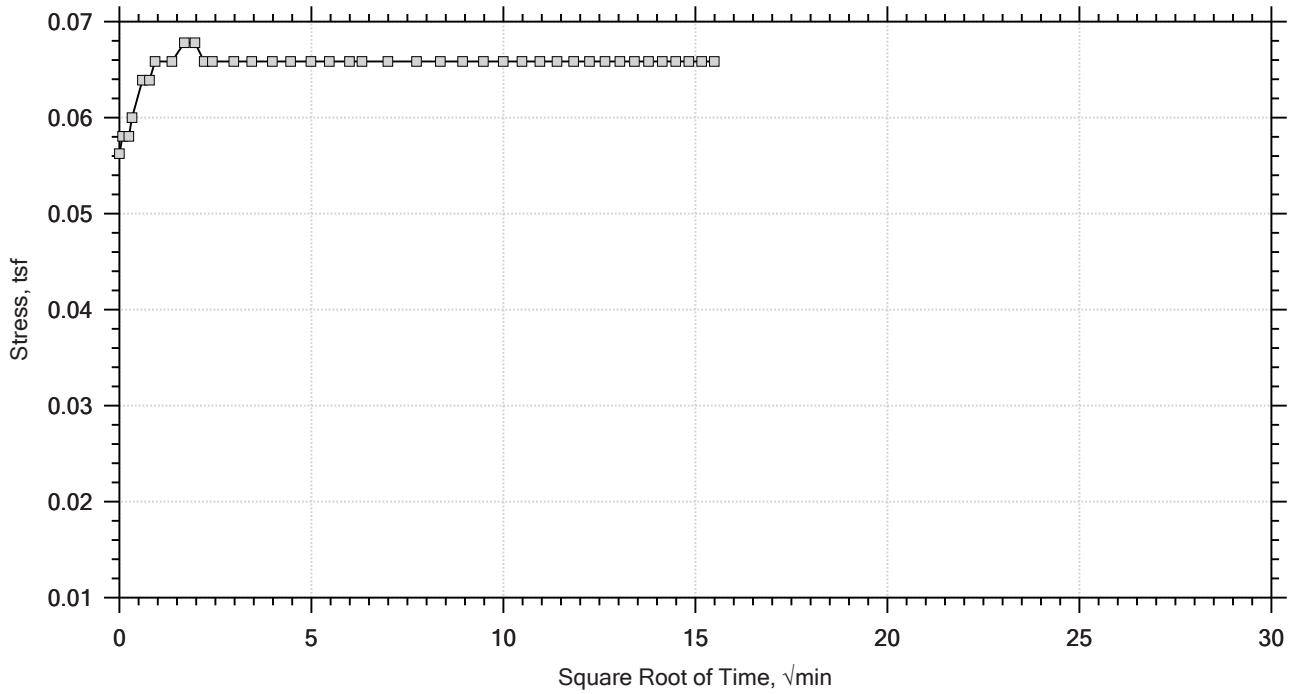
				Before Test	After Test
Current Vertical Effective Stress: ---				Water Content, %	57.55	32.34
Preconsolidation Stress: ---				Dry Unit Weight, pcf	65.031	90.12
Compression Ratio: ---				Saturation, %	97.45	100.00
Diameter: 2.5 in		Height: 1 in		Void Ratio	1.60	0.88
LL: 81	PL: 27	PI: 54	GS: 2.71			

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-4	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System Q, Swell Pressure = 0.0659 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 11
Constant Volume Step
Stress: 0.0659 tsf

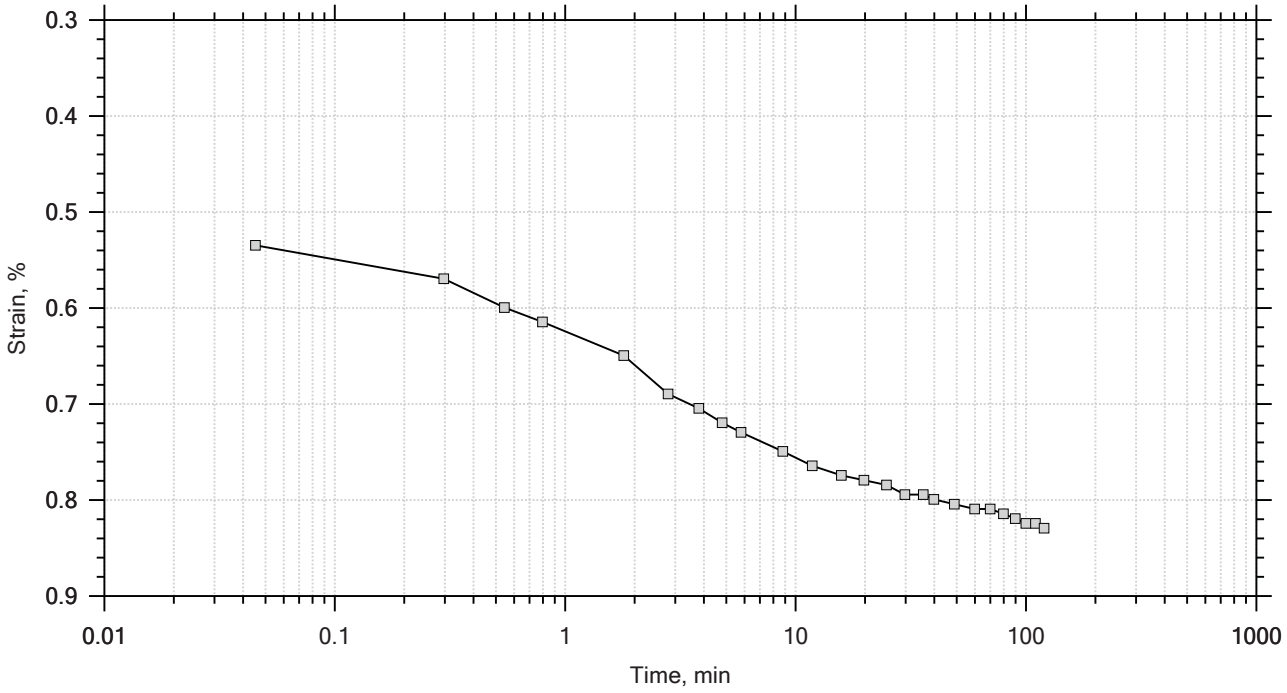


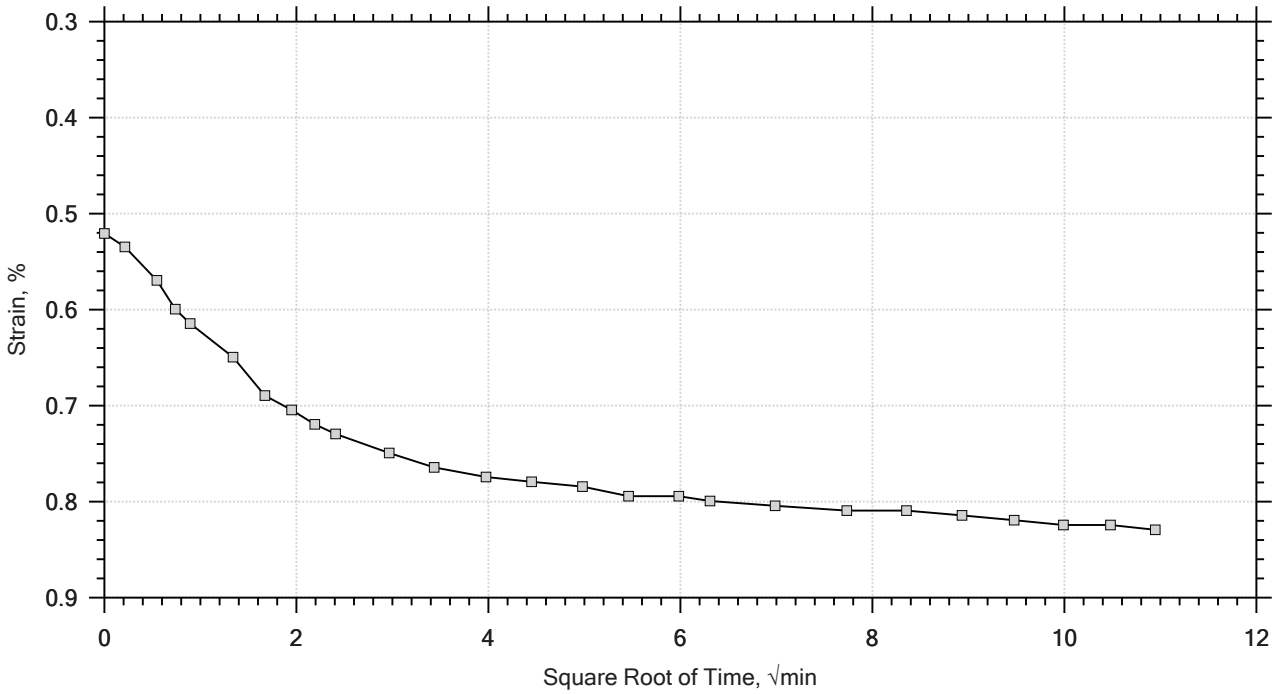


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
Test No.: IP-4	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System Q, Swell Pressure = 0.0659 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 11
Constant Load Step
Stress: 0.125 tsf

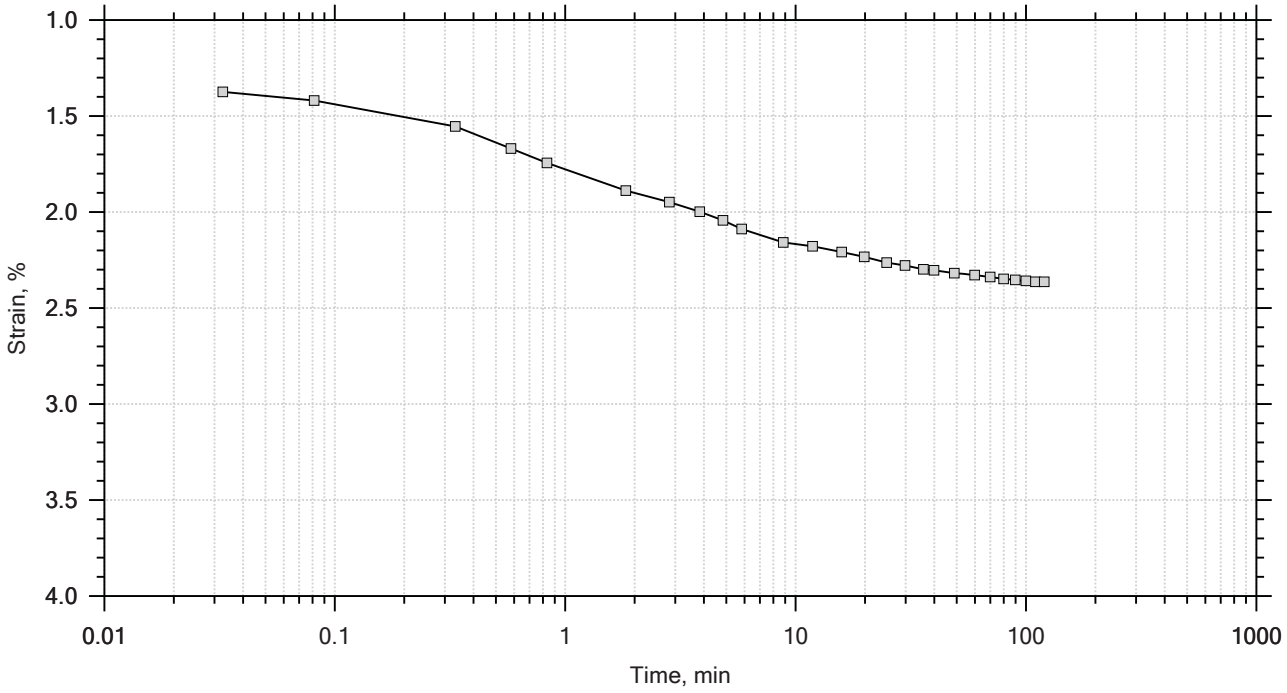


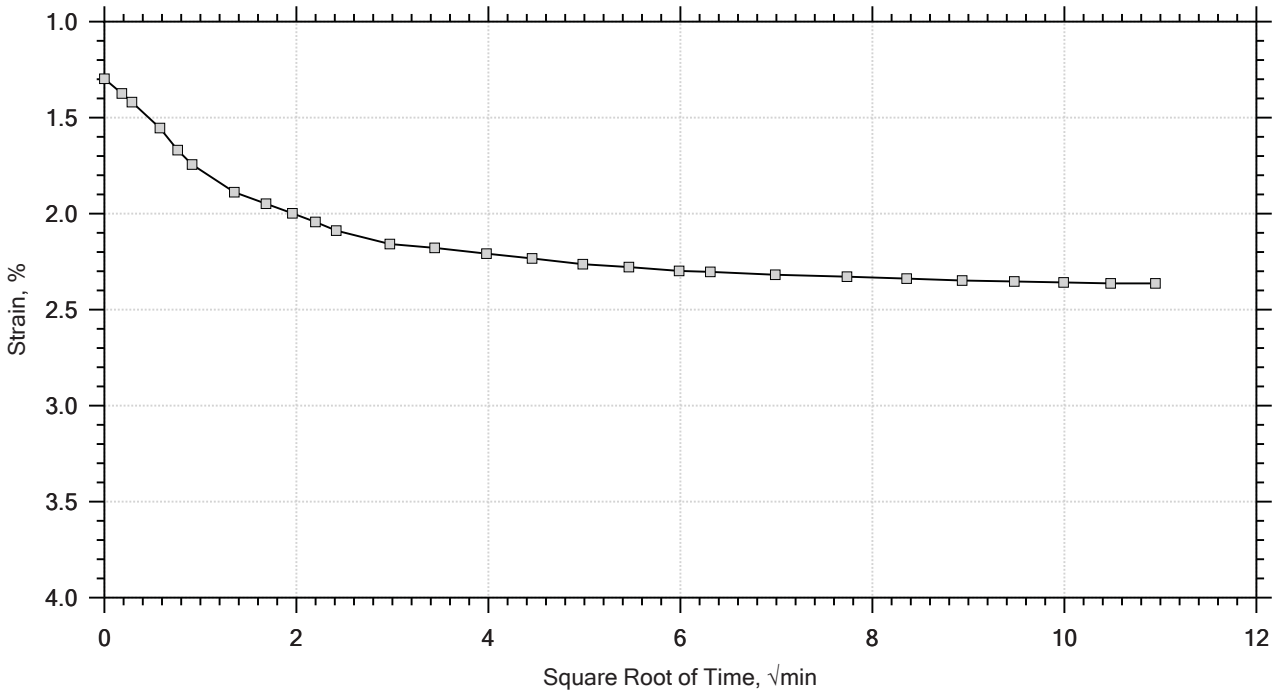


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-4	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System Q, Swell Pressure = 0.0659 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 11
Constant Load Step
Stress: 0.25 tsf

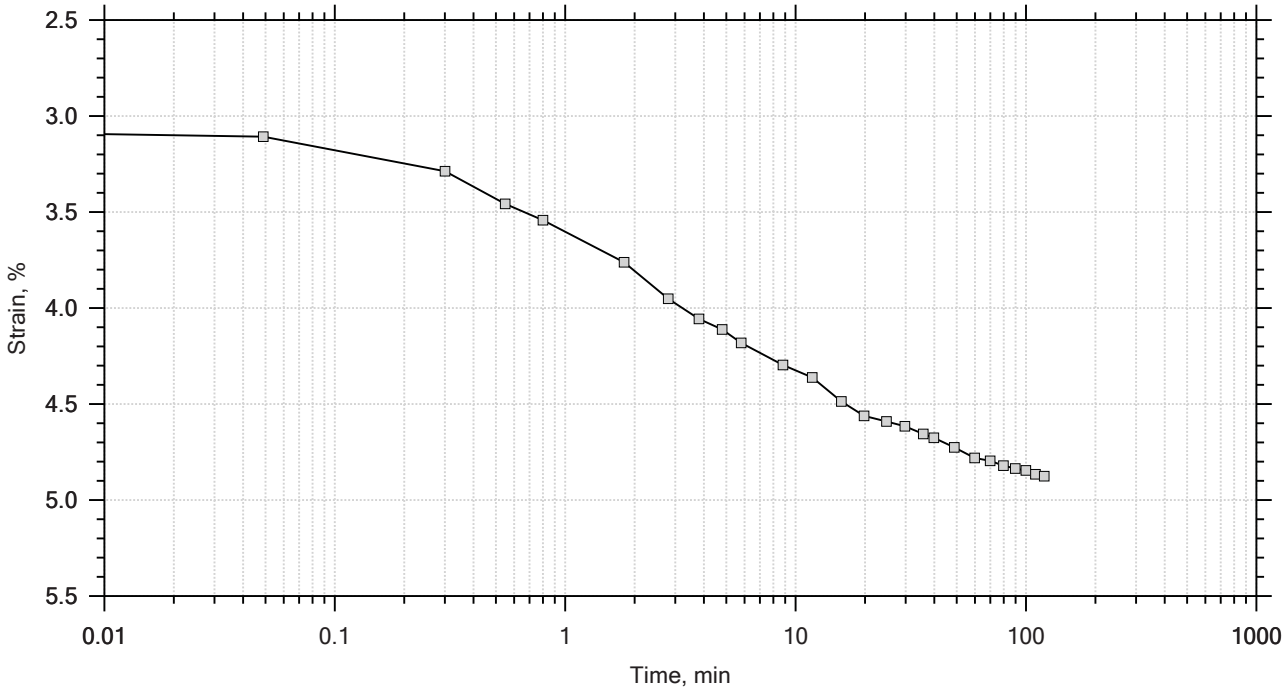


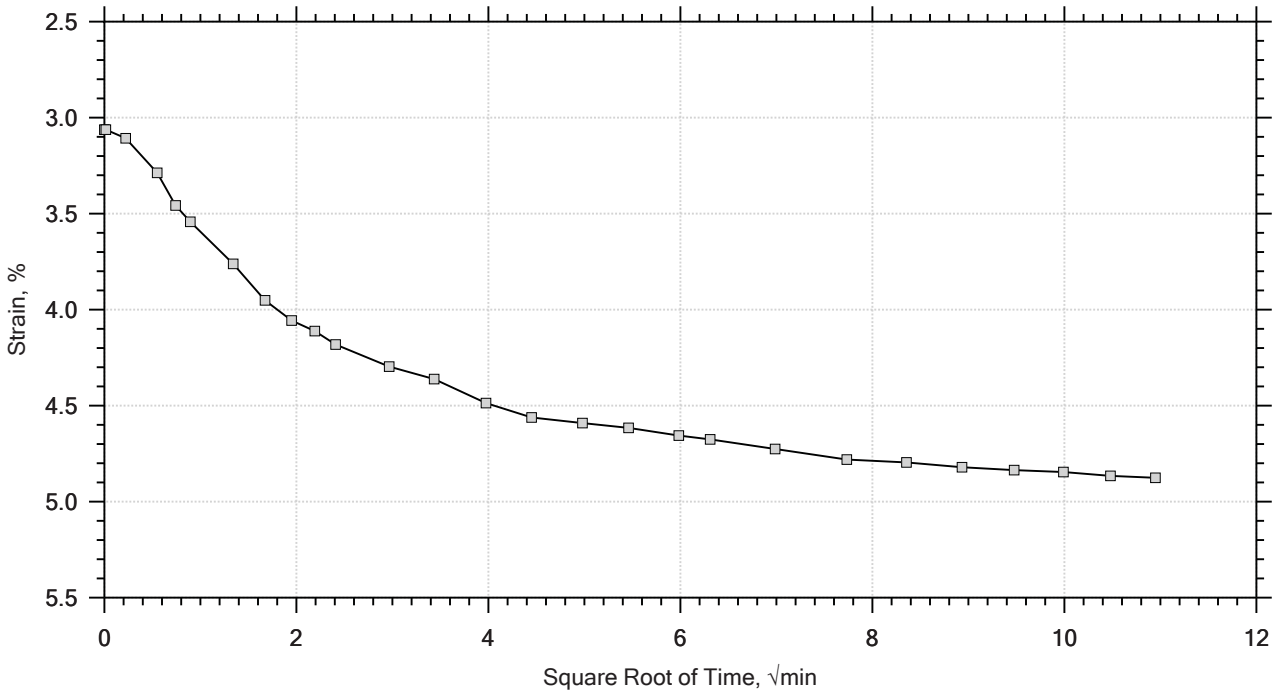


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
Test No.: IP-4	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System Q, Swell Pressure = 0.0659 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 11
Constant Load Step
Stress: 0.5 tsf

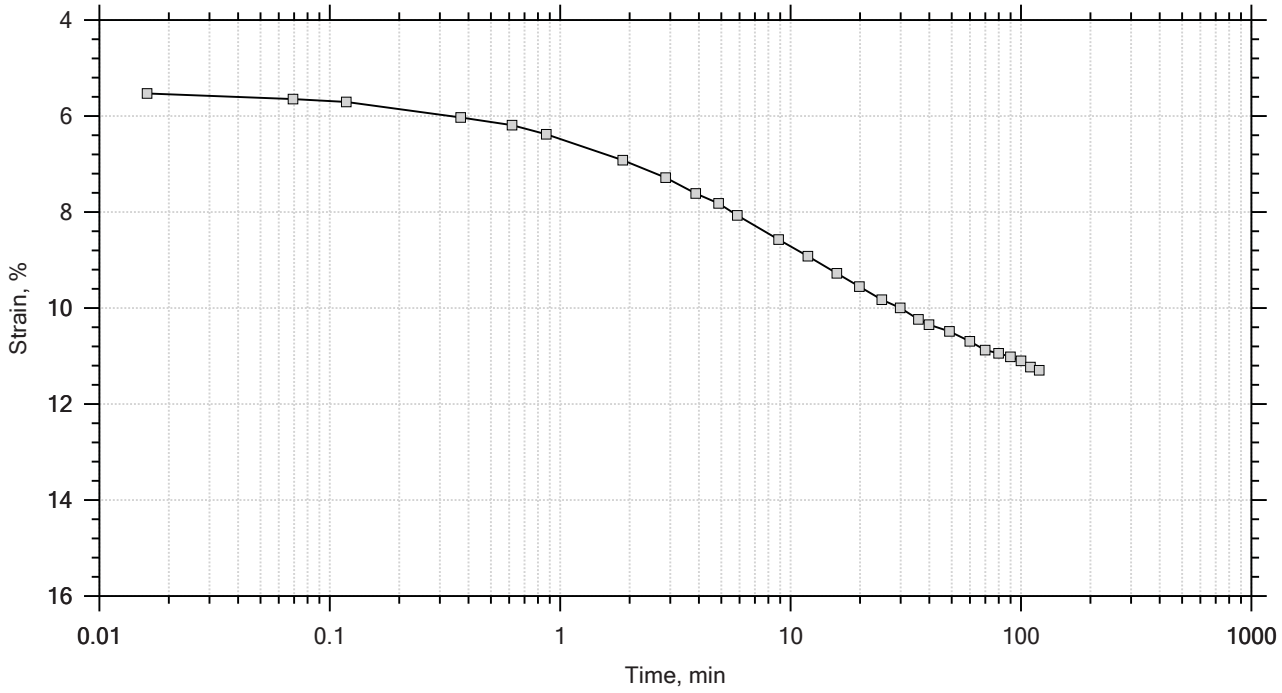


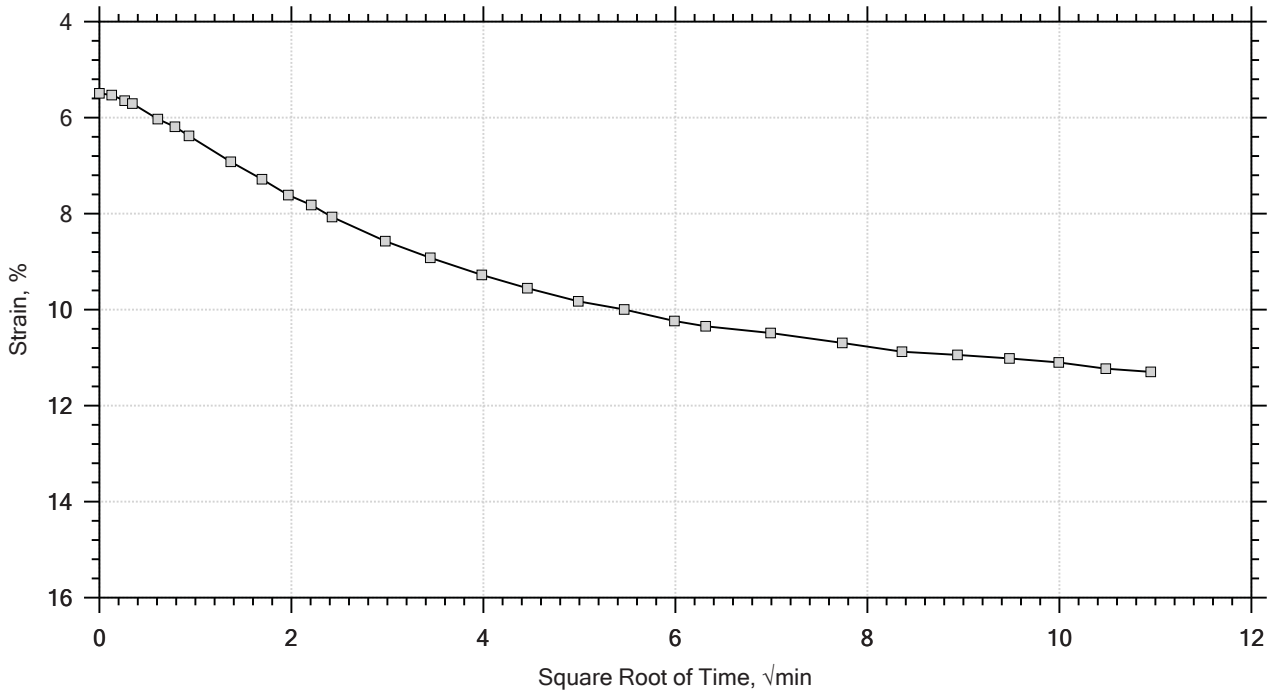


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-4	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System Q, Swell Pressure = 0.0659 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 11
Constant Load Step
Stress: 1 tsf

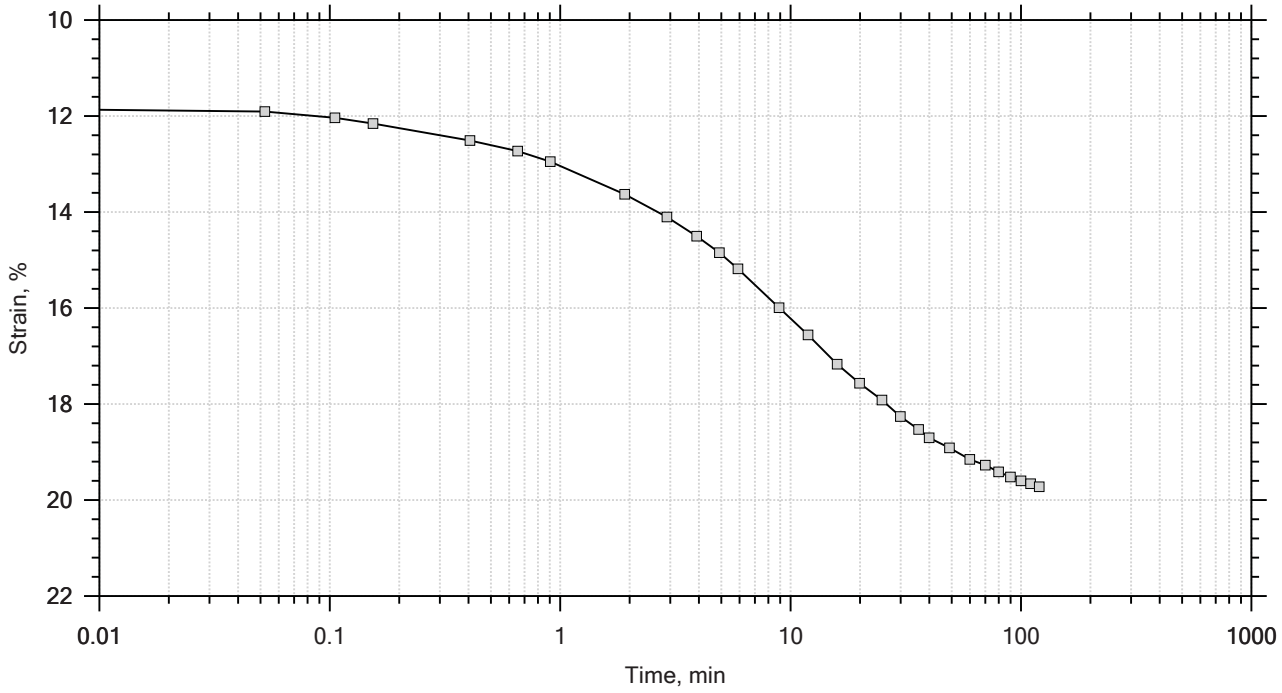


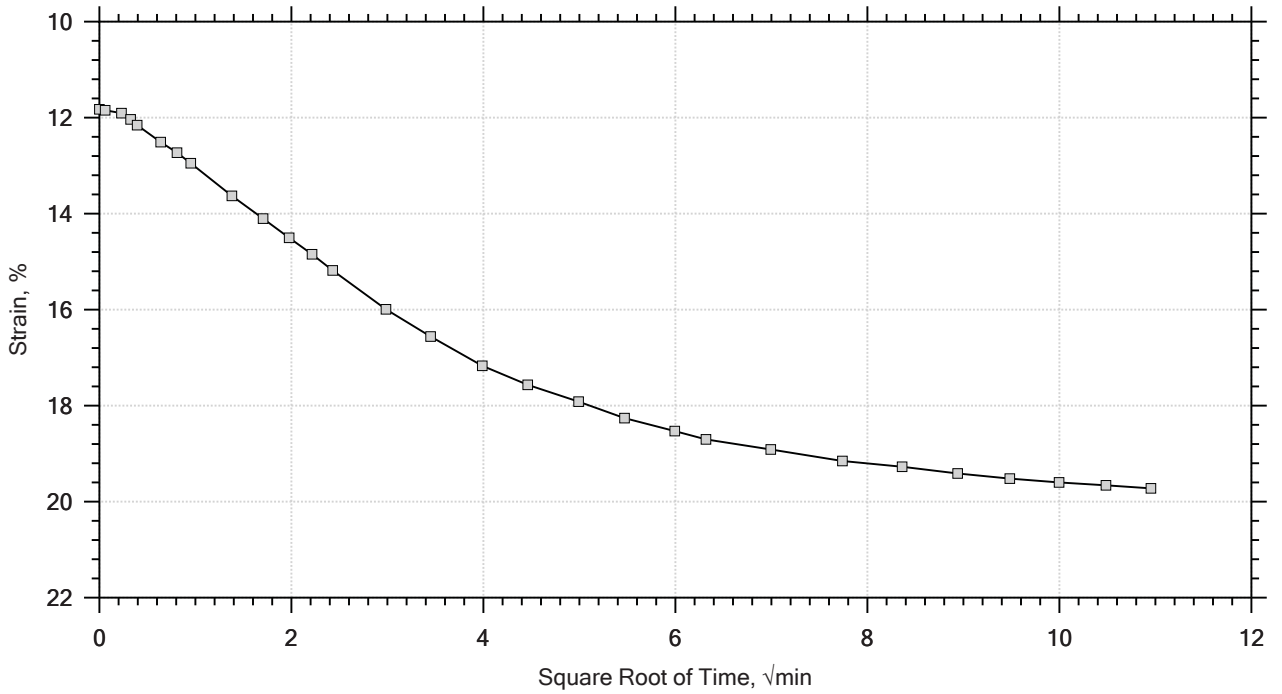


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
Test No.: IP-4	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System Q, Swell Pressure = 0.0659 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 11
Constant Load Step
Stress: 2 tsf

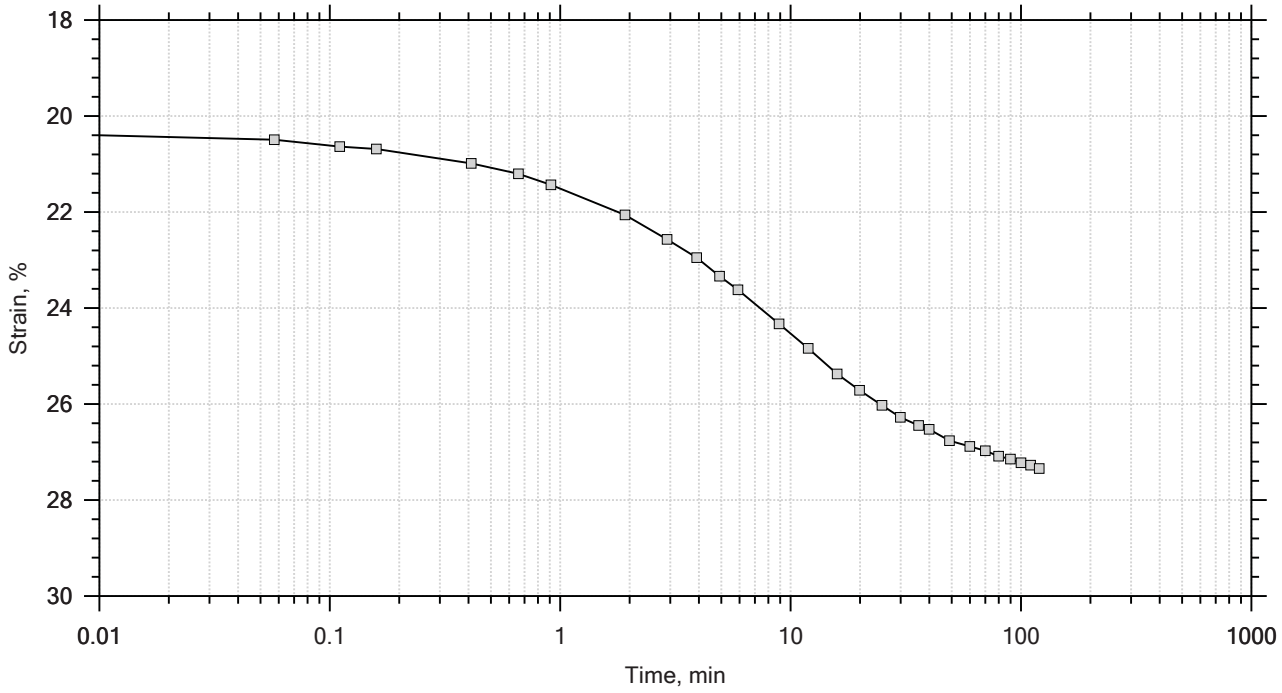


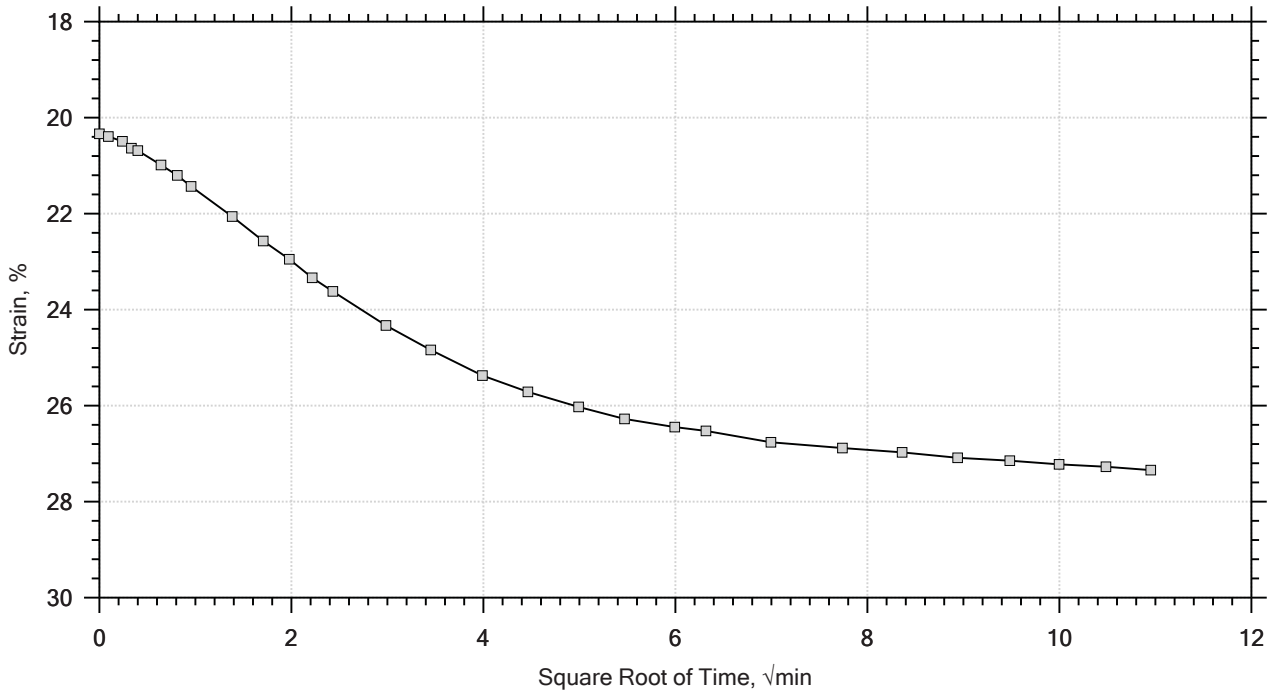


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-4	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System Q, Swell Pressure = 0.0659 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 11
Constant Load Step
Stress: 4 tsf

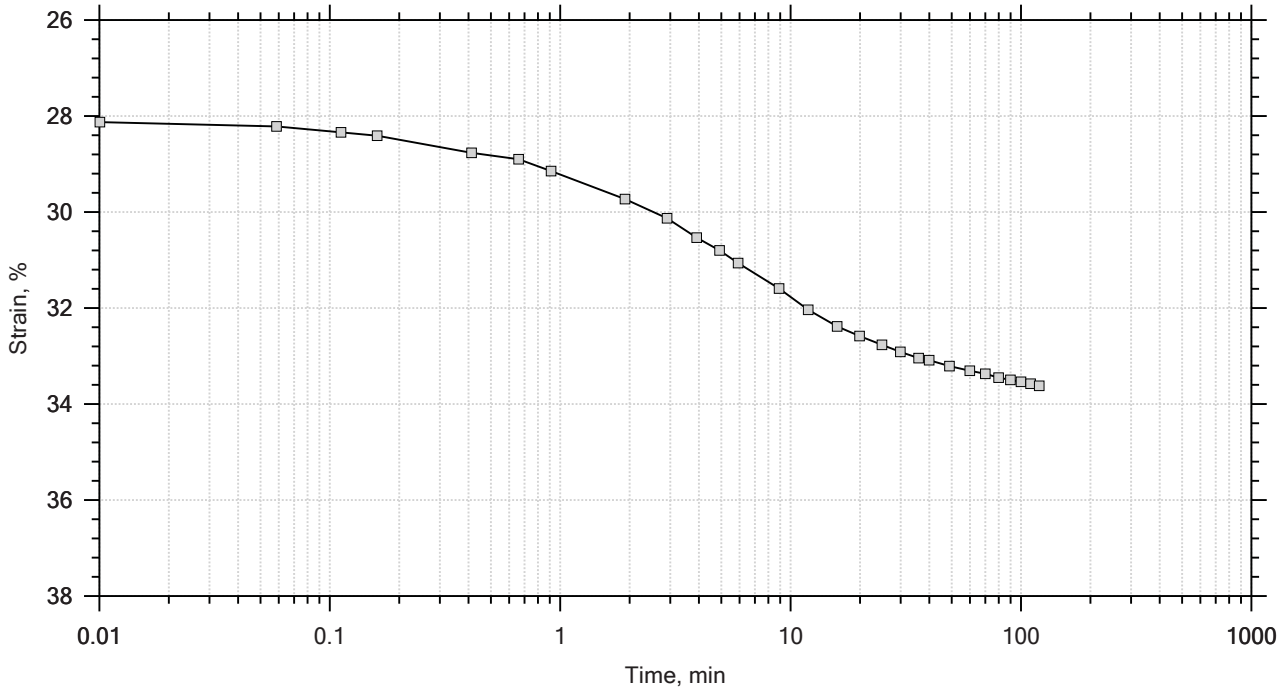


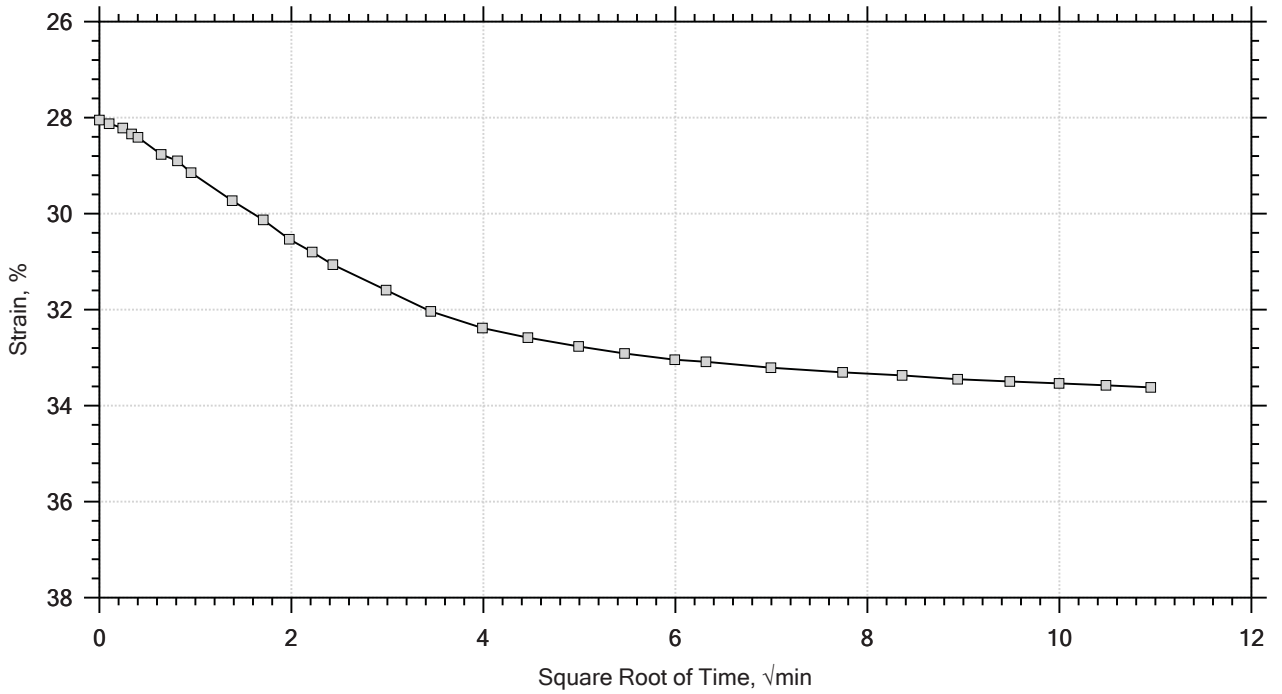


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
Test No.: IP-4	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System Q, Swell Pressure = 0.0659 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 11
Constant Load Step
Stress: 8 tsf

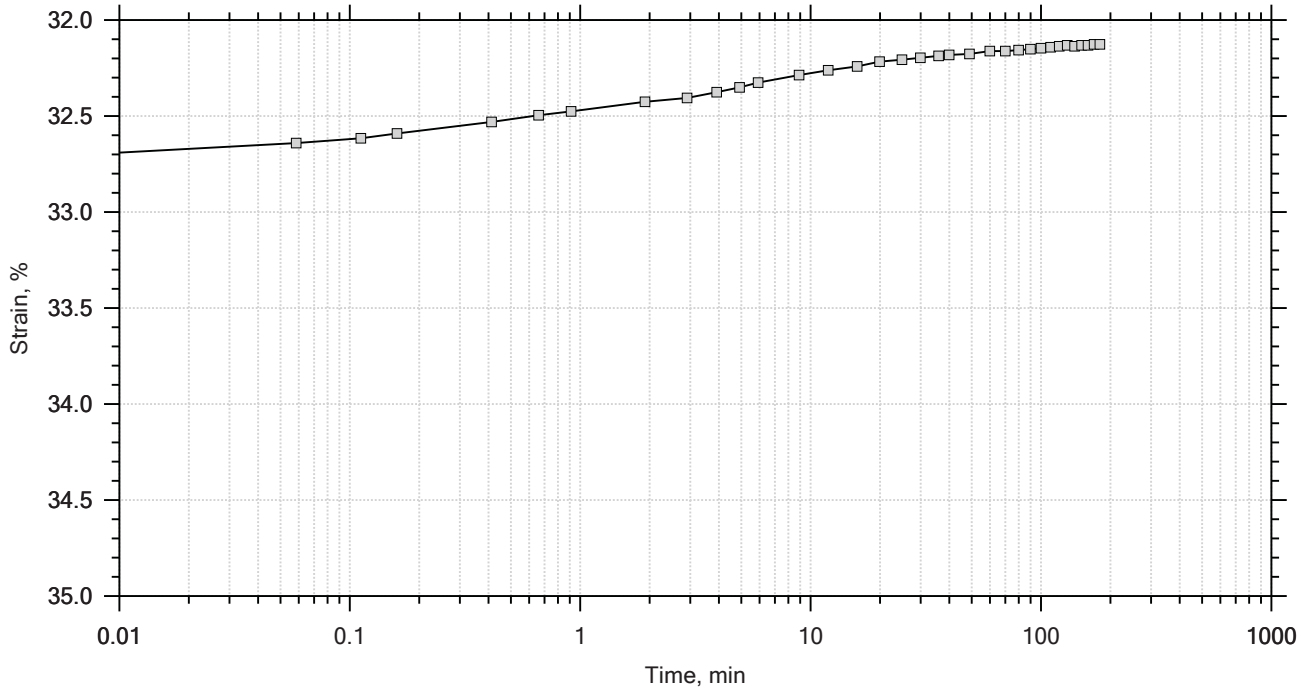


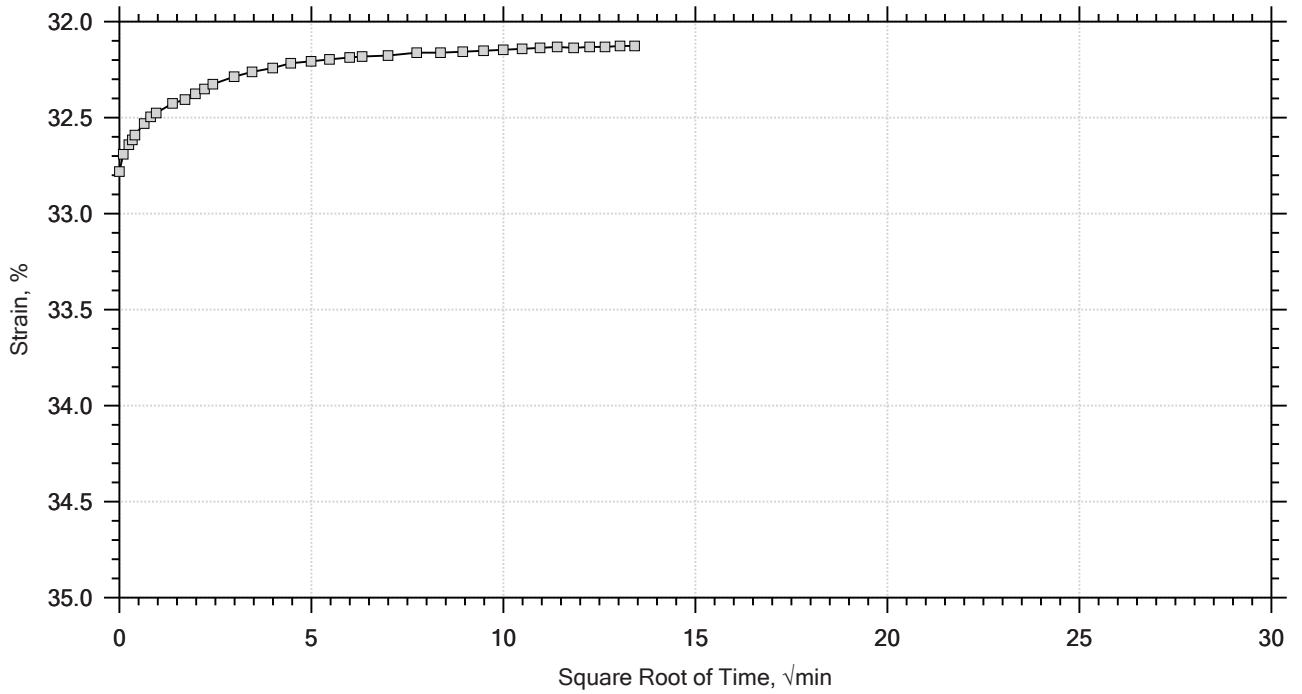


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-4	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System Q, Swell Pressure = 0.0659 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 11
Constant Load Step
Stress: 2 tsf

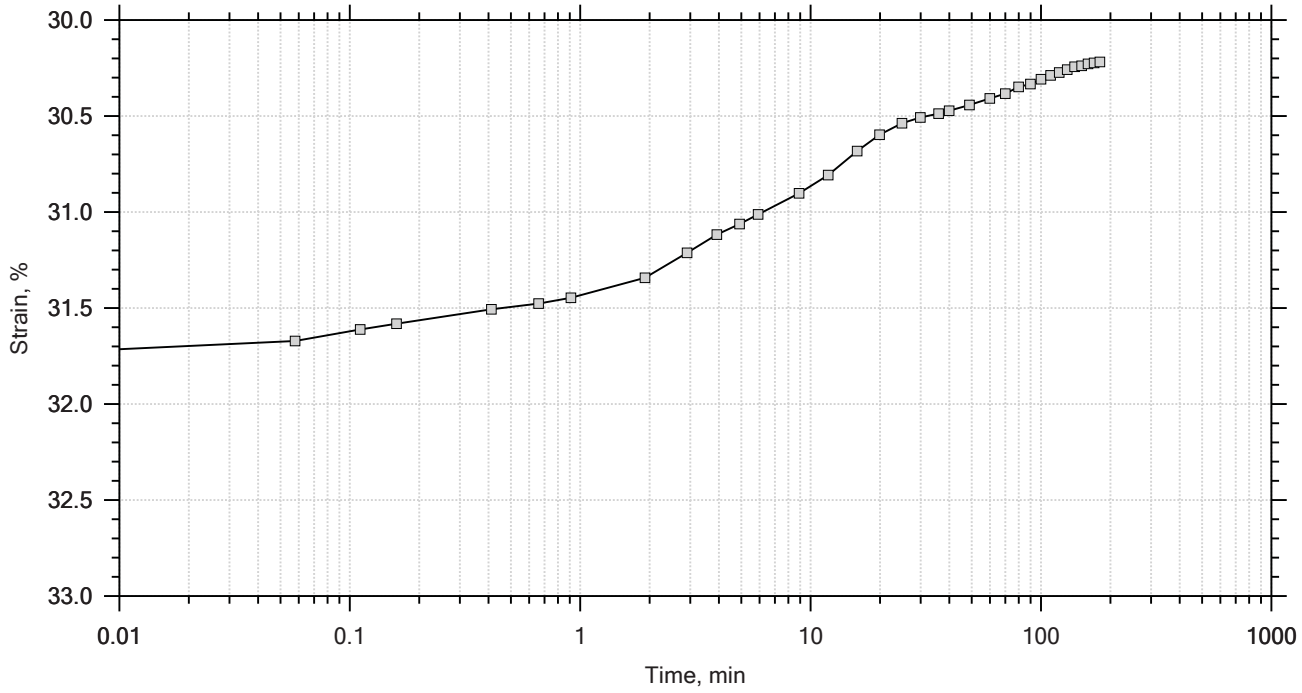


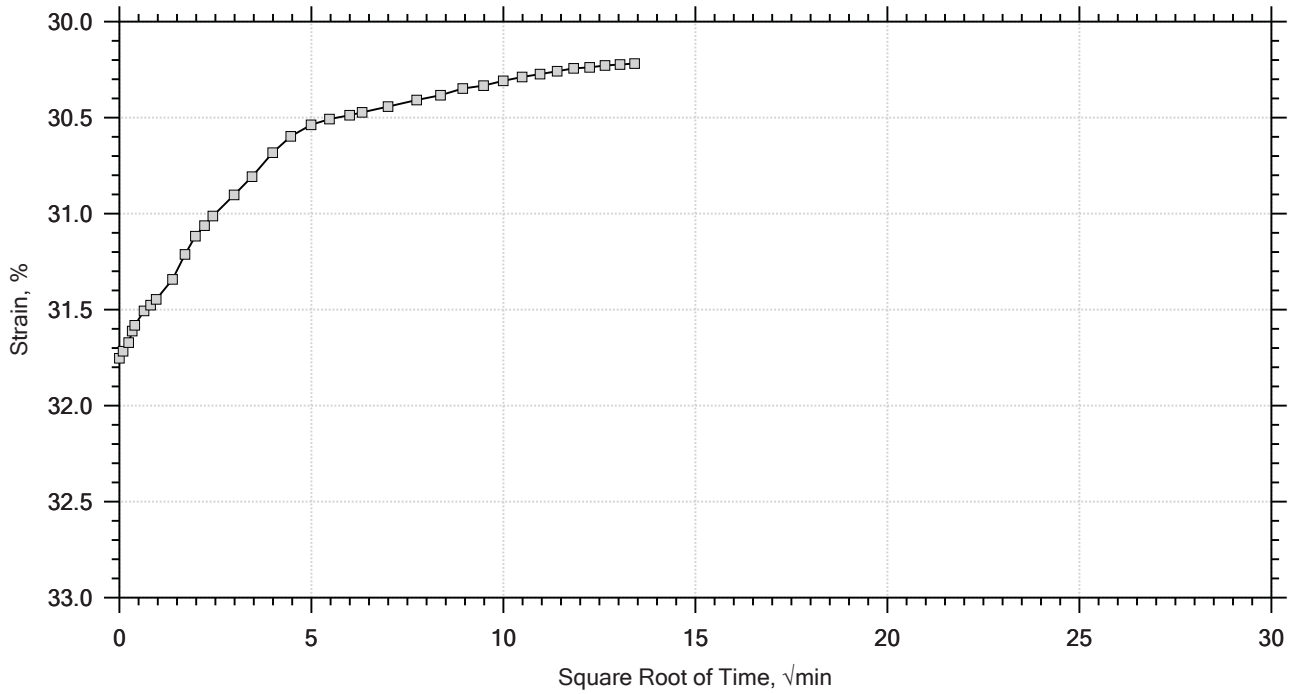


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
Test No.: IP-4	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System Q, Swell Pressure = 0.0659 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 11
Constant Load Step
Stress: 0.5 tsf

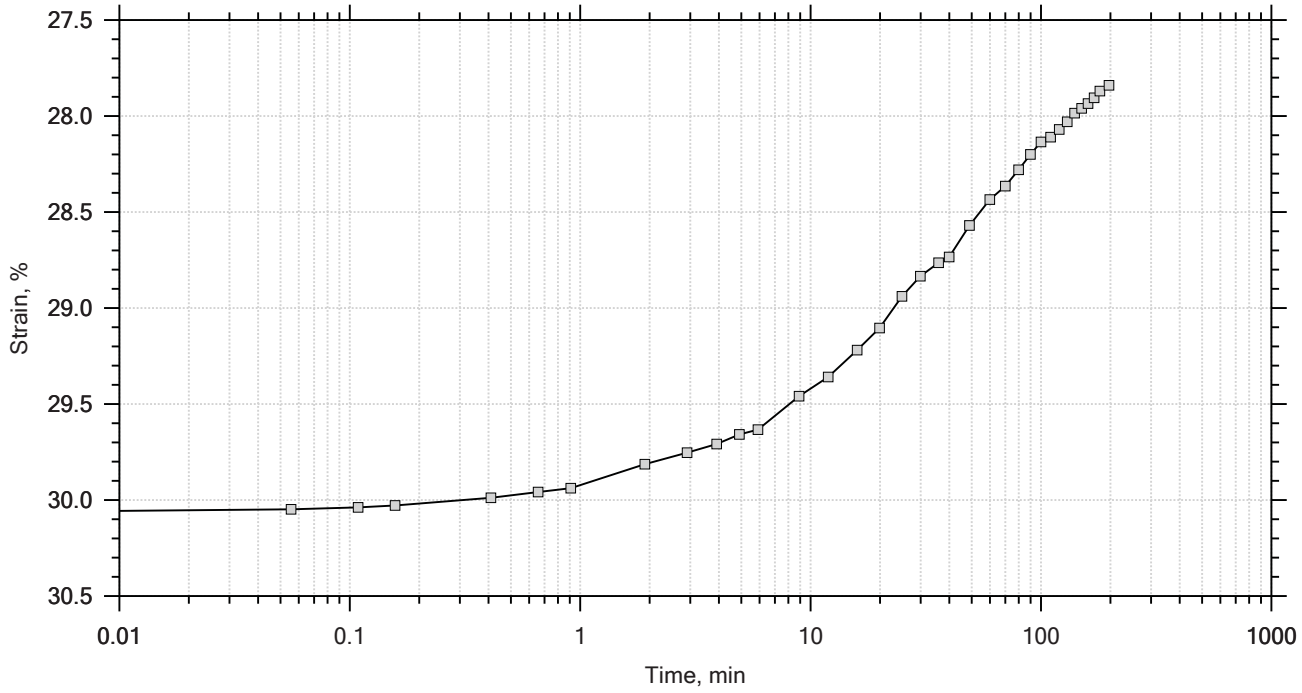


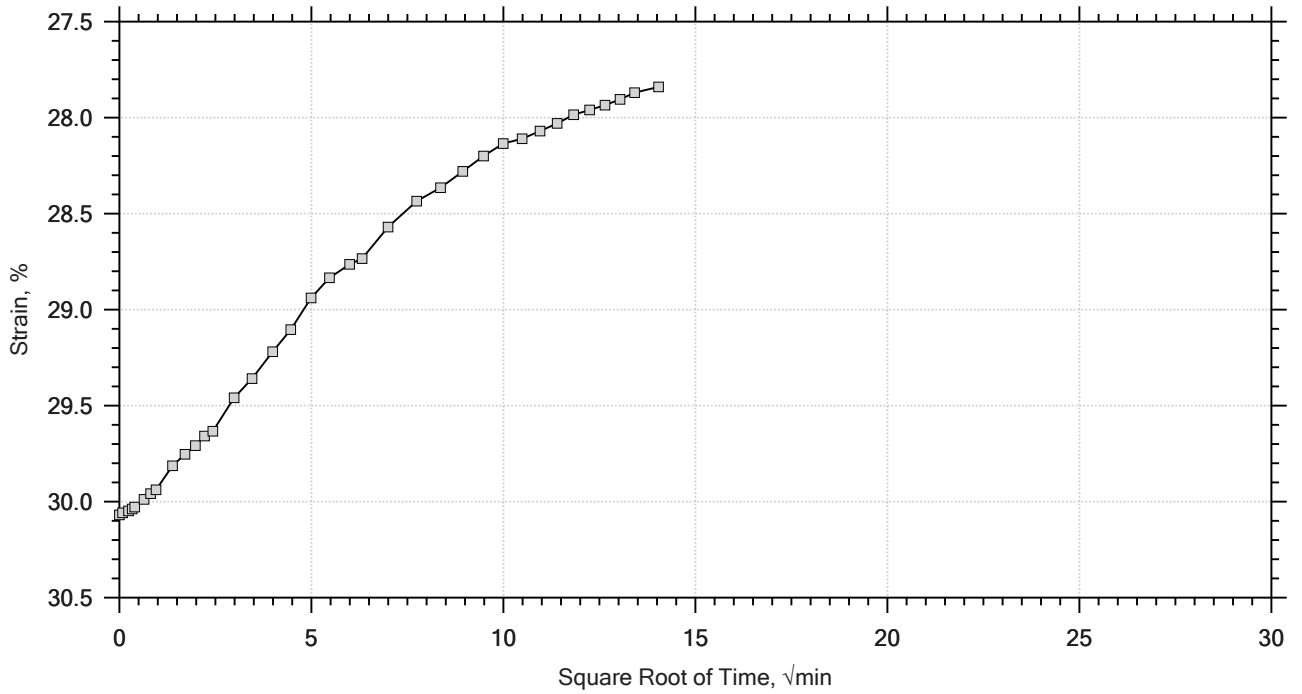


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
Test No.: IP-4	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System Q, Swell Pressure = 0.0659 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 11
Constant Load Step
Stress: 0.125 tsf





GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-4	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System Q, Swell Pressure = 0.0659 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.71	Liquid Limit: 81
Initial Height: 1.00 in	Initial Void Ratio: 1.60	Plastic Limit: 27
Final Height: 0.72 in	Final Void Ratio: 0.876	Plasticity Index: 54

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	C-2032	RING		C-1962
Mass Container, gm	8.52	111.14	111.14	8.44
Mass Container + Wet Soil, gm	220	243.16	222.03	119.18
Mass Container + Dry Soil, gm	127.93	194.93	194.93	92.12
Mass Dry Soil, gm	119.41	83.793	83.793	83.68
Water Content, %	77.10	57.55	32.34	32.34
Void Ratio	---	1.60	0.88	---
Degree of Saturation, %	---	97.45	100.00	---
Dry Unit Weight, pcf	---	65.031	90.12	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-2	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
	Test No.: IP-4	Sample Type: intact	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System Q, Swell Pressure = 0.0659 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Log of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/s	Mv 1/tsf	k ft/day	Ca %
1	0.0659	0.002648	1.59	0.265	0.000	0.00e+00	4.02e-02	0.00e+00	0.00e+00
2	0.125	0.008293	1.58	0.829	1.928	2.92e-06	9.54e-02	7.53e-04	0.00e+00
3	0.250	0.02363	1.54	2.36	1.789	3.08e-06	1.23e-01	1.02e-03	0.00e+00
4	0.500	0.04876	1.47	4.88	1.845	2.87e-06	1.01e-01	7.78e-04	0.00e+00
5	1.00	0.1129	1.31	11.3	7.718	6.24e-07	1.28e-01	2.16e-04	0.00e+00
6	2.00	0.1972	1.09	19.7	5.999	6.78e-07	8.43e-02	1.54e-04	0.00e+00
7	4.00	0.2734	0.889	27.3	5.715	5.83e-07	3.81e-02	5.99e-05	0.00e+00
8	8.00	0.3362	0.725	33.6	4.146	6.64e-07	1.57e-02	2.81e-05	0.00e+00
9	2.00	0.3213	0.764	32.1	1.793	1.43e-06	2.49e-03	9.62e-06	0.00e+00
10	0.500	0.3022	0.814	30.2	6.717	4.02e-07	1.27e-02	1.38e-05	0.00e+00
11	0.125	0.2784	0.876	27.8	0.000	0.00e+00	6.34e-02	0.00e+00	0.00e+00

GeoTesting EXPRESS

Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
Test No.: IP-4	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System Q, Swell Pressure = 0.0659 tsf		
Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Square Root of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv ft²/s	Mv 1/tsf	k ft/day
1	0.0659	0.002648	1.59	0.265	176.539	1.39e-07	4.02e-02	1.50e-05
2	0.125	0.008293	1.58	0.829	7.943	3.06e-06	9.54e-02	7.86e-04
3	0.250	0.02363	1.54	2.36	5.565	4.27e-06	1.23e-01	1.41e-03
4	0.500	0.04876	1.47	4.88	12.180	1.87e-06	1.01e-01	5.07e-04
5	1.00	0.1129	1.31	11.3	23.249	8.92e-07	1.28e-01	3.09e-04
6	2.00	0.1972	1.09	19.7	31.229	5.61e-07	8.43e-02	1.27e-04
7	4.00	0.2734	0.889	27.3	26.374	5.44e-07	3.81e-02	5.59e-05
8	8.00	0.3362	0.725	33.6	20.477	5.79e-07	1.57e-02	2.45e-05
9	2.00	0.3213	0.764	32.1	11.581	9.55e-07	2.49e-03	6.41e-06
10	0.500	0.3022	0.814	30.2	22.537	5.16e-07	1.27e-02	1.77e-05
11	0.125	0.2784	0.876	27.8	107.764	1.15e-07	6.34e-02	1.96e-05

GeoTesting EXPRESS

Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-2	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 18.0-20.0 ft
Test No.: IP-4	Sample Type: intact	Elevation: ---
Description: Moist, olive sandy clay		
Remarks: System Q, Swell Pressure = 0.0659 tsf		
Displacement at End of Increment		

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	---	Sample Type:	---	Tested By:	jbr
Sample ID:	---	Test Date:	08/30/16	Checked By:	mcm
Depth :	---	Test Id:	387124		

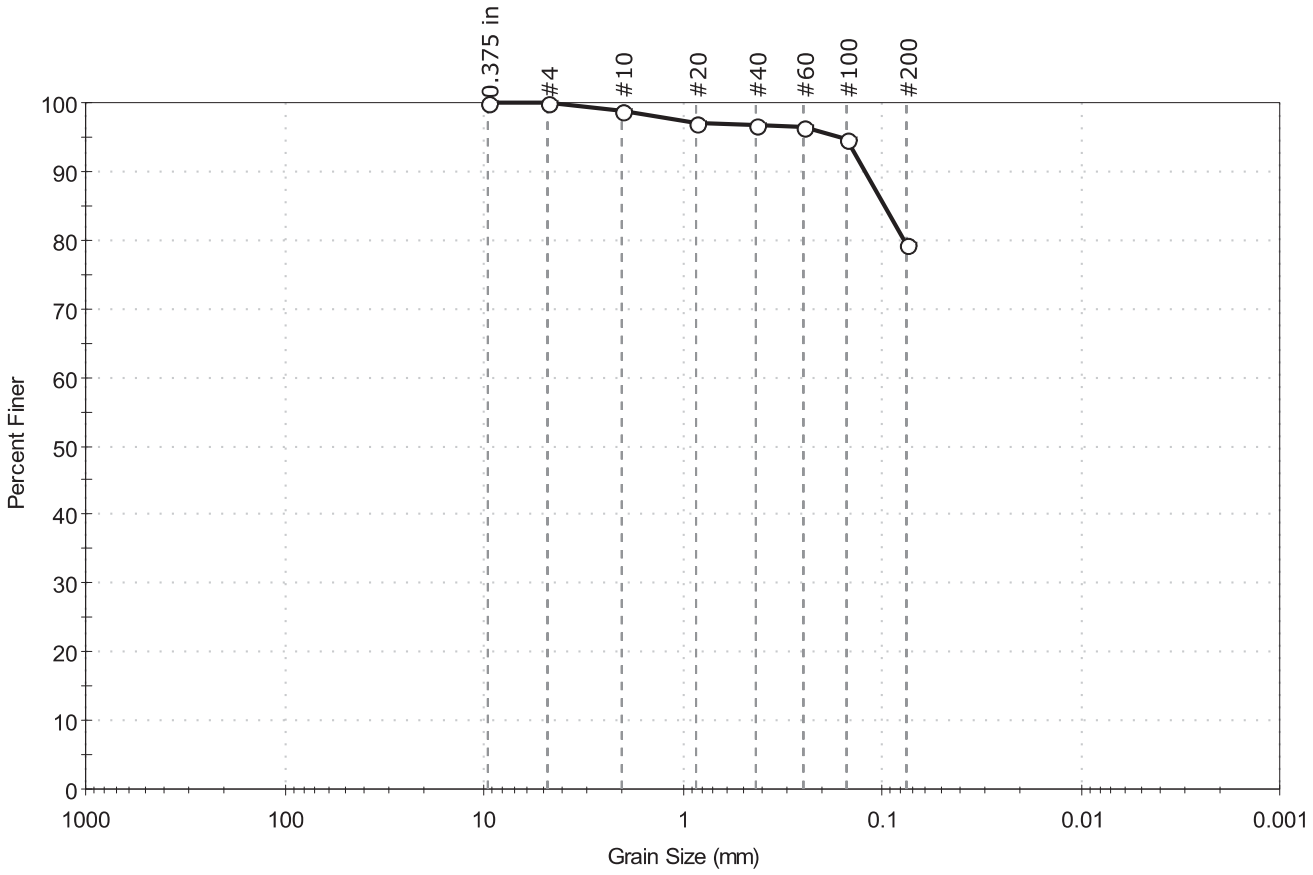
Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
AP-3	UD-1	25.0-27.0 ft	Moist, olive clay with sand	83.0

Notes: Temperature of Drying : 110º Celsius

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-3	Sample Type:	tube	Tested By:	jbr
Sample ID:	UD-1	Test Date:	08/29/16	Checked By:	mcm
Depth :	25.0-27.0 ft	Test Id:	387105		
Test Comment:	---				
Visual Description:	Moist, olive clay with sand				
Sample Comment:	Sample contains shells and shell fragments				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.1	20.4	79.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	99		
#20	0.85	97		
#40	0.42	97		
#60	0.25	96		
#100	0.15	95		
#200	0.075	79		

Coefficients

D_{85} =0.0966 mm	D_{30} =N/A
D_{60} =N/A	D_{15} =N/A
D_{50} =N/A	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM Fat clay with sand (CH)

AASHTO Clayey Soils (A-7-6 (50))

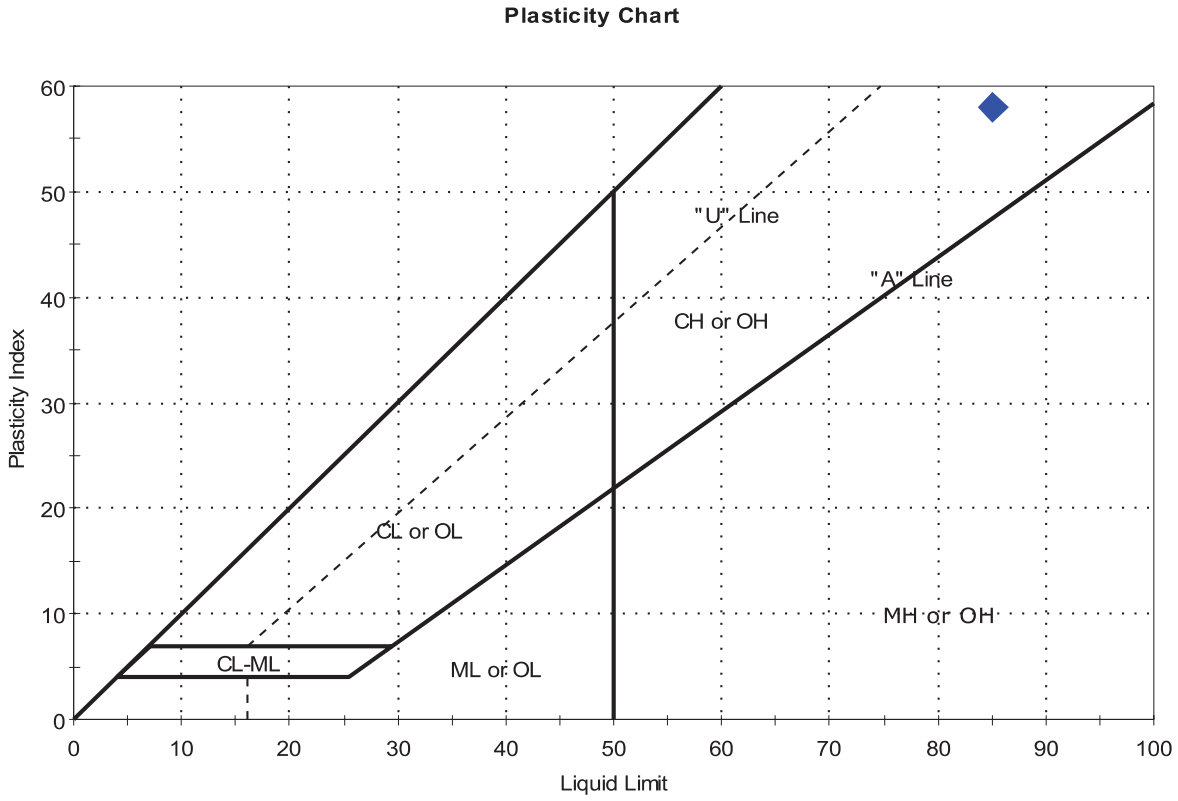
Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-3	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-1	Test Date:	08/31/16	Checked By:	mcm
Depth :	25.0-27.0 ft	Test Id:	387113		
Test Comment:	---				
Visual Description:	Moist, olive clay with sand				
Sample Comment:	Sample contains shells and shell fragments				

Atterberg Limits - ASTM D4318



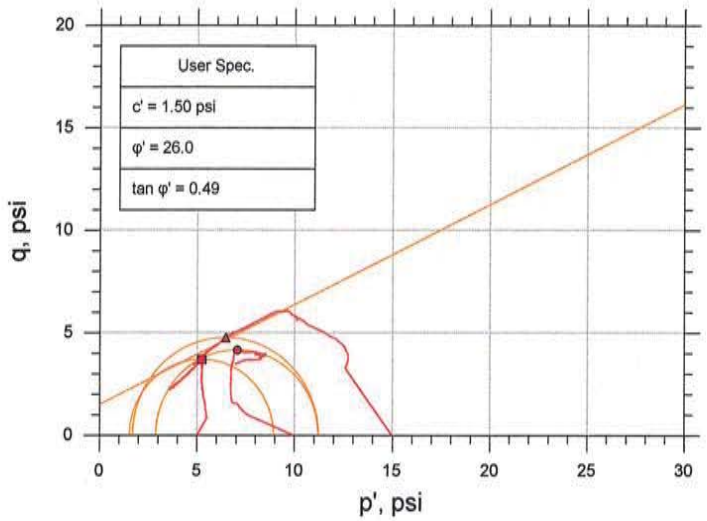
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	UD-1	AP-3	25.0-27.0 ft	83	85	27	58	1	Fat clay with sand (CH)

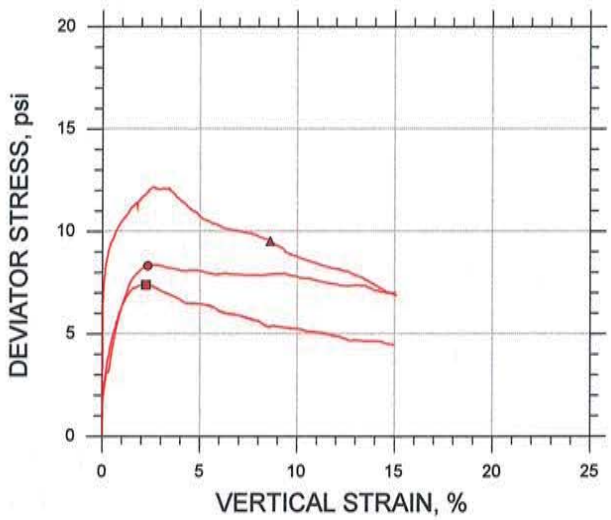
Sample Prepared using the WET method
3% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: NONE
Toughness: MEDIUM

GeoTesting EXPRESS

Client: F&ME Consultants	
Project Name: US-21 Replacement Bridge	
Project Location: ---	
Project Number: GTX-305005	
Tested By: md	Checked By: mcm
Boring ID: AP-3	
Preparation: intact	
Description: Moist, olive clay with sand	
Classification: Fat clay with sand	
Group Symbol: CH	
Liquid Limit: 85	Plastic Limit: 27
Plasticity Index: 58	Estimated Specific Gravity: 2.7

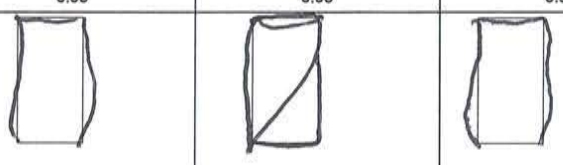
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		■	●	▲	
Sample ID		ST-1	ST-1	ST-1	
Depth, ft		25.0-27.0 ft	25.0.-27.0 ft	25.0-27.0 ft	
Test Number		CU-6-1	CU-6-2	CU-6-3	
Initial	Height, in	4.720	4.620	4.580	
	Diameter, in	2.030	2.030	2.030	
	Moisture Content (from Cuttings), %	81.4	86.2	82.4	
	Dry Density, pcf	51.4	50.4	50.0	
	Saturation (Wet Method), %	96.3	99.3	93.8	
	Void Ratio	2.28	2.35	2.37	
Before Shear	Moisture Content, %	82.9	85.0	69.4	
	Dry Density, pcf	52.0	51.1	58.7	
	Cross-sectional Area (Method A), in²	3.214	3.191	2.870	
	Saturation, %	100.0	100.0	100.0	
	Void Ratio	2.24	2.30	1.87	
	Back Pressure, psi	152.9	160.8	39.02	
Vertical Effective Consolidation Stress, psi		4.946	9.960	14.65	
Horizontal Effective Consolidation Stress, psi		4.999	9.962	14.97	
Vertical Strain after Consolidation, %		0.6778	0.08763	3.850	
Volumetric Strain after Consolidation, %		1.541	1.531	14.69	
Time to 50% Consolidation, min		45.56	16.81	297.6	
Shear Strength, psi		3.695	4.164	4.763	
Strain at Failure, %		2.24	2.33	8.61	
Strain Rate, %/min		0.01600	0.01600	0.01600	
Deviator Stress at Failure, psi		7.391	8.329	9.526	
Effective Minor Principal Stress at Failure, psi		1.536	2.888	1.698	
Effective Major Principal Stress at Failure, psi		8.927	11.22	11.22	
B-Value		0.95	0.95	0.96	

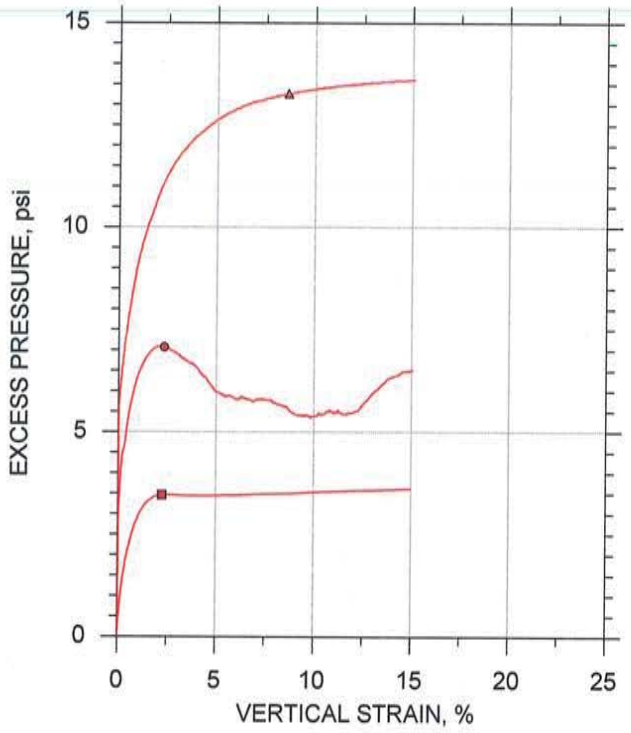
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

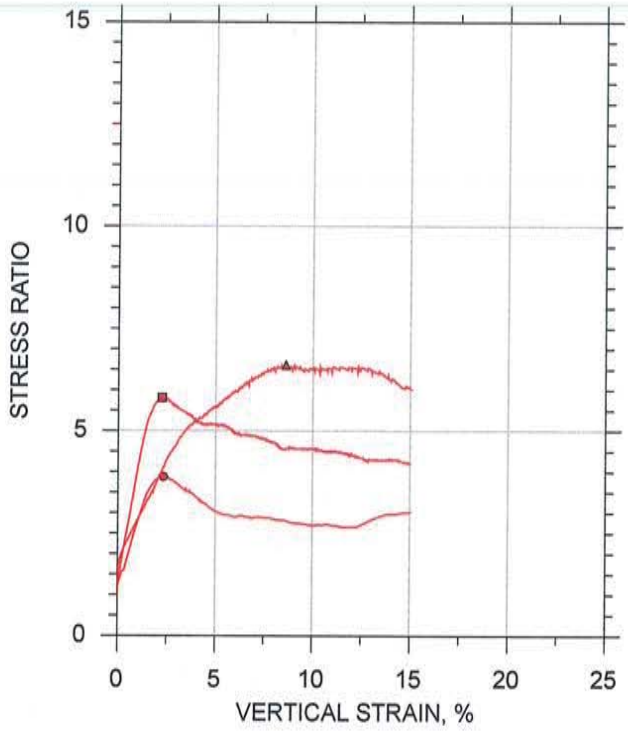


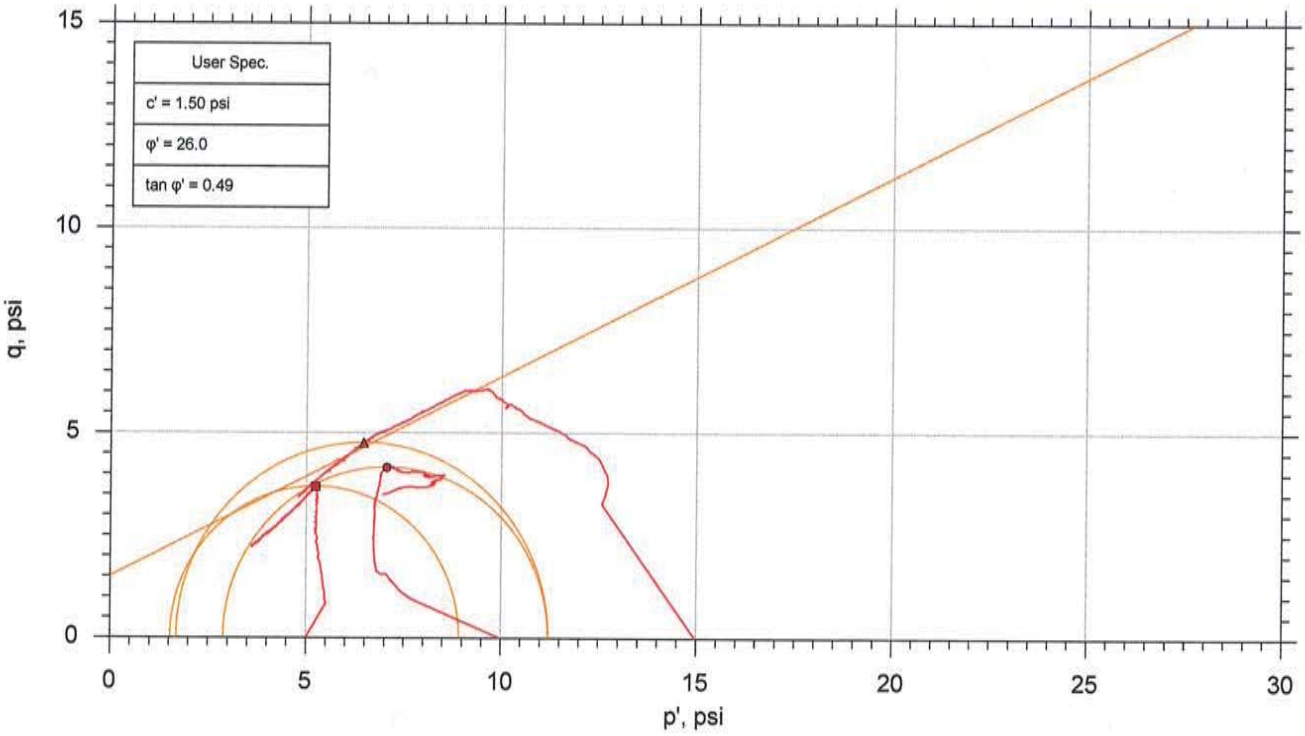
Remarks:

System X

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







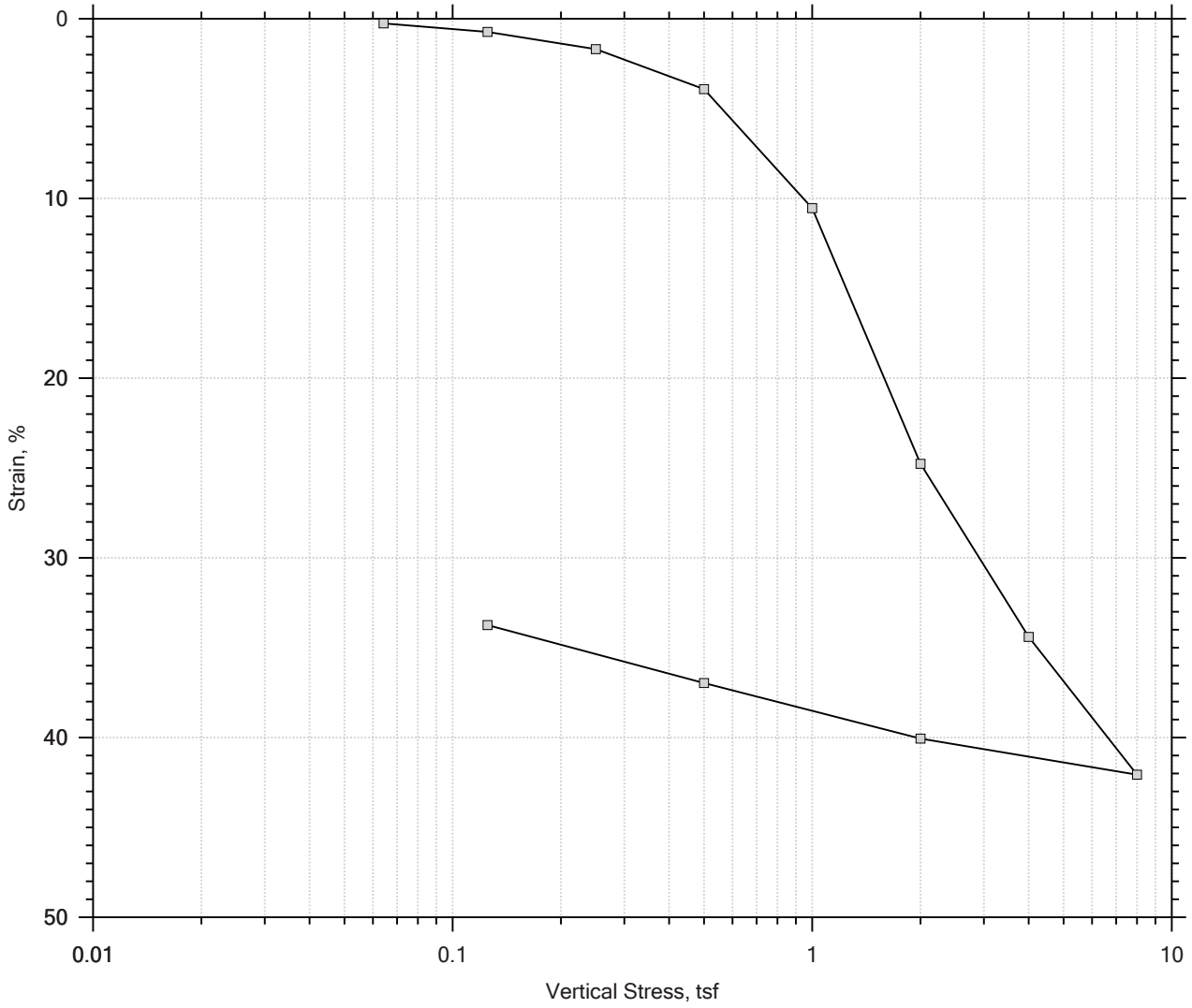
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	ST-1	CU-6-1	25.0-27.0 ft	md	8/25/16	mcm	9/7/16	305005-CU-6-1m.dat
●	ST-1	CU-6-2	25.0.-27.0 ft	md	08/26/16	mcm	9/7/16	305005-CU-6-2m.dat
▲	ST-1	CU-6-3	25.0-27.0 ft	md	08/25/16	mcm	9/7/16	305005-CU-6-3m.dat

GeoTesting EXPRESS

Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Sample Type: intact	
Description: Moist, olive clay with sand		
Remarks: System X		

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report

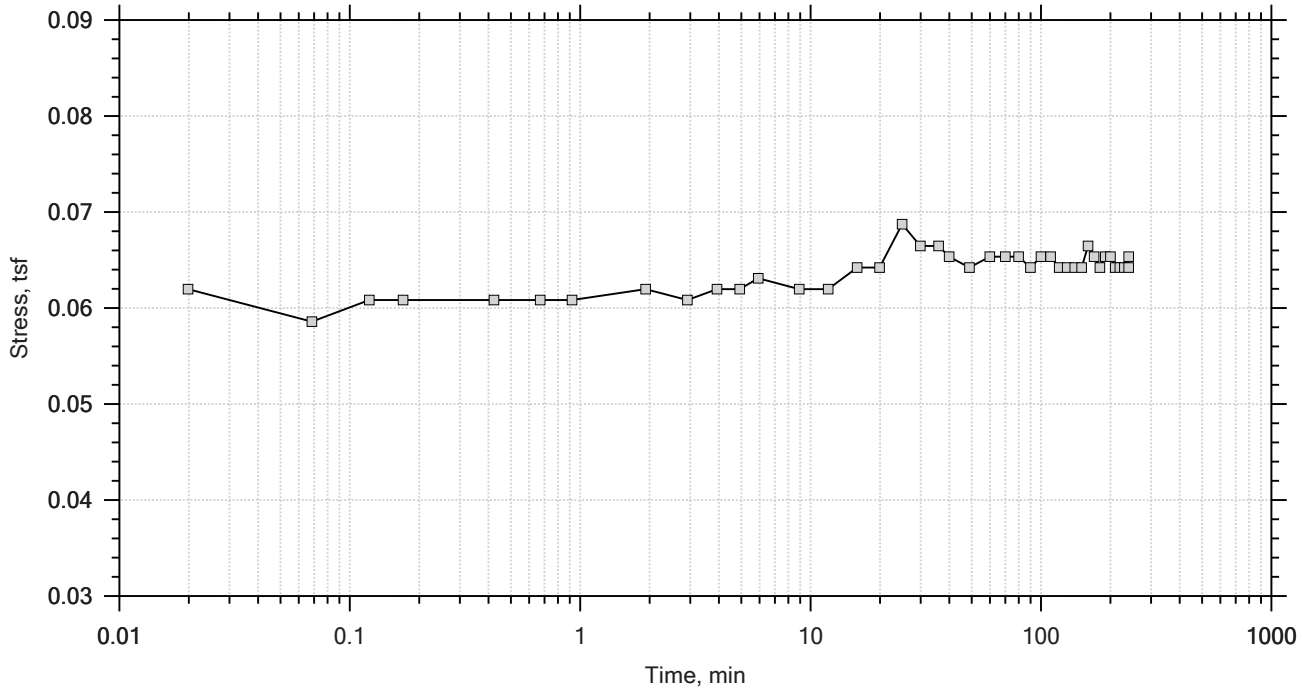


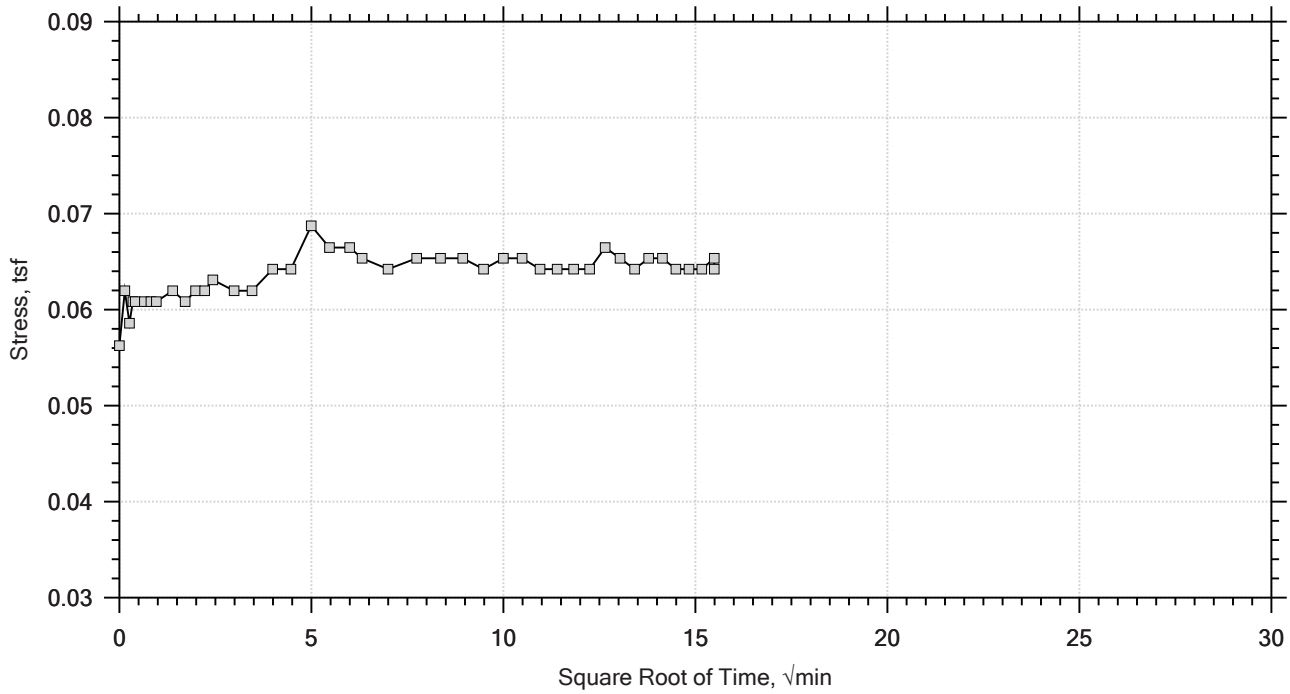
					Before Test	After Test
Current Vertical Effective Stress: ---				Water Content, %	105.01	58.58
Preconsolidation Stress: ---				Dry Unit Weight, pcf	43.621	65.827
Compression Ratio: ---				Saturation, %	98.28	100.00
Diameter: 2.5 in		Height: 1 in		Void Ratio	2.95	1.62
LL: 85	PL: 27	PI: 58	GS: 2.76			

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-3	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
	Test No.: IP-6	Sample Type: intact	Elevation: ---
	Description: Moist, grey clay		
	Remarks: System S, Swell Pressure =		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 11
Constant Volume Step
Stress: 0.0642 tsf

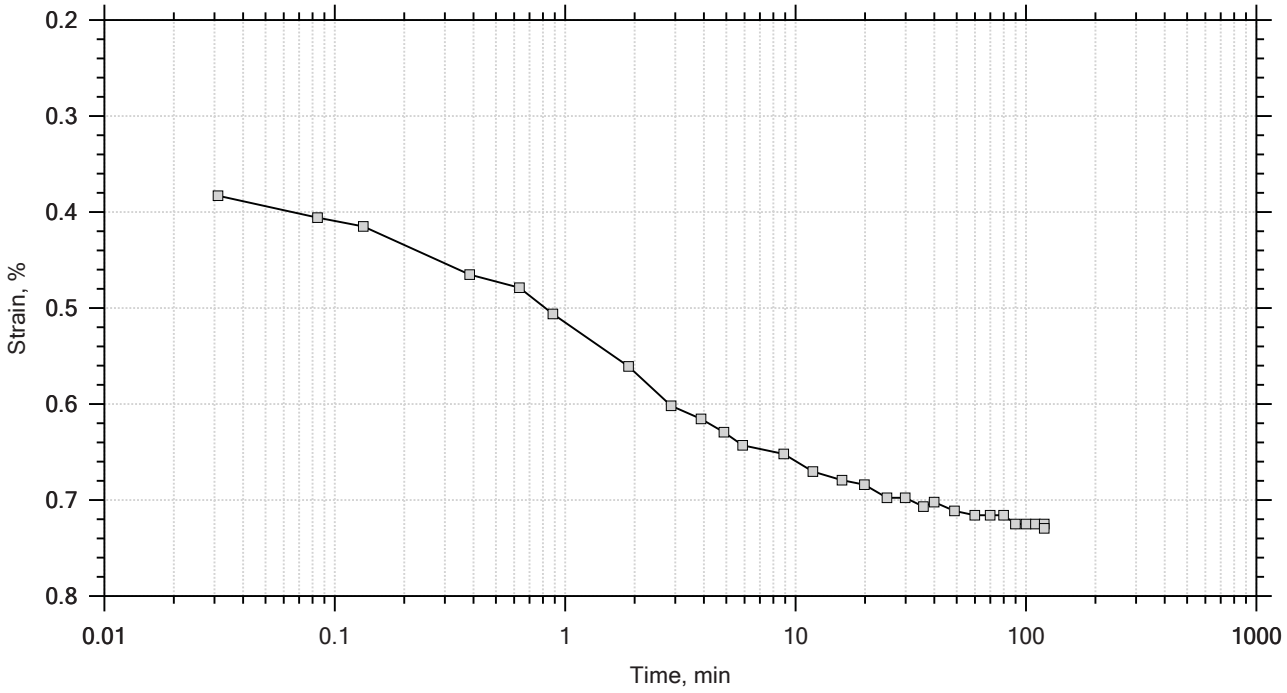


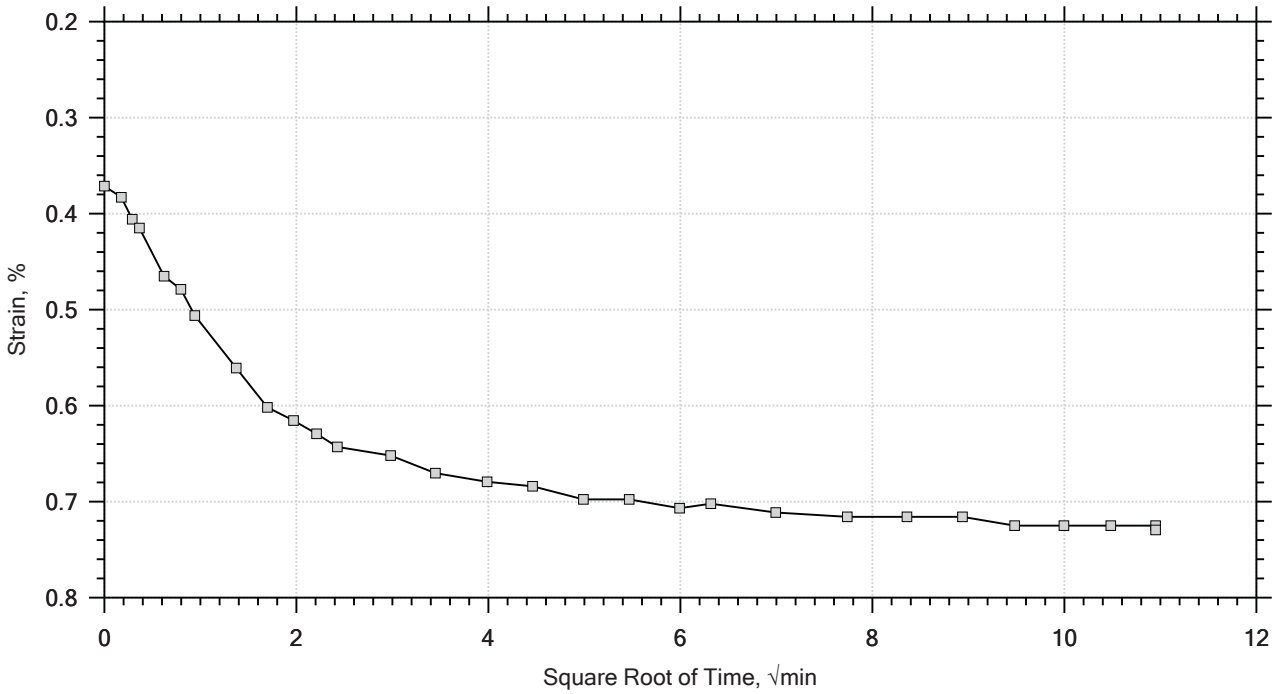


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
Test No.: IP-6	Sample Type: intact	Elevation: ---
Description: Moist, grey clay		
Remarks: System S, Swell Pressure =		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 11
Constant Load Step
Stress: 0.125 tsf

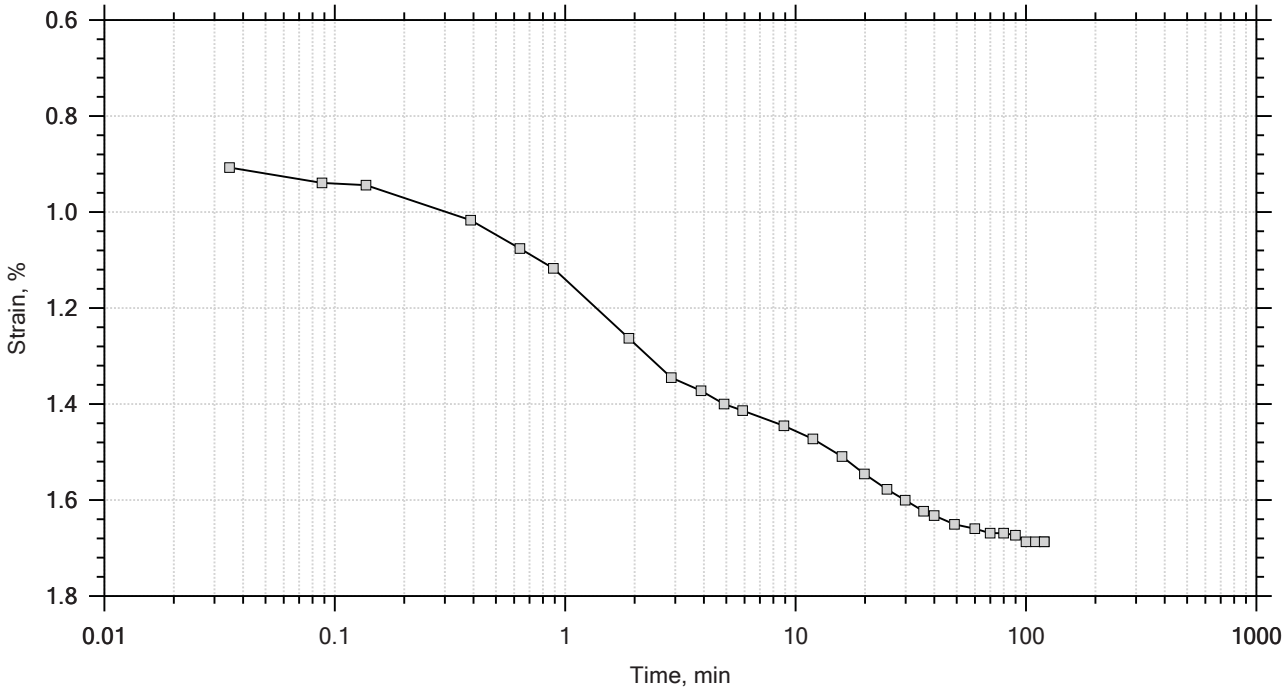


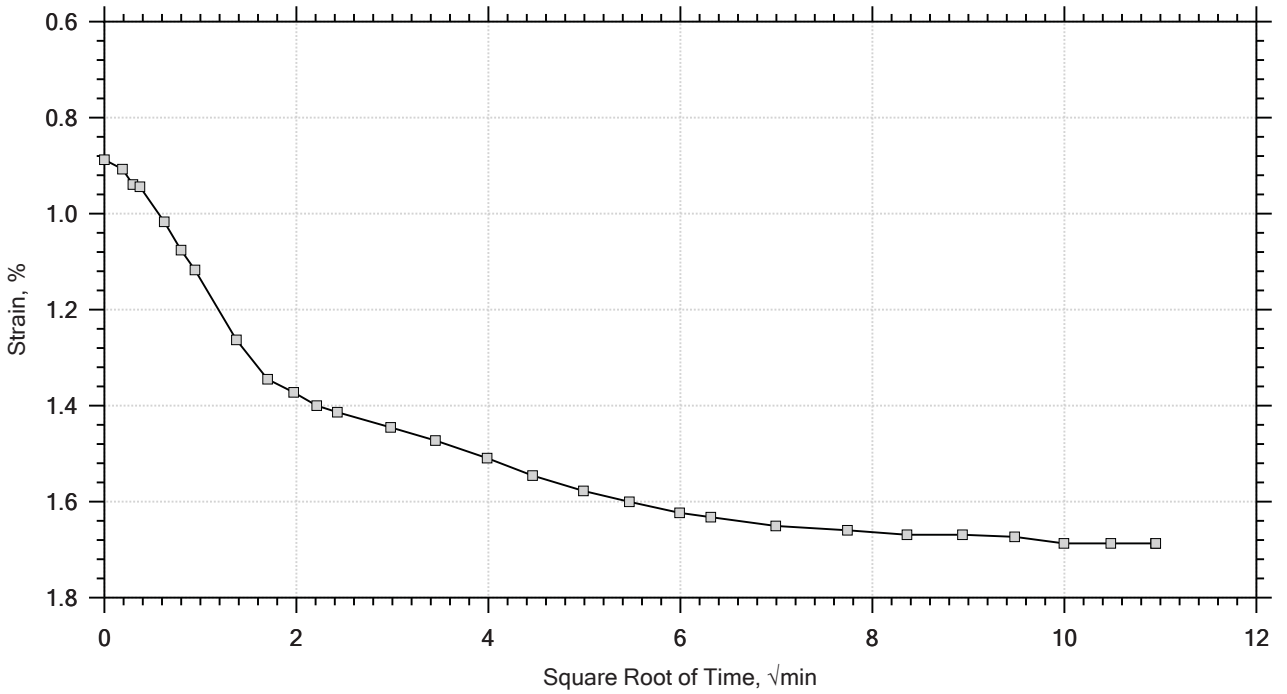


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-3	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
	Test No.: IP-6	Sample Type: intact	Elevation: ---
	Description: Moist, grey clay		
	Remarks: System S, Swell Pressure =		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 11
Constant Load Step
Stress: 0.25 tsf

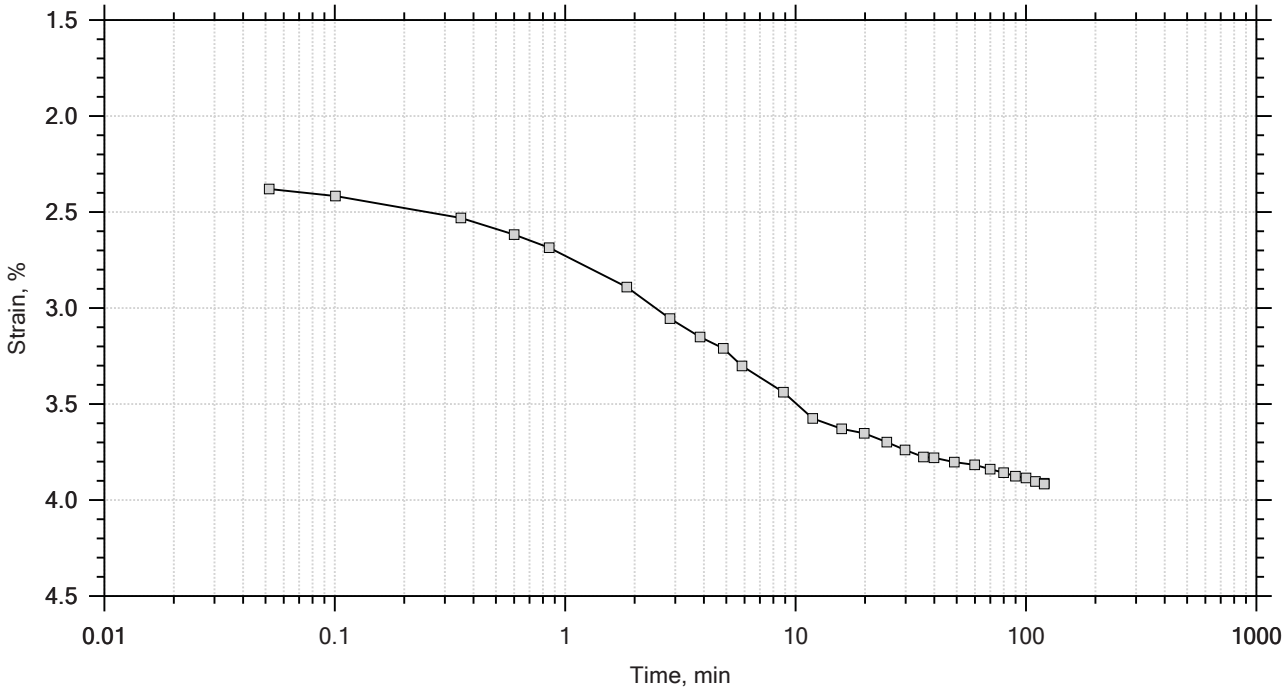


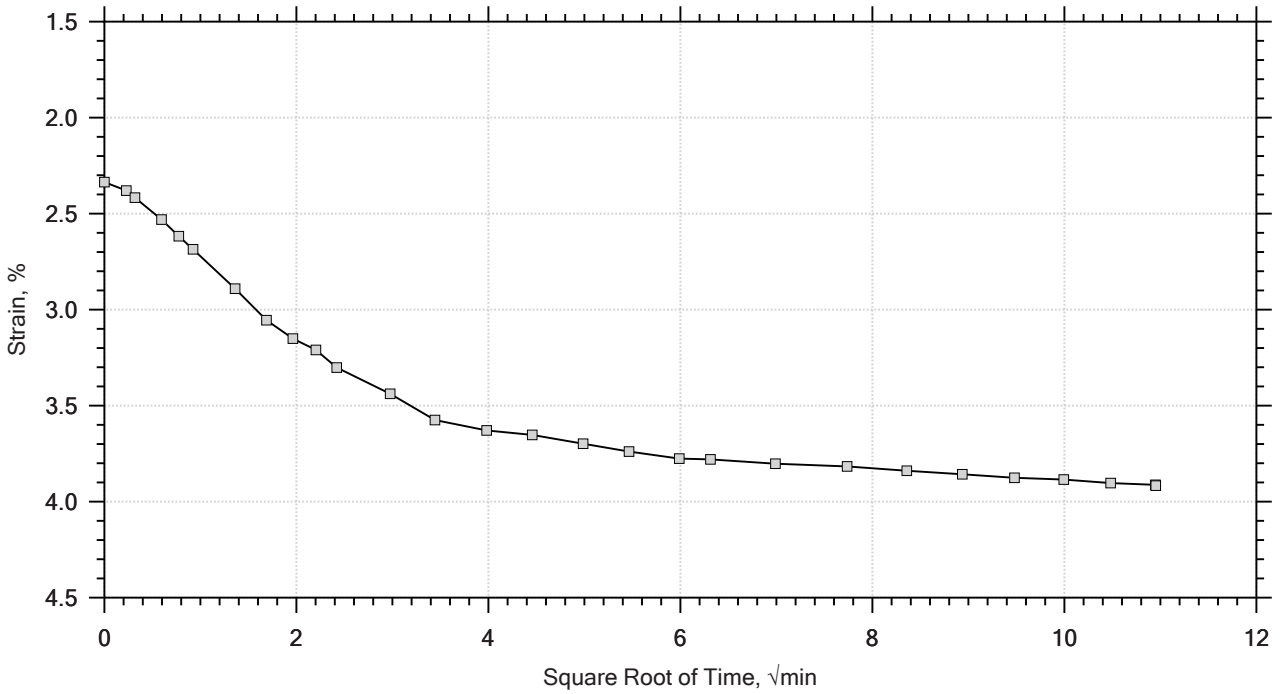


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
Test No.: IP-6	Sample Type: intact	Elevation: ---
Description: Moist, grey clay		
Remarks: System S, Swell Pressure =		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 11
Constant Load Step
Stress: 0.5 tsf

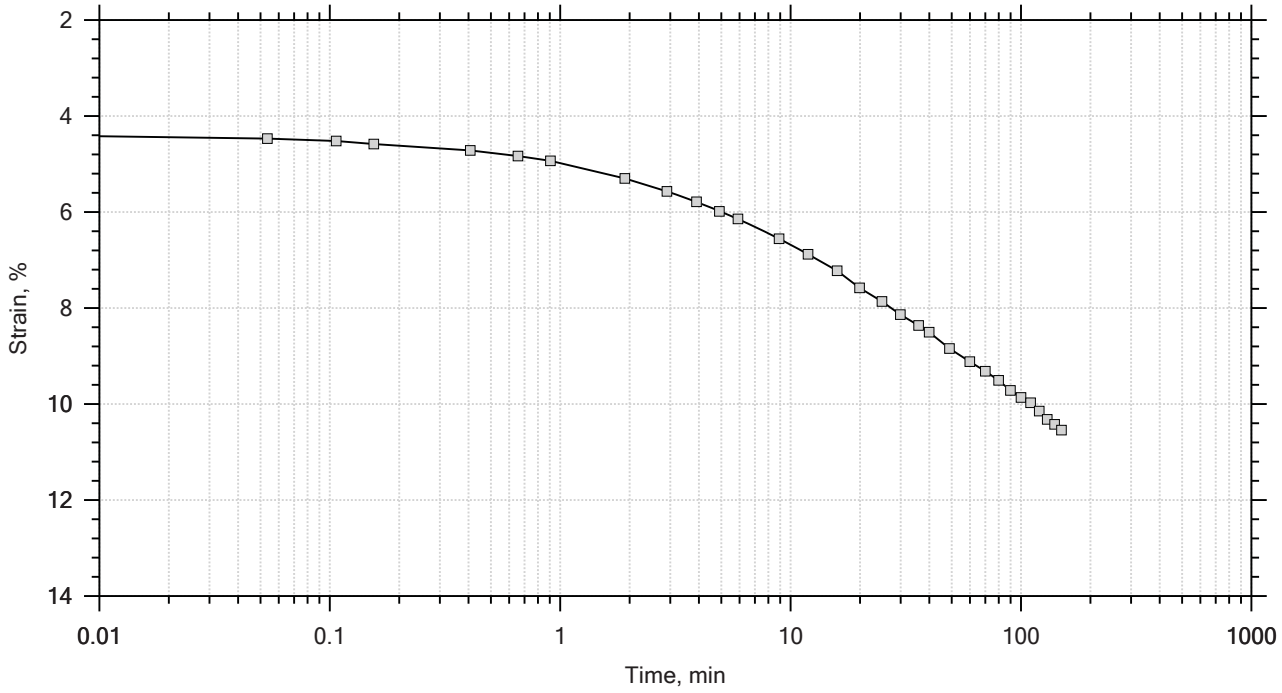


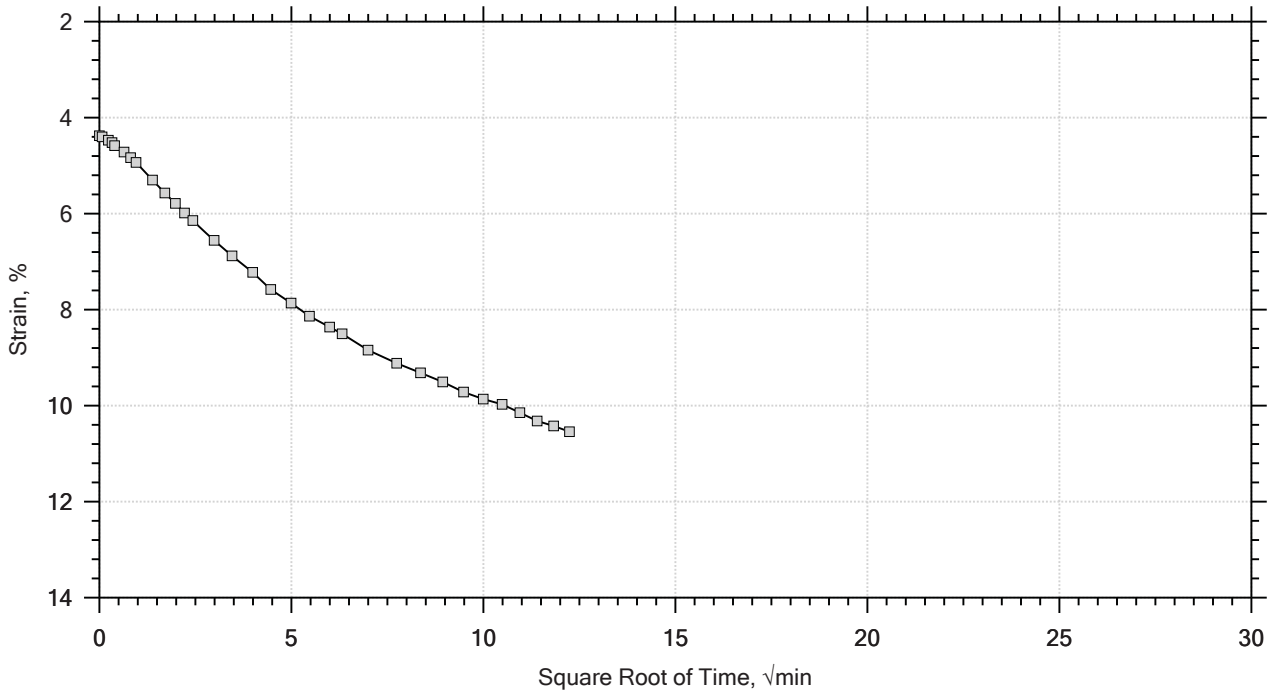


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
Test No.: IP-6	Sample Type: intact	Elevation: ---
Description: Moist, grey clay		
Remarks: System S, Swell Pressure =		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 11
Constant Load Step
Stress: 1 tsf

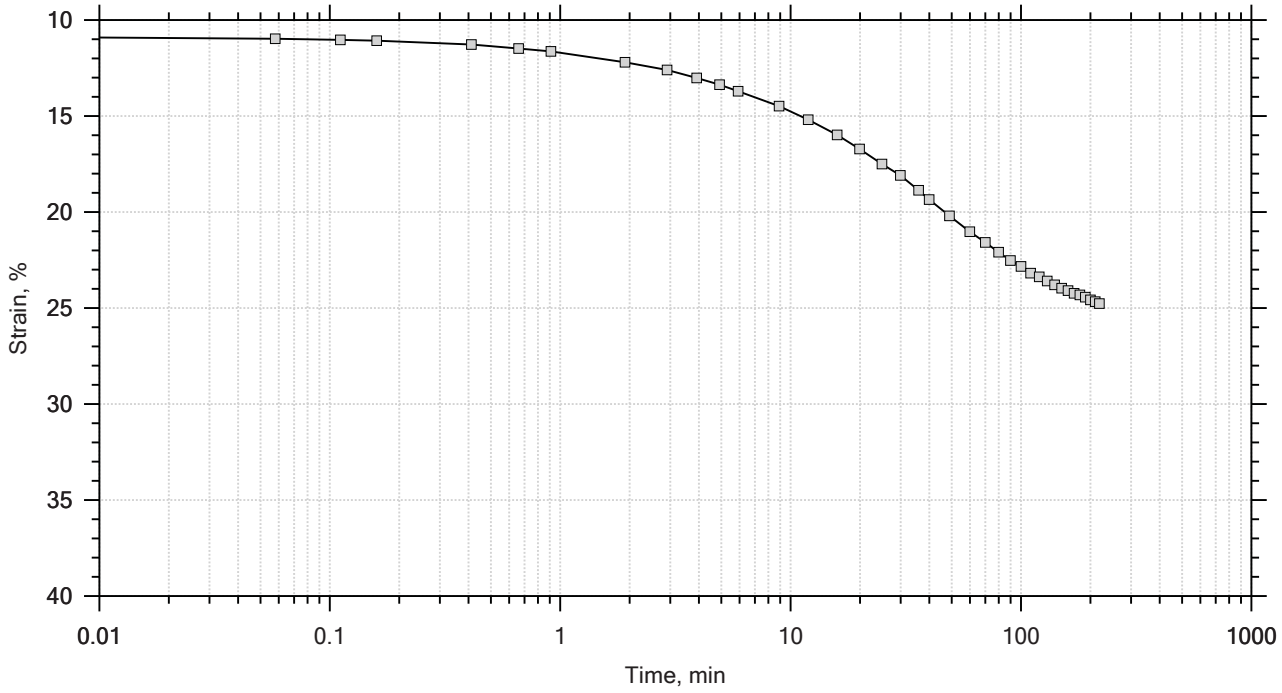


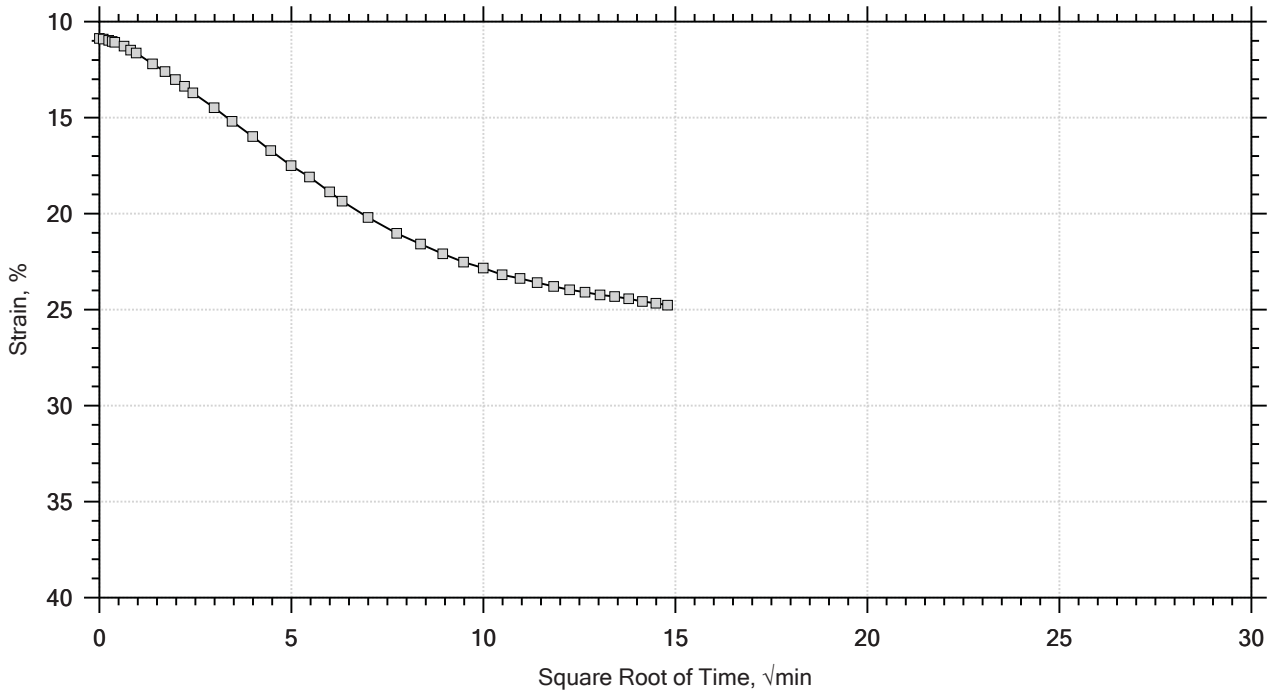


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-3	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
	Test No.: IP-6	Sample Type: intact	Elevation: ---
	Description: Moist, grey clay		
	Remarks: System S, Swell Pressure =		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 11
Constant Load Step
Stress: 2 tsf

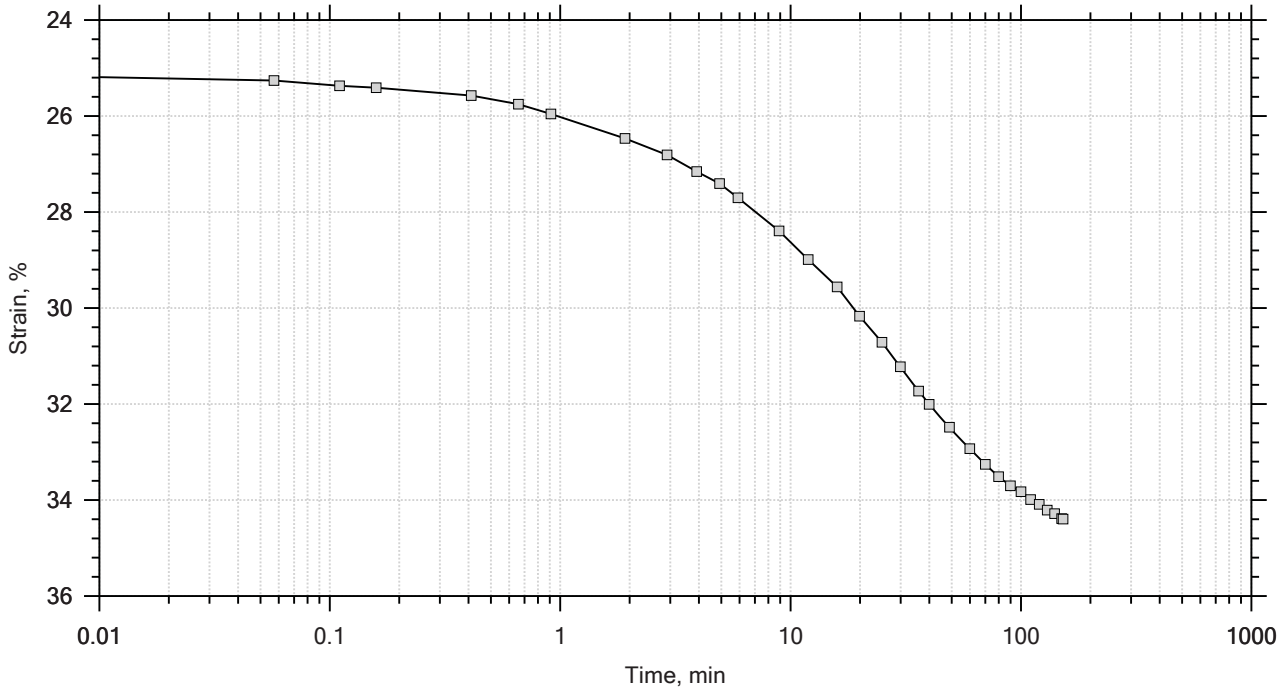


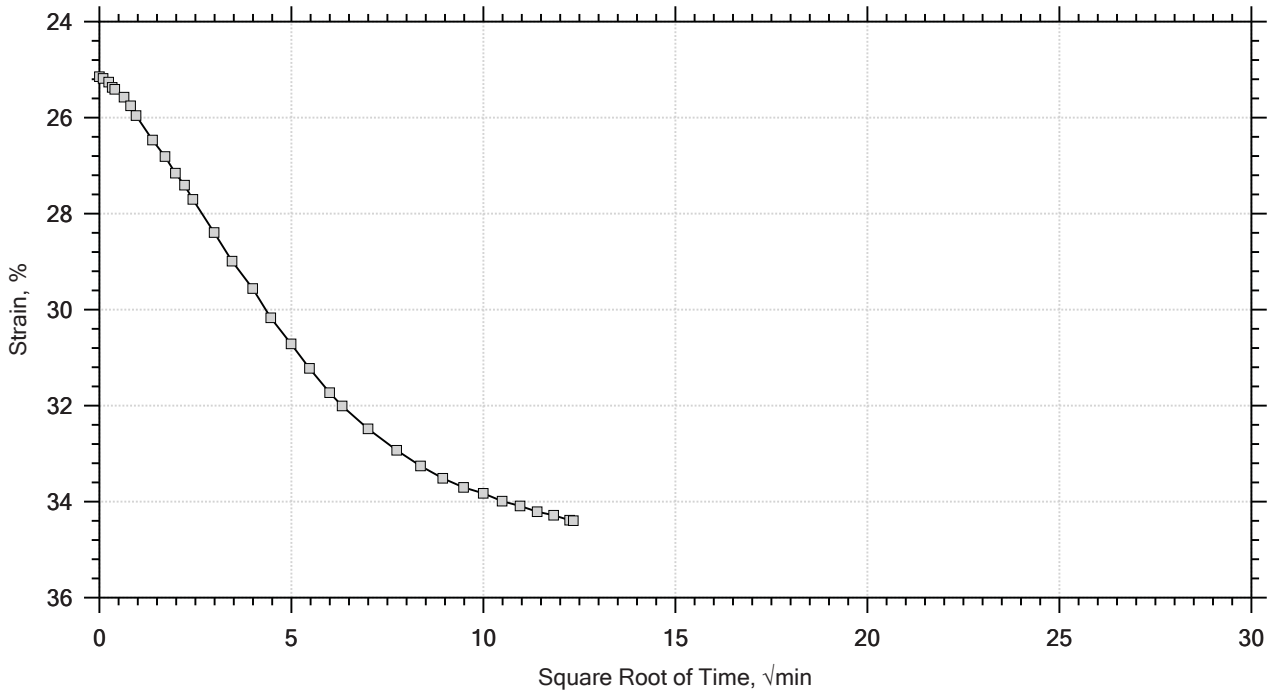


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
Test No.: IP-6	Sample Type: intact	Elevation: ---
Description: Moist, grey clay		
Remarks: System S, Swell Pressure =		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 11
Constant Load Step
Stress: 4 tsf

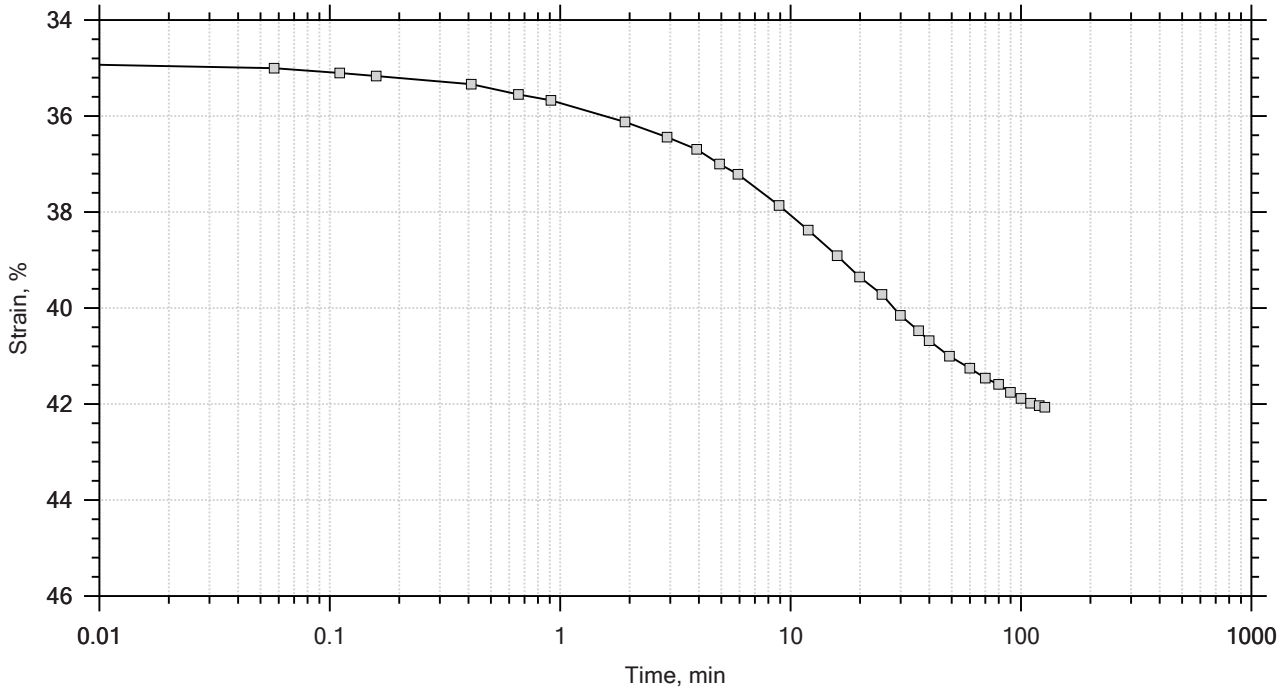


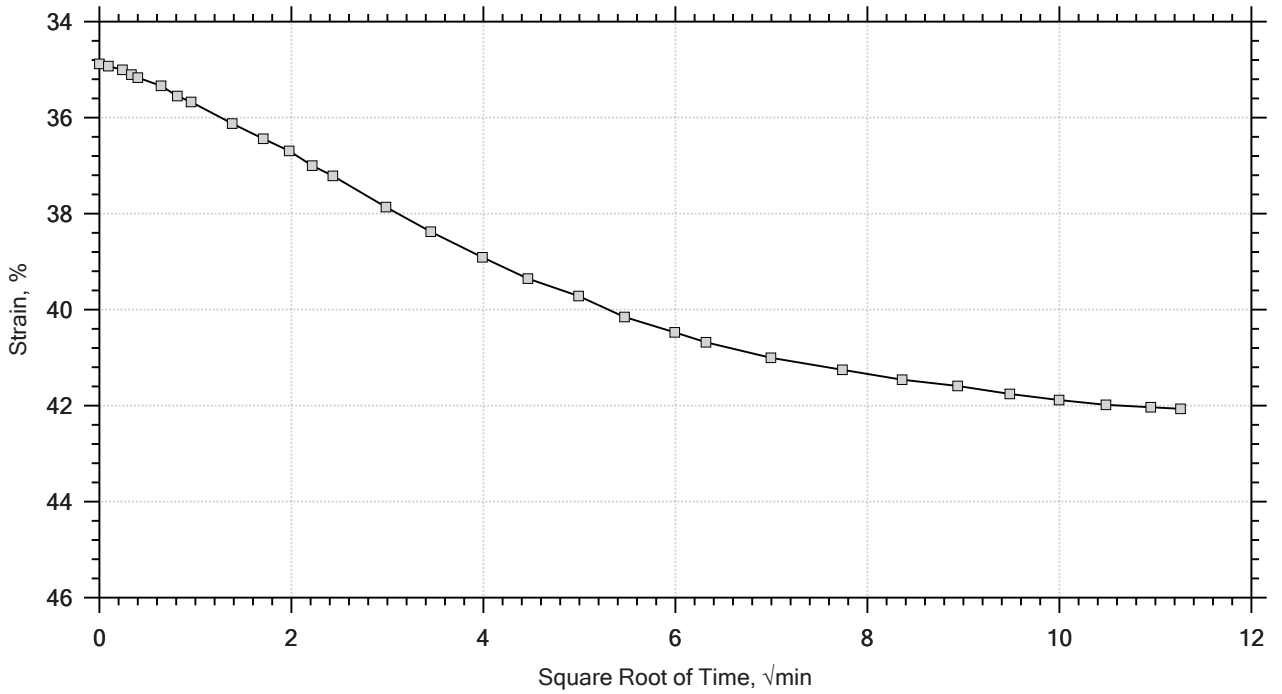


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
Test No.: IP-6	Sample Type: intact	Elevation: ---
Description: Moist, grey clay		
Remarks: System S, Swell Pressure =		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 11
Constant Load Step
Stress: 8 tsf

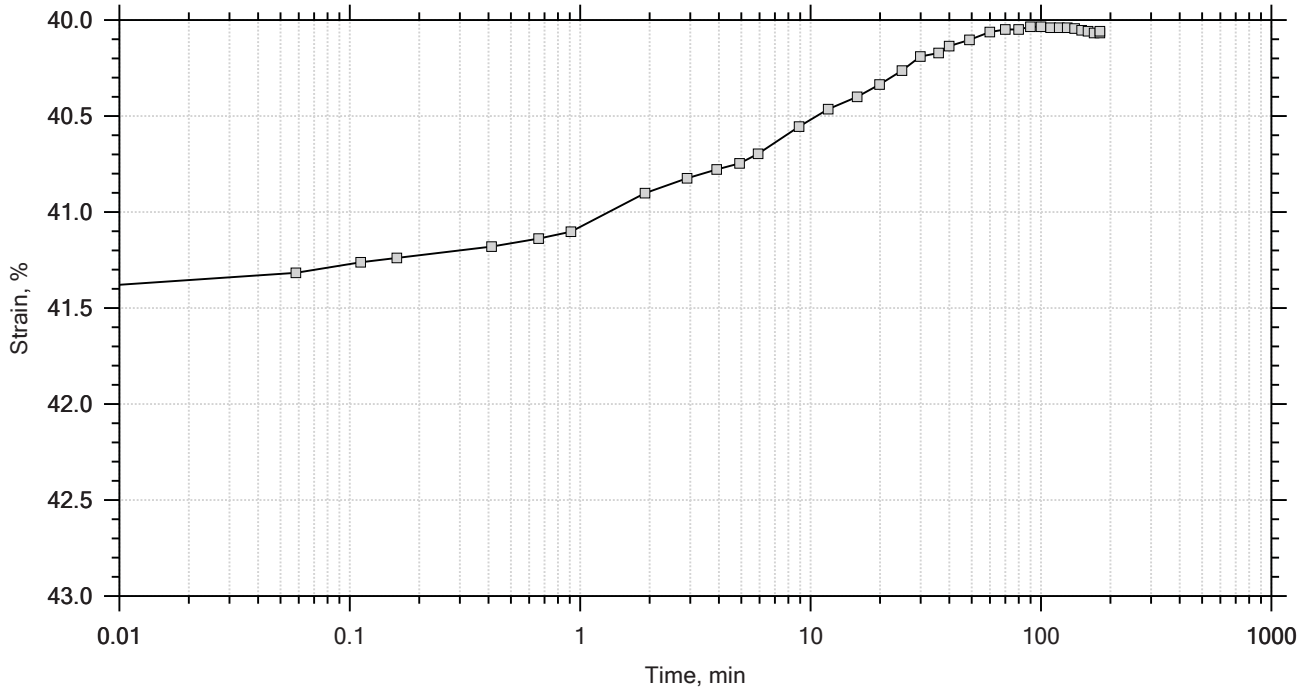


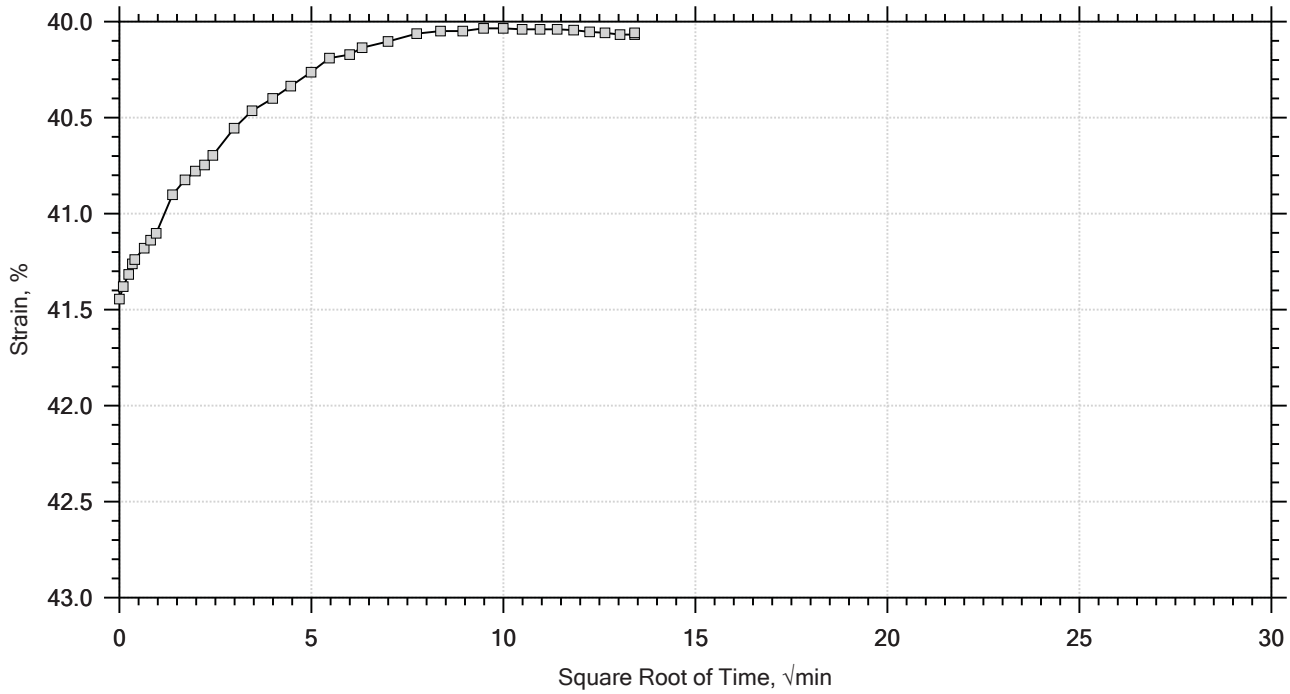


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-3	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
	Test No.: IP-6	Sample Type: intact	Elevation: ---
	Description: Moist, grey clay		
	Remarks: System S, Swell Pressure =		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 11
Constant Load Step
Stress: 2 tsf

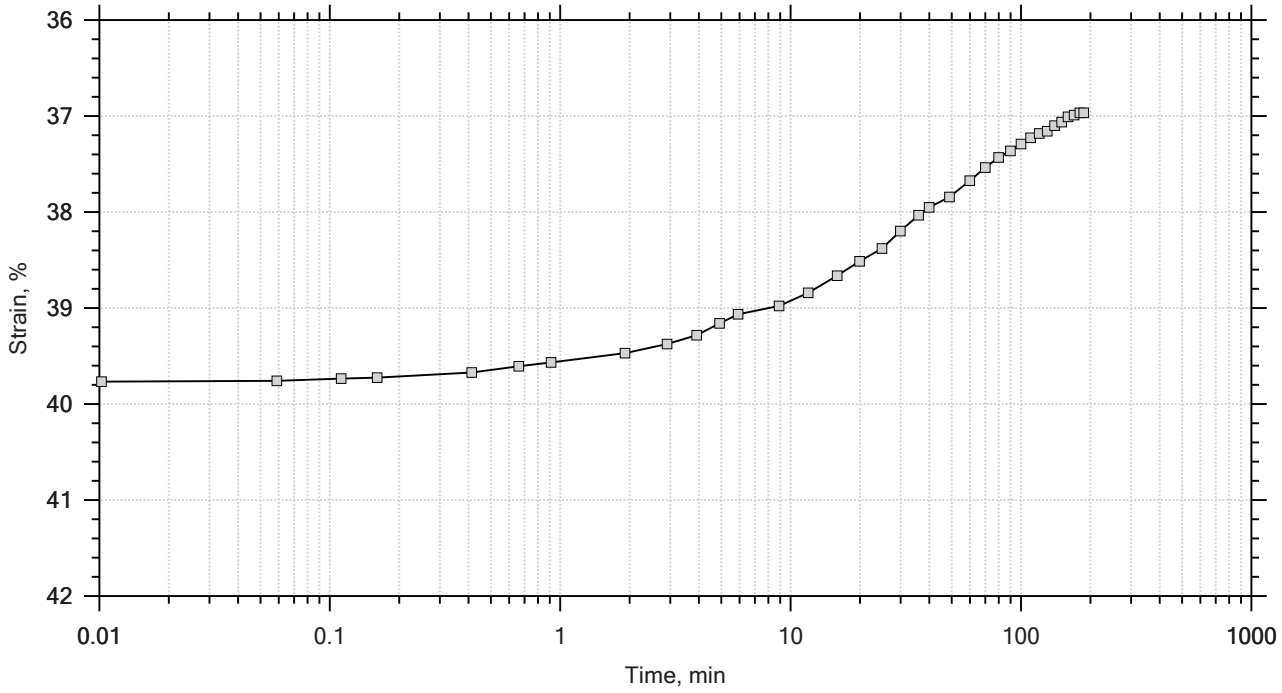


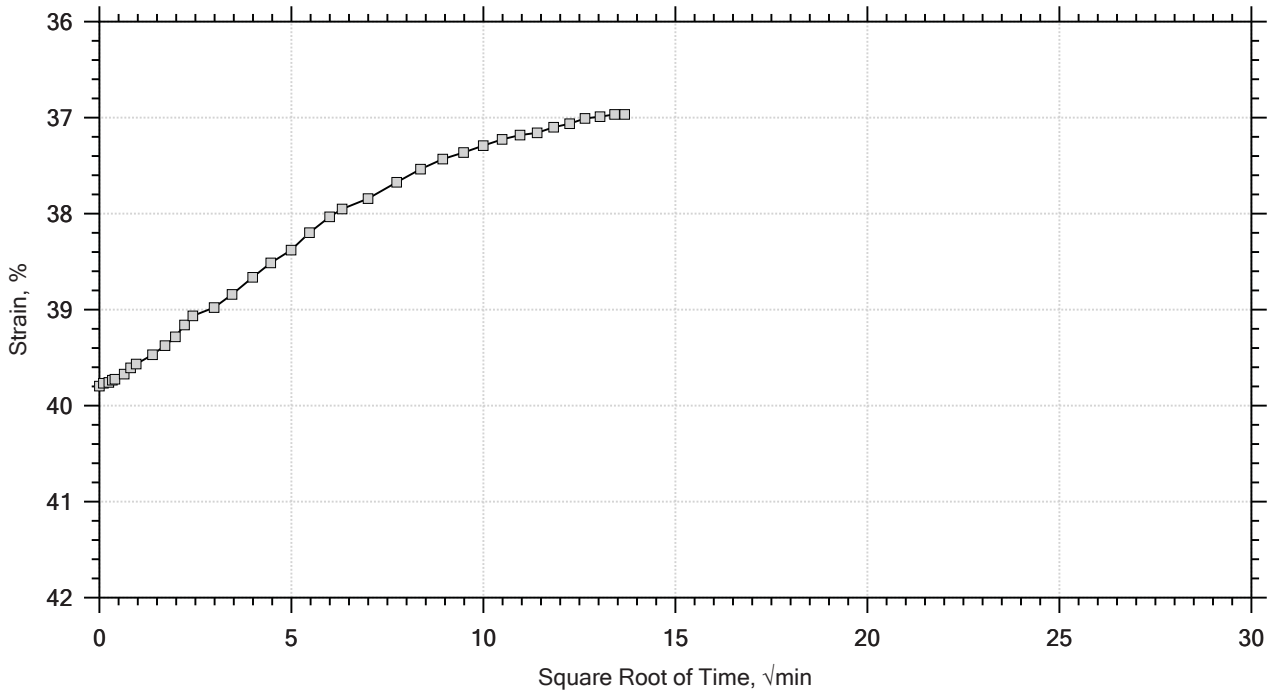


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
Test No.: IP-6	Sample Type: intact	Elevation: ---
Description: Moist, grey clay		
Remarks: System S, Swell Pressure =		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 11
Constant Load Step
Stress: 0.5 tsf

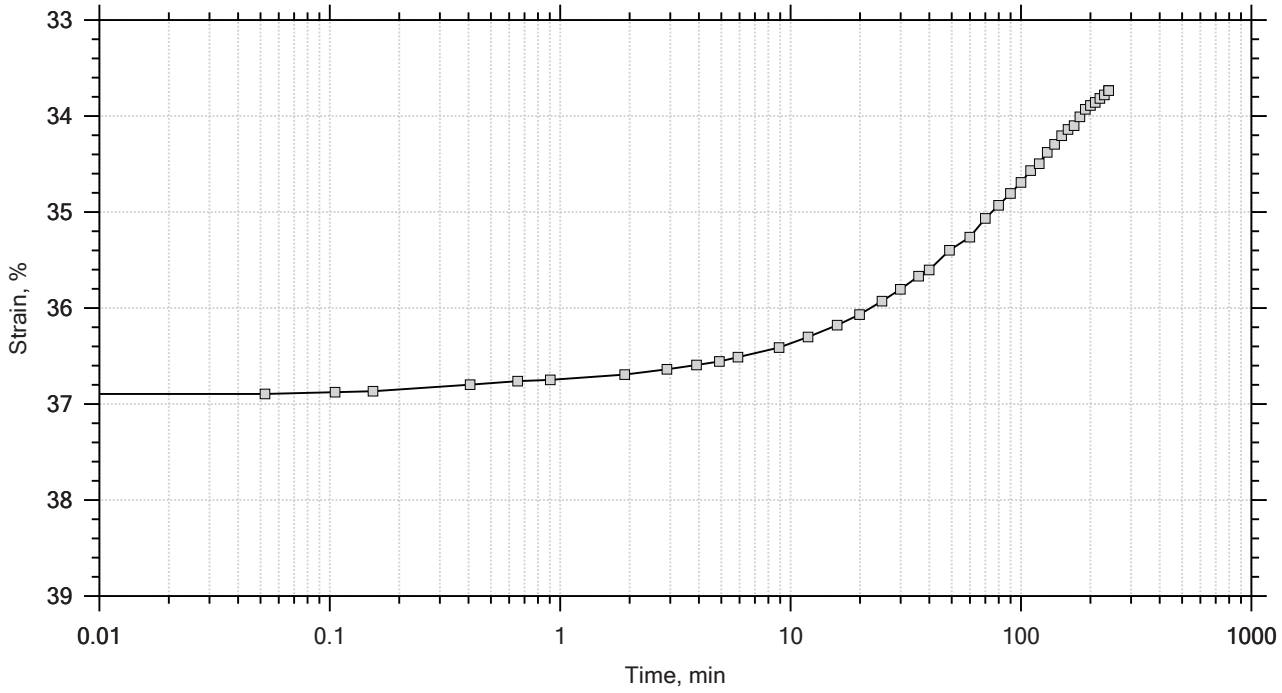


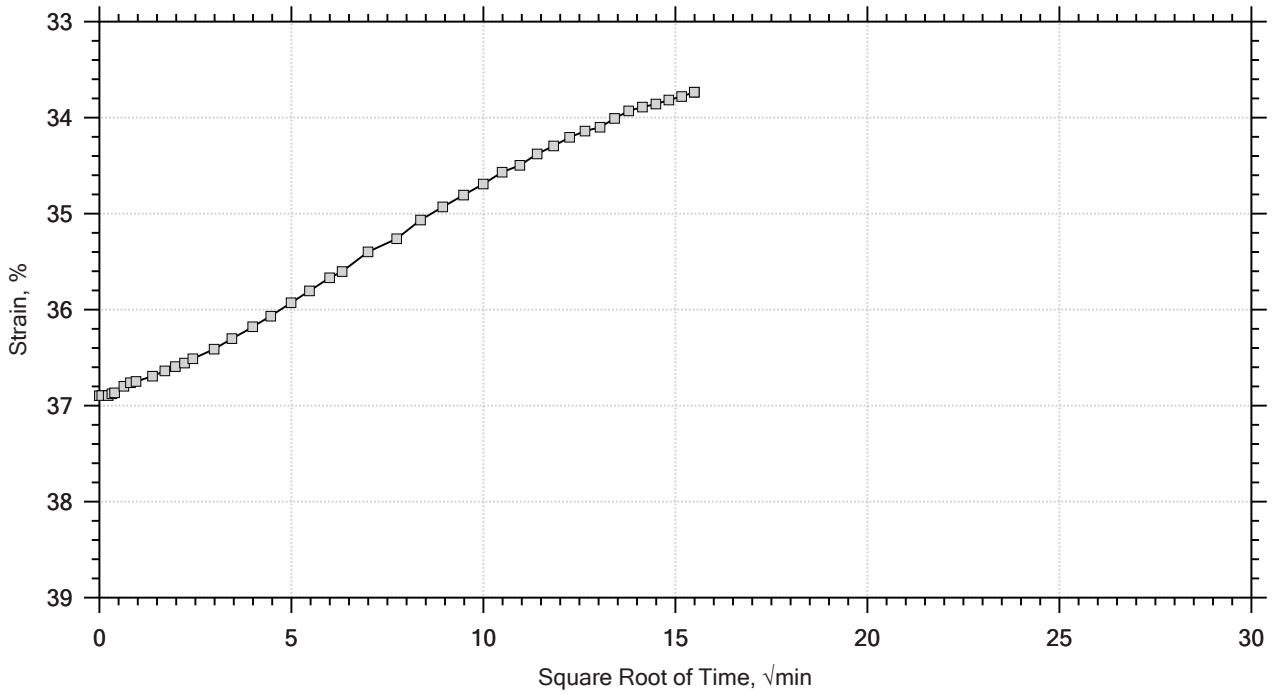


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
Test No.: IP-6	Sample Type: intact	Elevation: ---
Description: Moist, grey clay		
Remarks: System S, Swell Pressure =		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 11
Constant Load Step
Stress: 0.125 tsf





Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
Test No.: IP-6	Sample Type: intact	Elevation: ---
Description: Moist, grey clay		
Remarks: System S, Swell Pressure =		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.76	Liquid Limit: 85
Initial Height: 1.00 in	Initial Void Ratio: 2.95	Plastic Limit: 27
Final Height: 0.66 in	Final Void Ratio: 1.62	Plasticity Index: 58

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	C-1757	RING		C-1676
Mass Container, gm	8.34	108.89	108.89	8.64
Mass Container + Wet Soil, gm	169.13	224.12	198.02	97.49
Mass Container + Dry Soil, gm	93.83	165.1	165.1	64.67
Mass Dry Soil, gm	85.49	56.207	56.207	56.03
Water Content, %	88.08	105.01	58.58	58.58
Void Ratio	---	2.95	1.62	---
Degree of Saturation, %	---	98.28	100.00	---
Dry Unit Weight, pcf	---	43.621	65.827	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-3	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
	Test No.: IP-6	Sample Type: intact	Elevation: ---
	Description: Moist, grey clay		
	Remarks: System S, Swell Pressure =		

One-Dimensional Consolidation by ASTM D2435 - Method B

Log of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/s	Mv 1/tsf	k ft/day	Ca %
1	0.0642	0.002508	2.94	0.251	0.000	0.00e+00	3.90e-02	0.00e+00	0.00e+00
2	0.125	0.007295	2.92	0.729	1.399	4.03e-06	7.88e-02	8.57e-04	0.00e+00
3	0.250	0.01687	2.88	1.69	1.511	3.68e-06	7.66e-02	7.61e-04	0.00e+00
4	0.500	0.03916	2.79	3.92	3.672	1.47e-06	8.92e-02	3.53e-04	0.00e+00
5	1.00	0.1054	2.53	10.5	0.000	0.00e+00	1.32e-01	0.00e+00	0.00e+00
6	2.00	0.2476	1.97	24.8	25.262	1.53e-07	1.42e-01	5.87e-05	0.00e+00
7	4.00	0.3440	1.59	34.4	15.415	1.83e-07	4.82e-02	2.38e-05	0.00e+00
8	8.00	0.4206	1.29	42.1	0.000	0.00e+00	1.92e-02	0.00e+00	0.00e+00
9	2.00	0.4006	1.37	40.1	0.000	0.00e+00	3.34e-03	0.00e+00	0.00e+00
10	0.500	0.3697	1.49	37.0	19.431	1.11e-07	2.06e-02	6.16e-06	0.00e+00
11	0.125	0.3373	1.62	33.7	0.000	0.00e+00	8.62e-02	0.00e+00	0.00e+00

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-3	Tested By: md	Checked By: mcm
	Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
	Test No.: IP-6	Sample Type: intact	Elevation: ---
	Description: Moist, grey clay		
	Remarks: System S, Swell Pressure =		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Square Root of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv ft²/s	Mv 1/tsf	k ft/day
1	0.0642	0.002508	2.94	0.251	184.101	1.33e-07	3.90e-02	1.40e-05
2	0.125	0.007295	2.92	0.729	6.160	3.94e-06	7.88e-02	8.38e-04
3	0.250	0.01687	2.88	1.69	12.448	1.92e-06	7.66e-02	3.97e-04
4	0.500	0.03916	2.79	3.92	13.265	1.75e-06	8.92e-02	4.20e-04
5	1.00	0.1054	2.53	10.5	54.411	3.88e-07	1.32e-01	1.39e-04
6	2.00	0.2476	1.97	24.8	118.237	1.41e-07	1.42e-01	5.40e-05
7	4.00	0.3440	1.59	34.4	72.960	1.67e-07	4.82e-02	2.17e-05
8	8.00	0.4206	1.29	42.1	58.751	1.59e-07	1.92e-02	8.24e-06
9	2.00	0.4006	1.37	40.1	12.642	6.74e-07	3.34e-03	6.08e-06
10	0.500	0.3697	1.49	37.0	105.455	8.80e-08	2.06e-02	4.89e-06
11	0.125	0.3373	1.62	33.7	189.648	5.41e-08	8.62e-02	1.26e-05

GeoTesting EXPRESS

Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-1	Test Date: 8/26/16	Depth: 25-27 ft
Test No.: IP-6	Sample Type: intact	Elevation: ---
Description: Moist, grey clay		
Remarks: System S, Swell Pressure =		
Displacement at End of Increment		

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	---	Sample Type:	---	Tested By:	jbr
Sample ID:	---	Test Date:	08/30/16	Checked By:	mcm
Depth :	---	Test Id:	387124		

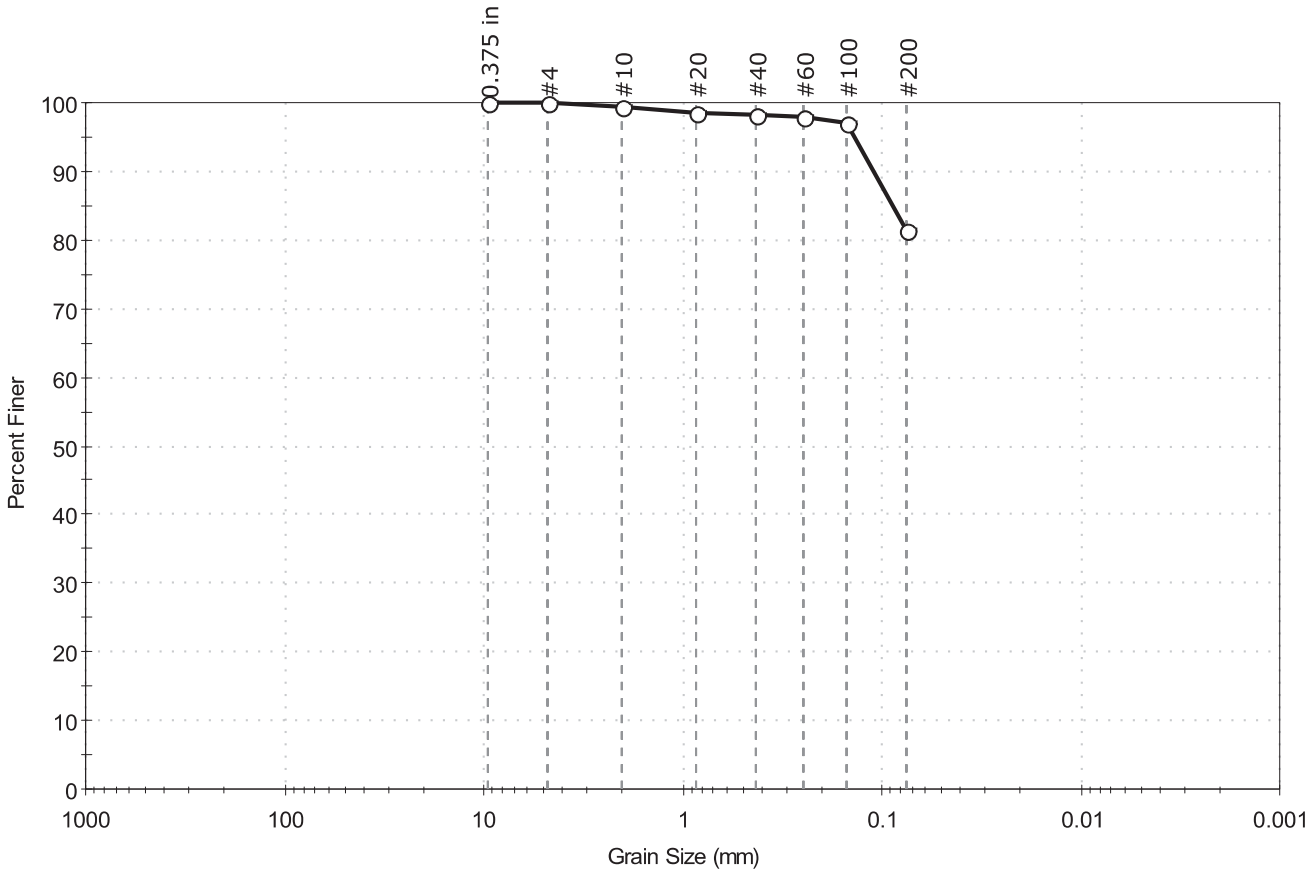
Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
AP-3	UD-2	27.0-29.0 ft	Moist, olive clay with sand	78.8

Notes: Temperature of Drying : 110º Celsius

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-3	Sample Type:	tube	Tested By:	jbr
Sample ID:	UD-2	Test Date:	08/23/16	Checked By:	mcm
Depth :	27.0-29.0 ft	Test Id:	387106		
Test Comment:	---				
Visual Description:	Moist, olive clay with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.1	18.5	81.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	98		
#60	0.25	98		
#100	0.15	97		
#200	0.075	81		

Coefficients

D_{85} =0.0878 mm	D_{30} =N/A
D_{60} =N/A	D_{15} =N/A
D_{50} =N/A	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM Fat clay with sand (CH)

AASHTO Clayey Soils (A-7-6 (43))

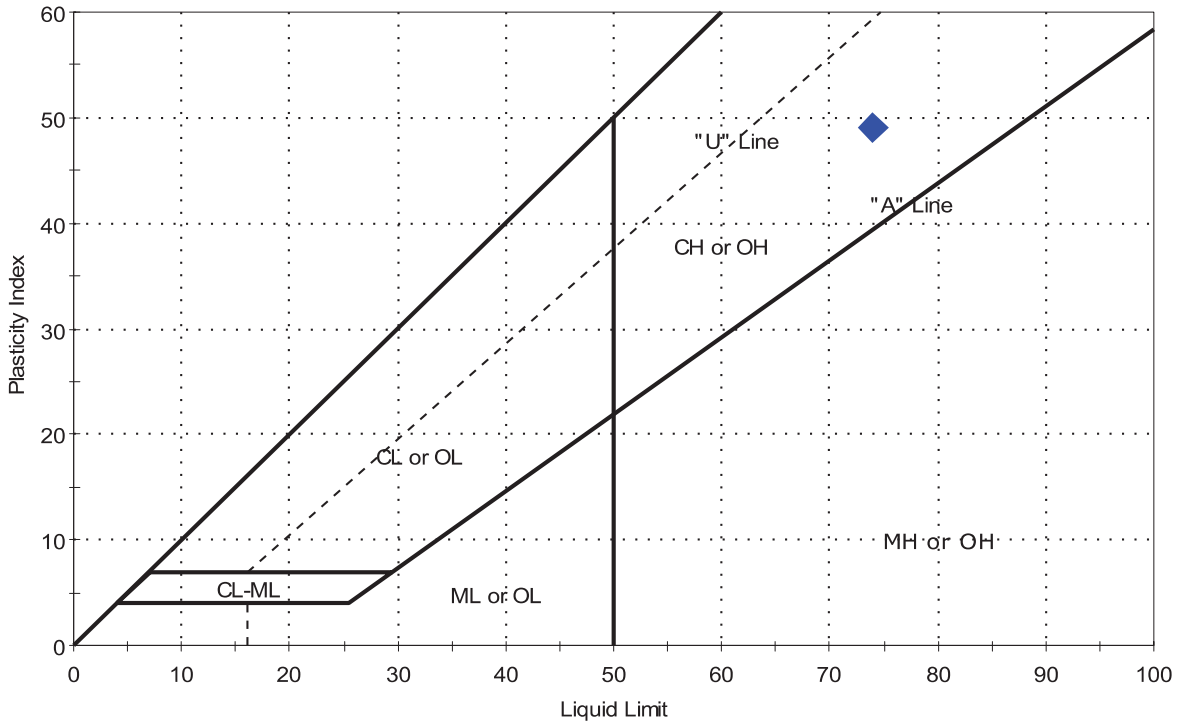
Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-3	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-2	Test Date:	08/31/16	Checked By:	mcm
Depth :	27.0-29.0 ft	Test Id:	387114		
Test Comment:	---				
Visual Description:	Moist, olive clay with sand				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



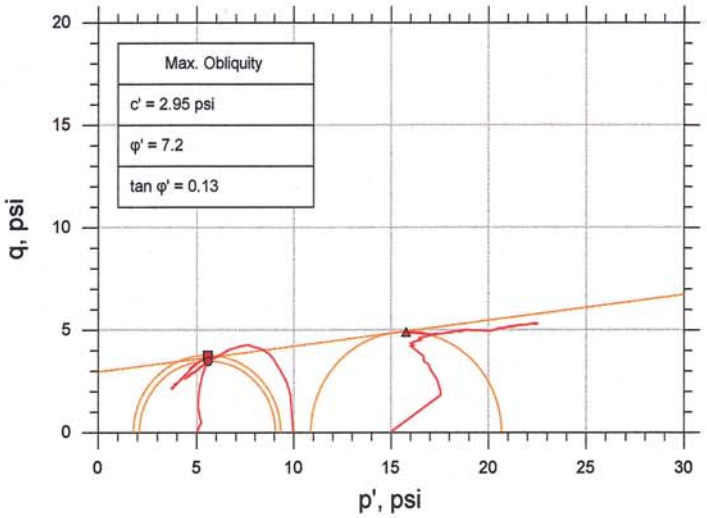
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	UD-2	AP-3	27.0-29.0 ft	79	74	25	49	1.1	Fat clay with sand (CH)

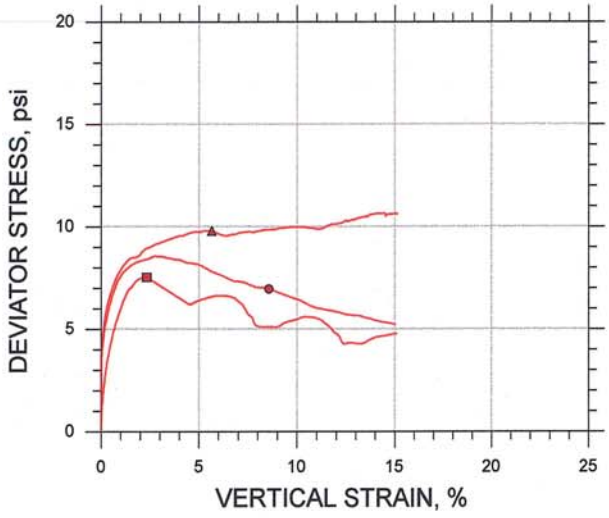
Sample Prepared using the WET method
2% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilatancy: NONE
Toughness: MEDIUM

GeoTesting EXPRESS

Client: F&ME Consultants	
Project Name: US-21 Replacement Bridge	
Project Location: ---	
Project Number: GTX-305005	
Tested By: md	Checked By: mcm
Boring ID: AP-3	
Preparation: intact	
Description: Moist, olive clay with sand	
Classification: Fat clay with sand	
Group Symbol: CH	
Liquid Limit: 74	Plastic Limit: 25
Plasticity Index: 49	Estimated Specific Gravity: 2.7

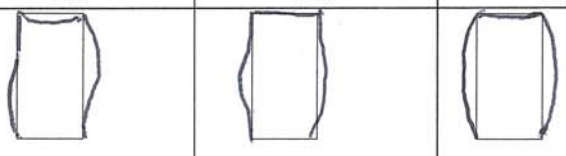
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





		■	●	▲	
Symbol					
Sample ID		ST-2	ST-2	ST-2	
Depth, ft		27.0-29.0 ft	27.0-29.0 ft	27.0-29.0 ft	
Test Number		CU-1-1	CU-1-2	CU-1-3A	
Initial	Height, in	4.550	4.750	4.410	
	Diameter, in	2.030	2.030	2.040	
	Moisture Content (from Cuttings), %	59.7	78.5	94.1	
	Dry Density, pcf	62.0	51.8	47.3	
	Saturation (Wet Method), %	93.8	94.1	99.3	
	Void Ratio	1.72	2.25	2.56	
Before Shear	Moisture Content, %	62.7	74.6	85.0	
	Dry Density, pcf	62.6	55.9	51.2	
	Cross-sectional Area (Method A), in²	3.208	3.048	3.185	
	Saturation, %	100.0	100.0	100.0	
	Void Ratio	1.69	2.02	2.29	
	Back Pressure, psi	149.0	152.8	162.9	
Vertical Effective Consolidation Stress, psi		4.995	9.855	14.56	
Horizontal Effective Consolidation Stress, psi		5.004	9.975	14.97	
Vertical Strain after Consolidation, %		0.1308	1.490	5.016	
Volumetric Strain after Consolidation, %		1.243	7.152	7.479	
Time to 50% Consolidation, min		9.610	121.0	30.25	
Shear Strength, psi		3.769	3.482	4.897	
Strain at Failure, %		2.33	8.55	5.65	
Strain Rate, %/min		0.01600	0.01600	0.01600	
Deviator Stress at Failure, psi		7.539	6.965	9.794	
Effective Minor Principal Stress at Failure, psi		1.790	2.097	10.87	
Effective Major Principal Stress at Failure, psi		9.329	9.062	20.67	
B-Value		0.96	0.95	0.96	

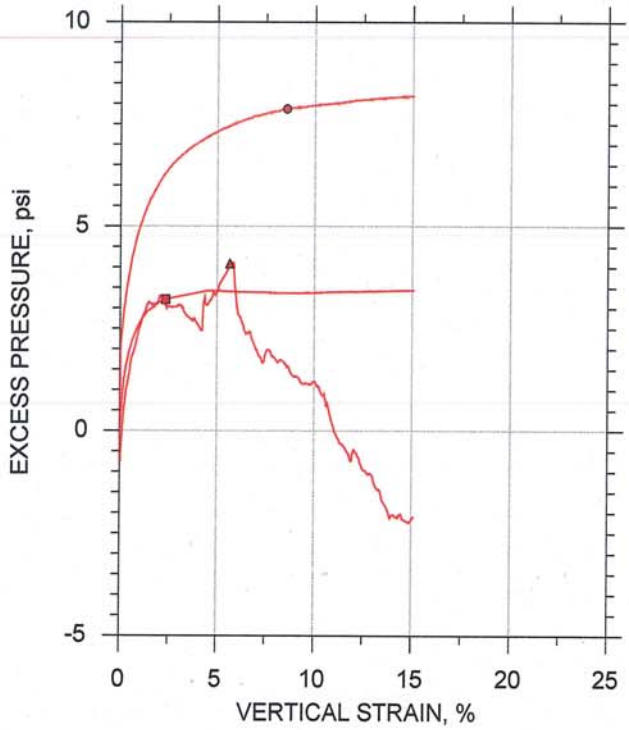
Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

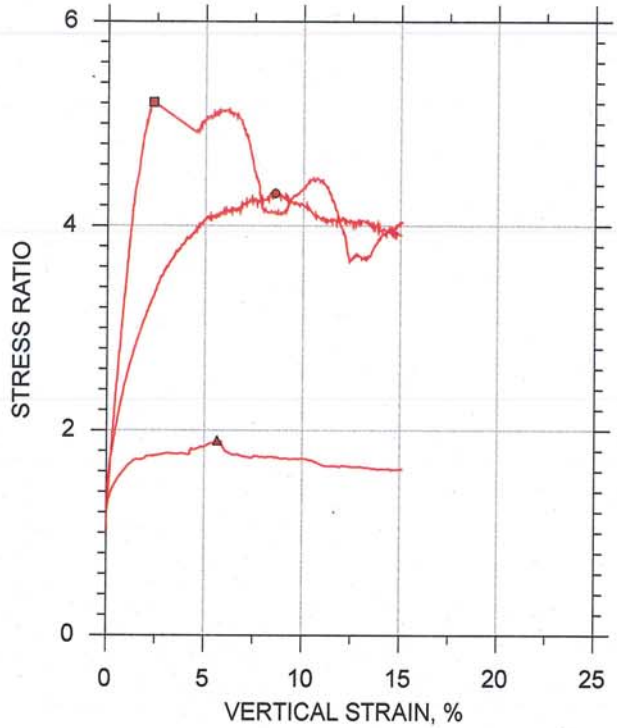


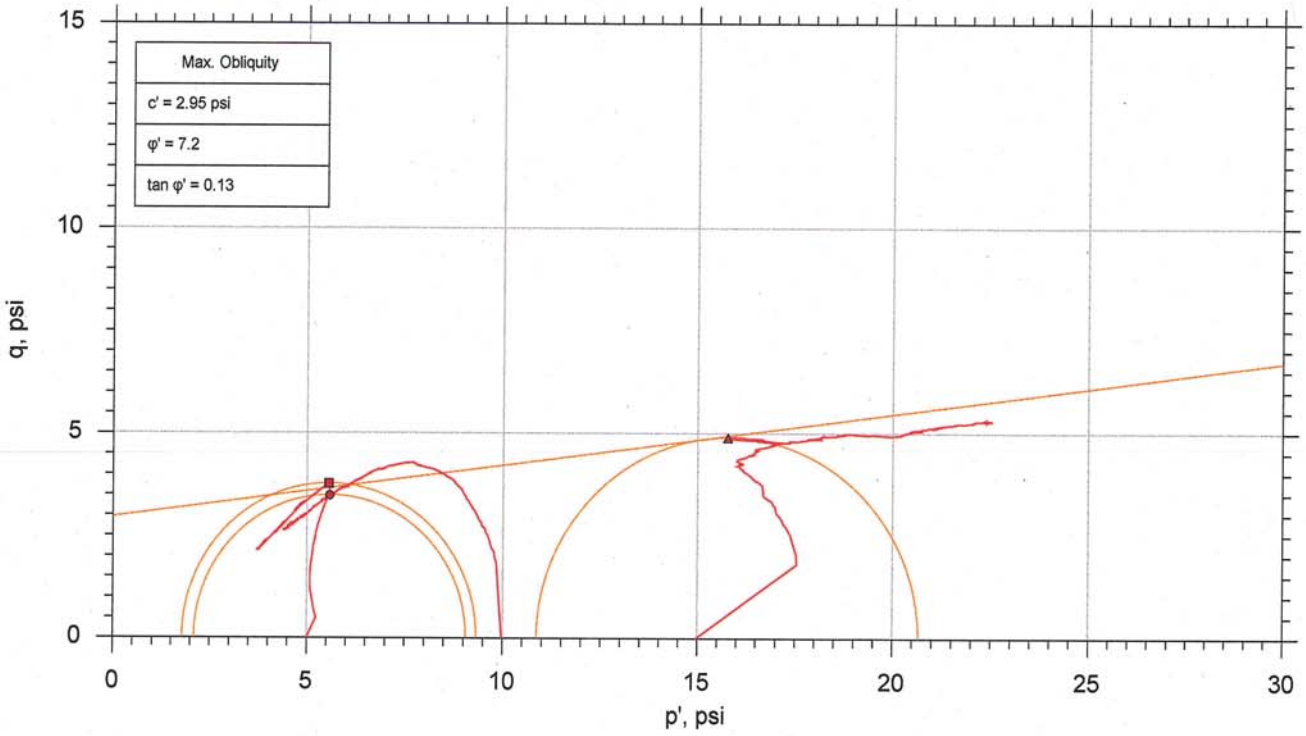
Remarks:

System X

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







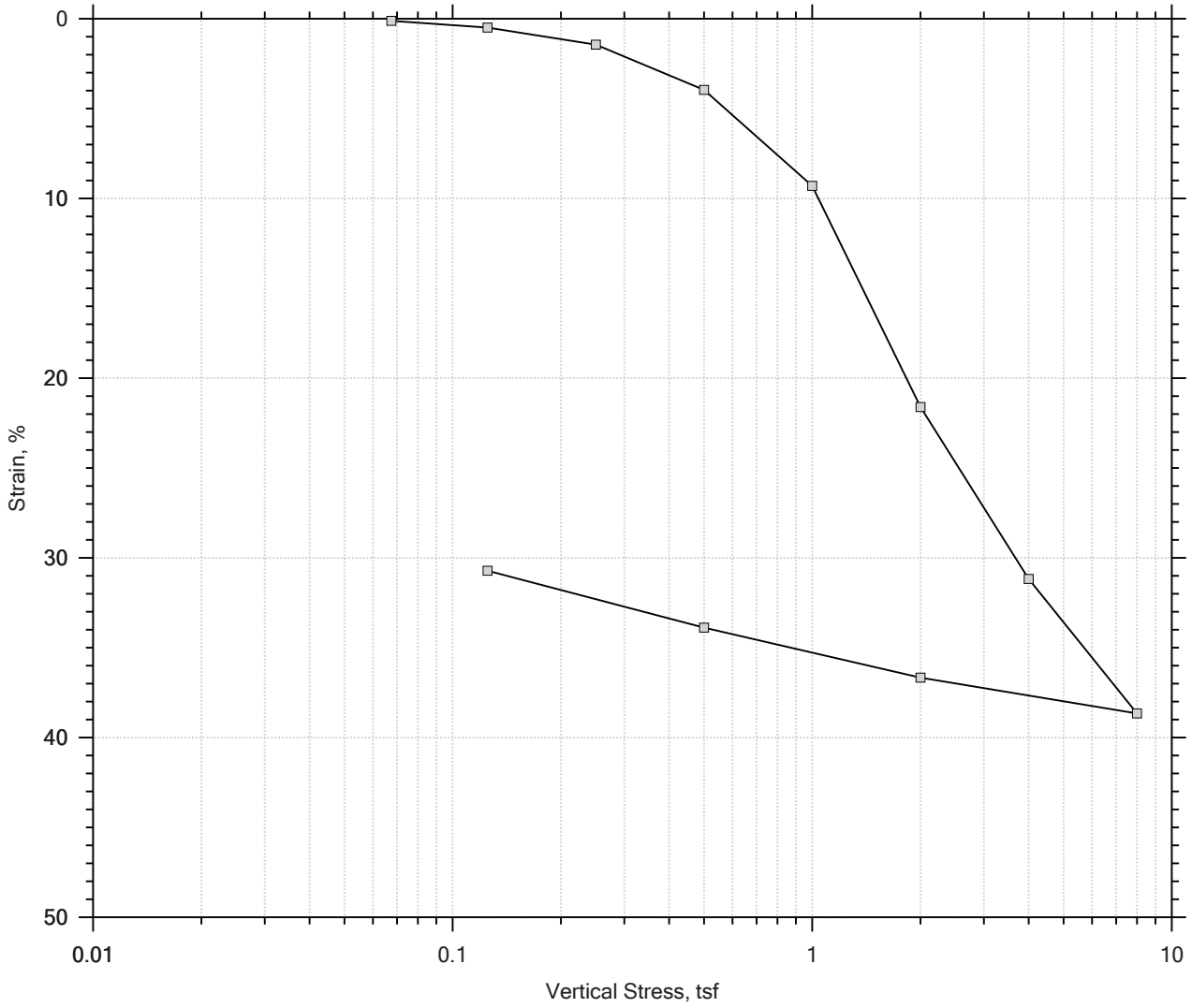
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	ST-2	CU-1-1	27.0-29.0 ft	md	8/16/16	mcm	9/8/16	305005-CU-1-1m.dat
●	ST-2	CU-1-2	27.0-29.0 ft	md	8/16/16	mcm	9/8/16	305005-CU-1-2m.dat
▲	ST-2	CU-1-3A	27.0-29.0 ft	md	8/22/16	mcm	9/8/16	305005-CU-1-3Am.dat

GeoTesting EXPRESS

Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Sample Type: intact	
Description: Moist, olive clay with sand		
Remarks: System X		

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report

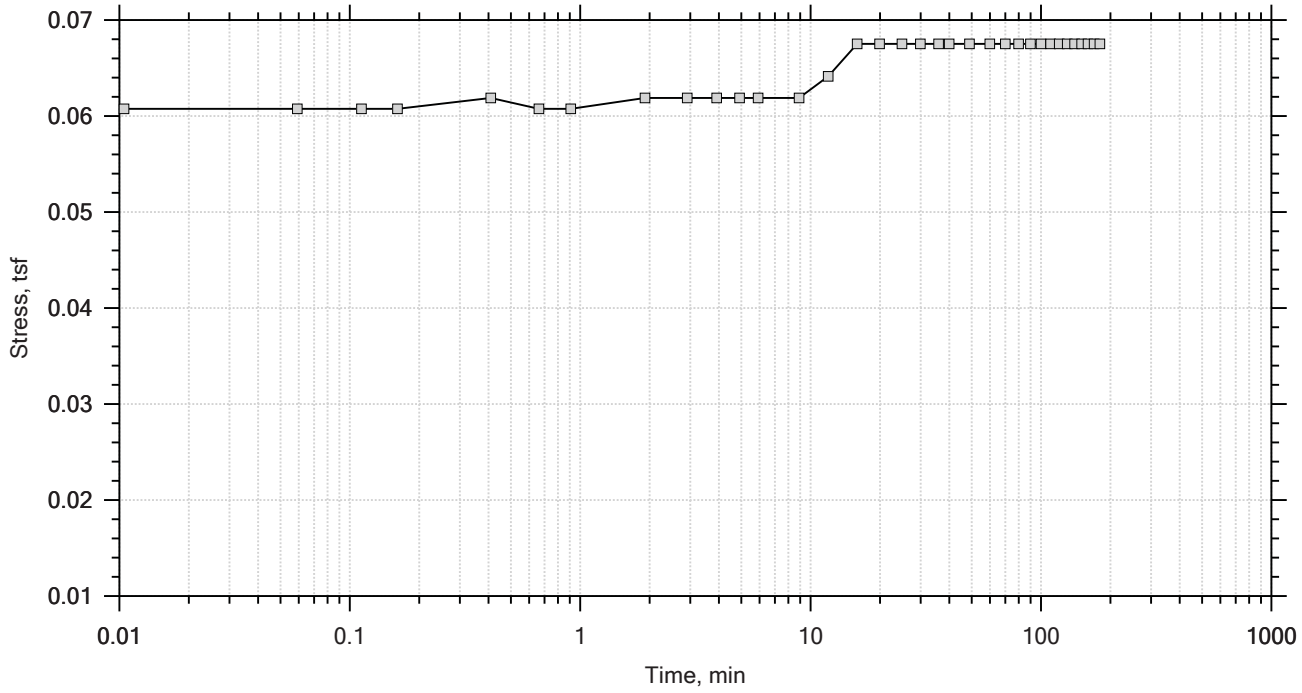


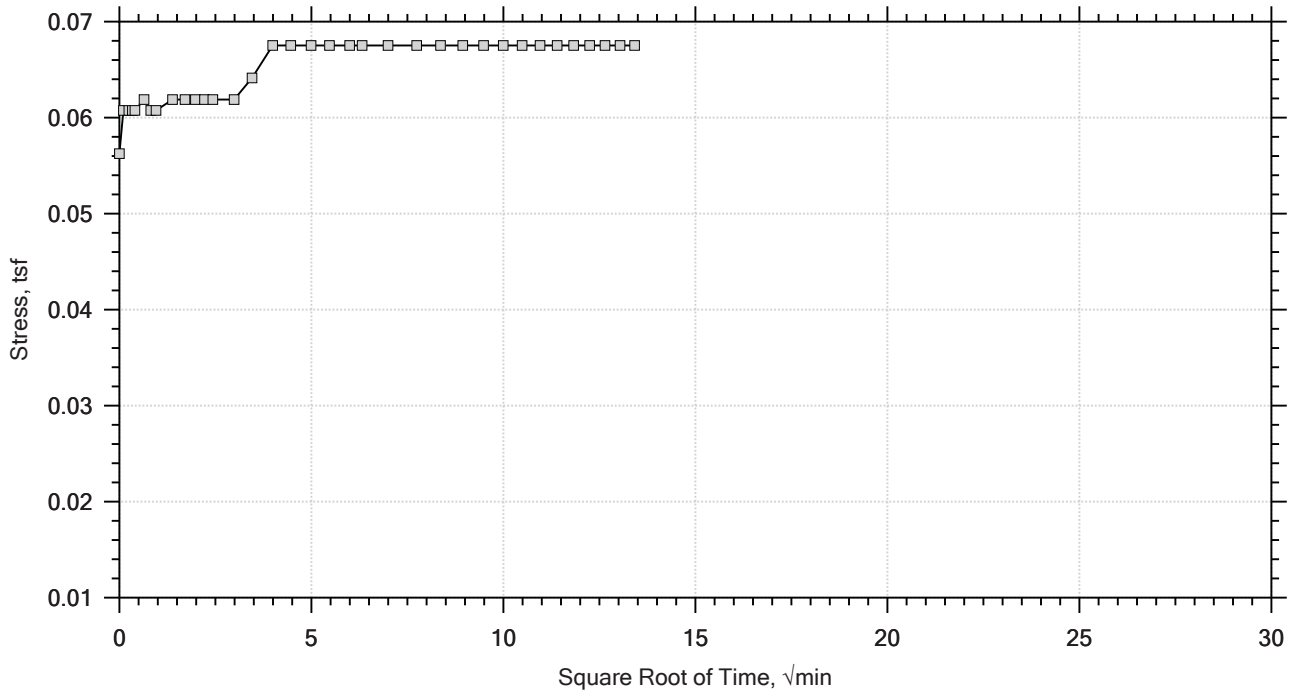
				Before Test	After Test
Current Vertical Effective Stress: ---				Water Content, %	83.73	52.10
Preconsolidation Stress: ---				Dry Unit Weight, pcf	51.8	70.476
Compression Ratio: ---				Saturation, %	99.63	100.00
Diameter: 2.5 in		Height: 1 in		Void Ratio	2.30	1.43
LL: ---	PL: ---	PI: ---	GS: 2.74			

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-3	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
	Test No.: IP-1	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System W, Swell Pressure = 0.0675 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 11
Constant Volume Step
Stress: 0.0675 tsf

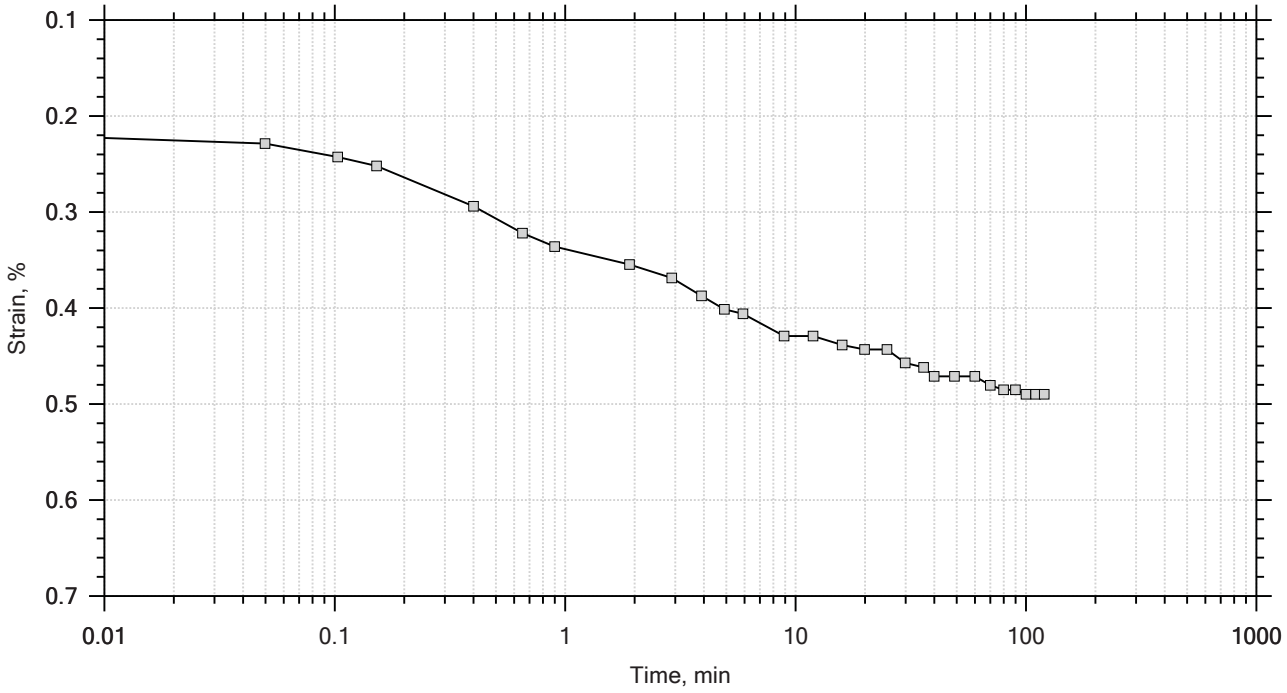


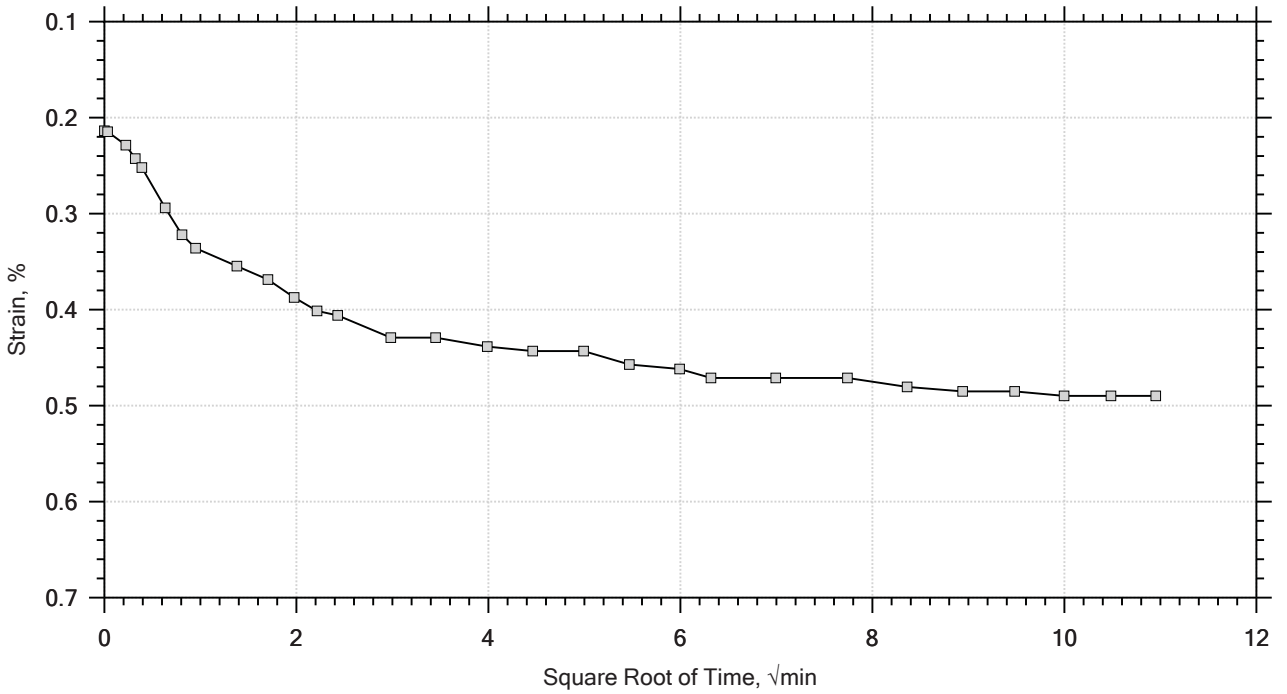


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
Test No.: IP-1	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System W, Swell Pressure = 0.0675 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 11
Constant Load Step
Stress: 0.125 tsf

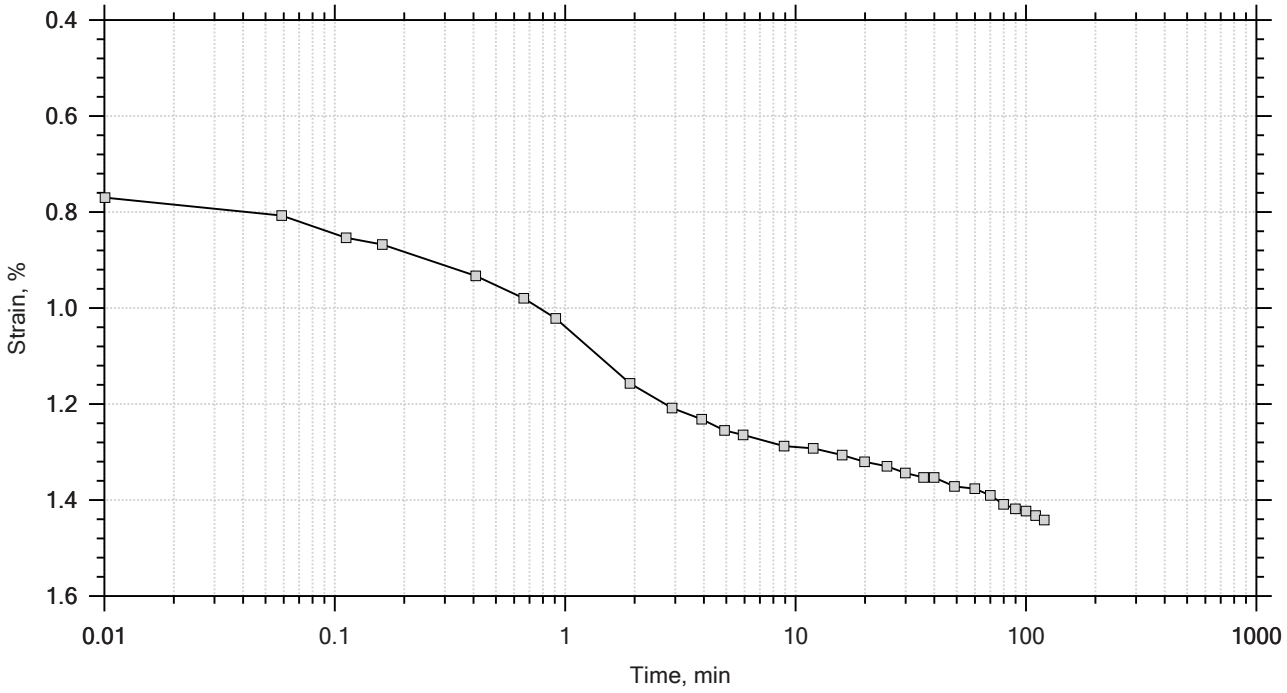


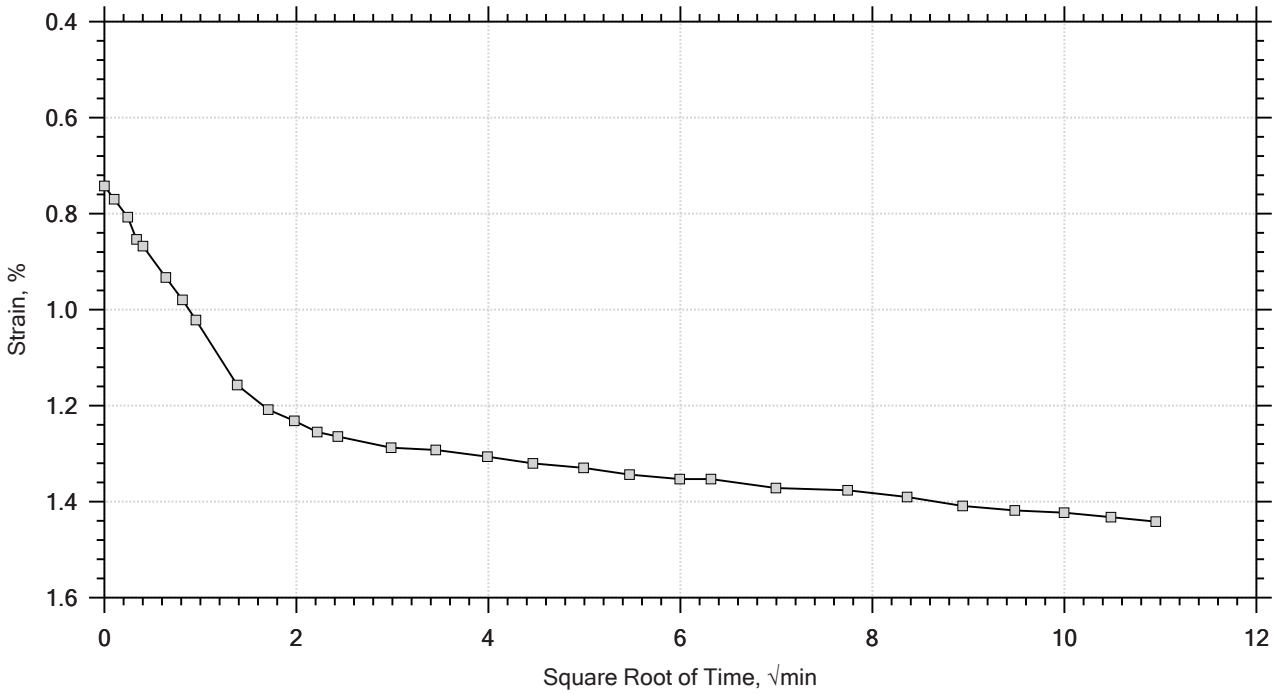


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
Test No.: IP-1	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System W, Swell Pressure = 0.0675 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 11
Constant Load Step
Stress: 0.25 tsf

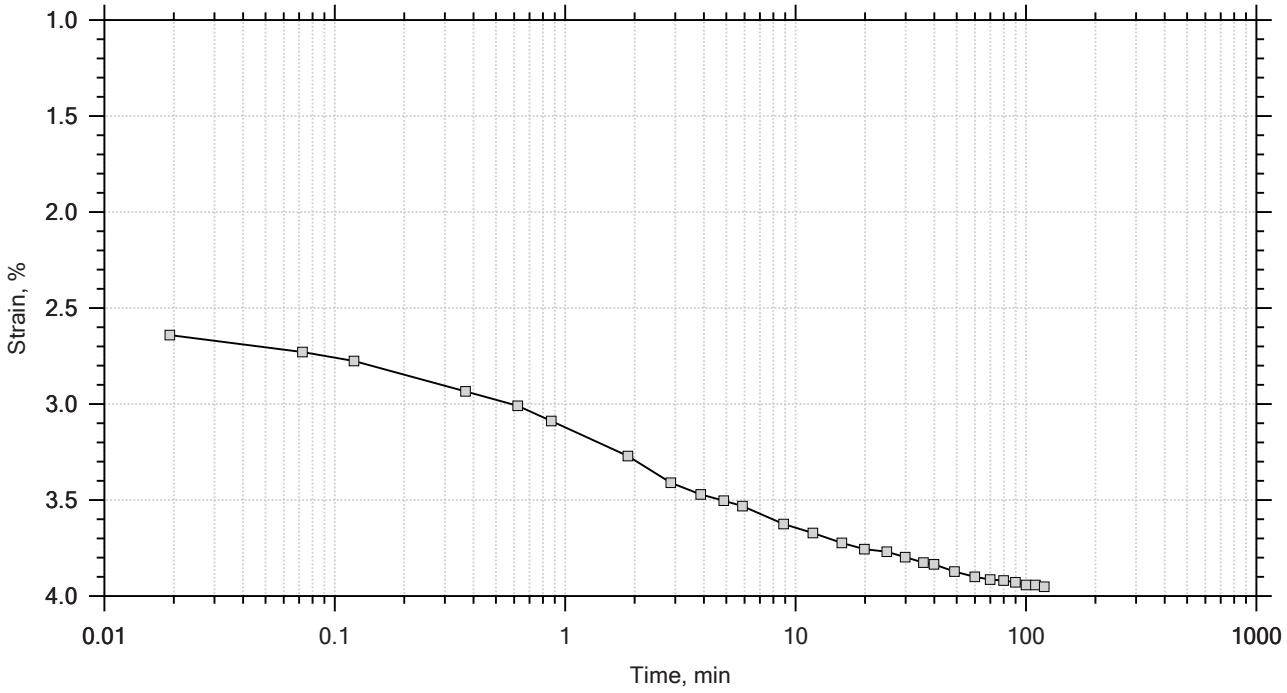


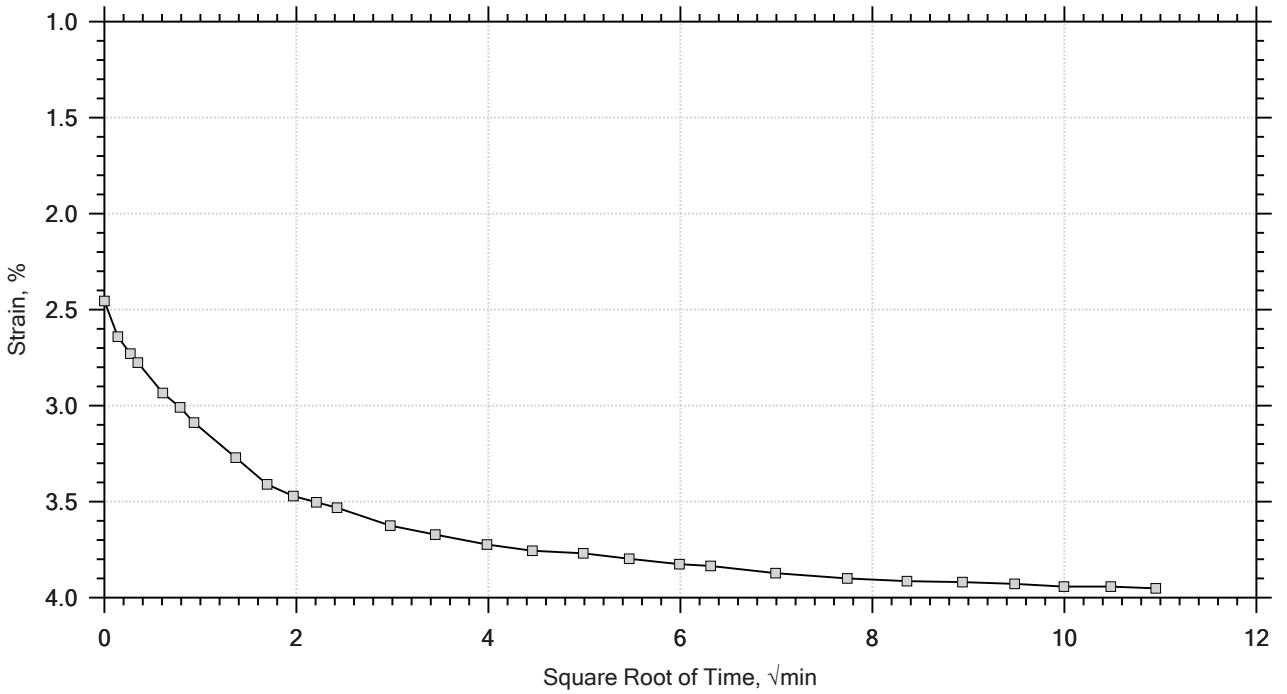


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
Test No.: IP-1	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System W, Swell Pressure = 0.0675 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 11
Constant Load Step
Stress: 0.5 tsf

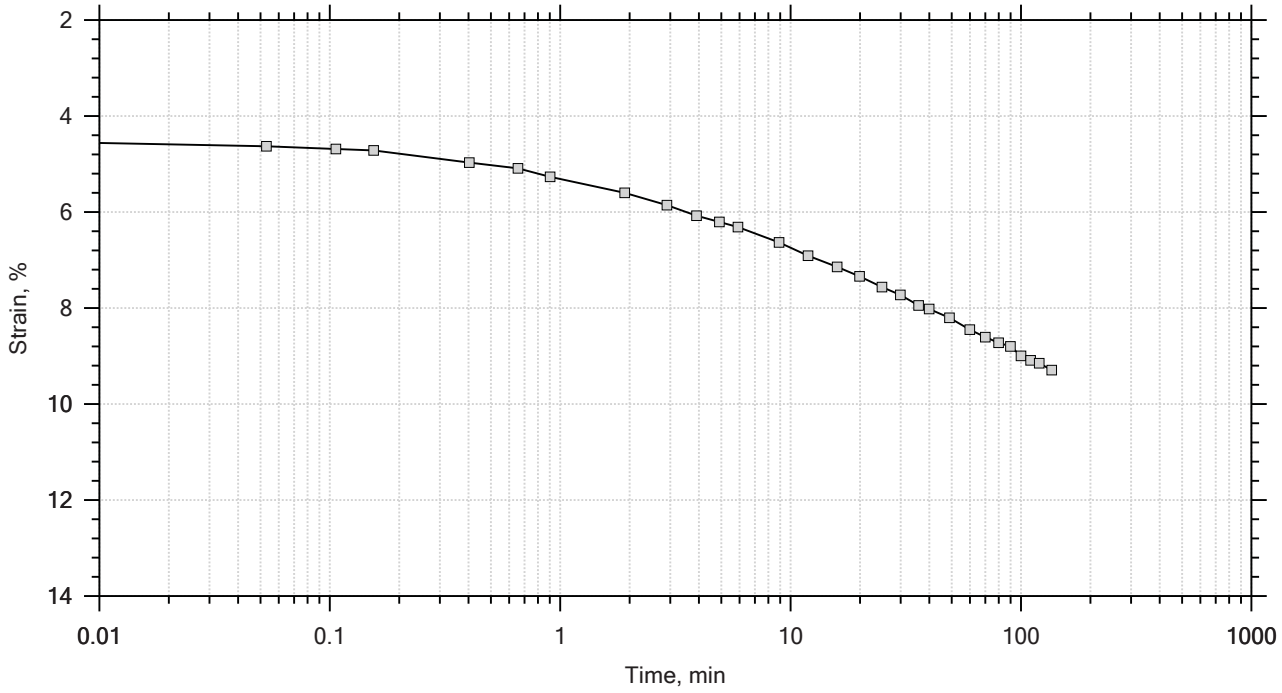


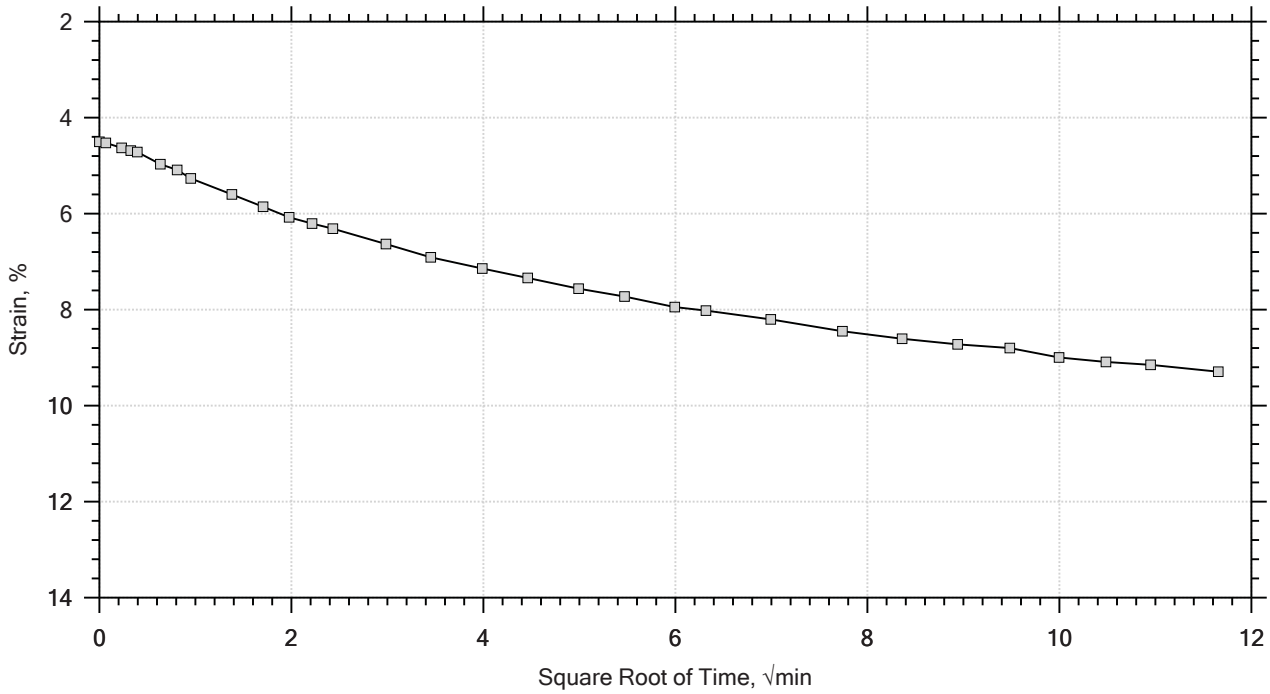


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
Test No.: IP-1	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System W, Swell Pressure = 0.0675 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 11
Constant Load Step
Stress: 1 tsf

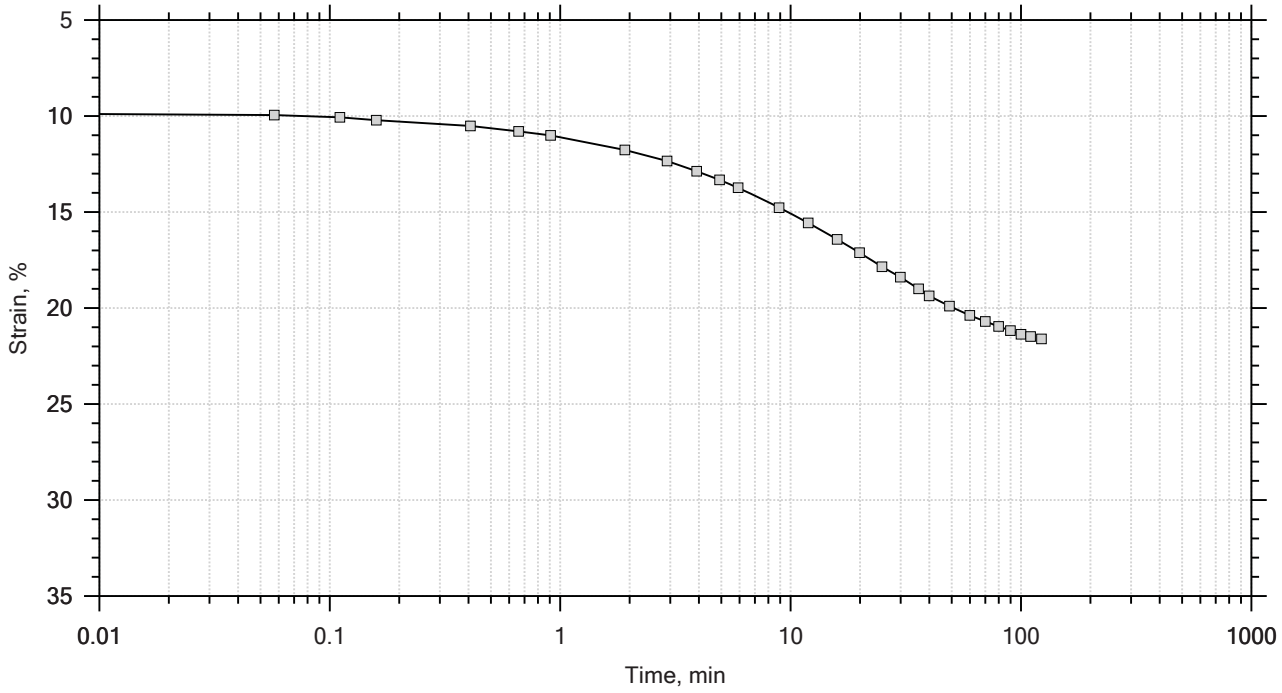


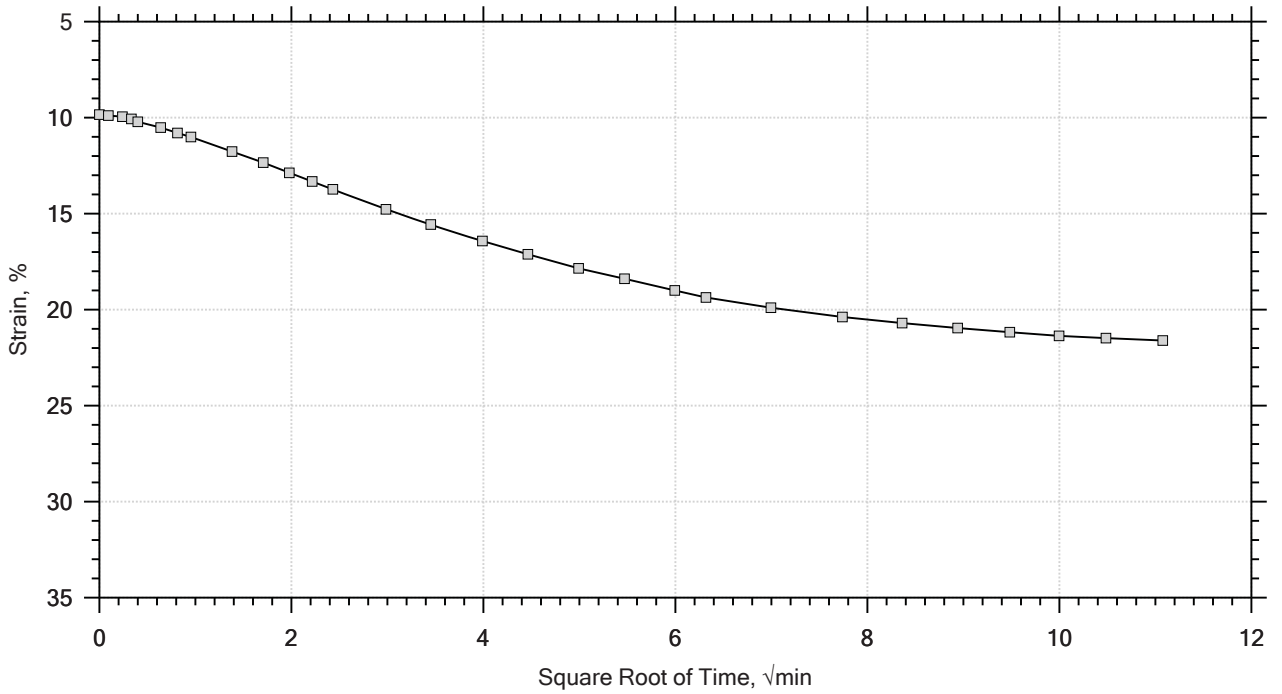


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
Test No.: IP-1	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System W, Swell Pressure = 0.0675 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 11
Constant Load Step
Stress: 2 tsf

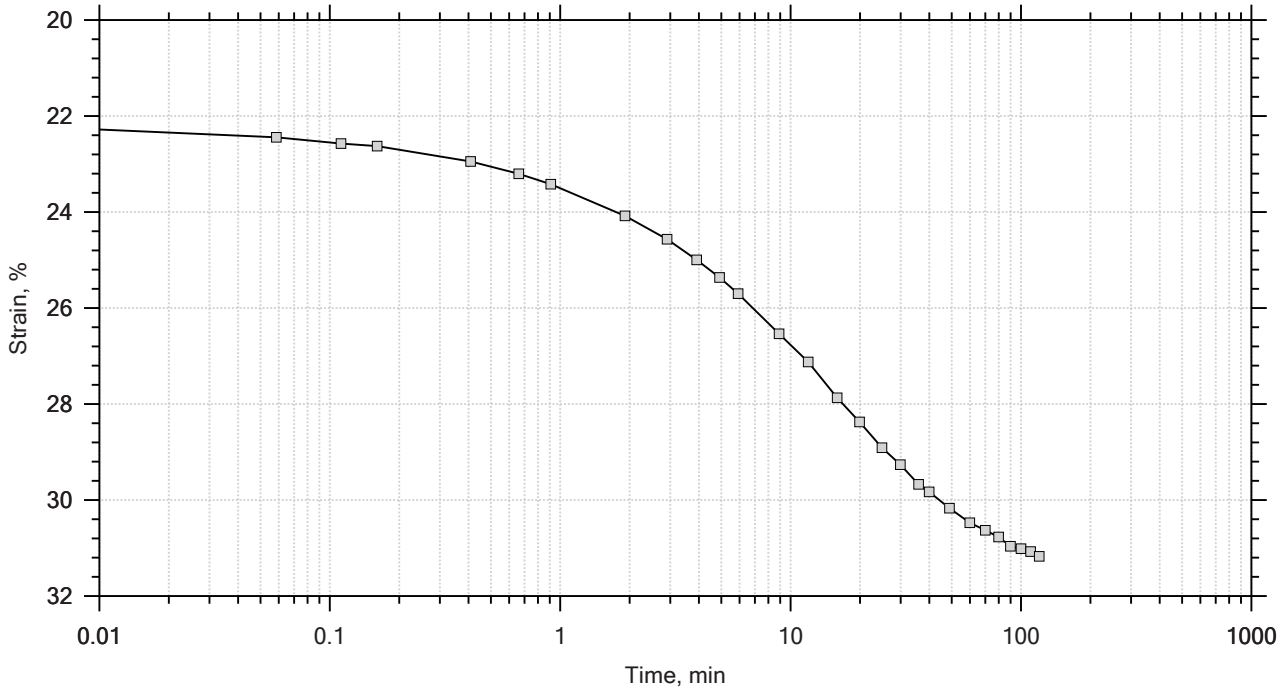


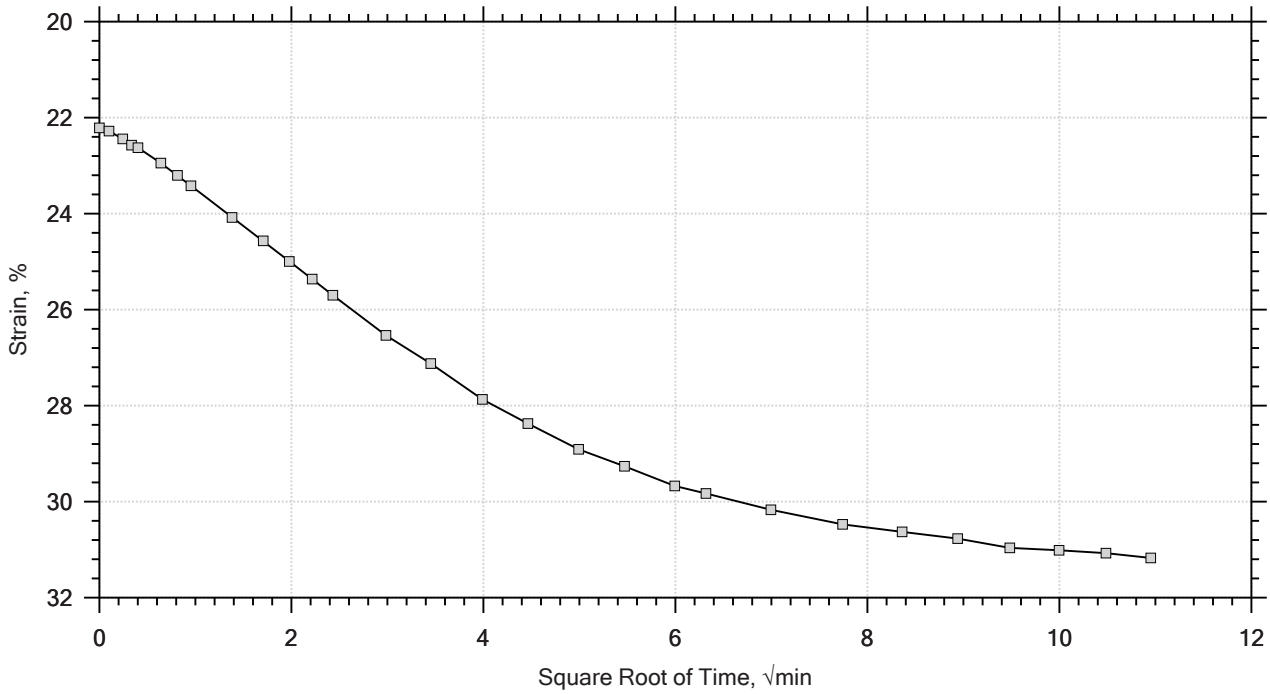


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
Test No.: IP-1	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System W, Swell Pressure = 0.0675 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 11
Constant Load Step
Stress: 4 tsf

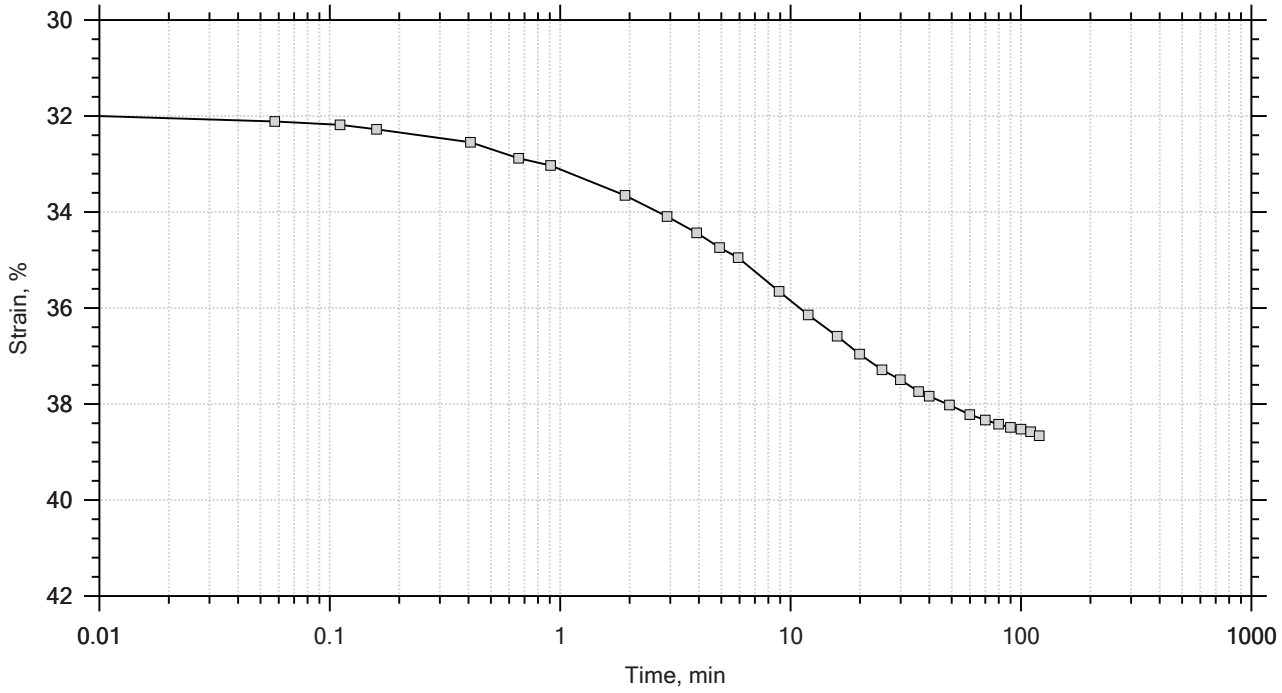


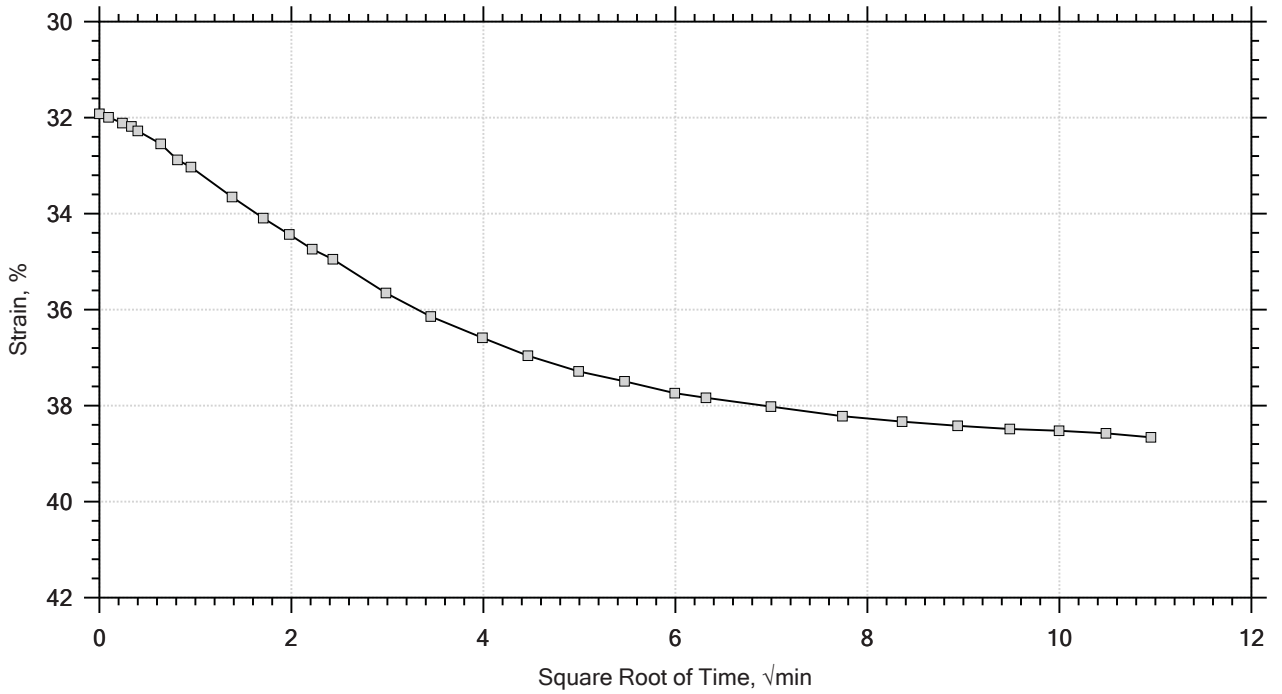


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
Test No.: IP-1	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System W, Swell Pressure = 0.0675 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 11
Constant Load Step
Stress: 8 tsf

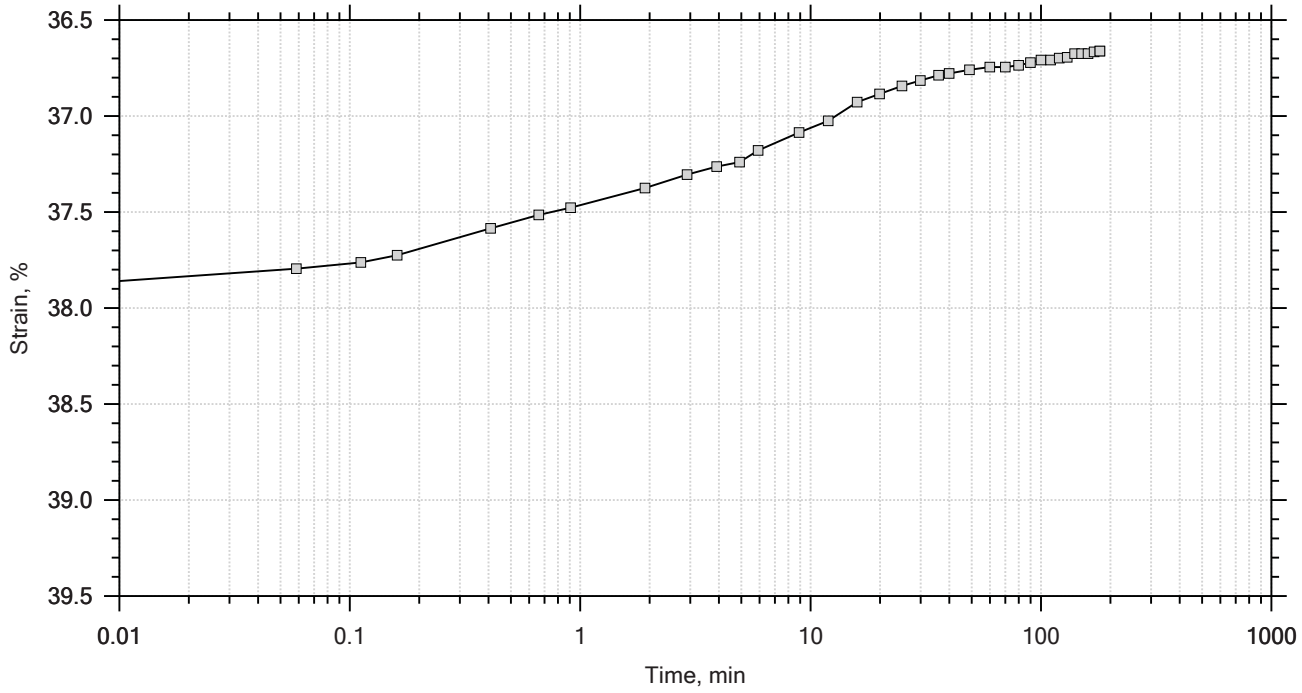


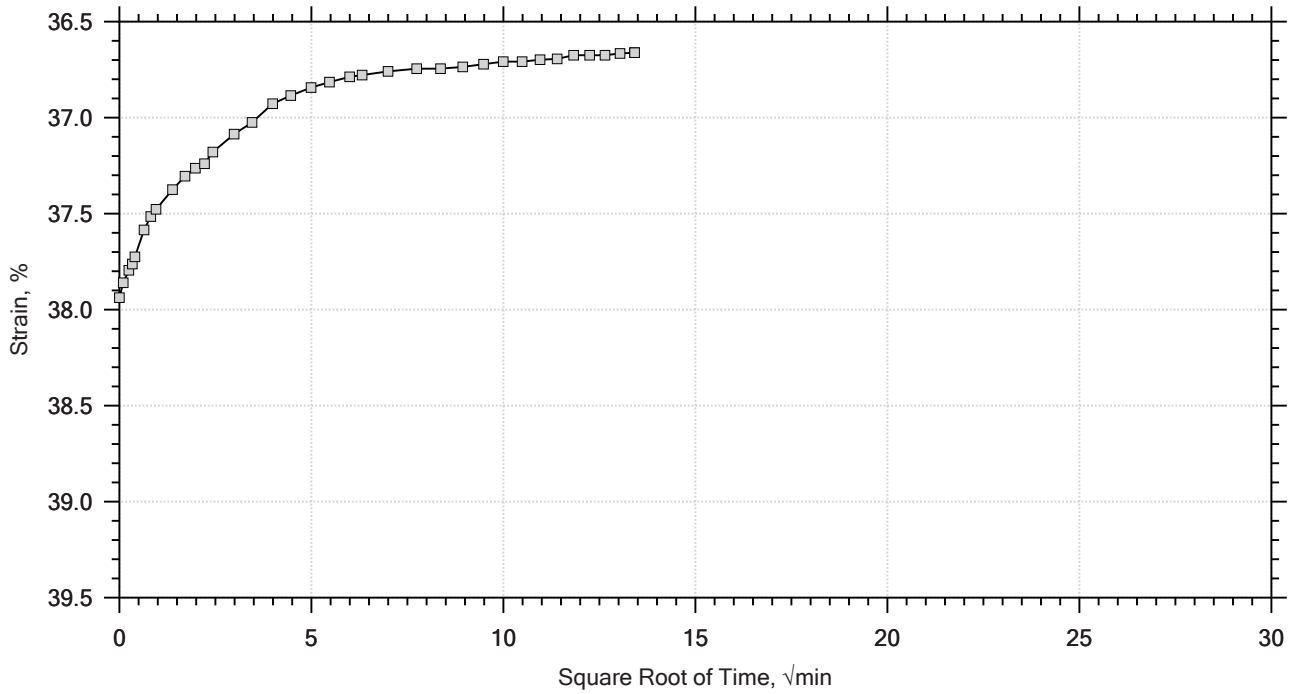


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
Test No.: IP-1	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System W, Swell Pressure = 0.0675 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 11
Constant Load Step
Stress: 2 tsf

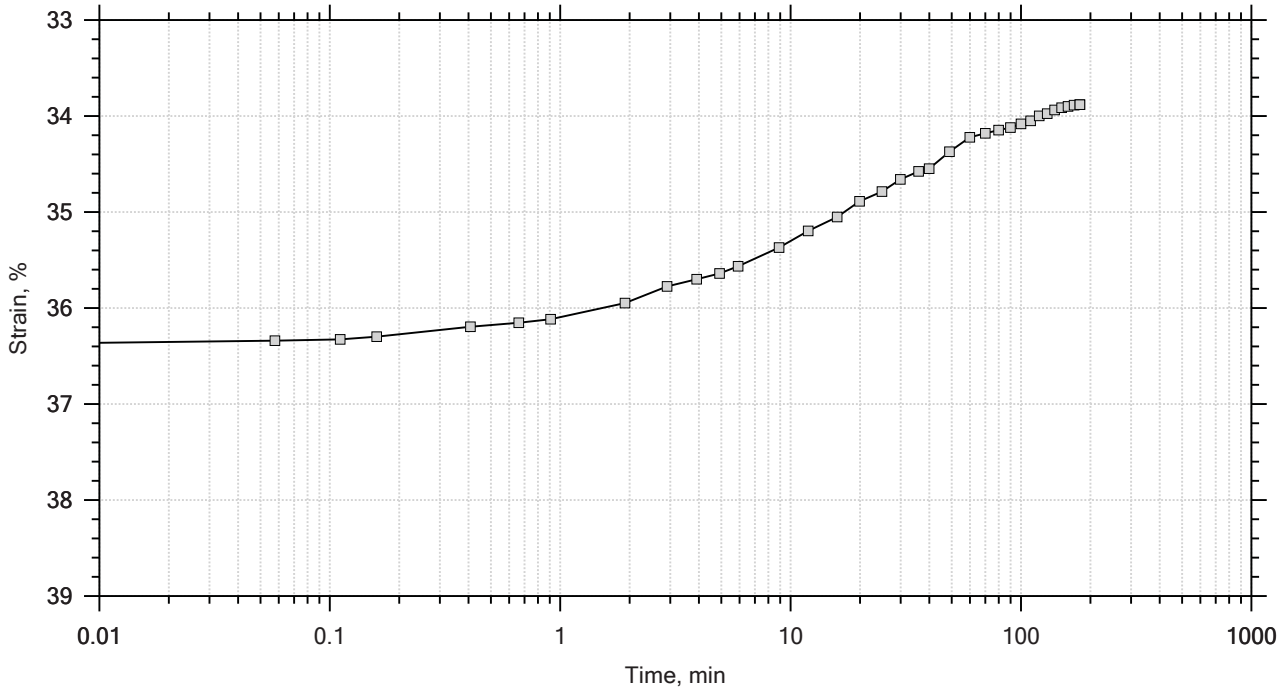


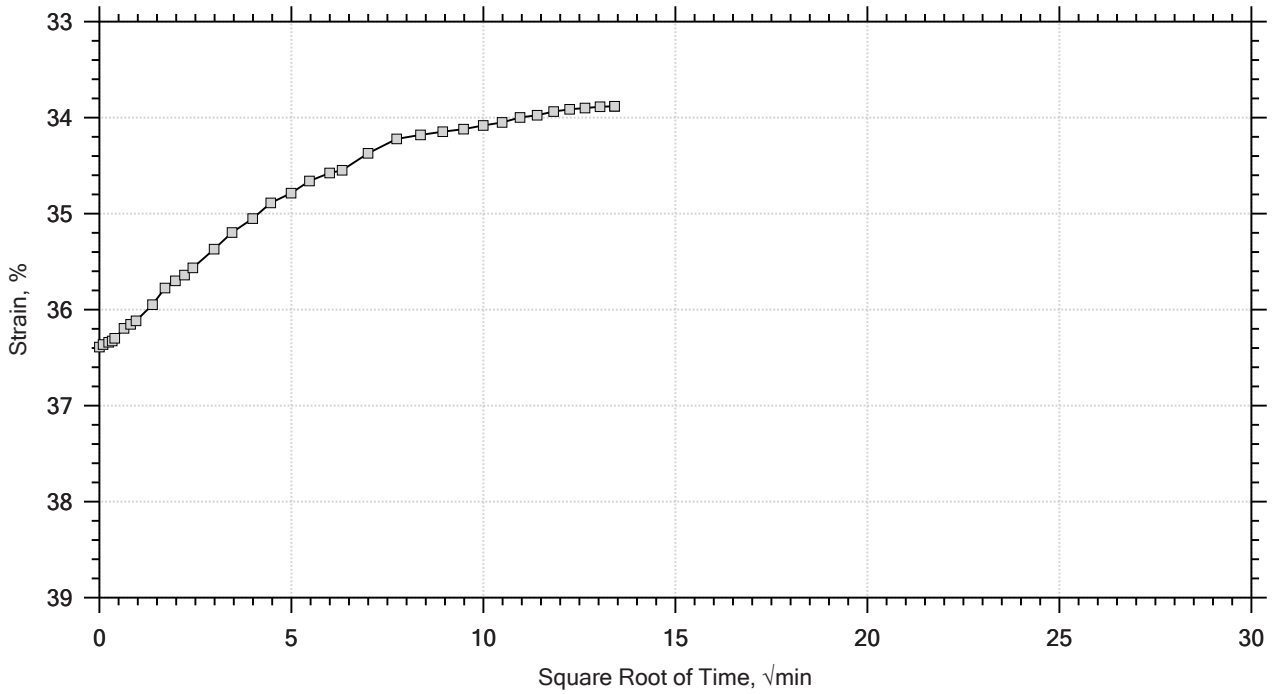


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
Test No.: IP-1	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System W, Swell Pressure = 0.0675 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 11
Constant Load Step
Stress: 0.5 tsf

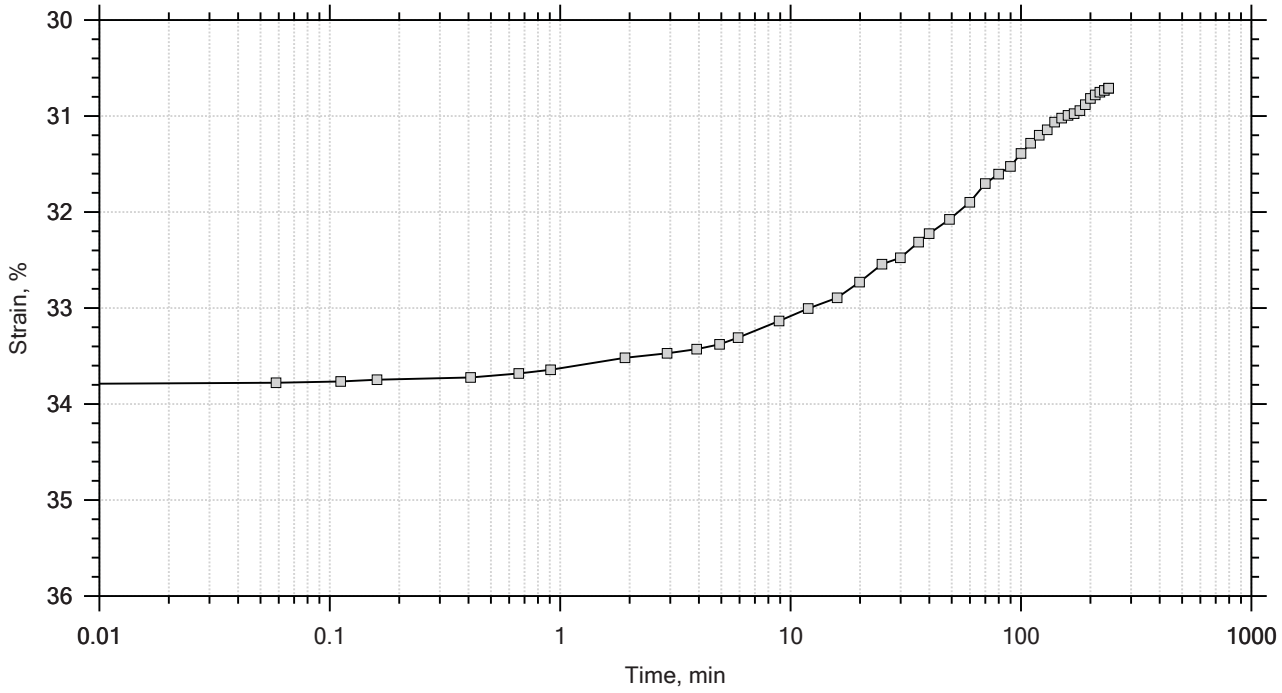


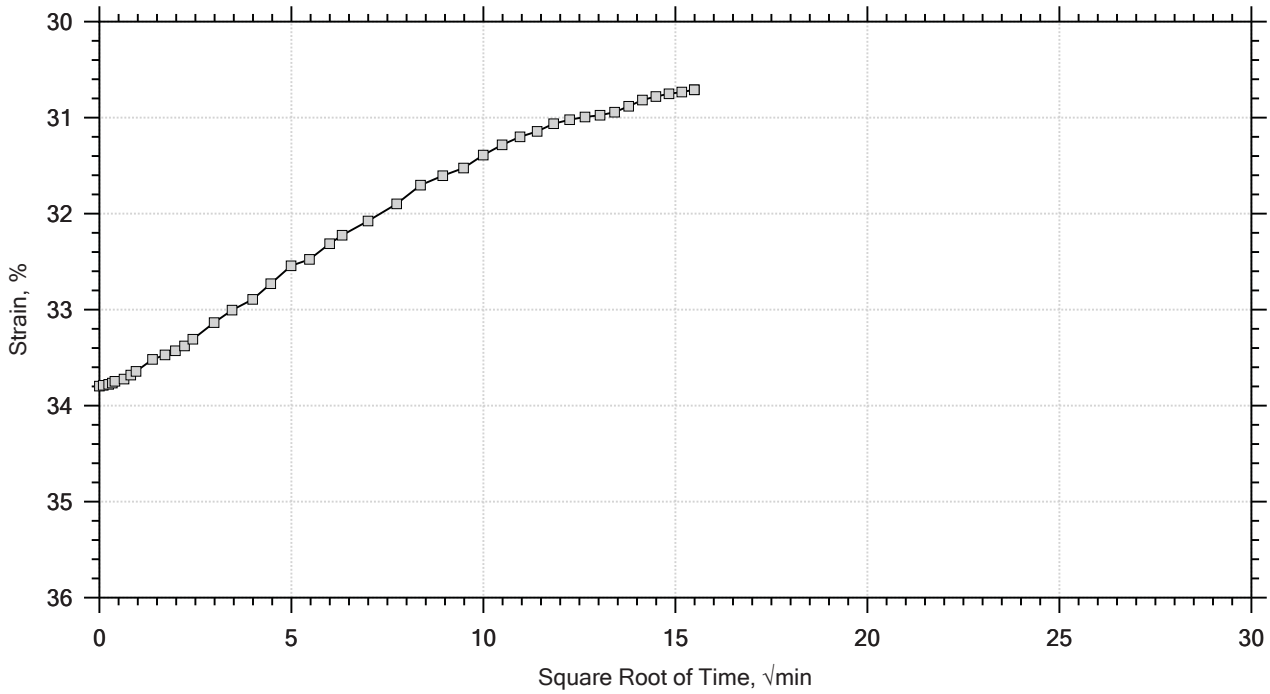


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-3	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
	Test No.: IP-1	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System W, Swell Pressure = 0.0675 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 11
Constant Load Step
Stress: 0.125 tsf





Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
Test No.: IP-1	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System W, Swell Pressure = 0.0675 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.74	Liquid Limit: ---
Initial Height: 1.00 in	Initial Void Ratio: 2.30	Plastic Limit: ---
Final Height: 0.73 in	Final Void Ratio: 1.43	Plasticity Index: ---

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID		RING		B-990
Mass Container, gm	0	109.41	109.41	7.92
Mass Container + Wet Soil, gm	122.63	232.04	210.93	107.44
Mass Container + Dry Soil, gm	65.43	176.15	176.15	73.35
Mass Dry Soil, gm	65.43	66.745	66.745	65.43
Water Content, %	87.42	83.73	52.10	52.10
Void Ratio	---	2.30	1.43	---
Degree of Saturation, %	---	99.63	100.00	---
Dry Unit Weight, pcf	---	51.8	70.476	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-3	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
	Test No.: IP-1	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System W, Swell Pressure = 0.0675 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Log of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/s	Mv 1/tsf	k ft/day	Ca %
1	0.0675	0.001166	2.30	0.117	0.000	0.00e+00	1.73e-02	0.00e+00	0.00e+00
2	0.125	0.004898	2.29	0.490	0.000	0.00e+00	6.49e-02	0.00e+00	0.00e+00
3	0.250	0.01441	2.26	1.44	1.040	5.37e-06	7.61e-02	1.10e-03	0.00e+00
4	0.500	0.03951	2.17	3.95	1.335	4.04e-06	1.00e-01	1.09e-03	0.00e+00
5	1.00	0.09292	2.00	9.29	0.000	0.00e+00	1.07e-01	0.00e+00	0.00e+00
6	2.00	0.2160	1.59	21.6	0.000	0.00e+00	1.23e-01	0.00e+00	0.00e+00
7	4.00	0.3117	1.27	31.2	9.347	3.30e-07	4.78e-02	4.26e-05	0.00e+00
8	8.00	0.3866	1.03	38.7	5.938	4.07e-07	1.87e-02	2.05e-05	0.00e+00
9	2.00	0.3666	1.09	36.7	3.892	5.69e-07	3.33e-03	5.11e-06	0.00e+00
10	0.500	0.3388	1.18	33.9	15.451	1.55e-07	1.85e-02	7.73e-06	0.00e+00
11	0.125	0.3071	1.29	30.7	42.917	6.09e-08	8.46e-02	1.39e-05	0.00e+00

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-3	Tested By: md	Checked By: mcm
	Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
	Test No.: IP-1	Sample Type: intact	Elevation: ---
	Description: Moist, olive clay with sand		
	Remarks: System W, Swell Pressure = 0.0675 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Square Root of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv ft²/s	Mv 1/tsf	k ft/day
1	0.0675	0.001166	2.30	0.117	48.912	5.01e-07	1.73e-02	2.33e-05
2	0.125	0.004898	2.29	0.490	8.899	2.74e-06	6.49e-02	4.80e-04
3	0.250	0.01441	2.26	1.44	4.112	5.85e-06	7.61e-02	1.20e-03
4	0.500	0.03951	2.17	3.95	8.449	2.75e-06	1.00e-01	7.44e-04
5	1.00	0.09292	2.00	9.29	37.237	5.75e-07	1.07e-01	1.66e-04
6	2.00	0.2160	1.59	21.6	52.562	3.34e-07	1.23e-01	1.11e-04
7	4.00	0.3117	1.27	31.2	37.716	3.53e-07	4.78e-02	4.55e-05
8	8.00	0.3866	1.03	38.7	25.023	4.15e-07	1.87e-02	2.10e-05
9	2.00	0.3666	1.09	36.7	19.766	4.82e-07	3.33e-03	4.33e-06
10	0.500	0.3388	1.18	33.9	58.196	1.77e-07	1.85e-02	8.83e-06
11	0.125	0.3071	1.29	30.7	188.851	5.96e-08	8.46e-02	1.36e-05

GeoTesting EXPRESS

Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-3	Tested By: md	Checked By: mcm
Sample No.: UD-2	Test Date: 8/19/16	Depth: 27.0-29.0 ft
Test No.: IP-1	Sample Type: intact	Elevation: ---
Description: Moist, olive clay with sand		
Remarks: System W, Swell Pressure = 0.0675 tsf		
Displacement at End of Increment		

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	---	Sample Type:	---	Tested By:	GA
Sample ID:	---	Test Date:	10/31/16	Checked By:	mcm
Depth :	---	Test Id:	397035		

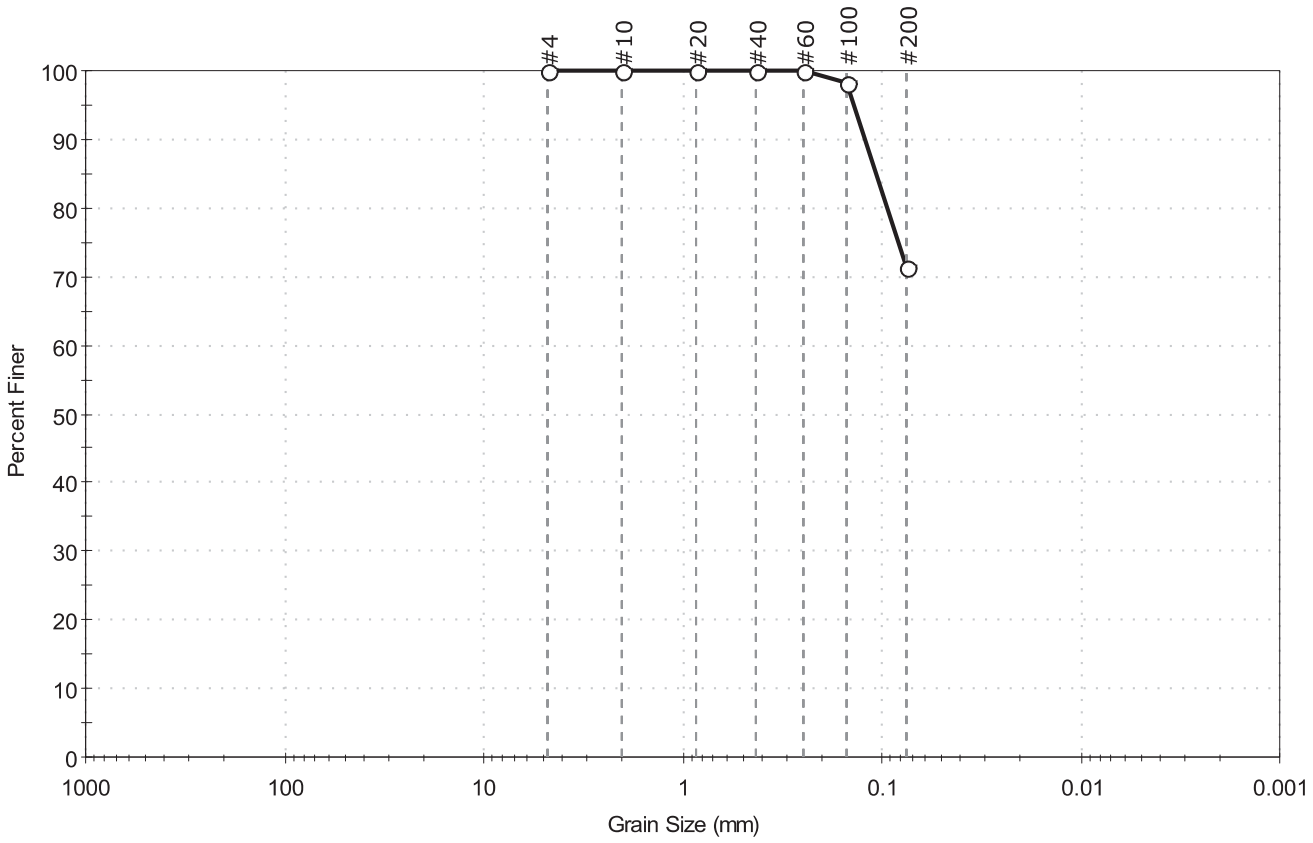
Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
AP-4	UD-1	38.0-40.0 ft	Moist, very dark greenish gray clay with sand	69.0

Notes: Temperature of Drying : 110º Celsius

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-4	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-1	Test Date:	10/31/16	Checked By:	mcm
Depth :	38.0-40.0 ft	Test Id:	397033		
Test Comment:	---				
Visual Description:	Moist, very dark greenish gray clay with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	28.7	71.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	98		
#200	0.075	71		

Coefficients

D_{85} =0.1068 mm	D_{30} =N/A
D_{60} =N/A	D_{15} =N/A
D_{50} =N/A	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM Fat clay with sand (CH)

AASHTO Clayey Soils (A-7-6 (34))

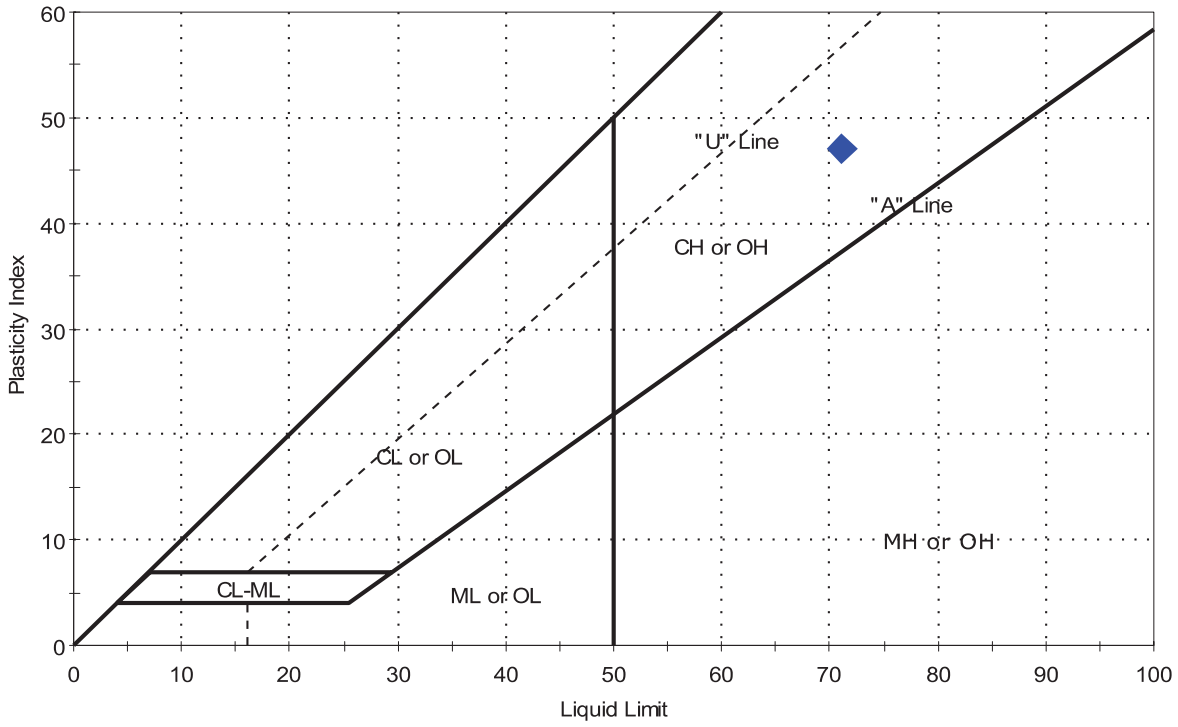
Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client:	F&ME Consultants				
Project:	US-21 Replacement Bridge over Harbor River				
Location:	---			Project No:	GTX-305005
Boring ID:	AP-4	Sample Type:	tube	Tested By:	GA
Sample ID:	UD-1	Test Date:	10/31/16	Checked By:	mcm
Depth :	38.0-40.0 ft	Test Id:	397034		
Test Comment:	---				
Visual Description:	Moist, very dark greenish gray clay with sand				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	UD-1	AP-4	38.0-40.0 ft	69	71	24	47	1	Fat clay with sand (CH)

Sample Prepared using the WET method
0% Retained on #40 Sieve
Dry Strength: HIGH
Dilatancy: SLOW
Toughness: LOW

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1281	**DATE SAMPLE RECEIVED:**	8/8/2016
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MB	**DATE OF TESTING:**	8/19/2016
		DATE OF WEIGHING:	8/22/2016

BORING NO.	AP-4/UD-2	AP-4/UD-3			
SAMPLE NO.	16-1281E	16-1281H			
SAMPLE DEPTH	40.0-42.0'	70.0-72.0'			
WATER CONTENT, W%	33.8	58.8			

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

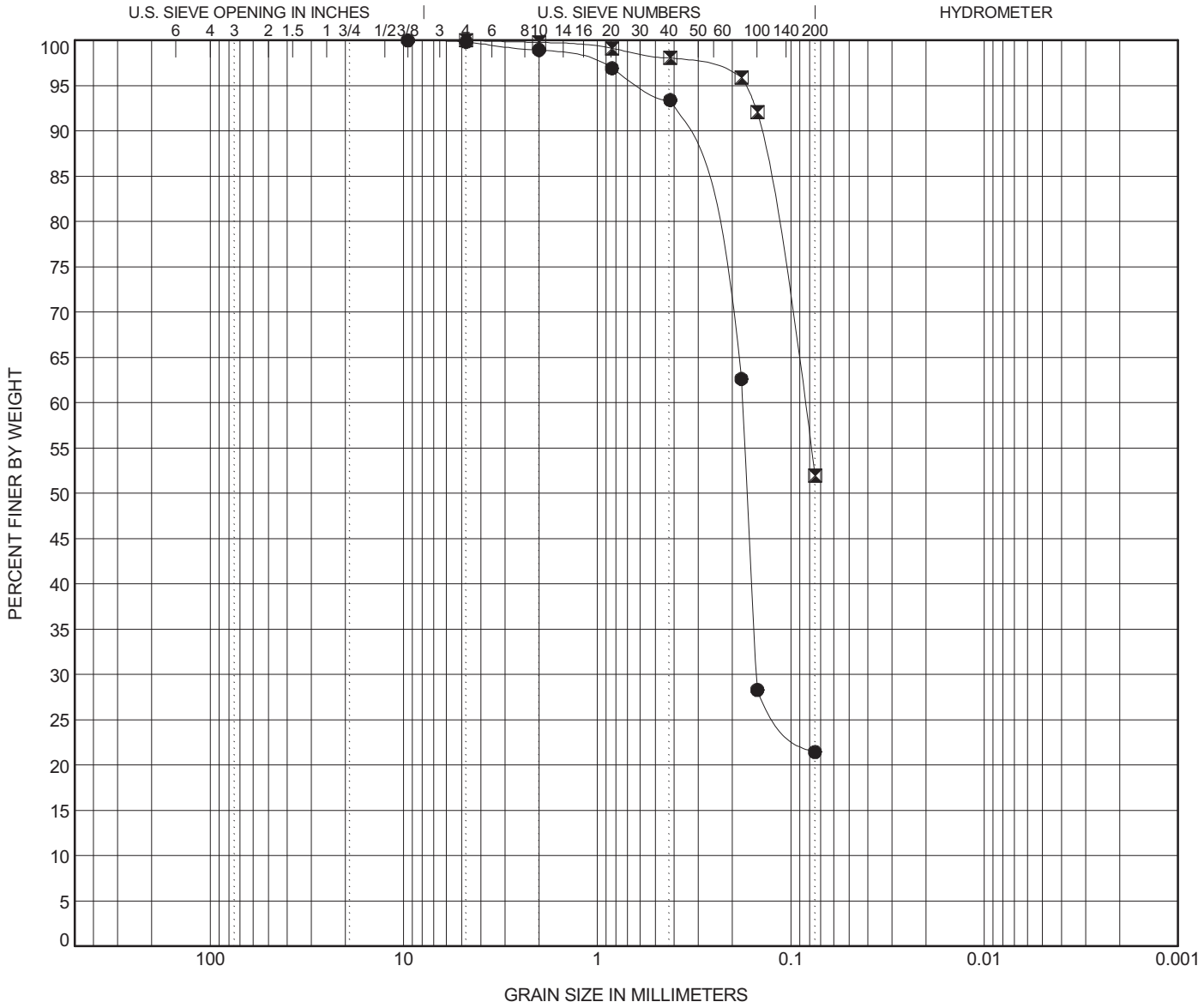
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**AP-4**	**42.0**	**Silty SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
⊠	**AP-4**	**72.0**	**Sandy SILT (ML) A-4(0)**	**NP**	**NP**	**NP**		

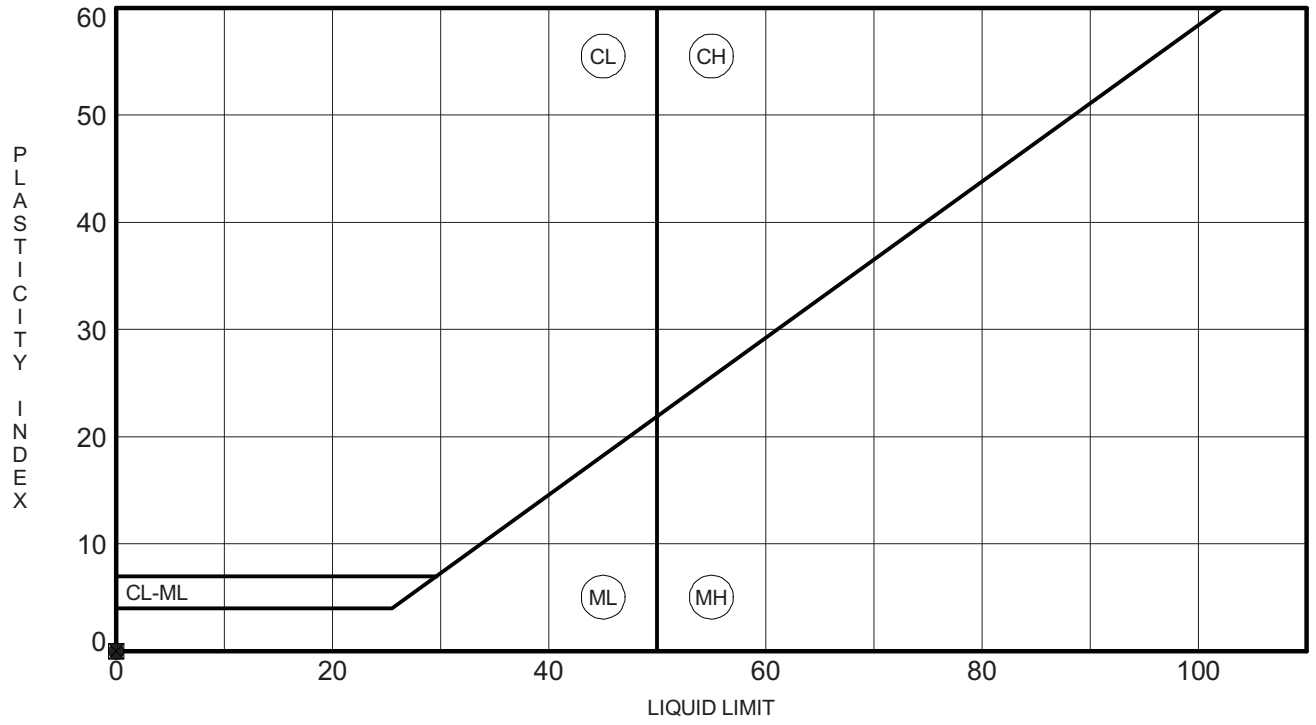
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**AP-4**	**42.0**	**9.52**	**0.574**	**0.168**		**0.2**	**78.4**	**21.5**	
⊠	**AP-4**	**72.0**	**4.76**	**0.172**			**0.0**	**48.0**	**52.0**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/18/16

ATTERBERG LIMITS' RESULTS

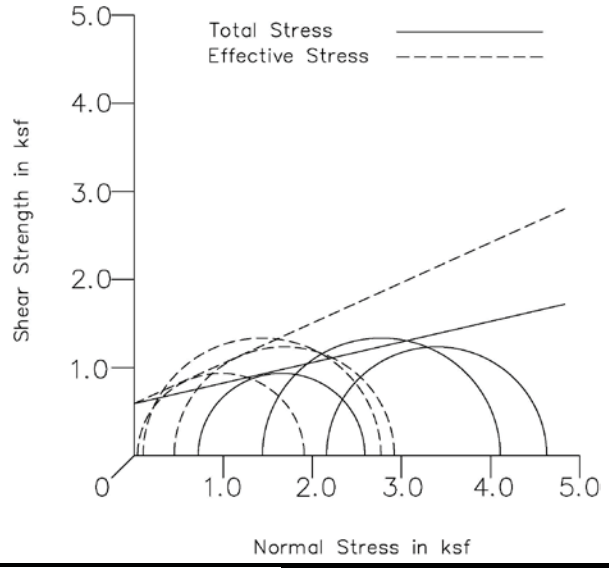
PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort

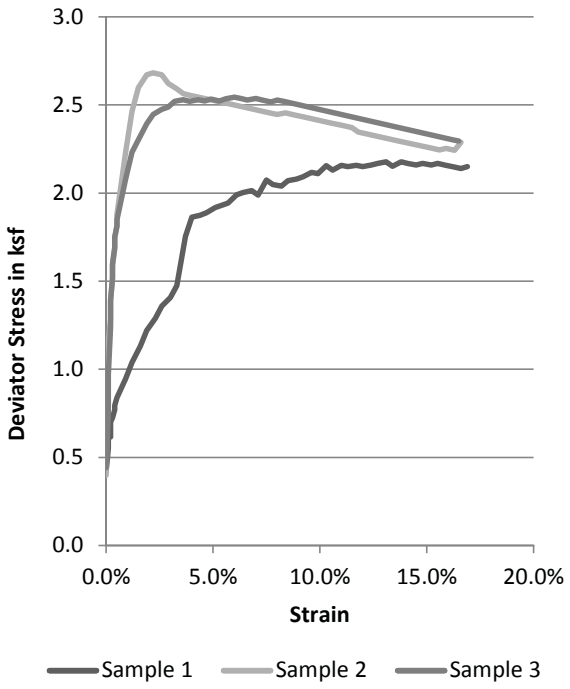


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**AP-4**	**42.0**	**NP**	**NP**	**NP**	**21**	**Silty SAND (SM) A-2-4**
⊠	**AP-4**	**72.0**	**NP**	**NP**	**NP**	**52**	**Sandy SILT (ML) A-4(0)**

TRIAXIAL SHEAR TEST REPORT
ASTM D4767 / AASHTO T297



Stress-Strain Curves



		Sample 1	Sample 2	Sample 3
Initial	Water Content, %	33.8%	33.8%	33.8%
	Void Ratio	1.13	1.40	0.88
	Diameter, in.	2.84	2.84	2.85
	Height, in.	5.74	5.84	5.87
	Volume, in^3	36.47	36.94	37.35
Final	Water Content, %	59.5%	53.8%	33.8%
	Void Ratio	1.56	1.40	0.90
	Diameter, in.	2.84	2.84	2.85
	Height, in.	5.66	5.72	5.79
	Volume, in^3	35.95	36.19	36.84
	Saturation, %	100.0%	100.0%	100.0%
	Dry Density, PCF	64.9	69.1	87.0
	Cell Pressure (ksf)	5.76	6.48	7.20
	Sample Pressure (ksf)	5.04	5.04	5.04
	Stress at Failure (ksf)	1.87	2.67	2.47
	Strain at Failure, %	4.4%	1.9%	2.6%
	σ_1 at Failure (ksf)	2.59	4.11	4.63
	σ_3 at Failure (ksf)	0.72	1.44	2.16
	σ'_1 at Failure (ksf)	1.91	2.77	2.92
	σ'_3 at Failure (ksf)	0.04	0.10	0.45

Project Name: US 21 Bridge Replacement over Harbor River

Project Number: G5396 Date: 9/1/2016

SCDOT Project ID: P026862

Location/Sample: AP-4/UD-2 / Sample #16-1281A

Depth/Elevation: 40.0' - 42.0'

Type of Test : Consolidated Undrained

Sample Type : Undisturbed - Shelby Tube

Description: Dark Grey Silty Fine to Medium SAND (SM), A-2-4

PI= NP % Fines= 21.5

C= 0.59 ksf C'= 0.59 ksf

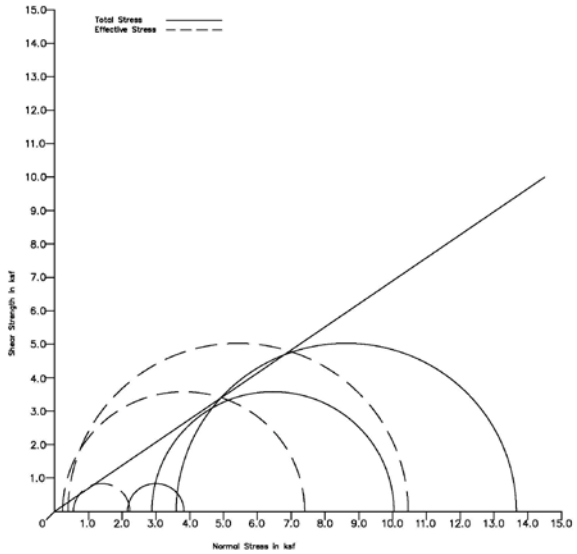
ϕ= 13° ϕ'= 24°

F&ME CONSULTANTS

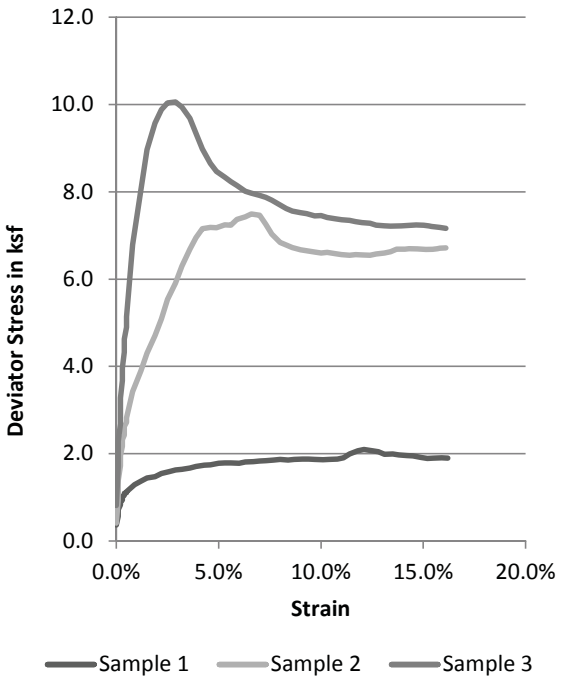
3112 Devine Street Columbia, SC 29205

Geotechnical · Environmental · Materials

TRIAXIAL SHEAR TEST REPORT
ASTM D4767 / AASHTO T297



Stress-Strain Curves



		Sample 1	Sample 2	Sample 3
Initial	Water Content, %	58.8%	58.8%	58.8%
	Void Ratio	1.75	1.49	1.51
	Diameter, in.	2.87	2.87	2.86
	Height, in.	5.86	5.90	5.90
	Volume, in^3	37.81	38.26	37.79
Final	Water Content, %	57.0%	52.0%	56.6%
	Void Ratio	1.61	1.36	1.45
	Diameter, in.	2.87	2.87	2.86
	Height, in.	5.47	5.79	5.82
	Volume, in^3	35.31	37.56	37.31
	Saturation, %	93.9%	100.0%	100.0%
	Dry Density, PCF	63.5	70.3	67.7
	Cell Pressure (ksf)	7.20	7.92	8.64
	Sample Pressure (ksf)	5.04	5.04	5.04
	Stress at Failure (ksf)	1.67	7.16	10.06
	Strain at Failure, %	3.6%	4.2%	2.9%
	σ_1 at Failure (ksf)	3.83	10.04	13.66
	σ_3 at Failure (ksf)	2.16	2.88	3.60
	σ'_1 at Failure (ksf)	2.23	7.40	10.46
	σ'_3 at Failure (ksf)	0.56	0.24	0.40

Project Name	US 21 Bridge Replacement over Harbor River
Project Number	G5396
Date	9/8/2016
SCDOT Project ID	P026862
Location/Sample	AP-4/UD-3 / Sample #16-1281B
Depth/Elevation	70.0' - 72.0'

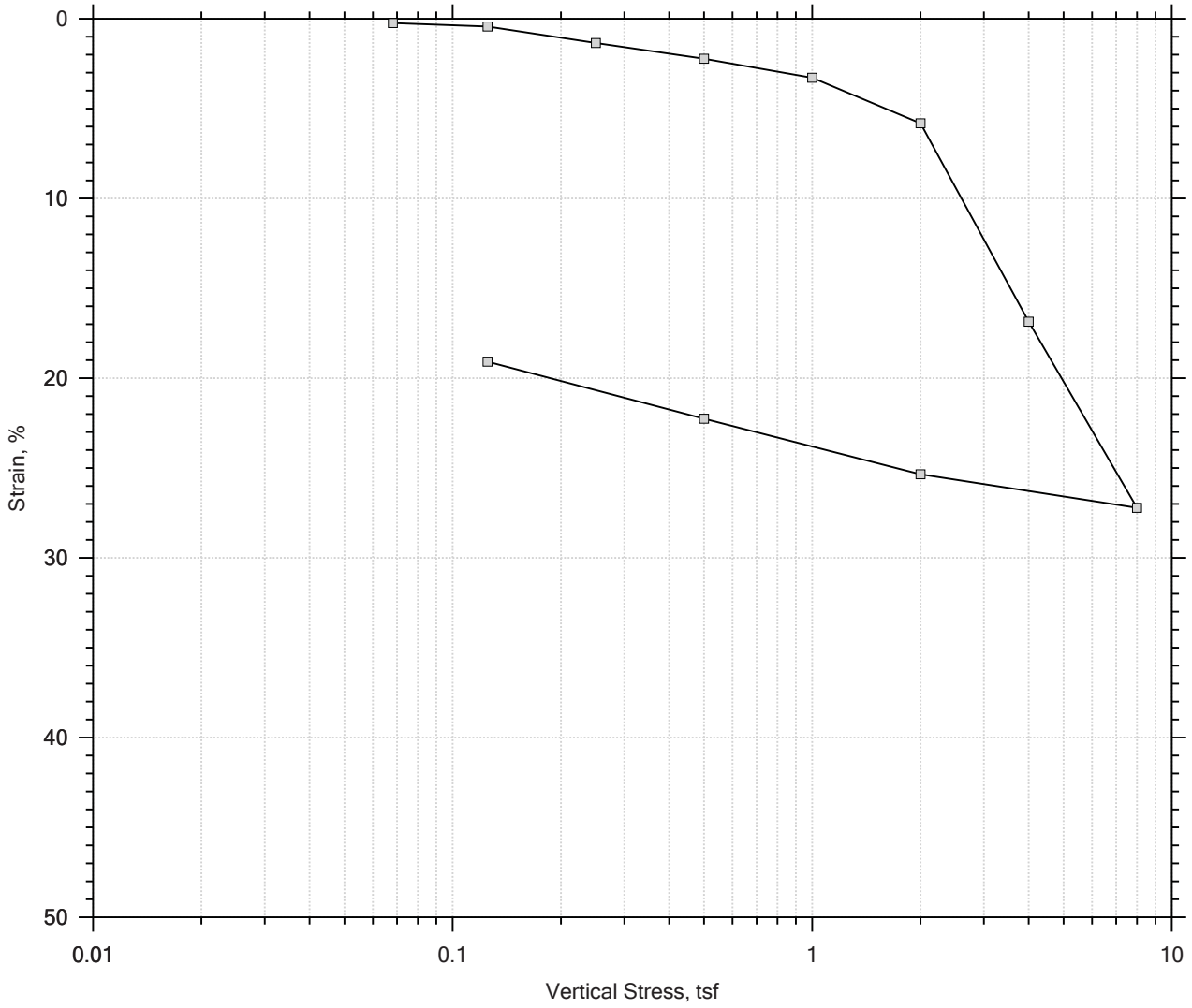
Type of Test : Consolidated Undrained
Sample Type : Undisturbed - Shelby Tube
Description: Dark Grey Fine Sandy SILT (ML), A-4(0)

PI= NP % Fines= 52.0
C= 0 C'= --
ϕ= 34° ϕ'= --

F&ME CONSULTANTS
3112 Devine Street Columbia, SC 29205
Geotechnical · Environmental · Materials

One-Dimensional Consolidation by ASTM D2435 - Method B

Summary Report

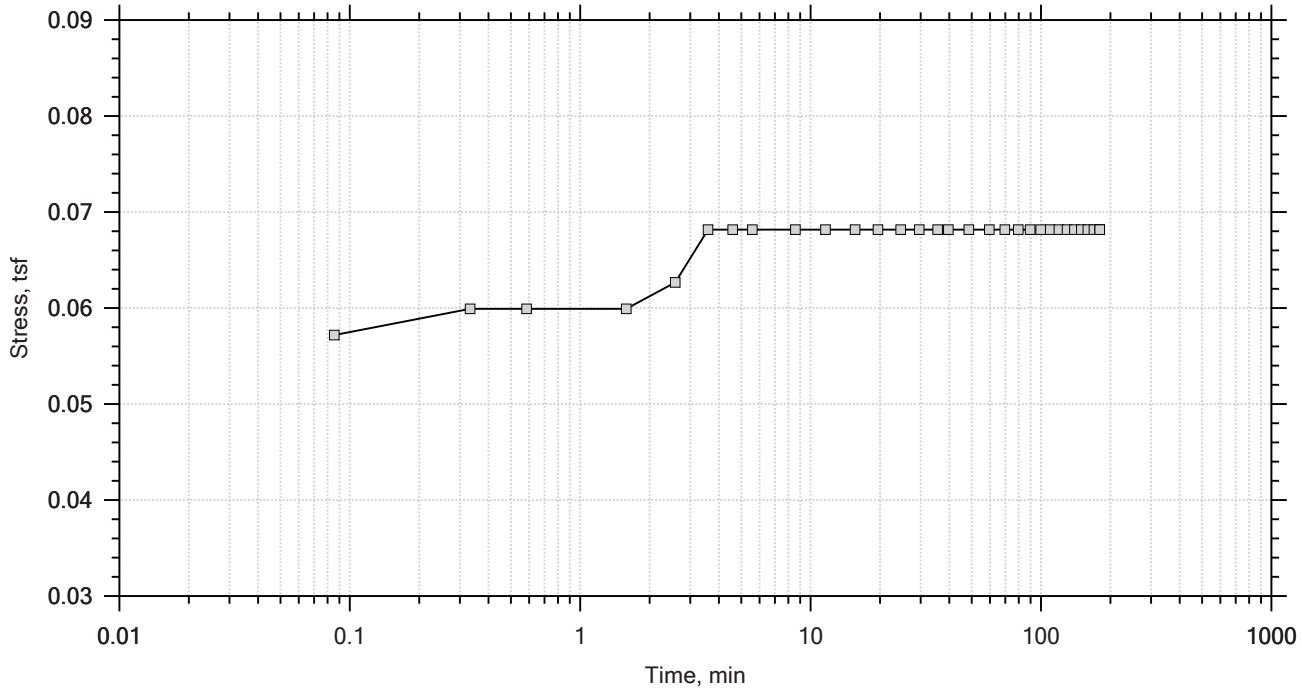


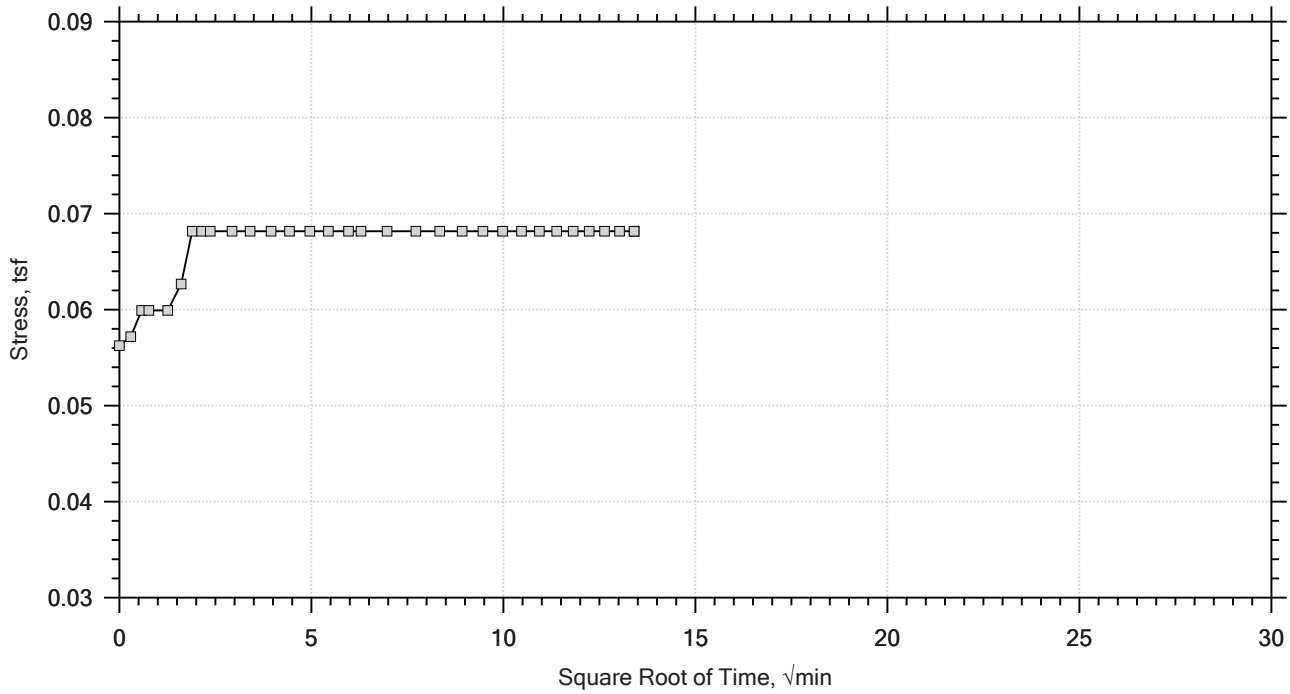
				Before Test	After Test
Current Vertical Effective Stress: ---				Water Content, %	76.63	57.24
Preconsolidation Stress: ---				Dry Unit Weight, pcf	53.798	66.486
Compression Ratio: ---				Saturation, %	96.53	100.00
Diameter: 2.5 in		Height: 1 in		Void Ratio	2.17	1.56
LL: ---	PL: ---	PI: ---	GS: 2.73			

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-4	Tested By: jm	Checked By: mcm
	Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
	Test No.: IP-7	Sample Type: intact	Elevation: ---
	Description: Moist, very dark greenish gray clay with sand		
	Remarks: System 5077 Swell Pressure = 0.0682 tsf		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 1 of 11
Constant Volume Step
Stress: 0.0682 tsf

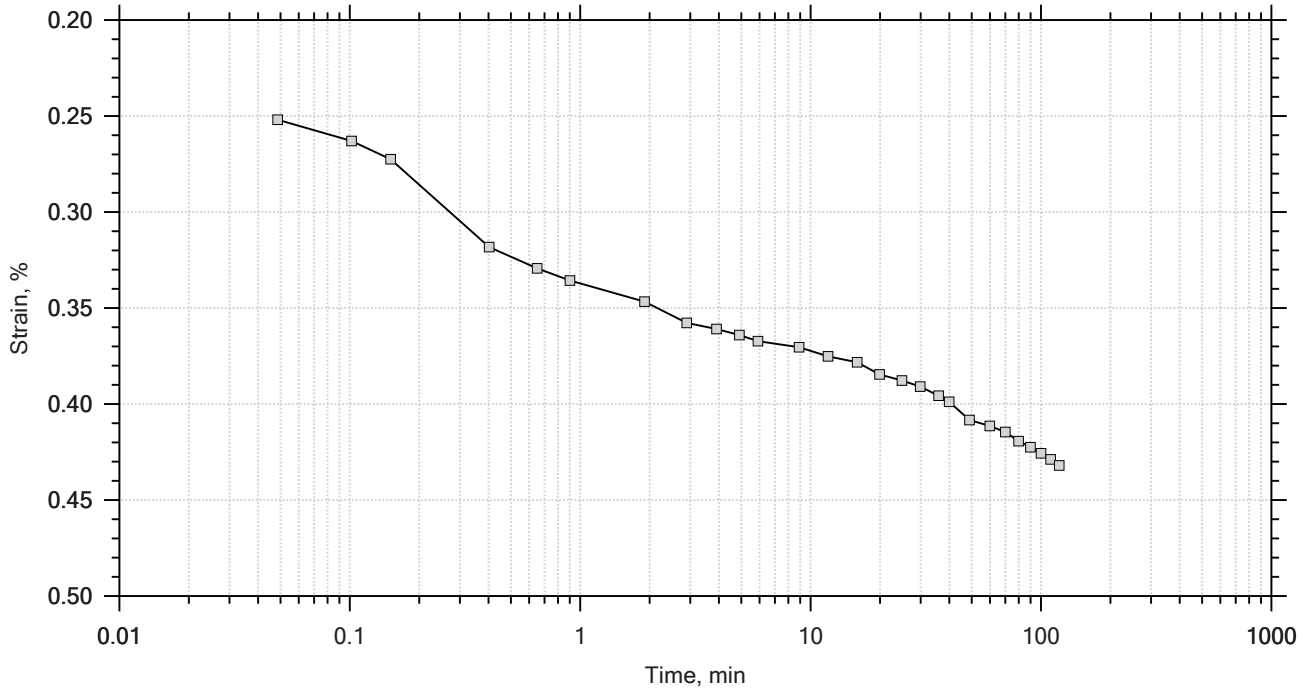


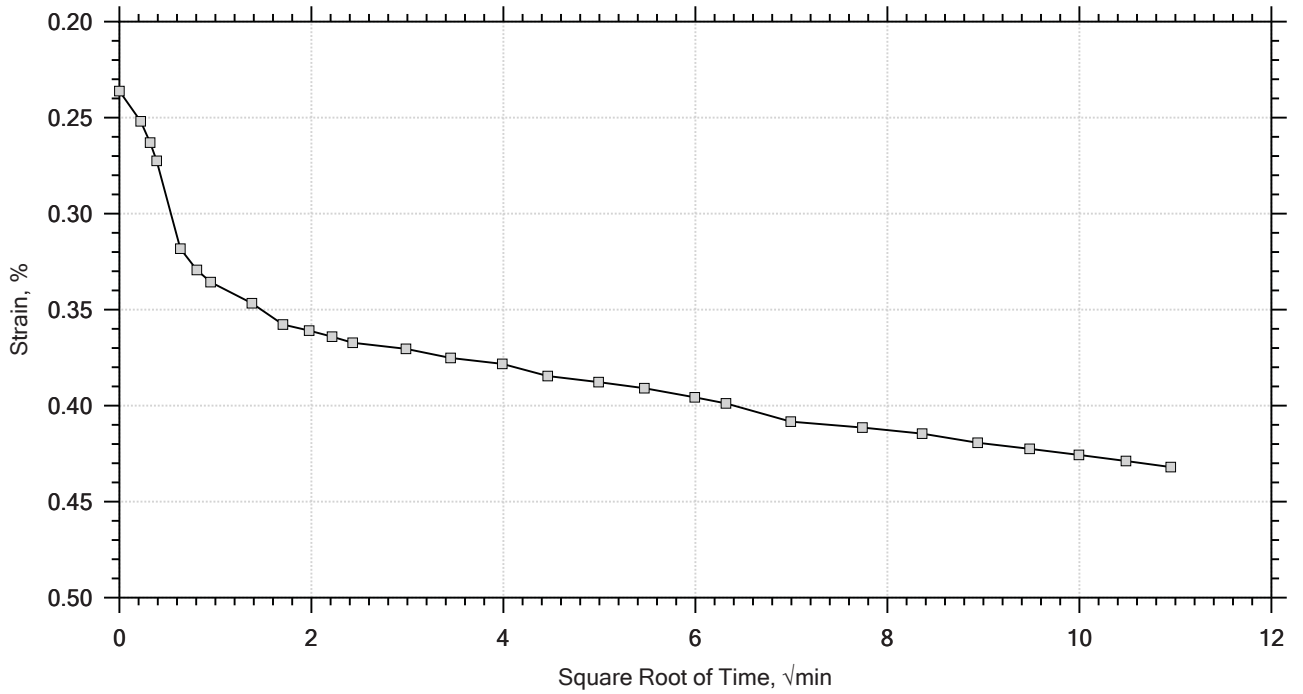


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-4	Tested By: jm	Checked By: mcm
	Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
	Test No.: IP-7	Sample Type: intact	Elevation: ---
	Description: Moist, very dark greenish gray clay with sand		
	Remarks: System 5077 Swell Pressure = 0.0682 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 2 of 11
Constant Load Step
Stress: 0.125 tsf

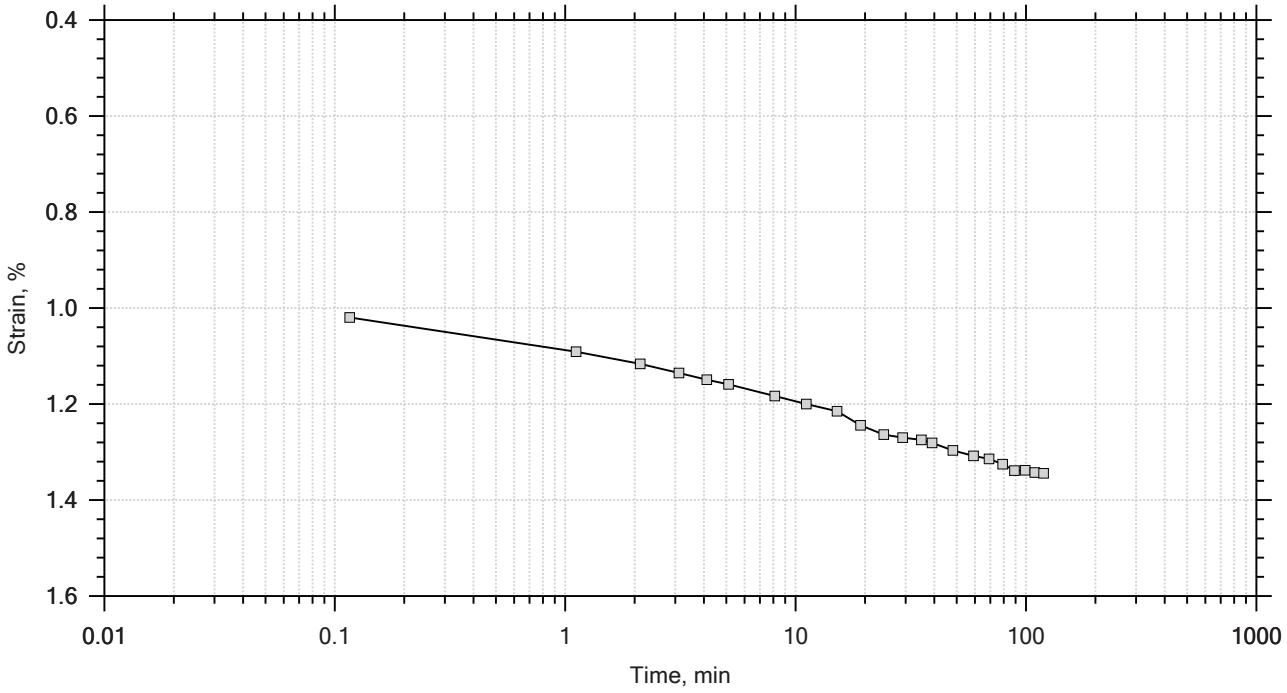


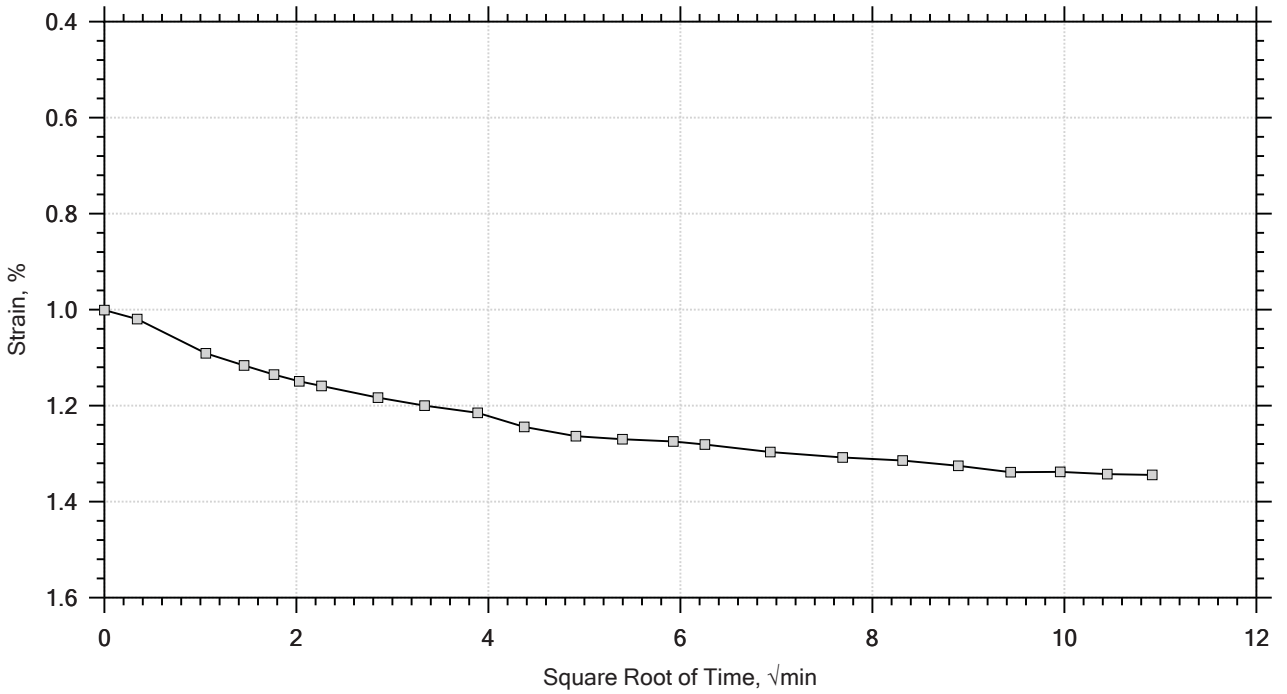


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-4	Tested By: jm	Checked By: mcm
Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
Test No.: IP-7	Sample Type: intact	Elevation: ---
Description: Moist, very dark greenish gray clay with sand		
Remarks: System 5077 Swell Pressure = 0.0682 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 3 of 11
Constant Load Step
Stress: 0.25 tsf

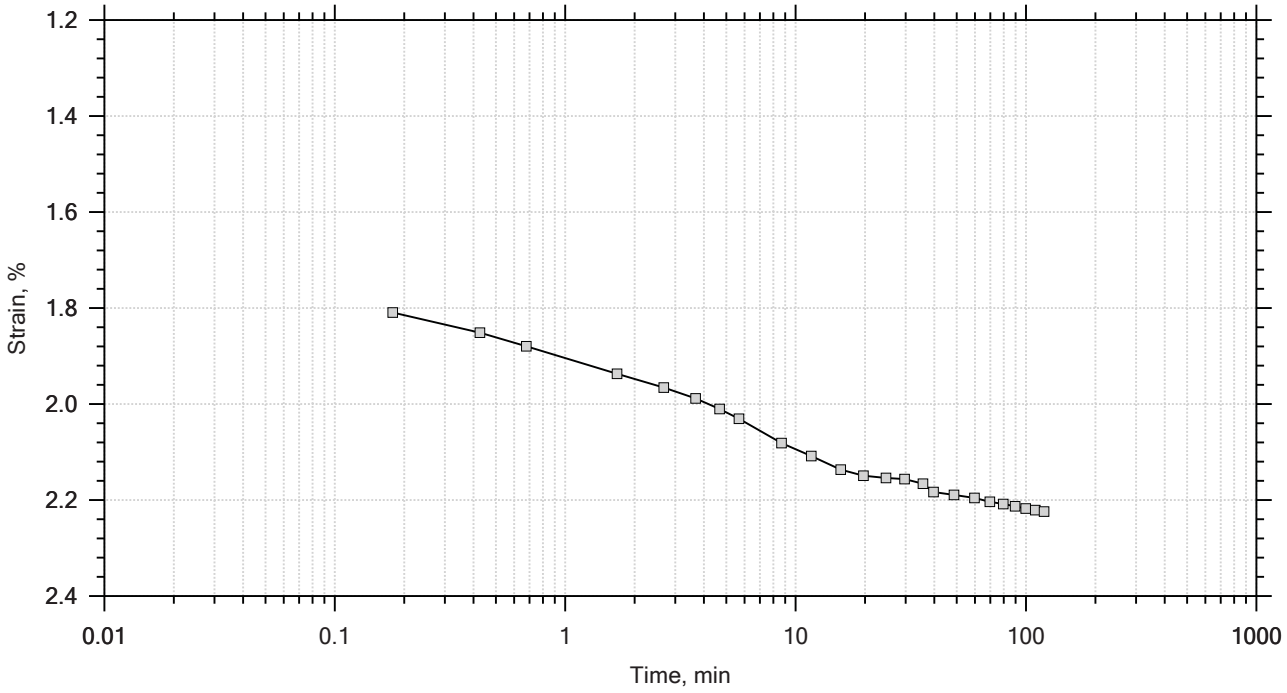


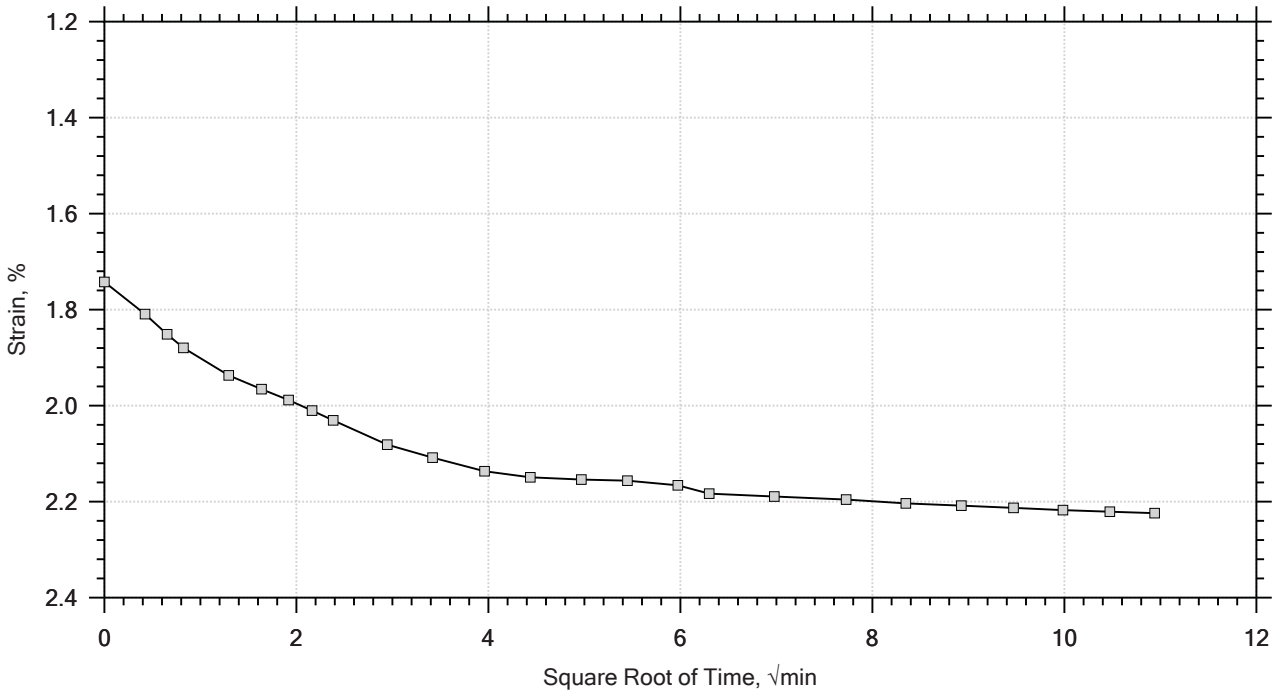


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-4	Tested By: jm	Checked By: mcm
Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
Test No.: IP-7	Sample Type: intact	Elevation: ---
Description: Moist, very dark greenish gray clay with sand		
Remarks: System 5077 Swell Pressure = 0.0682 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 4 of 11
Constant Load Step
Stress: 0.5 tsf

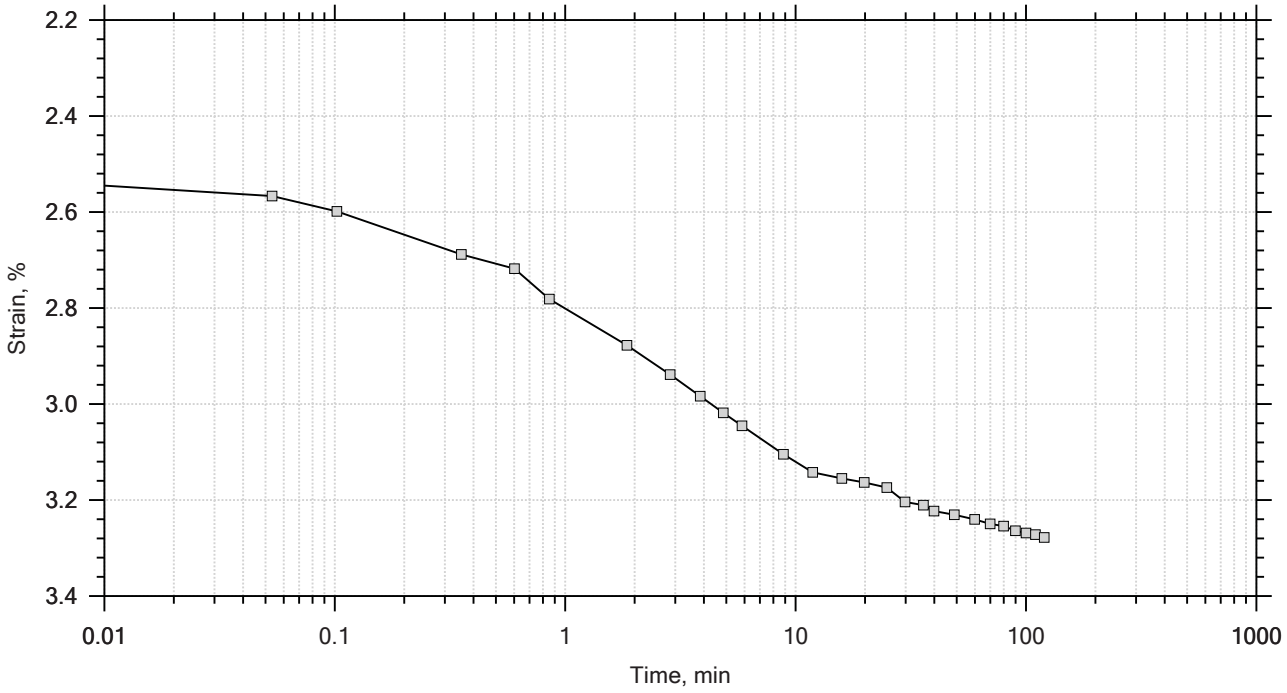


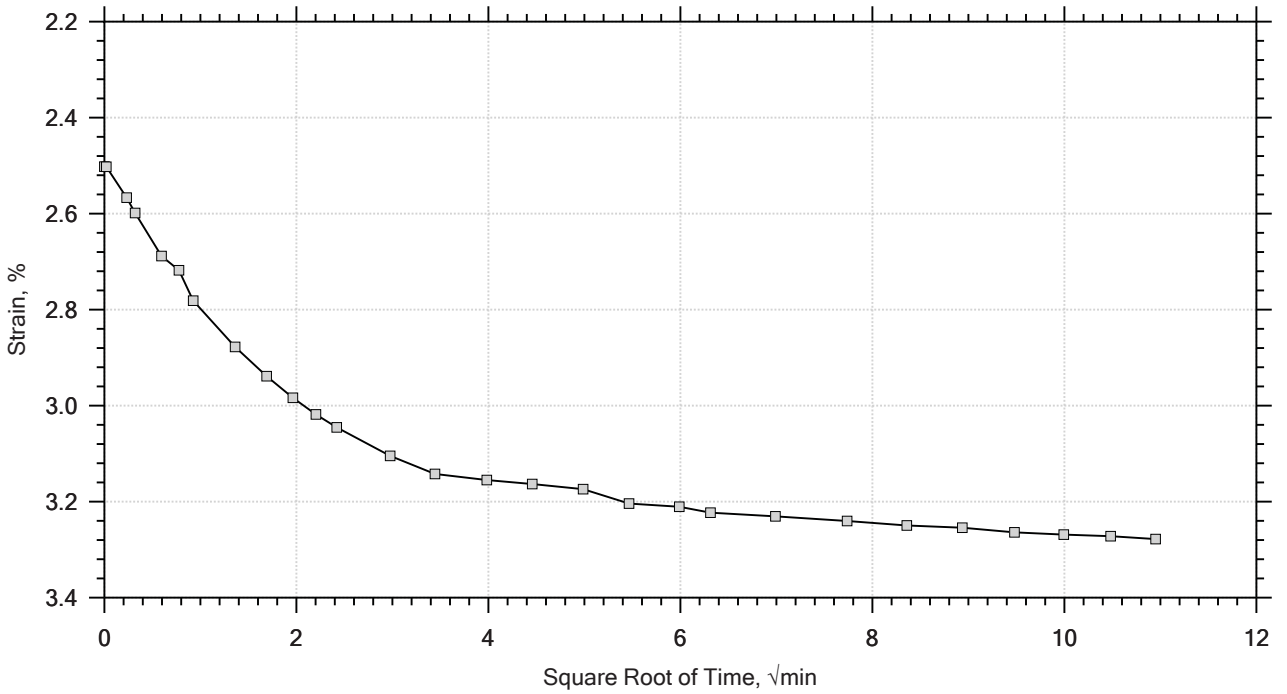


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-4	Tested By: jm	Checked By: mcm
Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
Test No.: IP-7	Sample Type: intact	Elevation: ---
Description: Moist, very dark greenish gray clay with sand		
Remarks: System 5077 Swell Pressure = 0.0682 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 5 of 11
Constant Load Step
Stress: 1 tsf

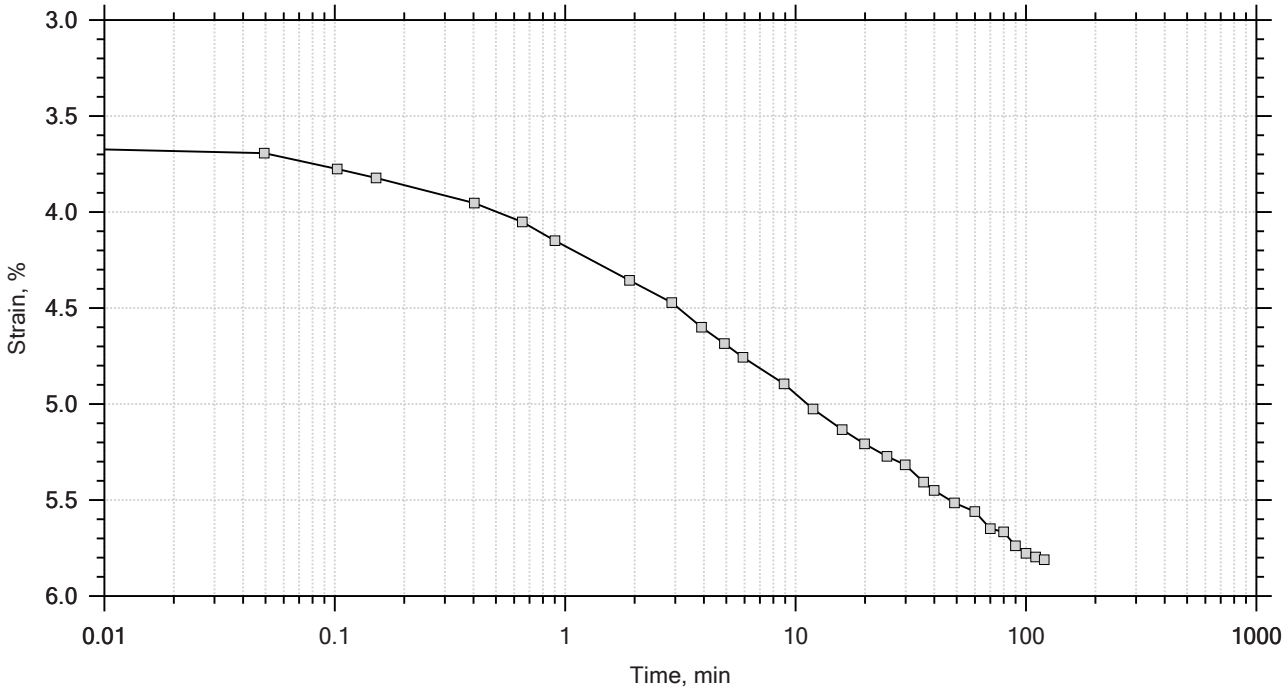


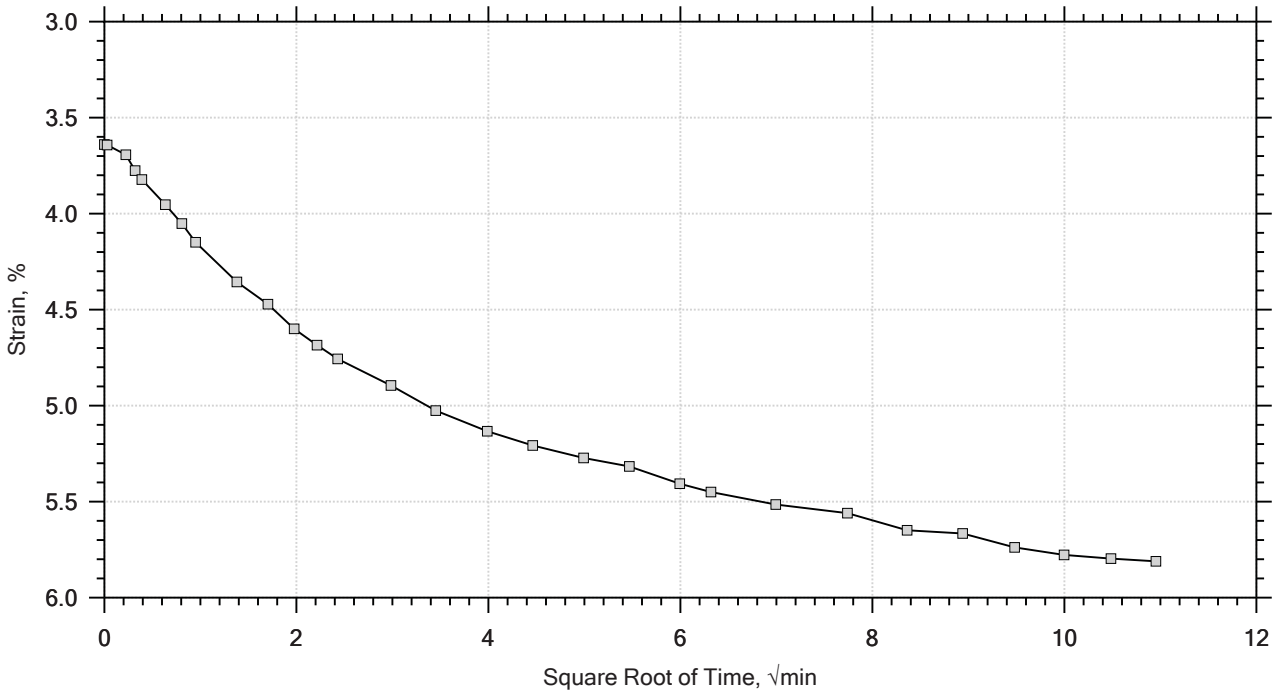


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-4	Tested By: jm	Checked By: mcm
Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
Test No.: IP-7	Sample Type: intact	Elevation: ---
Description: Moist, very dark greenish gray clay with sand		
Remarks: System 5077 Swell Pressure = 0.0682 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 6 of 11
Constant Load Step
Stress: 2 tsf

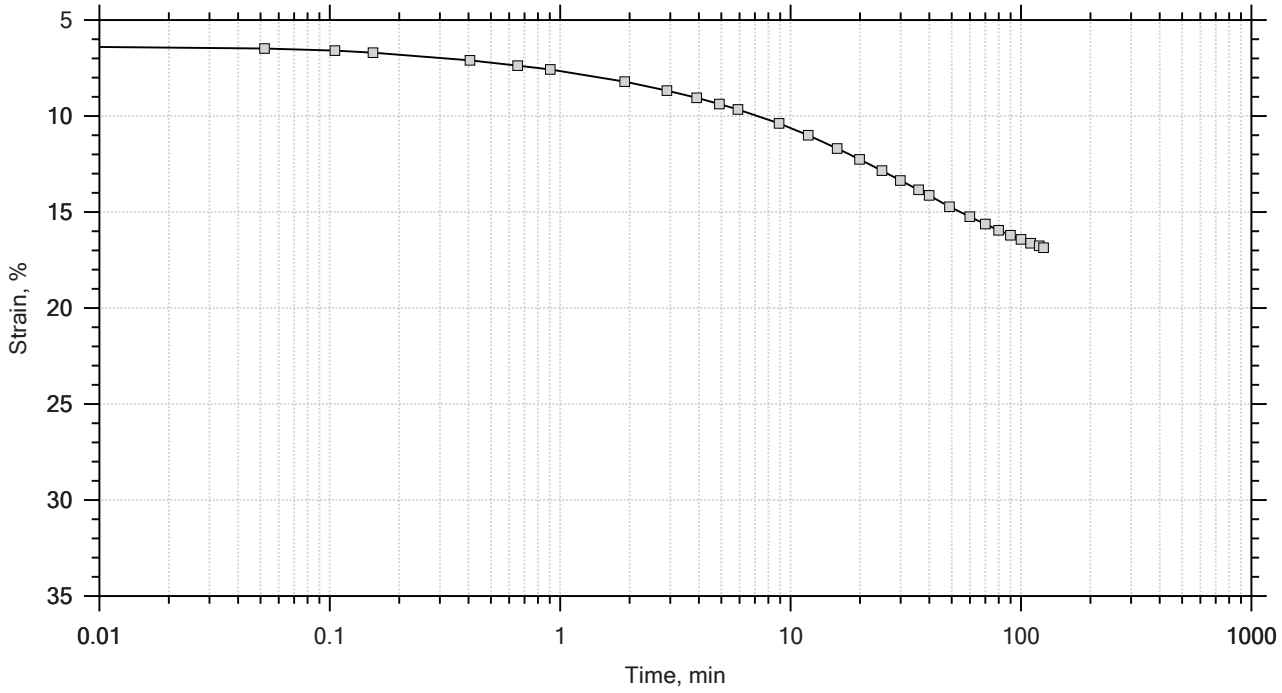


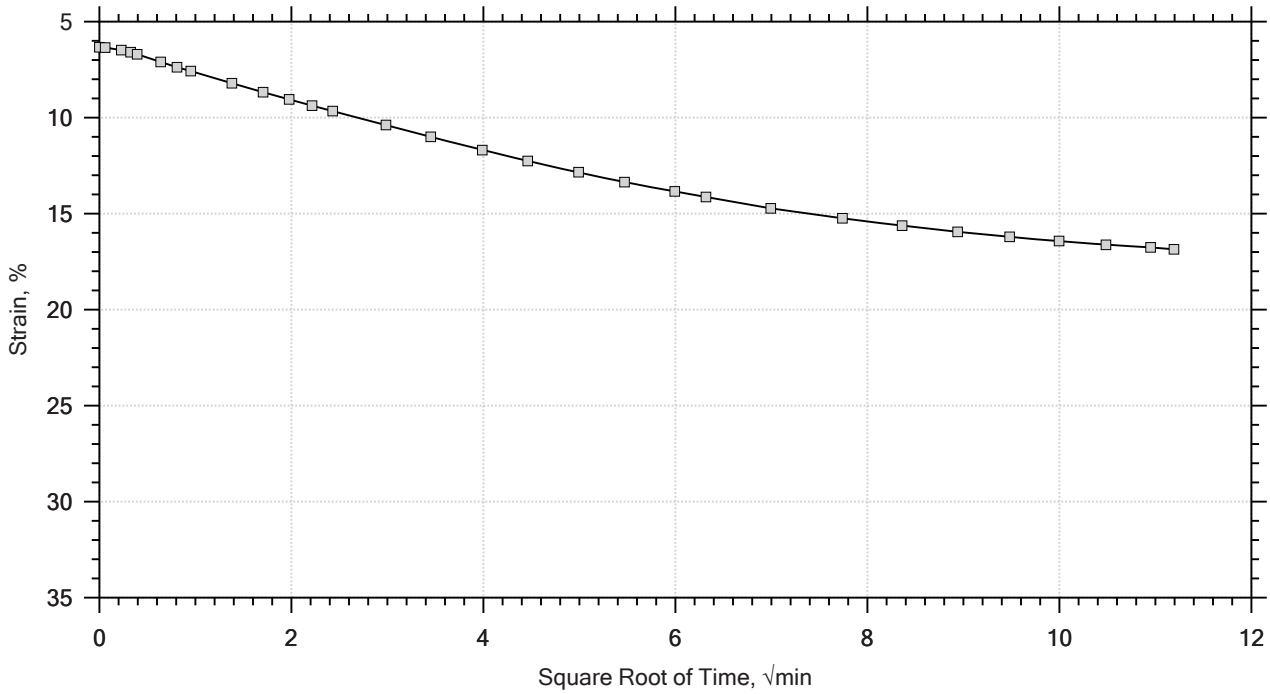


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-4	Tested By: jm	Checked By: mcm
Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
Test No.: IP-7	Sample Type: intact	Elevation: ---
Description: Moist, very dark greenish gray clay with sand		
Remarks: System 5077 Swell Pressure = 0.0682 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 7 of 11
Constant Load Step
Stress: 4 tsf

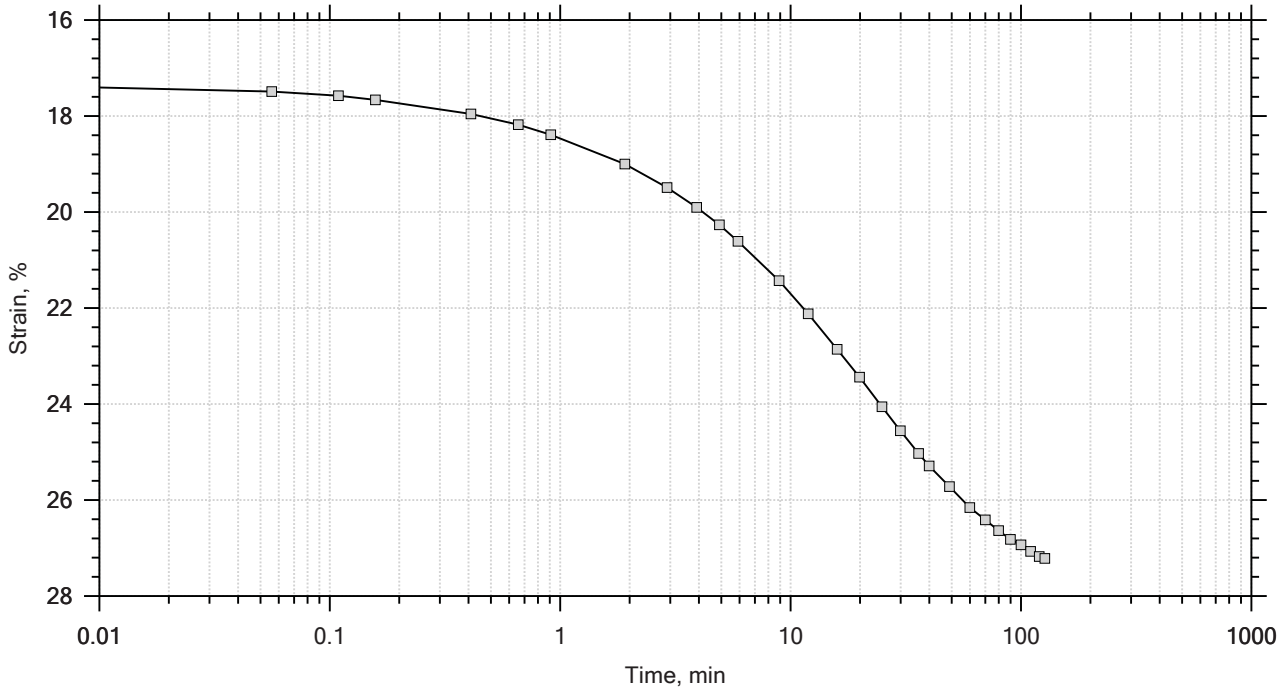


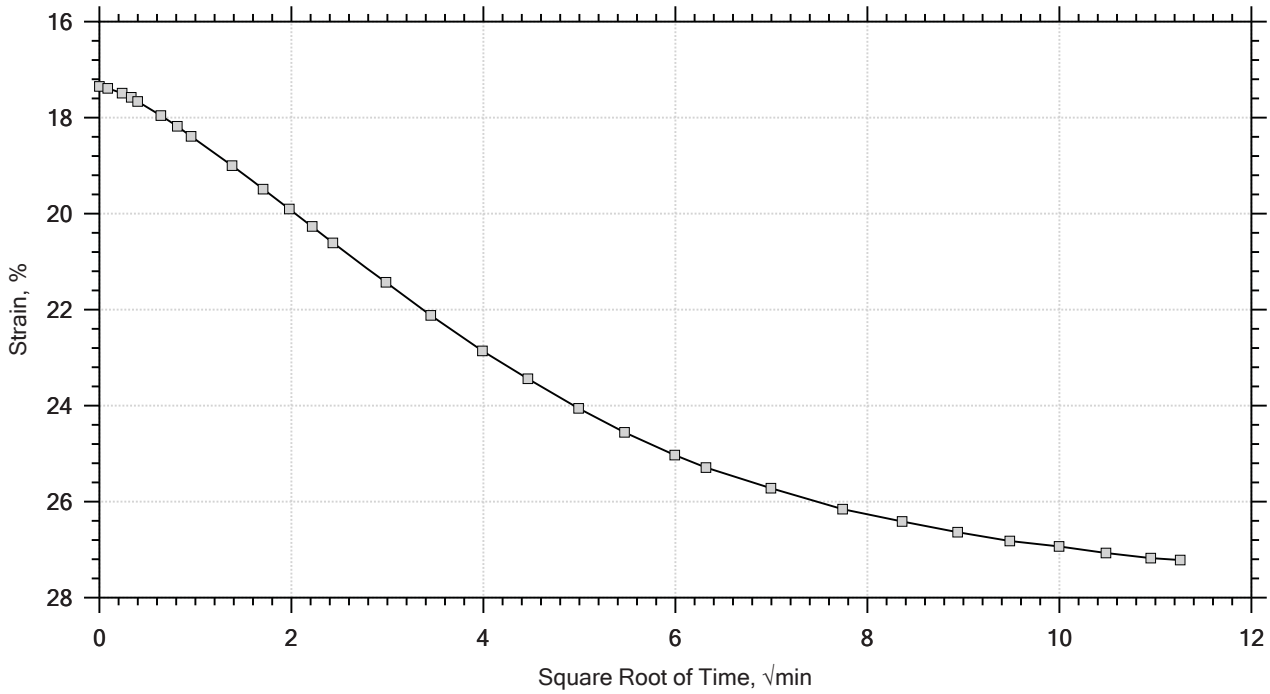


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-4	Tested By: jm	Checked By: mcm
Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
Test No.: IP-7	Sample Type: intact	Elevation: ---
Description: Moist, very dark greenish gray clay with sand		
Remarks: System 5077 Swell Pressure = 0.0682 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 8 of 11
Constant Load Step
Stress: 8 tsf

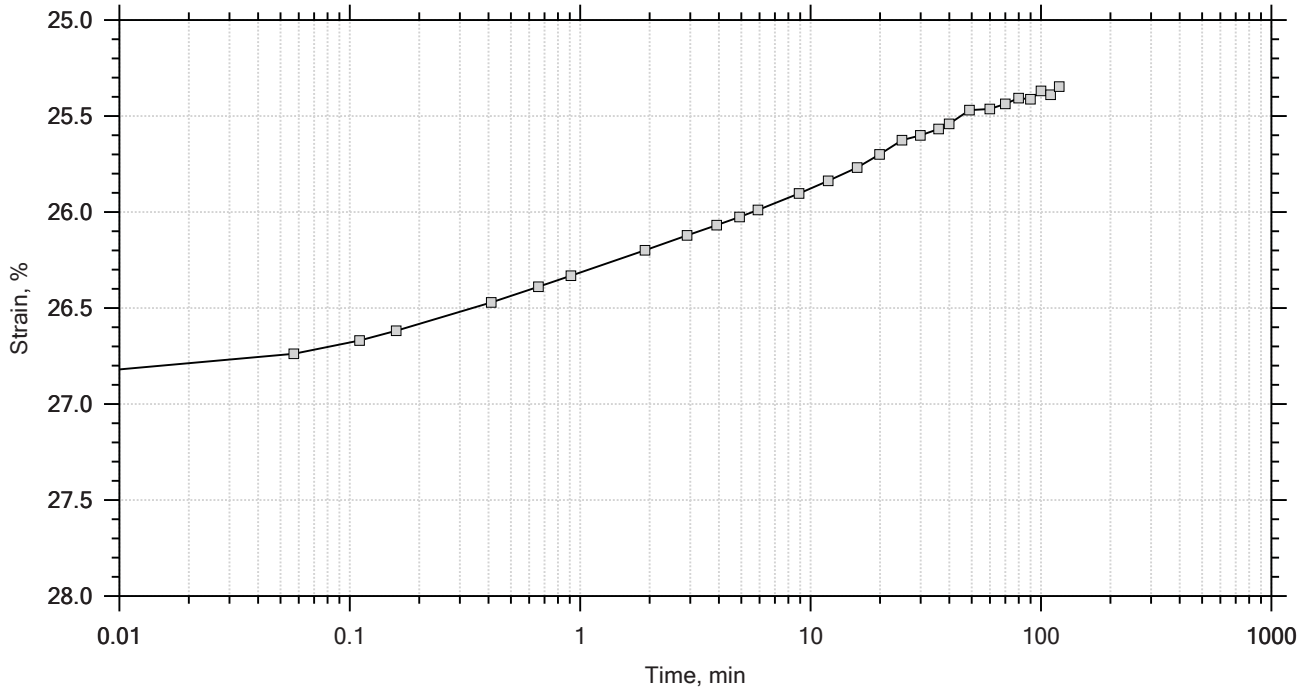


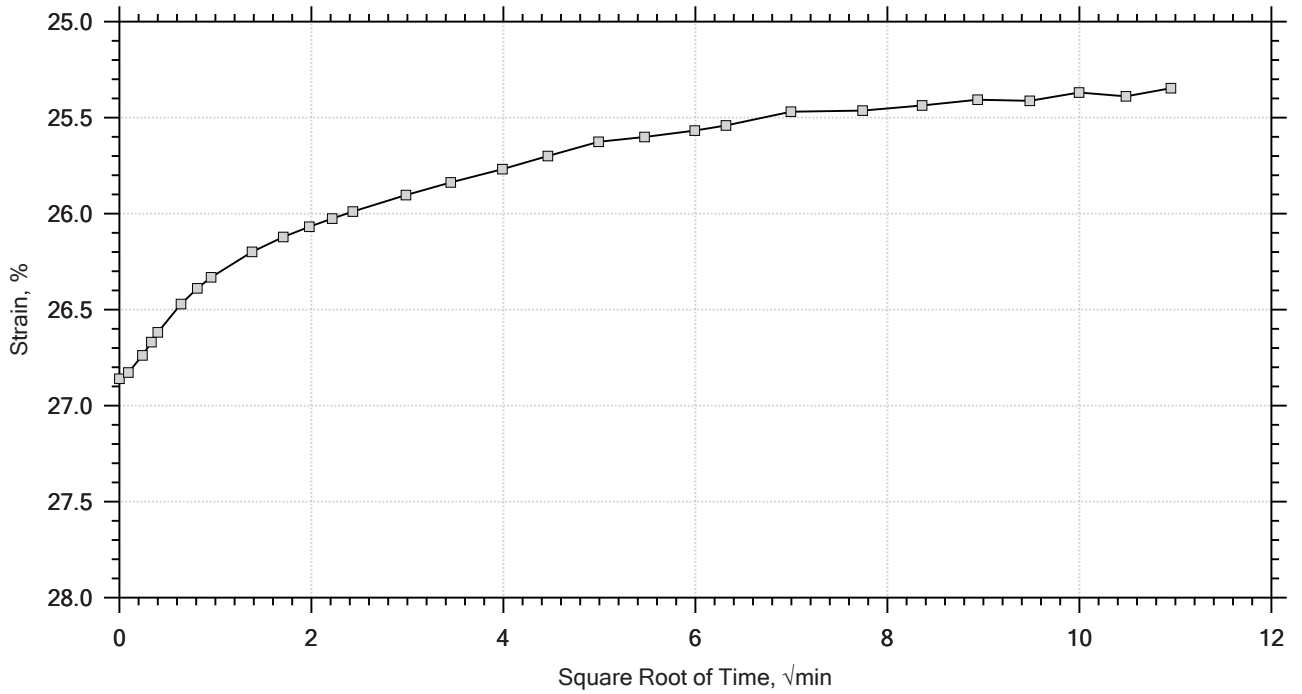


GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-4	Tested By: jm	Checked By: mcm
	Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
	Test No.: IP-7	Sample Type: intact	Elevation: ---
	Description: Moist, very dark greenish gray clay with sand		
	Remarks: System 5077 Swell Pressure = 0.0682 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 9 of 11
Constant Load Step
Stress: 2 tsf

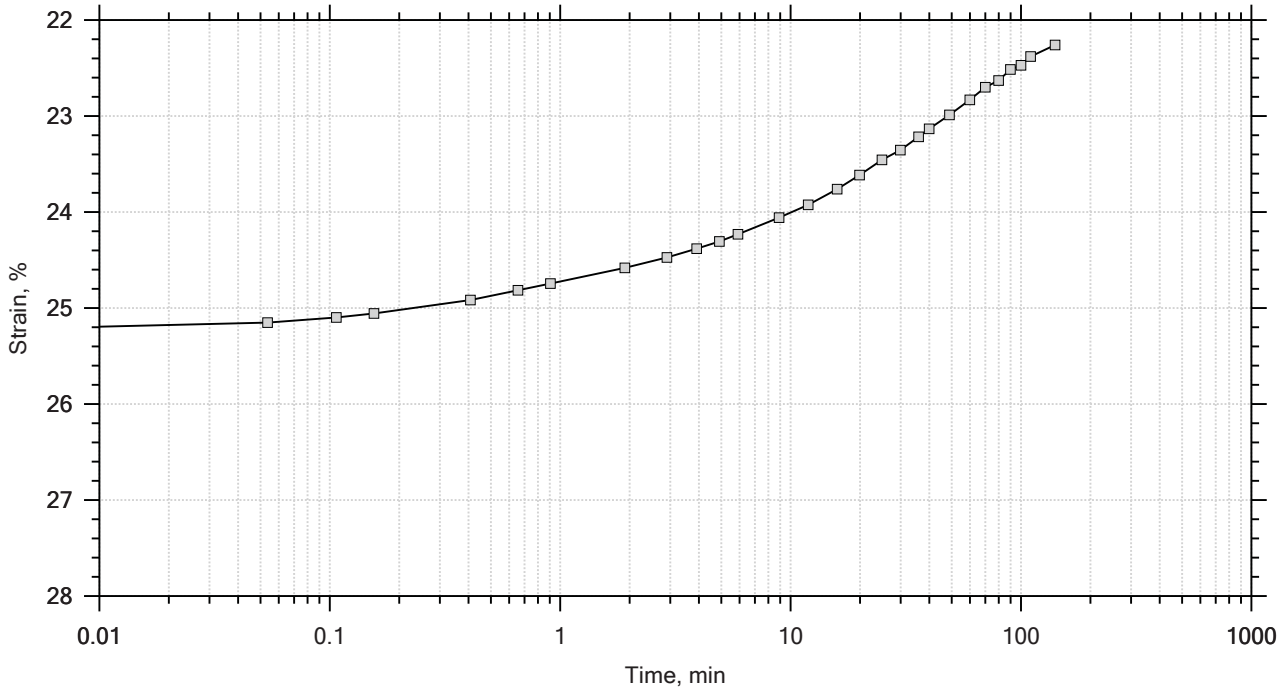


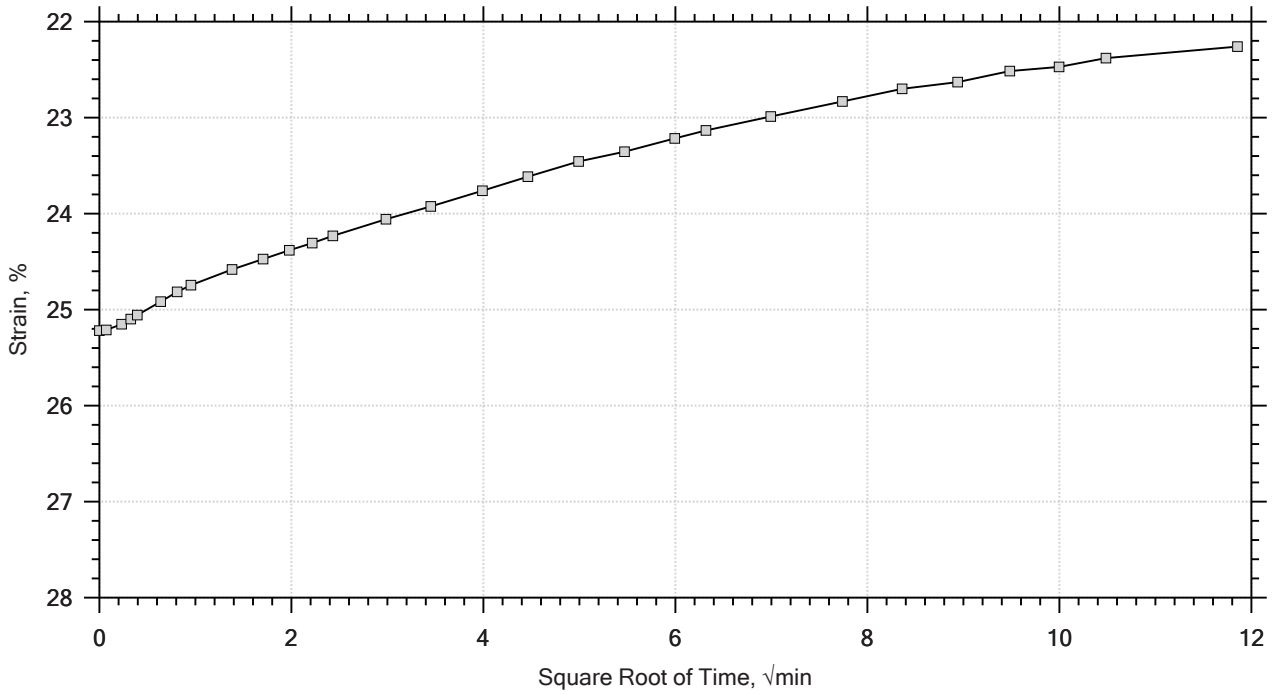


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-4	Tested By: jm	Checked By: mcm
Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
Test No.: IP-7	Sample Type: intact	Elevation: ---
Description: Moist, very dark greenish gray clay with sand		
Remarks: System 5077 Swell Pressure = 0.0682 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 10 of 11
Constant Load Step
Stress: 0.5 tsf

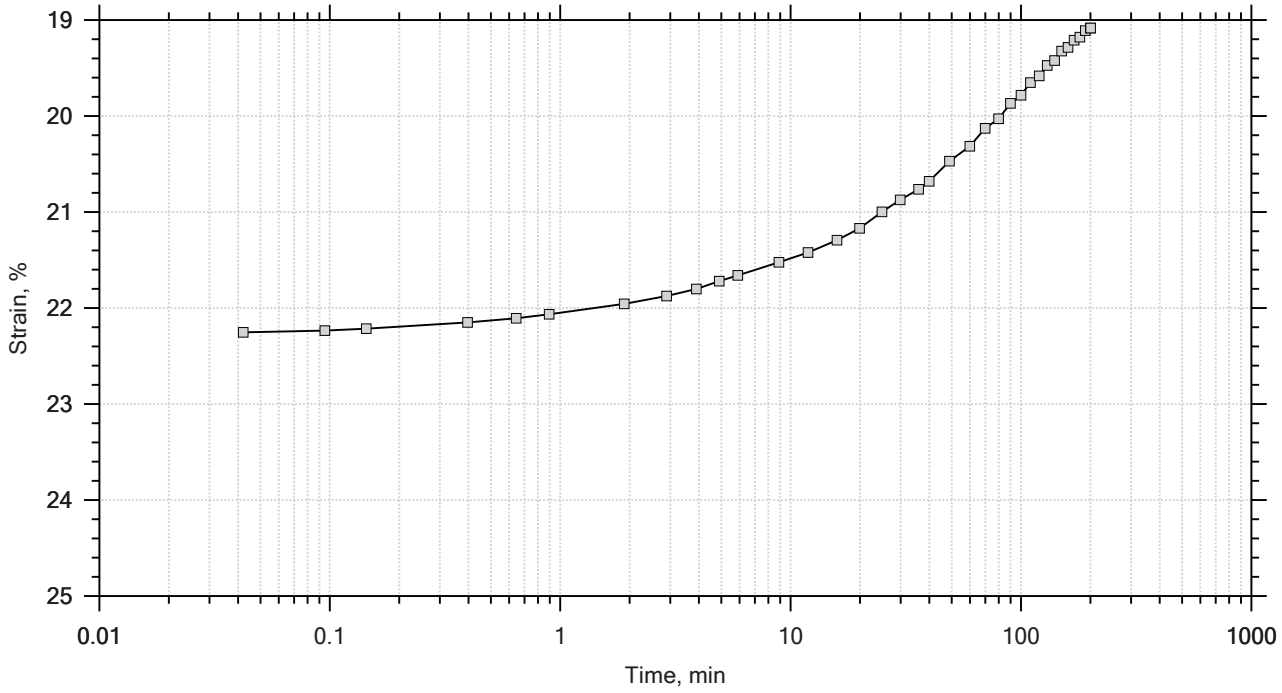


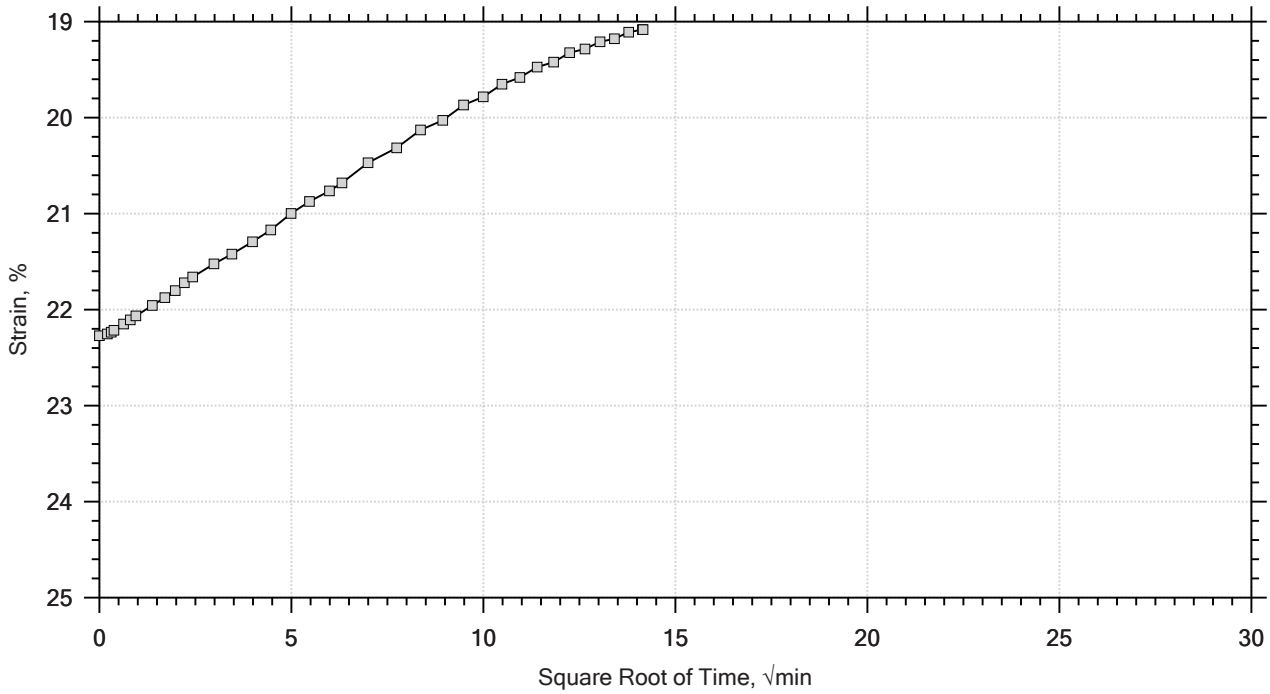


Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-4	Tested By: jm	Checked By: mcm
Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
Test No.: IP-7	Sample Type: intact	Elevation: ---
Description: Moist, very dark greenish gray clay with sand		
Remarks: System 5077 Swell Pressure = 0.0682 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Time Curve 11 of 11
Constant Load Step
Stress: 0.125 tsf





Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-4	Tested By: jm	Checked By: mcm
Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
Test No.: IP-7	Sample Type: intact	Elevation: ---
Description: Moist, very dark greenish gray clay with sand		
Remarks: System 5077 Swell Pressure = 0.0682 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.73	Liquid Limit: ---
Initial Height: 1.00 in	Initial Void Ratio: 2.17	Plastic Limit: ---
Final Height: 0.81 in	Final Void Ratio: 1.56	Plasticity Index: ---

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	a31	RING	a34	a34
Mass Container, gm	16.39	17.08	17.08	17.08
Mass Container + Wet Soil, gm	92.25	139.52	126.08	126.08
Mass Container + Dry Soil, gm	61.37	86.4	86.4	86.4
Mass Dry Soil, gm	44.98	69.32	69.32	69.32
Water Content, %	68.65	76.63	57.24	57.24
Void Ratio	---	2.17	1.56	---
Degree of Saturation, %	---	96.53	100.00	---
Dry Unit Weight, pcf	---	53.798	66.486	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS	Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
	Boring No.: AP-4	Tested By: jm	Checked By: mcm
	Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
	Test No.: IP-7	Sample Type: intact	Elevation: ---
	Description: Moist, very dark greenish gray clay with sand		
	Remarks: System 5077 Swell Pressure = 0.0682 tsf		

One-Dimensional Consolidation by ASTM D2435 - Method B

Log of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/s	Mv 1/tsf	k cm/s	Ca %
1	0.0682	0.002345	2.16	0.235	0.000	0.00e+00	3.44e-02	0.00e+00	0.00e+00
2	0.125	0.004319	2.15	0.432	0.000	0.00e+00	3.47e-02	0.00e+00	0.00e+00
3	0.250	0.01344	2.12	1.34	7.623	7.35e-07	7.30e-02	5.10e-08	0.00e+00
4	0.500	0.02224	2.10	2.22	4.343	1.27e-06	3.52e-02	4.24e-08	0.00e+00
5	1.00	0.03278	2.06	3.28	1.756	3.07e-06	2.11e-02	6.16e-08	0.00e+00
6	2.00	0.05810	1.98	5.81	0.000	0.00e+00	2.53e-02	0.00e+00	0.00e+00
7	4.00	0.1686	1.63	16.9	0.000	0.00e+00	5.52e-02	0.00e+00	0.00e+00
8	8.00	0.2721	1.30	27.2	13.862	2.50e-07	2.59e-02	6.16e-09	0.00e+00
9	2.00	0.2535	1.36	25.3	0.000	0.00e+00	3.11e-03	0.00e+00	0.00e+00
10	0.500	0.2226	1.46	22.3	0.000	0.00e+00	2.06e-02	0.00e+00	0.00e+00
11	0.125	0.1908	1.56	19.1	0.000	0.00e+00	8.47e-02	0.00e+00	0.00e+00

GeoTesting EXPRESS

Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-4	Tested By: jm	Checked By: mcm
Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
Test No.: IP-7	Sample Type: intact	Elevation: ---
Description: Moist, very dark greenish gray clay with sand		
Remarks: System 5077 Swell Pressure = 0.0682 tsf		
Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Square Root of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv ft²/s	Mv 1/tsf	k cm/s
1	0.0682	0.002345	2.16	0.235	156.469	1.56e-07	3.44e-02	5.12e-09
2	0.125	0.004319	2.15	0.432	93.234	2.61e-07	3.47e-02	8.64e-09
3	0.250	0.01344	2.12	1.34	20.743	1.16e-06	7.30e-02	8.07e-08
4	0.500	0.02224	2.10	2.22	17.290	1.37e-06	3.52e-02	4.58e-08
5	1.00	0.03278	2.06	3.28	5.957	3.90e-06	2.11e-02	7.81e-08
6	2.00	0.05810	1.98	5.81	23.280	9.60e-07	2.53e-02	2.31e-08
7	4.00	0.1686	1.63	16.9	53.337	3.62e-07	5.52e-02	1.90e-08
8	8.00	0.2721	1.30	27.2	49.954	2.99e-07	2.59e-02	7.35e-09
9	2.00	0.2535	1.36	25.3	14.786	9.02e-07	3.11e-03	2.67e-09
10	0.500	0.2226	1.46	22.3	40.501	3.52e-07	2.06e-02	6.89e-09
11	0.125	0.1908	1.56	19.1	182.068	8.48e-08	8.47e-02	6.83e-09

GeoTesting EXPRESS

Project: US-21 Replacement Bridge	Location: ---	Project No.: GTX-305005
Boring No.: AP-4	Tested By: jm	Checked By: mcm
Sample No.: UD-1	Test Date: 10/3/16	Depth: 38-40 ft
Test No.: IP-7	Sample Type: intact	Elevation: ---
Description: Moist, very dark greenish gray clay with sand		
Remarks: System 5077 Swell Pressure = 0.0682 tsf		
Displacement at End of Increment		

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1282	**DATE SAMPLE RECEIVED:**	8/29/2016
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MB	**DATE OF TESTING:**	8/29/2016
		DATE OF WEIGHING:	9/1/2016

BORING NO.	AP-5/UD-1 & UD-2	AP-5/UD-4			
SAMPLE NO.	16-1282E	16-1282H			
SAMPLE DEPTH	6.0-10.0'	30.0-32.0'			
WATER CONTENT, W%	21.6	26.6			

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

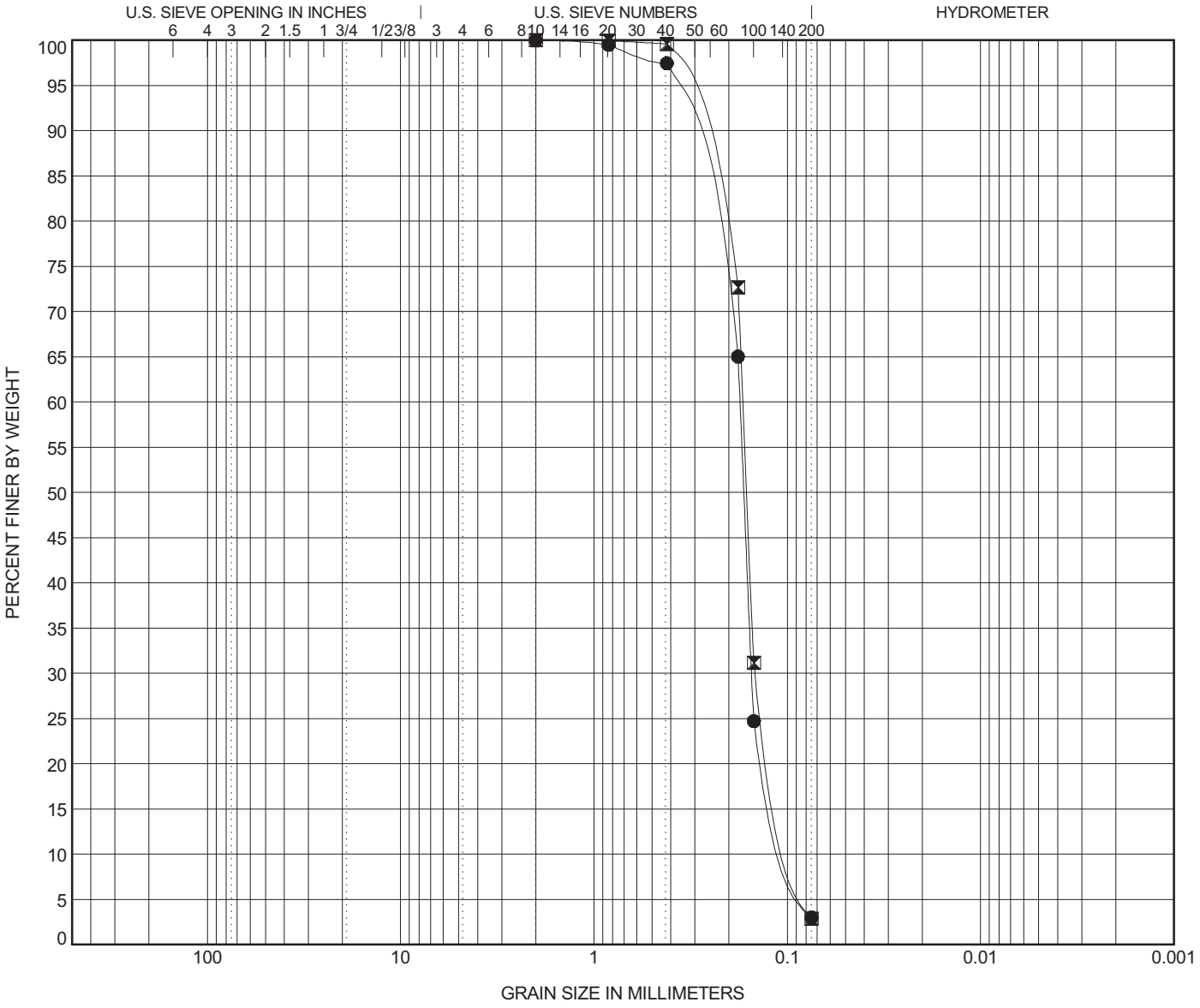
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**AP-5**	**10.0**	**Poorly Graded Fine SAND (SP) A-3**	**NP**	**NP**	**NP**	**1.42**	**1.88**
⊠	**AP-5**	**32.0**	**Poorly Graded Fine SAND (SP) A-3**	**NP**	**NP**	**NP**	**1.39**	**1.91**

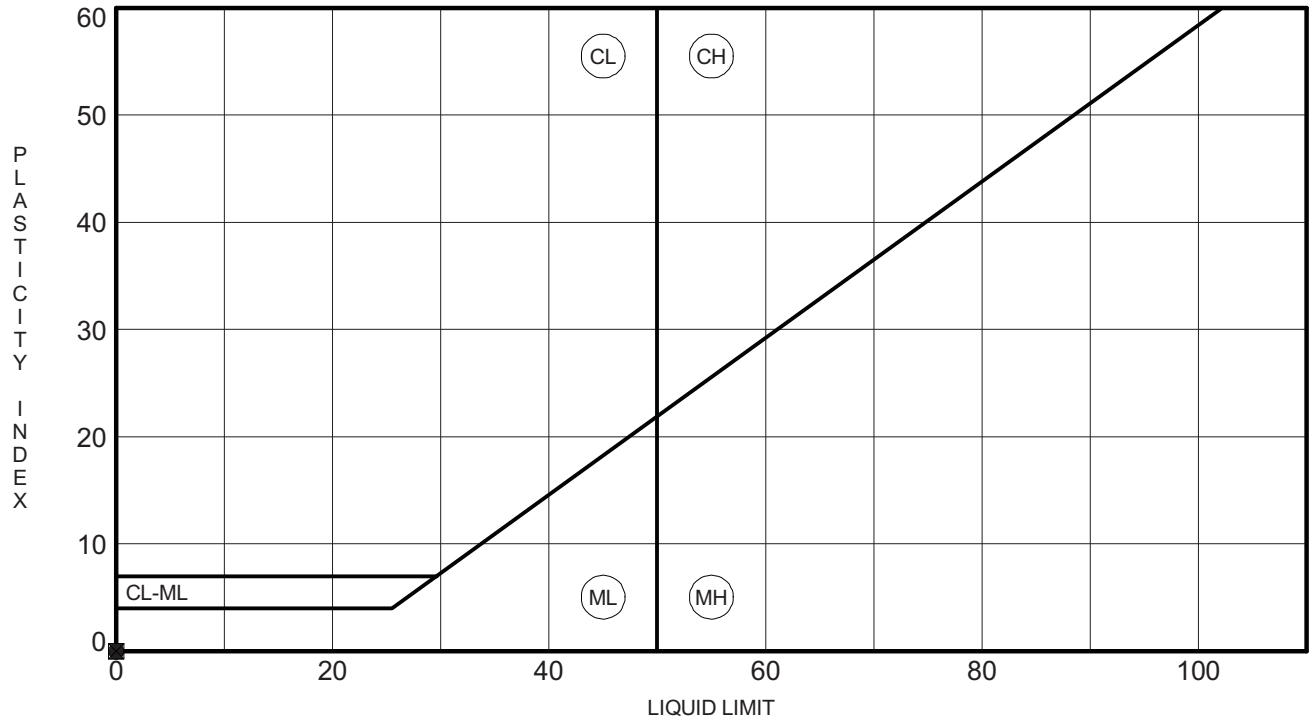
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**AP-5**	**10.0**	**2**	**0.394**	**0.168**	**0.094**	**0.0**	**97.0**	**3.0**	
⊠	**AP-5**	**32.0**	**2**	**0.363**	**0.162**	**0.089**	**0.0**	**97.1**	**2.9**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 11/4/16

ATTERBERG LIMITS' RESULTS

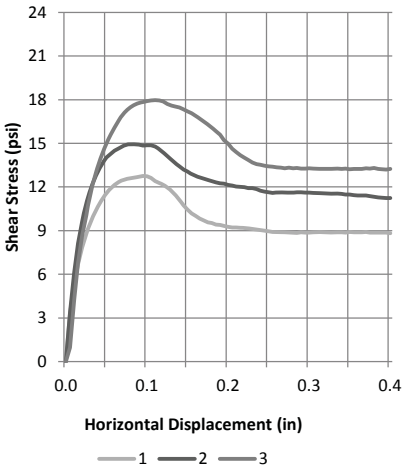
PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

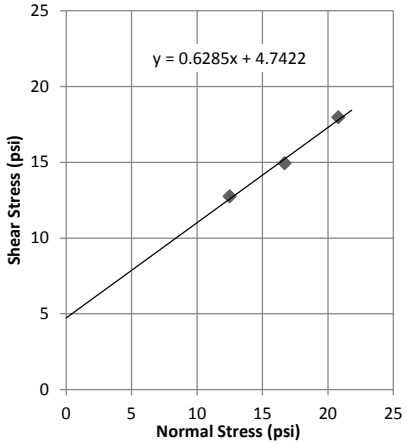
PROJECT COUNTY Beaufort



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**AP-5**	**10.0**	**NP**	**NP**	**NP**	**3**	**Poorly Graded Fine SAND (SP) A-3**
⊠	**AP-5**	**32.0**	**NP**	**NP**	**NP**	**3**	**Poorly Graded Fine SAND (SP) A-3**

DIRECT SHEAR TEST REPORT
ASTM - D3080 / AASHTO T236





Sample 1	
Normal Stress (psi)	12.5
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	23.6%
Wet Density (pcf)	121.0
Dry Density (pcf)	97.9
t50 (min.)	0.2
Saturation (%)	90.9%
Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	3.33
0.010	5.26
0.015	6.68
0.020	7.86
0.030	9.56
0.040	10.71
0.050	11.58
0.060	12.15
0.070	12.47
0.080	12.59
0.090	12.71
0.100	12.74
0.125	11.98
0.150	10.46
0.175	9.57
0.200	9.27
0.225	9.14
0.250	8.95
0.300	8.86
0.350	8.90
0.400	8.83
Max Shear Stress	**12.75**

Sample 2	
Normal Stress (psi)	16.7
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	24.4%
Wet Density (pcf)	122.0
Dry Density (pcf)	98.1
t50 (min)	0.2
Saturation (%)	94.2%
Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	3.38
0.010	6.12
0.015	8.12
0.020	9.63
0.030	11.79
0.040	13.12
0.050	14.03
0.060	14.49
0.070	14.81
0.080	14.93
0.090	14.91
0.100	14.88
0.125	14.13
0.150	13.06
0.175	12.48
0.200	12.13
0.225	11.92
0.250	11.64
0.300	11.61
0.350	11.48
0.400	11.25
Max Shear Stress	**14.93**

Sample 3	
Normal Stress (psi)	20.8
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	24.3%
Wet Density (pcf)	122.2
Dry Density (pcf)	98.3
t50 (min.)	0.2
Saturation (%)	94.4%
Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	0.96
0.010	4.22
0.015	6.77
0.020	8.66
0.030	11.48
0.040	13.54
0.050	14.98
0.060	16.09
0.070	16.96
0.080	17.49
0.090	17.77
0.100	17.90
0.125	17.71
0.150	17.19
0.175	16.30
0.200	14.97
0.225	13.85
0.250	13.43
0.300	13.29
0.350	13.22
0.400	13.25
Max Shear Stress	**17.97**

Project Name: US 21 Bridge Replacement over Harbor River

Project Number: G5396 Date: 9/8/16

SCDOT Project ID: P026862

Location/Sample: AP-5, UD-1 & UD-2 / Sample #16-1282A

Depth/Elevation: 6.0' - 10.0'

Type of Test : Direct Shear - 4" by 4" Square Shear Box

Sample Type : Remolded 1" Thick, Innundated

Description: Grey Poorly Graded Fine SAND with Silt (SP-SM), A-3

PI= NP % Fines= 3.0

SG= 2.65 Box Gap= 1.0 mm

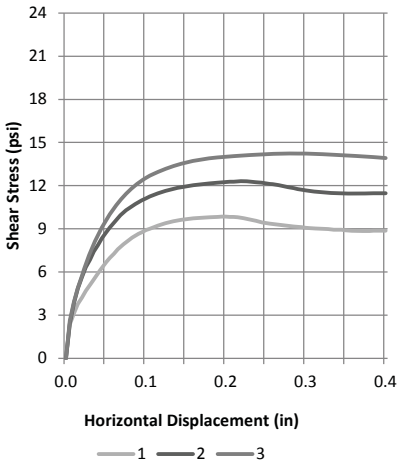
ϕ= 32.1° $C_{apparent}$= 4.74 psi

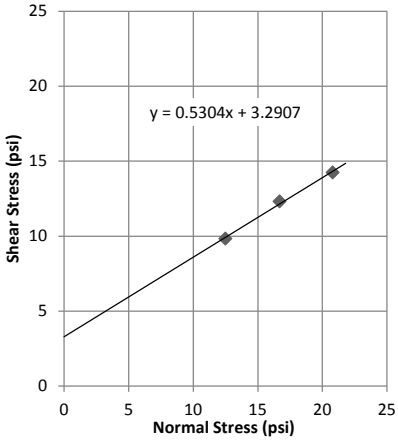
F&ME CONSULTANTS

3112 Devine Street Columbia, SC 29205

Geotechnical · Environmental · Materials

DIRECT SHEAR TEST REPORT
ASTM - D3080 / AASHTO T236





Sample 1	
Normal Stress (psi)	12.5
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	23.3%
Wet Density (pcf)	119.0
Dry Density (pcf)	96.5
t50 (min.)	0.2
Saturation (%)	86.6%
Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	2.35
0.010	3.13
0.015	3.77
0.020	4.22
0.030	5.09
0.040	5.91
0.050	6.64
0.060	7.27
0.070	7.83
0.080	8.27
0.090	8.61
0.100	8.91
0.125	9.38
0.150	9.66
0.175	9.79
0.200	9.84
0.225	9.71
0.250	9.41
0.300	9.08
0.350	8.89
0.400	8.88
Max Shear Stress	**9.84**

Sample 2	
Normal Stress (psi)	16.7
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	23.0%
Wet Density (pcf)	118.6
Dry Density (pcf)	96.4
t50 (min)	0.2
Saturation (%)	85.3%
Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	2.43
0.010	3.84
0.015	4.83
0.020	5.64
0.030	6.84
0.040	7.87
0.050	8.73
0.060	9.43
0.070	10.04
0.080	10.50
0.090	10.83
0.100	11.12
0.125	11.64
0.150	11.95
0.175	12.13
0.200	12.26
0.225	12.29
0.250	12.16
0.300	11.68
0.350	11.44
0.400	11.47
Max Shear Stress	**12.31**

Sample 3	
Normal Stress (psi)	20.8
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	22.8%
Wet Density (pcf)	119.6
Dry Density (pcf)	97.4
t50 (min.)	0.2
Saturation (%)	86.6%
Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	2.63
0.010	3.94
0.015	4.88
0.020	5.74
0.030	7.31
0.040	8.56
0.050	9.57
0.060	10.41
0.070	11.10
0.080	11.71
0.090	12.18
0.100	12.54
0.125	13.16
0.150	13.60
0.175	13.85
0.200	14.01
0.225	14.09
0.250	14.18
0.300	14.23
0.350	14.11
0.400	13.92
Max Shear Stress	**14.24**

Project Name	US 21 Bridge Replacement over Harbor River
Project Number	G5396
Date	9/21/16
SCDOT Project ID	P026862
Location/Sample	AP-5, UD-4 / Sample #16-1282B
Depth/Elevation	30.0' - 32.0'

Type of Test : Direct Shear - 4" by 4" Square Shear Box
Sample Type : Remolded 1" Thick, Innundated

Description:	Grey Poorly Graded Fine SAND with Silt (SP-SM), A-3		
PI=	NP	% Fines=	2.9
SG=	2.65	Box Gap=	1.0 mm
ϕ=	27.9°	$C_{apparent}$=	3.29 psi

F&ME CONSULTANTS
3112 Devine Street Columbia, SC 29205
Geotechnical · Environmental · Materials

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1189	**DATE SAMPLE RECEIVED:**	7/19/2016
DESCRIPTION OF SOIL:	Poorly Graded F/M SAND (SP-SM) with Silt A-3		
TESTED BY:	MB	**DATE OF TESTING:**	7/25/2016
		DATE OF WEIGHING:	7/26/2016

BORING NO.	BS-1				
SAMPLE NO.	16-1189C				
SAMPLE DEPTH	0.0-5.0'				
WATER CONTENT, W%	5.3				

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

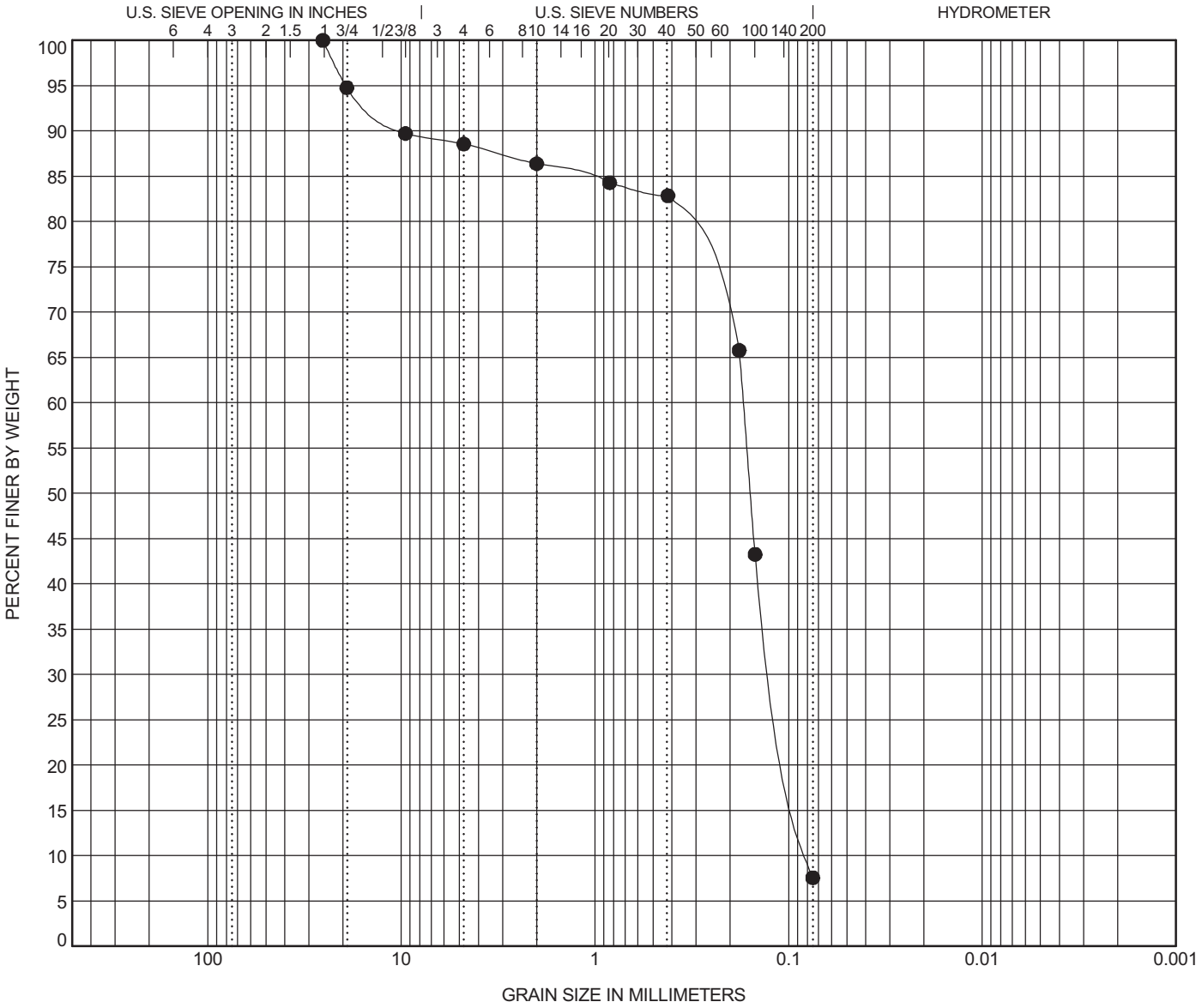
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**BS-1**	**5.0**	**Poorly Graded F/M SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**0.99**	**2.18**

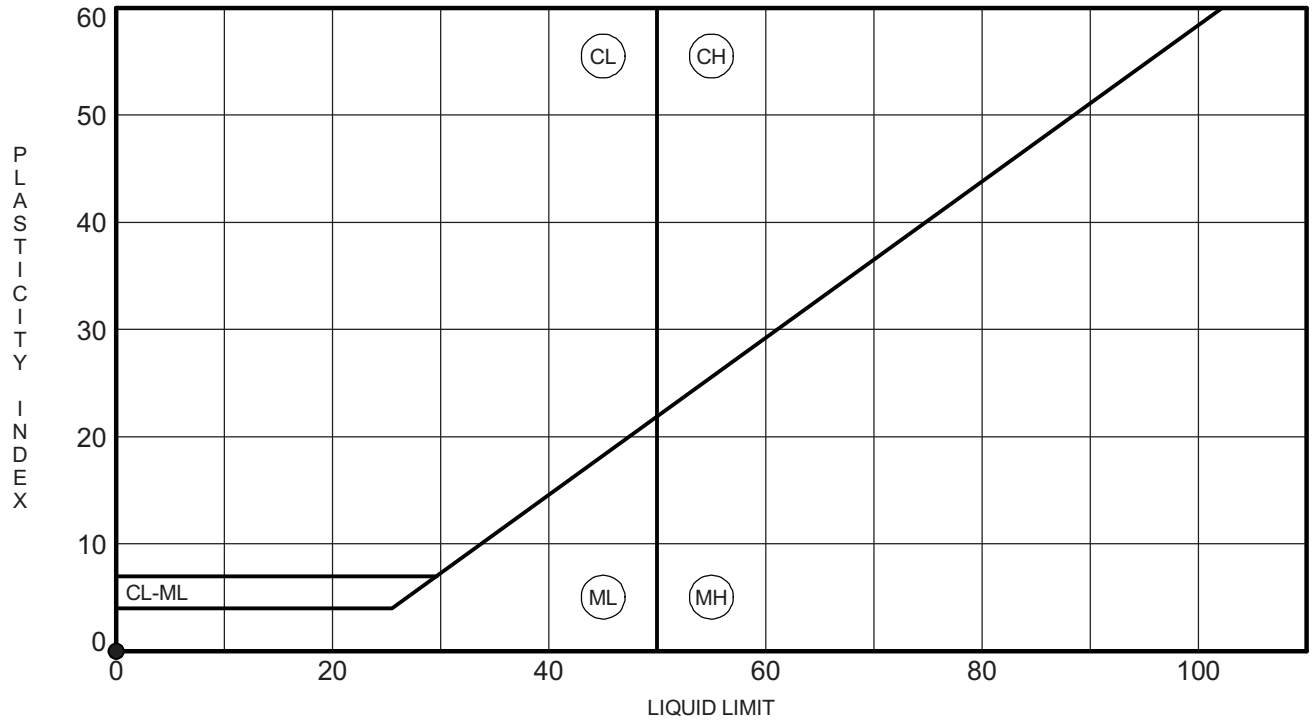
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**BS-1**	**5.0**	**25.4**	**19.331**	**0.158**	**0.079**	**11.4**	**81.0**	**7.6**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort

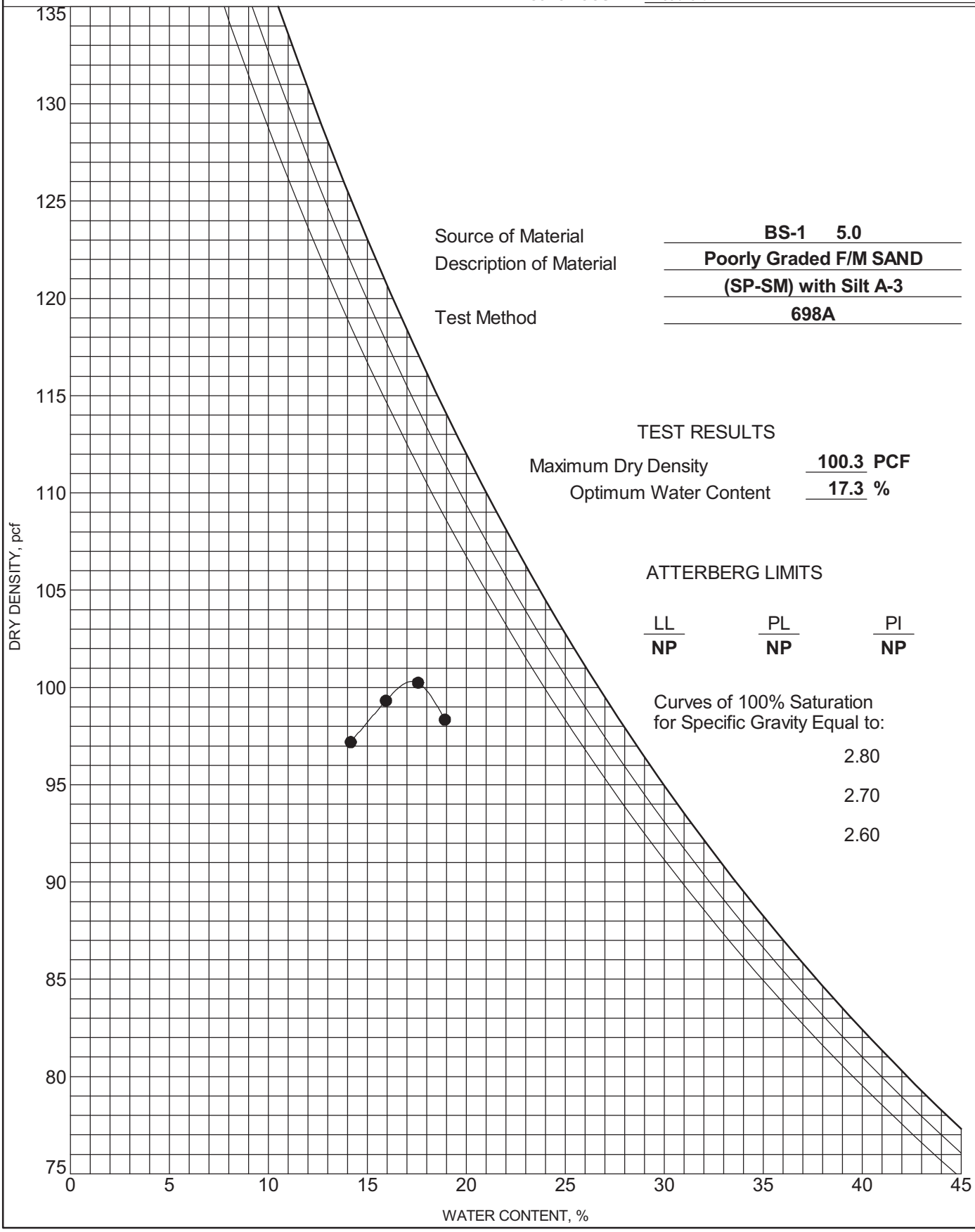


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**BS-1**	**5.0**	**NP**	**NP**	**NP**	**8**	**Poorly Graded F/M SAND (SP-SM) with Silt A-3**

MOISTURE-DENSITY RELATIONSHIP

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



Source of Material	**BS-1 5.0**
Description of Material	**Poorly Graded F/M SAND (SP-SM) with Silt A-3**
Test Method	**698A**

TEST RESULTS

Maximum Dry Density	**100.3**	**PCF**
Optimum Water Content	**17.3**	**%**

ATTERBERG LIMITS

LL	PL	PI
NP	**NP**	**NP**

Curves of 100% Saturation for Specific Gravity Equal to:

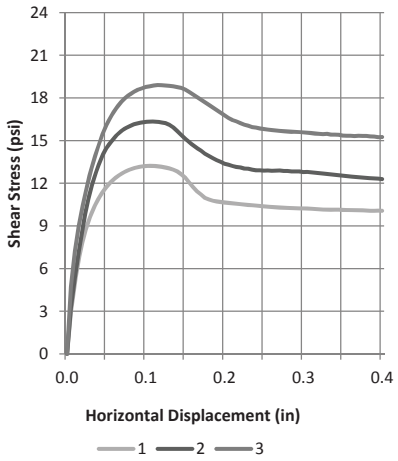
2.80

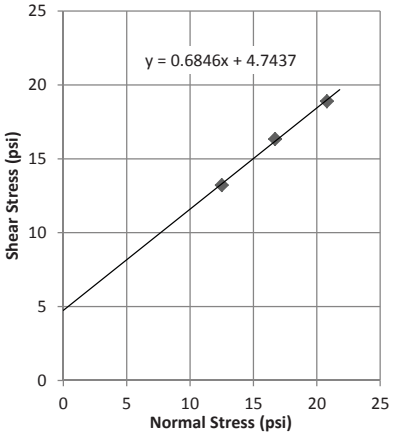
2.70

2.60

COMPACTION G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

DIRECT SHEAR TEST REPORT
ASTM - D3080 / AASHTO T236





Sample 1	
Normal Stress (psi)	12.5
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	19.0%
Wet Density (pcf)	114.3
Dry Density (pcf)	96.0
t50 (min.)	0.2
Saturation (%)	69.8%
Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	2.94
0.010	4.93
0.015	6.73
0.020	7.92
0.030	9.75
0.040	10.91
0.050	11.75
0.060	12.31
0.070	12.70
0.080	12.95
0.090	13.13
0.100	13.22
0.125	13.11
0.150	12.40
0.175	10.97
0.200	10.64
0.225	10.51
0.250	10.37
0.300	10.23
0.350	10.12
0.400	10.06
Max Shear Stress	**13.22**

Sample 2	
Normal Stress (psi)	16.7
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	19.3%
Wet Density (pcf)	114.0
Dry Density (pcf)	95.6
t50 (min)	0.2
Saturation (%)	70.0%
Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	3.24
0.010	5.38
0.015	7.19
0.020	8.89
0.030	11.54
0.040	13.28
0.050	14.46
0.060	15.21
0.070	15.71
0.080	16.03
0.090	16.22
0.100	16.32
0.125	16.23
0.150	15.15
0.175	14.08
0.200	13.38
0.225	13.04
0.250	12.88
0.300	12.78
0.350	12.54
0.400	12.29
Max Shear Stress	**16.34**

Sample 3	
Normal Stress (psi)	20.8
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	18.9%
Wet Density (pcf)	114.8
Dry Density (pcf)	96.5
t50 (min.)	0.2
Saturation (%)	70.2%
Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	4.73
0.010	7.23
0.015	9.00
0.020	10.43
0.030	12.89
0.040	14.64
0.050	16.09
0.060	17.07
0.070	17.78
0.080	18.25
0.090	18.57
0.100	18.77
0.125	18.87
0.150	18.59
0.175	17.70
0.200	16.76
0.225	16.12
0.250	15.82
0.300	15.58
0.350	15.35
0.400	15.25
Max Shear Stress	**18.90**

Project Name: US 21 Bridge Replacement over Harbor River

Project Number: G5396 Date: 8/3/2016

SCDOT Project ID: P026862

Location/Sample: BS-1 / Sample #16-1189

Depth/Elevation: 0.0' - 5.0'

Type of Test : Direct Shear - 4" by 4" Square Shear Box

Sample Type : Remolded 1" Thick, Non-Innundated

Description: Grey Poorly Graded Fine to Medium SAND with Silt (SP-SM), A-3

PI= NP % Fines= 7.6

SG= 2.65 Box Gap= 0.75mm

ϕ= 34.4° $C_{apparent}$= 4.74 psi

F&ME CONSULTANTS

3112 Devine Street Columbia, SC 29205

Geotechnical · Environmental · Materials

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1190	**DATE SAMPLE RECEIVED:**	7/19/2016
DESCRIPTION OF SOIL:	Poorly Graded F/M SAND (SP-SM) with Silt A-3		
TESTED BY:	MB	**DATE OF TESTING:**	7/25/2016
		DATE OF WEIGHING:	7/26/2016

BORING NO.	BS-2				
SAMPLE NO.	16-1190C				
SAMPLE DEPTH	0.0-5.0'				
WATER CONTENT, W%	5.6				

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

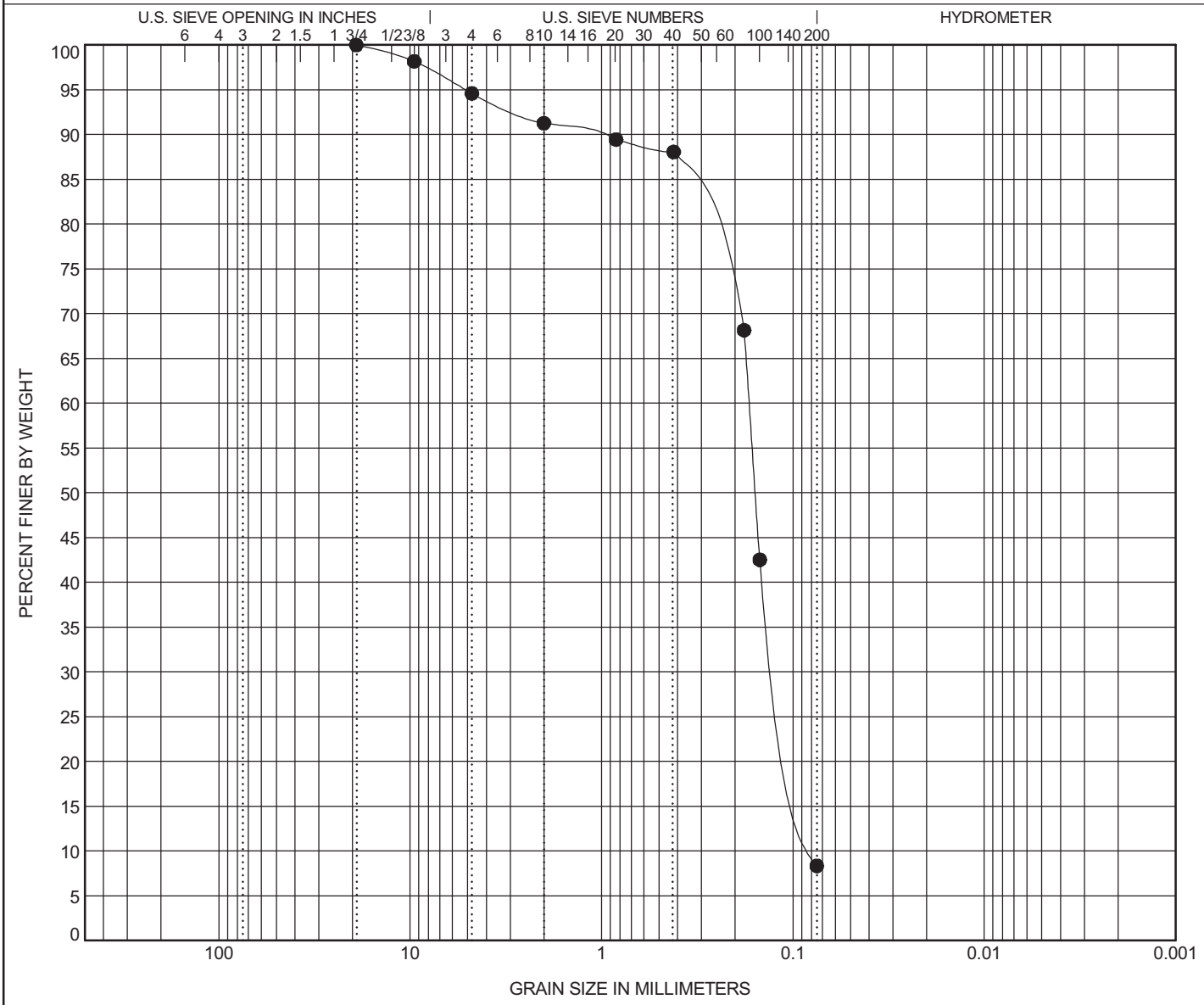
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**BS-2**	**5.0**	**Poorly Graded F/M SAND (SP-SM) with Silt A-3**	**NP**	**NP**	**NP**	**1.02**	**2.19**

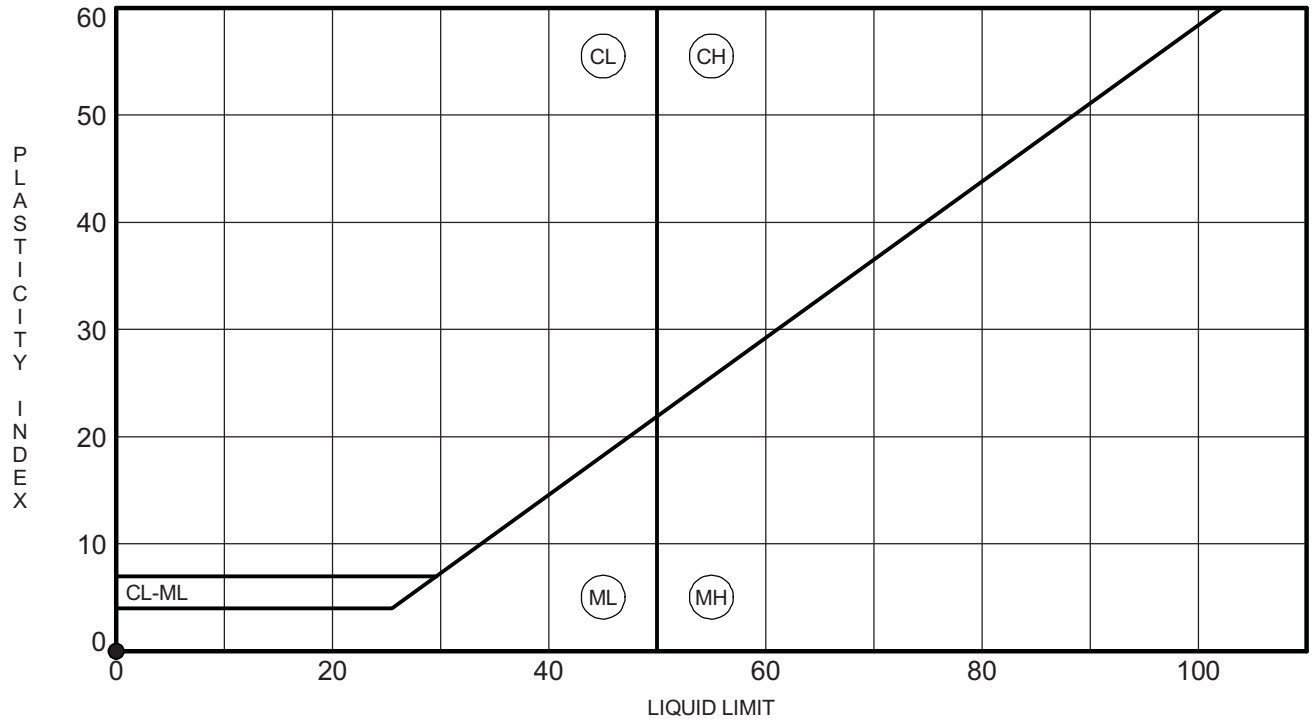
	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**BS-2**	**5.0**	**19.1**	**5.143**	**0.157**	**0.078**	**5.4**	**86.2**	**8.3**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort

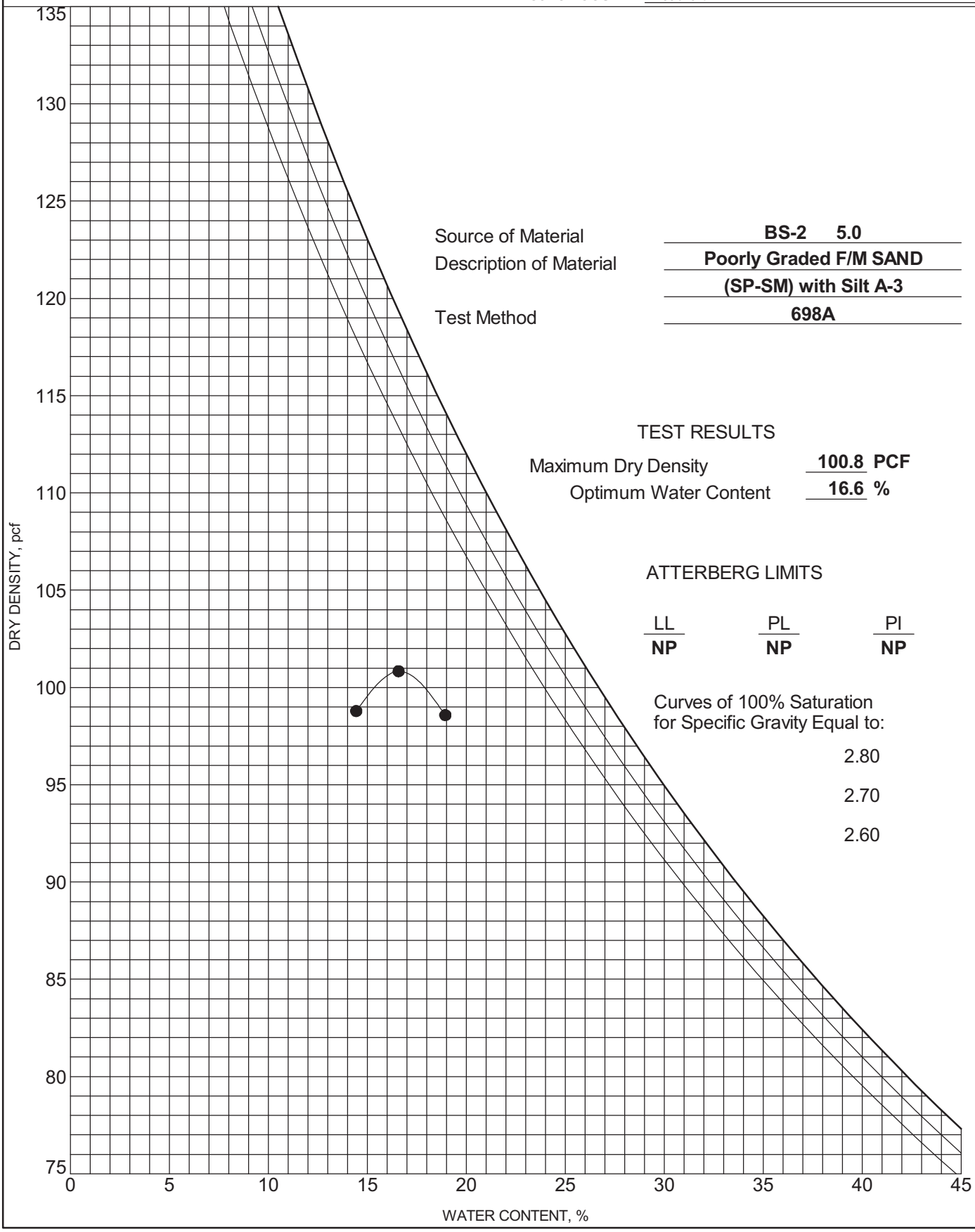


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**BS-2**	**5.0**	**NP**	**NP**	**NP**	**8**	**Poorly Graded F/M SAND (SP-SM) with Silt A-3**

MOISTURE-DENSITY RELATIONSHIP

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



Source of Material	**BS-2 5.0**
Description of Material	**Poorly Graded F/M SAND (SP-SM) with Silt A-3**
Test Method	**698A**

TEST RESULTS

Maximum Dry Density	**100.8**	**PCF**
Optimum Water Content	**16.6**	**%**

ATTERBERG LIMITS

LL	PL	PI
NP	**NP**	**NP**

Curves of 100% Saturation for Specific Gravity Equal to:

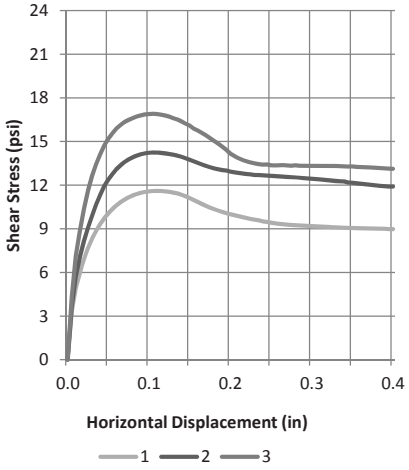
2.80

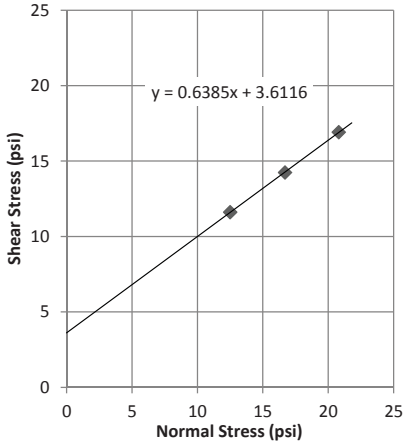
2.70

2.60

COMPACTION G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

DIRECT SHEAR TEST REPORT
ASTM - D3080 / AASHTO T236





Sample 1	
Normal Stress (psi)	12.5
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	19.5%
Wet Density (pcf)	115.2
Dry Density (pcf)	96.4
t50 (min.)	0.2
Saturation (%)	72.2%

Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	3.34
0.010	4.94
0.015	6.00
0.020	6.88
0.030	8.32
0.040	9.34
0.050	10.09
0.060	10.61
0.070	11.01
0.080	11.30
0.090	11.49
0.100	11.57
0.125	11.54
0.150	11.12
0.175	10.46
0.200	10.00
0.225	9.68
0.250	9.42
0.300	9.18
0.350	9.06
0.400	8.98
Max Shear Stress	**11.61**

Sample 2	
Normal Stress (psi)	16.7
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	18.9%
Wet Density (pcf)	114.3
Dry Density (pcf)	96.2
t50 (min)	0.2
Saturation (%)	69.5%

Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	3.67
0.010	5.74
0.015	7.08
0.020	8.16
0.030	9.91
0.040	11.34
0.050	12.40
0.060	13.10
0.070	13.60
0.080	13.91
0.090	14.12
0.100	14.23
0.125	14.14
0.150	13.73
0.175	13.23
0.200	12.93
0.225	12.74
0.250	12.65
0.300	12.44
0.350	12.16
0.400	11.90
Max Shear Stress	**14.24**

Sample 3	
Normal Stress (psi)	20.8
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	18.6%
Wet Density (pcf)	114.3
Dry Density (pcf)	96.4
t50 (min.)	0.2
Saturation (%)	68.9%

Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	4.35
0.010	7.14
0.015	8.89
0.020	10.36
0.030	12.65
0.040	14.14
0.050	15.20
0.060	15.89
0.070	16.34
0.080	16.61
0.090	16.79
0.100	16.89
0.125	16.70
0.150	16.09
0.175	15.24
0.200	14.17
0.225	13.55
0.250	13.37
0.300	13.34
0.350	13.28
0.400	13.13
Max Shear Stress	**16.91**

Project Name: US 21 Bridge Replacement over Harbor River

Project Number: G5396 Date: 8/12/16

SCDOT Project ID: P026862

Location/Sample: BS-2 / Sample #16-1190

Depth/Elevation: 0.0' - 5.0'

Type of Test : Direct Shear - 4" by 4" Square Shear Box

Sample Type : Remolded 1" Thick, Non-Innundated

Description: Grey Poorly Graded Fine to Medium SAND with Silt (SP-SM), A-3

PI= NP

SG= 2.65

ϕ= 32.6°

% Fines= 8.3

Box Gap= 1.0 mm

$C_{apparent}$= 3.61 psi

F&ME CONSULTANTS

3112 Devine Street Columbia, SC 29205

Geotechnical · Environmental · Materials

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1191	**DATE SAMPLE RECEIVED:**	7/19/2016
DESCRIPTION OF SOIL:	Poorly Graded F/M SAND (SP) A-3		
TESTED BY:	MB	**DATE OF TESTING:**	7/25/2016
		DATE OF WEIGHING:	7/26/2016

BORING NO.	BS-3				
SAMPLE NO.	16-1191C				
SAMPLE DEPTH	0.0-5.0'				
WATER CONTENT, W%	1.3				

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

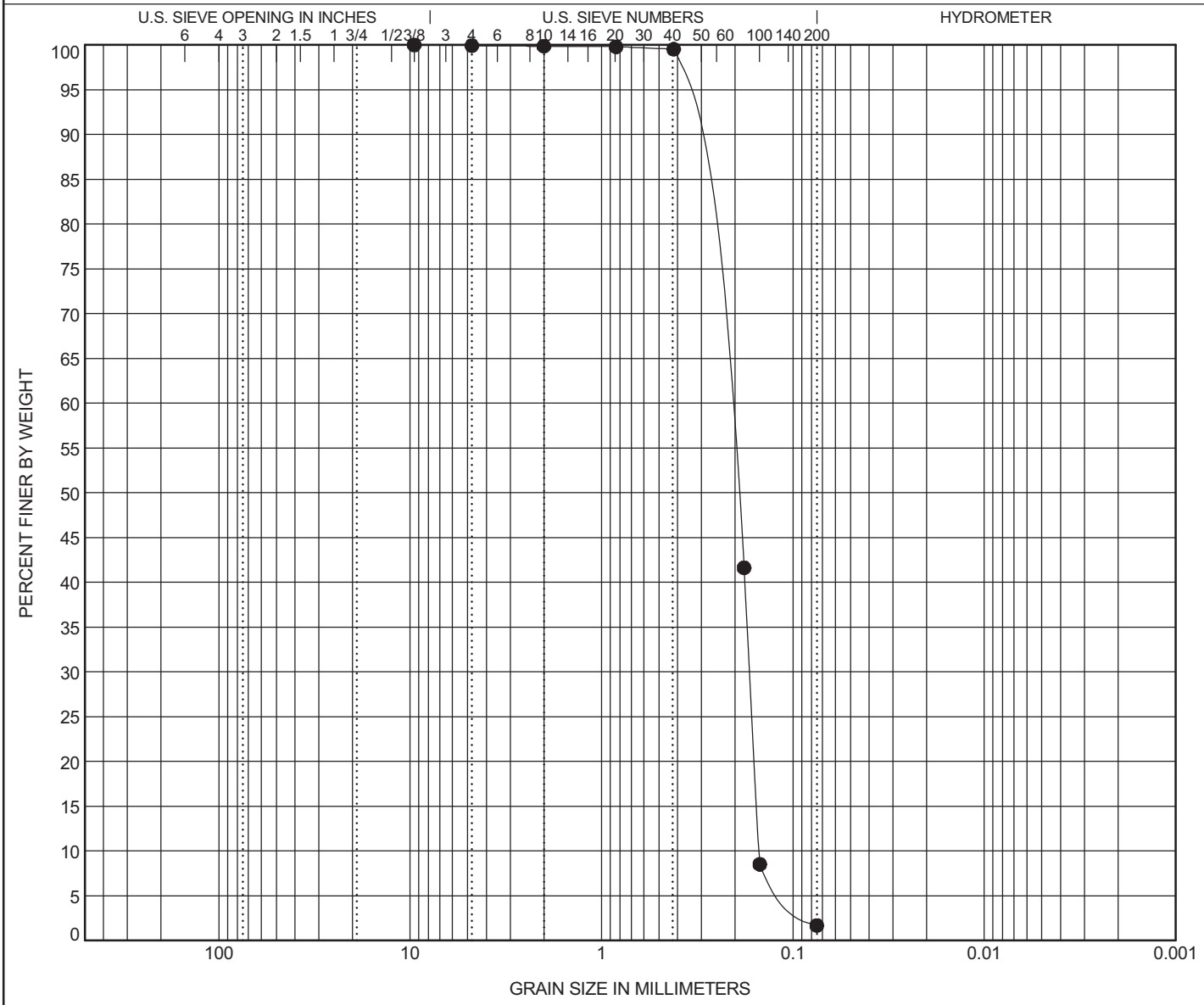
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● **BS-3**	**5.0**	**Poorly Graded F/M SAND (SP) A-3**	**NP**	**NP**	**NP**	**0.80**	**1.57**

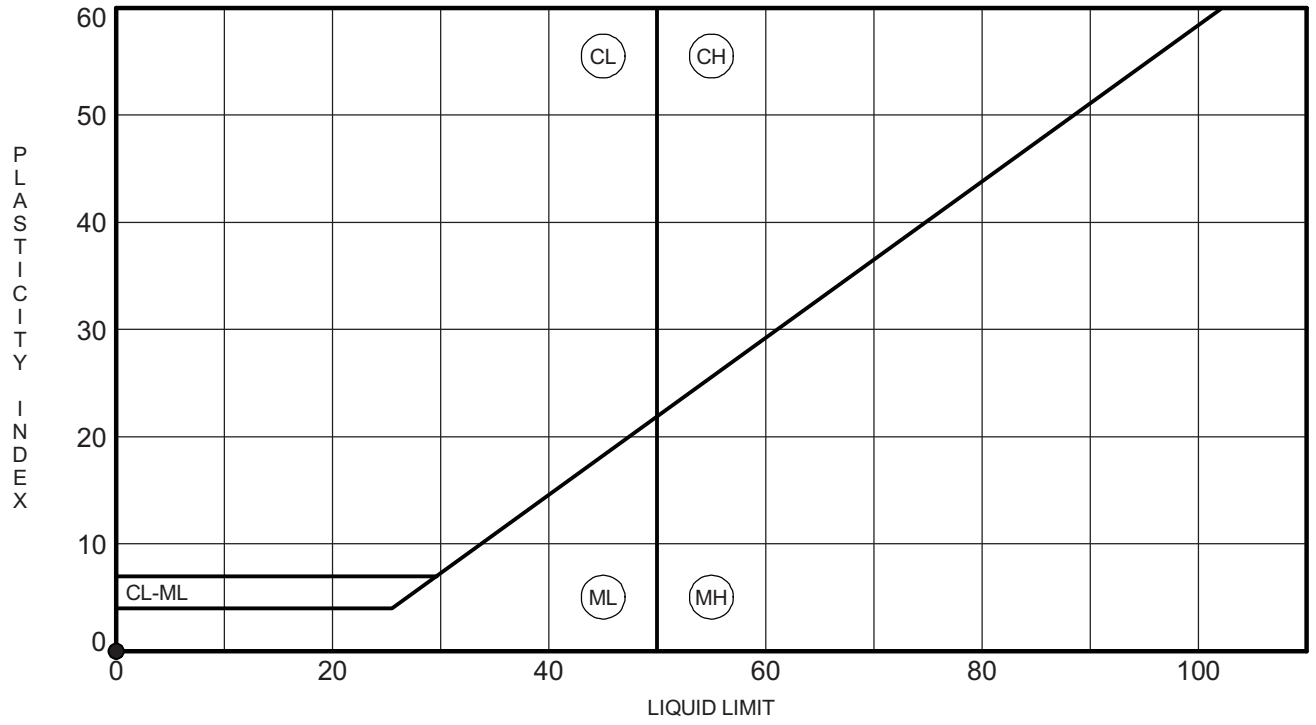
BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **BS-3**	**5.0**	**9.52**	**0.393**	**0.203**	**0.15**	**0.1**	**98.2**	**1.7**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort

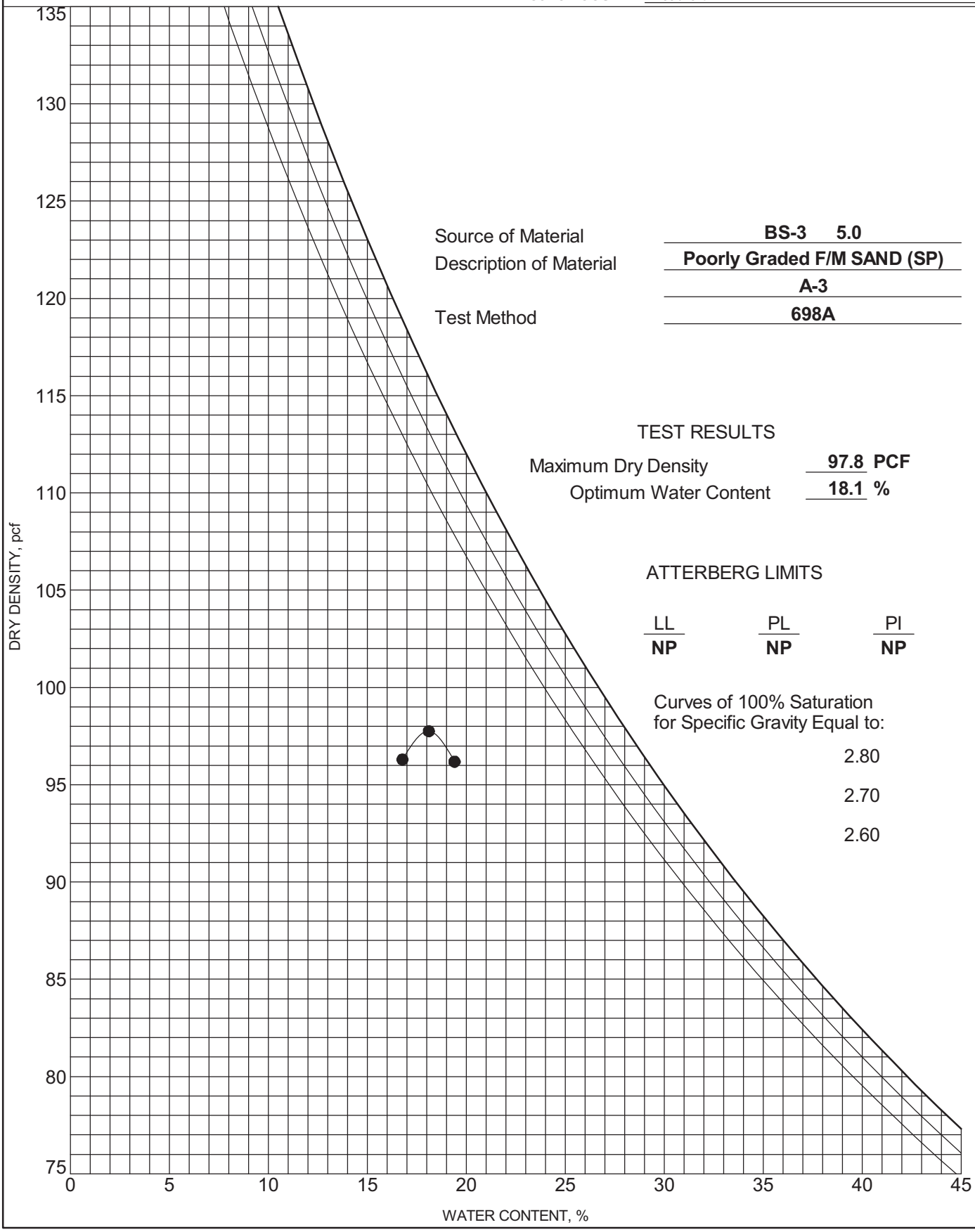


BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
● **BS-3**	**5.0**	**NP**	**NP**	**NP**	**2**	**Poorly Graded F/M SAND (SP) A-3**

MOISTURE-DENSITY RELATIONSHIP

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



Source of Material	**BS-3 5.0**
Description of Material	**Poorly Graded F/M SAND (SP)**
	A-3
Test Method	**698A**

TEST RESULTS

Maximum Dry Density	**97.8 PCF**
Optimum Water Content	**18.1 %**

ATTERBERG LIMITS

LL	PL	PI
NP	**NP**	**NP**

Curves of 100% Saturation for Specific Gravity Equal to:

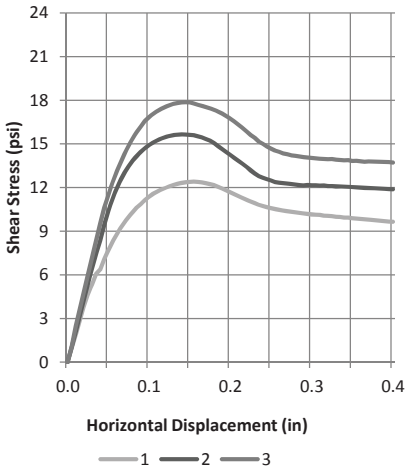
2.80

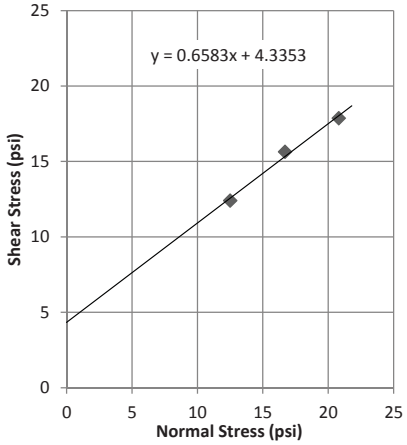
2.70

2.60

COMPACTION G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

DIRECT SHEAR TEST REPORT
ASTM - D3080 / AASHTO T236





Sample 1	
Normal Stress (psi)	12.5
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	17.6%
Wet Density (pcf)	112.5
Dry Density (pcf)	95.7
t50 (min.)	0.2
Saturation (%)	64.0%

Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	0.98
0.010	1.93
0.015	2.88
0.020	3.83
0.030	5.35
0.040	6.38
0.050	7.68
0.060	8.76
0.070	9.63
0.080	10.31
0.090	10.87
0.100	11.38
0.125	12.08
0.150	12.39
0.175	12.24
0.200	11.68
0.225	11.04
0.250	10.59
0.300	10.14
0.350	9.89
0.400	9.64
Max Shear Stress	**12.41**

Sample 2	
Normal Stress (psi)	16.7
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	17.5%
Wet Density (pcf)	111.6
Dry Density (pcf)	95.0
t50 (min)	0.2
Saturation (%)	62.6%

Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	1.03
0.010	2.11
0.015	3.27
0.020	4.25
0.030	6.56
0.040	8.35
0.050	10.40
0.060	11.91
0.070	13.03
0.080	13.85
0.090	14.45
0.100	14.93
0.125	15.54
0.150	15.63
0.175	15.22
0.200	14.24
0.225	13.17
0.250	12.49
0.300	12.16
0.350	12.04
0.400	11.88
Max Shear Stress	**15.64**

Sample 3	
Normal Stress (psi)	20.8
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	18.1%
Wet Density (pcf)	112.5
Dry Density (pcf)	95.2
t50 (min.)	0.2
Saturation (%)	65.1%

Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	1.09
0.010	2.48
0.015	3.71
0.020	4.81
0.030	7.17
0.040	9.55
0.050	11.50
0.060	13.05
0.070	14.34
0.080	15.40
0.090	16.20
0.100	16.84
0.125	17.66
0.150	17.85
0.175	17.44
0.200	16.74
0.225	15.60
0.250	14.68
0.300	14.02
0.350	13.83
0.400	13.72
Max Shear Stress	**17.87**

Project Name: US 21 Bridge Replacement over Harbor River

Project Number: G5396 Date: 8/31/16

SCDOT Project ID: P026862

Location/Sample: BS-3 / Sample #16-1191

Depth/Elevation: 0.0' - 5.0'

Type of Test : Direct Shear - 4" by 4" Square Shear Box

Sample Type : Remolded 1" Thick, Non-Innundated

Description: Grey Poorly Graded Fine to Medium SAND (SP), A-3

PI= NP % Fines= 1.7

SG= 2.65 Box Gap= 1.0 mm

ϕ= 33.5° $C_{apparent}$= 4.34 psi

F&ME CONSULTANTS

3112 Devine Street Columbia, SC 29205

Geotechnical · Environmental · Materials

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	US 21 Bridge Replacement over Harbor River	**PROJECT NO.:**	G5396
SAMPLE NUMBER:	16-1192	**DATE SAMPLE RECEIVED:**	7/19/2016
DESCRIPTION OF SOIL:	Poorly Graded F/M SAND (SP) A-3		
TESTED BY:	MB	**DATE OF TESTING:**	7/25/2016
		DATE OF WEIGHING:	7/26/2016

BORING NO.	BS-4				
SAMPLE NO.	16-1192C				
SAMPLE DEPTH	0.0-5.0'				
WATER CONTENT, W%	2.6				

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

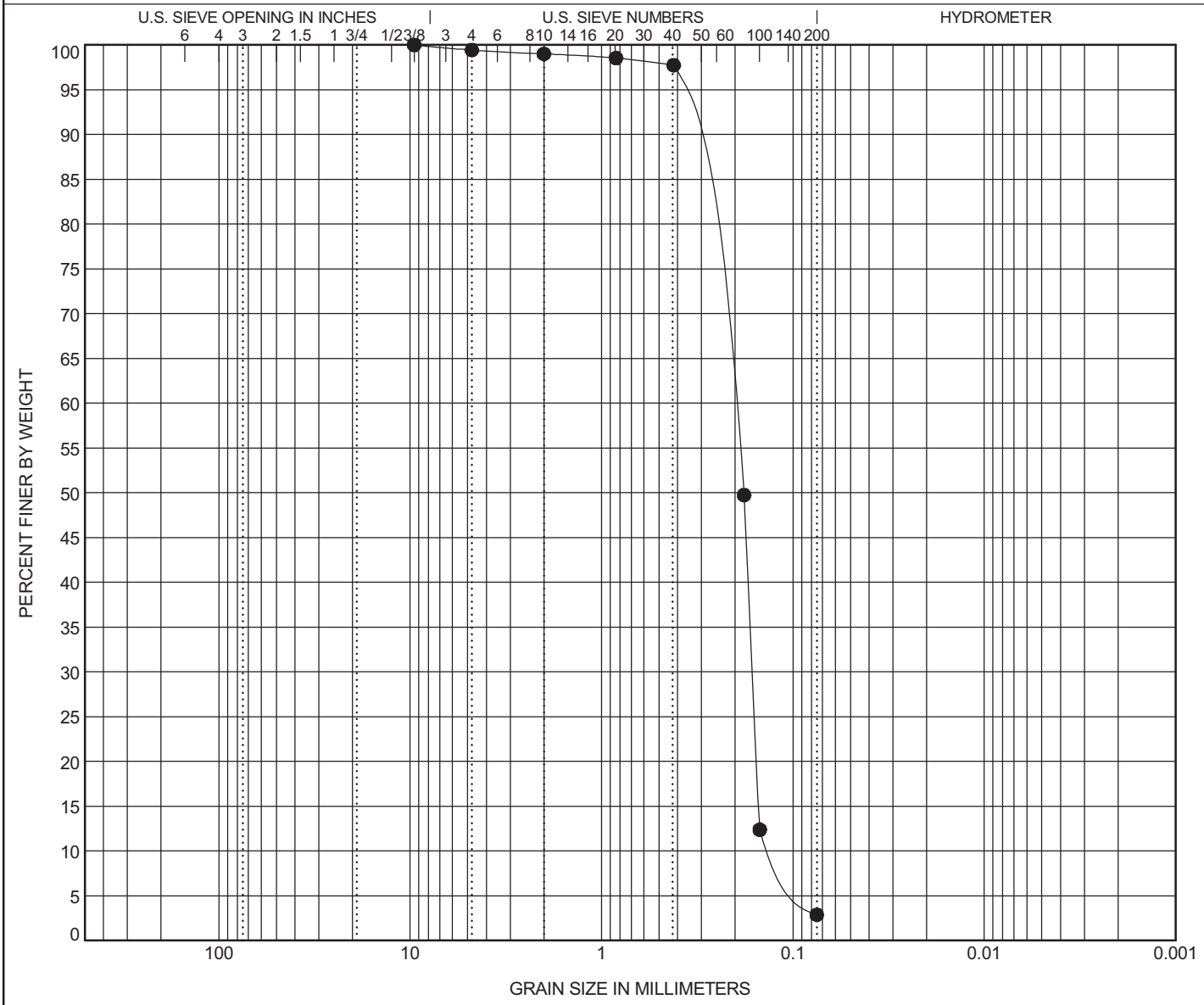
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

GRAIN SIZE DISTRIBUTION

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● **BS-4**	**5.0**	**Poorly Graded F/M SAND (SP) A-3**	**NP**	**NP**	**NP**	**0.98**	**1.72**

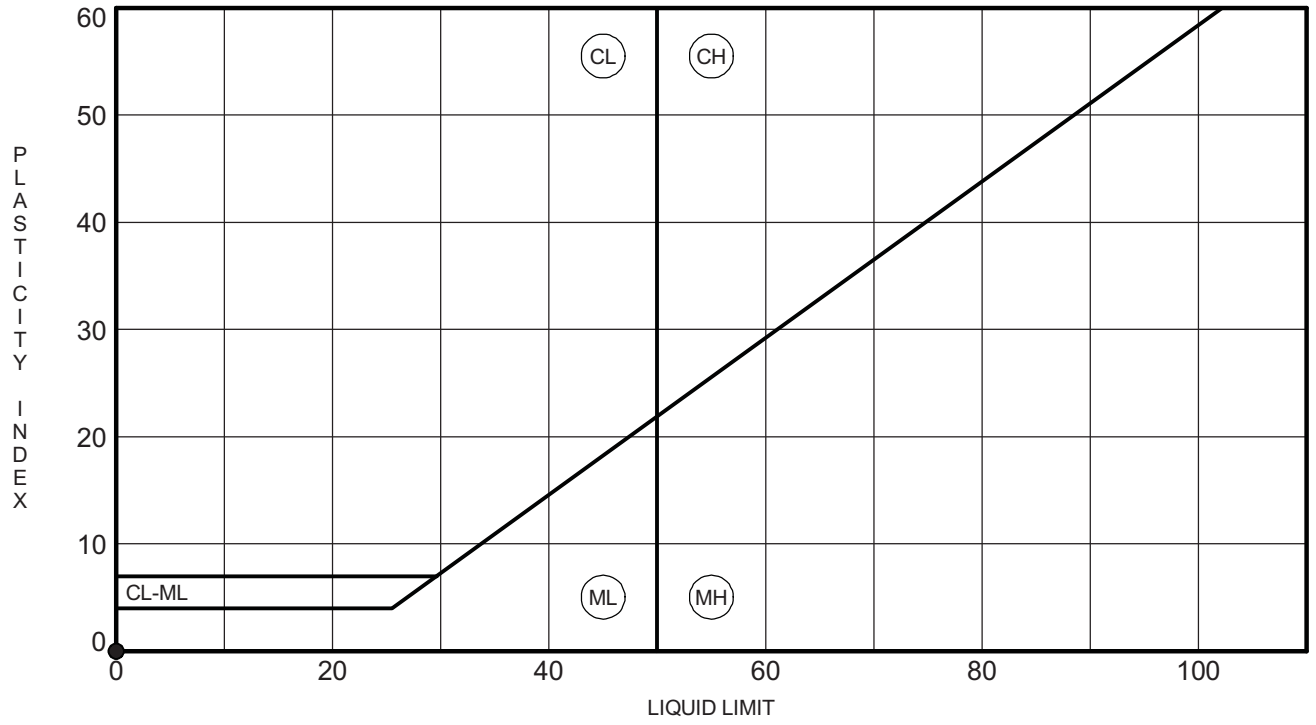
BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **BS-4**	**5.0**	**9.52**	**0.4**	**0.181**	**0.125**	**0.6**	**96.6**	**2.9**	

GRAIN SIZE G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

ATTERBERG LIMITS' RESULTS

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort

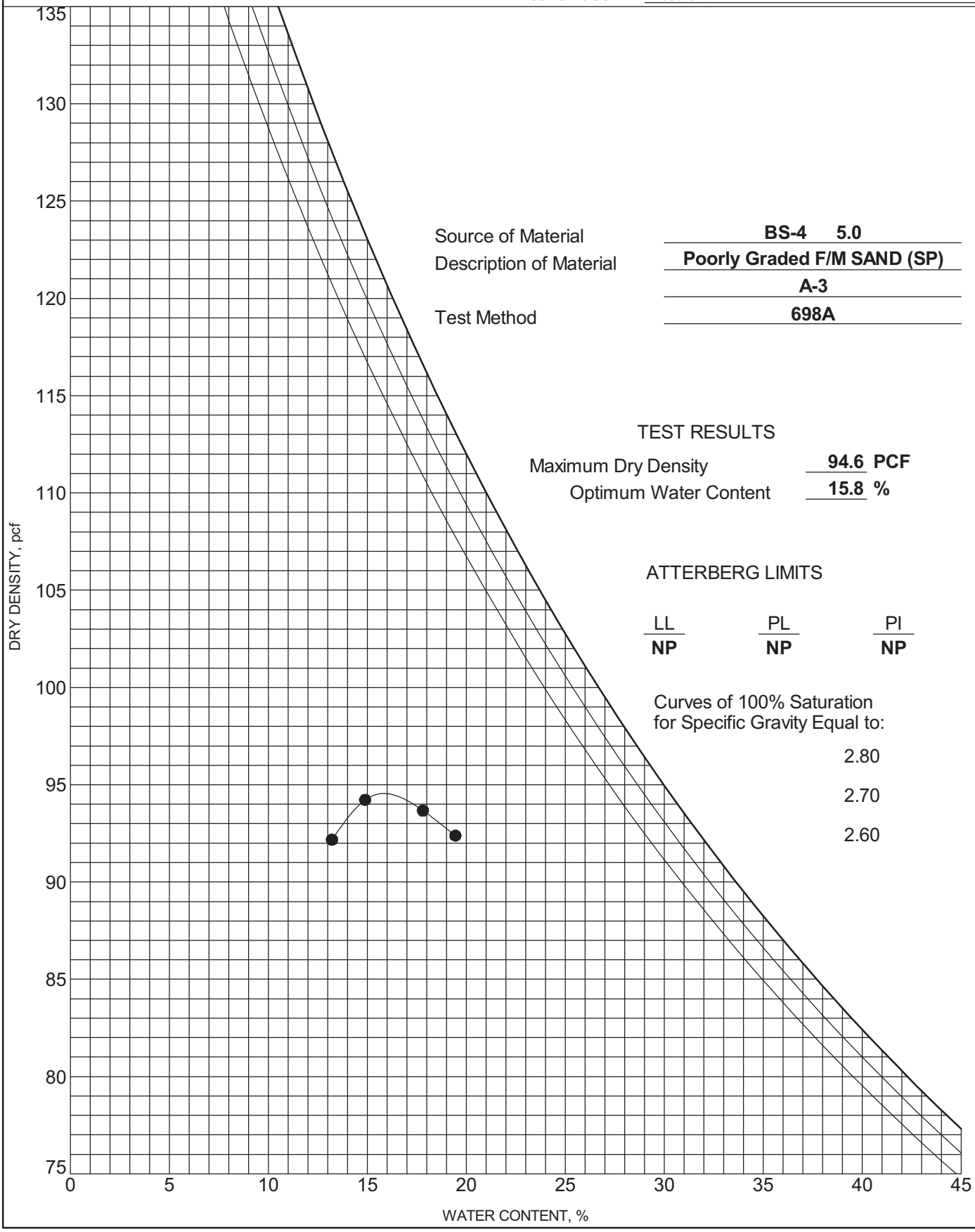


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**BS-4**	**5.0**	**NP**	**NP**	**NP**	**3**	**Poorly Graded F/M SAND (SP) A-3**

MOISTURE-DENSITY RELATIONSHIP

PROJECT ID P026862 **PROJECT NAME** US 21 Bridge Replacement over Harbor River

PROJECT COUNTY Beaufort



Source of Material	**BS-4 5.0**
Description of Material	**Poorly Graded F/M SAND (SP)**
	A-3
Test Method	**698A**

TEST RESULTS

Maximum Dry Density	**94.6 PCF**
Optimum Water Content	**15.8 %**

ATTERBERG LIMITS

LL	PL	PI
NP	**NP**	**NP**

Curves of 100% Saturation for Specific Gravity Equal to:

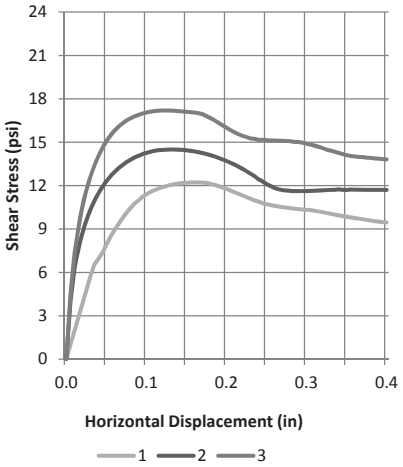
2.80

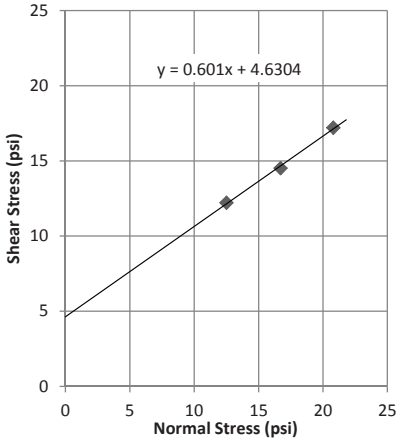
2.70

2.60

COMPACTION G5396 - HARBOR RIVER SPT AND CPT.GPJ GINT STD US LAB.GDT 10/5/16

DIRECT SHEAR TEST REPORT
ASTM - D3080 / AASHTO T236





Sample 1	
Normal Stress (psi)	12.5
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	16.8%
Wet Density (pcf)	106.8
Dry Density (pcf)	91.5
t50 (min.)	0.2
Saturation (%)	55.1%
Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	0.99
0.010	1.94
0.015	2.89
0.020	3.81
0.030	5.74
0.040	6.94
0.050	7.94
0.060	8.92
0.070	9.74
0.080	10.45
0.090	10.98
0.100	11.40
0.125	11.97
0.150	12.20
0.175	12.19
0.200	11.77
0.225	11.22
0.250	10.72
0.300	10.33
0.350	9.84
0.400	9.45
Max Shear Stress	**12.22**

Sample 2	
Normal Stress (psi)	16.7
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	16.6%
Wet Density (pcf)	106.8
Dry Density (pcf)	91.6
t50 (min)	0.2
Saturation (%)	54.6%
Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	3.99
0.010	6.27
0.015	7.61
0.020	8.71
0.030	10.34
0.040	11.46
0.050	12.32
0.060	12.94
0.070	13.42
0.080	13.79
0.090	14.07
0.100	14.28
0.125	14.49
0.150	14.46
0.175	14.18
0.200	13.69
0.225	12.99
0.250	12.11
0.300	11.63
0.350	11.70
0.400	11.70
Max Shear Stress	**14.51**

Sample 3	
Normal Stress (psi)	20.8
Speed (in./min.)	0.01
Sample Width (in.)	4.00
Percent Moisture	16.3%
Wet Density (pcf)	108.0
Dry Density (pcf)	92.9
t50 (min.)	0.2
Saturation (%)	55.2%
Horizontal Displacement (in.)	Shear Stress (psi)
0.000	0.00
0.005	4.47
0.010	7.29
0.015	9.08
0.020	10.59
0.030	12.59
0.040	14.03
0.050	15.07
0.060	15.80
0.070	16.30
0.080	16.65
0.090	16.88
0.100	17.06
0.125	17.20
0.150	17.11
0.175	16.81
0.200	15.99
0.225	15.36
0.250	15.15
0.300	14.89
0.350	14.11
0.400	13.81
Max Shear Stress	**17.21**

Project Name	US 21 Bridge Replacement over Harbor River		
Project Number	G5396	Date	9/1/16
SCDOT Project ID	P026862		
Location/Sample	BS-4 / Sample #16-1192		
Depth/Elevation	0.0' - 5.0'		

Type of Test : Direct Shear - 4" by 4" Square Shear Box
Sample Type : Remolded 1" Thick, Non-Innundated

Description:	Grey Poorly Graded Fine to Medium SAND (SP), A-3		
PI=	NP	% Fines=	2.9
SG=	2.65	Box Gap=	1.0 mm
ϕ=	31.0°	$C_{apparent}$=	4.63 psi

F&ME CONSULTANTS
3112 Devine Street Columbia, SC 29205
Geotechnical · Environmental · Materials

Client:	FME Consultants
Project Name:	US-21 Replacement Bridge over Harbor River
Project Location:	---
GTX #:	305005
Test Date:	8/23/2016
Tested By:	jbr
Checked By:	emm

pH of Water by ASTM D1293

Boring ID	Sample ID	Depth, ft	Description	pH of water	Temperature, °C
East End	16-1283	---	Wet, clear water	6.9	19
West End	16-1284	---	Wet, clear water	6.8	19

Notes: Method B, pH meter used

Client:	FME Consultants
Project:	US-21 Replacement Bridge over Harbor River
Location:	---
GTX#:	305005
Test Date:	09/01/16
Tested By:	jbr
Checked By:	mcm

Laboratory Measurement of Soil Resistivity Using the Wenner Four-Electrode Method by ASTM G57 (Laboratory Measurement)

Boring ID	Sample ID	Depth, ft.	Sample Description	Electrical Resistivity, ohm-cm	Electrical Conductivity, $(ohm\text{-}cm)^{-1}$
East End	16-1283	---	Wet, clear water	26	3.87E-02
West End	16-1284	---	Wet, clear water	27	3.72E-02

Notes: Test Equipment: Nilsson Model 400 Soil Resistance Meter, MC Miller Soil Box

Water added to sample to create a thick slurry prior to testing (saturated condition).

Electrical Conductivity is calculated as inverse of Electrical Resistivity (per ASTM G57)

Test conducted in standard laboratory atmosphere: 68-73 F

FUGRO CONSULTANTS, INC.

6100 HILLCROFT
PHONE (713) 369-5400

HOUSTON, TEXAS 77081
FAX (713) 369-5518

RESULTS OF TESTS

PROJECT: US-21 REPLACEMENT BRIDGE (GTX 305005)
SAMPLE ID: EAST END 16-1283

FOR: GEOTESTING EXPRESS, INC.
125 NAGOG PARK ACTION, MA 01720

REPORTED TO: ETHAN MARRO

LAB NUMBER: 0817030

REPORT DATE: 08-22-16
CLIENT NUMBER:
JOB NUMBER: 04.1115-0003
REPORT NUMBER:
DATE SAMPLED:
TIME SAMPLED:
SAMPLED BY: CLIENT
DATE RECEIVED:
TIME RECEIVED:
RECEIVED BY:

PARAMETER	RESULTS	UNITS	METHOD	TIME/DATE	ANALYST
Sulfate, Soluble	23,227	mg/L	ASTM D-516 **	1400/08-19-16	SD
Chloride, Soluble	16,396	mg/L	ASTM D-512 **	1100/08-22-16	SD

SO4CL 078-16

Respectfully submitted,

*** Dry weight basis**

Steve DeGregorio
Chemist

SD

**** WATER EXTRACTION PERFORMED BY USING A 1:10 RATIO OF SAMPLE AND REAGENT WATER FOLLOWED BY CENTRIFUGE AND VACUUME FILTRATION. THE WATER EXTRACT IS THEN ANALYZED USING THE ASTM D-512 AND D-516 METHODS.**

**THE RESULTS RELATE AS TO THE LOCATION TESTED AND NO OTHER REFERENCE SHALL BE MADE.
THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN APPROVAL OF THE LABORATORY.**

END OF REPORT

FUGRO CONSULTANTS, INC.

6100 HILLCROFT
PHONE (713) 369-5400

HOUSTON, TEXAS 77081
FAX (713) 369-5518

RESULTS OF TESTS

PROJECT: US-21 REPLACEMENT BRIDGE (GTX 305005)
SAMPLE ID: WEST END 16-1284

FOR: GEOTESTING EXPRESS, INC.
125 NAGOG PARK ACTION, MA 01720

REPORTED TO: ETHAN MARRO

LAB NUMBER: 0817031

REPORT DATE: 08-22-16
CLIENT NUMBER:
JOB NUMBER: 04.1115-0003
REPORT NUMBER:
DATE SAMPLED:
TIME SAMPLED:
SAMPLED BY: CLIENT
DATE RECEIVED:
TIME RECEIVED:
RECEIVED BY:

PARAMETER	RESULTS	UNITS	METHOD	TIME/DATE	ANALYST
Sulfate, Soluble	22,715	mg/L	ASTM D-516 **	1400/08-19-16	SD
Chloride, Soluble	16,596	mg/L	ASTM D-512 **	1100/08-22-16	SD

SO4CL 078-16

Respectfully submitted,

* Dry weight basis

Steve DeGregorio
Chemist

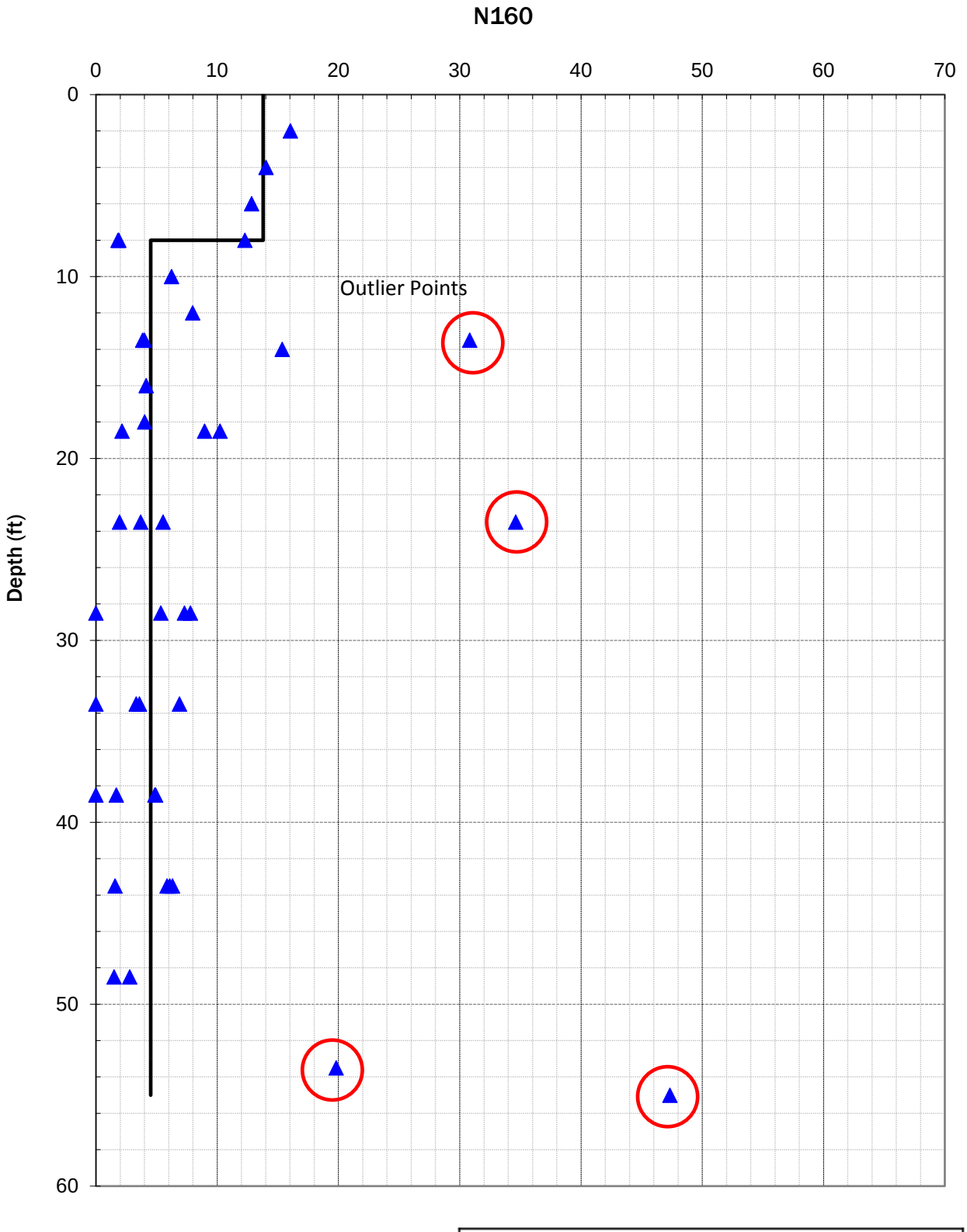
SD

** WATER EXTRACTION PERFORMED BY USING A 1:10 RATIO OF SAMPLE AND REAGENT WATER FOLLOWED BY CENTRIFUGE AND VACUUME FILTRATION. THE WATER EXTRACT IS THEN ANALYZED USING THE ASTM D-512 AND D-516 METHODS.

THE RESULTS RELATE AS TO THE LOCATION TESTED AND NO OTHER REFERENCE SHALL BE MADE.
THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN APPROVAL OF THE LABORATORY.

END OF REPORT

APPENDIX C
Soil Parameter Determination



Borings Included: B-1, B-3, B-4, and B-7

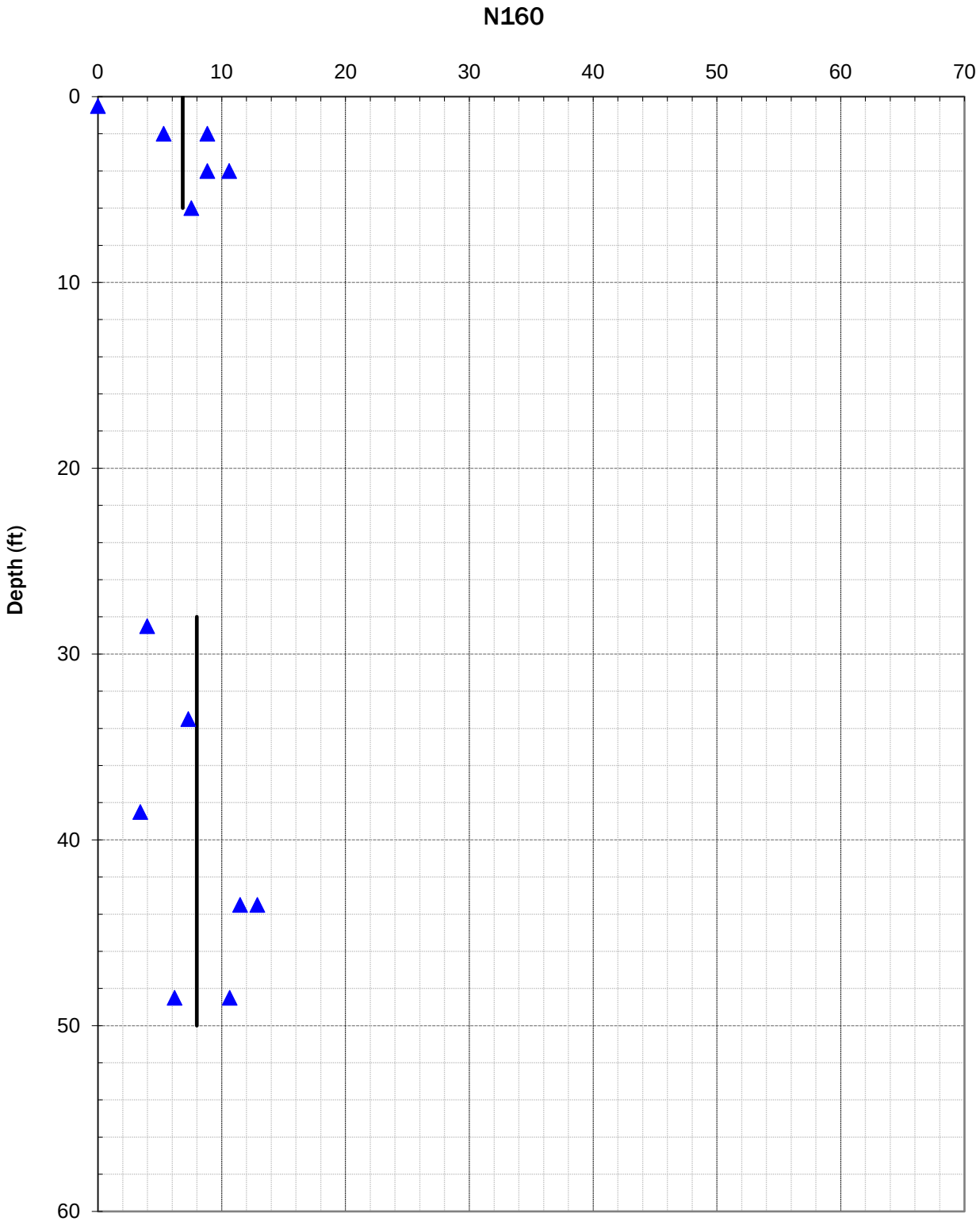
West Embankment 1 (<59+00)

Harbor River Bridge
Harbor Island, South Carolina

GeoEngineers

Figure C-1

18461-007-01



Borings Included: B-8, B-9

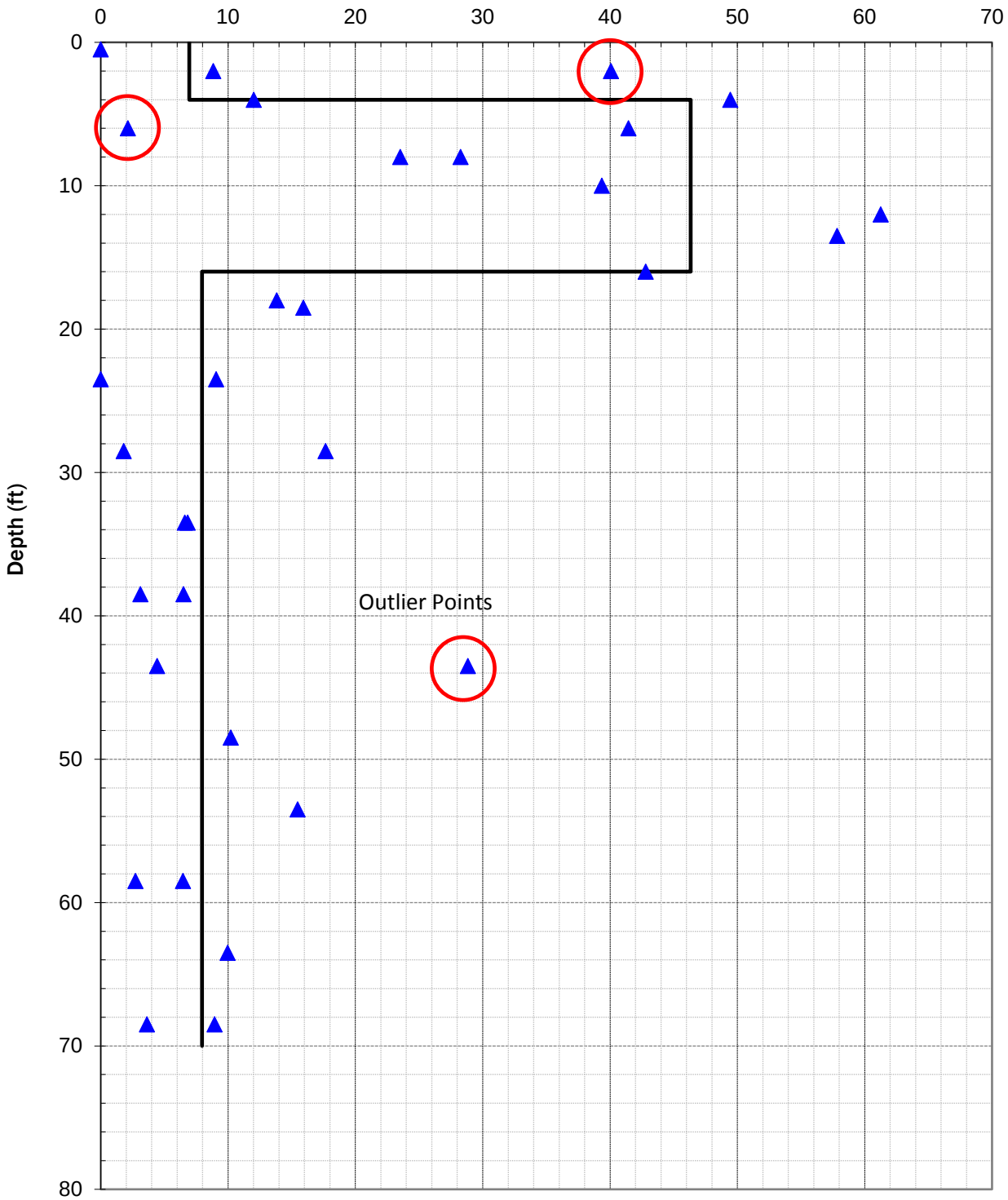
West Embankment 2, 3, and 4
(59+00 to 70+40)

Harbor River Bridge
Harbor Island, South Carolina

GeoEngineers

Figure C-2

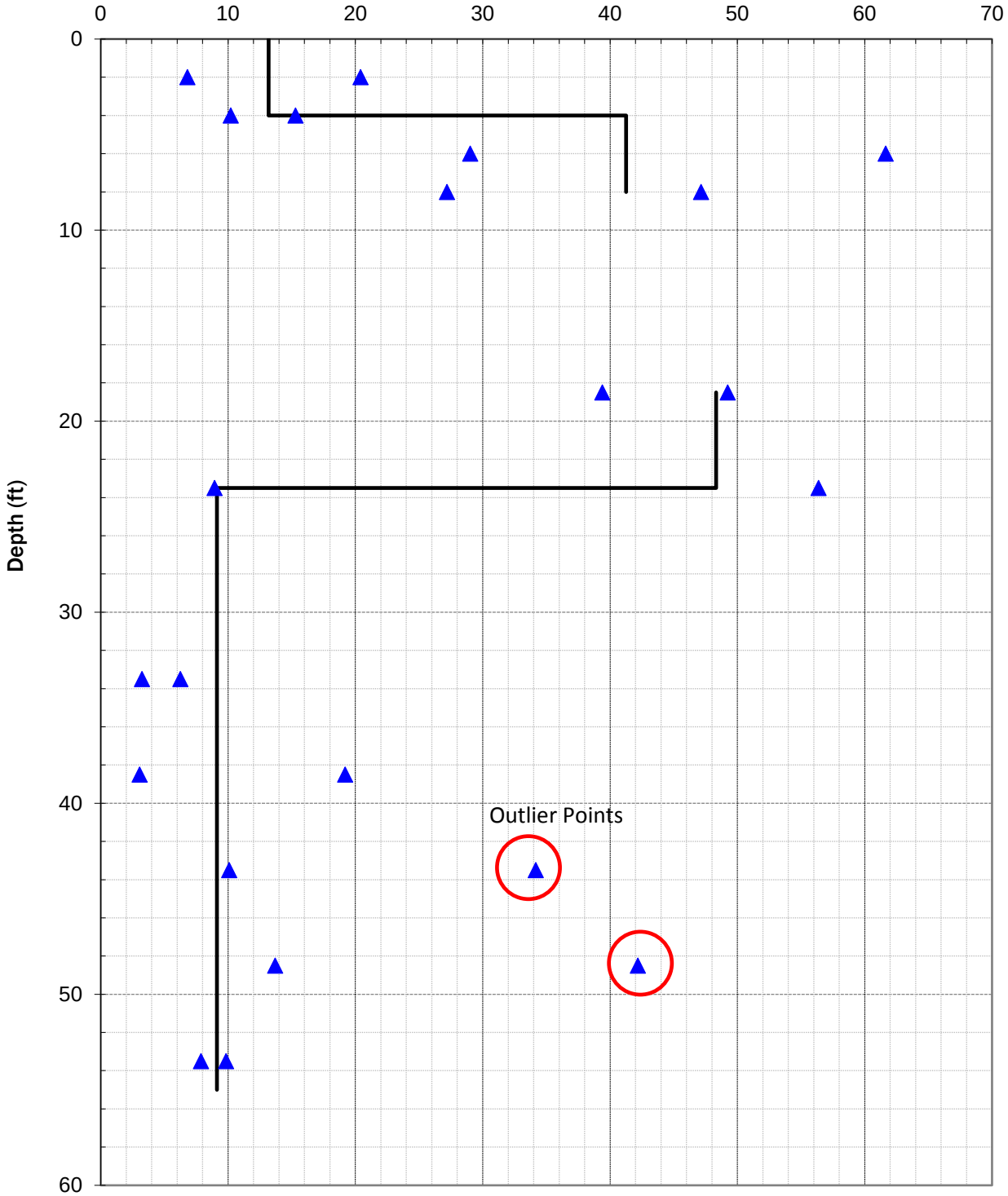
18461-007-01



Borings Included: B-2, B-16

East Embankment 1 and 2 (103+80 to 112+00)	
Harbor River Bridge Harbor Island, South Carolina	
GeoEngineers	Figure C-3

18461-007-01



Borings Included: B-5, B-6

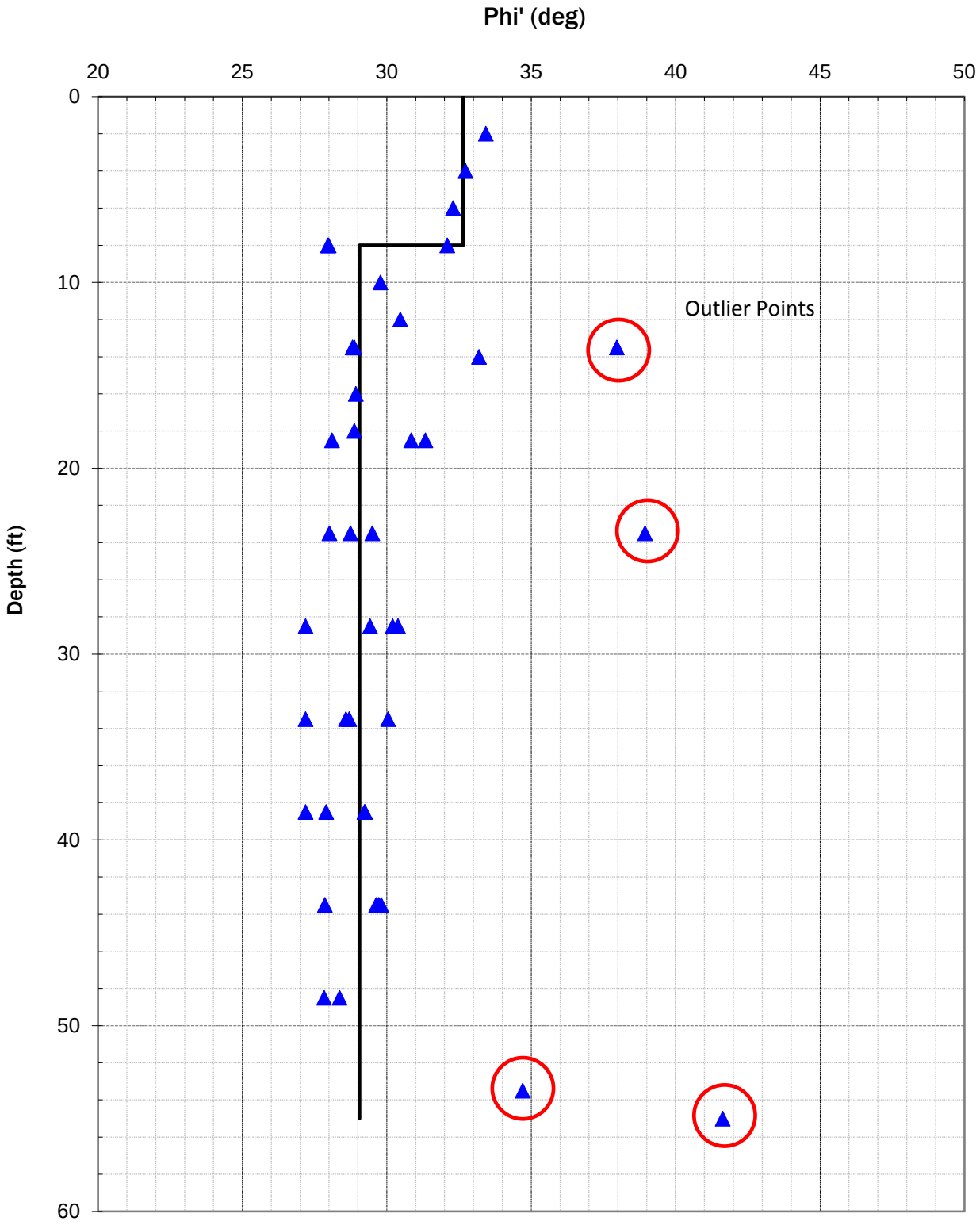
East Embankment 3
(>112+00)

Harbor River Bridge
Harbor Island, South Carolina

GeoEngineers

Figure C-4

18461-007-01



Borings Included: B-1, B-3, B-4, and B-7

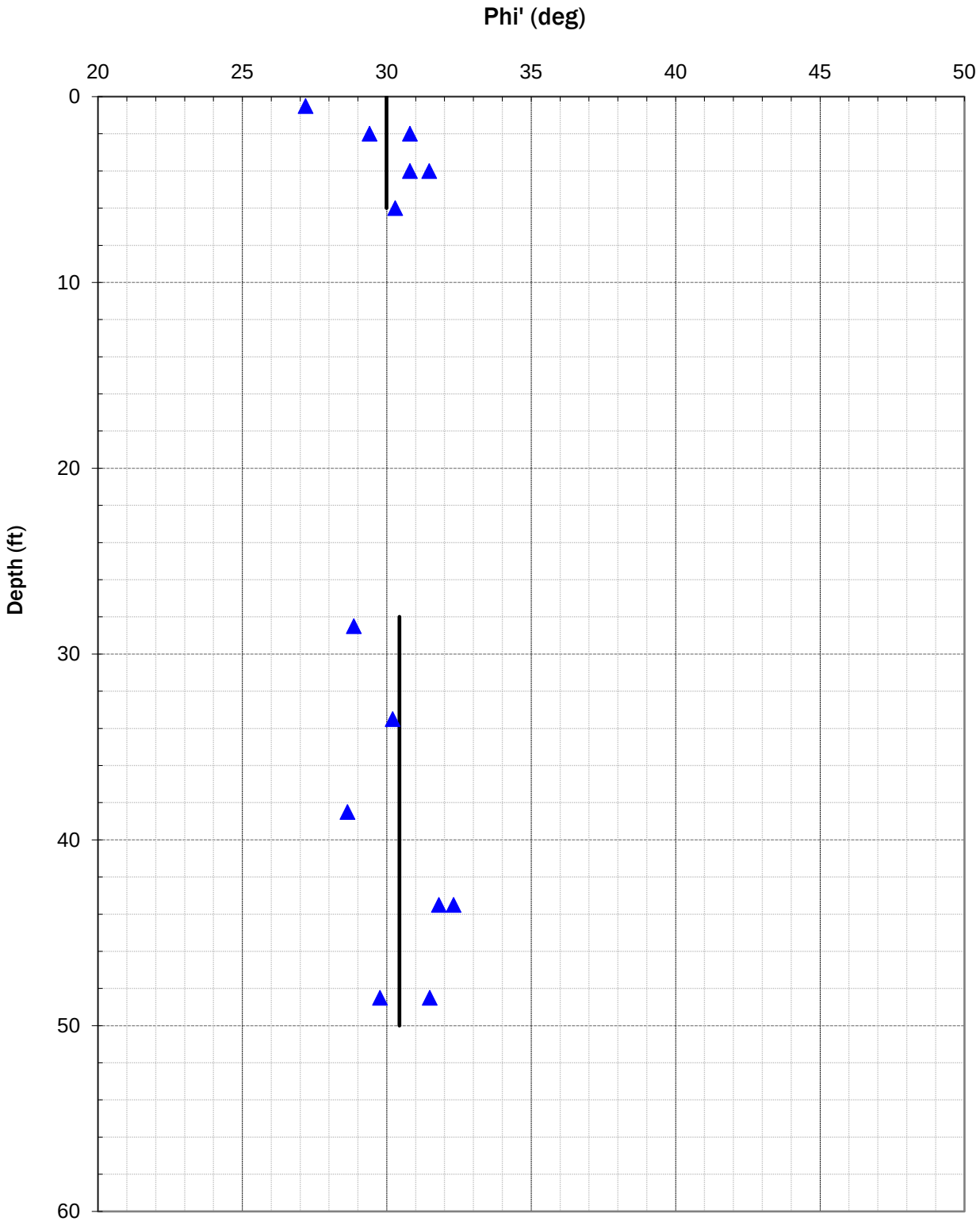
West Embankment 1 (<59+00)

Harbor River Bridge
Harbor Island, South Carolina

GeoEngineers

Figure C-5

18461-007-01



Borings Included: B-8, B-9

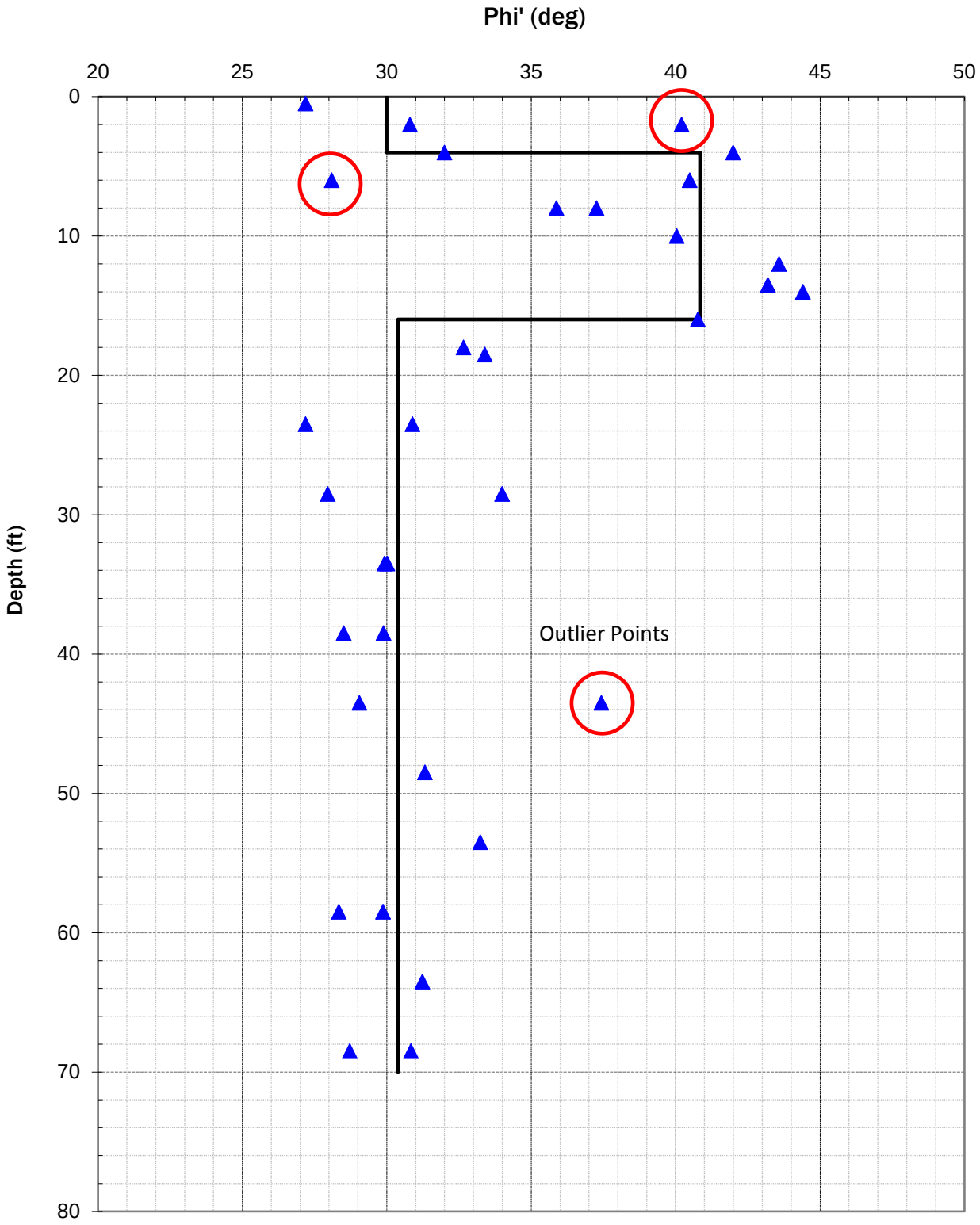
West Embankment 2, 3, and 4
(59+00 to 70+40)

Harbor River Bridge
Harbor Island, South Carolina

GeoEngineers

Figure C-6

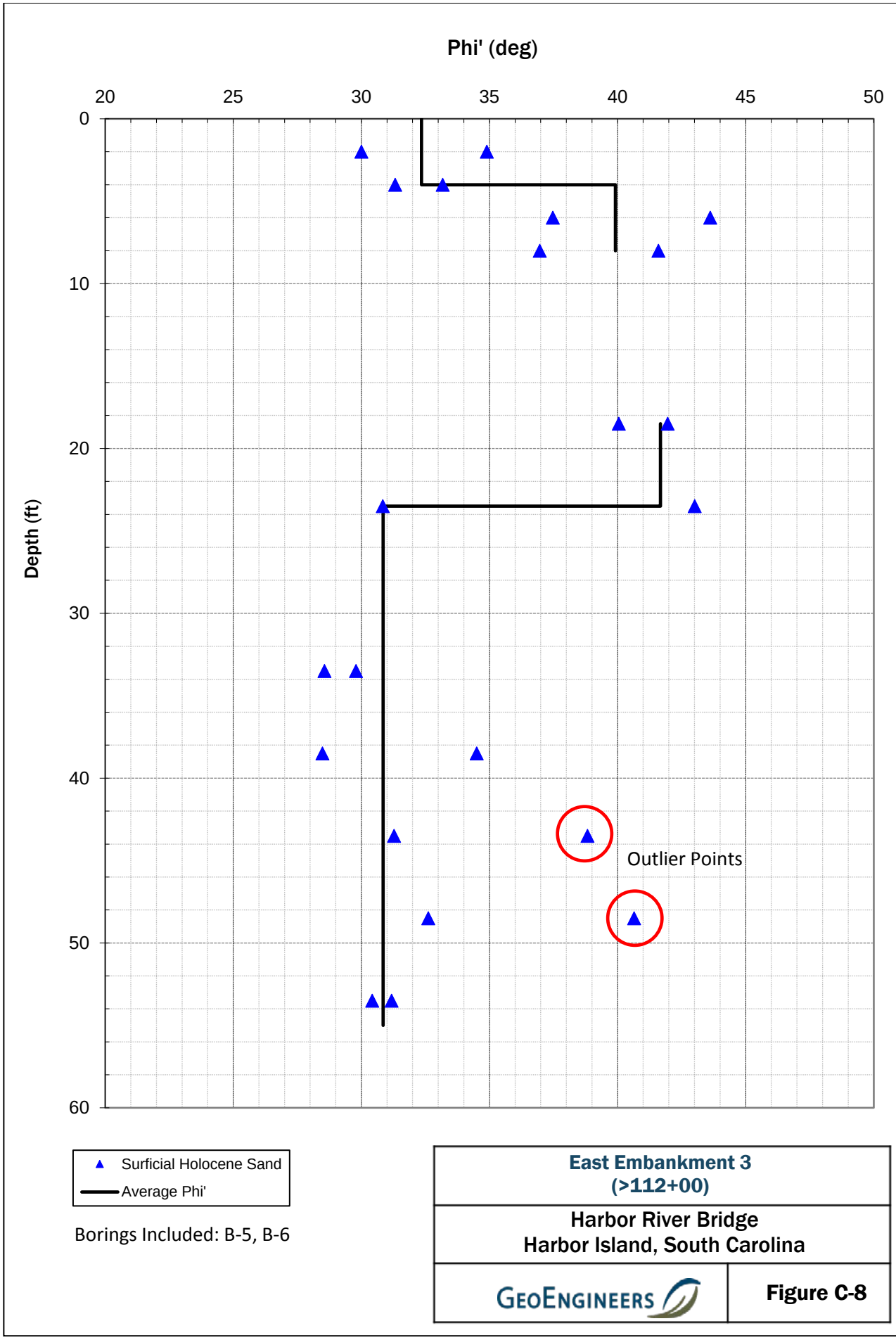
18461-007-01



Borings Included: B-2, B-16

East Embankment 1 and 2 (103+80 to 112+00)	
Harbor River Bridge Harbor Island, South Carolina	
GeoEngineers	Figure C-7

18461-007-01



Borings Included: B-5, B-6

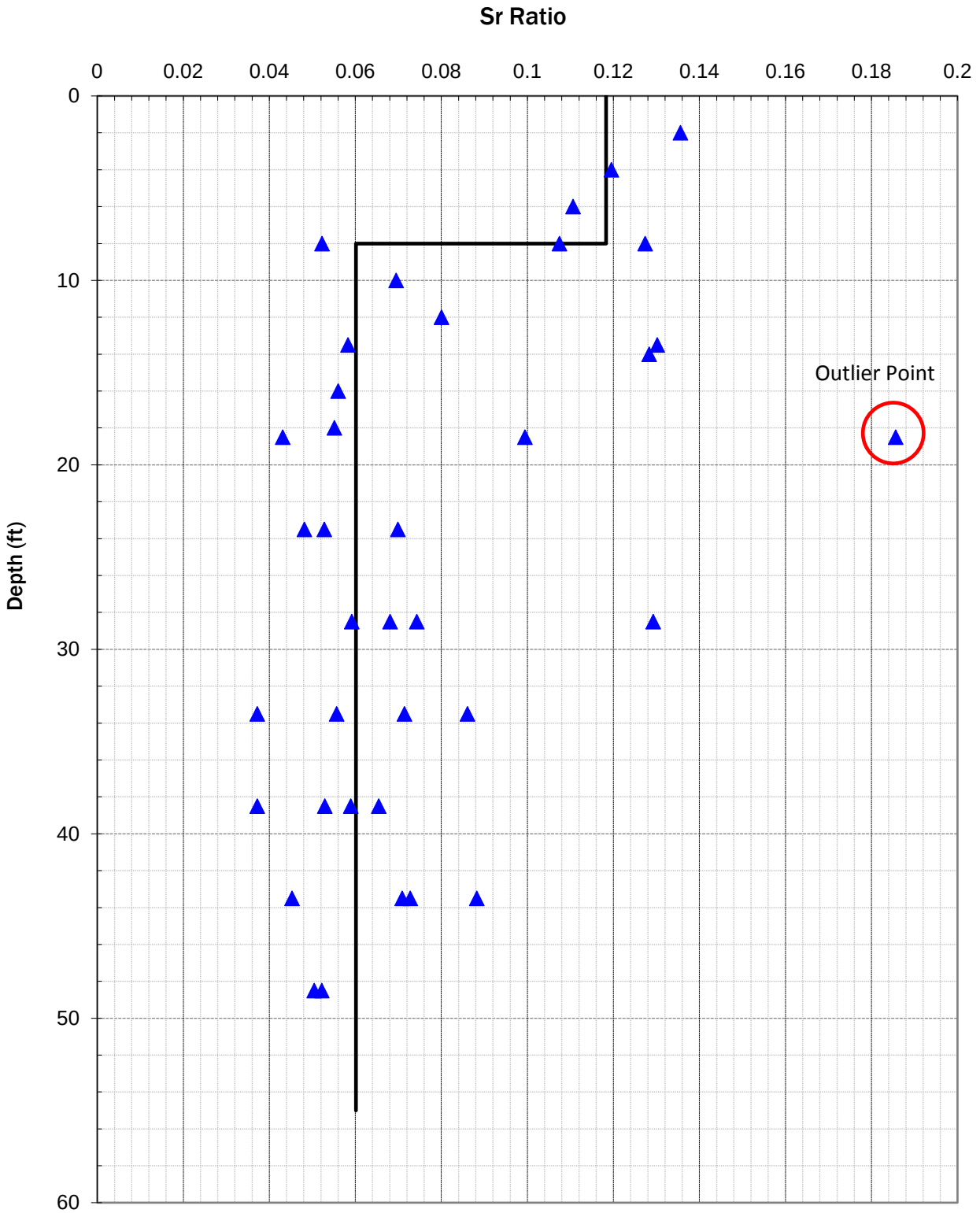
East Embankment 3
(>112+00)

Harbor River Bridge
Harbor Island, South Carolina

GeoEngineers

Figure C-8

18461-007-01



Borings Included: B-1, B-3, B-4, and B-7

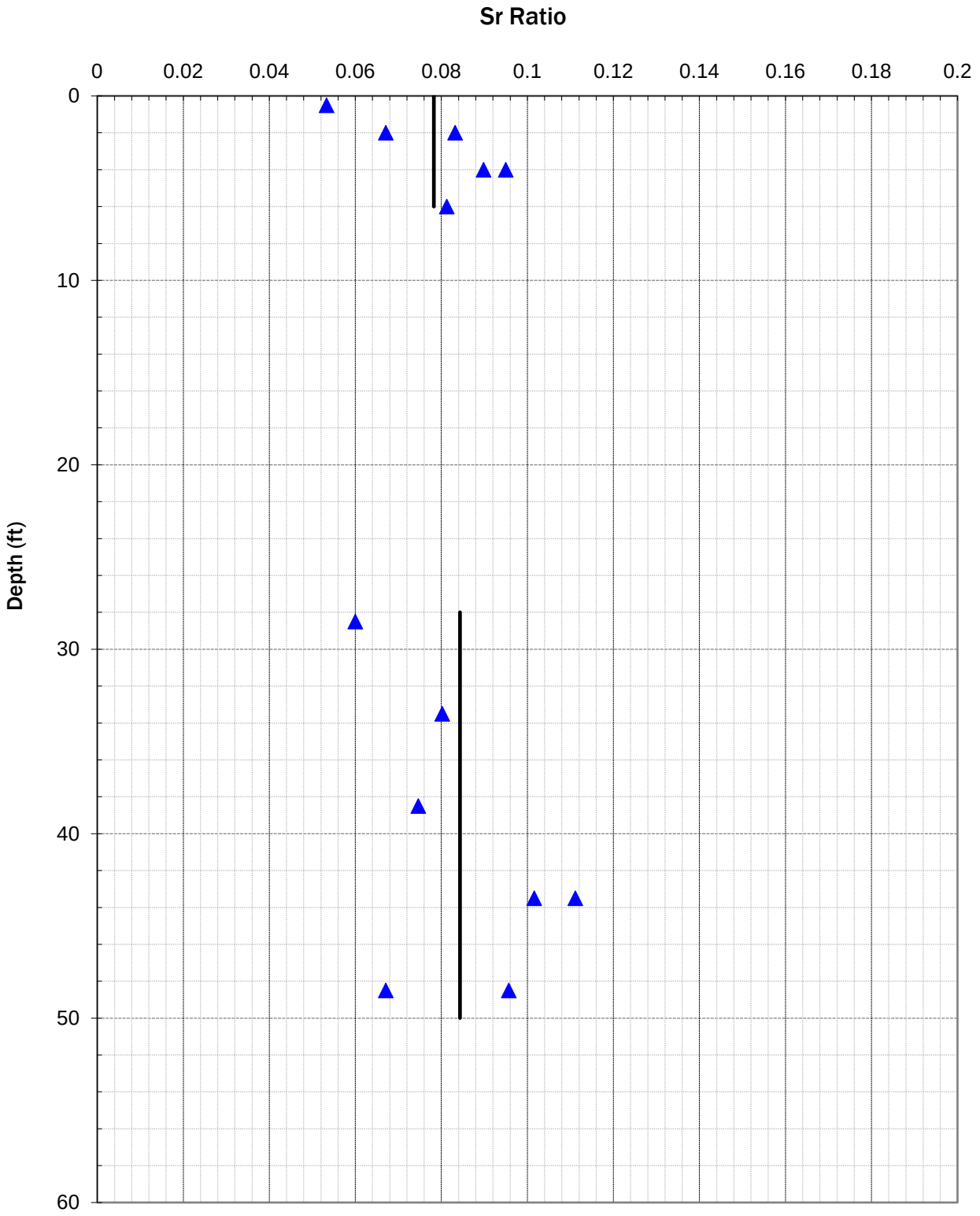
West Embankment 1
(<59+00)

Harbor River Bridge
Harbor Island, South Carolina

GeoEngineers

Figure C-9

18461-007-01



Borings Included: B-8, B-9

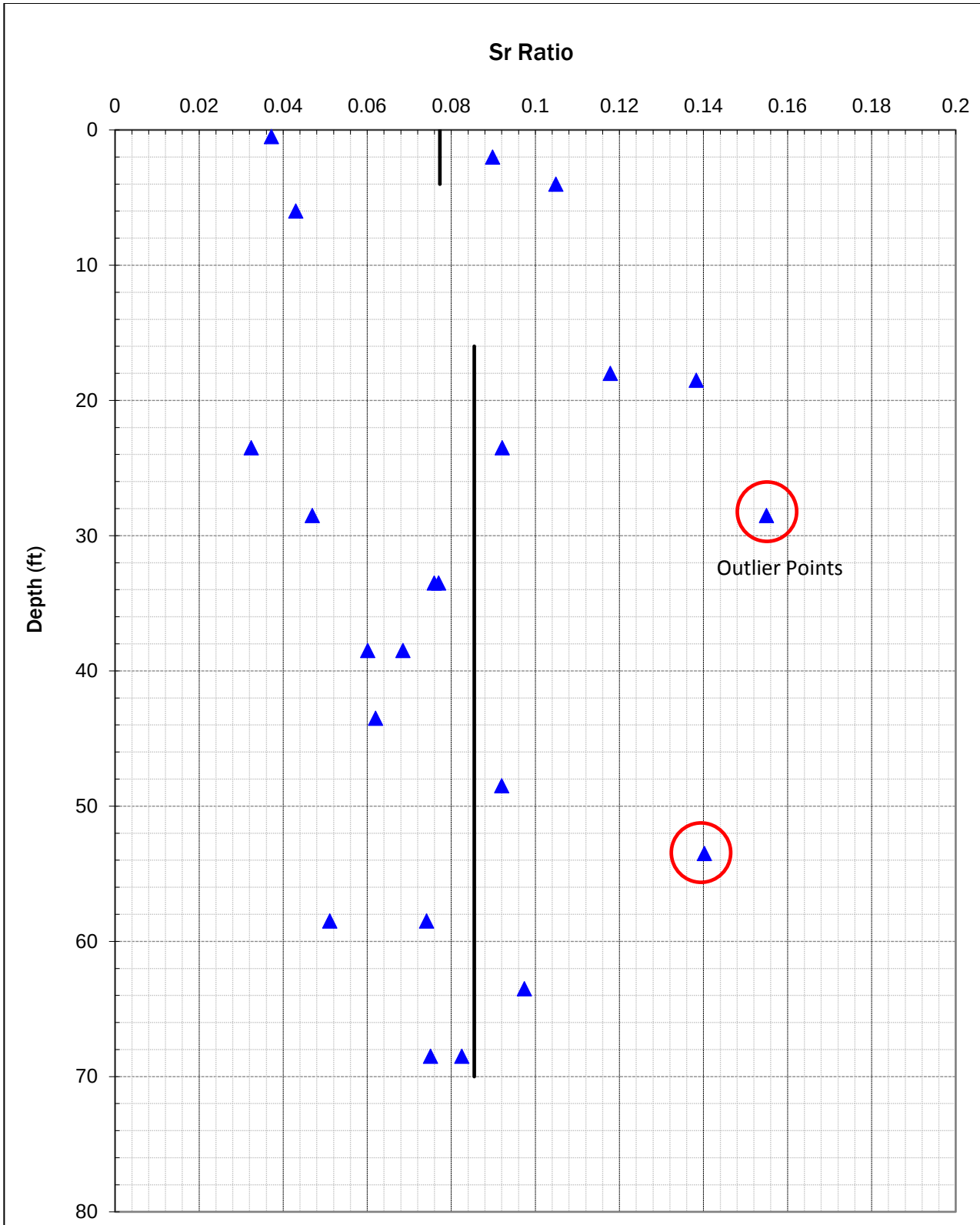
West Embankment 2, 3, and 4
(59+00 to 70+40)

Harbor River Bridge
Harbor Island, South Carolina

GeoEngineers

Figure C-10

18461-007-01



Borings Included: B-2, B-16

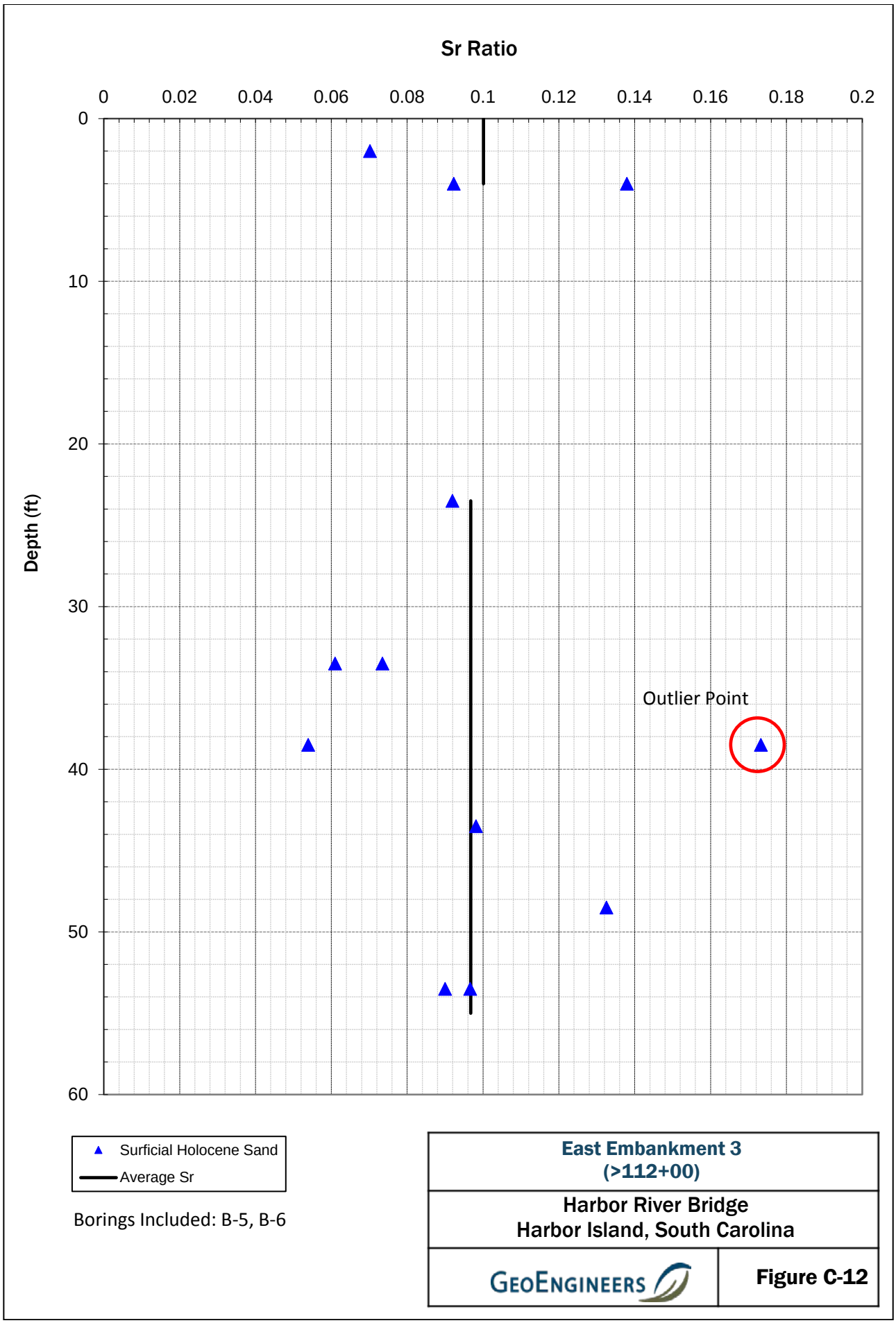
East Embankment 1 and 2
(103+80 to 112+00)

Harbor River Bridge
Harbor Island, South Carolina

GeoEngineers

Figure C-11

18461-007-01



Borings Included: B-5, B-6

East Embankment 3
(>112+00)

Harbor River Bridge
Harbor Island, South Carolina

GeoEngineers

Figure C-12

18461-007-01

APPENDIX D
Consolidation Analyses

Project: 18461-007-01
Author: IAH

Analysis: West Embankment 1
< 59+00

Cross Section	57+99	
Ground Surface Elevation	10	ft
Groundwater Elevation	0	ft
Embankment Height	6.2	ft
Embankment Total Unit Weight	125	pcf
Embankment Design Width	120	ft
Load applied by Embankment	775	psf
Settlement	1.2	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Silts/Clays	12	95	-	-	-	-	12	6	0.03	97.3	570	754	-	-
Silts/Clays	0	32.6	0.557	0.072	0.035	2.375	5	-2.5	0.10	91.7	1222	710	2901	0.07
Silts/Clays	-5	32.6	0.557	0.072	0.035	2.125	2	-6	0.13	89.3	1336	692	2838	0.03
Sands	-7	37.6	-	-	-	-	43	-28.5	0.32	74.3	2177	576	-	-
Hawthorn Marl	-50	57.6	-	-	-	-	20	-60	0.58	56.0	3561	434	-	-
Cooper Group Limestone	-70	57.6	-	-	-	-	130	-135	1.21	34.0	7881	264	-	-
	-200													

Project: 18461-007-01
Author: IAH

Analysis: West Embankment 2
59+00 to 69+65

Cross Section	60+88	
Ground Surface Elevation	10	ft
Groundwater Elevation	0	ft
Embankment Height	8.2	ft
Embankment Total Unit Weight	125	pcf
Embankment Design Width	120	ft
Load applied by Embankment	1025	psf
Settlement	2.1	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Silts/Clays	10	95	-	-	-	-	10	5	0.04	96.7	475	991	-	-
Silts/Clays	0	32.6	0.359	0.047	0.035	2.375	5	-2.5	0.10	91.7	1032	940	2450	0.07
Silts/Clays	-5	32.6	0.359	0.047	0.035	2.125	5	-7.5	0.15	88.3	1195	905	2538	0.06
Silts/Clays	-10	32.6	0.359	0.047	0.035	1.875	5	-12.5	0.19	85.0	1358	871	2545	0.05
Sands (2)	-15	37.6	-	-	-	-	35	-32.5	0.35	71.7	2097	735	-	-
Hawthorn Marl	-50	57.6	-	-	-	-	20	-60	0.58	56.0	3331	574	-	-
Cooper Group Limestone	-70	57.6	-	-	-	-	130	-135	1.21	34.0	7651	349	-	-
	-200													

Project: 18461-007-01
Author: IAH

Analysis: West Embankment 2
59+00 to 69+65

Cross Section	**65+00**	
Ground Surface Elevation	**3**	ft
Groundwater Elevation	**0**	ft
Embankment Height	**10.2**	ft
Embankment Total Unit Weight	**125**	pcf
Embankment Design Width	120	ft
Load applied by Embankment	1275	psf
Settlement	4.3	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Sands (1)	**3**	**100**	**-**	**-**	**-**	**-**	3	1.5	0.01	99.0	150	1262	-	-
Sands (1)	**0**	**37.6**	**-**	**-**	**-**	**-**	10	-5	0.07	94.7	488	1207	-	-
Silts/Clays	**-10**	**32.6**	**0.359**	**0.047**	**0.035**	**2.225**	5	-12.5	0.13	89.7	758	1143	1685	0.17
Silts/Clays	**-15**	**32.6**	**0.359**	**0.047**	**0.035**	**1.975**	7	-18.5	0.18	85.7	953	1092	1882	0.19
Sands (2)	**-22**	**37.6**	**-**	**-**	**-**	**-**	28	-36	0.33	74.0	1594	944	-	-
Hawthorn Marl	**-50**	**57.6**	**-**	**-**	**-**	**-**	22	-61	0.53	58.4	2754	745	-	-
Cooper Group Limestone	**-72**	**57.6**	**-**	**-**	**-**	**-**	128	-136	1.16	35.2	7074	449	-	-
	-200													

Project: 18461-007-01
Author: IAH

Analysis: West Embankment 2
59+00 to 69+65

Cross Section	67+04	
Ground Surface Elevation	3	ft
Groundwater Elevation	0	ft
Embankment Height	11.2	ft
Embankment Total Unit Weight	125	pcf
Embankment Design Width	120	ft
Load applied by Embankment	1400	psf
Settlement	22.2	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Sands (1)	3	100	-	-	-	-	3	1.5	0.01	99.0	150	1386	-	-
Sands (1)	0	37.6	-	-	-	-	5	-2.5	0.05	96.3	394	1349	-	-
Silts/Clays	-5	32.6	0.359	0.047	0.035	2.500	5	-7.5	0.09	93.0	570	1302	1424	0.31
Silts/Clays	-10	32.6	0.359	0.047	0.035	2.250	5	-12.5	0.13	89.7	733	1255	1648	0.23
Silts/Clays	-15	32.6	0.359	0.047	0.035	2.000	5	-17.5	0.17	86.3	896	1209	1791	0.20
Silts/Clays	-20	32.6	0.359	0.047	0.035	1.750	5	-22.5	0.21	83.0	1059	1162	1852	0.20
Silts/Clays	-25	32.6	0.359	0.047	0.035	1.500	5	-27.5	0.25	79.7	1222	1115	1832	0.23
Silts/Clays	-30	32.6	0.359	0.047	0.035	1.250	5	-32.5	0.30	76.3	1385	1069	1731	0.29
Silts/Clays	-35	32.6	0.359	0.047	0.035	1.000	5	-37.5	0.34	73.0	1548	1022	1548	0.40
Sands (2)	-40	37.6	-	-	-	-	8	-44	0.39	68.7	1779	961	-	-
Hawthorn Marl	-48	57.6	-	-	-	-	24	-60	0.53	58.8	2621	823	-	-
Cooper Group Limestone	-72	57.6	-	-	-	-	128	-136	1.16	35.2	6999	493	-	-
	-200													

Project: 18461-007-01
Author: IAH

Analysis: East Embankment 2
104+55 to 112+00

Cross Section	**105+97**	
Ground Surface Elevation	**3**	ft
Groundwater Elevation	**0**	ft
Embankment Height	**14.2**	ft
Embankment Total Unit Weight	**125**	pcf
Embankment Design Width	120	ft
Load applied by Embankment	1775	psf
Settlement	7.5	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Sands (1)	**3**	**100**	**-**	**-**	**-**	**-**	5	0.5	0.02	98.3	250	1745	-	-
Sands (2)	**-2**	**57.6**	**-**	**-**	**-**	**-**	13	-8.5	0.10	92.3	874	1639	-	-
Sands (3)	**-15**	**37.6**	**-**	**-**	**-**	**-**	30	-30	0.28	78.0	1813	1385	-	-
Silts/Clays	**-45**	**32.6**	**0.386**	**0.050**	**0.035**	**1.000**	5	-47.5	0.42	66.3	2458	1177	2458	0.33
Silts/Clays	**-50**	**32.6**	**0.386**	**0.050**	**0.035**	**1.000**	5	-52.5	0.46	63.0	2621	1118	2621	0.30
Sands (4)	**-55**	**37.6**	**-**	**-**	**-**	**-**	10	-60	0.53	58.8	2891	1044	-	-
Hawthorn Marl	**-65**	**57.6**	**-**	**-**	**-**	**-**	12	-71	0.62	54.4	3424	966	-	-
Cooper Group Limestone	**-77**	**57.6**	**-**	**-**	**-**	**-**	123	-138.5	1.18	34.7	7312	616	-	-
	-200													

Project: 18461-007-01
Author: IAH

Analysis: East Embankment 2
104+55 to 112+00

Cross Section	**109+84**	
Ground Surface Elevation	**3**	ft
Groundwater Elevation	**0**	ft
Embankment Height	**11.2**	ft
Embankment Total Unit Weight	**125**	pcf
Embankment Design Width	120	ft
Load applied by Embankment	1400	psf
Settlement	6.1	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Sands (1)	**3**	**100**	**-**	**-**	**-**	**-**	5	0.5	0.02	98.3	250	1377	-	-
Sands (2)	**-2**	**57.6**	**-**	**-**	**-**	**-**	13	-8.5	0.10	92.3	874	1293	-	-
Sands (3)	**-15**	**37.6**	**-**	**-**	**-**	**-**	30	-30	0.28	78.0	1813	1092	-	-
Silts/Clays	**-45**	**32.6**	**0.386**	**0.050**	**0.035**	**1.000**	10	-50	0.44	64.7	2540	905	2540	0.51
Sands (4)	**-55**	**37.6**	**-**	**-**	**-**	**-**	10	-60	0.53	58.8	2891	823	-	-
Hawthorn Marl	**-65**	**57.6**	**-**	**-**	**-**	**-**	12	-71	0.62	54.4	3424	762	-	-
Cooper Group Limestone	**-77**	**57.6**	**-**	**-**	**-**	**-**	123	-138.5	1.18	34.7	7312	486	-	-
	-200													

Project: 18461-007-01
Author: IAH

Analysis: East Embankment 3
>112+00

Cross Section	**116+48**	
Ground Surface Elevation	**10**	ft
Groundwater Elevation	**0**	ft
Embankment Height	**10.2**	ft
Embankment Total Unit Weight	**125**	pcf
Embankment Design Width	120	ft
Load applied by Embankment	1275	psf
Settlement	1.1	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Sands (1)	**10**	**100**	**-**	**-**	**-**	**-**	13	3.5	0.05	95.7	650	1220	-	-
Sands (2)	**-3**	**57.6**	**-**	**-**	**-**	**-**	7	-6.5	0.14	89.0	1502	1135	-	-
Silts/Clays (1)	**-10**	**32.6**	**0.386**	**0.050**	**0.035**	**2.250**	5	-12.5	0.19	85.0	1785	1084	4016	0.05
Sands (3)	**-15**	**57.6**	**-**	**-**	**-**	**-**	8	-19	0.24	80.7	2097	1029	-	-
Silts/Clays (2)	**-23**	**32.6**	**0.386**	**0.050**	**0.035**	**1.500**	5	-25.5	0.30	76.3	2409	973	3613	0.04
Sands (4)	**-28**	**37.6**	**-**	**-**	**-**	**-**	28	-42	0.43	65.3	3016	833	-	-
Hawthorn Marl	**-56**	**57.6**	**-**	**-**	**-**	**-**	21	-66.5	0.64	53.4	4148	681	-	-
Cooper Group Limestone	**-77**	**57.6**	**-**	**-**	**-**	**-**	123	-138.5	1.24	33.3	8295	425	-	-
	-200													

Project: 18461-007-01
Author: IAH

Analysis: West Embankment 1
< 59+00

Cross Section	57+99	
Ground Surface Elevation	10	ft
Groundwater Elevation	0	ft
Embankment Height	5.4	ft
Embankment Total Unit Weight	125	pcf
Embankment Design Width	120	ft
Load applied by Embankment	675	psf
Settlement	1.1	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Silts/Clays	12	95	-	-	-	-	12	6	0.03	97.3	570	657	-	-
Silts/Clays	0	32.6	0.557	0.072	0.035	2.375	5	-2.5	0.10	91.7	1222	619	2901	0.06
Silts/Clays	-5	32.6	0.557	0.072	0.035	2.125	2	-6	0.13	89.3	1336	603	2838	0.02
Sands	-7	37.6	-	-	-	-	43	-28.5	0.32	74.3	2177	502	-	-
Hawthorn Marl	-50	57.6	-	-	-	-	20	-60	0.58	56.0	3561	378	-	-
Cooper Group Limestone	-70	57.6	-	-	-	-	130	-135	1.21	34.0	7881	230	-	-
	-200													

Project: 18461-007-01
Author: IAH

Analysis: West Embankment 2
59+00 to 69+65

Cross Section	**60+88**	
Ground Surface Elevation	**10**	ft
Groundwater Elevation	**0**	ft
Embankment Height	**7.4**	ft
Embankment Total Unit Weight	**125**	pcf
Embankment Design Width	120	ft
Load applied by Embankment	925	psf
Settlement	1.9	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Silts/Clays	**10**	**95**	**-**	**-**	**-**	**-**	10	5	0.04	96.7	475	894	-	-
Silts/Clays	**0**	**32.6**	**0.359**	**0.047**	**0.035**	**2.375**	5	-2.5	0.10	91.7	1032	848	2450	0.06
Silts/Clays	**-5**	**32.6**	**0.359**	**0.047**	**0.035**	**2.125**	5	-7.5	0.15	88.3	1195	817	2538	0.05
Silts/Clays	**-10**	**32.6**	**0.359**	**0.047**	**0.035**	**1.875**	5	-12.5	0.19	85.0	1358	786	2545	0.05
Sands (2)	**-15**	**37.6**	**-**	**-**	**-**	**-**	35	-32.5	0.35	71.7	2097	663	-	-
Hawthorn Marl	**-50**	**57.6**	**-**	**-**	**-**	**-**	20	-60	0.58	56.0	3331	518	-	-
Cooper Group Limestone	**-70**	**57.6**	**-**	**-**	**-**	**-**	130	-135	1.21	34.0	7651	315	-	-
	-200													

Project: 18461-007-01
Author: IAH

Analysis: West Embankment 2
59+00 to 69+65

Cross Section	**65+00**	
Ground Surface Elevation	**3**	ft
Groundwater Elevation	**0**	ft
Embankment Height	**9.4**	ft
Embankment Total Unit Weight	**125**	pcf
Embankment Design Width	120	ft
Load applied by Embankment	1175	psf
Settlement	2.3	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Sands (1)	**3**	**100**	**-**	**-**	**-**	**-**	3	1.5	0.01	99.0	150	1163	1462	-
Sands (1)	**0**	**37.6**	**-**	**-**	**-**	**-**	10	-5	0.07	94.7	488	1112	1742	-
Silts/Clays	**-10**	**32.6**	**0.359**	**0.047**	**0.035**	**2.225**	5	-12.5	0.13	89.7	758	1054	1946	0.09
Silts/Clays	**-15**	**32.6**	**0.359**	**0.047**	**0.035**	**1.975**	7	-18.5	0.18	85.7	953	1007	2088	0.10
Sands (2)	**-22**	**37.6**	**-**	**-**	**-**	**-**	28	-36	0.33	74.0	1594	870	2574	-
Hawthorn Marl	**-50**	**57.6**	**-**	**-**	**-**	**-**	22	-61	0.53	58.4	2754	686	3527	-
Cooper Group Limestone	**-72**	**57.6**	**-**	**-**	**-**	**-**	128	-136	1.16	35.2	7074	414	5370	-
	-200													

Project: 18461-007-01
Author: IAH

Analysis: West Embankment 2
59+00 to 69+65

Cross Section	67+04	
Ground Surface Elevation	3	ft
Groundwater Elevation	0	ft
Embankment Height	10.4	ft
Embankment Total Unit Weight	125	pcf
Embankment Design Width	120	ft
Load applied by Embankment	1300	psf
Settlement	6.4	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Sands (1)	3	100	-	-	-	-	3	1.5	0.01	99.0	150	1287	1759	-
Sands (1)	0	37.6	-	-	-	-	5	-2.5	0.05	96.3	394	1252	1959	-
Silts/Clays	-5	32.6	0.359	0.047	0.035	2.500	5	-7.5	0.09	93.0	570	1209	2081	0.12
Silts/Clays	-10	32.6	0.359	0.047	0.035	2.250	5	-12.5	0.13	89.7	733	1166	2190	0.10
Silts/Clays	-15	32.6	0.359	0.047	0.035	2.000	5	-17.5	0.17	86.3	896	1122	2298	0.08
Silts/Clays	-20	32.6	0.359	0.047	0.035	1.750	5	-22.5	0.21	83.0	1059	1079	2407	0.07
Silts/Clays	-25	32.6	0.359	0.047	0.035	1.500	5	-27.5	0.25	79.7	1222	1036	2516	0.06
Silts/Clays	-30	32.6	0.359	0.047	0.035	1.250	5	-32.5	0.30	76.3	1385	992	2625	0.05
Silts/Clays	-35	32.6	0.359	0.047	0.035	1.000	5	-37.5	0.34	73.0	1548	949	2734	0.05
Sands (2)	-40	37.6	-	-	-	-	8	-44	0.39	68.7	1779	893	2895	-
Hawthorn Marl	-48	57.6	-	-	-	-	24	-60	0.53	58.8	2621	764	3577	-
Cooper Group Limestone	-72	57.6	-	-	-	-	128	-136	1.16	35.2	6999	458	5431	-
	-200													

Project: 18461-007-01
Author: IAH

Analysis: East Embankment 2
104+55 to 112+00

Cross Section	105+97	
Ground Surface Elevation	3	ft
Groundwater Elevation	0	ft
Embankment Height	13.4	ft
Embankment Total Unit Weight	125	pcf
Embankment Design Width	120	ft
Load applied by Embankment	1675	psf
Settlement	0.9	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Sands (1)	3	100	-	-	-	-	5	0.5	0.02	98.3	250	1647	2069	-
Sands (2)	-2	57.6	-	-	-	-	13	-8.5	0.10	92.3	874	1547	2583	-
Sands (3)	-15	37.6	-	-	-	-	30	-30	0.28	78.0	1813	1307	3256	-
Silts/Clays	-45	32.6	0.386	0.050	0.035	1.000	5	-47.5	0.42	66.3	2458	1111	3685	0.04
Silts/Clays	-50	32.6	0.386	0.050	0.035	1.000	5	-52.5	0.46	63.0	2621	1055	3787	0.04
Sands (4)	-55	37.6	-	-	-	-	10	-60	0.53	58.8	2891	985	3979	-
Hawthorn Marl	-65	57.6	-	-	-	-	12	-71	0.62	54.4	3424	911	4431	-
Cooper Group Limestone	-77	57.6	-	-	-	-	123	-138.5	1.18	34.7	7312	581	5833	-
	-200													

Project: 18461-007-01
Author: IAH

Analysis: East Embankment 2
104+55 to 112+00

Cross Section	109+84	
Ground Surface Elevation	3	ft
Groundwater Elevation	0	ft
Embankment Height	10.4	ft
Embankment Total Unit Weight	125	pcf
Embankment Design Width	120	ft
Load applied by Embankment	1300	psf
Settlement	0.7	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Sands (1)	3	100	-	-	-	-	5	0.5	0.02	98.3	250	1278	1688	-
Sands (2)	-2	57.6	-	-	-	-	13	-8.5	0.10	92.3	874	1200	2225	-
Sands (3)	-15	37.6	-	-	-	-	30	-30	0.28	78.0	1813	1014	2954	-
Silts/Clays	-45	32.6	0.386	0.050	0.035	1.000	10	-50	0.44	64.7	2540	841	3486	0.06
Sands (4)	-55	37.6	-	-	-	-	10	-60	0.53	58.8	2891	764	3751	-
Hawthorn Marl	-65	57.6	-	-	-	-	12	-71	0.62	54.4	3424	707	4220	-
Cooper Group Limestone	-77	57.6	-	-	-	-	123	-138.5	1.18	34.7	7312	451	5660	-
	-200													

Project: 18461-007-01
Author: IAH

Analysis: East Embankment 3
>112+00

Cross Section	**116+48**	
Ground Surface Elevation	**10**	ft
Groundwater Elevation	**0**	ft
Embankment Height	**9.4**	ft
Embankment Total Unit Weight	**125**	pcf
Embankment Design Width	120	ft
Load applied by Embankment	1175	psf
Settlement	1.0	in

σ'v0 Δσv σ'p

Material	Layer Top Elv. (ft)	Unit Weight (pcf)	Cce	Cre	Cv (ft^2/day)	OCR	Layer Thickness (ft)	Layer Center Elevation (ft)	z/B	Percent Vertical Stress	Effective Overburden Stress @ Center of Layer (psf)	Increase in Vertical Effective Stress (psf)	Preconsolidation Stress (psf)	Settlement of Layer (ft)
Sands (1)	**10**	**100**	**-**	**-**	**-**	**-**	13	3.5	0.05	95.7	650	1124	-	-
Sands (2)	**-3**	**57.6**	**-**	**-**	**-**	**-**	7	-6.5	0.14	89.0	1502	1046	-	-
Silts/Clays (1)	**-10**	**32.6**	**0.386**	**0.050**	**0.035**	**2.250**	5	-12.5	0.19	85.0	1785	999	4016	0.05
Sands (3)	**-15**	**57.6**	**-**	**-**	**-**	**-**	8	-19	0.24	80.7	2097	948	-	-
Silts/Clays (2)	**-23**	**32.6**	**0.386**	**0.050**	**0.035**	**1.500**	5	-25.5	0.30	76.3	2409	897	3613	0.03
Sands (4)	**-28**	**37.6**	**-**	**-**	**-**	**-**	28	-42	0.43	65.3	3016	768	-	-
Hawthorn Marl	**-56**	**57.6**	**-**	**-**	**-**	**-**	21	-66.5	0.64	53.4	4148	627	-	-
Cooper Group Limestone	**-77**	**57.6**	**-**	**-**	**-**	**-**	123	-138.5	1.24	33.3	8295	391	-	-
	-200													

APPENDIX E
Soil Liquefaction Analyses

1. Static

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Yoon Seok Choi
Last Edited By: Heidi Cashman
Revision Number: 109
Date: 9/28/2017
Time: 2:14:51 PM
Tool Version: 8.16.1.13452
File Name: 1) Station 59_00.gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

1. Static

Description: Static Case
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: No

Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 10 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.46
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 29 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl

Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 4,000 psf
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone

Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 6,000 psf
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-91, 3) ft
Left-Zone Right Coordinate: (-41, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-23, 12) ft
Right-Zone Right Coordinate: (21, 12) ft
Right-Zone Increment: 9
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-41, 3) ft
Inside Point: (-6, 12) ft
Length: 36.138622 ft
Direction: 194.42 °
F of S Dependent: Yes
Pullout Resistance: 350 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: Yes
Tensile Capacity: 33,980 lbs

Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 350 lbs/ft
Max. Pullout Force: 12,648.518 lbs
Factored Tensile Capacity: 33,980 lbs

Points

	X (ft)	Y (ft)
Point 1	-41	3
Point 2	-23	12
Point 3	21	12
Point 4	46	3
Point 5	-20	3
Point 6	35	3
Point 7	-250	3
Point 8	250	3
Point 9	250	-10
Point 10	-250	-10
Point 11	250	-50
Point 12	-250	-50
Point 13	250	-70
Point 14	-250	-70
Point 15	250	-100
Point 16	-250	-100
Point 17	-15	16
Point 18	13	16
Point 19	0	3
Point 20	124	3
Point 21	60	3
Point 22	-6	12

Regions

	Material	Points	Area (ft²)
Region 1	Silts/Clays	7,10,9,8,20,21,4,6,19,5,1	6,500
Region 2	Sands	10,9,11,12	20,000
Region 3	Hawthorn Marl	12,11,13,14	10,000
Region 4	Cooper Group Limestone	14,13,15,16	15,000
Region 5		2,17,18,3,22	144
Region 6	Compacted Fill	1,22,2	76.5
Region 7	Silts/Clays	5,19,6,4,21,3,22,1	576

2. Static - Trafic

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Yoon Seok Choi
Last Edited By: Heidi Cashman
Revision Number: 109
Date: 9/28/2017
Time: 2:14:51 PM
Tool Version: 8.16.1.13452
File Name: 1) Station 59_00.gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

2. Static - Trafic

Description: Static Case
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: No

Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 2 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.46
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 29 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl

Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 4,000 psf
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone

Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 6,000 psf
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-91, 3) ft
Left-Zone Right Coordinate: (-41, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-23, 12) ft
Right-Zone Right Coordinate: (21, 12) ft
Right-Zone Increment: 9
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 400 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	-23	12
	-23	13
	21	13

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-41, 3) ft
Inside Point: (-6, 12) ft
Length: 36.138622 ft
Direction: 194.42 °
F of S Dependent: Yes
Pullout Resistance: 350 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: Yes
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 350 lbs/ft
Max. Pullout Force: 12,648.518 lbs
Factored Tensile Capacity: 33,980 lbs

Points

	X (ft)	Y (ft)
Point 1	-41	3
Point 2	-23	12
Point 3	21	12
Point 4	46	3
Point 5	-20	3
Point 6	35	3
Point 7	-250	3
Point 8	250	3
Point 9	250	-10
Point 10	-250	-10
Point 11	250	-50
Point 12	-250	-50
Point 13	250	-70
Point 14	-250	-70
Point 15	250	-100
Point 16	-250	-100
Point 17	-15	16
Point 18	13	16
Point 19	0	3
Point 20	124	3
Point 21	60	3
Point 22	-6	12

Regions

	Material	Points	Area (ft²)
Region 1	Silts/Clays	7,10,9,8,20,21,4,6,19,5,1	6,500
Region 2	Sands	10,9,11,12	20,000
Region 3	Hawthorn Marl	12,11,13,14	10,000
Region 4	Cooper Group Limestone	14,13,15,16	15,000
Region 5		2,17,18,3,22	144
Region 6	Compacted Fill	1,22,2	76.5
Region 7	Silts/Clays	5,19,6,4,21,3,22,1	576

1. Static- Preload

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Yoon Seok Choi
Last Edited By: Heidi Cashman
Revision Number: 144
Date: 9/28/2017
Time: 2:37:28 PM
Tool Version: 8.16.1.13452
File Name: 2) Station 69_00.gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

1. Static- Preload

Description: Static Case
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: No

Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.38
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands (2)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl

Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 4,000 psf
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone

Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 6,000 psf
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-99, 3) ft
Left-Zone Right Coordinate: (-49, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-15, 20) ft
Right-Zone Right Coordinate: (15, 20) ft
Right-Zone Increment: 6
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 4) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-49, 3) ft

Inside Point: (30, 3) ft
Length: 79 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,460 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,460 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Points

	X (ft)	Y (ft)
Point 1	-49	3
Point 2	-23	16
Point 3	23	16
Point 4	50	3
Point 5	-36	3
Point 6	36	3
Point 7	-250	3
Point 8	250	3
Point 9	250	-3
Point 10	-250	-3.00642
Point 11	250	-33
Point 12	-250	-33
Point 13	250	-50
Point 14	-250	-50
Point 15	250	-73
Point 16	-250	-73
Point 17	250	-100
Point 18	-250	-100
Point 19	-15	20
Point 20	15	20
Point 21	250	4
Point 22	130	4
Point 23	106	5
Point 24	70	11
Point 25	50	11
Point 26	39.92762	7.84967
Point 27	30	3
Point 28	34.0309	4.9691

Point 29	-49	-73
Point 30	-49	-3.00384
Point 31	-49	-33
Point 32	-49	-50
Point 33	50	-73
Point 34	50	-3.00257
Point 35	50	-33
Point 36	50	-50
Point 37	-49	0
Point 38	50	0
Point 39	-250	0
Point 40	250	0

Regions

	Material	Points	Area (ft²)
Region 1	Compacted Fill	2,5,27,28,3	761.09
Region 2	Compacted Fill	2,1,5	84.5
Region 3	Compacted Fill	3,28,26	48.411
Region 4	Sands (1)	7,39,37,1	603
Region 5	Silts/Clays	10,30,31,12	6,029
Region 6	Sands (2)	12,31,32,14	3,417
Region 7	Hawthorn Marl	32,14,16,29,33,15,13,36	11,500
Region 8	Cooper Group Limestone	16,29,33,15,17,18	13,500
Region 9	Compacted Fill	2,19,20,3	152
Region 10	Sands (1)	8,21,22,23,24,25,26,28,27,6,4	584.79
Region 11	Sands (1)	9,40,38,34	600.26
Region 12	Silts/Clays	9,11,35,34	5,999.7
Region 13	Sands (2)	11,13,36,35	3,400
Region 14	Sands (1)	6,27,5,1,37,38,4	297
Region 15	Silts/Clays	31,30,34,35	2,969.7
Region 16	Sands (2)	32,31,35,36	1,683
Region 17	Sands (1)	30,34,38,37	297.32
Region 18	Sands (1)	39,37,30,10	604.03

Region 19	Sands (1)	4,8,40,38	600

2. Static- Trafic

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Yoon Seok Choi
Last Edited By: Heidi Cashman
Revision Number: 144
Date: 9/28/2017
Time: 2:37:28 PM
Tool Version: 8.16.1.13452
File Name: 2) Station 69_00.gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

2. Static- Trafic

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: No
- Tension Crack

Tension Crack Option: (none)

F of S Distribution

F of S Calculation Option: Constant

Advanced

Number of Slices: 30

F of S Tolerance: 0.001

Minimum Slip Surface Depth: 3 ft

Search Method: Root Finder

Tolerable difference between starting and converged F of S: 3

Maximum iterations to calculate converged lambda: 20

Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb

Unit Weight: 125 pcf

Cohesion': 0 psf

Phi': 38 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb

Unit Weight: 100 pcf

Cohesion': 0 psf

Phi': 30 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)

Unit Weight: 95 pcf

Tau/Sigma Ratio: 0.38

Minimum Strength: 0 psf

Pore Water Pressure

Piezometric Line: 1

Sands (2)

Model: Mohr-Coulomb

Unit Weight: 100 pcf

Cohesion': 0 psf

Phi': 30 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Hawthorn Marl

Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 4,000 psf
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone

Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 6,000 psf
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-99, 3) ft
Left-Zone Right Coordinate: (-49, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-23, 16) ft
Right-Zone Right Coordinate: (23, 16) ft
Right-Zone Increment: 9
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 4) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 400 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	-23	16
	-23	17
	23	17

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-49, 3) ft
Inside Point: (30, 3) ft
Length: 79 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,016 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,016 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Points

	X (ft)	Y (ft)
Point 1	-49	3
Point 2	-23	16
Point 3	23	16
Point 4	50	3
Point 5	-36	3
Point 6	36	3
Point 7	-250	3
Point 8	250	3
Point 9	250	-3
Point 10	-250	-3.00642
Point 11	250	-33
Point 12	-250	-33
Point 13	250	-50
Point 14	-250	-50
Point 15	250	-73
Point 16	-250	-73

Point 17	250	-100
Point 18	-250	-100
Point 19	-15	20
Point 20	15	20
Point 21	250	4
Point 22	130	4
Point 23	106	5
Point 24	70	11
Point 25	50	11
Point 26	39.92762	7.84967
Point 27	30	3
Point 28	34.0309	4.9691
Point 29	-49	-73
Point 30	-49	-3.00384
Point 31	-49	-33
Point 32	-49	-50
Point 33	50	-73
Point 34	50	-3.00257
Point 35	50	-33
Point 36	50	-50
Point 37	-49	0
Point 38	50	0
Point 39	-250	0
Point 40	250	0

Regions

	Material	Points	Area (ft²)
Region 1	Compacted Fill	2,5,27,28,3	761.09
Region 2	Compacted Fill	2,1,5	84.5
Region 3	Compacted Fill	3,28,26	48.411
Region 4	Sands (1)	7,39,37,1	603
Region 5	Silts/Clays	10,30,31,12	6,029
Region 6	Sands (2)	12,31,32,14	3,417
Region 7	Hawthorn Marl	32,14,16,29,33,15,13,36	11,500
Region 8	Cooper Group Limestone	16,29,33,15,17,18	13,500
Region 9		2,19,20,3	152
Region 10	Sands (1)	8,21,22,23,24,25,26,28,27,6,4	584.79
Region 11	Sands (1)	9,40,38,34	600.26
Region 12	Silts/Clays	9,11,35,34	5,999.7
Region 13	Sands (2)	11,13,36,35	3,400
Region 14	Sands (1)	6,27,5,1,37,38,4	297
Region 15	Silts/Clays	31,30,34,35	2,969.7
Region 16	Sands (2)	32,31,35,36	1,683
Region 17	Sands (1)	30,34,38,37	297.32
Region 18	Sands (1)	39,37,30,10	604.03
Region 19	Sands (1)	4,8,40,38	600

1. Static- Preload

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Yoon Seok Choi
Last Edited By: Heidi Cashman
Revision Number: 118
Date: 9/28/2017
Time: 3:06:31 PM
Tool Version: 8.16.1.13452
File Name: 3) Station 69_65 - No improvement.gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

1. Static- Preload

Description: Static Case
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
Side Function
Interslice force function option: Half-Sine
PWP Conditions Source: Piezometric Line
Apply Phreatic Correction: No
Use Staged Rapid Drawdown: No
Slip Surface
Direction of movement: Right to Left
Use Passive Mode: No
Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Resisting Side Maximum Convex Angle: 1 °
Driving Side Maximum Convex Angle: 5 °
Optimize Critical Slip Surface Location: No

Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.37
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands (2)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl

Model: Undrained (Phi=0)
Unit Weight: 100 pcf
Cohesion: 4,000 psf
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone

Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 6,000 psf
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-103, 3) ft
Left-Zone Right Coordinate: (-53, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-17, 21) ft
Right-Zone Right Coordinate: (17, 21) ft
Right-Zone Increment: 7
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-53, 3) ft

Inside Point: (53, 3) ft
Length: 106 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,406 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,406 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Points

	X (ft)	Y (ft)
Point 1	-53	3
Point 2	-23	18
Point 3	23	18
Point 4	53	3
Point 5	-38	3
Point 6	38	3
Point 7	-250	3
Point 8	250	3
Point 9	250	-4
Point 10	-250	-4.00642
Point 11	250	-34
Point 12	-250	-34
Point 13	250	-50
Point 14	-250	-50
Point 15	250	-73
Point 16	-250	-73
Point 17	250	-100
Point 18	-250	-100
Point 19	-17	21
Point 20	17	21
Point 21	30	3
Point 22	-53	-4
Point 23	-53	-34
Point 24	-53	-50
Point 25	53	-4
Point 26	53	-34
Point 27	53	-50
Point 28	-53	0

Point 29	53	0
Point 30	-250	0
Point 31	250	0

Regions

	Material	Points	Area (ft²)
Region 1	Compacted Fill	2,5,21,6,3	915
Region 2	Compacted Fill	2,1,5	112.5
Region 3	Compacted Fill	3,6,4	112.5
Region 4	Sands (1)	7,1,28,30	591
Region 5	Silts/Clays	10,22,23,12	5,909.4
Region 6	Sands (2)	12,23,24,14	3,152
Region 7	Hawthorn Marl	24,14,16,15,13,27	11,500
Region 8	Cooper Group Limestone	16,15,17,18	13,500
Region 9	Compacted Fill	2,19,20,3	120
Region 10	Sands (1)	4,8,31,29	591
Region 11	Silts/Clays	9,11,26,25	5,910
Region 12	Sands (2)	11,13,27,26	3,152
Region 13	Sands (1)	6,21,5,1,28,29,4	318
Region 14	Silts/Clays	23,22,25,26	3,180
Region 15	Sands (2)	24,23,26,27	1,696
Region 16	Sands (1)	22,25,29,28	424
Region 17	Sands (1)	30,28,22,10	788.63
Region 18	Sands (1)	29,31,9,25	788

2. Static- Traffic

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Yoon Seok Choi
Last Edited By: Heidi Cashman
Revision Number: 118
Date: 9/28/2017
Time: 3:06:31 PM
Tool Version: 8.16.1.13452
File Name: 3) Station 69_65 - No improvement.gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

2. Static- Traffic

Description: Static Case
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: No

Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.37
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands (2)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl

Model: Undrained (Phi=0)
Unit Weight: 100 pcf
Cohesion: 4,000 psf
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone

Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 6,000 psf
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-103, 3) ft
Left-Zone Right Coordinate: (-53, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-23, 18) ft
Right-Zone Right Coordinate: (23, 18) ft
Right-Zone Increment: 9
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 400 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	-23	18
	-23	19
	23	19

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-53, 3) ft
Inside Point: (53, 3) ft
Length: 106 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,172 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,172 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Points

	X (ft)	Y (ft)
Point 1	-53	3
Point 2	-23	18
Point 3	23	18
Point 4	53	3
Point 5	-38	3
Point 6	38	3
Point 7	-250	3
Point 8	250	3
Point 9	250	-4
Point 10	-250	-4.00642
Point 11	250	-34
Point 12	-250	-34
Point 13	250	-50
Point 14	-250	-50
Point 15	250	-73
Point 16	-250	-73

Point 17	250	-100
Point 18	-250	-100
Point 19	-17	21
Point 20	17	21
Point 21	30	3
Point 22	-53	-4
Point 23	-53	-34
Point 24	-53	-50
Point 25	53	-4
Point 26	53	-34
Point 27	53	-50
Point 28	-53	0
Point 29	53	0
Point 30	-250	0
Point 31	250	0

Regions

	Material	Points	Area (ft²)
Region 1	Compacted Fill	2,5,21,6,3	915
Region 2	Compacted Fill	2,1,5	112.5
Region 3	Compacted Fill	3,6,4	112.5
Region 4	Sands (1)	7,1,28,30	591
Region 5	Silts/Clays	10,22,23,12	5,909.4
Region 6	Sands (2)	12,23,24,14	3,152
Region 7	Hawthorn Marl	24,14,16,15,13,27	11,500
Region 8	Cooper Group Limestone	16,15,17,18	13,500
Region 9		2,19,20,3	120
Region 10	Sands (1)	4,8,31,29	591
Region 11	Silts/Clays	9,11,26,25	5,910
Region 12	Sands (2)	11,13,27,26	3,152

Region 13	Sands (1)	6,21,5,1,28,29,4	318
Region 14	Silts/Clays	23,22,25,26	3,180
Region 15	Sands (2)	24,23,26,27	1,696
Region 16	Sands (1)	22,25,29,28	424
Region 17	Sands (1)	30,28,22,10	788.63
Region 18	Sands (1)	29,31,9,25	788

1. Static - Preload

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Yoon Seok Choi
Last Edited By: Heidi Cashman
Revision Number: 106
Date: 9/29/2017
Time: 10:46:38 AM
Tool Version: 8.16.1.13452
File Name: 4) Station 70_40 - (2xGeotextile).gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

1. Static - Preload

Description: Static Case
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: No

Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.36
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands (2)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl
Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 4,000 psf
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone
Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 6,000 psf
Pore Water Pressure
Piezometric Line: 1

Sands (1) - Improved
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays - Improved
Model: Mohr-Coulomb
Unit Weight: 95 pcf
Cohesion': 348 psf
Phi': 19.8 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (2) - Improved
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit
Left Projection: Range
Left-Zone Left Coordinate: (-110, 3) ft
Left-Zone Right Coordinate: (-60, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-18, 24) ft
Right-Zone Right Coordinate: (18, 24) ft

Right-Zone Increment: 7
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-60, 3) ft
Inside Point: (60, 3) ft
Length: 120 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,641 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,641 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Reinforcement 2

Type: Geosynthetic
Outside Point: (-26, 19) ft
Inside Point: (-8, 19) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 391 psf
Resistance Reduction Factor: 1

Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 391 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 3

Type: Geosynthetic
Outside Point: (-28, 17) ft
Inside Point: (-10, 17) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 547 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 547 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 4

Type: Geosynthetic
Outside Point: (-30, 15) ft
Inside Point: (-12, 15) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 703 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 703 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 5

Type: Geosynthetic
Outside Point: (-32, 13) ft
Inside Point: (-14, 13) ft
Length: 18 ft

Direction: 180 °
F of S Dependent: No
Pullout Resistance: 859 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 859 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 6

Type: Geosynthetic
Outside Point: (-34, 11) ft
Inside Point: (-16, 11) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,016 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,016 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 7

Type: Geosynthetic
Outside Point: (-36, 9) ft
Inside Point: (-18, 9) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,172 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,172 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 8

Type: Geosynthetic
Outside Point: (-38, 7) ft
Inside Point: (-20, 7) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,328 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,328 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 9

Type: Geosynthetic
Outside Point: (-40, 5) ft
Inside Point: (40, 5) ft
Length: 80 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,484 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,484 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Reinforcement 10

Type: Geosynthetic
Outside Point: (8, 19) ft
Inside Point: (26, 19) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 391 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 391 lbs/ft

Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 11

Type: Geosynthetic
Outside Point: (10, 17) ft
Inside Point: (28, 17) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 547 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 547 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 12

Type: Geosynthetic
Outside Point: (12, 15) ft
Inside Point: (30, 15) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 703 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 703 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 13

Type: Geosynthetic
Outside Point: (14, 13) ft
Inside Point: (32, 13) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 859 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No

Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 859 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 14

Type: Geosynthetic
Outside Point: (16, 11) ft
Inside Point: (34, 11) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,016 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,016 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 15

Type: Geosynthetic
Outside Point: (18, 9) ft
Inside Point: (36, 9) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,172 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,172 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 16

Type: Geosynthetic
Outside Point: (20, 7) ft
Inside Point: (38, 7) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No

Pullout Resistance: 1,328 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,328 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Points

	X (ft)	Y (ft)
Point 1	-60	3
Point 2	-24	21
Point 3	24	21
Point 4	60	3
Point 5	-42	3
Point 6	42	3
Point 7	-250	3
Point 8	250	3
Point 9	250	-5
Point 10	-250	-5
Point 11	250	-35
Point 12	-250	-35
Point 13	250	-50
Point 14	-250	-50
Point 15	250	-74
Point 16	-250	-74
Point 17	250	-100
Point 18	-250	-100
Point 19	-18	24
Point 20	18	24
Point 21	-34	-50
Point 22	-34	-5
Point 23	-34	-35
Point 24	34	-50
Point 25	34	-35
Point 26	34	-5
Point 27	-34	0
Point 28	34	0
Point 29	-34	3
Point 30	34	3
Point 31	-250	0

Point 32	250	0

Regions

	Material	Points	Area (ft²)
Region 1	Compacted Fill	2,5,29,30,6,3	1,188
Region 2	Compacted Fill	2,1,5	162
Region 3	Compacted Fill	3,6,4	162
Region 4	Sands (1)	7,1,5,29,27,31	648
Region 5	Silts/Clays	10,22,23,12	6,480
Region 6	Sands (2)	12,23,21,14	3,240
Region 7	Hawthorn Marl	14,21,24,13,15,16	12,000
Region 8	Cooper Group Limestone	16,15,17,18	13,000
Region 9	Compacted Fill	2,19,20,3	126
Region 10	Sands (1)	30,6,4,8,32,28	648
Region 11	Silts/Clays	9,11,25,26	6,480
Region 12	Sands (2)	11,13,24,25	3,240
Region 13	Sands (2) - Improved	21,23,25,24	1,020
Region 14	Silts/Clays - Improved	23,22,26,25	2,040
Region 15	Sands (1) - Improved	29,30,28,27	204
Region 16	Sands (1) - Improved	22,26,28,27	340
Region 17	Sands (1)	31,27,22,10	1,080
Region 18	Sands (1)	28,32,9,26	1,080

2. Static - Traffic

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Yoon Seok Choi
Last Edited By: Heidi Cashman
Revision Number: 106
Date: 9/29/2017
Time: 10:46:38 AM
Tool Version: 8.16.1.13452
File Name: 4) Station 70_40 - (2xGeotextile).gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

2. Static - Traffic

Description: Static Case
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: No

Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.36
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands (2)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl
Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 4,000 psf
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone
Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 6,000 psf
Pore Water Pressure
Piezometric Line: 1

Sands (1) - Improved
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays - Improved
Model: Mohr-Coulomb
Unit Weight: 95 pcf
Cohesion': 348 psf
Phi': 19.8 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (2) - Improved
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit
Left Projection: Range
Left-Zone Left Coordinate: (-110, 3) ft
Left-Zone Right Coordinate: (-60, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-24, 21) ft
Right-Zone Right Coordinate: (24, 21) ft

Right-Zone Increment: 10
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 400 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	-24	21
	-24	22
	24	22

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-60, 3) ft
Inside Point: (60, 3) ft
Length: 120 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,406 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs

Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,406 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Reinforcement 2

Type: Geosynthetic
Outside Point: (-26, 19) ft
Inside Point: (-8, 19) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 156 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 156 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 3

Type: Geosynthetic
Outside Point: (-28, 17) ft
Inside Point: (-10, 17) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 313 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 313 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 4

Type: Geosynthetic
Outside Point: (-30, 15) ft
Inside Point: (-12, 15) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 469 psf

Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 469 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 5

Type: Geosynthetic
Outside Point: (-32, 13) ft
Inside Point: (-14, 13) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 625 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 625 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 6

Type: Geosynthetic
Outside Point: (-34, 11) ft
Inside Point: (-16, 11) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 781 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 781 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 7

Type: Geosynthetic
Outside Point: (-36, 9) ft
Inside Point: (-18, 9) ft

Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 938 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 938 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 8

Type: Geosynthetic
Outside Point: (-38, 7) ft
Inside Point: (-20, 7) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,094 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,094 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 9

Type: Geosynthetic
Outside Point: (-40, 5) ft
Inside Point: (40, 5) ft
Length: 80 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,250 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,250 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Reinforcement 10

Type: Geosynthetic
Outside Point: (8, 19) ft
Inside Point: (26, 19) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 156 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 156 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 11

Type: Geosynthetic
Outside Point: (10, 17) ft
Inside Point: (28, 17) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 313 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 313 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 12

Type: Geosynthetic
Outside Point: (12, 15) ft
Inside Point: (30, 15) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 469 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0

Factored Pullout Resistance: 469 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 13

Type: Geosynthetic
Outside Point: (14, 13) ft
Inside Point: (32, 13) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 625 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 625 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 14

Type: Geosynthetic
Outside Point: (16, 11) ft
Inside Point: (34, 11) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 781 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 781 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 15

Type: Geosynthetic
Outside Point: (18, 9) ft
Inside Point: (36, 9) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 938 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed

Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 938 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 16

Type: Geosynthetic
Outside Point: (20, 7) ft
Inside Point: (38, 7) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,094 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,094 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Points

	X (ft)	Y (ft)
Point 1	-60	3
Point 2	-24	21
Point 3	24	21
Point 4	60	3
Point 5	-42	3
Point 6	42	3
Point 7	-250	3
Point 8	250	3
Point 9	250	-5
Point 10	-250	-5
Point 11	250	-35
Point 12	-250	-35
Point 13	250	-50
Point 14	-250	-50
Point 15	250	-74
Point 16	-250	-74
Point 17	250	-100
Point 18	-250	-100

Point 19	-18	24
Point 20	18	24
Point 21	-34	-50
Point 22	-34	-5
Point 23	-34	-35
Point 24	34	-50
Point 25	34	-35
Point 26	34	-5
Point 27	-34	0
Point 28	34	0
Point 29	-34	3
Point 30	34	3
Point 31	-250	0
Point 32	250	0

Regions

	Material	Points	Area (ft²)
Region 1	Compacted Fill	2,5,29,30,6,3	1,188
Region 2	Compacted Fill	2,1,5	162
Region 3	Compacted Fill	3,6,4	162
Region 4	Sands (1)	7,1,5,29,27,31	648
Region 5	Silts/Clays	10,22,23,12	6,480
Region 6	Sands (2)	12,23,21,14	3,240
Region 7	Hawthorn Marl	14,21,24,13,15,16	12,000
Region 8	Cooper Group Limestone	16,15,17,18	13,000
Region 9		2,19,20,3	126
Region 10	Sands (1)	30,6,4,8,32,28	648
Region 11	Silts/Clays	9,11,25,26	6,480
Region 12	Sands (2)	11,13,24,25	3,240
Region 13	Sands (2) - Improved	21,23,25,24	1,020
Region 14	Silts/Clays - Improved	23,22,26,25	2,040

Region 15	Sands (1) - Improved	29,30,28,27	204
Region 16	Sands (1) - Improved	22,26,28,27	340
Region 17	Sands (1)	31,27,22,10	1,080
Region 18	Sands (1)	28,32,9,26	1,080

3. Post Seismic

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Yoon Seok Choi
Last Edited By: Heidi Cashman
Revision Number: 106
Date: 9/29/2017
Time: 10:46:38 AM
Tool Version: 8.16.1.13452
File Name: 4) Station 70_40 - (2xGeotextile).gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

3. Post Seismic

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
Side Function
Interslice force function option: Half-Sine
PWP Conditions Source: Piezometric Line
Apply Phreatic Correction: No
Use Staged Rapid Drawdown: No
Slip Surface
Direction of movement: Right to Left
Use Passive Mode: No
Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Resisting Side Maximum Convex Angle: 1 °
Driving Side Maximum Convex Angle: 5 °
Optimize Critical Slip Surface Location: No
Tension Crack

Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.36
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone

Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 6,000 psf
Pore Water Pressure
Piezometric Line: 1

Sands (1) - Improved

Model: Mohr-Coulomb

Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays - Improved

Model: Mohr-Coulomb
Unit Weight: 95 pcf
Cohesion': 348 psf
Phi': 19.8 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1) - Residual

Model: S=f(overburden)
Unit Weight: 100 pcf
Tau/Sigma Ratio: 0.08
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands (2) - Residual

Model: S=f(overburden)
Unit Weight: 100 pcf
Tau/Sigma Ratio: 0.08
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl - Seismic

Model: Undrained (Phi=0)
Unit Weight: 120 pcf
Cohesion: 3,400 psf
Pore Water Pressure
Piezometric Line: 1

Sands (1) - Residual Improved

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 4.6 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (2) - Residual Improved

Model: Mohr-Coulomb

Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 4.6 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-110, 3) ft
Left-Zone Right Coordinate: (-60, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-24, 21) ft
Right-Zone Right Coordinate: (24, 21) ft
Right-Zone Increment: 10
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Seismic Coefficients

Horz Seismic Coef.: 0.29

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-60, 3) ft
Inside Point: (60, 3) ft
Length: 120 ft
Direction: 180 °

F of S Dependent: No
Pullout Resistance: 1,406 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,406 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Reinforcement 2

Type: Geosynthetic
Outside Point: (-26, 19) ft
Inside Point: (-8, 19) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 156 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 156 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 3

Type: Geosynthetic
Outside Point: (-28, 17) ft
Inside Point: (-10, 17) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 313 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 313 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 4

Type: Geosynthetic

Outside Point: (-30, 15) ft
Inside Point: (-12, 15) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 469 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 469 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 5

Type: Geosynthetic
Outside Point: (-32, 13) ft
Inside Point: (-14, 13) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 625 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 625 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 6

Type: Geosynthetic
Outside Point: (-34, 11) ft
Inside Point: (-16, 11) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 781 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 781 lbs/ft
Max. Pullout Force: 960 lbs

Factored Tensile Capacity: 960 lbs

Reinforcement 7

Type: Geosynthetic
Outside Point: (-36, 9) ft
Inside Point: (-18, 9) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 938 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 938 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 8

Type: Geosynthetic
Outside Point: (-38, 7) ft
Inside Point: (-20, 7) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,094 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,094 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 9

Type: Geosynthetic
Outside Point: (-40, 5) ft
Inside Point: (40, 5) ft
Length: 80 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,250 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs

Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,250 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Reinforcement 10

Type: Geosynthetic
Outside Point: (8, 19) ft
Inside Point: (26, 19) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 156 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 156 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 11

Type: Geosynthetic
Outside Point: (10, 17) ft
Inside Point: (28, 17) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 313 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 313 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 12

Type: Geosynthetic
Outside Point: (12, 15) ft
Inside Point: (30, 15) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 469 psf

Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 469 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 13

Type: Geosynthetic
Outside Point: (14, 13) ft
Inside Point: (32, 13) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 625 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 625 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 14

Type: Geosynthetic
Outside Point: (16, 11) ft
Inside Point: (34, 11) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 781 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 781 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 15

Type: Geosynthetic
Outside Point: (18, 9) ft
Inside Point: (36, 9) ft

Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 938 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 938 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 16

Type: Geosynthetic
Outside Point: (20, 7) ft
Inside Point: (38, 7) ft
Length: 18 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,094 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,094 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Points

	X (ft)	Y (ft)
Point 1	-60	3
Point 2	-24	21
Point 3	24	21
Point 4	60	3
Point 5	-42	3
Point 6	42	3
Point 7	-250	3
Point 8	250	3
Point 9	250	-5
Point 10	-250	-5
Point 11	250	-35
Point 12	-250	-35
Point 13	250	-50

Point 14	-250	-50
Point 15	250	-74
Point 16	-250	-74
Point 17	250	-100
Point 18	-250	-100
Point 19	-18	24
Point 20	18	24
Point 21	-34	-50
Point 22	-34	-5
Point 23	-34	-35
Point 24	34	-50
Point 25	34	-35
Point 26	34	-5
Point 27	-34	0
Point 28	34	0
Point 29	-34	3
Point 30	34	3
Point 31	-250	0
Point 32	250	0

Regions

	Material	Points	Area (ft²)
Region 1	Compacted Fill	2,5,29,30,6,3	1,188
Region 2	Compacted Fill	2,1,5	162
Region 3	Compacted Fill	3,6,4	162
Region 4	Sands (1)	7,1,5,29,27,31	648
Region 5	Silts/Clays	10,22,23,12	6,480

Region 6	Sands (2) - Residual	12,23,21,14	3,240
Region 7	Hawthorn Marl - Seismic	14,21,24,13,15,16	12,000
Region 8	Cooper Group Limestone	16,15,17,18	13,000
Region 9		2,19,20,3	126
Region 10	Sands (1)	30,6,4,8,32,28	648
Region 11	Silts/Clays	9,11,25,26	6,480
Region 12	Sands (2) - Residual	11,13,24,25	3,240
Region 13	Sands (2) - Residual Improved	21,23,25,24	1,020
Region 14	Silts/Clays - Improved	23,22,26,25	2,040
Region 15	Sands (1) - Improved	29,30,28,27	204
Region 16	Sands (1) - Residual Improved	22,26,28,27	340
Region 17	Sands (1) - Residual	31,27,22,10	1,080
Region 18	Sands (1) - Residual	28,32,9,26	1,080

1. Static - Preload

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Colton W. McInelly
Last Edited By: Heidi Cashman
Revision Number: 126
Date: 9/29/2017
Time: 11:12:51 AM
Tool Version: 8.16.1.13452
File Name: 5) Station 103_80.gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

1. Static - Preload

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
Side Function
Interslice force function option: Half-Sine
PWP Conditions Source: Piezometric Line
Apply Phreatic Correction: No
Use Staged Rapid Drawdown: No
Slip Surface
Direction of movement: Right to Left
Use Passive Mode: No
Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Resisting Side Maximum Convex Angle: 1 °
Driving Side Maximum Convex Angle: 5 °
Optimize Critical Slip Surface Location: No
Tension Crack

Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 5 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (2)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 41 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (3)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays
Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.23
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands (4)
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 4,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 6,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1) - Improved
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (2) - Improved
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 348 psf
Phi': 41 °
Phi-B: 0 °

Pore Water Pressure
Piezometric Line: 1

Sands (3) - Improved
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (4) - Improved
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays - Improved
Model: Mohr-Coulomb
Unit Weight: 95 pcf
Cohesion': 348 psf
Phi': 13 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit
Left Projection: Range
Left-Zone Left Coordinate: (-107, 3) ft
Left-Zone Right Coordinate: (-57, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-20, 23) ft
Right-Zone Right Coordinate: (20, 23) ft
Right-Zone Increment: 8
Radius Increments: 10

Slip Surface Limits
Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-57, 3) ft
Inside Point: (34, 3) ft
Length: 91 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,563 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,563 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Reinforcement 2

Type: Geosynthetic
Outside Point: (34, 3) ft
Inside Point: (49, 7) ft
Length: 15.524175 ft
Direction: 194.93 °
F of S Dependent: No
Pullout Resistance: 1,563 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,563 lbs/ft
Max. Pullout Force: 24,264.285 lbs
Factored Tensile Capacity: 33,980 lbs

Reinforcement 3

Type: Geosynthetic
Outside Point: (-42, 4) ft
Inside Point: (-28, 4) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,484 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,484 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 4

Type: Geosynthetic
Outside Point: (-40, 6) ft
Inside Point: (-26, 6) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,328 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,328 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 5

Type: Geosynthetic
Outside Point: (-38, 8) ft
Inside Point: (-24, 8) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,172 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0

Factored Pullout Resistance: 1,172 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 6

Type: Geosynthetic
Outside Point: (-36, 10) ft
Inside Point: (-22, 10) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,016 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,016 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 7

Type: Geosynthetic
Outside Point: (-34, 12) ft
Inside Point: (-20, 12) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 859 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 859 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 8

Type: Geosynthetic
Outside Point: (-32, 14) ft
Inside Point: (-18, 14) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 703 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed

Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 703 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 9

Type: Geosynthetic
Outside Point: (-30, 16) ft
Inside Point: (-16, 16) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 547 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 547 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 10

Type: Geosynthetic
Outside Point: (-28, 18) ft
Inside Point: (-14, 18) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 391 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 391 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 11

Type: Geosynthetic
Outside Point: (38, 4) ft
Inside Point: (28, 4) ft
Length: 10 ft
Direction: 0 °

F of S Dependent: No
Pullout Resistance: 1,484 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,484 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 12

Type: Geosynthetic
Outside Point: (40, 6) ft
Inside Point: (26, 6) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 1,328 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,328 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 13

Type: Geosynthetic
Outside Point: (38, 8) ft
Inside Point: (24, 8) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 1,172 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,172 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 14

Type: Geosynthetic

Outside Point: (36, 10) ft
Inside Point: (22, 10) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 1,016 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,016 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 15

Type: Geosynthetic
Outside Point: (34, 12) ft
Inside Point: (20, 12) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 859 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 859 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 16

Type: Geosynthetic
Outside Point: (32, 14) ft
Inside Point: (18, 14) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 703 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 703 lbs/ft
Max. Pullout Force: 960 lbs

Factored Tensile Capacity: 960 lbs

Reinforcement 17

Type: Geosynthetic
Outside Point: (30, 16) ft
Inside Point: (16, 16) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 547 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 547 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 18

Type: Geosynthetic
Outside Point: (28, 18) ft
Inside Point: (14, 18) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 391 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 391 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Points

	X (ft)	Y (ft)
Point 1	-250	3
Point 2	-57	3
Point 3	-26	20
Point 4	-20	23
Point 5	20	23
Point 6	26	20
Point 7	49	7
Point 8	82	7

Point 9	94	3
Point 10	250	3
Point 11	34	3
Point 12	-43	3
Point 13	41.1	4.9
Point 14	250	0
Point 15	250	-15
Point 16	250	-31
Point 17	250	-50
Point 18	250	-67
Point 19	250	-77
Point 20	-250	-77
Point 21	-250	-67
Point 22	-250	-50
Point 23	-250	-31
Point 24	-250	-15
Point 25	-250	0
Point 26	-36	-67
Point 27	-36	0
Point 28	-36	-15
Point 29	-36	-31
Point 30	-36	-50
Point 31	36	-67
Point 32	36	-50

Point 33	36	-31
Point 34	36	-15
Point 35	36	0
Point 36	-250	-100
Point 37	250	-100
Point 38	-36	3
Point 39	36	3.52

Regions

	Material	Points	Area (ft²)
Region 1	Compacted Fill	12,3,6,13,39,11,38	1,164.5
Region 2	Sands (1)	1,2,12,38,27,25	642
Region 3	Sands (2)	25,27,28,24	3,210
Region 4	Sands (3)	24,28,29,23	3,424
Region 5	Silts/Clays	23,29,30,22	4,066
Region 6	Sands (4)	22,30,26,21	3,638
Region 7	Hawthorn Marl	21,26,31,18,19,20	5,000
Region 8	Cooper Group Limestone	20,19,37,36	11,500
Region 9	Compacted Fill	2,12,3	119
Region 10	Compacted Fill	6,13,7	75.5
Region 11	Compacted Fill	4,5,6,3	138
Region 12	Sands (1) - Improved	38,11,39,35,27	216.52
Region 13	Sands (2)	14,15,34,35	3,210
Region 14	Sands (3)	15,16,33,34	3,424
Region 15	Silts/Clays	16,17,32,33	4,066
Region 16	Sands (4)	17,18,31,32	3,638
Region 17	Sands (4) - Improved	26,30,32,31	1,224
Region 18	Silts/Clays - Improved	30,29,33,32	1,368
Region 19	Sands (3) - Improved	29,28,34,33	1,152
Region 20	Sands (2) - Improved	28,27,35,34	1,080
Region 21	Sands (1)	8,9,10,14,35,39,13,7	827.48

2. Static - Trafic

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Colton W. McInelly
Last Edited By: Heidi Cashman
Revision Number: 126
Date: 9/29/2017
Time: 11:12:51 AM
Tool Version: 8.16.1.13452
File Name: 5) Station 103_80.gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

2. Static - Trafic

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: No
- Tension Crack

Tension Crack Option: (none)

F of S Distribution

F of S Calculation Option: Constant

Advanced

Number of Slices: 30

F of S Tolerance: 0.001

Minimum Slip Surface Depth: 5 ft

Search Method: Root Finder

Tolerable difference between starting and converged F of S: 3

Maximum iterations to calculate converged lambda: 20

Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb

Unit Weight: 125 pcf

Cohesion': 0 psf

Phi': 38 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb

Unit Weight: 100 pcf

Cohesion': 0 psf

Phi': 30 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Sands (2)

Model: Mohr-Coulomb

Unit Weight: 120 pcf

Cohesion': 0 psf

Phi': 41 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Sands (3)

Model: Mohr-Coulomb

Unit Weight: 100 pcf

Cohesion': 0 psf

Phi': 30 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Silts/Clays
Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.23
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands (4)
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 4,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 6,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1) - Improved
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (2) - Improved
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 348 psf
Phi': 41 °
Phi-B: 0 °

Pore Water Pressure
Piezometric Line: 1

Sands (3) - Improved

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (4) - Improved

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays - Improved

Model: Mohr-Coulomb
Unit Weight: 95 pcf
Cohesion': 348 psf
Phi': 13 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-107, 3) ft
Left-Zone Right Coordinate: (-57, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-26, 20) ft
Right-Zone Right Coordinate: (26, 20) ft
Right-Zone Increment: 10
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 400 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	-26	20
	-26	21
	26	21

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-57, 3) ft
Inside Point: (34, 3) ft
Length: 91 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,328 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,328 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Reinforcement 2

Type: Geosynthetic
Outside Point: (34, 3) ft
Inside Point: (49, 7) ft

Length: 15.524175 ft
Direction: 194.93 °
F of S Dependent: No
Pullout Resistance: 1,328 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,328 lbs/ft
Max. Pullout Force: 20,616.104 lbs
Factored Tensile Capacity: 33,980 lbs

Reinforcement 3

Type: Geosynthetic
Outside Point: (-42, 4) ft
Inside Point: (-28, 4) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,250 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,250 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 4

Type: Geosynthetic
Outside Point: (-40, 6) ft
Inside Point: (-26, 6) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,094 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,094 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 5

Type: Geosynthetic
Outside Point: (-38, 8) ft
Inside Point: (-24, 8) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 938 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 938 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 6

Type: Geosynthetic
Outside Point: (-36, 10) ft
Inside Point: (-22, 10) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 781 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 781 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 7

Type: Geosynthetic
Outside Point: (-34, 12) ft
Inside Point: (-20, 12) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 625 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0

Factored Pullout Resistance: 625 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 8

Type: Geosynthetic
Outside Point: (-32, 14) ft
Inside Point: (-18, 14) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 469 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 469 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 9

Type: Geosynthetic
Outside Point: (-30, 16) ft
Inside Point: (-16, 16) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 313 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 313 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 10

Type: Geosynthetic
Outside Point: (-28, 18) ft
Inside Point: (-14, 18) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 156 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed

Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 156 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 11

Type: Geosynthetic
Outside Point: (38, 4) ft
Inside Point: (28, 4) ft
Length: 10 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 1,250 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,250 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 12

Type: Geosynthetic
Outside Point: (40, 6) ft
Inside Point: (26, 6) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 1,094 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,094 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 13

Type: Geosynthetic
Outside Point: (38, 8) ft
Inside Point: (24, 8) ft
Length: 14 ft
Direction: 0 °

F of S Dependent: No
Pullout Resistance: 938 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 938 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 14

Type: Geosynthetic
Outside Point: (36, 10) ft
Inside Point: (22, 10) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 781 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 781 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 15

Type: Geosynthetic
Outside Point: (34, 12) ft
Inside Point: (20, 12) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 625 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 625 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 16

Type: Geosynthetic

Outside Point: (32, 14) ft
Inside Point: (18, 14) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 469 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 469 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 17

Type: Geosynthetic
Outside Point: (30, 16) ft
Inside Point: (16, 16) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 313 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 313 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 18

Type: Geosynthetic
Outside Point: (28, 18) ft
Inside Point: (14, 18) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 156 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 156 lbs/ft
Max. Pullout Force: 960 lbs

Factored Tensile Capacity: 960 lbs

Points

	X (ft)	Y (ft)
Point 1	-250	3
Point 2	-57	3
Point 3	-26	20
Point 4	-20	23
Point 5	20	23
Point 6	26	20
Point 7	49	7
Point 8	82	7
Point 9	94	3
Point 10	250	3
Point 11	34	3
Point 12	-43	3
Point 13	41.1	4.9
Point 14	250	0
Point 15	250	-15
Point 16	250	-31
Point 17	250	-50
Point 18	250	-67
Point 19	250	-77
Point 20	-250	-77
Point 21	-250	-67
Point 22	-250	-50
Point 23	-250	-31
Point 24	-250	-15
Point 25	-250	0
Point 26	-36	-67
Point 27	-36	0
Point 28	-36	-15
Point 29	-36	-31
Point 30	-36	-50
Point 31	36	-67
Point 32	36	-50
Point 33	36	-31
Point 34	36	-15
Point 35	36	0
Point 36	-250	-100
Point 37	250	-100
Point 38	-36	3
Point 39	36	3.52

Regions

	Material	Points	Area (ft²)
Region 1	Compacted Fill	12,3,6,13,39,11,38	1,164.5
Region 2	Sands (1)	1,2,12,38,27,25	642
Region 3	Sands (2)	25,27,28,24	3,210
Region 4	Sands (3)	24,28,29,23	3,424
Region 5	Silts/Clays	23,29,30,22	4,066
Region 6	Sands (4)	22,30,26,21	3,638
Region 7	Hawthorn Marl	21,26,31,18,19,20	5,000
Region 8	Cooper Group Limestone	20,19,37,36	11,500
Region 9	Compacted Fill	2,12,3	119
Region 10	Compacted Fill	6,13,7	75.5
Region 11		4,5,6,3	138
Region 12	Sands (1) - Improved	38,11,39,35,27	216.52
Region 13	Sands (2)	14,15,34,35	3,210
Region 14	Sands (3)	15,16,33,34	3,424
Region 15	Silts/Clays	16,17,32,33	4,066
Region 16	Sands (4)	17,18,31,32	3,638
Region 17	Sands (4) - Improved	26,30,32,31	1,224
Region 18	Silts/Clays - Improved	30,29,33,32	1,368
Region 19	Sands (3) - Improved	29,28,34,33	1,152
Region 20	Sands (2) - Improved	28,27,35,34	1,080
Region 21	Sands (1)	8,9,10,14,35,39,13,7	827.48

3. Post Seismic

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Colton W. McInelly
Last Edited By: Heidi Cashman
Revision Number: 126
Date: 9/29/2017
Time: 11:12:51 AM
Tool Version: 8.16.1.13452
File Name: 5) Station 103_80.gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

3. Post Seismic

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
Side Function
Interslice force function option: Half-Sine
PWP Conditions Source: Piezometric Line
Apply Phreatic Correction: No
Use Staged Rapid Drawdown: No
Slip Surface
Direction of movement: Right to Left
Use Passive Mode: No
Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Resisting Side Maximum Convex Angle: 1 °
Driving Side Maximum Convex Angle: 5 °
Optimize Critical Slip Surface Location: No
Tension Crack

Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 5 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (2)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 41 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.23
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 6,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (3) - Residual

Model: S=f(overburden)
Unit Weight: 100 pcf
Tau/Sigma Ratio: 0.09
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands (4) - Residual

Model: S=f(overburden)
Unit Weight: 100 pcf
Tau/Sigma Ratio: 0.09
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl - Seismic

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 3,400 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1) - Improved

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (2) - Improved

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 348 psf
Phi': 41 °
Phi-B: 0 °
Pore Water Pressure

Piezometric Line: 1

Silts/Clays - Improved

Model: Mohr-Coulomb
Unit Weight: 95 pcf
Cohesion': 348 psf
Phi': 13 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (3) - Residual Improved

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 5.1 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (4) - Residual Improved

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 348 psf
Phi': 5.1 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-107, 3) ft
Left-Zone Right Coordinate: (-57, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-26, 20) ft
Right-Zone Right Coordinate: (26, 20) ft
Right-Zone Increment: 10
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Seismic Coefficients

Horz Seismic Coef.: 0.46

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-57, 3) ft
Inside Point: (34, 3) ft
Length: 91 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,328 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,328 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Reinforcement 2

Type: Geosynthetic
Outside Point: (34, 3) ft
Inside Point: (49, 7) ft
Length: 15.524175 ft
Direction: 194.93 °
F of S Dependent: No
Pullout Resistance: 1,328 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,328 lbs/ft
Max. Pullout Force: 20,616.104 lbs

Factored Tensile Capacity: 33,980 lbs

Reinforcement 3

Type: Geosynthetic
Outside Point: (-42, 4) ft
Inside Point: (-28, 4) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,250 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,250 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 4

Type: Geosynthetic
Outside Point: (-40, 6) ft
Inside Point: (-26, 6) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,094 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,094 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 5

Type: Geosynthetic
Outside Point: (-38, 8) ft
Inside Point: (-24, 8) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 938 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs

Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 938 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 6

Type: Geosynthetic
Outside Point: (-36, 10) ft
Inside Point: (-22, 10) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 781 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 781 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 7

Type: Geosynthetic
Outside Point: (-34, 12) ft
Inside Point: (-20, 12) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 625 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 625 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 8

Type: Geosynthetic
Outside Point: (-32, 14) ft
Inside Point: (-18, 14) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 469 psf

Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 469 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 9

Type: Geosynthetic
Outside Point: (-30, 16) ft
Inside Point: (-16, 16) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 313 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 313 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 10

Type: Geosynthetic
Outside Point: (-28, 18) ft
Inside Point: (-14, 18) ft
Length: 14 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 156 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 156 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 11

Type: Geosynthetic
Outside Point: (38, 4) ft
Inside Point: (28, 4) ft

Length: 10 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 1,250 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,250 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 12

Type: Geosynthetic
Outside Point: (40, 6) ft
Inside Point: (26, 6) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 1,094 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,094 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 13

Type: Geosynthetic
Outside Point: (38, 8) ft
Inside Point: (24, 8) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 938 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 938 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 14

Type: Geosynthetic
Outside Point: (36, 10) ft
Inside Point: (22, 10) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 781 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 781 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 15

Type: Geosynthetic
Outside Point: (34, 12) ft
Inside Point: (20, 12) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 625 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 625 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 16

Type: Geosynthetic
Outside Point: (32, 14) ft
Inside Point: (18, 14) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 469 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0

Factored Pullout Resistance: 469 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 17

Type: Geosynthetic
Outside Point: (30, 16) ft
Inside Point: (16, 16) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 313 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 313 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Reinforcement 18

Type: Geosynthetic
Outside Point: (28, 18) ft
Inside Point: (14, 18) ft
Length: 14 ft
Direction: 0 °
F of S Dependent: No
Pullout Resistance: 156 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 960 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 156 lbs/ft
Max. Pullout Force: 960 lbs
Factored Tensile Capacity: 960 lbs

Points

	X (ft)	Y (ft)
Point 1	-250	3
Point 2	-57	3
Point 3	-26	20
Point 4	-20	23
Point 5	20	23
Point 6	26	20

Point 7	49	7
Point 8	82	7
Point 9	94	3
Point 10	250	3
Point 11	34	3
Point 12	-43	3
Point 13	41.1	4.9
Point 14	250	0
Point 15	250	-15
Point 16	250	-31
Point 17	250	-50
Point 18	250	-67
Point 19	250	-77
Point 20	-250	-77
Point 21	-250	-67
Point 22	-250	-50
Point 23	-250	-31
Point 24	-250	-15
Point 25	-250	0
Point 26	-36	-67
Point 27	-36	0
Point 28	-36	-15
Point 29	-36	-31
Point 30	-36	-50

Point 31	36	-67
Point 32	36	-50
Point 33	36	-31
Point 34	36	-15
Point 35	36	0
Point 36	-250	-100
Point 37	250	-100
Point 38	-36	3
Point 39	36	3.52

Regions

	Material	Points	Area (ft²)
Region 1	Compacted Fill	12,3,6,13,39,11,38	1,164.5
Region 2	Sands (1)	1,2,12,38,27,25	642
Region 3	Sands (2)	25,27,28,24	3,210
Region 4	Sands (3) - Residual	24,28,29,23	3,424
Region 5	Silts/Clays	23,29,30,22	4,066
Region 6	Sands (4) - Residual	22,30,26,21	3,638
Region 7	Hawthorn Marl - Seismic	21,26,31,18,19,20	5,000
Region 8	Cooper Group Limestone	20,19,37,36	11,500
Region 9	Compacted Fill	2,12,3	119
Region 10	Compacted Fill	6,13,7	75.5
Region 11		4,5,6,3	138
Region 12	Sands (1) - Improved	38,11,39,35,27	216.52
Region 13	Sands (2)	14,15,34,35	3,210
Region 14	Sands (3) - Residual	15,16,33,34	3,424
Region 15	Silts/Clays	16,17,32,33	4,066
Region 16	Sands (4) - Residual	17,18,31,32	3,638
Region 17	Sands (4) - Residual Improved	26,30,32,31	1,224
Region 18	Silts/Clays - Improved	30,29,33,32	1,368
Region 19	Sands (3) - Residual Improved	29,28,34,33	1,152
Region 20	Sands (2) - Improved	28,27,35,34	1,080
Region 21	Sands (1)	8,9,10,14,35,39,13,7	827.48

1. Static - Preload

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Colton W. McInelly
Last Edited By: Heidi Cashman
Revision Number: 136
Date: 9/29/2017
Time: 11:51:20 AM
Tool Version: 8.16.1.13452
File Name: 6) Station 104_55.gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

1. Static - Preload

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
Side Function
Interslice force function option: Half-Sine
PWP Conditions Source: Piezometric Line
Apply Phreatic Correction: No
Use Staged Rapid Drawdown: No
Slip Surface
Direction of movement: Right to Left
Use Passive Mode: No
Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Resisting Side Maximum Convex Angle: 1 °
Driving Side Maximum Convex Angle: 5 °
Optimize Critical Slip Surface Location: No
Tension Crack

Tension Crack Option: (none)

F of S Distribution

F of S Calculation Option: Constant

Advanced

Number of Slices: 30

F of S Tolerance: 0.001

Minimum Slip Surface Depth: 5 ft

Search Method: Root Finder

Tolerable difference between starting and converged F of S: 3

Maximum iterations to calculate converged lambda: 20

Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb

Unit Weight: 125 pcf

Cohesion': 0 psf

Phi': 38 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb

Unit Weight: 100 pcf

Cohesion': 0 psf

Phi': 30 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Sands (2)

Model: Mohr-Coulomb

Unit Weight: 120 pcf

Cohesion': 0 psf

Phi': 41 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Sands (3)

Model: Mohr-Coulomb

Unit Weight: 100 pcf

Cohesion': 0 psf

Phi': 30 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.22
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands (4)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 4,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 6,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-107, 3) ft
Left-Zone Right Coordinate: (-57, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-20, 21) ft
Right-Zone Right Coordinate: (20, 21) ft
Right-Zone Increment: 8
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-57.00077, 3) ft
Inside Point: (40.97119, 3) ft
Length: 97.97196 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,406 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,406 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Points

	X (ft)	Y (ft)
Point 1	-250	3
Point 2	-56	3
Point 3	-26	18
Point 4	-20	21
Point 5	20	21
Point 6	26	18
Point 7	56	3
Point 8	82	7
Point 9	94	3

Point 10	250	3
Point 11	41.1	3.00137
Point 12	-41	3
Point 13	250	0
Point 14	250	-15
Point 15	250	-37
Point 16	250	-53
Point 17	250	-67
Point 18	250	-77
Point 19	-250	-77
Point 20	-250	-67
Point 21	-250	-53
Point 22	-250	-37
Point 23	-250	-15
Point 24	-250	0
Point 25	-56	-67
Point 26	-56	0
Point 27	-56.01575	-15
Point 28	-56	-37
Point 29	-56	-53
Point 30	56	-67
Point 31	56	-53
Point 32	56	-37
Point 33	56	-15

Point 34	56	0
Point 35	-250	-100
Point 36	250	-100
Point 37	48	7

Regions

	Material	Points	Area (ft²)
Region 1	Compacted Fill	12,3,6,11	1,005.7
Region 2	Sands (1)	1,2,26,24	582
Region 3	Sands (2)	24,26,27,23	2,909.9
Region 4	Sands (3)	23,27,28,22	4,267.8
Region 5	Silts/Clays	22,28,29,21	3,104
Region 6	Sands (4)	21,29,25,20	2,716
Region 7	Hawthorn Marl	20,25,30,17,18,19	5,000
Region 8	Cooper Group Limestone	19,18,36,35	11,500
Region 9	Compacted Fill	2,12,3	112.5
Region 10	Compacted Fill	6,11,37	81.935
Region 11	Compacted Fill	4,5,6,3	138
Region 12	Sands (1)	12,11,7,34,26,2	336.07
Region 13	Sands (2)	13,14,33,34	2,910
Region 14	Sands (3)	14,15,32,33	4,268
Region 15	Silts/Clays	15,16,31,32	3,104
Region 16	Sands (4)	16,17,30,31	2,716
Region 17	Sands (4)	25,29,31,30	1,568
Region 18	Silts/Clays	29,28,32,31	1,792
Region 19	Sands (3)	28,27,33,32	2,464.2
Region 20	Sands (2)	27,26,34,33	1,680.1
Region 21	Sands (1)	8,9,10,13,34,7,37	726
Region 22	Sands (1)	7,37,11	29.795

2. Static - Trafic

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Colton W. McInelly
Last Edited By: Heidi Cashman
Revision Number: 136
Date: 9/29/2017
Time: 11:51:20 AM
Tool Version: 8.16.1.13452
File Name: 6) Station 104_55.gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

2. Static - Trafic

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: No
- Tension Crack

Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 5 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (2)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 41 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (3)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.22
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands (4)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 4,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 6,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-107, 3) ft
Left-Zone Right Coordinate: (-57, 3) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-26, 18) ft
Right-Zone Right Coordinate: (26, 18) ft
Right-Zone Increment: 10
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 400 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	-26	18
	-26	19
	26	19

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-57.00077, 3) ft
Inside Point: (40.97119, 3) ft
Length: 97.97196 ft
Direction: 180 °
F of S Dependent: No
Pullout Resistance: 1,172 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: No
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 1,172 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Points

	X (ft)	Y (ft)
Point 1	-250	3
Point 2	-56	3
Point 3	-26	18
Point 4	-20	21
Point 5	20	21
Point 6	26	18
Point 7	56	3
Point 8	82	7
Point 9	94	3
Point 10	250	3
Point 11	41.1	3.00137
Point 12	-41	3
Point 13	250	0
Point 14	250	-15
Point 15	250	-37
Point 16	250	-53
Point 17	250	-67
Point 18	250	-77
Point 19	-250	-77
Point 20	-250	-67
Point 21	-250	-53
Point 22	-250	-37
Point 23	-250	-15
Point 24	-250	0
Point 25	-56	-67
Point 26	-56	0
Point 27	-56.01575	-15
Point 28	-56	-37
Point 29	-56	-53
Point 30	56	-67
Point 31	56	-53
Point 32	56	-37
Point 33	56	-15
Point 34	56	0
Point 35	-250	-100
Point 36	250	-100
Point 37	48	7

Regions

	Material	Points	Area (ft²)

Region 1	Compacted Fill	12,3,6,11	1,005.7
Region 2	Sands (1)	1,2,26,24	582
Region 3	Sands (2)	24,26,27,23	2,909.9
Region 4	Sands (3)	23,27,28,22	4,267.8
Region 5	Silts/Clays	22,28,29,21	3,104
Region 6	Sands (4)	21,29,25,20	2,716
Region 7	Hawthorn Marl	20,25,30,17,18,19	5,000
Region 8	Cooper Group Limestone	19,18,36,35	11,500
Region 9	Compacted Fill	2,12,3	112.5
Region 10	Compacted Fill	6,11,37	81.935
Region 11		4,5,6,3	138
Region 12	Sands (1)	12,11,7,34,26,2	336.07
Region 13	Sands (2)	13,14,33,34	2,910
Region 14	Sands (3)	14,15,32,33	4,268
Region 15	Silts/Clays	15,16,31,32	3,104
Region 16	Sands (4)	16,17,30,31	2,716
Region 17	Sands (4)	25,29,31,30	1,568
Region 18	Silts/Clays	29,28,32,31	1,792
Region 19	Sands (3)	28,27,33,32	2,464.2
Region 20	Sands (2)	27,26,34,33	1,680.1
Region 21	Sands (1)	8,9,10,13,34,7,37	726
Region 22	Sands (1)	7,37,11	29.795

1. Static - Preload

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Colton W. McInelly
Last Edited By: Heidi Cashman
Revision Number: 129
Date: 9/29/2017
Time: 12:15:42 PM
Tool Version: 8.16.1.13452
File Name: 7) Station 112+00.gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

1. Static - Preload

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
Side Function
Interslice force function option: Half-Sine
PWP Conditions Source: Piezometric Line
Apply Phreatic Correction: No
Use Staged Rapid Drawdown: No
Slip Surface
Direction of movement: Right to Left
Use Passive Mode: No
Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Resisting Side Maximum Convex Angle: 1 °
Driving Side Maximum Convex Angle: 5 °
Optimize Critical Slip Surface Location: No
Tension Crack

Tension Crack Option: (none)

F of S Distribution

F of S Calculation Option: Constant

Advanced

Number of Slices: 30

F of S Tolerance: 0.001

Minimum Slip Surface Depth: 0.1 ft

Search Method: Root Finder

Tolerable difference between starting and converged F of S: 3

Maximum iterations to calculate converged lambda: 20

Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb

Unit Weight: 125 pcf

Cohesion': 0 psf

Phi': 38 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb

Unit Weight: 100 pcf

Cohesion': 0 psf

Phi': 32 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Sands (2)

Model: Mohr-Coulomb

Unit Weight: 120 pcf

Cohesion': 0 psf

Phi': 40 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Sands (3)

Model: Mohr-Coulomb

Unit Weight: 120 pcf

Cohesion': 0 psf

Phi': 42 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.22
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands (4)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 31 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 4,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 6,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-84, 3) ft
Left-Zone Right Coordinate: (-34, 8) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-20, 15.5) ft
Right-Zone Right Coordinate: (10, 13.5) ft
Right-Zone Increment: 6
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-34, 8) ft
Inside Point: (10, 3) ft
Length: 44.28318 ft
Direction: 173.52 °
F of S Dependent: Yes
Pullout Resistance: 781 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: Yes
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 781 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Points

	X (ft)	Y (ft)
Point 1	-250	3
Point 2	250	3
Point 3	250	-2
Point 4	250	-15
Point 5	250	-58
Point 6	250	-60
Point 7	250	-61
Point 8	250	-77
Point 9	-250	-77

Point 10	-250	-61
Point 11	-250	-60
Point 12	-250	-58
Point 13	-250	-15
Point 14	-250	-2
Point 15	-250	-100
Point 16	250	-100
Point 17	-80	3
Point 18	-50	7
Point 19	-34	8
Point 20	-26	12
Point 21	-20	15.5
Point 22	10	13.5
Point 23	17	9
Point 24	22	9
Point 25	54	6.5
Point 26	70	3
Point 27	-22	6.5
Point 28	-13	6
Point 29	-3	4
Point 30	3	5
Point 31	250	0
Point 32	-250	0

Regions

	Material	Points	Area (ft²)
Region 1	Compacted Fill	19,20,23,30,29,28,27	213.25
Region 2	Sands (1)	1,17,18,19,27,28,29,30,23,24,25,26,2,31,32	2,007.3
Region 3	Sands (2)	14,13,4,3	6,500
Region 4	Sands (3)	13,12,5,4	21,500
Region 5	Silts/Clays	12,11,6,5	1,000
Region 6	Sands (4)	11,10,7,6	500
Region 7	Hawthorn Marl	10,7,8,9	8,000
Region 8	Cooper Group Limestone	9,8,16,15	11,500
Region 9	Compacted Fill	21,22,23,20	144.75
Region 10	Sands (1)	32,31,3,14	1,000

2. Static - Traffic

Report generated using GeoStudio 2016. Copyright © 1991-2016 GEO-SLOPE International Ltd.

File Information

File Version: 8.16
Created By: Colton W. McInelly
Last Edited By: Heidi Cashman
Revision Number: 129
Date: 9/29/2017
Time: 12:15:42 PM
Tool Version: 8.16.1.13452
File Name: 7) Station 112+00.gsz
Directory: Z:\18461-007-01 (US 21 Harbor River Bridge Design Phase)\3 - Technical Analysis\Slope-W\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

2. Static - Traffic

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: No
- Tension Crack

Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (1)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (2)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 40 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sands (3)

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 42 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Silts/Clays

Model: S=f(overburden)
Unit Weight: 95 pcf
Tau/Sigma Ratio: 0.22
Minimum Strength: 0 psf
Pore Water Pressure
Piezometric Line: 1

Sands (4)

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 31 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Hawthorn Marl

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 4,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cooper Group Limestone

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 6,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-84, 3) ft
Left-Zone Right Coordinate: (-34, 8) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (-26, 12) ft
Right-Zone Right Coordinate: (17, 9) ft
Right-Zone Increment: 9
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (-250, 3) ft
Right Coordinate: (250, 3) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	-250	0
Coordinate 2	250	0

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 400 pcf
Direction: Normal

Coordinates

	X (ft)	Y (ft)
	-26	12
	-26	13
	17	10

Reinforcements

Reinforcement 1

Type: Geosynthetic
Outside Point: (-34, 8) ft
Inside Point: (10, 3) ft
Length: 44.28318 ft
Direction: 173.52 °
F of S Dependent: Yes
Pullout Resistance: 781 psf
Resistance Reduction Factor: 1
Force Distribution: Distributed
Anchorage: Yes
Tensile Capacity: 33,980 lbs
Reduction Factor: 1
Force Orientation: 0
Factored Pullout Resistance: 781 lbs/ft
Max. Pullout Force: 33,980 lbs
Factored Tensile Capacity: 33,980 lbs

Points

	X (ft)	Y (ft)
Point 1	-250	3
Point 2	250	3
Point 3	250	-2
Point 4	250	-15
Point 5	250	-58
Point 6	250	-60
Point 7	250	-61
Point 8	250	-77
Point 9	-250	-77
Point 10	-250	-61
Point 11	-250	-60
Point 12	-250	-58
Point 13	-250	-15
Point 14	-250	-2
Point 15	-250	-100
Point 16	250	-100
Point 17	-80	3
Point 18	-50	7
Point 19	-34	8
Point 20	-26	12
Point 21	-20	15.5
Point 22	10	13.5
Point 23	17	9
Point 24	22	9
Point 25	54	6.5
Point 26	70	3
Point 27	-22	6.5
Point 28	-13	6
Point 29	-3	4
Point 30	3	5
Point 31	250	0
Point 32	-250	0

Regions

	Material	Points	Area (ft²)
Region 1	Compacted Fill	19,20,23,30,29,28,27	213.25
Region 2	Sands (1)	1,17,18,19,27,28,29,30,23,24,25,26,2,31,32	2,007.3
Region 3	Sands (2)	14,13,4,3	6,500
Region 4	Sands (3)	13,12,5,4	21,500
Region 5	Silts/Clays	12,11,6,5	1,000

Region 6	Sands (4)	11,10,7,6	500
Region 7	Hawthorn Marl	10,7,8,9	8,000
Region 8	Cooper Group Limestone	9,8,16,15	11,500
Region 9		21,22,23,20	144.75
Region 10	Sands (1)	32,31,3,14	1,000

APPENDIX F
Global Stability Analyses

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:59 PM
Boring Designation:	B-1
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	8
SPT Liner (Yes/No):	No
Hammer Energy, %:	82
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	6

Earthquake Information

Max Acceleration (g) :	0.26
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	8	SP-SM	8	100		Unsaturated
2	4.0	7	SP-SM	8	100		Unsaturated
3	6.0	6	SP-SM	8	100		Unsaturated
4	8.0	6	SP-SM	8	100		
5	10.0	3	SP-SM	8	100		
6	12.0	4	SP-SM	8	100		
7	14.0	8	SP-SM	8	100		
8	16.0	2	SP-SM	8	100		
9	18.0	2	SP	3	100		
10	23.5	2	SP	3	100		
11	28.5	4	SP-SM	7	100		
12	33.5	4	SP-SM	7	100		
13	38.5	3	SP-SM	7	100		
14	43.5	1	SP-SM	11	100		
15	48.5	1	SM	33	100		
16	53.5	14	ML	50	120		Clay
17	55.0	34	ML	50	120		Clay
18	58.5	7	ML	50	120		Clay
19	63.5	6	ML	50	120		Clay
20	65.0	7	ML	50	120		Clay
21	66.5	10	ML	50	120		Clay
22	68.5	12	ML	50	120		Clay
23	73.5	11	ML	50	120		Clay
24	78.5	23	ML	50	120		Clay
25	83.5	3	SM	15	120		Clay
26	88.5	10	SM	15	120		Clay
27	93.5	11	SM	15	120		Clay
28	100.0	25	SM	15	120		Clay
29	103.5	10	SM	15	120		Clay
30	108.5	9	SM	15	120		Clay
31	113.5	12	SM	15	120		Clay
32	118.5	12	SM	15	120		Clay
33	123.5	16	SM	15	120		Clay
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

Liquefaction Calculations B-1 (SEE)

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	8.0	SP-SM	8.0	100.0	Unsaturated	200	200	1.37	1.15	0.75	1.00	9.43	1.70	16.03	0.37	16.40	1.002	0.169
2	4.0	7.0	SP-SM	8.0	100.0	Unsaturated	400	400	1.37	1.15	0.75	1.00	8.25	1.70	14.03	0.37	14.39	0.997	0.168
3	6.0	6.0	SP-SM	8.0	100.0	Unsaturated	600	600	1.37	1.15	0.80	1.00	7.54	1.70	12.82	0.37	13.19	0.991	0.167
4	8.0	6.0	SP-SM	8.0	100.0		800	800	1.37	1.15	0.80	1.00	7.54	1.64	12.39	0.37	12.75	0.985	0.166
5	10.0	3.0	SP-SM	8.0	100.0		1000	875	1.37	1.15	0.85	1.00	4.01	1.67	6.69	0.37	7.06	0.978	0.189
6	12.0	4.0	SP-SM	8.0	100.0		1200	950	1.37	1.15	0.85	1.00	5.34	1.56	8.35	0.37	8.72	0.971	0.207
7	14.0	8.0	SP-SM	8.0	100.0		1400	1026	1.37	1.15	0.85	1.00	10.69	1.42	15.15	0.37	15.51	0.964	0.222
8	16.0	2.0	SP-SM	8.0	100.0		1600	1101	1.37	1.15	0.95	1.00	2.99	1.49	4.46	0.37	4.83	0.957	0.235
9	18.0	2.0	SP	3.3	100.0		1800	1176	1.37	1.15	0.95	1.00	2.99	1.44	4.31	0.00	4.31	0.949	0.245
10	23.5	2.0	SP	3.3	100.0		2350	1383	1.37	1.15	0.95	1.00	2.99	1.31	3.91	0.00	3.91	0.926	0.266
11	28.5	4.0	SP-SM	7.4	100.0		2850	1571	1.37	1.15	1.00	1.00	6.29	1.19	7.45	0.21	7.67	0.903	0.277
12	33.5	4.0	SP-SM	7.0	100.0		3350	1759	1.37	1.15	1.00	1.00	6.29	1.11	7.00	0.14	7.13	0.879	0.283
13	38.5	3.0	SP-SM	7.0	100.0		3850	1947	1.37	1.15	1.00	1.00	4.72	1.05	4.96	0.14	5.10	0.855	0.286
14	43.5	1.0	SP-SM	11.0	100.0		4350	2135	1.37	1.15	1.00	1.00	1.57	0.99	1.56	1.61	3.17	0.830	0.286
15	48.5	1.0	SM	33.2	100.0		4850	2323	1.37	1.15	1.00	1.00	1.57	0.95	1.49	5.47	6.95	0.805	0.284
16	53.5	14.0	ML	50.0	120.0	Clay	5450	2611	1.37	1.15	1.00	1.00	22.00	0.92	20.26	5.61	25.87	0.781	0.275
17	55.0	34.0	ML	50.0	120.0	Clay	5630	2697	1.37	1.15	1.00	1.00	53.44	0.94	50.13	5.61	55.75	0.773	0.273
18	58.5	7.0	ML	50.0	120.0	Clay	6050	2899	1.37	1.15	1.00	1.00	11.00	0.86	9.44	5.61	15.06	0.757	0.267
19	63.5	6.0	ML	50.0	120.0	Clay	6650	3187	1.37	1.15	1.00	1.00	9.43	0.81	7.67	5.61	13.29	0.734	0.259
20	65.0	7.0	ML	50.0	120.0	Clay	6830	3273	1.37	1.15	1.00	1.00	11.00	0.81	8.88	5.61	14.49	0.727	0.256
21	66.5	10.0	ML	50.0	120.0	Clay	7010	3360	1.37	1.15	1.00	1.00	15.72	0.81	12.74	5.61	18.35	0.720	0.254
22	68.5	12.0	ML	50.0	120.0	Clay	7250	3475	1.37	1.15	1.00	1.00	18.86	0.81	15.21	5.61	20.83	0.712	0.251
23	73.5	11.0	ML	50.0	120.0	Clay	7850	3763	1.37	1.15	1.00	1.00	17.29	0.77	13.35	5.61	18.96	0.691	0.244
24	78.5	23.0	ML	50.0	120.0	Clay	8450	4051	1.37	1.15	1.00	1.00	36.15	0.81	29.15	5.61	34.77	0.672	0.237
25	83.5	3.0	SM	15.0	120.0	Clay	9050	4339	1.37	1.15	1.00	1.00	4.72	0.65	3.09	3.26	6.35	0.654	0.231
26	88.5	10.0	SM	15.0	120.0	Clay	9650	4627	1.37	1.15	1.00	1.00	15.72	0.68	10.65	3.26	13.91	0.639	0.225
27	93.5	11.0	SM	15.0	120.0	Clay	10250	4915	1.37	1.15	1.00	1.00	17.29	0.66	11.44	3.26	14.71	0.625	0.220
28	100.0	25.0	SM	15.0	120.0	Clay	11030	5289	1.37	1.15	1.00	1.00	39.29	0.72	28.48	3.26	31.74	0.610	0.215
29	103.5	10.0	SM	15.0	120.0	Clay	11450	5491	1.37	1.15	1.00	1.00	15.72	0.62	9.69	3.26	12.95	0.603	0.213
30	108.5	9.0	SM	15.0	120.0	Clay	12050	5779	1.37	1.15	1.00	1.00	14.15	0.59	8.37	3.26	11.63	0.596	0.210
31	113.5	12.0	SM	15.0	120.0	Clay	12650	6067	1.37	1.15	1.00	1.00	18.86	0.60	11.24	3.26	14.50	0.590	0.208
32	118.5	12.0	SM	15.0	120.0	Clay	13250	6355	1.37	1.15	1.00	1.00	18.86	0.58	10.95	3.26	14.21	0.587	0.207
33	123.5	16.0	SM	15.0	120.0	Clay	13850	6643	1.37	1.15	1.00	1.00	25.15	0.59	14.92	3.26	18.18	0.586	0.207
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

Liquefaction Calculations B-1 (SEE)

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.36	1.02	1.10	0.168	0.190	2.00
1.30	1.02	1.10	0.151	0.170	2.00
1.27	1.02	1.10	0.142	0.158	2.00
1.25	1.02	1.10	0.138	0.154	0.93
1.14	1.01	1.07	0.099	0.107	0.56
1.17	1.01	1.07	0.109	0.118	0.57
1.33	1.02	1.08	0.161	0.178	0.80
1.11	1.01	1.05	0.085	0.090	0.38
1.11	1.01	1.04	0.082	0.086	0.35
1.11	1.01	1.03	0.080	0.083	0.31
1.15	1.01	1.03	0.102	0.106	0.38
1.14	1.01	1.02	0.099	0.102	0.36
1.12	1.01	1.01	0.087	0.088	0.31
1.10	1.01	1.00	0.076	0.077	0.27
1.14	1.01	0.99	0.098	0.098	0.35
1.76	1.05	0.96	0.312	0.317	2.00
2.20	1.08	0.93	2.000	2.000	2.00
1.32	1.02	0.97	0.157	0.154	2.00
1.27	1.02	0.96	0.142	0.139	2.00
1.30	1.02	0.95	0.152	0.148	2.00
1.43	1.03	0.94	0.187	0.182	2.00
1.53	1.04	0.93	0.216	0.209	2.00
1.45	1.03	0.93	0.194	0.185	2.00
2.20	1.08	0.83	1.057	0.951	2.00
1.13	1.01	0.94	0.094	0.090	2.00
1.29	1.02	0.92	0.147	0.138	2.00
1.31	1.02	0.91	0.154	0.142	2.00
2.11	1.08	0.80	0.619	0.531	2.00
1.26	1.02	0.90	0.140	0.128	2.00
1.23	1.02	0.90	0.130	0.119	2.00
1.30	1.02	0.89	0.152	0.137	2.00
1.29	1.02	0.88	0.150	0.135	2.00
1.42	1.03	0.86	0.186	0.164	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	0.0	0.000	0.00	25.34
4	0.0	0.000	0.00	25.34
6	0.0	0.000	0.00	25.34
8	1.0	0.027	0.33	25.34
10	2.0	0.045	1.08	25.02
12	2.0	0.040	0.97	23.94
14	2.0	0.028	0.67	22.97
16	2.0	0.053	1.28	22.30
18	3.8	0.056	2.51	21.02
23.5	5.3	0.058	3.65	18.51
28.5	5.0	0.043	2.59	14.86
33.5	5.0	0.045	2.69	12.27
38.5	5.0	0.052	3.13	9.58
43.5	5.0	0.062	3.73	6.45
48.5	5.0	0.045	2.72	2.72
53.5	3.3	0.000	0.00	0.00
55	2.5	0.000	0.00	0.00
58.5	4.3	0.000	0.00	0.00
63.5	3.3	0.000	0.00	0.00
65	1.5	0.000	0.00	0.00
66.5	1.8	0.000	0.00	0.00
68.5	3.5	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.8	0.000	0.00	0.00
100	5.0	0.000	0.00	0.00
103.5	4.3	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	4.0	0.000	0.00	0.00
126.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:55 PM
Boring Designation:	B-2
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	6
SPT Liner (Yes/No):	No
Hammer Energy, %:	82
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	6

Earthquake Information

Max Acceleration (g) :	0.29
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	20	SP	5	100		Unsaturated
2	4.0	6	SP	5	100		Unsaturated
3	6.0	1	SP	5	100		
4	8.0	11	SP	3	100		
5	10.0	18	SP	3	120		
6	12.0	30	SP	3	120		
7	14.0	38	SP	3	120		
8	16.0	21	SP	3	120		
9	18.0	7	SP-SM	6	100		
10	23.5	0	SP-SM	6	100		
11	28.5	1	SM	14	100		
12	33.5	4	SM	14	100		
13	38.5	4	SP-SM	9	100		
14	43.5	19	SP-SM	9	120		
15	48.5	7	SP-SM	9	100		
16	53.5	11	SP-SM	10	100		
17	58.5	2	SP-SM	10	100		
18	63.5	1	CL	50	100		Clay
19	68.5	7	SP-SM	5	100		
20	73.5	5	ML	50	120		Clay
21	78.5	5	ML	50	120		Clay
22	83.5	4	ML	50	120		Clay
23	88.5	32	SM	15	120		Clay
24	93.5	5	SM	15	120		Clay
25	98.5	6	SM	15	120		Clay
26	103.5	4	SM	15	120		Clay
27	108.5	7	SM	15	120		Clay
28	113.5	10	SM	15	120		Clay
29	118.5	7	SM	15	120		Clay
30	123.5	7	SM	15	120		Clay
31							Clay
32							Clay
33							Clay
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	20.0	SP	5.0	100.0	Unsaturated	200	200	1.37	1.15	0.75	1.00	23.58	1.70	40.08	0.00	40.08	1.002	0.189
2	4.0	6.0	SP	5.0	100.0	Unsaturated	400	400	1.37	1.15	0.75	1.00	7.07	1.70	12.02	0.00	12.03	0.997	0.188
3	6.0	1.0	SP	4.9	100.0		600	600	1.37	1.15	0.80	1.00	1.26	1.70	2.14	0.00	2.14	0.991	0.187
4	8.0	11.0	SP	2.5	100.0		800	675	1.37	1.15	0.80	1.00	13.83	1.62	22.37	0.00	22.37	0.985	0.220
5	10.0	18.0	SP	3.0	120.0		1040	790	1.37	1.15	0.85	1.00	24.05	1.40	33.58	0.00	33.58	0.978	0.243
6	12.0	30.0	SP	3.0	120.0		1280	906	1.37	1.15	0.85	1.00	40.08	1.25	50.10	0.00	50.10	0.971	0.259
7	14.0	38.0	SP	3.0	120.0		1520	1021	1.37	1.15	0.85	1.00	50.76	1.21	61.50	0.00	61.50	0.964	0.271
8	16.0	21.0	SP	3.0	120.0		1760	1136	1.37	1.15	0.95	1.00	31.35	1.21	38.03	0.00	38.03	0.957	0.279
9	18.0	7.0	SP-SM	6.3	100.0		1960	1211	1.37	1.15	0.95	1.00	10.45	1.32	13.80	0.05	13.85	0.949	0.289
10	23.5	0.0	SP-SM	6.0	100.0		2510	1418	1.37	1.15	0.95	1.00	0.00	1.36	0.00	0.03	0.03	0.926	0.309
11	28.5	1.0	SM	14.0	100.0		3010	1606	1.37	1.15	1.00	1.00	1.57	1.19	1.86	2.91	4.77	0.903	0.319
12	33.5	4.0	SM	14.0	100.0		3510	1794	1.37	1.15	1.00	1.00	6.29	1.09	6.88	2.91	9.78	0.879	0.324
13	38.5	4.0	SP-SM	8.8	100.0		4010	1982	1.37	1.15	1.00	1.00	6.29	1.04	6.53	0.64	7.17	0.855	0.326
14	43.5	19.0	SP-SM	9.0	120.0		4610	2270	1.37	1.15	1.00	1.00	29.86	0.97	29.11	0.72	29.83	0.830	0.318
15	48.5	7.0	SP-SM	9.0	100.0		5110	2458	1.37	1.15	1.00	1.00	11.00	0.92	10.16	0.72	10.88	0.805	0.316
16	53.5	11.0	SP-SM	10.0	100.0		5610	2646	1.37	1.15	1.00	1.00	17.29	0.90	15.56	1.15	16.71	0.781	0.312
17	58.5	2.0	SP-SM	10.0	100.0		6110	2834	1.37	1.15	1.00	1.00	3.14	0.83	2.61	1.15	3.76	0.757	0.308
18	63.5	1.0	CL	50.0	100.0	Clay	6610	3022	1.37	1.15	1.00	1.00	1.57	0.81	1.28	5.61	6.89	0.734	0.303
19	68.5	7.0	SP-SM	5.0	100.0		7110	3210	1.37	1.15	1.00	1.00	11.00	0.79	8.72	0.00	8.72	0.712	0.297
20	73.5	5.0	ML	50.0	120.0	Clay	7710	3498	1.37	1.15	1.00	1.00	7.86	0.77	6.05	5.61	11.66	0.691	0.287
21	78.5	5.0	ML	50.0	120.0	Clay	8310	3786	1.37	1.15	1.00	1.00	7.86	0.74	5.79	5.61	11.41	0.672	0.278
22	83.5	4.0	ML	50.0	120.0	Clay	8910	4074	1.37	1.15	1.00	1.00	6.29	0.70	4.41	5.61	10.03	0.654	0.270
23	88.5	32.0	SM	15.0	120.0	Clay	9510	4362	1.37	1.15	1.00	1.00	50.29	0.82	41.34	3.26	44.60	0.639	0.263
24	93.5	5.0	SM	15.0	120.0	Clay	10110	4650	1.37	1.15	1.00	1.00	7.86	0.64	5.05	3.26	8.31	0.625	0.256
25	98.5	6.0	SM	15.0	120.0	Clay	10710	4938	1.37	1.15	1.00	1.00	9.43	0.63	5.91	3.26	9.17	0.613	0.251
26	103.5	4.0	SM	15.0	120.0	Clay	11310	5226	1.37	1.15	1.00	1.00	6.29	0.59	3.72	3.26	6.98	0.603	0.246
27	108.5	7.0	SM	15.0	120.0	Clay	11910	5514	1.37	1.15	1.00	1.00	11.00	0.59	6.54	3.26	9.80	0.596	0.243
28	113.5	10.0	SM	15.0	120.0	Clay	12510	5802	1.37	1.15	1.00	1.00	15.72	0.60	9.39	3.26	12.65	0.590	0.240
29	118.5	7.0	SM	15.0	120.0	Clay	13110	6090	1.37	1.15	1.00	1.00	11.00	0.56	6.16	3.26	9.42	0.587	0.238
30	123.5	7.0	SM	15.0	120.0	Clay	13710	6378	1.37	1.15	1.00	1.00	11.00	0.54	5.99	3.26	9.26	0.586	0.237
31																			
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
2.20	1.08	1.10	2.000	2.000	2.00
1.24	1.02	1.10	0.133	0.148	2.00
1.09	1.01	1.08	0.071	0.077	0.41
1.59	1.04	1.10	0.239	0.273	1.24
2.20	1.08	1.10	0.840	1.000	2.00
2.20	1.08	1.10	2.000	2.000	2.00
2.20	1.08	1.10	2.000	2.000	2.00
2.20	1.08	1.10	2.000	2.000	2.00
1.28	1.02	1.06	0.147	0.158	0.55
1.09	1.01	1.02	0.061	0.063	0.20
1.11	1.01	1.02	0.085	0.087	0.27
1.19	1.01	1.02	0.117	0.120	0.37
1.14	1.01	1.01	0.099	0.101	0.31
1.99	1.07	0.99	0.474	0.499	1.57
1.21	1.01	0.99	0.124	0.124	0.39
1.37	1.03	0.97	0.171	0.171	0.55
1.10	1.01	0.98	0.079	0.078	0.25
1.14	1.01	0.97	0.098	0.096	2.00
1.17	1.01	0.96	0.109	0.107	0.36
1.23	1.02	0.95	0.130	0.125	2.00
1.22	1.02	0.94	0.128	0.123	2.00
1.19	1.01	0.94	0.118	0.113	2.00
2.20	1.08	0.79	2.000	1.701	2.00
1.16	1.01	0.93	0.107	0.100	2.00
1.17	1.01	0.92	0.112	0.105	2.00
1.14	1.01	0.93	0.098	0.092	2.00
1.19	1.01	0.91	0.117	0.108	2.00
1.25	1.02	0.90	0.137	0.125	2.00
1.18	1.01	0.90	0.114	0.104	2.00
1.18	1.01	0.90	0.113	0.103	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	0.0	0.000	0.00	27.39
4	0.0	0.000	0.00	27.39
6	1.0	0.070	0.84	27.39
8	2.0	0.005	0.12	26.55
10	2.0	0.000	0.00	26.43
12	2.0	0.000	0.00	26.43
14	2.0	0.000	0.00	26.43
16	2.0	0.000	0.00	26.43
18	3.8	0.030	1.37	26.43
23.5	5.3	0.113	7.11	25.06
28.5	5.0	0.054	3.22	17.95
33.5	5.0	0.038	2.27	14.73
38.5	5.0	0.045	2.68	12.46
43.5	5.0	0.002	0.12	9.78
48.5	5.0	0.036	2.13	9.67
53.5	5.0	0.027	1.59	7.53
58.5	5.0	0.059	3.52	5.94
63.5	5.0	0.000	0.00	2.42
68.5	5.0	0.040	2.42	2.42
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.0	0.000	0.00	0.00
103.5	5.0	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	4.0	0.000	0.00	0.00
126.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 6:00 PM
Boring Designation:	B-3
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	1
SPT Liner (Yes/No):	No
Hammer Energy, %:	80
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.26
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	0	SM	38	100		
2	4.0	0	SM	38	100		
3	6.0	0	MH	99	95		Clay
4	8.0	0	MH	99	95		Clay
5	13.5	16	SP-SM	8	100		
6	18.5	1	SP-SM	8	100		
7	23.5	1	SM	25	100		
8	28.5	0	MH	97	95		Clay
9	33.5	0	SP-SM	10	100		
10	38.5	3	SP-SM	10	100		
11	43.5	4	SP-SM	10	100		
12	48.5	7	ML	50	120		Clay
13	53.5	4	ML	50	120		Clay
14	58.5	7	ML	50	120		Clay
15	63.5	5	ML	50	120		Clay
16	68.5	10	ML	50	120		Clay
17	73.5	8	ML	50	120		Clay
18	78.5	6	SM	15	120		Clay
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	0.0	SM	37.5	100.0		200	106	1.33	1.00	0.75	1.00	0.00	1.70	0.00	5.55	5.55	1.002	0.318
2	4.0	0.0	SM	38.0	100.0		400	182	1.33	1.00	0.75	1.00	0.00	1.70	0.00	5.55	5.55	0.997	0.371
3	6.0	0.0	MH	98.8	95.0	Clay	590	247	1.33	1.00	0.80	1.00	0.00	1.70	0.00	5.49	5.49	0.991	0.400
4	8.0	0.0	MH	98.8	95.0	Clay	780	312	1.33	1.00	0.80	1.00	0.00	1.70	0.00	5.49	5.49	0.985	0.416
5	13.5	16.0	SP-SM	7.7	100.0		1330	519	1.33	1.00	0.85	1.00	18.13	1.66	30.11	0.28	30.39	0.966	0.419
6	18.5	1.0	SP-SM	7.7	100.0		1830	707	1.33	1.00	0.95	1.00	1.27	1.70	2.15	0.28	2.44	0.947	0.414
7	23.5	1.0	SM	24.5	100.0		2330	895	1.33	1.00	0.95	1.00	1.27	1.65	2.09	5.03	7.12	0.926	0.407
8	28.5	0.0	MH	96.6	95.0	Clay	2805	1058	1.33	1.00	1.00	1.00	0.00	1.52	0.00	5.50	5.50	0.903	0.405
9	33.5	0.0	SP-SM	10.4	100.0		3305	1246	1.33	1.00	1.00	1.00	0.00	1.45	0.00	1.33	1.33	0.879	0.394
10	38.5	3.0	SP-SM	10.4	100.0		3805	1434	1.33	1.00	1.00	1.00	4.00	1.26	5.03	1.33	6.37	0.855	0.383
11	43.5	4.0	SP-SM	10.4	100.0		4305	1622	1.33	1.00	1.00	1.00	5.33	1.16	6.21	1.33	7.54	0.830	0.372
12	48.5	7.0	ML	50.0	120.0	Clay	4905	1910	1.33	1.00	1.00	1.00	9.33	1.05	9.81	5.61	15.42	0.805	0.349
13	53.5	4.0	ML	50.0	120.0	Clay	5505	2198	1.33	1.00	1.00	1.00	5.33	0.98	5.23	5.61	10.84	0.781	0.330
14	58.5	7.0	ML	50.0	120.0	Clay	6105	2486	1.33	1.00	1.00	1.00	9.33	0.92	8.62	5.61	14.23	0.757	0.314
15	63.5	5.0	ML	50.0	120.0	Clay	6705	2774	1.33	1.00	1.00	1.00	6.67	0.87	5.78	5.61	11.40	0.734	0.300
16	68.5	10.0	ML	50.0	120.0	Clay	7305	3062	1.33	1.00	1.00	1.00	13.33	0.84	11.21	5.61	16.83	0.712	0.287
17	73.5	8.0	ML	50.0	120.0	Clay	7905	3350	1.33	1.00	1.00	1.00	10.67	0.80	8.50	5.61	14.11	0.691	0.276
18	78.5	6.0	SM	15.0	120.0	Clay	8505	3638	1.33	1.00	1.00	1.00	8.00	0.74	5.93	3.26	9.20	0.672	0.266
19																			
20																			
21																			
22																			
23																			
24																			
25																			
26																			
27																			
28																			
29																			
30																			
31																			
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.12	1.01	1.10	0.089	0.099	0.31
1.12	1.01	1.10	0.089	0.099	0.27
1.12	1.01	1.10	0.089	0.099	2.00
1.12	1.01	1.10	0.089	0.099	2.00
2.02	1.07	1.10	0.510	0.600	1.43
1.10	1.01	1.07	0.072	0.078	0.19
1.14	1.01	1.07	0.099	0.107	0.26
1.12	1.01	1.05	0.089	0.095	2.00
1.09	1.01	1.03	0.067	0.069	0.18
1.13	1.01	1.03	0.094	0.098	0.26
1.15	1.01	1.02	0.102	0.105	0.28
1.33	1.02	1.01	0.160	0.165	2.00
1.21	1.01	1.00	0.124	0.125	2.00
1.29	1.02	0.98	0.150	0.150	2.00
1.22	1.02	0.97	0.128	0.127	2.00
1.38	1.03	0.96	0.172	0.169	2.00
1.29	1.02	0.95	0.149	0.144	2.00
1.18	1.01	0.95	0.113	0.108	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	2.5	0.050	1.51	19.78
4	2.0	0.050	1.21	18.27
6	2.0	0.000	0.00	17.07
8	3.8	0.000	0.00	17.07
13.5	5.3	0.003	0.18	17.07
18.5	5.0	0.067	4.05	16.89
23.5	5.0	0.045	2.69	12.84
28.5	5.0	0.000	0.00	10.15
33.5	5.0	0.078	4.70	10.15
38.5	5.0	0.047	2.84	5.45
43.5	5.0	0.044	2.61	2.61
48.5	5.0	0.000	0.00	0.00
53.5	5.0	0.000	0.00	0.00
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	4.0	0.000	0.00	0.00
81.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 6:01 PM
Boring Designation:	B-4
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	2
SPT Liner (Yes/No):	No
Hammer Energy, %:	80
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.26
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	1	SM	32	100		
2	4.0	0	SM	32	100		
3	6.0	0	CL	50	95		Clay
4	8.0	1	SM	26	100		
5	13.5	2	SM	15	100		
6	18.5	5	SM	15	100		
7	23.5	3	SM	15	100		
8	28.5	3	SM	22	100		
9	33.5	2	SM	22	100		
10	38.5	0	SM	22	100		
11	43.5	4	SM	17	100		
12	48.5	2	SM	17	100		
13	53.5	4	ML	50	120		Clay
14	58.5	7	MH	53	120		Clay
15	63.5	7	MH	53	120		Clay
16	68.5	6	MH	53	120		Clay
17	73.5	100	SM	15	120		Clay
18	78.5	9	SM	15	120		Clay
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	1.0	SM	31.9	100.0		200	200	1.33	1.00	0.75	1.00	1.00	1.70	1.70	5.43	7.13	1.002	0.169
2	4.0	0.0	SM	31.9	100.0		400	275	1.33	1.00	0.75	1.00	0.00	1.70	0.00	5.43	5.43	0.997	0.245
3	6.0	0.0	CL	50.0	95.0	Clay	590	340	1.33	1.00	0.80	1.00	0.00	1.70	0.00	5.61	5.61	0.991	0.290
4	8.0	1.0	SM	26.0	100.0		790	416	1.33	1.00	0.80	1.00	1.07	1.70	1.81	5.15	6.96	0.985	0.316
5	13.5	2.0	SM	15.1	100.0		1340	622	1.33	1.00	0.85	1.00	2.27	1.70	3.85	3.29	7.15	0.966	0.352
6	18.5	5.0	SM	15.0	100.0		1840	810	1.33	1.00	0.95	1.00	6.33	1.62	10.25	3.26	13.51	0.947	0.363
7	23.5	3.0	SM	15.0	100.0		2340	998	1.33	1.00	0.95	1.00	3.80	1.52	5.76	3.26	9.02	0.926	0.367
8	28.5	3.0	SM	22.0	100.0		2840	1186	1.33	1.00	1.00	1.00	4.00	1.37	5.46	4.77	10.23	0.903	0.365
9	33.5	2.0	SM	21.6	100.0		3340	1374	1.33	1.00	1.00	1.00	2.67	1.28	3.40	4.72	8.12	0.879	0.361
10	38.5	0.0	SM	22.0	100.0		3840	1562	1.33	1.00	1.00	1.00	0.00	1.21	0.00	4.77	4.77	0.855	0.355
11	43.5	4.0	SM	17.0	100.0		4340	1750	1.33	1.00	1.00	1.00	5.33	1.11	5.91	3.85	9.76	0.830	0.348
12	48.5	2.0	SM	17.0	100.0		4840	1938	1.33	1.00	1.00	1.00	2.67	1.05	2.81	3.85	6.66	0.805	0.340
13	53.5	4.0	ML	50.0	120.0	Clay	5440	2226	1.33	1.00	1.00	1.00	5.33	0.97	5.19	5.61	10.81	0.781	0.322
14	58.5	7.0	MH	53.1	120.0	Clay	6040	2514	1.33	1.00	1.00	1.00	9.33	0.92	8.57	5.61	14.18	0.757	0.307
15	63.5	7.0	MH	53.1	120.0	Clay	6640	2802	1.33	1.00	1.00	1.00	9.33	0.87	8.11	5.61	13.73	0.734	0.294
16	68.5	6.0	MH	53.1	120.0	Clay	7240	3090	1.33	1.00	1.00	1.00	8.00	0.82	6.58	5.61	12.19	0.712	0.282
17	73.5	100.0	SM	15.0	120.0	Clay	7840	3378	1.33	1.00	1.00	1.00	133.33	0.88	117.89	3.26	121.15	0.691	0.271
18	78.5	9.0	SM	15.0	120.0	Clay	8440	3666	1.33	1.00	1.00	1.00	12.00	0.75	9.04	3.26	12.30	0.672	0.261
19																			
20																			
21																			
22																			
23																			
24																			
25																			
26																			
27																			
28																			
29																			
30																			
31																			
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.14	1.01	1.10	0.099	0.110	0.65
1.12	1.01	1.10	0.089	0.098	0.40
1.12	1.01	1.10	0.090	0.100	2.00
1.14	1.01	1.10	0.098	0.109	0.34
1.14	1.01	1.10	0.099	0.110	0.31
1.27	1.02	1.10	0.144	0.161	0.44
1.17	1.01	1.07	0.111	0.120	0.33
1.20	1.01	1.05	0.120	0.128	0.35
1.16	1.01	1.04	0.105	0.110	0.31
1.11	1.01	1.02	0.085	0.087	0.25
1.19	1.01	1.02	0.116	0.120	0.34
1.13	1.01	1.01	0.096	0.098	0.29
1.21	1.01	1.00	0.124	0.125	2.00
1.29	1.02	0.98	0.149	0.150	2.00
1.28	1.02	0.97	0.146	0.144	2.00
1.24	1.02	0.96	0.134	0.131	2.00
2.20	1.08	0.86	2.000	1.864	2.00
1.24	1.02	0.94	0.135	0.129	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	1.0	0.045	0.54	23.84
4	2.0	0.051	1.22	23.31
6	2.0	0.000	0.00	22.09
8	3.8	0.045	2.04	22.09
13.5	5.3	0.045	2.82	20.05
18.5	5.0	0.031	1.85	17.23
23.5	5.0	0.040	2.38	15.37
28.5	5.0	0.037	2.21	13.00
33.5	5.0	0.042	2.52	10.78
38.5	5.0	0.054	3.22	8.27
43.5	5.0	0.038	2.27	5.05
48.5	5.0	0.046	2.78	2.78
53.5	5.0	0.000	0.00	0.00
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	4.0	0.000	0.00	0.00
81.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:56 PM
Boring Designation:	B-5
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	80
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.29
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	4	SP-SM	7	100		
2	4.0	6	SP-SM	7	100		
3	6.0	34	SM	15	120		
4	8.0	15	SM	15	120		
5	13.5	2	SM	20	100		
6	18.5	25	SP-SM	11	120		
7	23.5	5	SP-SM	11	100		
8	28.5	0	SM	33	100		
9	33.5	2	SM	33	100		
10	38.5	2	SM	21	100		
11	43.5	7	SM	21	100		
12	48.5	10	SM	26	100		
13	53.5	6	SM	26	100		
14	58.5	5	MH	50	120		Clay
15	63.5	4	MH	50	120		Clay
16	68.5	5	MH	50	120		Clay
17	73.5	5	MH	50	120		Clay
18	78.5	43	GC	15	120		Clay
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	4.0	SP-SM	6.6	100.0		200	75	1.33	1.00	0.75	1.00	4.00	1.70	6.80	0.08	6.88	1.002	0.502
2	4.0	6.0	SP-SM	6.6	100.0		400	150	1.33	1.00	0.75	1.00	6.00	1.70	10.20	0.08	10.28	0.997	0.500
3	6.0	34.0	SM	14.6	120.0		640	266	1.33	1.00	0.80	1.00	36.27	1.70	61.65	3.12	64.78	0.991	0.450
4	8.0	15.0	SM	14.6	120.0		880	381	1.33	1.00	0.80	1.00	16.00	1.70	27.20	3.12	30.32	0.985	0.429
5	13.5	2.0	SM	19.7	100.0		1430	588	1.33	1.00	0.85	1.00	2.27	1.70	3.85	4.43	8.28	0.966	0.443
6	18.5	25.0	SP-SM	10.5	120.0		2030	876	1.33	1.00	0.95	1.00	31.67	1.29	40.74	1.38	42.12	0.947	0.414
7	23.5	5.0	SP-SM	10.5	100.0		2530	1064	1.33	1.00	0.95	1.00	6.33	1.44	9.15	1.38	10.53	0.926	0.415
8	28.5	0.0	SM	32.8	100.0		3030	1252	1.33	1.00	1.00	1.00	0.00	1.37	0.00	5.46	5.46	0.903	0.412
9	33.5	2.0	SM	32.8	100.0		3530	1440	1.33	1.00	1.00	1.00	2.67	1.24	3.30	5.46	8.76	0.879	0.406
10	38.5	2.0	SM	20.9	100.0		4030	1628	1.33	1.00	1.00	1.00	2.67	1.16	3.10	4.62	7.72	0.855	0.399
11	43.5	7.0	SM	20.9	100.0		4530	1816	1.33	1.00	1.00	1.00	9.33	1.08	10.06	4.62	14.68	0.830	0.390
12	48.5	10.0	SM	26.0	100.0		5030	2004	1.33	1.00	1.00	1.00	13.33	1.02	13.67	5.15	18.81	0.805	0.381
13	53.5	6.0	SM	26.0	100.0		5530	2192	1.33	1.00	1.00	1.00	8.00	0.98	7.86	5.15	13.01	0.781	0.371
14	58.5	5.0	MH	50.0	120.0	Clay	6130	2480	1.33	1.00	1.00	1.00	6.67	0.92	6.14	5.61	11.75	0.757	0.353
15	63.5	4.0	MH	50.0	120.0	Clay	6730	2768	1.33	1.00	1.00	1.00	5.33	0.87	4.62	5.61	10.23	0.734	0.336
16	68.5	5.0	MH	50.0	120.0	Clay	7330	3056	1.33	1.00	1.00	1.00	6.67	0.82	5.49	5.61	11.11	0.712	0.322
17	73.5	5.0	MH	50.0	120.0	Clay	7930	3344	1.33	1.00	1.00	1.00	6.67	0.78	5.23	5.61	10.84	0.691	0.309
18	78.5	43.0	GC	15.0	120.0	Clay	8530	3632	1.33	1.00	1.00	1.00	57.33	0.87	49.74	3.26	53.00	0.672	0.298
19																			
20																			
21																			
22																			
23																			
24																			
25																			
26																			
27																			
28																			
29																			
30																			
31																			
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF			Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB	IB
1.14	1.01	1.10	0.097	0.108	0.22	
1.20	1.01	1.10	0.120	0.134	0.27	
2.20	1.08	1.10	2.000	2.000	2.00	
2.02	1.07	1.10	0.506	0.595	1.39	
1.16	1.01	1.10	0.106	0.118	0.27	
2.20	1.08	1.10	2.000	2.000	2.00	
1.20	1.01	1.06	0.122	0.131	0.32	
1.12	1.01	1.04	0.089	0.093	0.23	
1.17	1.01	1.03	0.110	0.115	0.28	
1.15	1.01	1.02	0.103	0.106	0.27	
1.31	1.02	1.02	0.153	0.159	0.41	
1.45	1.03	1.01	0.192	0.199	0.52	
1.26	1.02	1.00	0.140	0.142	0.38	
1.23	1.02	0.98	0.131	0.131	2.00	
1.20	1.01	0.98	0.120	0.118	2.00	
1.21	1.01	0.96	0.126	0.123	2.00	
1.21	1.01	0.96	0.124	0.120	2.00	
2.20	1.08	0.84	2.000	1.818	2.00	

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	3.0	0.046	1.64	20.60
4	2.0	0.037	0.88	18.96
6	2.0	0.000	0.00	18.08
8	3.8	0.003	0.14	18.08
13.5	5.3	0.042	2.61	17.94
18.5	5.0	0.000	0.00	15.32
23.5	5.0	0.036	2.17	15.32
28.5	5.0	0.051	3.04	13.15
33.5	5.0	0.040	2.42	10.11
38.5	5.0	0.043	2.58	7.69
43.5	5.0	0.029	1.75	5.11
48.5	5.0	0.024	1.45	3.36
53.5	5.0	0.032	1.90	1.90
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	4.0	0.000	0.00	0.00
81.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:56 PM
Boring Designation:	B-6
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	80
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.29
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	12	SM	17	100		
2	4.0	9	SM	17	100		
3	6.0	16	SM	16	120		
4	8.0	26	SM	16	120		
5	13.5	0	SM	26	100		
6	18.5	20	SM	14	120		
7	23.5	33	SM	14	120		
8	28.5	0	SP-SM	11	100		
9	33.5	4	SM	18	100		
10	38.5	13	SM	18	100		
11	43.5	25	SM	18	120		
12	48.5	33	SM	18	120		
13	53.5	8	SM	18	100		
14	58.5	5	MH	50	120		Clay
15	63.5	5	MH	50	120		Clay
16	68.5	7	MH	50	120		Clay
17	73.5	6	MH	50	120		Clay
18	78.5	100	ML	50	120		Clay
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	12.0	SM	17.2	100.0		200	75	1.33	1.00	0.75	1.00	12.00	1.70	20.40	3.90	24.30	1.002	0.502
2	4.0	9.0	SM	17.2	100.0		400	150	1.33	1.00	0.75	1.00	9.00	1.70	15.30	3.90	19.20	0.997	0.500
3	6.0	16.0	SM	15.7	120.0		640	266	1.33	1.00	0.80	1.00	17.07	1.70	29.01	3.49	32.50	0.991	0.450
4	8.0	26.0	SM	15.7	120.0		880	381	1.33	1.00	0.80	1.00	27.73	1.57	43.55	3.49	47.03	0.985	0.429
5	13.5	0.0	SM	26.1	100.0		1430	588	1.33	1.00	0.85	1.00	0.00	1.70	0.00	5.15	5.15	0.966	0.443
6	18.5	20.0	SM	13.7	120.0		2030	876	1.33	1.00	0.95	1.00	25.33	1.33	33.62	2.79	36.41	0.947	0.414
7	23.5	33.0	SM	13.7	120.0		2630	1164	1.33	1.00	0.95	1.00	41.80	1.17	48.92	2.79	51.71	0.926	0.394
8	28.5	0.0	SP-SM	11.0	100.0		3130	1352	1.33	1.00	1.00	1.00	0.00	1.36	0.00	1.61	1.61	0.903	0.394
9	33.5	4.0	SM	18.3	100.0		3630	1540	1.33	1.00	1.00	1.00	5.33	1.19	6.32	4.16	10.48	0.879	0.391
10	38.5	13.0	SM	18.3	100.0		4130	1728	1.33	1.00	1.00	1.00	17.33	1.09	18.86	4.16	23.01	0.855	0.385
11	43.5	25.0	SM	18.3	120.0		4730	2016	1.33	1.00	1.00	1.00	33.33	1.02	33.84	4.16	38.00	0.830	0.367
12	48.5	33.0	SM	18.3	120.0		5330	2304	1.33	1.00	1.00	1.00	44.00	0.98	43.03	4.16	47.18	0.805	0.351
13	53.5	8.0	SM	18.3	100.0		5830	2492	1.33	1.00	1.00	1.00	10.67	0.92	9.84	4.16	13.99	0.781	0.344
14	58.5	5.0	MH	50.0	120.0	Clay	6430	2780	1.33	1.00	1.00	1.00	6.67	0.87	5.78	5.61	11.39	0.757	0.330
15	63.5	5.0	MH	50.0	120.0	Clay	7030	3068	1.33	1.00	1.00	1.00	6.67	0.82	5.48	5.61	11.09	0.734	0.317
16	68.5	7.0	MH	50.0	120.0	Clay	7630	3356	1.33	1.00	1.00	1.00	9.33	0.79	7.39	5.61	13.00	0.712	0.305
17	73.5	6.0	MH	50.0	120.0	Clay	8230	3644	1.33	1.00	1.00	1.00	8.00	0.75	6.02	5.61	11.64	0.691	0.294
18	78.5	100.0	ML	50.0	120.0	Clay	8830	3932	1.33	1.00	1.00	1.00	133.33	0.85	113.28	5.61	118.89	0.672	0.284
19																			
20																			
21																			
22																			
23																			
24																			
25																			
26																			
27																			
28																			
29																			
30																			
31																			
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.69	1.05	1.10	0.274	0.316	0.63
1.46	1.03	1.10	0.197	0.223	0.45
2.15	1.08	1.10	0.698	0.828	1.84
2.20	1.08	1.10	2.000	2.000	2.00
1.12	1.01	1.10	0.087	0.096	0.22
2.20	1.08	1.10	1.514	1.802	2.00
2.20	1.08	1.10	2.000	2.000	2.00
1.09	1.01	1.03	0.068	0.071	0.18
1.20	1.01	1.03	0.121	0.127	0.32
1.62	1.04	1.03	0.250	0.268	0.70
2.20	1.08	1.01	2.000	2.000	2.00
2.20	1.08	0.97	2.000	2.000	2.00
1.29	1.02	0.98	0.148	0.148	0.43
1.22	1.01	0.97	0.128	0.126	2.00
1.21	1.01	0.96	0.126	0.123	2.00
1.26	1.02	0.95	0.140	0.136	2.00
1.23	1.02	0.95	0.130	0.125	2.00
2.20	1.08	0.82	2.000	1.768	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	3.0	0.019	0.70	14.28
4	2.0	0.024	0.57	13.58
6	2.0	0.001	0.01	13.01
8	3.8	0.000	0.00	13.00
13.5	5.3	0.052	3.27	13.00
18.5	5.0	0.000	0.00	9.72
23.5	5.0	0.000	0.00	9.72
28.5	5.0	0.075	4.51	9.72
33.5	5.0	0.036	2.18	5.22
38.5	5.0	0.020	1.23	3.04
43.5	5.0	0.000	0.00	1.81
48.5	5.0	0.000	0.00	1.81
53.5	5.0	0.030	1.81	1.81
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	4.0	0.000	0.00	0.00
81.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 6:01 PM
Boring Designation:	B-7
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.26
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"	
1	2.0	9	SM	13	100			
2	4.0	4	SM	13	100			
3	6.0	0	SM	18	100			
4	8.0	1	SM	18	100			
5	13.5	2	SM	31	100			
6	18.5	4	SP-SM	11	100			
7	23.5	17	SP-SM	11	100			
8	28.5	4	SP-SM	11	100			
9	33.5	2	CL	50	100		Clay	
10	38.5	1	SM	18	100			
11	43.5	4	SM	18	100			
12	48.5	5	SM	18	100			
13	53.5	10	ML	50	120		Clay	*Assumes Marl/Limestone NonLiq
14	58.5	4	ML	50	120		Clay	
15	63.5	8	ML	50	120		Clay	
16	68.5	8	SM	15	120		Clay	
17	73.5	100	SM	15	120		Clay	
18	78.5	12	SM	15	120		Clay	
19	83.5	6	SM	15	120		Clay	
20	88.5	6	SM	15	120		Clay	
21	93.5	12	SM	15	120		Clay	
22	98.5	13	SM	15	120		Clay	
23	103.5	11	SM	15	120		Clay	
24	108.5	6	SM	15	120		Clay	
25	113.5	11	SM	15	120		Clay	
26	118.5	9	SM	15	120		Clay	
27	123.5	7	SM	15	120		Clay	
28	128.5	13	SM	15	120		Clay	
29	133.5	12	SM	15	120		Clay	
30	138.5	11	SM	15	120		Clay	
31	143.5	9	SM	15	120		Clay	
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								
46								
47								
48								
49								
50								

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	9.0	SM	12.8	100.0		200	75	1.39	1.00	0.75	1.00	9.35	1.70	15.89	2.42	18.32	1.002	0.450
2	4.0	4.0	SM	12.8	100.0		400	150	1.39	1.00	0.75	1.00	4.16	1.70	7.06	2.42	9.49	0.997	0.448
3	6.0	0.0	SM	18.2	100.0		600	226	1.39	1.00	0.80	1.00	0.00	1.70	0.00	4.13	4.13	0.991	0.445
4	8.0	1.0	SM	18.2	100.0		800	301	1.39	1.00	0.80	1.00	1.11	1.70	1.88	4.13	6.02	0.985	0.443
5	13.5	2.0	SM	31.3	100.0		1350	508	1.39	1.00	0.85	1.00	2.35	1.70	4.00	5.41	9.41	0.966	0.434
6	18.5	4.0	SP-SM	10.8	100.0		1850	696	1.39	1.00	0.95	1.00	5.26	1.70	8.95	1.52	10.47	0.947	0.426
7	23.5	17.0	SP-SM	10.8	100.0		2350	884	1.39	1.00	0.95	1.00	22.37	1.36	30.37	1.52	31.89	0.926	0.416
8	28.5	4.0	SP-SM	10.8	100.0		2850	1072	1.39	1.00	1.00	1.00	5.54	1.45	8.04	1.52	9.55	0.903	0.406
9	33.5	2.0	CL	50.0	100.0	Clay	3350	1260	1.39	1.00	1.00	1.00	2.77	1.33	3.68	5.61	9.30	0.879	0.395
10	38.5	1.0	SM	17.9	100.0		3850	1448	1.39	1.00	1.00	1.00	1.39	1.26	1.74	4.07	5.81	0.855	0.384
11	43.5	4.0	SM	17.9	100.0		4350	1636	1.39	1.00	1.00	1.00	5.54	1.15	6.36	4.07	10.43	0.830	0.373
12	48.5	5.0	SM	17.9	100.0		4850	1824	1.39	1.00	1.00	1.00	6.93	1.08	7.49	4.07	11.55	0.805	0.362
13	53.5	10.0	ML	50.0	120.0	Clay	5450	2112	1.39	1.00	1.00	1.00	13.85	1.00	13.86	5.61	19.48	0.781	0.341
14	58.5	4.0	ML	50.0	120.0	Clay	6050	2400	1.39	1.00	1.00	1.00	5.54	0.94	5.18	5.61	10.80	0.757	0.322
15	63.5	8.0	ML	50.0	120.0	Clay	6650	2688	1.39	1.00	1.00	1.00	11.08	0.89	9.87	5.61	15.49	0.734	0.307
16	68.5	8.0	SM	15.0	120.0	Clay	7250	2976	1.39	1.00	1.00	1.00	11.08	0.84	9.31	3.26	12.57	0.712	0.293
17	73.5	100.0	SM	15.0	120.0	Clay	7850	3264	1.39	1.00	1.00	1.00	138.50	0.89	123.58	3.26	126.84	0.691	0.281
18	78.5	12.0	SM	15.0	120.0	Clay	8450	3552	1.39	1.00	1.00	1.00	16.62	0.78	13.00	3.26	16.26	0.672	0.270
19	83.5	6.0	SM	15.0	120.0	Clay	9050	3840	1.39	1.00	1.00	1.00	8.31	0.72	5.99	3.26	9.25	0.654	0.261
20	88.5	6.0	SM	15.0	120.0	Clay	9650	4128	1.39	1.00	1.00	1.00	8.31	0.69	5.74	3.26	9.00	0.639	0.252
21	93.5	12.0	SM	15.0	120.0	Clay	10250	4416	1.39	1.00	1.00	1.00	16.62	0.70	11.61	3.26	14.87	0.625	0.245
22	98.5	13.0	SM	15.0	120.0	Clay	10850	4704	1.39	1.00	1.00	1.00	18.01	0.68	12.26	3.26	15.52	0.613	0.239
23	103.5	11.0	SM	15.0	120.0	Clay	11450	4992	1.39	1.00	1.00	1.00	15.24	0.65	9.87	3.26	13.13	0.603	0.234
24	108.5	6.0	SM	15.0	120.0	Clay	12050	5280	1.39	1.00	1.00	1.00	8.31	0.60	4.96	3.26	8.22	0.596	0.230
25	113.5	11.0	SM	15.0	120.0	Clay	12650	5568	1.39	1.00	1.00	1.00	15.24	0.61	9.28	3.26	12.55	0.590	0.227
26	118.5	9.0	SM	15.0	120.0	Clay	13250	5856	1.39	1.00	1.00	1.00	12.47	0.58	7.23	3.26	10.49	0.587	0.224
27	123.5	7.0	SM	15.0	120.0	Clay	13850	6144	1.39	1.00	1.00	1.00	9.70	0.55	5.34	3.26	8.61	0.586	0.223
28	128.5	13.0	SM	15.0	120.0	Clay	14450	6432	1.39	1.00	1.00	1.00	18.01	0.57	10.32	3.26	13.58	0.588	0.223
29	133.5	12.0	SM	15.0	120.0	Clay	15050	6720	1.39	1.00	1.00	1.00	16.62	0.55	9.19	3.26	12.45	0.592	0.224
30	138.5	11.0	SM	15.0	120.0	Clay	15650	7008	1.39	1.00	1.00	1.00	15.24	0.53	8.13	3.26	11.39	0.598	0.226
31	143.5	9.0	SM	15.0	120.0	Clay	16250	7296	1.39	1.00	1.00	1.00	12.47	0.51	6.34	3.26	9.60	0.607	0.228
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.43	1.03	1.10	0.187	0.212	0.47
1.18	1.01	1.10	0.115	0.128	0.28
1.11	1.01	1.10	0.081	0.090	0.20
1.13	1.01	1.10	0.092	0.102	0.23
1.18	1.01	1.10	0.114	0.127	0.29
1.20	1.01	1.10	0.121	0.135	0.32
2.11	1.08	1.10	0.633	0.749	1.80
1.18	1.01	1.06	0.115	0.124	0.30
1.18	1.01	1.05	0.113	0.120	2.00
1.12	1.01	1.03	0.091	0.094	0.25
1.20	1.01	1.02	0.121	0.126	0.34
1.22	1.02	1.01	0.129	0.133	0.37
1.47	1.03	1.00	0.200	0.206	2.00
1.21	1.01	0.99	0.124	0.124	2.00
1.33	1.02	0.97	0.160	0.159	2.00
1.25	1.02	0.97	0.137	0.134	2.00
2.20	1.08	0.87	2.000	1.886	2.00
1.36	1.02	0.94	0.167	0.161	2.00
1.18	1.01	0.95	0.113	0.108	2.00
1.17	1.01	0.94	0.111	0.106	2.00
1.31	1.02	0.92	0.155	0.145	2.00
1.33	1.02	0.91	0.161	0.149	2.00
1.26	1.02	0.91	0.141	0.131	2.00
1.16	1.01	0.92	0.106	0.099	2.00
1.25	1.02	0.90	0.137	0.125	2.00
1.20	1.01	0.90	0.122	0.111	2.00
1.16	1.01	0.91	0.109	0.100	2.00
1.28	1.02	0.88	0.145	0.130	2.00
1.25	1.02	0.88	0.136	0.122	2.00
1.22	1.01	0.88	0.128	0.115	2.00
1.18	1.01	0.89	0.115	0.104	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	3.0	0.025	0.89	19.53
4	2.0	0.039	0.92	18.64
6	2.0	0.057	1.36	17.71
8	3.8	0.049	2.18	16.35
13.5	5.3	0.039	2.44	14.17
18.5	5.0	0.036	2.18	11.73
23.5	5.0	0.001	0.05	9.55
28.5	5.0	0.038	2.30	9.50
33.5	5.0	0.000	0.00	7.20
38.5	5.0	0.049	2.96	7.20
43.5	5.0	0.036	2.19	4.24
48.5	5.0	0.034	2.05	2.05
53.5	5.0	0.000	0.00	0.00
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.0	0.000	0.00	0.00
103.5	5.0	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	5.0	0.000	0.00	0.00
128.5	5.0	0.000	0.00	0.00
133.5	5.0	0.000	0.00	0.00
138.5	5.0	0.000	0.00	0.00
143.5	4.0	0.000	0.00	0.00
146.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 6:02 PM
Boring Designation:	B-8
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.26
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	3	SP-SM	12	100		
2	4.0	5	SP-SM	12	100		
3	6.0	4	SP-SM	12	100		
4	8.0	2	SP-SM	12	100		
5	10.0	2	SP-SM	12	100		
6	13.5	0	CL	68	95		Clay
7	18.5	0	CL	68	95		Clay
8	23.5	0	SC	35	100		
9	28.5	2	SM	22	100		
10	33.5	4	SM	22	100		
11	38.5	2	CL	50	95		Clay
12	43.5	8	SP-SM	7	100		
13	48.5	7	SP-SM	8	100		
14	53.5	5	SM	15	120		Clay
15	58.5	6	ML	50	120		Clay
16	63.5	6	ML	50	120		Clay
17	68.5	5	ML	50	120		Clay
18	73.5	18	ML	50	120		Clay
19	78.5	13	SM	15	120		Clay
20	83.5	5	SM	15	120		Clay
21	88.5	8	SM	15	120		Clay
22	93.5	9	SM	15	120		Clay
23	98.5	8	SM	15	120		Clay
24	103.5	9	SM	15	120		Clay
25	108.5	6	SM	15	120		Clay
26	113.5	12	SM	15	120		Clay
27	118.5	9	SM	15	120		Clay
28	123.5	7	SM	15	120		Clay
29	128.5	19	SM	15	120		Clay
30	133.5	11	SM	15	120		Clay
31	138.5		SM	15	120		Clay
32	143.5	10	SM	15	120		Clay
33	148.5	11	SM	15	120		Clay
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	3.0	SP-SM	11.9	100.0		200	75	1.39	1.00	0.75	1.00	3.12	1.70	5.30	2.03	7.32	1.002	0.450
2	4.0	5.0	SP-SM	11.9	100.0		400	150	1.39	1.00	0.75	1.00	5.19	1.70	8.83	2.03	10.86	0.997	0.448
3	6.0	4.0	SP-SM	11.9	100.0		600	226	1.39	1.00	0.80	1.00	4.43	1.70	7.53	2.03	9.56	0.991	0.445
4	8.0	2.0	SP-SM	11.9	100.0		800	301	1.39	1.00	0.80	1.00	2.22	1.70	3.77	2.03	5.79	0.985	0.443
5	10.0	2.0	SP-SM	11.9	100.0		1000	376	1.39	1.00	0.85	1.00	2.35	1.70	4.00	2.03	6.03	0.978	0.440
6	13.5	0.0	CL	67.5	95.0	Clay	1333	490	1.39	1.00	0.85	1.00	0.00	1.70	0.00	5.58	5.58	0.966	0.444
7	18.5	0.0	CL	67.5	95.0	Clay	1808	653	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.58	5.58	0.947	0.443
8	23.5	0.0	SC	34.9	100.0		2308	841	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.50	5.50	0.926	0.429
9	28.5	2.0	SM	22.0	100.0		2808	1029	1.39	1.00	1.00	1.00	2.77	1.49	4.13	4.77	8.90	0.903	0.416
10	33.5	4.0	SM	22.0	100.0		3308	1217	1.39	1.00	1.00	1.00	5.54	1.33	7.37	4.77	12.14	0.879	0.404
11	38.5	2.0	CL	50.0	95.0	Clay	3783	1380	1.39	1.00	1.00	1.00	2.77	1.27	3.51	5.61	9.12	0.855	0.396
12	43.5	8.0	SP-SM	6.5	100.0		4283	1568	1.39	1.00	1.00	1.00	11.08	1.16	12.90	0.07	12.97	0.830	0.383
13	48.5	7.0	SP-SM	8.2	100.0		4783	1756	1.39	1.00	1.00	1.00	9.70	1.10	10.70	0.43	11.13	0.805	0.371
14	53.5	5.0	SM	15.0	120.0	Clay	5383	2044	1.39	1.00	1.00	1.00	6.93	1.02	7.05	3.26	10.32	0.781	0.347
15	58.5	6.0	ML	50.0	120.0	Clay	5983	2332	1.39	1.00	1.00	1.00	8.31	0.95	7.91	5.61	13.53	0.757	0.328
16	63.5	6.0	ML	50.0	120.0	Clay	6583	2620	1.39	1.00	1.00	1.00	8.31	0.90	7.46	5.61	13.07	0.734	0.312
17	68.5	5.0	ML	50.0	120.0	Clay	7183	2908	1.39	1.00	1.00	1.00	6.93	0.85	5.86	5.61	11.48	0.712	0.297
18	73.5	18.0	ML	50.0	120.0	Clay	7783	3196	1.39	1.00	1.00	1.00	24.93	0.85	21.26	5.61	26.88	0.691	0.284
19	78.5	13.0	SM	15.0	120.0	Clay	8383	3484	1.39	1.00	1.00	1.00	18.01	0.79	14.30	3.26	17.56	0.672	0.273
20	83.5	5.0	SM	15.0	120.0	Clay	8983	3772	1.39	1.00	1.00	1.00	6.93	0.72	5.00	3.26	8.26	0.654	0.263
21	88.5	8.0	SM	15.0	120.0	Clay	9583	4060	1.39	1.00	1.00	1.00	11.08	0.71	7.85	3.26	11.12	0.639	0.255
22	93.5	9.0	SM	15.0	120.0	Clay	10183	4348	1.39	1.00	1.00	1.00	12.47	0.69	8.57	3.26	11.83	0.625	0.247
23	98.5	8.0	SM	15.0	120.0	Clay	10783	4636	1.39	1.00	1.00	1.00	11.08	0.66	7.29	3.26	10.55	0.613	0.241
24	103.5	9.0	SM	15.0	120.0	Clay	11383	4924	1.39	1.00	1.00	1.00	12.47	0.64	7.99	3.26	11.25	0.603	0.236
25	108.5	6.0	SM	15.0	120.0	Clay	11983	5212	1.39	1.00	1.00	1.00	8.31	0.60	5.00	3.26	8.26	0.596	0.231
26	113.5	12.0	SM	15.0	120.0	Clay	12583	5500	1.39	1.00	1.00	1.00	16.62	0.62	10.30	3.26	13.56	0.590	0.228
27	118.5	9.0	SM	15.0	120.0	Clay	13183	5788	1.39	1.00	1.00	1.00	12.47	0.58	7.28	3.26	10.54	0.587	0.226
28	123.5	7.0	SM	15.0	120.0	Clay	13783	6076	1.39	1.00	1.00	1.00	9.70	0.55	5.38	3.26	8.64	0.586	0.225
29	128.5	19.0	SM	15.0	120.0	Clay	14383	6364	1.39	1.00	1.00	1.00	26.32	0.61	16.10	3.26	19.36	0.588	0.224
30	133.5	11.0	SM	15.0	120.0	Clay	14983	6652	1.39	1.00	1.00	1.00	15.24	0.55	8.38	3.26	11.64	0.592	0.225
31	138.5	0.0	SM	15.0	120.0	Clay	15583	6940	1.39	1.00	1.00	1.00	0.00	0.46	0.00	3.26	3.26	0.598	0.227
32	143.5	10.0	SM	15.0	120.0	Clay	16183	7228	1.39	1.00	1.00	1.00	13.85	0.52	7.17	3.26	10.43	0.607	0.230
33	148.5	11.0	SM	15.0	120.0	Clay	16783	7516	1.39	1.00	1.00	1.00	15.24	0.51	7.80	3.26	11.06	0.618	0.233
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.14	1.01	1.10	0.100	0.111	0.25
1.21	1.01	1.10	0.124	0.138	0.31
1.18	1.01	1.10	0.115	0.128	0.29
1.12	1.01	1.10	0.091	0.101	0.23
1.13	1.01	1.10	0.092	0.102	0.23
1.12	1.01	1.10	0.090	0.099	2.00
1.12	1.01	1.09	0.090	0.099	2.00
1.12	1.01	1.07	0.089	0.096	0.22
1.17	1.01	1.06	0.111	0.119	0.29
1.24	1.02	1.06	0.133	0.143	0.35
1.17	1.01	1.04	0.112	0.118	2.00
1.26	1.02	1.03	0.140	0.147	0.38
1.21	1.01	1.02	0.126	0.130	0.35
1.20	1.01	1.00	0.120	0.122	2.00
1.27	1.02	0.99	0.144	0.145	2.00
1.26	1.02	0.98	0.141	0.140	2.00
1.22	1.02	0.97	0.129	0.127	2.00
1.82	1.06	0.93	0.342	0.335	2.00
1.40	1.03	0.94	0.179	0.173	2.00
1.16	1.01	0.95	0.106	0.102	2.00
1.21	1.01	0.94	0.126	0.120	2.00
1.23	1.02	0.93	0.131	0.124	2.00
1.20	1.01	0.93	0.122	0.114	2.00
1.22	1.01	0.92	0.127	0.118	2.00
1.16	1.01	0.92	0.106	0.099	2.00
1.28	1.02	0.90	0.144	0.132	2.00
1.20	1.01	0.91	0.122	0.112	2.00
1.17	1.01	0.91	0.109	0.100	2.00
1.47	1.03	0.86	0.198	0.175	2.00
1.23	1.02	0.89	0.130	0.117	2.00
1.10	1.01	0.92	0.077	0.071	2.00
1.20	1.01	0.88	0.121	0.109	2.00
1.21	1.01	0.88	0.126	0.112	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	3.0	0.044	1.59	17.57
4	2.0	0.036	0.85	15.98
6	2.0	0.038	0.92	15.13
8	2.0	0.049	1.18	14.21
10	2.8	0.048	1.60	13.02
13.5	4.3	0.000	0.00	11.42
18.5	5.0	0.000	0.00	11.42
23.5	5.0	0.050	3.03	11.42
28.5	5.0	0.040	2.39	8.39
33.5	5.0	0.033	1.99	6.00
38.5	5.0	0.000	0.00	4.01
43.5	5.0	0.032	1.91	4.01
48.5	5.0	0.035	2.10	2.10
53.5	5.0	0.000	0.00	0.00
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.0	0.000	0.00	0.00
103.5	5.0	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	5.0	0.000	0.00	0.00
128.5	5.0	0.000	0.00	0.00
133.5	5.0	0.000	0.00	0.00
138.5	5.0	0.000	0.00	0.00
143.5	5.0	0.000	0.00	0.00
148.5	4.0	0.000	0.00	0.00
151.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 6:03 PM
Boring Designation:	B-9
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.26
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"	
1	0.5	0	ML	50	95		Clay	
2	2.0	5	SP-SM	8	100			
3	4.0	6	SP-SM	7	100			
4	6.0	0	SP-SM	7	100			
5	8.0	2	SP-SM	10	100			
6	13.5	0	SP-SM	10	100			
7	18.5	0	CL	79	95		Clay	
8	23.5	0	CL	79	95		Clay	
9	28.5	0	CL	79	95		Clay	
10	33.5	1	CL	79	95		Clay	
11	38.5	2	CL	79	95		Clay	
12	43.5	7	SP-SM	8	100			
13	48.5	4	SP-SM	8	100			
14	53.5	4	ML	50	120		Clay	*Assumes Marl/Limestone NonLiq
15	58.5	5	ML	50	120		Clay	
16	63.5	7	ML	50	120		Clay	
17	68.5	5	ML	50	120		Clay	
18	73.5	13	ML	50	120		Clay	
19	78.5	100	SM	15	120		Clay	
20	83.5	5	SM	15	120		Clay	
21	88.5	8	SM	15	120		Clay	
22	93.5	8	SM	15	120		Clay	
23	98.5	8	SM	15	120		Clay	
24	103.5	14	SM	15	120		Clay	
25	108.5	8	SM	15	120		Clay	
26	113.5	7	SM	15	120		Clay	
27	118.5	7	SM	15	120		Clay	
28	123.5	6	SM	15	120		Clay	
29	128.5	6	SM	15	120		Clay	
30	133.5	13	ML	50	120		Clay	
31	138.5	11	ML	50	120		Clay	
32	143.5	11	SM	15	120		Clay	
33	148.5	10	SM	15	120		Clay	
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								
46								
47								
48								
49								
50								

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
									IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	0.0	ML	50.0	95.0	Clay	48	16	1.39	1.00	0.75	1.00	0.00	1.70	0.00	5.61	5.61	1.005	0.495
2	2.0	5.0	SP-SM	7.7	100.0		198	73	1.39	1.00	0.75	1.00	5.19	1.70	8.83	0.28	9.11	1.002	0.460
3	4.0	6.0	SP-SM	7.2	100.0		398	148	1.39	1.00	0.75	1.00	6.23	1.70	10.60	0.17	10.77	0.997	0.453
4	6.0	0.0	SP-SM	7.0	100.0		598	223	1.39	1.00	0.80	1.00	0.00	1.70	0.00	0.14	0.14	0.991	0.448
5	8.0	2.0	SP-SM	10.3	100.0		798	298	1.39	1.00	0.80	1.00	2.22	1.70	3.77	1.29	5.05	0.985	0.445
6	13.5	0.0	SP-SM	10.0	100.0		1348	505	1.39	1.00	0.85	1.00	0.00	1.70	0.00	1.15	1.15	0.966	0.436
7	18.5	0.0	CL	79.0	95.0	Clay	1823	668	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.55	5.55	0.947	0.436
8	23.5	0.0	CL	79.0	95.0	Clay	2298	831	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.55	5.55	0.926	0.432
9	28.5	0.0	CL	79.1	95.0	Clay	2773	994	1.39	1.00	1.00	1.00	0.00	1.58	0.00	5.55	5.55	0.903	0.426
10	33.5	1.0	CL	79.0	95.0	Clay	3248	1157	1.39	1.00	1.00	1.00	1.39	1.41	1.96	5.55	7.51	0.879	0.417
11	38.5	2.0	CL	79.0	95.0	Clay	3723	1320	1.39	1.00	1.00	1.00	2.77	1.30	3.59	5.55	9.14	0.855	0.407
12	43.5	7.0	SP-SM	7.5	100.0		4223	1508	1.39	1.00	1.00	1.00	9.70	1.19	11.56	0.23	11.80	0.830	0.393
13	48.5	4.0	SP-SM	8.0	100.0		4723	1696	1.39	1.00	1.00	1.00	5.54	1.14	6.31	0.37	6.67	0.805	0.379
14	53.5	4.0	ML	50.0	120.0	Clay	5323	1984	1.39	1.00	1.00	1.00	5.54	1.03	5.73	5.61	11.35	0.781	0.354
15	58.5	5.0	ML	50.0	120.0	Clay	5923	2272	1.39	1.00	1.00	1.00	6.93	0.96	6.68	5.61	12.29	0.757	0.333
16	63.5	7.0	ML	50.0	120.0	Clay	6523	2560	1.39	1.00	1.00	1.00	9.70	0.91	8.83	5.61	14.44	0.734	0.316
17	68.5	5.0	ML	50.0	120.0	Clay	7123	2848	1.39	1.00	1.00	1.00	6.93	0.86	5.93	5.61	11.54	0.712	0.301
18	73.5	13.0	ML	50.0	120.0	Clay	7723	3136	1.39	1.00	1.00	1.00	18.01	0.84	15.18	5.61	20.79	0.691	0.288
19	78.5	100.0	SM	15.0	120.0	Clay	8323	3424	1.39	1.00	1.00	1.00	138.50	0.88	122.03	3.26	125.29	0.672	0.276
20	83.5	5.0	SM	15.0	120.0	Clay	8923	3712	1.39	1.00	1.00	1.00	6.93	0.73	5.05	3.26	8.31	0.654	0.266
21	88.5	8.0	SM	15.0	120.0	Clay	9523	4000	1.39	1.00	1.00	1.00	11.08	0.71	7.92	3.26	11.18	0.639	0.257
22	93.5	8.0	SM	15.0	120.0	Clay	10123	4288	1.39	1.00	1.00	1.00	11.08	0.69	7.62	3.26	10.88	0.625	0.249
23	98.5	8.0	SM	15.0	120.0	Clay	10723	4576	1.39	1.00	1.00	1.00	11.08	0.66	7.34	3.26	10.60	0.613	0.243
24	103.5	14.0	SM	15.0	120.0	Clay	11323	4864	1.39	1.00	1.00	1.00	19.39	0.67	13.07	3.26	16.33	0.603	0.237
25	108.5	8.0	SM	15.0	120.0	Clay	11923	5152	1.39	1.00	1.00	1.00	11.08	0.62	6.85	3.26	10.12	0.596	0.233
26	113.5	7.0	SM	15.0	120.0	Clay	12523	5440	1.39	1.00	1.00	1.00	9.70	0.59	5.75	3.26	9.01	0.590	0.230
27	118.5	7.0	SM	15.0	120.0	Clay	13123	5728	1.39	1.00	1.00	1.00	9.70	0.57	5.57	3.26	8.84	0.587	0.227
28	123.5	6.0	SM	15.0	120.0	Clay	13723	6016	1.39	1.00	1.00	1.00	8.31	0.55	4.59	3.26	7.85	0.586	0.226
29	128.5	6.0	SM	15.0	120.0	Clay	14323	6304	1.39	1.00	1.00	1.00	8.31	0.54	4.46	3.26	7.72	0.588	0.226
30	133.5	13.0	ML	50.0	120.0	Clay	14923	6592	1.39	1.00	1.00	1.00	18.01	0.58	10.48	5.61	16.10	0.592	0.226
31	138.5	11.0	ML	50.0	120.0	Clay	15523	6880	1.39	1.00	1.00	1.00	15.24	0.56	8.49	5.61	14.11	0.598	0.228
32	143.5	11.0	SM	15.0	120.0	Clay	16123	7168	1.39	1.00	1.00	1.00	15.24	0.53	8.02	3.26	11.28	0.607	0.231
33	148.5	10.0	SM	15.0	120.0	Clay	16723	7456	1.39	1.00	1.00	1.00	13.85	0.51	7.04	3.26	10.30	0.618	0.234
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.12	1.01	1.10	0.090	0.100	2.00
1.17	1.01	1.10	0.112	0.125	0.27
1.21	1.01	1.10	0.123	0.138	0.30
1.09	1.01	1.10	0.061	0.068	0.15
1.12	1.01	1.10	0.086	0.096	0.22
1.09	1.01	1.09	0.066	0.072	0.17
1.12	1.01	1.09	0.089	0.098	2.00
1.12	1.01	1.07	0.089	0.097	2.00
1.12	1.01	1.06	0.089	0.095	2.00
1.15	1.01	1.05	0.101	0.108	2.00
1.17	1.01	1.04	0.112	0.118	2.00
1.23	1.02	1.03	0.131	0.137	0.35
1.13	1.01	1.02	0.096	0.099	0.26
1.22	1.01	1.01	0.128	0.130	2.00
1.24	1.02	0.99	0.135	0.136	2.00
1.30	1.02	0.98	0.151	0.151	2.00
1.22	1.02	0.97	0.129	0.127	2.00
1.53	1.04	0.95	0.216	0.212	2.00
2.20	1.08	0.86	2.000	1.856	2.00
1.16	1.01	0.95	0.107	0.103	2.00
1.22	1.01	0.94	0.126	0.120	2.00
1.21	1.01	0.93	0.124	0.118	2.00
1.20	1.01	0.93	0.122	0.115	2.00
1.36	1.02	0.90	0.168	0.155	2.00
1.19	1.01	0.92	0.119	0.110	2.00
1.17	1.01	0.92	0.111	0.103	2.00
1.17	1.01	0.91	0.110	0.102	2.00
1.15	1.01	0.91	0.104	0.095	2.00
1.15	1.01	0.91	0.103	0.094	2.00
1.35	1.02	0.87	0.166	0.147	2.00
1.29	1.02	0.87	0.149	0.133	2.00
1.22	1.01	0.88	0.127	0.114	2.00
1.20	1.01	0.88	0.120	0.107	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.000	0.00	16.45
2	1.8	0.039	0.83	16.45
4	2.0	0.036	0.86	15.62
6	2.0	0.105	2.51	14.76
8	3.8	0.052	2.36	12.25
13.5	5.3	0.081	5.09	9.89
18.5	5.0	0.000	0.00	4.80
23.5	5.0	0.000	0.00	4.80
28.5	5.0	0.000	0.00	4.80
33.5	5.0	0.000	0.00	4.80
38.5	5.0	0.000	0.00	4.80
43.5	5.0	0.034	2.03	4.80
48.5	5.0	0.046	2.78	2.78
53.5	5.0	0.000	0.00	0.00
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.0	0.000	0.00	0.00
103.5	5.0	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	5.0	0.000	0.00	0.00
128.5	5.0	0.000	0.00	0.00
133.5	5.0	0.000	0.00	0.00
138.5	5.0	0.000	0.00	0.00
143.5	5.0	0.000	0.00	0.00
148.5	4.0	0.000	0.00	0.00
151.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 6:03 PM
Boring Designation:	B-10
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	-2
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	7
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.26
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	0.5	0	SC	41	100		
2	2.0	0	SC	41	100		
3	4.0	6	SC	41	100		
4	6.0	2	SP-SM	8	100		
5	8.0	2	SP-SM	8	100		
6	10.0	2	ML	57	95		Clay
7	13.0	0	ML	57	95		Clay
8	18.0	0	ML	57	95		Clay
9	23.0	0	ML	57	95		Clay
10	28.5	0	ML	57	95		Clay
11	33.5	0	ML	57	95		Clay
12	38.5	1	ML	57	95		Clay
13	44.0	6	SP-SM	6	100		
14	49.0	17	SP-SM	6	100		
15	54.5	3	SM	31	120		Clay
16	59.5	6	SM	31	120		Clay
17	64.5	5	SM	31	120		Clay
18	69.5	8	SM	31	120		Clay
19	74.5	7	SM	15	120		Clay
20	79.5	11	SM	15	120		Clay
21	84.5	13	SM	15	120		Clay
22	89.5	16	SM	15	120		Clay
23	94.5	7	SM	15	120		Clay
24	99.5	11	SM	15	120		Clay
25	104.5	7	SM	15	120		Clay
26	109.5	7	SM	15	120		Clay
27	114.5	9	SM	15	120		Clay
28	119.5	6	SM	15	120		Clay
29	124.5	3	SM	15	120		Clay
30	128.0	6	SM	15	120		Clay
31	133.0	5	SM	15	120		Clay
32	140.0	8	SM	15	120		Clay
33	145.0	13	SM	15	120		Clay
34	150.0	10	SM	15	120		Clay
35	155.5	7	SM	15	120		Clay
36	160.0	7	SM	15	120		Clay
37	165.0	16	SM	15	120		Clay
38	170.0	9	SM	15	120		Clay
39	175.0	10	SM	15	120		Clay
40	180.0	18	SM	15	120		Clay
41	185.0	37	SM	15	120		Clay
42	189.5	10	SM	15	120		Clay
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	0.0	SC	41.0	100.0		175	19	1.39	1.00	0.75	1.00	0.00	1.70	0.00	5.58	5.58	1.005	1.580
2	2.0	0.0	SC	41.1	100.0		325	75	1.39	1.00	0.75	1.00	0.00	1.70	0.00	5.59	5.59	1.002	0.731
3	4.0	6.0	SC	41.0	100.0		525	150	1.39	1.00	0.80	1.00	6.65	1.70	11.30	5.58	16.89	0.997	0.588
4	6.0	2.0	SP-SM	7.9	100.0		725	226	1.39	1.00	0.80	1.00	2.22	1.70	3.77	0.34	4.11	0.991	0.538
5	8.0	2.0	SP-SM	8.0	100.0		925	301	1.39	1.00	0.85	1.00	2.35	1.70	4.00	0.37	4.37	0.985	0.512
6	10.0	2.0	ML	57.0	95.0	Clay	1115	366	1.39	1.00	0.85	1.00	2.35	1.70	4.00	5.61	9.61	0.978	0.504
7	13.0	0.0	ML	57.0	95.0	Clay	1400	464	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.61	5.61	0.968	0.494
8	18.0	0.0	ML	57.2	95.0	Clay	1875	627	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.61	5.61	0.949	0.480
9	23.0	0.0	ML	57.0	95.0	Clay	2350	790	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.61	5.61	0.928	0.466
10	28.5	0.0	ML	57.0	95.0	Clay	2872	969	1.39	1.00	1.00	1.00	0.00	1.60	0.00	5.61	5.61	0.903	0.452
11	33.5	0.0	ML	57.0	95.0	Clay	3347	1132	1.39	1.00	1.00	1.00	0.00	1.46	0.00	5.61	5.61	0.879	0.439
12	38.5	1.0	ML	57.0	95.0	Clay	3822	1295	1.39	1.00	1.00	1.00	1.39	1.33	1.84	5.61	7.44	0.855	0.426
13	44.0	6.0	SP-SM	6.0	100.0		4372	1502	1.39	1.00	1.00	1.00	8.31	1.20	10.00	0.03	10.03	0.827	0.407
14	49.0	17.0	SP-SM	6.0	100.0		4872	1690	1.39	1.00	1.00	1.00	23.55	1.09	25.73	0.03	25.76	0.803	0.391
15	54.5	3.0	SM	31.0	120.0	Clay	5532	2007	1.39	1.00	1.00	1.00	4.16	1.03	4.28	5.40	9.68	0.776	0.361
16	59.5	6.0	SM	31.0	120.0	Clay	6132	2295	1.39	1.00	1.00	1.00	8.31	0.96	7.98	5.40	13.38	0.752	0.340
17	64.5	5.0	SM	31.0	120.0	Clay	6732	2583	1.39	1.00	1.00	1.00	6.93	0.90	6.24	5.40	11.64	0.729	0.321
18	69.5	8.0	SM	31.0	120.0	Clay	7332	2871	1.39	1.00	1.00	1.00	11.08	0.86	9.55	5.40	14.95	0.708	0.305
19	74.5	7.0	SM	15.0	120.0	Clay	7932	3159	1.39	1.00	1.00	1.00	9.70	0.81	7.85	3.26	11.11	0.687	0.292
20	79.5	11.0	SM	15.0	120.0	Clay	8532	3447	1.39	1.00	1.00	1.00	15.24	0.79	12.03	3.26	15.29	0.668	0.280
21	84.5	13.0	SM	15.0	120.0	Clay	9132	3735	1.39	1.00	1.00	1.00	18.01	0.77	13.81	3.26	17.07	0.651	0.269
22	89.5	16.0	SM	15.0	120.0	Clay	9732	4023	1.39	1.00	1.00	1.00	22.16	0.75	16.69	3.26	19.96	0.636	0.260
23	94.5	7.0	SM	15.0	120.0	Clay	10332	4311	1.39	1.00	1.00	1.00	9.70	0.68	6.59	3.26	9.85	0.622	0.252
24	99.5	11.0	SM	15.0	120.0	Clay	10932	4599	1.39	1.00	1.00	1.00	15.24	0.68	10.33	3.26	13.59	0.611	0.245
25	104.5	7.0	SM	15.0	120.0	Clay	11532	4887	1.39	1.00	1.00	1.00	9.70	0.63	6.12	3.26	9.39	0.602	0.240
26	109.5	7.0	SM	15.0	120.0	Clay	12132	5175	1.39	1.00	1.00	1.00	9.70	0.61	5.92	3.26	9.18	0.594	0.236
27	114.5	9.0	SM	15.0	120.0	Clay	12732	5463	1.39	1.00	1.00	1.00	12.47	0.60	7.53	3.26	10.79	0.589	0.232
28	119.5	6.0	SM	15.0	120.0	Clay	13332	5751	1.39	1.00	1.00	1.00	8.31	0.57	4.71	3.26	7.98	0.587	0.230
29	124.5	3.0	SM	15.0	120.0	Clay	13932	6039	1.39	1.00	1.00	1.00	4.16	0.53	2.20	3.26	5.47	0.586	0.229
30	128.0	6.0	SM	15.0	120.0	Clay	14352	6240	1.39	1.00	1.00	1.00	8.31	0.54	4.48	3.26	7.75	0.587	0.228
31	133.0	5.0	SM	15.0	120.0	Clay	14952	6528	1.39	1.00	1.00	1.00	6.93	0.52	3.59	3.26	6.85	0.591	0.229
32	140.0	8.0	SM	15.0	120.0	Clay	15792	6932	1.39	1.00	1.00	1.00	11.08	0.52	5.75	3.26	9.01	0.600	0.231
33	145.0	13.0	SM	15.0	120.0	Clay	16392	7220	1.39	1.00	1.00	1.00	18.01	0.54	9.65	3.26	12.91	0.610	0.234
34	150.0	10.0	SM	15.0	120.0	Clay	16992	7508	1.39	1.00	1.00	1.00	13.85	0.51	7.01	3.26	10.27	0.622	0.238
35	155.5	7.0	SM	15.0	120.0	Clay	17652	7824	1.39	1.00	1.00	1.00	9.70	0.48	4.61	3.26	7.87	0.639	0.244
36	160.0	7.0	SM	15.0	120.0	Clay	18192	8084	1.39	1.00	1.00	1.00	9.70	0.47	4.52	3.26	7.78	0.655	0.249
37	165.0	16.0	SM	15.0	120.0	Clay	18792	8372	1.39	1.00	1.00	1.00	22.16	0.51	11.28	3.26	14.54	0.675	0.256
38	170.0	9.0	SM	15.0	120.0	Clay	19392	8660	1.39	1.00	1.00	1.00	12.47	0.46	5.71	3.26	8.97	0.697	0.264
39	175.0	10.0	SM	15.0	120.0	Clay	19992	8948	1.39	1.00	1.00	1.00	13.85	0.45	6.30	3.26	9.56	0.722	0.273
40	180.0	18.0	SM	15.0	120.0	Clay	20592	9236	1.39	1.00	1.00	1.00	24.93	0.49	12.26	3.26	15.53	0.750	0.283
41	185.0	37.0	SM	15.0	120.0	Clay	21192	9524	1.39	1.00	1.00	1.00	51.25	0.60	30.98	3.26	34.24	0.780	0.293
42	189.5	10.0	SM	15.0	120.0	Clay	21732	9783	1.39	1.00	1.00	1.00	13.85	0.43	5.96	3.26	9.22	0.808	0.303
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.12	1.01	1.10	0.090	0.099	0.06
1.12	1.01	1.10	0.090	0.099	0.14
1.38	1.03	1.10	0.173	0.195	0.33
1.11	1.01	1.10	0.081	0.090	0.17
1.11	1.01	1.10	0.083	0.091	0.18
1.18	1.01	1.10	0.115	0.128	2.00
1.12	1.01	1.10	0.090	0.099	2.00
1.12	1.01	1.09	0.090	0.099	2.00
1.12	1.01	1.08	0.090	0.097	2.00
1.12	1.01	1.06	0.090	0.096	2.00
1.12	1.01	1.05	0.090	0.095	2.00
1.15	1.01	1.04	0.101	0.106	2.00
1.19	1.01	1.03	0.118	0.124	0.30
1.76	1.05	1.04	0.309	0.337	0.86
1.18	1.01	1.00	0.116	0.118	2.00
1.27	1.02	0.99	0.143	0.144	2.00
1.23	1.02	0.98	0.130	0.129	2.00
1.32	1.02	0.97	0.156	0.154	2.00
1.21	1.01	0.96	0.126	0.123	2.00
1.33	1.02	0.95	0.159	0.153	2.00
1.38	1.03	0.93	0.175	0.167	2.00
1.49	1.03	0.91	0.205	0.194	2.00
1.19	1.01	0.93	0.117	0.111	2.00
1.28	1.02	0.92	0.145	0.135	2.00
1.18	1.01	0.92	0.114	0.107	2.00
1.17	1.01	0.92	0.112	0.105	2.00
1.21	1.01	0.91	0.124	0.114	2.00
1.15	1.01	0.91	0.104	0.097	2.00
1.12	1.01	0.92	0.089	0.082	2.00
1.15	1.01	0.91	0.103	0.094	2.00
1.14	1.01	0.91	0.097	0.089	2.00
1.17	1.01	0.89	0.111	0.101	2.00
1.26	1.02	0.87	0.139	0.124	2.00
1.20	1.01	0.88	0.120	0.107	2.00
1.15	1.01	0.89	0.104	0.093	2.00
1.15	1.01	0.89	0.103	0.092	2.00
1.30	1.02	0.85	0.152	0.132	2.00
1.17	1.01	0.87	0.111	0.098	2.00
1.18	1.01	0.87	0.115	0.101	2.00
1.33	1.02	0.83	0.161	0.137	2.00
2.20	1.08	0.62	0.952	0.640	2.00
1.18	1.01	0.86	0.113	0.098	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.050	0.75	8.18
2	1.8	0.050	1.05	7.43
4	2.0	0.026	0.63	6.37
6	2.0	0.057	1.36	5.74
8	2.0	0.055	1.33	4.38
10	2.5	0.000	0.00	3.05
13	4.0	0.000	0.00	3.05
18	5.0	0.000	0.00	3.05
23	5.3	0.000	0.00	3.05
28.5	5.3	0.000	0.00	3.05
33.5	5.0	0.000	0.00	3.05
38.5	5.3	0.000	0.00	3.05
44	5.3	0.037	2.35	3.05
49	5.3	0.011	0.70	0.70
54.5	5.3	0.000	0.00	0.00
59.5	5.0	0.000	0.00	0.00
64.5	5.0	0.000	0.00	0.00
69.5	5.0	0.000	0.00	0.00
74.5	5.0	0.000	0.00	0.00
79.5	5.0	0.000	0.00	0.00
84.5	5.0	0.000	0.00	0.00
89.5	5.0	0.000	0.00	0.00
94.5	5.0	0.000	0.00	0.00
99.5	5.0	0.000	0.00	0.00
104.5	5.0	0.000	0.00	0.00
109.5	5.0	0.000	0.00	0.00
114.5	5.0	0.000	0.00	0.00
119.5	5.0	0.000	0.00	0.00
124.5	4.3	0.000	0.00	0.00
128	4.3	0.000	0.00	0.00
133	6.0	0.000	0.00	0.00
140	6.0	0.000	0.00	0.00
145	5.0	0.000	0.00	0.00
150	5.3	0.000	0.00	0.00
155.5	5.0	0.000	0.00	0.00
160	4.8	0.000	0.00	0.00
165	5.0	0.000	0.00	0.00
170	5.0	0.000	0.00	0.00
175	5.0	0.000	0.00	0.00
180	5.0	0.000	0.00	0.00
185	4.8	0.000	0.00	0.00
189.5	3.8	0.000	0.00	0.00
192.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 6:04 PM
Boring Designation:	B-11
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	-22
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	27
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.26
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	0.5	0	ML	50	95		Clay
2	2.0	1	ML	50	95		Clay
3	4.0	0	SM	18	100		
4	6.0	0	CL	52	95		Clay
5	8.0	0	SM	15	100		
6	14.5	0	MH	94	95		Clay
7	20.0	0	MH	94	95		Clay
8	25.5	2	SM	15	100		
9	31.5	7	SM	15	100		
10	36.0	6	ML	50	120		Clay
11	41.5	5	ML	50	120		Clay
12	46.5	7	ML	50	120		Clay
13	51.5	7	ML	50	120		Clay
14	56.5	23	SM	15	120		Clay
15	61.0	6	SM	45	120		Clay
16	65.5	5	SM	15	120		Clay
17	70.5	5	SM	15	120		Clay
18	75.0	6	SM	15	120		Clay
19	78.0	5	SM	15	120		Clay
20	82.5	27	SM	15	120		Clay
21	85.0	1	SM	15	120		Clay
22	90.0	8	SM	15	120		Clay
23	98.5	9	SM	15	120		Clay
24	104.0	11	SM	15	120		Clay
25	110.0	8	SM	15	120		Clay
26	115.5	10	SM	15	120		Clay
27	121.5	8	SM	15	120		Clay
28	125.5	10	SM	15	120		Clay
29	132.0	9	SM	15	120		Clay
30	137.0	10	SM	15	120		Clay
31	141.5	12	SM	15	120		Clay
32	146.0	10	SM	15	120		Clay
33	150.5	8	SM	15	120		Clay
34	155.0	19	SM	15	120		Clay
35	159.5	10	SM	15	120		Clay
36	164.0	9	SM	15	120		Clay
37	168.5	9	SM	15	120		Clay
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
									IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	0.0	ML	50.0	95.0	Clay	1420	16	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.61	5.61	1.005	14.805
2	2.0	1.0	ML	50.0	95.0	Clay	1563	65	1.39	1.00	0.95	1.00	1.32	1.70	2.24	5.61	7.85	1.002	4.058
3	4.0	0.0	SM	18.1	100.0		1763	140	1.39	1.00	0.95	1.00	0.00	1.70	0.00	4.11	4.11	0.997	2.115
4	6.0	0.0	CL	52.1	95.0	Clay	1953	206	1.39	1.00	1.00	1.00	0.00	1.70	0.00	5.61	5.61	0.991	1.591
5	8.0	0.0	SM	15.3	100.0		2153	281	1.39	1.00	1.00	1.00	0.00	1.70	0.00	3.36	3.36	0.985	1.276
6	14.5	0.0	MH	93.7	95.0	Clay	2770	493	1.39	1.00	1.00	1.00	0.00	1.70	0.00	5.50	5.50	0.962	0.914
7	20.0	0.0	MH	94.0	95.0	Clay	3293	672	1.39	1.00	1.00	1.00	0.00	1.70	0.00	5.50	5.50	0.941	0.779
8	25.5	2.0	SM	15.0	100.0		3843	879	1.39	1.00	1.00	1.00	2.77	1.65	4.57	3.26	7.83	0.917	0.677
9	31.5	7.0	SM	15.0	100.0		4443	1104	1.39	1.00	1.00	1.00	9.70	1.36	13.18	3.26	16.44	0.889	0.604
10	36.0	6.0	ML	50.0	120.0	Clay	4983	1364	1.39	1.00	1.00	1.00	8.31	1.23	10.25	5.61	15.87	0.867	0.535
11	41.5	5.0	ML	50.0	120.0	Clay	5643	1680	1.39	1.00	1.00	1.00	6.93	1.12	7.78	5.61	13.39	0.840	0.477
12	46.5	7.0	ML	50.0	120.0	Clay	6243	1968	1.39	1.00	1.00	1.00	9.70	1.04	10.04	5.61	15.65	0.815	0.437
13	51.5	7.0	ML	50.0	120.0	Clay	6843	2256	1.39	1.00	1.00	1.00	9.70	0.97	9.40	5.61	15.01	0.790	0.405
14	56.5	23.0	SM	15.0	120.0	Clay	7443	2544	1.39	1.00	1.00	1.00	31.86	0.94	29.91	3.26	33.17	0.766	0.379
15	61.0	6.0	SM	45.3	120.0	Clay	7983	2804	1.39	1.00	1.00	1.00	8.31	0.87	7.20	5.61	12.81	0.745	0.359
16	65.5	5.0	SM	15.0	120.0	Clay	8523	3063	1.39	1.00	1.00	1.00	6.93	0.81	5.64	3.26	8.90	0.725	0.341
17	70.5	5.0	SM	15.0	120.0	Clay	9123	3351	1.39	1.00	1.00	1.00	6.93	0.77	5.36	3.26	8.62	0.703	0.324
18	75.0	6.0	SM	15.0	120.0	Clay	9663	3610	1.39	1.00	1.00	1.00	8.31	0.75	6.20	3.26	9.46	0.685	0.310
19	78.0	5.0	SM	15.0	120.0	Clay	10023	3783	1.39	1.00	1.00	1.00	6.93	0.72	4.99	3.26	8.25	0.674	0.302
20	82.5	27.0	SM	15.0	120.0	Clay	10563	4042	1.39	1.00	1.00	1.00	37.40	0.80	29.99	3.26	33.25	0.658	0.291
21	85.0	1.0	SM	15.0	120.0	Clay	10863	4186	1.39	1.00	1.00	1.00	1.39	0.65	0.90	3.26	4.16	0.650	0.285
22	90.0	8.0	SM	15.0	120.0	Clay	11463	4474	1.39	1.00	1.00	1.00	11.08	0.67	7.43	3.26	10.70	0.634	0.275
23	98.5	9.0	SM	15.0	120.0	Clay	12483	4964	1.39	1.00	1.00	1.00	12.47	0.64	7.95	3.26	11.22	0.613	0.261
24	104.0	11.0	SM	15.0	120.0	Clay	13143	5280	1.39	1.00	1.00	1.00	15.24	0.63	9.57	3.26	12.83	0.602	0.253
25	110.0	8.0	SM	15.0	120.0	Clay	13863	5626	1.39	1.00	1.00	1.00	11.08	0.59	6.51	3.26	9.77	0.594	0.247
26	115.5	10.0	SM	15.0	120.0	Clay	14523	5943	1.39	1.00	1.00	1.00	13.85	0.58	8.05	3.26	11.31	0.589	0.243
27	121.5	8.0	SM	15.0	120.0	Clay	15243	6288	1.39	1.00	1.00	1.00	11.08	0.55	6.09	3.26	9.35	0.586	0.240
28	125.5	10.0	SM	15.0	120.0	Clay	15723	6519	1.39	1.00	1.00	1.00	13.85	0.55	7.62	3.26	10.89	0.586	0.239
29	132.0	9.0	SM	15.0	120.0	Clay	16503	6893	1.39	1.00	1.00	1.00	12.47	0.53	6.56	3.26	9.82	0.590	0.239
30	137.0	10.0	SM	15.0	120.0	Clay	17103	7181	1.39	1.00	1.00	1.00	13.85	0.52	7.20	3.26	10.46	0.596	0.240
31	141.5	12.0	SM	15.0	120.0	Clay	17643	7440	1.39	1.00	1.00	1.00	16.62	0.52	8.66	3.26	11.92	0.603	0.242
32	146.0	10.0	SM	15.0	120.0	Clay	18183	7700	1.39	1.00	1.00	1.00	13.85	0.50	6.90	3.26	10.16	0.612	0.244
33	150.5	8.0	SM	15.0	120.0	Clay	18723	7959	1.39	1.00	1.00	1.00	11.08	0.48	5.28	3.26	8.54	0.624	0.248
34	155.0	19.0	SM	15.0	120.0	Clay	19263	8218	1.39	1.00	1.00	1.00	26.32	0.53	14.00	3.26	17.27	0.637	0.252
35	159.5	10.0	SM	15.0	120.0	Clay	19803	8477	1.39	1.00	1.00	1.00	13.85	0.47	6.51	3.26	9.77	0.653	0.258
36	164.0	9.0	SM	15.0	120.0	Clay	20343	8736	1.39	1.00	1.00	1.00	12.47	0.46	5.68	3.26	8.94	0.670	0.264
37	168.5	9.0	SM	15.0	120.0	Clay	20883	8996	1.39	1.00	1.00	1.00	12.47	0.45	5.58	3.26	8.84	0.690	0.271
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.12	1.01	1.10	0.090	0.100	2.00
1.15	1.01	1.10	0.104	0.115	2.00
1.11	1.01	1.10	0.081	0.090	0.04
1.12	1.01	1.10	0.090	0.100	2.00
1.10	1.01	1.10	0.077	0.085	0.07
1.12	1.01	1.10	0.089	0.099	2.00
1.12	1.01	1.09	0.089	0.098	2.00
1.15	1.01	1.07	0.103	0.112	0.17
1.36	1.02	1.08	0.169	0.186	0.31
1.34	1.02	1.05	0.164	0.176	2.00
1.27	1.02	1.02	0.143	0.149	2.00
1.34	1.02	1.01	0.162	0.167	2.00
1.32	1.02	0.99	0.156	0.158	2.00
2.20	1.08	0.96	0.782	0.809	2.00
1.26	1.02	0.97	0.139	0.137	2.00
1.17	1.01	0.97	0.111	0.108	2.00
1.16	1.01	0.96	0.109	0.105	2.00
1.18	1.01	0.95	0.114	0.110	2.00
1.16	1.01	0.95	0.106	0.102	2.00
2.20	1.08	0.85	0.792	0.725	2.00
1.11	1.01	0.95	0.081	0.078	2.00
1.21	1.01	0.93	0.123	0.116	2.00
1.22	1.01	0.92	0.127	0.118	2.00
1.26	1.02	0.91	0.139	0.128	2.00
1.19	1.01	0.91	0.116	0.107	2.00
1.22	1.01	0.90	0.127	0.116	2.00
1.18	1.01	0.90	0.114	0.104	2.00
1.21	1.01	0.89	0.124	0.113	2.00
1.19	1.01	0.89	0.117	0.106	2.00
1.20	1.01	0.89	0.121	0.109	2.00
1.23	1.02	0.88	0.132	0.117	2.00
1.19	1.01	0.88	0.119	0.106	2.00
1.16	1.01	0.88	0.108	0.097	2.00
1.39	1.03	0.84	0.176	0.152	2.00
1.19	1.01	0.87	0.116	0.103	2.00
1.17	1.01	0.87	0.111	0.098	2.00
1.17	1.01	0.87	0.110	0.097	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.000	0.00	9.12
2	1.8	0.000	0.00	9.12
4	2.0	0.057	1.36	9.12
6	2.0	0.000	0.00	7.75
8	4.3	0.061	3.11	7.75
14.5	6.0	0.000	0.00	4.64
20	5.5	0.000	0.00	4.64
25.5	5.8	0.043	2.95	4.64
31.5	5.3	0.027	1.69	1.69
36	5.0	0.000	0.00	0.00
41.5	5.3	0.000	0.00	0.00
46.5	5.0	0.000	0.00	0.00
51.5	5.0	0.000	0.00	0.00
56.5	4.8	0.000	0.00	0.00
61	4.5	0.000	0.00	0.00
65.5	4.8	0.000	0.00	0.00
70.5	4.8	0.000	0.00	0.00
75	3.8	0.000	0.00	0.00
78	3.8	0.000	0.00	0.00
82.5	3.5	0.000	0.00	0.00
85	3.8	0.000	0.00	0.00
90	6.8	0.000	0.00	0.00
98.5	7.0	0.000	0.00	0.00
104	5.8	0.000	0.00	0.00
110	5.8	0.000	0.00	0.00
115.5	5.8	0.000	0.00	0.00
121.5	5.0	0.000	0.00	0.00
125.5	5.3	0.000	0.00	0.00
132	5.8	0.000	0.00	0.00
137	4.8	0.000	0.00	0.00
141.5	4.5	0.000	0.00	0.00
146	4.5	0.000	0.00	0.00
150.5	4.5	0.000	0.00	0.00
155	4.5	0.000	0.00	0.00
159.5	4.5	0.000	0.00	0.00
164	4.5	0.000	0.00	0.00
168.5	3.8	0.000	0.00	0.00
171.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:53 PM
Boring Designation:	B-12
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	-33
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	38
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.29
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	0.5	1	CL	50	95		Clay
2	2.0	4	CL	50	95		Clay
3	4.0	3	SM	24	100		
4	6.0	9	SC	15	100		
5	8.0	4	SP	0	100		
6	12.5	5	SP-SM	10	100		
7	17.5	7	SM	48	120		Clay
8	23.0	8	SM	48	120		Clay
9	28.0	4	SM	48	120		Clay
10	36.5	6	SM	48	120		Clay
11	42.0	9	SM	48	120		Clay
12	47.0	6	SM	47	120		Clay
13	53.0	8	SM	47	120		Clay
14	58.0	12	SM	15	120		Clay
15	63.5	11	SM	50	120		Clay
16	69.0	9	SM	15	120		Clay
17	73.5	12	SM	15	120		Clay
18	77.5	8	SM	15	120		Clay
19	82.5	5	SM	15	120		Clay
20	87.5		SM	15	120		Clay
21	92.5	14	SM	15	120		Clay
22	97.5	12	SM	15	120		Clay
23	102.5	7	SM	15	120		Clay
24	108.0	12	SM	15	120		Clay
25	115.5	8	SM	15	120		Clay
26	118.5	11	SM	15	120		Clay
27	122.5	9	SM	15	120		Clay
28	127.0	19	SM	15	120		Clay
29	132.0	10	SM	15	120		Clay
30	137.0	8	SM	15	120		Clay
31	141.5	20	SM	15	120		Clay
32	147.0		SM	15	120		Clay
33	152.5	12	SM	15	120		Clay
34	157.5	8	SM	15	120		Clay
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
									IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	1.0	CL	50.0	95.0	Clay	2107	16	1.39	1.00	1.00	1.00	1.39	1.70	2.35	5.61	7.97	1.005	24.495
2	2.0	4.0	CL	50.0	95.0	Clay	2249	65	1.39	1.00	1.00	1.00	5.54	1.70	9.42	5.61	15.03	1.002	6.514
3	4.0	3.0	SM	23.8	100.0		2449	140	1.39	1.00	1.00	1.00	4.16	1.70	7.06	4.97	12.03	0.997	3.277
4	6.0	9.0	SC	15.0	100.0		2649	216	1.39	1.00	1.00	1.00	12.47	1.70	21.19	3.26	24.45	0.991	2.295
5	8.0	4.0	SP	0.0	100.0		2849	291	1.39	1.00	1.00	1.00	5.54	1.70	9.42	0.00	9.42	0.985	1.819
6	12.5	5.0	SP-SM	10.4	100.0		3299	460	1.39	1.00	1.00	1.00	6.93	1.70	11.77	1.33	13.11	0.970	1.311
7	17.5	7.0	SM	48.0	120.0	Clay	3899	748	1.39	1.00	1.00	1.00	9.70	1.57	15.22	5.61	20.83	0.951	0.934
8	23.0	8.0	SM	48.0	120.0	Clay	4559	1065	1.39	1.00	1.00	1.00	11.08	1.35	14.95	5.61	20.56	0.928	0.749
9	28.0	4.0	SM	48.0	120.0	Clay	5159	1353	1.39	1.00	1.00	1.00	5.54	1.26	6.96	5.61	12.58	0.905	0.651
10	36.5	6.0	SM	48.0	120.0	Clay	6179	1842	1.39	1.00	1.00	1.00	8.31	1.07	8.90	5.61	14.51	0.865	0.547
11	42.0	9.0	SM	48.0	120.0	Clay	6839	2159	1.39	1.00	1.00	1.00	12.47	0.99	12.35	5.61	17.96	0.837	0.500
12	47.0	6.0	SM	46.6	120.0	Clay	7439	2447	1.39	1.00	1.00	1.00	8.31	0.93	7.72	5.61	13.33	0.813	0.466
13	53.0	8.0	SM	47.0	120.0	Clay	8159	2793	1.39	1.00	1.00	1.00	11.08	0.87	9.69	5.61	15.30	0.783	0.431
14	58.0	12.0	SM	15.0	120.0	Clay	8759	3081	1.39	1.00	1.00	1.00	16.62	0.84	13.95	3.26	17.22	0.759	0.407
15	63.5	11.0	SM	49.7	120.0	Clay	9419	3398	1.39	1.00	1.00	1.00	15.24	0.80	12.26	5.61	17.87	0.734	0.383
16	69.0	9.0	SM	15.0	120.0	Clay	10079	3714	1.39	1.00	1.00	1.00	12.47	0.75	9.35	3.26	12.61	0.710	0.363
17	73.5	12.0	SM	15.0	120.0	Clay	10619	3974	1.39	1.00	1.00	1.00	16.62	0.74	12.27	3.26	15.53	0.691	0.348
18	77.5	8.0	SM	15.0	120.0	Clay	11099	4204	1.39	1.00	1.00	1.00	11.08	0.70	7.70	3.26	10.96	0.676	0.336
19	82.5	5.0	SM	15.0	120.0	Clay	11699	4492	1.39	1.00	1.00	1.00	6.93	0.65	4.51	3.26	7.77	0.658	0.323
20	87.5	0.0	SM	15.0	120.0	Clay	12299	4780	1.39	1.00	1.00	1.00	0.00	0.59	0.00	3.26	3.26	0.642	0.311
21	92.5	14.0	SM	15.0	120.0	Clay	12899	5068	1.39	1.00	1.00	1.00	19.39	0.66	12.79	3.26	16.05	0.628	0.301
22	97.5	12.0	SM	15.0	120.0	Clay	13499	5356	1.39	1.00	1.00	1.00	16.62	0.63	10.45	3.26	13.71	0.615	0.292
23	102.5	7.0	SM	15.0	120.0	Clay	14099	5644	1.39	1.00	1.00	1.00	9.70	0.58	5.62	3.26	8.89	0.605	0.285
24	108.0	12.0	SM	15.0	120.0	Clay	14759	5961	1.39	1.00	1.00	1.00	16.62	0.59	9.84	3.26	13.10	0.596	0.278
25	115.5	8.0	SM	15.0	120.0	Clay	15659	6393	1.39	1.00	1.00	1.00	11.08	0.54	6.03	3.26	9.29	0.589	0.272
26	118.5	11.0	SM	15.0	120.0	Clay	16019	6566	1.39	1.00	1.00	1.00	15.24	0.55	8.44	3.26	11.70	0.587	0.270
27	122.5	9.0	SM	15.0	120.0	Clay	16499	6796	1.39	1.00	1.00	1.00	12.47	0.53	6.62	3.26	9.88	0.586	0.268
28	127.0	19.0	SM	15.0	120.0	Clay	17039	7055	1.39	1.00	1.00	1.00	26.32	0.58	15.24	3.26	18.50	0.587	0.267
29	132.0	10.0	SM	15.0	120.0	Clay	17639	7343	1.39	1.00	1.00	1.00	13.85	0.51	7.10	3.26	10.36	0.590	0.267
30	137.0	8.0	SM	15.0	120.0	Clay	18239	7631	1.39	1.00	1.00	1.00	11.08	0.49	5.42	3.26	8.68	0.596	0.268
31	141.5	20.0	SM	15.0	120.0	Clay	18779	7890	1.39	1.00	1.00	1.00	27.70	0.55	15.25	3.26	18.51	0.603	0.270
32	147.0	0.0	SM	15.0	120.0	Clay	19439	8207	1.39	1.00	1.00	1.00	0.00	0.42	0.00	3.26	3.26	0.615	0.274
33	152.5	12.0	SM	15.0	120.0	Clay	20099	8524	1.39	1.00	1.00	1.00	16.62	0.48	7.98	3.26	11.24	0.629	0.280
34	157.5	8.0	SM	15.0	120.0	Clay	20699	8812	1.39	1.00	1.00	1.00	11.08	0.45	4.96	3.26	8.22	0.645	0.286
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.15	1.01	1.10	0.104	0.116	2.00
1.32	1.02	1.10	0.156	0.176	2.00
1.24	1.02	1.10	0.133	0.148	0.05
1.69	1.05	1.10	0.278	0.320	0.14
1.18	1.01	1.10	0.114	0.127	0.07
1.26	1.02	1.10	0.141	0.158	0.12
1.53	1.04	1.10	0.216	0.247	2.00
1.52	1.04	1.09	0.213	0.241	2.00
1.25	1.02	1.05	0.137	0.145	2.00
1.30	1.02	1.02	0.152	0.157	2.00
1.42	1.03	1.00	0.183	0.188	2.00
1.27	1.02	0.98	0.143	0.143	2.00
1.33	1.02	0.97	0.159	0.157	2.00
1.39	1.03	0.95	0.176	0.172	2.00
1.41	1.03	0.94	0.182	0.177	2.00
1.25	1.02	0.94	0.137	0.131	2.00
1.33	1.02	0.93	0.161	0.153	2.00
1.21	1.01	0.93	0.125	0.118	2.00
1.15	1.01	0.94	0.103	0.098	2.00
1.10	1.01	0.94	0.077	0.073	2.00
1.35	1.02	0.90	0.165	0.152	2.00
1.28	1.02	0.90	0.146	0.134	2.00
1.17	1.01	0.91	0.110	0.102	2.00
1.26	1.02	0.89	0.141	0.128	2.00
1.18	1.01	0.90	0.113	0.103	2.00
1.23	1.02	0.89	0.130	0.118	2.00
1.19	1.01	0.89	0.117	0.106	2.00
1.43	1.03	0.85	0.189	0.165	2.00
1.20	1.01	0.88	0.121	0.108	2.00
1.17	1.01	0.89	0.109	0.098	2.00
1.44	1.03	0.83	0.189	0.162	2.00
1.10	1.01	0.91	0.077	0.070	2.00
1.22	1.01	0.87	0.127	0.111	2.00
1.16	1.01	0.88	0.106	0.094	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.000	0.00	4.57
2	1.8	0.000	0.00	4.57
4	2.0	0.033	0.80	4.57
6	2.0	0.019	0.46	3.77
8	3.3	0.039	1.51	3.31
12.5	4.8	0.032	1.80	1.80
17.5	5.3	0.000	0.00	0.00
23	5.3	0.000	0.00	0.00
28	6.8	0.000	0.00	0.00
36.5	7.0	0.000	0.00	0.00
42	5.3	0.000	0.00	0.00
47	5.5	0.000	0.00	0.00
53	5.5	0.000	0.00	0.00
58	5.3	0.000	0.00	0.00
63.5	5.5	0.000	0.00	0.00
69	5.0	0.000	0.00	0.00
73.5	4.3	0.000	0.00	0.00
77.5	4.5	0.000	0.00	0.00
82.5	5.0	0.000	0.00	0.00
87.5	5.0	0.000	0.00	0.00
92.5	5.0	0.000	0.00	0.00
97.5	5.0	0.000	0.00	0.00
102.5	5.3	0.000	0.00	0.00
108	6.5	0.000	0.00	0.00
115.5	5.3	0.000	0.00	0.00
118.5	3.5	0.000	0.00	0.00
122.5	4.3	0.000	0.00	0.00
127	4.8	0.000	0.00	0.00
132	5.0	0.000	0.00	0.00
137	4.8	0.000	0.00	0.00
141.5	5.0	0.000	0.00	0.00
147	5.5	0.000	0.00	0.00
152.5	5.3	0.000	0.00	0.00
157.5	4.0	0.000	0.00	0.00
160.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:54 PM
Boring Designation:	B-13
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	-28
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	33
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.29
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"	
1	0.5	1	SM	23	100			
2	2.0	3	SM	23	100			
3	4.0	3	SM	23	100			
4	6.0	3	SM	23	100			
5	8.0	1	SC	15	100			
6	14.5	1	CL	64	95		Clay	
7	19.5	0	CL	64	95		Clay	
8	24.5	2	ML	65	95			
9	30.0	6	SC	44	120		Clay	*Assumes Marl/Limestone NonLiq
10	35.5	4	SC	44	120		Clay	
11	41.0	6	SC	44	120		Clay	
12	48.5	6	ML	50	120		Clay	
13	53.5	7	ML	50	120		Clay	
14	58.5	4	ML	50	120		Clay	
15	62.5	23	ML	50	120		Clay	
16	66.5	7	ML	50	120		Clay	
17	71.5	7	ML	50	120		Clay	
18	76.0	10	ML	50	120		Clay	
19	81.0	6	ML	50	120		Clay	
20	88.5	6	ML	50	120		Clay	
21	93.5	12	ML	50	120		Clay	
22	99.0	11	ML	50	120		Clay	
23	104.5	7	ML	50	120		Clay	
24	110.0	9	ML	50	120		Clay	
25	118.0	8	ML	50	120		Clay	
26	120.0	8	ML	50	120		Clay	
27	124.5	7	ML	50	120		Clay	
28	129.0	8	ML	50	120		Clay	
29	134.0	10	ML	50	120		Clay	
30	138.5	9	ML	50	120		Clay	
31	144.0	12	ML	50	120		Clay	
32	149.5	7	ML	50	120		Clay	
33	155.5	13	ML	50	120		Clay	
34	161.0	17	ML	50	120		Clay	
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								
46								
47								
48								
49								
50								

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR	MS
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB (MSFmax)
1	0.5	1.0	SM	23.0	100.0		1797	19	1.39	1.00	1.00	1.00	1.39	1.70	2.35	4.88	7.24	1.005	18.117	1.14
2	2.0	3.0	SM	23.0	100.0		1947	75	1.39	1.00	1.00	1.00	4.16	1.70	7.06	4.88	11.95	1.002	4.890	1.23
3	4.0	3.0	SM	22.8	100.0		2147	150	1.39	1.00	1.00	1.00	4.16	1.70	7.06	4.86	11.93	0.997	2.682	1.23
4	6.0	3.0	SM	23.0	100.0		2347	226	1.39	1.00	1.00	1.00	4.16	1.70	7.06	4.88	11.95	0.991	1.943	1.23
5	8.0	1.0	SC	15.0	100.0		2547	301	1.39	1.00	1.00	1.00	1.39	1.70	2.35	3.26	5.62	0.985	1.572	1.12
6	14.5	1.0	CL	64.2	95.0	Clay	3165	513	1.39	1.00	1.00	1.00	1.39	1.70	2.35	5.59	7.95	0.962	1.120	1.15
7	19.5	0.0	CL	64.0	95.0	Clay	3640	676	1.39	1.00	1.00	1.00	0.00	1.70	0.00	5.59	5.59	0.943	0.957	1.12
8	24.5	2.0	ML	65.3	95.0		4115	839	1.39	1.00	1.00	1.00	2.77	1.65	4.56	5.59	10.15	0.921	0.852	1.19
9	30.0	6.0	SC	44.0	120.0	Clay	4775	1156	1.39	1.00	1.00	1.00	8.31	1.33	11.05	5.60	16.65	0.896	0.698	1.37
10	35.5	4.0	SC	43.9	120.0	Clay	5435	1472	1.39	1.00	1.00	1.00	5.54	1.21	6.68	5.60	12.28	0.869	0.605	1.24
11	41.0	6.0	SC	44.0	120.0	Clay	6095	1789	1.39	1.00	1.00	1.00	8.31	1.09	9.02	5.60	14.62	0.842	0.541	1.31
12	48.5	6.0	ML	50.0	120.0	Clay	6995	2221	1.39	1.00	1.00	1.00	8.31	0.98	8.11	5.61	13.73	0.805	0.478	1.28
13	53.5	7.0	ML	50.0	120.0	Clay	7595	2509	1.39	1.00	1.00	1.00	9.70	0.92	8.92	5.61	14.53	0.781	0.445	1.30
14	58.5	4.0	ML	50.0	120.0	Clay	8195	2797	1.39	1.00	1.00	1.00	5.54	0.86	4.77	5.61	10.38	0.757	0.418	1.20
15	62.5	23.0	ML	50.0	120.0	Clay	8675	3028	1.39	1.00	1.00	1.00	31.86	0.89	28.23	5.61	33.85	0.738	0.399	2.20
16	66.5	7.0	ML	50.0	120.0	Clay	9155	3258	1.39	1.00	1.00	1.00	9.70	0.80	7.80	5.61	13.42	0.720	0.382	1.27
17	71.5	7.0	ML	50.2	120.0	Clay	9755	3546	1.39	1.00	1.00	1.00	9.70	0.77	7.47	5.61	13.08	0.699	0.363	1.26
18	76.0	10.0	ML	50.0	120.0	Clay	10295	3805	1.39	1.00	1.00	1.00	13.85	0.76	10.48	5.61	16.09	0.681	0.347	1.35
19	81.0	6.0	ML	50.0	120.0	Clay	10895	4093	1.39	1.00	1.00	1.00	8.31	0.71	5.88	5.61	11.50	0.663	0.333	1.22
20	88.5	6.0	ML	50.0	120.0	Clay	11795	4525	1.39	1.00	1.00	1.00	8.31	0.67	5.57	5.61	11.18	0.639	0.314	1.22
21	93.5	12.0	ML	50.0	120.0	Clay	12395	4813	1.39	1.00	1.00	1.00	16.62	0.68	11.31	5.61	16.93	0.625	0.303	1.38
22	99.0	11.0	ML	50.0	120.0	Clay	13055	5130	1.39	1.00	1.00	1.00	15.24	0.65	9.95	5.61	15.57	0.612	0.294	1.33
23	104.5	7.0	ML	50.0	120.0	Clay	13715	5447	1.39	1.00	1.00	1.00	9.70	0.61	5.91	5.61	11.53	0.602	0.286	1.22
24	110.0	9.0	ML	50.0	120.0	Clay	14375	5764	1.39	1.00	1.00	1.00	12.47	0.60	7.51	5.61	13.12	0.594	0.279	1.26
25	118.0	8.0	ML	50.0	120.0	Clay	15335	6224	1.39	1.00	1.00	1.00	11.08	0.57	6.33	5.61	11.95	0.587	0.273	1.23
26	120.0	8.0	ML	50.0	120.0	Clay	15575	6340	1.39	1.00	1.00	1.00	11.08	0.57	6.27	5.61	11.88	0.587	0.272	1.23
27	124.5	7.0	ML	50.0	120.0	Clay	16115	6599	1.39	1.00	1.00	1.00	9.70	0.55	5.30	5.61	10.92	0.586	0.270	1.21
28	129.0	8.0	ML	50.0	120.0	Clay	16655	6858	1.39	1.00	1.00	1.00	11.08	0.54	6.00	5.61	11.61	0.588	0.269	1.23
29	134.0	10.0	ML	50.0	120.0	Clay	17255	7146	1.39	1.00	1.00	1.00	13.85	0.54	7.48	5.61	13.10	0.592	0.269	1.26
30	138.5	9.0	ML	50.0	120.0	Clay	17795	7405	1.39	1.00	1.00	1.00	12.47	0.52	6.53	5.61	12.14	0.598	0.271	1.24
31	144.0	12.0	ML	50.0	120.0	Clay	18455	7722	1.39	1.00	1.00	1.00	16.62	0.53	8.78	5.61	14.40	0.608	0.274	1.30
32	149.5	7.0	ML	50.0	120.0	Clay	19115	8039	1.39	1.00	1.00	1.00	9.70	0.49	4.73	5.61	10.35	0.621	0.278	1.20
33	155.5	13.0	ML	50.0	120.0	Clay	19835	8384	1.39	1.00	1.00	1.00	18.01	0.51	9.19	5.61	14.80	0.639	0.285	1.31
34	161.0	17.0	ML	50.0	120.0	Clay	20495	8701	1.39	1.00	1.00	1.00	23.55	0.52	12.31	5.61	17.92	0.658	0.292	1.41
35																				
36																				
37																				
38																				
39																				
40																				
41																				
42																				
43																				
44																				
45																				
46																				
47																				
48																				
49																				
50																				

ıF	Ksig	CRR	Corrected CRR	Factor of Safety
IB	IB	IB	IB	IB
1.01	1.10	0.100	0.111	0.01
1.02	1.10	0.132	0.148	0.03
1.02	1.10	0.132	0.147	0.05
1.02	1.10	0.132	0.148	0.08
1.01	1.10	0.090	0.100	0.06
1.01	1.10	0.104	0.116	2.00
1.01	1.09	0.090	0.098	2.00
1.01	1.09	0.119	0.131	0.15
1.03	1.07	0.171	0.187	2.00
1.02	1.04	0.135	0.142	2.00
1.02	1.02	0.153	0.159	2.00
1.02	0.99	0.146	0.148	2.00
1.02	0.98	0.152	0.152	2.00
1.01	0.97	0.121	0.119	2.00
1.08	0.91	0.883	0.871	2.00
1.02	0.95	0.143	0.139	2.00
1.02	0.95	0.141	0.136	2.00
1.02	0.93	0.166	0.158	2.00
1.02	0.94	0.129	0.122	2.00
1.01	0.93	0.126	0.119	2.00
1.03	0.90	0.173	0.160	2.00
1.02	0.90	0.161	0.148	2.00
1.02	0.91	0.129	0.119	2.00
1.02	0.90	0.141	0.129	2.00
1.02	0.89	0.132	0.120	2.00
1.02	0.89	0.132	0.119	2.00
1.01	0.89	0.125	0.113	2.00
1.02	0.88	0.130	0.116	2.00
1.02	0.87	0.141	0.125	2.00
1.02	0.87	0.134	0.119	2.00
1.02	0.86	0.151	0.133	2.00
1.01	0.88	0.121	0.107	2.00
1.02	0.85	0.154	0.134	2.00
1.03	0.83	0.183	0.155	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.044	0.67	7.87
2	1.8	0.034	0.70	7.20
4	2.0	0.034	0.81	6.50
6	2.0	0.034	0.80	5.69
8	4.3	0.050	2.55	4.89
14.5	5.8	0.000	0.00	2.33
19.5	5.0	0.000	0.00	2.33
24.5	5.3	0.037	2.33	2.33
30	5.5	0.000	0.00	0.00
35.5	5.5	0.000	0.00	0.00
41	6.5	0.000	0.00	0.00
48.5	6.3	0.000	0.00	0.00
53.5	5.0	0.000	0.00	0.00
58.5	4.5	0.000	0.00	0.00
62.5	4.0	0.000	0.00	0.00
66.5	4.5	0.000	0.00	0.00
71.5	4.8	0.000	0.00	0.00
76	4.8	0.000	0.00	0.00
81	6.3	0.000	0.00	0.00
88.5	6.3	0.000	0.00	0.00
93.5	5.3	0.000	0.00	0.00
99	5.5	0.000	0.00	0.00
104.5	5.5	0.000	0.00	0.00
110	6.8	0.000	0.00	0.00
118	5.0	0.000	0.00	0.00
120	3.3	0.000	0.00	0.00
124.5	4.5	0.000	0.00	0.00
129	4.8	0.000	0.00	0.00
134	4.8	0.000	0.00	0.00
138.5	5.0	0.000	0.00	0.00
144	5.5	0.000	0.00	0.00
149.5	5.8	0.000	0.00	0.00
155.5	5.8	0.000	0.00	0.00
161	4.3	0.000	0.00	0.00
164				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:58 PM
Boring Designation:	B-14
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.29
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	0.5	1	SM	14	100		
2	2.0	2	SM	14	100		
3	4.0	4	SM	14	100		
4	6.0	25	SM	14	120		
5	8.0	3	SM	14	100		
6	13.5	16	SM	14	120		
7	18.5	5	SM	14	100		
8	23.5	9	SM	18	100		
9	28.5	2	SM	44	100		
10	33.5	4	ML	52	95		Clay
11	38.5	2	ML	52	95		Clay
12	43.5	2	ML	52	95		Clay
13	48.5	4	SM	30	100		
14	53.5	9	ML	50	120		Clay
15	58.5	4	ML	50	120		Clay
16	63.0	7	ML	50	120		Clay
17	68.0	7	ML	50	120		Clay
18	72.5	7	ML	50	120		Clay
19	77.5	13	SC	15	120		Clay
20	83.5	9	SC	15	120		Clay
21	88.5	5	SC	15	120		Clay
22	93.5	26	SC	15	120		Clay
23	98.5	8	ML	50	120		Clay
24	104.0	4	ML	50	120		Clay
25	108.5	5	ML	50	120		Clay
26	113.5	6	ML	50	120		Clay
27	118.5	9	ML	50	120		Clay
28	123.5	8	SM	15	120		Clay
29	128.5	6	SM	15	120		Clay
30	133.0	5	SM	15	120		Clay
31	138.0	11	SM	15	120		Clay
32	142.5	9	SM	15	120		Clay
33	148.5	8	SM	15	120		Clay
34	153.5	9	SM	15	120		Clay
35	158.5	9	SM	15	120		Clay
36	163.5	7	SM	15	120		Clay
37	168.5	8	SM	15	120		Clay
38	173.5	8	SM	15	120		Clay
39	178.5	6	SM	15	120		Clay
40	183.5	8	SM	15	120		Clay
41	188.5	6	SM	15	120		Clay
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	1.0	SM	14.0	100.0		50	19	1.39	1.00	0.75	1.00	1.04	1.70	1.77	2.91	4.67	1.005	0.504
2	2.0	2.0	SM	14.0	100.0		200	75	1.39	1.00	0.75	1.00	2.08	1.70	3.53	2.91	6.44	1.002	0.502
3	4.0	4.0	SM	14.0	100.0		400	150	1.39	1.00	0.75	1.00	4.16	1.70	7.06	2.91	9.97	0.997	0.500
4	6.0	25.0	SM	14.0	120.0		640	266	1.39	1.00	0.80	1.00	27.70	1.70	47.09	2.91	50.00	0.991	0.450
5	8.0	3.0	SM	13.8	100.0		840	341	1.39	1.00	0.80	1.00	3.32	1.70	5.65	2.83	8.48	0.985	0.458
6	13.5	16.0	SM	14.0	120.0		1500	658	1.39	1.00	0.85	1.00	18.84	1.51	28.48	2.91	31.39	0.966	0.415
7	18.5	5.0	SM	14.0	100.0		2000	846	1.39	1.00	0.95	1.00	6.58	1.59	10.44	2.91	13.35	0.947	0.422
8	23.5	9.0	SM	17.6	100.0		2500	1034	1.39	1.00	0.95	1.00	11.84	1.37	16.22	4.00	20.21	0.926	0.422
9	28.5	2.0	SM	43.7	100.0		3000	1222	1.39	1.00	1.00	1.00	2.77	1.35	3.75	5.60	9.35	0.903	0.418
10	33.5	4.0	ML	52.0	95.0	Clay	3475	1385	1.39	1.00	1.00	1.00	5.54	1.24	6.88	5.61	12.50	0.879	0.416
11	38.5	2.0	ML	52.0	95.0	Clay	3950	1548	1.39	1.00	1.00	1.00	2.77	1.19	3.29	5.61	8.91	0.855	0.411
12	43.5	2.0	ML	52.0	95.0	Clay	4425	1711	1.39	1.00	1.00	1.00	2.77	1.13	3.12	5.61	8.73	0.830	0.405
13	48.5	4.0	SM	30.1	100.0		4925	1899	1.39	1.00	1.00	1.00	5.54	1.06	5.87	5.37	11.23	0.805	0.394
14	53.5	9.0	ML	50.0	120.0	Clay	5525	2187	1.39	1.00	1.00	1.00	12.47	0.99	12.28	5.61	17.89	0.781	0.372
15	58.5	4.0	ML	50.0	120.0	Clay	6125	2475	1.39	1.00	1.00	1.00	5.54	0.92	5.10	5.61	10.71	0.757	0.353
16	63.0	7.0	ML	50.0	120.0	Clay	6665	2734	1.39	1.00	1.00	1.00	9.70	0.88	8.54	5.61	14.16	0.736	0.338
17	68.0	7.0	ML	50.0	120.0	Clay	7265	3022	1.39	1.00	1.00	1.00	9.70	0.84	8.11	5.61	13.73	0.714	0.324
18	72.5	7.0	ML	50.0	120.0	Clay	7805	3281	1.39	1.00	1.00	1.00	9.70	0.80	7.78	5.61	13.39	0.695	0.312
19	77.5	13.0	SC	15.0	120.0	Clay	8405	3569	1.39	1.00	1.00	1.00	18.01	0.78	14.13	3.26	17.39	0.676	0.300
20	83.5	9.0	SC	15.0	120.0	Clay	9125	3915	1.39	1.00	1.00	1.00	12.47	0.73	9.09	3.26	12.35	0.654	0.288
21	88.5	5.0	SC	15.0	120.0	Clay	9725	4203	1.39	1.00	1.00	1.00	6.93	0.68	4.69	3.26	7.95	0.639	0.279
22	93.5	26.0	SC	15.0	120.0	Clay	10325	4491	1.39	1.00	1.00	1.00	36.01	0.76	27.51	3.26	30.77	0.625	0.271
23	98.5	8.0	ML	50.0	120.0	Clay	10925	4779	1.39	1.00	1.00	1.00	11.08	0.66	7.33	5.61	12.94	0.613	0.264
24	104.0	4.0	ML	50.0	120.0	Clay	11585	5095	1.39	1.00	1.00	1.00	5.54	0.61	3.41	5.61	9.02	0.602	0.258
25	108.5	5.0	ML	50.0	120.0	Clay	12125	5355	1.39	1.00	1.00	1.00	6.93	0.60	4.18	5.61	9.80	0.596	0.254
26	113.5	6.0	ML	50.0	120.0	Clay	12725	5643	1.39	1.00	1.00	1.00	8.31	0.59	4.92	5.61	10.53	0.590	0.251
27	118.5	9.0	ML	50.0	120.0	Clay	13325	5931	1.39	1.00	1.00	1.00	12.47	0.59	7.39	5.61	13.01	0.587	0.249
28	123.5	8.0	SM	15.0	120.0	Clay	13925	6219	1.39	1.00	1.00	1.00	11.08	0.55	6.13	3.26	9.39	0.586	0.247
29	128.5	6.0	SM	15.0	120.0	Clay	14525	6507	1.39	1.00	1.00	1.00	8.31	0.53	4.37	3.26	7.63	0.588	0.247
30	133.0	5.0	SM	15.0	120.0	Clay	15065	6766	1.39	1.00	1.00	1.00	6.93	0.51	3.51	3.26	6.77	0.591	0.248
31	138.0	11.0	SM	15.0	120.0	Clay	15665	7054	1.39	1.00	1.00	1.00	15.24	0.53	8.10	3.26	11.36	0.597	0.250
32	142.5	9.0	SM	15.0	120.0	Clay	16205	7313	1.39	1.00	1.00	1.00	12.47	0.51	6.33	3.26	9.59	0.605	0.253
33	148.5	8.0	SM	15.0	120.0	Clay	16925	7659	1.39	1.00	1.00	1.00	11.08	0.49	5.41	3.26	8.67	0.618	0.258
34	153.5	9.0	SM	15.0	120.0	Clay	17525	7947	1.39	1.00	1.00	1.00	12.47	0.48	6.02	3.26	9.28	0.632	0.263
35	158.5	9.0	SM	15.0	120.0	Clay	18125	8235	1.39	1.00	1.00	1.00	12.47	0.47	5.89	3.26	9.15	0.649	0.269
36	163.5	7.0	SM	15.0	120.0	Clay	18725	8523	1.39	1.00	1.00	1.00	9.70	0.45	4.37	3.26	7.63	0.668	0.277
37	168.5	8.0	SM	15.0	120.0	Clay	19325	8811	1.39	1.00	1.00	1.00	11.08	0.45	4.96	3.26	8.22	0.690	0.285
38	173.5	8.0	SM	15.0	120.0	Clay	19925	9099	1.39	1.00	1.00	1.00	11.08	0.44	4.86	3.26	8.12	0.715	0.295
39	178.5	6.0	SM	15.0	120.0	Clay	20525	9387	1.39	1.00	1.00	1.00	8.31	0.42	3.48	3.26	6.74	0.741	0.306
40	183.5	8.0	SM	15.0	120.0	Clay	21125	9675	1.39	1.00	1.00	1.00	11.08	0.42	4.68	3.26	7.94	0.771	0.317
41	188.5	6.0	SM	15.0	120.0	Clay	21725	9963	1.39	1.00	1.00	1.00	8.31	0.40	3.35	3.26	6.61	0.802	0.330
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.11	1.01	1.10	0.084	0.093	0.19
1.13	1.01	1.10	0.095	0.105	0.21
1.19	1.01	1.10	0.118	0.131	0.26
2.20	1.08	1.10	2.000	2.000	2.00
1.16	1.01	1.10	0.108	0.120	0.26
2.08	1.07	1.10	0.587	0.693	1.67
1.27	1.02	1.10	0.143	0.159	0.38
1.50	1.03	1.10	0.208	0.236	0.56
1.18	1.01	1.05	0.114	0.121	0.29
1.25	1.02	1.04	0.136	0.144	2.00
1.17	1.01	1.03	0.111	0.115	2.00
1.17	1.01	1.02	0.109	0.113	2.00
1.22	1.01	1.01	0.127	0.130	0.33
1.41	1.03	1.00	0.183	0.187	2.00
1.21	1.01	0.99	0.123	0.123	2.00
1.29	1.02	0.97	0.149	0.148	2.00
1.28	1.02	0.96	0.146	0.143	2.00
1.27	1.02	0.95	0.143	0.139	2.00
1.39	1.03	0.94	0.178	0.171	2.00
1.24	1.02	0.94	0.135	0.129	2.00
1.15	1.01	0.94	0.104	0.099	2.00
2.04	1.07	0.84	0.537	0.484	2.00
1.26	1.02	0.92	0.140	0.130	2.00
1.17	1.01	0.92	0.111	0.104	2.00
1.19	1.01	0.91	0.117	0.108	2.00
1.20	1.01	0.91	0.122	0.112	2.00
1.26	1.02	0.89	0.140	0.127	2.00
1.18	1.01	0.90	0.114	0.104	2.00
1.15	1.01	0.91	0.102	0.093	2.00
1.14	1.01	0.91	0.097	0.088	2.00
1.22	1.01	0.88	0.128	0.114	2.00
1.18	1.01	0.89	0.115	0.104	2.00
1.17	1.01	0.89	0.109	0.098	2.00
1.18	1.01	0.88	0.113	0.101	2.00
1.17	1.01	0.88	0.112	0.100	2.00
1.15	1.01	0.88	0.102	0.091	2.00
1.16	1.01	0.88	0.106	0.094	2.00
1.16	1.01	0.87	0.105	0.093	2.00
1.14	1.01	0.88	0.097	0.086	2.00
1.15	1.01	0.87	0.104	0.092	2.00
1.13	1.01	0.87	0.096	0.085	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.054	0.81	12.29
2	1.8	0.047	0.99	11.48
4	2.0	0.037	0.90	10.49
6	2.0	0.000	0.00	9.59
8	3.8	0.041	1.84	9.59
13.5	5.3	0.001	0.09	7.75
18.5	5.0	0.031	1.87	7.66
23.5	5.0	0.023	1.37	5.79
28.5	5.0	0.039	2.33	4.42
33.5	5.0	0.000	0.00	2.09
38.5	5.0	0.000	0.00	2.09
43.5	5.0	0.000	0.00	2.09
48.5	5.0	0.035	2.09	2.09
53.5	5.0	0.000	0.00	0.00
58.5	4.8	0.000	0.00	0.00
63	4.8	0.000	0.00	0.00
68	4.8	0.000	0.00	0.00
72.5	4.8	0.000	0.00	0.00
77.5	5.5	0.000	0.00	0.00
83.5	5.5	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.3	0.000	0.00	0.00
104	5.0	0.000	0.00	0.00
108.5	4.8	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	5.0	0.000	0.00	0.00
128.5	4.8	0.000	0.00	0.00
133	4.8	0.000	0.00	0.00
138	4.8	0.000	0.00	0.00
142.5	5.3	0.000	0.00	0.00
148.5	5.5	0.000	0.00	0.00
153.5	5.0	0.000	0.00	0.00
158.5	5.0	0.000	0.00	0.00
163.5	5.0	0.000	0.00	0.00
168.5	5.0	0.000	0.00	0.00
173.5	5.0	0.000	0.00	0.00
178.5	5.0	0.000	0.00	0.00
183.5	5.0	0.000	0.00	0.00
188.5	4.0	0.000	0.00	0.00
191.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:58 PM
Boring Designation:	B-15
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.29
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	0.5	0	SP-SM	5	100		
2	2.0	2	SP-SM	5	100		
3	4.0	16	SP-SM	8	120		
4	6.0	17	SP-SM	5	120		
5	8.0	14	SP-SM	5	120		
6	13.5	25	SP-SM	6	120		
7	18.5	7	SM	18	100		
8	23.5	7	SM	18	100		
9	28.5	4	SM	18	100		
10	33.5	4	SM	18	100		
11	38.5	0	CL	50	95		Clay
12	43.5	0	SM	21	100		
13	48.5	9	SM	21	100		
14	53.5	14	SM	21	100		
15	58.5	2	SM	21	100		
16	63.5	6	SM	21	100		
17	68.5	8	SM	15	120		Clay
18	73.5	10	SM	15	120		Clay
19	78.5	23	SM	15	120		Clay
20	83.5	9	SM	15	120		Clay
21	88.5	27	SM	15	120		Clay
22	93.5	17	SM	15	120		Clay
23	98.5	8	SM	15	120		Clay
24	103.5	16	SM	15	120		Clay
25	108.5	10	SM	15	120		Clay
26	113.5	5	SM	15	120		Clay
27	118.5	6	SM	15	120		Clay
28	123.5	5	SM	15	120		Clay
29	128.5	7	SM	15	120		Clay
30	133.5	8	SM	15	120		Clay
31	138.5	8	SM	15	120		Clay
32	143.5	9	ML	50	120		Clay
33	148.5	12	SM	15	120		Clay
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	0.0	SP-SM	5.0	100.0		50	19	1.39	1.00	0.75	1.00	0.00	1.70	0.00	0.00	0.00	1.005	0.504
2	2.0	2.0	SP-SM	5.0	100.0		200	75	1.39	1.00	0.75	1.00	2.08	1.70	3.53	0.00	3.53	1.002	0.502
3	4.0	16.0	SP-SM	8.2	120.0		440	190	1.39	1.00	0.75	1.00	16.62	1.70	28.25	0.43	28.68	0.997	0.434
4	6.0	17.0	SP-SM	5.1	120.0		680	306	1.39	1.00	0.80	1.00	18.84	1.70	32.02	0.00	32.02	0.991	0.416
5	8.0	14.0	SP-SM	5.0	120.0		920	421	1.39	1.00	0.80	1.00	15.51	1.70	26.37	0.00	26.37	0.985	0.406
6	13.5	25.0	SP-SM	5.5	120.0		1580	738	1.39	1.00	0.85	1.00	29.43	1.37	40.24	0.01	40.25	0.966	0.390
7	18.5	7.0	SM	17.5	100.0		2080	926	1.39	1.00	0.95	1.00	9.21	1.47	13.51	3.97	17.48	0.947	0.401
8	23.5	7.0	SM	18.0	100.0		2580	1114	1.39	1.00	0.95	1.00	9.21	1.35	12.47	4.09	16.56	0.926	0.404
9	28.5	4.0	SM	18.0	100.0		3080	1302	1.39	1.00	1.00	1.00	5.54	1.29	7.16	4.09	11.25	0.903	0.403
10	33.5	4.0	SM	18.0	100.0		3580	1490	1.39	1.00	1.00	1.00	5.54	1.21	6.68	4.09	10.77	0.879	0.398
11	38.5	0.0	CL	50.0	95.0	Clay	4055	1653	1.39	1.00	1.00	1.00	0.00	1.16	0.00	5.61	5.61	0.855	0.395
12	43.5	0.0	SM	20.7	100.0		4555	1841	1.39	1.00	1.00	1.00	0.00	1.09	0.00	4.59	4.59	0.830	0.387
13	48.5	9.0	SM	21.0	100.0		5055	2029	1.39	1.00	1.00	1.00	12.47	1.02	12.71	4.63	17.34	0.805	0.378
14	53.5	14.0	SM	21.0	100.0		5555	2217	1.39	1.00	1.00	1.00	19.39	0.98	19.02	4.63	23.66	0.781	0.369
15	58.5	2.0	SM	21.0	100.0		6055	2405	1.39	1.00	1.00	1.00	2.77	0.93	2.57	4.63	7.21	0.757	0.359
16	63.5	6.0	SM	21.0	100.0		6555	2593	1.39	1.00	1.00	1.00	8.31	0.90	7.48	4.63	12.12	0.734	0.350
17	68.5	8.0	SM	15.0	120.0	Clay	7155	2881	1.39	1.00	1.00	1.00	11.08	0.85	9.47	3.26	12.73	0.712	0.333
18	73.5	10.0	SM	15.0	120.0	Clay	7755	3169	1.39	1.00	1.00	1.00	13.85	0.82	11.36	3.26	14.62	0.691	0.319
19	78.5	23.0	SM	15.0	120.0	Clay	8355	3457	1.39	1.00	1.00	1.00	31.86	0.84	26.64	3.26	29.91	0.672	0.306
20	83.5	9.0	SM	15.0	120.0	Clay	8955	3745	1.39	1.00	1.00	1.00	12.47	0.75	9.31	3.26	12.57	0.654	0.295
21	88.5	27.0	SM	15.0	120.0	Clay	9555	4033	1.39	1.00	1.00	1.00	37.40	0.80	30.01	3.26	33.27	0.639	0.285
22	93.5	17.0	SM	15.0	120.0	Clay	10155	4321	1.39	1.00	1.00	1.00	23.55	0.73	17.24	3.26	20.51	0.625	0.277
23	98.5	8.0	SM	15.0	120.0	Clay	10755	4609	1.39	1.00	1.00	1.00	11.08	0.66	7.31	3.26	10.57	0.613	0.270
24	103.5	16.0	SM	15.0	120.0	Clay	11355	4897	1.39	1.00	1.00	1.00	22.16	0.68	15.13	3.26	18.39	0.603	0.264
25	108.5	10.0	SM	15.0	120.0	Clay	11955	5185	1.39	1.00	1.00	1.00	13.85	0.63	8.70	3.26	11.97	0.596	0.259
26	113.5	5.0	SM	15.0	120.0	Clay	12555	5473	1.39	1.00	1.00	1.00	6.93	0.58	4.00	3.26	7.26	0.590	0.255
27	118.5	6.0	SM	15.0	120.0	Clay	13155	5761	1.39	1.00	1.00	1.00	8.31	0.57	4.71	3.26	7.97	0.587	0.253
28	123.5	5.0	SM	15.0	120.0	Clay	13755	6049	1.39	1.00	1.00	1.00	6.93	0.54	3.76	3.26	7.03	0.586	0.251
29	128.5	7.0	SM	15.0	120.0	Clay	14355	6337	1.39	1.00	1.00	1.00	9.70	0.54	5.25	3.26	8.51	0.588	0.251
30	133.5	8.0	SM	15.0	120.0	Clay	14955	6625	1.39	1.00	1.00	1.00	11.08	0.53	5.90	3.26	9.17	0.592	0.252
31	138.5	8.0	SM	15.0	120.0	Clay	15555	6913	1.39	1.00	1.00	1.00	11.08	0.52	5.75	3.26	9.02	0.598	0.254
32	143.5	9.0	ML	50.0	120.0	Clay	16155	7201	1.39	1.00	1.00	1.00	12.47	0.53	6.63	5.61	12.25	0.607	0.257
33	148.5	12.0	SM	15.0	120.0	Clay	16755	7489	1.39	1.00	1.00	1.00	16.62	0.52	8.62	3.26	11.88	0.618	0.261
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.09	1.01	1.10	0.061	0.067	0.13
1.10	1.01	1.10	0.078	0.086	0.17
1.92	1.06	1.10	0.414	0.483	1.11
2.12	1.08	1.10	0.647	0.766	1.84
1.79	1.05	1.10	0.327	0.379	0.93
2.20	1.08	1.10	2.000	2.000	2.00
1.40	1.03	1.10	0.179	0.202	0.50
1.37	1.02	1.08	0.170	0.187	0.46
1.22	1.01	1.05	0.127	0.135	0.33
1.21	1.01	1.03	0.123	0.129	0.32
1.12	1.01	1.02	0.090	0.092	2.00
1.11	1.01	1.01	0.084	0.085	0.22
1.39	1.03	1.01	0.177	0.183	0.48
1.65	1.04	0.99	0.261	0.271	0.74
1.14	1.01	0.99	0.099	0.099	0.28
1.24	1.02	0.98	0.133	0.133	0.38
1.25	1.02	0.97	0.138	0.136	2.00
1.31	1.02	0.96	0.153	0.149	2.00
1.99	1.07	0.90	0.479	0.461	2.00
1.25	1.02	0.94	0.137	0.131	2.00
2.20	1.08	0.85	0.796	0.729	2.00
1.51	1.03	0.90	0.212	0.198	2.00
1.20	1.01	0.93	0.122	0.115	2.00
1.43	1.03	0.89	0.188	0.173	2.00
1.23	1.02	0.91	0.132	0.122	2.00
1.14	1.01	0.92	0.100	0.093	2.00
1.15	1.01	0.91	0.104	0.096	2.00
1.14	1.01	0.91	0.098	0.091	2.00
1.16	1.01	0.90	0.108	0.099	2.00
1.17	1.01	0.90	0.112	0.102	2.00
1.17	1.01	0.89	0.111	0.101	2.00
1.24	1.02	0.88	0.134	0.120	2.00
1.23	1.02	0.87	0.132	0.117	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.118	1.77	21.53
2	1.8	0.060	1.26	19.76
4	2.0	0.006	0.14	18.50
6	2.0	0.001	0.01	18.36
8	3.8	0.009	0.41	18.35
13.5	5.3	0.000	0.00	17.94
18.5	5.0	0.026	1.54	17.94
23.5	5.0	0.027	1.60	16.40
28.5	5.0	0.035	2.09	14.79
33.5	5.0	0.036	2.15	12.70
38.5	5.0	0.000	0.00	10.56
43.5	5.0	0.054	3.27	10.56
48.5	5.0	0.026	1.55	7.29
53.5	5.0	0.018	1.08	5.74
58.5	5.0	0.045	2.67	4.67
63.5	5.0	0.033	1.99	1.99
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.0	0.000	0.00	0.00
103.5	5.0	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	5.0	0.000	0.00	0.00
128.5	5.0	0.000	0.00	0.00
133.5	5.0	0.000	0.00	0.00
138.5	5.0	0.000	0.00	0.00
143.5	5.0	0.000	0.00	0.00
148.5	4.0	0.000	0.00	0.00
151.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:57 PM
Boring Designation:	B-16
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.29
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	0.5	0	SM	15	100		
2	2.0	5	SM	15	100		
3	4.0	28	SP	2	120		
4	6.0	22	SP	2	120		
5	8.0	15	SP	2	120		
6	13.5	29	SP	2	120		
7	18.5	8	SM	14	100		
8	23.5	5	SM	14	100		
9	28.5	10	SM	14	100		
10	33.5	4	SM	14	100		
11	38.5	2	SC	47	100		
12	43.5	3	SM	15	100		
13	48.5	1	MH	91	100		Clay
14	53.5	2	MH	91	100		Clay
15	58.5	5	SM	15	100		
16	63.5	8	SM	15	100		
17	68.5	3	CL	50	95		Clay
18	73.5	6	SM	15	120		Clay
19	78.5	27	SM	15	120		Clay
20	83.5	11	SM	15	120		Clay
21	88.5	5	SM	15	120		Clay
22	93.5	28	SM	15	120		Clay
23	98.5	15	SM	15	120		Clay
24	103.5	10	SM	15	120		Clay
25	108.5	6	SM	15	120		Clay
26	113.5	9	SM	15	120		Clay
27	118.5	8	SM	15	120		Clay
28	123.5	9	SM	15	120		Clay
29	128.5	7	SM	15	120		Clay
30	133.5	6	SM	15	120		Clay
31	138.5	7	SM	15	120		Clay
32	143.5	12	SM	15	120		Clay
33	148.5	11	SM	15	120		Clay
34							Clay
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	0.0	SM	15.0	100.0		50	19	1.39	1.00	0.75	1.00	0.00	1.70	0.00	3.26	3.26	1.005	0.504
2	2.0	5.0	SM	15.0	100.0		200	75	1.39	1.00	0.75	1.00	5.19	1.70	8.83	3.26	12.09	1.002	0.502
3	4.0	28.0	SP	2.0	120.0		440	190	1.39	1.00	0.75	1.00	29.09	1.70	49.44	0.00	49.44	0.997	0.434
4	6.0	22.0	SP	2.1	120.0		680	306	1.39	1.00	0.80	1.00	24.38	1.70	41.44	0.00	41.44	0.991	0.416
5	8.0	15.0	SP	2.0	120.0		920	421	1.39	1.00	0.80	1.00	16.62	1.70	28.25	0.00	28.25	0.985	0.406
6	13.5	29.0	SP	2.1	120.0		1580	738	1.39	1.00	0.85	1.00	34.14	1.33	45.25	0.00	45.25	0.966	0.390
7	18.5	8.0	SM	14.0	100.0		2080	926	1.39	1.00	0.95	1.00	10.53	1.46	15.35	2.91	18.25	0.947	0.401
8	23.5	5.0	SM	13.9	100.0		2580	1114	1.39	1.00	0.95	1.00	6.58	1.39	9.17	2.87	12.04	0.926	0.404
9	28.5	10.0	SM	14.0	100.0		3080	1302	1.39	1.00	1.00	1.00	13.85	1.24	17.15	2.91	20.06	0.903	0.403
10	33.5	4.0	SM	14.0	100.0		3580	1490	1.39	1.00	1.00	1.00	5.54	1.21	6.71	2.91	9.62	0.879	0.398
11	38.5	2.0	SC	46.6	100.0		4080	1678	1.39	1.00	1.00	1.00	2.77	1.14	3.15	5.61	8.76	0.855	0.392
12	43.5	3.0	SM	15.0	100.0		4580	1866	1.39	1.00	1.00	1.00	4.16	1.07	4.46	3.26	7.73	0.830	0.384
13	48.5	1.0	MH	91.0	100.0	Clay	5080	2054	1.39	1.00	1.00	1.00	1.39	1.02	1.41	5.51	6.92	0.805	0.375
14	53.5	2.0	MH	91.0	100.0	Clay	5580	2242	1.39	1.00	1.00	1.00	2.77	0.97	2.68	5.51	8.19	0.781	0.366
15	58.5	5.0	SM	15.0	100.0		6080	2430	1.39	1.00	1.00	1.00	6.93	0.93	6.42	3.26	9.68	0.757	0.357
16	63.5	8.0	SM	15.0	100.0		6580	2618	1.39	1.00	1.00	1.00	11.08	0.90	9.95	3.26	13.21	0.734	0.348
17	68.5	3.0	CL	50.0	95.0	Clay	7055	2781	1.39	1.00	1.00	1.00	4.16	0.86	3.57	5.61	9.19	0.712	0.340
18	73.5	6.0	SM	15.0	120.0	Clay	7655	3069	1.39	1.00	1.00	1.00	8.31	0.82	6.80	3.26	10.06	0.691	0.325
19	78.5	27.0	SM	15.0	120.0	Clay	8255	3357	1.39	1.00	1.00	1.00	37.40	0.86	32.16	3.26	35.42	0.672	0.312
20	83.5	11.0	SM	15.0	120.0	Clay	8855	3645	1.39	1.00	1.00	1.00	15.24	0.77	11.69	3.26	14.95	0.654	0.300
21	88.5	5.0	SM	15.0	120.0	Clay	9455	3933	1.39	1.00	1.00	1.00	6.93	0.70	4.88	3.26	8.14	0.639	0.289
22	93.5	28.0	SM	15.0	120.0	Clay	10055	4221	1.39	1.00	1.00	1.00	38.78	0.79	30.75	3.26	34.01	0.625	0.281
23	98.5	15.0	SM	15.0	120.0	Clay	10655	4509	1.39	1.00	1.00	1.00	20.78	0.71	14.68	3.26	17.95	0.613	0.273
24	103.5	10.0	SM	15.0	120.0	Clay	11255	4797	1.39	1.00	1.00	1.00	13.85	0.66	9.09	3.26	12.36	0.603	0.267
25	108.5	6.0	SM	15.0	120.0	Clay	11855	5085	1.39	1.00	1.00	1.00	8.31	0.61	5.08	3.26	8.34	0.596	0.262
26	113.5	9.0	SM	15.0	120.0	Clay	12455	5373	1.39	1.00	1.00	1.00	12.47	0.61	7.60	3.26	10.86	0.590	0.258
27	118.5	8.0	SM	15.0	120.0	Clay	13055	5661	1.39	1.00	1.00	1.00	11.08	0.59	6.49	3.26	9.75	0.587	0.255
28	123.5	9.0	SM	15.0	120.0	Clay	13655	5949	1.39	1.00	1.00	1.00	12.47	0.57	7.16	3.26	10.42	0.586	0.254
29	128.5	7.0	SM	15.0	120.0	Clay	14255	6237	1.39	1.00	1.00	1.00	9.70	0.55	5.30	3.26	8.56	0.588	0.253
30	133.5	6.0	SM	15.0	120.0	Clay	14855	6525	1.39	1.00	1.00	1.00	8.31	0.53	4.36	3.26	7.63	0.592	0.254
31	138.5	7.0	SM	15.0	120.0	Clay	15455	6813	1.39	1.00	1.00	1.00	9.70	0.52	5.02	3.26	8.28	0.598	0.256
32	143.5	12.0	SM	15.0	120.0	Clay	16055	7101	1.39	1.00	1.00	1.00	16.62	0.54	8.90	3.26	12.16	0.607	0.259
33	148.5	11.0	SM	15.0	120.0	Clay	16655	7389	1.39	1.00	1.00	1.00	15.24	0.52	7.88	3.26	11.14	0.618	0.263
34						Clay													
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.10	1.01	1.10	0.077	0.085	0.17
1.24	1.02	1.10	0.133	0.149	0.30
2.20	1.08	1.10	2.000	2.000	2.00
2.20	1.08	1.10	2.000	2.000	2.00
1.89	1.06	1.10	0.394	0.460	1.13
2.20	1.08	1.10	2.000	2.000	2.00
1.43	1.03	1.10	0.186	0.211	0.53
1.24	1.02	1.06	0.133	0.143	0.35
1.50	1.03	1.06	0.207	0.227	0.56
1.18	1.01	1.03	0.115	0.121	0.30
1.17	1.01	1.02	0.110	0.113	0.29
1.15	1.01	1.01	0.103	0.105	0.27
1.14	1.01	1.00	0.098	0.099	2.00
1.16	1.01	1.00	0.106	0.106	2.00
1.18	1.01	0.99	0.116	0.116	0.32
1.27	1.02	0.98	0.142	0.141	0.41
1.18	1.01	0.98	0.112	0.111	2.00
1.19	1.01	0.97	0.118	0.116	2.00
2.20	1.08	0.88	1.212	1.148	2.00
1.32	1.02	0.94	0.156	0.149	2.00
1.16	1.01	0.95	0.106	0.101	2.00
2.20	1.08	0.83	0.911	0.816	2.00
1.41	1.03	0.91	0.183	0.171	2.00
1.24	1.02	0.92	0.135	0.126	2.00
1.16	1.01	0.92	0.107	0.100	2.00
1.21	1.01	0.91	0.124	0.115	2.00
1.19	1.01	0.91	0.116	0.107	2.00
1.20	1.01	0.90	0.121	0.111	2.00
1.16	1.01	0.91	0.108	0.099	2.00
1.15	1.01	0.91	0.102	0.093	2.00
1.16	1.01	0.90	0.106	0.097	2.00
1.24	1.02	0.88	0.134	0.119	2.00
1.22	1.01	0.88	0.126	0.113	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.062	0.92	18.20
2	1.8	0.033	0.70	17.28
4	2.0	0.000	0.00	16.58
6	2.0	0.000	0.00	16.58
8	3.8	0.006	0.25	16.58
13.5	5.3	0.000	0.00	16.33
18.5	5.0	0.025	1.49	16.33
23.5	5.0	0.033	2.00	14.84
28.5	5.0	0.023	1.38	12.84
33.5	5.0	0.038	2.29	11.46
38.5	5.0	0.040	2.42	9.16
43.5	5.0	0.043	2.58	6.75
48.5	5.0	0.000	0.00	4.17
53.5	5.0	0.000	0.00	4.17
58.5	5.0	0.038	2.28	4.17
63.5	5.0	0.031	1.88	1.88
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.0	0.000	0.00	0.00
103.5	5.0	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	5.0	0.000	0.00	0.00
128.5	5.0	0.000	0.00	0.00
133.5	5.0	0.000	0.00	0.00
138.5	5.0	0.000	0.00	0.00
143.5	5.0	0.000	0.00	0.00
148.5	4.0	0.000	0.00	0.00
151.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:46 PM
Boring Designation:	B-1
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	8
SPT Liner (Yes/No):	No
Hammer Energy, %:	82
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	6

Earthquake Information

Max Acceleration (g) :	0.14
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	8	SP-SM	8	100		Unsaturated
2	4.0	7	SP-SM	8	100		Unsaturated
3	6.0	6	SP-SM	8	100		Unsaturated
4	8.0	6	SP-SM	8	100		
5	10.0	3	SP-SM	8	100		
6	12.0	4	SP-SM	8	100		
7	14.0	8	SP-SM	8	100		
8	16.0	2	SP-SM	8	100		
9	18.0	2	SP	3	100		
10	23.5	2	SP	3	100		
11	28.5	4	SP-SM	7	100		
12	33.5	4	SP-SM	7	100		
13	38.5	3	SP-SM	7	100		
14	43.5	1	SP-SM	11	100		
15	48.5	1	SM	33	100		
16	53.5	14	ML	50	120		Clay
17	55.0	34	ML	50	120		Clay
18	58.5	7	ML	50	120		Clay
19	63.5	6	ML	50	120		Clay
20	65.0	7	ML	50	120		Clay
21	66.5	10	ML	50	120		Clay
22	68.5	12	ML	50	120		Clay
23	73.5	11	ML	50	120		Clay
24	78.5	23	ML	50	120		Clay
25	83.5	3	SM	15	120		Clay
26	88.5	10	SM	15	120		Clay
27	93.5	11	SM	15	120		Clay
28	100.0	25	SM	15	120		Clay
29	103.5	10	SM	15	120		Clay
30	108.5	9	SM	15	120		Clay
31	113.5	12	SM	15	120		Clay
32	118.5	12	SM	15	120		Clay
33	123.5	16	SM	15	120		Clay
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	8.0	SP-SM	8.0	100.0	Unsaturated	200	200	1.37	1.15	0.75	1.00	9.43	1.70	16.03	0.37	16.40	1.002	0.091
2	4.0	7.0	SP-SM	8.0	100.0	Unsaturated	400	400	1.37	1.15	0.75	1.00	8.25	1.70	14.03	0.37	14.39	0.997	0.091
3	6.0	6.0	SP-SM	8.0	100.0	Unsaturated	600	600	1.37	1.15	0.80	1.00	7.54	1.70	12.82	0.37	13.19	0.991	0.090
4	8.0	6.0	SP-SM	8.0	100.0		800	800	1.37	1.15	0.80	1.00	7.54	1.64	12.39	0.37	12.75	0.985	0.090
5	10.0	3.0	SP-SM	8.0	100.0		1000	875	1.37	1.15	0.85	1.00	4.01	1.67	6.69	0.37	7.06	0.978	0.102
6	12.0	4.0	SP-SM	8.0	100.0		1200	950	1.37	1.15	0.85	1.00	5.34	1.56	8.35	0.37	8.72	0.971	0.112
7	14.0	8.0	SP-SM	8.0	100.0		1400	1026	1.37	1.15	0.85	1.00	10.69	1.42	15.15	0.37	15.51	0.964	0.120
8	16.0	2.0	SP-SM	8.0	100.0		1600	1101	1.37	1.15	0.95	1.00	2.99	1.49	4.46	0.37	4.83	0.957	0.127
9	18.0	2.0	SP	3.3	100.0		1800	1176	1.37	1.15	0.95	1.00	2.99	1.44	4.31	0.00	4.31	0.949	0.132
10	23.5	2.0	SP	3.3	100.0		2350	1383	1.37	1.15	0.95	1.00	2.99	1.31	3.91	0.00	3.91	0.926	0.143
11	28.5	4.0	SP-SM	7.4	100.0		2850	1571	1.37	1.15	1.00	1.00	6.29	1.19	7.45	0.21	7.67	0.903	0.149
12	33.5	4.0	SP-SM	7.0	100.0		3350	1759	1.37	1.15	1.00	1.00	6.29	1.11	7.00	0.14	7.13	0.879	0.152
13	38.5	3.0	SP-SM	7.0	100.0		3850	1947	1.37	1.15	1.00	1.00	4.72	1.05	4.96	0.14	5.10	0.855	0.154
14	43.5	1.0	SP-SM	11.0	100.0		4350	2135	1.37	1.15	1.00	1.00	1.57	0.99	1.56	1.61	3.17	0.830	0.154
15	48.5	1.0	SM	33.2	100.0		4850	2323	1.37	1.15	1.00	1.00	1.57	0.95	1.49	5.47	6.95	0.805	0.153
16	53.5	14.0	ML	50.0	120.0	Clay	5450	2611	1.37	1.15	1.00	1.00	22.00	0.92	20.26	5.61	25.87	0.781	0.148
17	55.0	34.0	ML	50.0	120.0	Clay	5630	2697	1.37	1.15	1.00	1.00	53.44	0.94	50.13	5.61	55.75	0.773	0.147
18	58.5	7.0	ML	50.0	120.0	Clay	6050	2899	1.37	1.15	1.00	1.00	11.00	0.86	9.44	5.61	15.06	0.757	0.144
19	63.5	6.0	ML	50.0	120.0	Clay	6650	3187	1.37	1.15	1.00	1.00	9.43	0.81	7.67	5.61	13.29	0.734	0.139
20	65.0	7.0	ML	50.0	120.0	Clay	6830	3273	1.37	1.15	1.00	1.00	11.00	0.81	8.88	5.61	14.49	0.727	0.138
21	66.5	10.0	ML	50.0	120.0	Clay	7010	3360	1.37	1.15	1.00	1.00	15.72	0.81	12.74	5.61	18.35	0.720	0.137
22	68.5	12.0	ML	50.0	120.0	Clay	7250	3475	1.37	1.15	1.00	1.00	18.86	0.81	15.21	5.61	20.83	0.712	0.135
23	73.5	11.0	ML	50.0	120.0	Clay	7850	3763	1.37	1.15	1.00	1.00	17.29	0.77	13.35	5.61	18.96	0.691	0.131
24	78.5	23.0	ML	50.0	120.0	Clay	8450	4051	1.37	1.15	1.00	1.00	36.15	0.81	29.15	5.61	34.77	0.672	0.128
25	83.5	3.0	SM	15.0	120.0	Clay	9050	4339	1.37	1.15	1.00	1.00	4.72	0.65	3.09	3.26	6.35	0.654	0.124
26	88.5	10.0	SM	15.0	120.0	Clay	9650	4627	1.37	1.15	1.00	1.00	15.72	0.68	10.65	3.26	13.91	0.639	0.121
27	93.5	11.0	SM	15.0	120.0	Clay	10250	4915	1.37	1.15	1.00	1.00	17.29	0.66	11.44	3.26	14.71	0.625	0.119
28	100.0	25.0	SM	15.0	120.0	Clay	11030	5289	1.37	1.15	1.00	1.00	39.29	0.72	28.48	3.26	31.74	0.610	0.116
29	103.5	10.0	SM	15.0	120.0	Clay	11450	5491	1.37	1.15	1.00	1.00	15.72	0.62	9.69	3.26	12.95	0.603	0.114
30	108.5	9.0	SM	15.0	120.0	Clay	12050	5779	1.37	1.15	1.00	1.00	14.15	0.59	8.37	3.26	11.63	0.596	0.113
31	113.5	12.0	SM	15.0	120.0	Clay	12650	6067	1.37	1.15	1.00	1.00	18.86	0.60	11.24	3.26	14.50	0.590	0.112
32	118.5	12.0	SM	15.0	120.0	Clay	13250	6355	1.37	1.15	1.00	1.00	18.86	0.58	10.95	3.26	14.21	0.587	0.111
33	123.5	16.0	SM	15.0	120.0	Clay	13850	6643	1.37	1.15	1.00	1.00	25.15	0.59	14.92	3.26	18.18	0.586	0.111
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.36	1.02	1.10	0.168	0.190	2.00
1.30	1.02	1.10	0.151	0.170	2.00
1.27	1.02	1.10	0.142	0.158	2.00
1.25	1.02	1.10	0.138	0.154	1.72
1.14	1.01	1.07	0.099	0.107	1.05
1.17	1.01	1.07	0.109	0.118	1.06
1.33	1.02	1.08	0.161	0.178	1.48
1.11	1.01	1.05	0.085	0.090	0.71
1.11	1.01	1.04	0.082	0.086	0.65
1.11	1.01	1.03	0.080	0.083	0.58
1.15	1.01	1.03	0.102	0.106	0.71
1.14	1.01	1.02	0.099	0.102	0.67
1.12	1.01	1.01	0.087	0.088	0.57
1.10	1.01	1.00	0.076	0.077	0.50
1.14	1.01	0.99	0.098	0.098	0.64
1.76	1.05	0.96	0.312	0.317	2.00
2.20	1.08	0.93	2.000	2.000	2.00
1.32	1.02	0.97	0.157	0.154	2.00
1.27	1.02	0.96	0.142	0.139	2.00
1.30	1.02	0.95	0.152	0.148	2.00
1.43	1.03	0.94	0.187	0.182	2.00
1.53	1.04	0.93	0.216	0.209	2.00
1.45	1.03	0.93	0.194	0.185	2.00
2.20	1.08	0.83	1.057	0.951	2.00
1.13	1.01	0.94	0.094	0.090	2.00
1.29	1.02	0.92	0.147	0.138	2.00
1.31	1.02	0.91	0.154	0.142	2.00
2.11	1.08	0.80	0.619	0.531	2.00
1.26	1.02	0.90	0.140	0.128	2.00
1.23	1.02	0.90	0.130	0.119	2.00
1.30	1.02	0.89	0.152	0.137	2.00
1.29	1.02	0.88	0.150	0.135	2.00
1.42	1.03	0.86	0.186	0.164	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	0.0	0.000	0.00	22.80
4	0.0	0.000	0.00	22.80
6	0.0	0.000	0.00	22.80
8	1.0	0.001	0.01	22.80
10	2.0	0.010	0.23	22.79
12	2.0	0.009	0.21	22.56
14	2.0	0.002	0.05	22.35
16	2.0	0.053	1.28	22.30
18	3.8	0.056	2.51	21.02
23.5	5.3	0.058	3.65	18.51
28.5	5.0	0.043	2.59	14.86
33.5	5.0	0.045	2.69	12.27
38.5	5.0	0.052	3.13	9.58
43.5	5.0	0.062	3.73	6.45
48.5	5.0	0.045	2.72	2.72
53.5	3.3	0.000	0.00	0.00
55	2.5	0.000	0.00	0.00
58.5	4.3	0.000	0.00	0.00
63.5	3.3	0.000	0.00	0.00
65	1.5	0.000	0.00	0.00
66.5	1.8	0.000	0.00	0.00
68.5	3.5	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.8	0.000	0.00	0.00
100	5.0	0.000	0.00	0.00
103.5	4.3	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	4.0	0.000	0.00	0.00
126.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:40 PM
Boring Designation:	B-2
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	6
SPT Liner (Yes/No):	No
Hammer Energy, %:	82
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	6

Earthquake Information

Max Acceleration (g) :	0.12
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	20	SP	5	100		Unsaturated
2	4.0	6	SP	5	100		Unsaturated
3	6.0	1	SP	5	100		
4	8.0	11	SP	3	100		
5	10.0	18	SP	3	120		
6	12.0	30	SP	3	120		
7	14.0	38	SP	3	120		
8	16.0	21	SP	3	120		
9	18.0	7	SP-SM	6	100		
10	23.5	0	SP-SM	6	100		
11	28.5	1	SM	14	100		
12	33.5	4	SM	14	100		
13	38.5	4	SP-SM	9	100		
14	43.5	19	SP-SM	9	120		
15	48.5	7	SP-SM	9	100		
16	53.5	11	SP-SM	10	100		
17	58.5	2	SP-SM	10	100		
18	63.5	1	CL	50	100		Clay
19	68.5	7	SP-SM	5	100		
20	73.5	5	ML	50	120		Clay
21	78.5	5	ML	50	120		Clay
22	83.5	4	ML	50	120		Clay
23	88.5	32	SM	15	120		Clay
24	93.5	5	SM	15	120		Clay
25	98.5	6	SM	15	120		Clay
26	103.5	4	SM	15	120		Clay
27	108.5	7	SM	15	120		Clay
28	113.5	10	SM	15	120		Clay
29	118.5	7	SM	15	120		Clay
30	123.5	7	SM	15	120		Clay
31							Clay
32							Clay
33							Clay
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	20.0	SP	5.0	100.0	Unsaturated	200	200	1.37	1.15	0.75	1.00	23.58	1.70	40.08	0.00	40.08	1.002	0.078
2	4.0	6.0	SP	5.0	100.0	Unsaturated	400	400	1.37	1.15	0.75	1.00	7.07	1.70	12.02	0.00	12.03	0.997	0.078
3	6.0	1.0	SP	4.9	100.0		600	600	1.37	1.15	0.80	1.00	1.26	1.70	2.14	0.00	2.14	0.991	0.077
4	8.0	11.0	SP	2.5	100.0		800	675	1.37	1.15	0.80	1.00	13.83	1.62	22.37	0.00	22.37	0.985	0.091
5	10.0	18.0	SP	3.0	120.0		1040	790	1.37	1.15	0.85	1.00	24.05	1.40	33.58	0.00	33.58	0.978	0.100
6	12.0	30.0	SP	3.0	120.0		1280	906	1.37	1.15	0.85	1.00	40.08	1.25	50.10	0.00	50.10	0.971	0.107
7	14.0	38.0	SP	3.0	120.0		1520	1021	1.37	1.15	0.85	1.00	50.76	1.21	61.50	0.00	61.50	0.964	0.112
8	16.0	21.0	SP	3.0	120.0		1760	1136	1.37	1.15	0.95	1.00	31.35	1.21	38.03	0.00	38.03	0.957	0.116
9	18.0	7.0	SP-SM	6.3	100.0		1960	1211	1.37	1.15	0.95	1.00	10.45	1.32	13.80	0.05	13.85	0.949	0.120
10	23.5	0.0	SP-SM	6.0	100.0		2510	1418	1.37	1.15	0.95	1.00	0.00	1.36	0.00	0.03	0.03	0.926	0.128
11	28.5	1.0	SM	14.0	100.0		3010	1606	1.37	1.15	1.00	1.00	1.57	1.19	1.86	2.91	4.77	0.903	0.132
12	33.5	4.0	SM	14.0	100.0		3510	1794	1.37	1.15	1.00	1.00	6.29	1.09	6.88	2.91	9.78	0.879	0.134
13	38.5	4.0	SP-SM	8.8	100.0		4010	1982	1.37	1.15	1.00	1.00	6.29	1.04	6.53	0.64	7.17	0.855	0.135
14	43.5	19.0	SP-SM	9.0	120.0		4610	2270	1.37	1.15	1.00	1.00	29.86	0.97	29.11	0.72	29.83	0.830	0.131
15	48.5	7.0	SP-SM	9.0	100.0		5110	2458	1.37	1.15	1.00	1.00	11.00	0.92	10.16	0.72	10.88	0.805	0.131
16	53.5	11.0	SP-SM	10.0	100.0		5610	2646	1.37	1.15	1.00	1.00	17.29	0.90	15.56	1.15	16.71	0.781	0.129
17	58.5	2.0	SP-SM	10.0	100.0		6110	2834	1.37	1.15	1.00	1.00	3.14	0.83	2.61	1.15	3.76	0.757	0.127
18	63.5	1.0	CL	50.0	100.0	Clay	6610	3022	1.37	1.15	1.00	1.00	1.57	0.81	1.28	5.61	6.89	0.734	0.125
19	68.5	7.0	SP-SM	5.0	100.0		7110	3210	1.37	1.15	1.00	1.00	11.00	0.79	8.72	0.00	8.72	0.712	0.123
20	73.5	5.0	ML	50.0	120.0	Clay	7710	3498	1.37	1.15	1.00	1.00	7.86	0.77	6.05	5.61	11.66	0.691	0.119
21	78.5	5.0	ML	50.0	120.0	Clay	8310	3786	1.37	1.15	1.00	1.00	7.86	0.74	5.79	5.61	11.41	0.672	0.115
22	83.5	4.0	ML	50.0	120.0	Clay	8910	4074	1.37	1.15	1.00	1.00	6.29	0.70	4.41	5.61	10.03	0.654	0.112
23	88.5	32.0	SM	15.0	120.0	Clay	9510	4362	1.37	1.15	1.00	1.00	50.29	0.82	41.34	3.26	44.60	0.639	0.109
24	93.5	5.0	SM	15.0	120.0	Clay	10110	4650	1.37	1.15	1.00	1.00	7.86	0.64	5.05	3.26	8.31	0.625	0.106
25	98.5	6.0	SM	15.0	120.0	Clay	10710	4938	1.37	1.15	1.00	1.00	9.43	0.63	5.91	3.26	9.17	0.613	0.104
26	103.5	4.0	SM	15.0	120.0	Clay	11310	5226	1.37	1.15	1.00	1.00	6.29	0.59	3.72	3.26	6.98	0.603	0.102
27	108.5	7.0	SM	15.0	120.0	Clay	11910	5514	1.37	1.15	1.00	1.00	11.00	0.59	6.54	3.26	9.80	0.596	0.100
28	113.5	10.0	SM	15.0	120.0	Clay	12510	5802	1.37	1.15	1.00	1.00	15.72	0.60	9.39	3.26	12.65	0.590	0.099
29	118.5	7.0	SM	15.0	120.0	Clay	13110	6090	1.37	1.15	1.00	1.00	11.00	0.56	6.16	3.26	9.42	0.587	0.099
30	123.5	7.0	SM	15.0	120.0	Clay	13710	6378	1.37	1.15	1.00	1.00	11.00	0.54	5.99	3.26	9.26	0.586	0.098
31																			
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
2.20	1.08	1.10	2.000	2.000	2.00
1.24	1.02	1.10	0.133	0.148	2.00
1.09	1.01	1.08	0.071	0.077	1.00
1.59	1.04	1.10	0.239	0.273	2.00
2.20	1.08	1.10	0.840	1.000	2.00
2.20	1.08	1.10	2.000	2.000	2.00
2.20	1.08	1.10	2.000	2.000	2.00
2.20	1.08	1.10	2.000	2.000	2.00
1.28	1.02	1.06	0.147	0.158	1.32
1.09	1.01	1.02	0.061	0.063	0.49
1.11	1.01	1.02	0.085	0.087	0.66
1.19	1.01	1.02	0.117	0.120	0.89
1.14	1.01	1.01	0.099	0.101	0.75
1.99	1.07	0.99	0.474	0.499	2.00
1.21	1.01	0.99	0.124	0.124	0.95
1.37	1.03	0.97	0.171	0.171	1.32
1.10	1.01	0.98	0.079	0.078	0.61
1.14	1.01	0.97	0.098	0.096	2.00
1.17	1.01	0.96	0.109	0.107	0.87
1.23	1.02	0.95	0.130	0.125	2.00
1.22	1.02	0.94	0.128	0.123	2.00
1.19	1.01	0.94	0.118	0.113	2.00
2.20	1.08	0.79	2.000	1.701	2.00
1.16	1.01	0.93	0.107	0.100	2.00
1.17	1.01	0.92	0.112	0.105	2.00
1.14	1.01	0.93	0.098	0.092	2.00
1.19	1.01	0.91	0.117	0.108	2.00
1.25	1.02	0.90	0.137	0.125	2.00
1.18	1.01	0.90	0.114	0.104	2.00
1.18	1.01	0.90	0.113	0.103	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	0.0	0.000	0.00	23.78
4	0.0	0.000	0.00	23.78
6	1.0	0.032	0.39	23.78
8	2.0	0.000	0.00	23.40
10	2.0	0.000	0.00	23.40
12	2.0	0.000	0.00	23.40
14	2.0	0.000	0.00	23.40
16	2.0	0.000	0.00	23.40
18	3.8	0.003	0.16	23.40
23.5	5.3	0.113	7.11	23.24
28.5	5.0	0.054	3.22	16.14
33.5	5.0	0.038	2.27	12.92
38.5	5.0	0.045	2.68	10.65
43.5	5.0	0.000	0.00	7.97
48.5	5.0	0.030	1.79	7.97
53.5	5.0	0.004	0.23	6.18
58.5	5.0	0.059	3.52	5.94
63.5	5.0	0.000	0.00	2.42
68.5	5.0	0.040	2.42	2.42
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.0	0.000	0.00	0.00
103.5	5.0	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	4.0	0.000	0.00	0.00
126.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:47 PM
Boring Designation:	B-3
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	1
SPT Liner (Yes/No):	No
Hammer Energy, %:	80
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.14
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	0	SM	38	100		
2	4.0	0	SM	38	100		
3	6.0	0	MH	99	95		Clay
4	8.0	0	MH	99	95		Clay
5	13.5	16	SP-SM	8	100		
6	18.5	1	SP-SM	8	100		
7	23.5	1	SM	25	100		
8	28.5	0	MH	97	95		Clay
9	33.5	0	SP-SM	10	100		
10	38.5	3	SP-SM	10	100		
11	43.5	4	SP-SM	10	100		
12	48.5	7	ML	50	120		Clay
13	53.5	4	ML	50	120		Clay
14	58.5	7	ML	50	120		Clay
15	63.5	5	ML	50	120		Clay
16	68.5	10	ML	50	120		Clay
17	73.5	8	ML	50	120		Clay
18	78.5	6	SM	15	120		Clay
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	0.0	SM	37.5	100.0		200	106	1.33	1.00	0.75	1.00	0.00	1.70	0.00	5.55	5.55	1.002	0.171
2	4.0	0.0	SM	38.0	100.0		400	182	1.33	1.00	0.75	1.00	0.00	1.70	0.00	5.55	5.55	0.997	0.200
3	6.0	0.0	MH	98.8	95.0	Clay	590	247	1.33	1.00	0.80	1.00	0.00	1.70	0.00	5.49	5.49	0.991	0.216
4	8.0	0.0	MH	98.8	95.0	Clay	780	312	1.33	1.00	0.80	1.00	0.00	1.70	0.00	5.49	5.49	0.985	0.224
5	13.5	16.0	SP-SM	7.7	100.0		1330	519	1.33	1.00	0.85	1.00	18.13	1.66	30.11	0.28	30.39	0.966	0.225
6	18.5	1.0	SP-SM	7.7	100.0		1830	707	1.33	1.00	0.95	1.00	1.27	1.70	2.15	0.28	2.44	0.947	0.223
7	23.5	1.0	SM	24.5	100.0		2330	895	1.33	1.00	0.95	1.00	1.27	1.65	2.09	5.03	7.12	0.926	0.219
8	28.5	0.0	MH	96.6	95.0	Clay	2805	1058	1.33	1.00	1.00	1.00	0.00	1.52	0.00	5.50	5.50	0.903	0.218
9	33.5	0.0	SP-SM	10.4	100.0		3305	1246	1.33	1.00	1.00	1.00	0.00	1.45	0.00	1.33	1.33	0.879	0.212
10	38.5	3.0	SP-SM	10.4	100.0		3805	1434	1.33	1.00	1.00	1.00	4.00	1.26	5.03	1.33	6.37	0.855	0.206
11	43.5	4.0	SP-SM	10.4	100.0		4305	1622	1.33	1.00	1.00	1.00	5.33	1.16	6.21	1.33	7.54	0.830	0.200
12	48.5	7.0	ML	50.0	120.0	Clay	4905	1910	1.33	1.00	1.00	1.00	9.33	1.05	9.81	5.61	15.42	0.805	0.188
13	53.5	4.0	ML	50.0	120.0	Clay	5505	2198	1.33	1.00	1.00	1.00	5.33	0.98	5.23	5.61	10.84	0.781	0.178
14	58.5	7.0	ML	50.0	120.0	Clay	6105	2486	1.33	1.00	1.00	1.00	9.33	0.92	8.62	5.61	14.23	0.757	0.169
15	63.5	5.0	ML	50.0	120.0	Clay	6705	2774	1.33	1.00	1.00	1.00	6.67	0.87	5.78	5.61	11.40	0.734	0.161
16	68.5	10.0	ML	50.0	120.0	Clay	7305	3062	1.33	1.00	1.00	1.00	13.33	0.84	11.21	5.61	16.83	0.712	0.155
17	73.5	8.0	ML	50.0	120.0	Clay	7905	3350	1.33	1.00	1.00	1.00	10.67	0.80	8.50	5.61	14.11	0.691	0.148
18	78.5	6.0	SM	15.0	120.0	Clay	8505	3638	1.33	1.00	1.00	1.00	8.00	0.74	5.93	3.26	9.20	0.672	0.143
19																			
20																			
21																			
22																			
23																			
24																			
25																			
26																			
27																			
28																			
29																			
30																			
31																			
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.12	1.01	1.10	0.089	0.099	0.58
1.12	1.01	1.10	0.089	0.099	0.50
1.12	1.01	1.10	0.089	0.099	2.00
1.12	1.01	1.10	0.089	0.099	2.00
2.02	1.07	1.10	0.510	0.600	2.00
1.10	1.01	1.07	0.072	0.078	0.35
1.14	1.01	1.07	0.099	0.107	0.49
1.12	1.01	1.05	0.089	0.095	2.00
1.09	1.01	1.03	0.067	0.069	0.33
1.13	1.01	1.03	0.094	0.098	0.48
1.15	1.01	1.02	0.102	0.105	0.52
1.33	1.02	1.01	0.160	0.165	2.00
1.21	1.01	1.00	0.124	0.125	2.00
1.29	1.02	0.98	0.150	0.150	2.00
1.22	1.02	0.97	0.128	0.127	2.00
1.38	1.03	0.96	0.172	0.169	2.00
1.29	1.02	0.95	0.149	0.144	2.00
1.18	1.01	0.95	0.113	0.108	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	2.5	0.050	1.51	19.61
4	2.0	0.050	1.21	18.10
6	2.0	0.000	0.00	16.89
8	3.8	0.000	0.00	16.89
13.5	5.3	0.000	0.00	16.89
18.5	5.0	0.067	4.05	16.89
23.5	5.0	0.045	2.69	12.84
28.5	5.0	0.000	0.00	10.15
33.5	5.0	0.078	4.70	10.15
38.5	5.0	0.047	2.84	5.45
43.5	5.0	0.044	2.61	2.61
48.5	5.0	0.000	0.00	0.00
53.5	5.0	0.000	0.00	0.00
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	4.0	0.000	0.00	0.00
81.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:47 PM
Boring Designation:	B-4
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	2
SPT Liner (Yes/No):	No
Hammer Energy, %:	80
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.14
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	1	SM	32	100		
2	4.0	0	SM	32	100		
3	6.0	0	CL	50	95		Clay
4	8.0	1	SM	26	100		
5	13.5	2	SM	15	100		
6	18.5	5	SM	15	100		
7	23.5	3	SM	15	100		
8	28.5	3	SM	22	100		
9	33.5	2	SM	22	100		
10	38.5	0	SM	22	100		
11	43.5	4	SM	17	100		
12	48.5	2	SM	17	100		
13	53.5	4	ML	50	120		Clay
14	58.5	7	MH	53	120		Clay
15	63.5	7	MH	53	120		Clay
16	68.5	6	MH	53	120		Clay
17	73.5	100	SM	15	120		Clay
18	78.5	9	SM	15	120		Clay
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	1.0	SM	31.9	100.0		200	200	1.33	1.00	0.75	1.00	1.00	1.70	1.70	5.43	7.13	1.002	0.091
2	4.0	0.0	SM	31.9	100.0		400	275	1.33	1.00	0.75	1.00	0.00	1.70	0.00	5.43	5.43	0.997	0.132
3	6.0	0.0	CL	50.0	95.0	Clay	590	340	1.33	1.00	0.80	1.00	0.00	1.70	0.00	5.61	5.61	0.991	0.156
4	8.0	1.0	SM	26.0	100.0		790	416	1.33	1.00	0.80	1.00	1.07	1.70	1.81	5.15	6.96	0.985	0.170
5	13.5	2.0	SM	15.1	100.0		1340	622	1.33	1.00	0.85	1.00	2.27	1.70	3.85	3.29	7.15	0.966	0.189
6	18.5	5.0	SM	15.0	100.0		1840	810	1.33	1.00	0.95	1.00	6.33	1.62	10.25	3.26	13.51	0.947	0.196
7	23.5	3.0	SM	15.0	100.0		2340	998	1.33	1.00	0.95	1.00	3.80	1.52	5.76	3.26	9.02	0.926	0.197
8	28.5	3.0	SM	22.0	100.0		2840	1186	1.33	1.00	1.00	1.00	4.00	1.37	5.46	4.77	10.23	0.903	0.197
9	33.5	2.0	SM	21.6	100.0		3340	1374	1.33	1.00	1.00	1.00	2.67	1.28	3.40	4.72	8.12	0.879	0.194
10	38.5	0.0	SM	22.0	100.0		3840	1562	1.33	1.00	1.00	1.00	0.00	1.21	0.00	4.77	4.77	0.855	0.191
11	43.5	4.0	SM	17.0	100.0		4340	1750	1.33	1.00	1.00	1.00	5.33	1.11	5.91	3.85	9.76	0.830	0.187
12	48.5	2.0	SM	17.0	100.0		4840	1938	1.33	1.00	1.00	1.00	2.67	1.05	2.81	3.85	6.66	0.805	0.183
13	53.5	4.0	ML	50.0	120.0	Clay	5440	2226	1.33	1.00	1.00	1.00	5.33	0.97	5.19	5.61	10.81	0.781	0.174
14	58.5	7.0	MH	53.1	120.0	Clay	6040	2514	1.33	1.00	1.00	1.00	9.33	0.92	8.57	5.61	14.18	0.757	0.165
15	63.5	7.0	MH	53.1	120.0	Clay	6640	2802	1.33	1.00	1.00	1.00	9.33	0.87	8.11	5.61	13.73	0.734	0.158
16	68.5	6.0	MH	53.1	120.0	Clay	7240	3090	1.33	1.00	1.00	1.00	8.00	0.82	6.58	5.61	12.19	0.712	0.152
17	73.5	100.0	SM	15.0	120.0	Clay	7840	3378	1.33	1.00	1.00	1.00	133.33	0.88	117.89	3.26	121.15	0.691	0.146
18	78.5	9.0	SM	15.0	120.0	Clay	8440	3666	1.33	1.00	1.00	1.00	12.00	0.75	9.04	3.26	12.30	0.672	0.141
19																			
20																			
21																			
22																			
23																			
24																			
25																			
26																			
27																			
28																			
29																			
30																			
31																			
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.14	1.01	1.10	0.099	0.110	1.21
1.12	1.01	1.10	0.089	0.098	0.75
1.12	1.01	1.10	0.090	0.100	2.00
1.14	1.01	1.10	0.098	0.109	0.64
1.14	1.01	1.10	0.099	0.110	0.58
1.27	1.02	1.10	0.144	0.161	0.82
1.17	1.01	1.07	0.111	0.120	0.61
1.20	1.01	1.05	0.120	0.128	0.65
1.16	1.01	1.04	0.105	0.110	0.57
1.11	1.01	1.02	0.085	0.087	0.46
1.19	1.01	1.02	0.116	0.120	0.64
1.13	1.01	1.01	0.096	0.098	0.53
1.21	1.01	1.00	0.124	0.125	2.00
1.29	1.02	0.98	0.149	0.150	2.00
1.28	1.02	0.97	0.146	0.144	2.00
1.24	1.02	0.96	0.134	0.131	2.00
2.20	1.08	0.86	2.000	1.864	2.00
1.24	1.02	0.94	0.135	0.129	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	1.0	0.003	0.04	23.34
4	2.0	0.051	1.22	23.31
6	2.0	0.000	0.00	22.09
8	3.8	0.045	2.04	22.09
13.5	5.3	0.045	2.82	20.05
18.5	5.0	0.031	1.85	17.23
23.5	5.0	0.040	2.38	15.37
28.5	5.0	0.037	2.21	13.00
33.5	5.0	0.042	2.52	10.78
38.5	5.0	0.054	3.22	8.27
43.5	5.0	0.038	2.27	5.05
48.5	5.0	0.046	2.78	2.78
53.5	5.0	0.000	0.00	0.00
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	4.0	0.000	0.00	0.00
81.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:41 PM
Boring Designation:	B-5
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	80
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.12
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	4	SP-SM	7	100		
2	4.0	6	SP-SM	7	100		
3	6.0	34	SM	15	120		
4	8.0	15	SM	15	120		
5	13.5	2	SM	20	100		
6	18.5	25	SP-SM	11	120		
7	23.5	5	SP-SM	11	100		
8	28.5	0	SM	33	100		
9	33.5	2	SM	33	100		
10	38.5	2	SM	21	100		
11	43.5	7	SM	21	100		
12	48.5	10	SM	26	100		
13	53.5	6	SM	26	100		
14	58.5	5	MH	50	120		Clay
15	63.5	4	MH	50	120		Clay
16	68.5	5	MH	50	120		Clay
17	73.5	5	MH	50	120		Clay
18	78.5	43	GC	15	120		Clay
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	4.0	SP-SM	6.6	100.0		200	75	1.33	1.00	0.75	1.00	4.00	1.70	6.80	0.08	6.88	1.002	0.208
2	4.0	6.0	SP-SM	6.6	100.0		400	150	1.33	1.00	0.75	1.00	6.00	1.70	10.20	0.08	10.28	0.997	0.207
3	6.0	34.0	SM	14.6	120.0		640	266	1.33	1.00	0.80	1.00	36.27	1.70	61.65	3.12	64.78	0.991	0.186
4	8.0	15.0	SM	14.6	120.0		880	381	1.33	1.00	0.80	1.00	16.00	1.70	27.20	3.12	30.32	0.985	0.178
5	13.5	2.0	SM	19.7	100.0		1430	588	1.33	1.00	0.85	1.00	2.27	1.70	3.85	4.43	8.28	0.966	0.183
6	18.5	25.0	SP-SM	10.5	120.0		2030	876	1.33	1.00	0.95	1.00	31.67	1.29	40.74	1.38	42.12	0.947	0.171
7	23.5	5.0	SP-SM	10.5	100.0		2530	1064	1.33	1.00	0.95	1.00	6.33	1.44	9.15	1.38	10.53	0.926	0.172
8	28.5	0.0	SM	32.8	100.0		3030	1252	1.33	1.00	1.00	1.00	0.00	1.37	0.00	5.46	5.46	0.903	0.170
9	33.5	2.0	SM	32.8	100.0		3530	1440	1.33	1.00	1.00	1.00	2.67	1.24	3.30	5.46	8.76	0.879	0.168
10	38.5	2.0	SM	20.9	100.0		4030	1628	1.33	1.00	1.00	1.00	2.67	1.16	3.10	4.62	7.72	0.855	0.165
11	43.5	7.0	SM	20.9	100.0		4530	1816	1.33	1.00	1.00	1.00	9.33	1.08	10.06	4.62	14.68	0.830	0.162
12	48.5	10.0	SM	26.0	100.0		5030	2004	1.33	1.00	1.00	1.00	13.33	1.02	13.67	5.15	18.81	0.805	0.158
13	53.5	6.0	SM	26.0	100.0		5530	2192	1.33	1.00	1.00	1.00	8.00	0.98	7.86	5.15	13.01	0.781	0.154
14	58.5	5.0	MH	50.0	120.0	Clay	6130	2480	1.33	1.00	1.00	1.00	6.67	0.92	6.14	5.61	11.75	0.757	0.146
15	63.5	4.0	MH	50.0	120.0	Clay	6730	2768	1.33	1.00	1.00	1.00	5.33	0.87	4.62	5.61	10.23	0.734	0.139
16	68.5	5.0	MH	50.0	120.0	Clay	7330	3056	1.33	1.00	1.00	1.00	6.67	0.82	5.49	5.61	11.11	0.712	0.133
17	73.5	5.0	MH	50.0	120.0	Clay	7930	3344	1.33	1.00	1.00	1.00	6.67	0.78	5.23	5.61	10.84	0.691	0.128
18	78.5	43.0	GC	15.0	120.0	Clay	8530	3632	1.33	1.00	1.00	1.00	57.33	0.87	49.74	3.26	53.00	0.672	0.123
19																			
20																			
21																			
22																			
23																			
24																			
25																			
26																			
27																			
28																			
29																			
30																			
31																			
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.14	1.01	1.10	0.097	0.108	0.52
1.20	1.01	1.10	0.120	0.134	0.65
2.20	1.08	1.10	2.000	2.000	2.00
2.02	1.07	1.10	0.506	0.595	2.00
1.16	1.01	1.10	0.106	0.118	0.65
2.20	1.08	1.10	2.000	2.000	2.00
1.20	1.01	1.06	0.122	0.131	0.77
1.12	1.01	1.04	0.089	0.093	0.55
1.17	1.01	1.03	0.110	0.115	0.68
1.15	1.01	1.02	0.103	0.106	0.64
1.31	1.02	1.02	0.153	0.159	0.99
1.45	1.03	1.01	0.192	0.199	1.26
1.26	1.02	1.00	0.140	0.142	0.92
1.23	1.02	0.98	0.131	0.131	2.00
1.20	1.01	0.98	0.120	0.118	2.00
1.21	1.01	0.96	0.126	0.123	2.00
1.21	1.01	0.96	0.124	0.120	2.00
2.20	1.08	0.84	2.000	1.818	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	3.0	0.046	1.64	18.07
4	2.0	0.037	0.88	16.43
6	2.0	0.000	0.00	15.55
8	3.8	0.000	0.00	15.55
13.5	5.3	0.042	2.61	15.55
18.5	5.0	0.000	0.00	12.93
23.5	5.0	0.036	2.17	12.93
28.5	5.0	0.051	3.04	10.76
33.5	5.0	0.040	2.42	7.72
38.5	5.0	0.043	2.58	5.30
43.5	5.0	0.014	0.83	2.72
48.5	5.0	0.005	0.29	1.89
53.5	5.0	0.027	1.61	1.61
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	4.0	0.000	0.00	0.00
81.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:42 PM
Boring Designation:	B-6
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	80
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.12
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	12	SM	17	100		
2	4.0	9	SM	17	100		
3	6.0	16	SM	16	120		
4	8.0	26	SM	16	120		
5	13.5	0	SM	26	100		
6	18.5	20	SM	14	120		
7	23.5	33	SM	14	120		
8	28.5	0	SP-SM	11	100		
9	33.5	4	SM	18	100		
10	38.5	13	SM	18	100		
11	43.5	25	SM	18	120		
12	48.5	33	SM	18	120		
13	53.5	8	SM	18	100		
14	58.5	5	MH	50	120		Clay
15	63.5	5	MH	50	120		Clay
16	68.5	7	MH	50	120		Clay
17	73.5	6	MH	50	120		Clay
18	78.5	100	ML	50	120		Clay
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	12.0	SM	17.2	100.0		200	75	1.33	1.00	0.75	1.00	12.00	1.70	20.40	3.90	24.30	1.002	0.208
2	4.0	9.0	SM	17.2	100.0		400	150	1.33	1.00	0.75	1.00	9.00	1.70	15.30	3.90	19.20	0.997	0.207
3	6.0	16.0	SM	15.7	120.0		640	266	1.33	1.00	0.80	1.00	17.07	1.70	29.01	3.49	32.50	0.991	0.186
4	8.0	26.0	SM	15.7	120.0		880	381	1.33	1.00	0.80	1.00	27.73	1.57	43.55	3.49	47.03	0.985	0.178
5	13.5	0.0	SM	26.1	100.0		1430	588	1.33	1.00	0.85	1.00	0.00	1.70	0.00	5.15	5.15	0.966	0.183
6	18.5	20.0	SM	13.7	120.0		2030	876	1.33	1.00	0.95	1.00	25.33	1.33	33.62	2.79	36.41	0.947	0.171
7	23.5	33.0	SM	13.7	120.0		2630	1164	1.33	1.00	0.95	1.00	41.80	1.17	48.92	2.79	51.71	0.926	0.163
8	28.5	0.0	SP-SM	11.0	100.0		3130	1352	1.33	1.00	1.00	1.00	0.00	1.36	0.00	1.61	1.61	0.903	0.163
9	33.5	4.0	SM	18.3	100.0		3630	1540	1.33	1.00	1.00	1.00	5.33	1.19	6.32	4.16	10.48	0.879	0.162
10	38.5	13.0	SM	18.3	100.0		4130	1728	1.33	1.00	1.00	1.00	17.33	1.09	18.86	4.16	23.01	0.855	0.159
11	43.5	25.0	SM	18.3	120.0		4730	2016	1.33	1.00	1.00	1.00	33.33	1.02	33.84	4.16	38.00	0.830	0.152
12	48.5	33.0	SM	18.3	120.0		5330	2304	1.33	1.00	1.00	1.00	44.00	0.98	43.03	4.16	47.18	0.805	0.145
13	53.5	8.0	SM	18.3	100.0		5830	2492	1.33	1.00	1.00	1.00	10.67	0.92	9.84	4.16	13.99	0.781	0.142
14	58.5	5.0	MH	50.0	120.0	Clay	6430	2780	1.33	1.00	1.00	1.00	6.67	0.87	5.78	5.61	11.39	0.757	0.137
15	63.5	5.0	MH	50.0	120.0	Clay	7030	3068	1.33	1.00	1.00	1.00	6.67	0.82	5.48	5.61	11.09	0.734	0.131
16	68.5	7.0	MH	50.0	120.0	Clay	7630	3356	1.33	1.00	1.00	1.00	9.33	0.79	7.39	5.61	13.00	0.712	0.126
17	73.5	6.0	MH	50.0	120.0	Clay	8230	3644	1.33	1.00	1.00	1.00	8.00	0.75	6.02	5.61	11.64	0.691	0.122
18	78.5	100.0	ML	50.0	120.0	Clay	8830	3932	1.33	1.00	1.00	1.00	133.33	0.85	113.28	5.61	118.89	0.672	0.118
19																			
20																			
21																			
22																			
23																			
24																			
25																			
26																			
27																			
28																			
29																			
30																			
31																			
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.69	1.05	1.10	0.274	0.316	1.52
1.46	1.03	1.10	0.197	0.223	1.08
2.15	1.08	1.10	0.698	0.828	2.00
2.20	1.08	1.10	2.000	2.000	2.00
1.12	1.01	1.10	0.087	0.096	0.53
2.20	1.08	1.10	1.514	1.802	2.00
2.20	1.08	1.10	2.000	2.000	2.00
1.09	1.01	1.03	0.068	0.071	0.43
1.20	1.01	1.03	0.121	0.127	0.78
1.62	1.04	1.03	0.250	0.268	1.68
2.20	1.08	1.01	2.000	2.000	2.00
2.20	1.08	0.97	2.000	2.000	2.00
1.29	1.02	0.98	0.148	0.148	1.04
1.22	1.01	0.97	0.128	0.126	2.00
1.21	1.01	0.96	0.126	0.123	2.00
1.26	1.02	0.95	0.140	0.136	2.00
1.23	1.02	0.95	0.130	0.125	2.00
2.20	1.08	0.82	2.000	1.768	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	3.0	0.002	0.09	10.96
4	2.0	0.008	0.20	10.88
6	2.0	0.000	0.00	10.68
8	3.8	0.000	0.00	10.68
13.5	5.3	0.052	3.27	10.68
18.5	5.0	0.000	0.00	7.41
23.5	5.0	0.000	0.00	7.41
28.5	5.0	0.075	4.51	7.41
33.5	5.0	0.036	2.18	2.90
38.5	5.0	0.001	0.08	0.72
43.5	5.0	0.000	0.00	0.64
48.5	5.0	0.000	0.00	0.64
53.5	5.0	0.011	0.64	0.64
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	4.0	0.000	0.00	0.00
81.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:48 PM
Boring Designation:	B-7
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.14
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	9	SM	13	100		
2	4.0	4	SM	13	100		
3	6.0	0	SM	18	100		
4	8.0	1	SM	18	100		
5	13.5	2	SM	31	100		
6	18.5	4	SP-SM	11	100		
7	23.5	17	SP-SM	11	100		
8	28.5	4	SP-SM	11	100		
9	33.5	2	CL	50	100		Clay
10	38.5	1	SM	18	100		
11	43.5	4	SM	18	100		
12	48.5	5	SM	18	100		
13	53.5	10	ML	50	120		Clay
14	58.5	4	ML	50	120		Clay
15	63.5	8	ML	50	120		Clay
16	68.5	8	SM	15	120		Clay
17	73.5	100	SM	15	120		Clay
18	78.5	12	SM	15	120		Clay
19	83.5	6	SM	15	120		Clay
20	88.5	6	SM	15	120		Clay
21	93.5	12	SM	15	120		Clay
22	98.5	13	SM	15	120		Clay
23	103.5	11	SM	15	120		Clay
24	108.5	6	SM	15	120		Clay
25	113.5	11	SM	15	120		Clay
26	118.5	9	SM	15	120		Clay
27	123.5	7	SM	15	120		Clay
28	128.5	13	SM	15	120		Clay
29	133.5	12	SM	15	120		Clay
30	138.5	11	SM	15	120		Clay
31	143.5	9	SM	15	120		Clay
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

Liquefaction Calculations B-7 (FEE)

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
									IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	9.0	SM	12.8	100.0		200	75	1.39	1.00	0.75	1.00	9.35	1.70	15.89	2.42	18.32	1.002	0.242
2	4.0	4.0	SM	12.8	100.0		400	150	1.39	1.00	0.75	1.00	4.16	1.70	7.06	2.42	9.49	0.997	0.241
3	6.0	0.0	SM	18.2	100.0		600	226	1.39	1.00	0.80	1.00	0.00	1.70	0.00	4.13	4.13	0.991	0.240
4	8.0	1.0	SM	18.2	100.0		800	301	1.39	1.00	0.80	1.00	1.11	1.70	1.88	4.13	6.02	0.985	0.238
5	13.5	2.0	SM	31.3	100.0		1350	508	1.39	1.00	0.85	1.00	2.35	1.70	4.00	5.41	9.41	0.966	0.234
6	18.5	4.0	SP-SM	10.8	100.0		1850	696	1.39	1.00	0.95	1.00	5.26	1.70	8.95	1.52	10.47	0.947	0.229
7	23.5	17.0	SP-SM	10.8	100.0		2350	884	1.39	1.00	0.95	1.00	22.37	1.36	30.37	1.52	31.89	0.926	0.224
8	28.5	4.0	SP-SM	10.8	100.0		2850	1072	1.39	1.00	1.00	1.00	5.54	1.45	8.04	1.52	9.55	0.903	0.219
9	33.5	2.0	CL	50.0	100.0	Clay	3350	1260	1.39	1.00	1.00	1.00	2.77	1.33	3.68	5.61	9.30	0.879	0.213
10	38.5	1.0	SM	17.9	100.0		3850	1448	1.39	1.00	1.00	1.00	1.39	1.26	1.74	4.07	5.81	0.855	0.207
11	43.5	4.0	SM	17.9	100.0		4350	1636	1.39	1.00	1.00	1.00	5.54	1.15	6.36	4.07	10.43	0.830	0.201
12	48.5	5.0	SM	17.9	100.0		4850	1824	1.39	1.00	1.00	1.00	6.93	1.08	7.49	4.07	11.55	0.805	0.195
13	53.5	10.0	ML	50.0	120.0	Clay	5450	2112	1.39	1.00	1.00	1.00	13.85	1.00	13.86	5.61	19.48	0.781	0.183
14	58.5	4.0	ML	50.0	120.0	Clay	6050	2400	1.39	1.00	1.00	1.00	5.54	0.94	5.18	5.61	10.80	0.757	0.174
15	63.5	8.0	ML	50.0	120.0	Clay	6650	2688	1.39	1.00	1.00	1.00	11.08	0.89	9.87	5.61	15.49	0.734	0.165
16	68.5	8.0	SM	15.0	120.0	Clay	7250	2976	1.39	1.00	1.00	1.00	11.08	0.84	9.31	3.26	12.57	0.712	0.158
17	73.5	100.0	SM	15.0	120.0	Clay	7850	3264	1.39	1.00	1.00	1.00	138.50	0.89	123.58	3.26	126.84	0.691	0.151
18	78.5	12.0	SM	15.0	120.0	Clay	8450	3552	1.39	1.00	1.00	1.00	16.62	0.78	13.00	3.26	16.26	0.672	0.145
19	83.5	6.0	SM	15.0	120.0	Clay	9050	3840	1.39	1.00	1.00	1.00	8.31	0.72	5.99	3.26	9.25	0.654	0.140
20	88.5	6.0	SM	15.0	120.0	Clay	9650	4128	1.39	1.00	1.00	1.00	8.31	0.69	5.74	3.26	9.00	0.639	0.136
21	93.5	12.0	SM	15.0	120.0	Clay	10250	4416	1.39	1.00	1.00	1.00	16.62	0.70	11.61	3.26	14.87	0.625	0.132
22	98.5	13.0	SM	15.0	120.0	Clay	10850	4704	1.39	1.00	1.00	1.00	18.01	0.68	12.26	3.26	15.52	0.613	0.129
23	103.5	11.0	SM	15.0	120.0	Clay	11450	4992	1.39	1.00	1.00	1.00	15.24	0.65	9.87	3.26	13.13	0.603	0.126
24	108.5	6.0	SM	15.0	120.0	Clay	12050	5280	1.39	1.00	1.00	1.00	8.31	0.60	4.96	3.26	8.22	0.596	0.124
25	113.5	11.0	SM	15.0	120.0	Clay	12650	5568	1.39	1.00	1.00	1.00	15.24	0.61	9.28	3.26	12.55	0.590	0.122
26	118.5	9.0	SM	15.0	120.0	Clay	13250	5856	1.39	1.00	1.00	1.00	12.47	0.58	7.23	3.26	10.49	0.587	0.121
27	123.5	7.0	SM	15.0	120.0	Clay	13850	6144	1.39	1.00	1.00	1.00	9.70	0.55	5.34	3.26	8.61	0.586	0.120
28	128.5	13.0	SM	15.0	120.0	Clay	14450	6432	1.39	1.00	1.00	1.00	18.01	0.57	10.32	3.26	13.58	0.588	0.120
29	133.5	12.0	SM	15.0	120.0	Clay	15050	6720	1.39	1.00	1.00	1.00	16.62	0.55	9.19	3.26	12.45	0.592	0.121
30	138.5	11.0	SM	15.0	120.0	Clay	15650	7008	1.39	1.00	1.00	1.00	15.24	0.53	8.13	3.26	11.39	0.598	0.122
31	143.5	9.0	SM	15.0	120.0	Clay	16250	7296	1.39	1.00	1.00	1.00	12.47	0.51	6.34	3.26	9.60	0.607	0.123
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.43	1.03	1.10	0.187	0.212	0.87
1.18	1.01	1.10	0.115	0.128	0.53
1.11	1.01	1.10	0.081	0.090	0.38
1.13	1.01	1.10	0.092	0.102	0.43
1.18	1.01	1.10	0.114	0.127	0.54
1.20	1.01	1.10	0.121	0.135	0.59
2.11	1.08	1.10	0.633	0.749	2.00
1.18	1.01	1.06	0.115	0.124	0.57
1.18	1.01	1.05	0.113	0.120	2.00
1.12	1.01	1.03	0.091	0.094	0.46
1.20	1.01	1.02	0.121	0.126	0.63
1.22	1.02	1.01	0.129	0.133	0.68
1.47	1.03	1.00	0.200	0.206	2.00
1.21	1.01	0.99	0.124	0.124	2.00
1.33	1.02	0.97	0.160	0.159	2.00
1.25	1.02	0.97	0.137	0.134	2.00
2.20	1.08	0.87	2.000	1.886	2.00
1.36	1.02	0.94	0.167	0.161	2.00
1.18	1.01	0.95	0.113	0.108	2.00
1.17	1.01	0.94	0.111	0.106	2.00
1.31	1.02	0.92	0.155	0.145	2.00
1.33	1.02	0.91	0.161	0.149	2.00
1.26	1.02	0.91	0.141	0.131	2.00
1.16	1.01	0.92	0.106	0.099	2.00
1.25	1.02	0.90	0.137	0.125	2.00
1.20	1.01	0.90	0.122	0.111	2.00
1.16	1.01	0.91	0.109	0.100	2.00
1.28	1.02	0.88	0.145	0.130	2.00
1.25	1.02	0.88	0.136	0.122	2.00
1.22	1.01	0.88	0.128	0.115	2.00
1.18	1.01	0.89	0.115	0.104	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	3.0	0.018	0.65	19.24
4	2.0	0.039	0.92	18.59
6	2.0	0.057	1.36	17.66
8	3.8	0.049	2.18	16.30
13.5	5.3	0.039	2.44	14.12
18.5	5.0	0.036	2.18	11.68
23.5	5.0	0.000	0.00	9.50
28.5	5.0	0.038	2.30	9.50
33.5	5.0	0.000	0.00	7.20
38.5	5.0	0.049	2.96	7.20
43.5	5.0	0.036	2.19	4.24
48.5	5.0	0.034	2.05	2.05
53.5	5.0	0.000	0.00	0.00
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.0	0.000	0.00	0.00
103.5	5.0	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	5.0	0.000	0.00	0.00
128.5	5.0	0.000	0.00	0.00
133.5	5.0	0.000	0.00	0.00
138.5	5.0	0.000	0.00	0.00
143.5	4.0	0.000	0.00	0.00
146.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:49 PM
Boring Designation:	B-8
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.14
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	2.0	3	SP-SM	12	100		
2	4.0	5	SP-SM	12	100		
3	6.0	4	SP-SM	12	100		
4	8.0	2	SP-SM	12	100		
5	10.0	2	SP-SM	12	100		
6	13.5	0	CL	68	95		Clay
7	18.5	0	CL	68	95		Clay
8	23.5	0	SC	35	100		
9	28.5	2	SM	22	100		
10	33.5	4	SM	22	100		
11	38.5	2	CL	50	95		Clay
12	43.5	8	SP-SM	7	100		
13	48.5	7	SP-SM	8	100		
14	53.5	5	SM	15	120		Clay
15	58.5	6	ML	50	120		Clay
16	63.5	6	ML	50	120		Clay
17	68.5	5	ML	50	120		Clay
18	73.5	18	ML	50	120		Clay
19	78.5	13	SM	15	120		Clay
20	83.5	5	SM	15	120		Clay
21	88.5	8	SM	15	120		Clay
22	93.5	9	SM	15	120		Clay
23	98.5	8	SM	15	120		Clay
24	103.5	9	SM	15	120		Clay
25	108.5	6	SM	15	120		Clay
26	113.5	12	SM	15	120		Clay
27	118.5	9	SM	15	120		Clay
28	123.5	7	SM	15	120		Clay
29	128.5	19	SM	15	120		Clay
30	133.5	11	SM	15	120		Clay
31	138.5		SM	15	120		Clay
32	143.5	10	SM	15	120		Clay
33	148.5	11	SM	15	120		Clay
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

Liquefaction Calculations B-8 (FEE)

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
									IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	2.0	3.0	SP-SM	11.9	100.0		200	75	1.39	1.00	0.75	1.00	3.12	1.70	5.30	2.03	7.32	1.002	0.242
2	4.0	5.0	SP-SM	11.9	100.0		400	150	1.39	1.00	0.75	1.00	5.19	1.70	8.83	2.03	10.86	0.997	0.241
3	6.0	4.0	SP-SM	11.9	100.0		600	226	1.39	1.00	0.80	1.00	4.43	1.70	7.53	2.03	9.56	0.991	0.240
4	8.0	2.0	SP-SM	11.9	100.0		800	301	1.39	1.00	0.80	1.00	2.22	1.70	3.77	2.03	5.79	0.985	0.238
5	10.0	2.0	SP-SM	11.9	100.0		1000	376	1.39	1.00	0.85	1.00	2.35	1.70	4.00	2.03	6.03	0.978	0.237
6	13.5	0.0	CL	67.5	95.0	Clay	1333	490	1.39	1.00	0.85	1.00	0.00	1.70	0.00	5.58	5.58	0.966	0.239
7	18.5	0.0	CL	67.5	95.0	Clay	1808	653	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.58	5.58	0.947	0.238
8	23.5	0.0	SC	34.9	100.0		2308	841	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.50	5.50	0.926	0.231
9	28.5	2.0	SM	22.0	100.0		2808	1029	1.39	1.00	1.00	1.00	2.77	1.49	4.13	4.77	8.90	0.903	0.224
10	33.5	4.0	SM	22.0	100.0		3308	1217	1.39	1.00	1.00	1.00	5.54	1.33	7.37	4.77	12.14	0.879	0.217
11	38.5	2.0	CL	50.0	95.0	Clay	3783	1380	1.39	1.00	1.00	1.00	2.77	1.27	3.51	5.61	9.12	0.855	0.213
12	43.5	8.0	SP-SM	6.5	100.0		4283	1568	1.39	1.00	1.00	1.00	11.08	1.16	12.90	0.07	12.97	0.830	0.206
13	48.5	7.0	SP-SM	8.2	100.0		4783	1756	1.39	1.00	1.00	1.00	9.70	1.10	10.70	0.43	11.13	0.805	0.200
14	53.5	5.0	SM	15.0	120.0	Clay	5383	2044	1.39	1.00	1.00	1.00	6.93	1.02	7.05	3.26	10.32	0.781	0.187
15	58.5	6.0	ML	50.0	120.0	Clay	5983	2332	1.39	1.00	1.00	1.00	8.31	0.95	7.91	5.61	13.53	0.757	0.177
16	63.5	6.0	ML	50.0	120.0	Clay	6583	2620	1.39	1.00	1.00	1.00	8.31	0.90	7.46	5.61	13.07	0.734	0.168
17	68.5	5.0	ML	50.0	120.0	Clay	7183	2908	1.39	1.00	1.00	1.00	6.93	0.85	5.86	5.61	11.48	0.712	0.160
18	73.5	18.0	ML	50.0	120.0	Clay	7783	3196	1.39	1.00	1.00	1.00	24.93	0.85	21.26	5.61	26.88	0.691	0.153
19	78.5	13.0	SM	15.0	120.0	Clay	8383	3484	1.39	1.00	1.00	1.00	18.01	0.79	14.30	3.26	17.56	0.672	0.147
20	83.5	5.0	SM	15.0	120.0	Clay	8983	3772	1.39	1.00	1.00	1.00	6.93	0.72	5.00	3.26	8.26	0.654	0.142
21	88.5	8.0	SM	15.0	120.0	Clay	9583	4060	1.39	1.00	1.00	1.00	11.08	0.71	7.85	3.26	11.12	0.639	0.137
22	93.5	9.0	SM	15.0	120.0	Clay	10183	4348	1.39	1.00	1.00	1.00	12.47	0.69	8.57	3.26	11.83	0.625	0.133
23	98.5	8.0	SM	15.0	120.0	Clay	10783	4636	1.39	1.00	1.00	1.00	11.08	0.66	7.29	3.26	10.55	0.613	0.130
24	103.5	9.0	SM	15.0	120.0	Clay	11383	4924	1.39	1.00	1.00	1.00	12.47	0.64	7.99	3.26	11.25	0.603	0.127
25	108.5	6.0	SM	15.0	120.0	Clay	11983	5212	1.39	1.00	1.00	1.00	8.31	0.60	5.00	3.26	8.26	0.596	0.125
26	113.5	12.0	SM	15.0	120.0	Clay	12583	5500	1.39	1.00	1.00	1.00	16.62	0.62	10.30	3.26	13.56	0.590	0.123
27	118.5	9.0	SM	15.0	120.0	Clay	13183	5788	1.39	1.00	1.00	1.00	12.47	0.58	7.28	3.26	10.54	0.587	0.122
28	123.5	7.0	SM	15.0	120.0	Clay	13783	6076	1.39	1.00	1.00	1.00	9.70	0.55	5.38	3.26	8.64	0.586	0.121
29	128.5	19.0	SM	15.0	120.0	Clay	14383	6364	1.39	1.00	1.00	1.00	26.32	0.61	16.10	3.26	19.36	0.588	0.121
30	133.5	11.0	SM	15.0	120.0	Clay	14983	6652	1.39	1.00	1.00	1.00	15.24	0.55	8.38	3.26	11.64	0.592	0.121
31	138.5	0.0	SM	15.0	120.0	Clay	15583	6940	1.39	1.00	1.00	1.00	0.00	0.46	0.00	3.26	3.26	0.598	0.122
32	143.5	10.0	SM	15.0	120.0	Clay	16183	7228	1.39	1.00	1.00	1.00	13.85	0.52	7.17	3.26	10.43	0.607	0.124
33	148.5	11.0	SM	15.0	120.0	Clay	16783	7516	1.39	1.00	1.00	1.00	15.24	0.51	7.80	3.26	11.06	0.618	0.126
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.14	1.01	1.10	0.100	0.111	0.46
1.21	1.01	1.10	0.124	0.138	0.57
1.18	1.01	1.10	0.115	0.128	0.53
1.12	1.01	1.10	0.091	0.101	0.42
1.13	1.01	1.10	0.092	0.102	0.43
1.12	1.01	1.10	0.090	0.099	2.00
1.12	1.01	1.09	0.090	0.099	2.00
1.12	1.01	1.07	0.089	0.096	0.42
1.17	1.01	1.06	0.111	0.119	0.53
1.24	1.02	1.06	0.133	0.143	0.66
1.17	1.01	1.04	0.112	0.118	2.00
1.26	1.02	1.03	0.140	0.147	0.71
1.21	1.01	1.02	0.126	0.130	0.65
1.20	1.01	1.00	0.120	0.122	2.00
1.27	1.02	0.99	0.144	0.145	2.00
1.26	1.02	0.98	0.141	0.140	2.00
1.22	1.02	0.97	0.129	0.127	2.00
1.82	1.06	0.93	0.342	0.335	2.00
1.40	1.03	0.94	0.179	0.173	2.00
1.16	1.01	0.95	0.106	0.102	2.00
1.21	1.01	0.94	0.126	0.120	2.00
1.23	1.02	0.93	0.131	0.124	2.00
1.20	1.01	0.93	0.122	0.114	2.00
1.22	1.01	0.92	0.127	0.118	2.00
1.16	1.01	0.92	0.106	0.099	2.00
1.28	1.02	0.90	0.144	0.132	2.00
1.20	1.01	0.91	0.122	0.112	2.00
1.17	1.01	0.91	0.109	0.100	2.00
1.47	1.03	0.86	0.198	0.175	2.00
1.23	1.02	0.89	0.130	0.117	2.00
1.10	1.01	0.92	0.077	0.071	2.00
1.20	1.01	0.88	0.121	0.109	2.00
1.21	1.01	0.88	0.126	0.112	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
2	3.0	0.044	1.59	17.57
4	2.0	0.036	0.85	15.98
6	2.0	0.038	0.92	15.13
8	2.0	0.049	1.18	14.21
10	2.8	0.048	1.60	13.02
13.5	4.3	0.000	0.00	11.42
18.5	5.0	0.000	0.00	11.42
23.5	5.0	0.050	3.03	11.42
28.5	5.0	0.040	2.39	8.39
33.5	5.0	0.033	1.99	6.00
38.5	5.0	0.000	0.00	4.01
43.5	5.0	0.032	1.91	4.01
48.5	5.0	0.035	2.10	2.10
53.5	5.0	0.000	0.00	0.00
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.0	0.000	0.00	0.00
103.5	5.0	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	5.0	0.000	0.00	0.00
128.5	5.0	0.000	0.00	0.00
133.5	5.0	0.000	0.00	0.00
138.5	5.0	0.000	0.00	0.00
143.5	5.0	0.000	0.00	0.00
148.5	4.0	0.000	0.00	0.00
151.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 6:08 PM
Boring Designation:	B-9
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.14
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	0.5	0	ML	50	95		Clay
2	2.0	5	SP-SM	8	100		
3	4.0	6	SP-SM	7	100		
4	6.0	0	SP-SM	7	100		
5	8.0	2	SP-SM	10	100		
6	13.5	0	SP-SM	10	100		
7	18.5	0	CL	79	95		Clay
8	23.5	0	CL	79	95		Clay
9	28.5	0	CL	79	95		Clay
10	33.5	1	CL	79	95		Clay
11	38.5	2	CL	79	95		Clay
12	43.5	7	SP-SM	8	100		
13	48.5	4	SP-SM	8	100		
14	53.5	4	ML	50	120		Clay
15	58.5	5	ML	50	120		Clay
16	63.5	7	ML	50	120		Clay
17	68.5	5	ML	50	120		Clay
18	73.5	13	ML	50	120		Clay
19	78.5	100	SM	15	120		Clay
20	83.5	5	SM	15	120		Clay
21	88.5	8	SM	15	120		Clay
22	93.5	8	SM	15	120		Clay
23	98.5	8	SM	15	120		Clay
24	103.5	14	SM	15	120		Clay
25	108.5	8	SM	15	120		Clay
26	113.5	7	SM	15	120		Clay
27	118.5	7	SM	15	120		Clay
28	123.5	6	SM	15	120		Clay
29	128.5	6	SM	15	120		Clay
30	133.5	13	ML	50	120		Clay
31	138.5	11	ML	50	120		Clay
32	143.5	11	SM	15	120		Clay
33	148.5	10	SM	15	120		Clay
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
									IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	0.0	ML	50.0	95.0	Clay	48	16	1.39	1.00	0.75	1.00	0.00	1.70	0.00	5.61	5.61	1.005	0.267
2	2.0	5.0	SP-SM	7.7	100.0		198	73	1.39	1.00	0.75	1.00	5.19	1.70	8.83	0.28	9.11	1.002	0.248
3	4.0	6.0	SP-SM	7.2	100.0		398	148	1.39	1.00	0.75	1.00	6.23	1.70	10.60	0.17	10.77	0.997	0.244
4	6.0	0.0	SP-SM	7.0	100.0		598	223	1.39	1.00	0.80	1.00	0.00	1.70	0.00	0.14	0.14	0.991	0.241
5	8.0	2.0	SP-SM	10.3	100.0		798	298	1.39	1.00	0.80	1.00	2.22	1.70	3.77	1.29	5.05	0.985	0.240
6	13.5	0.0	SP-SM	10.0	100.0		1348	505	1.39	1.00	0.85	1.00	0.00	1.70	0.00	1.15	1.15	0.966	0.235
7	18.5	0.0	CL	79.0	95.0	Clay	1823	668	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.55	5.55	0.947	0.235
8	23.5	0.0	CL	79.0	95.0	Clay	2298	831	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.55	5.55	0.926	0.233
9	28.5	0.0	CL	79.1	95.0	Clay	2773	994	1.39	1.00	1.00	1.00	0.00	1.58	0.00	5.55	5.55	0.903	0.229
10	33.5	1.0	CL	79.0	95.0	Clay	3248	1157	1.39	1.00	1.00	1.00	1.39	1.41	1.96	5.55	7.51	0.879	0.225
11	38.5	2.0	CL	79.0	95.0	Clay	3723	1320	1.39	1.00	1.00	1.00	2.77	1.30	3.59	5.55	9.14	0.855	0.219
12	43.5	7.0	SP-SM	7.5	100.0		4223	1508	1.39	1.00	1.00	1.00	9.70	1.19	11.56	0.23	11.80	0.830	0.211
13	48.5	4.0	SP-SM	8.0	100.0		4723	1696	1.39	1.00	1.00	1.00	5.54	1.14	6.31	0.37	6.67	0.805	0.204
14	53.5	4.0	ML	50.0	120.0	Clay	5323	1984	1.39	1.00	1.00	1.00	5.54	1.03	5.73	5.61	11.35	0.781	0.191
15	58.5	5.0	ML	50.0	120.0	Clay	5923	2272	1.39	1.00	1.00	1.00	6.93	0.96	6.68	5.61	12.29	0.757	0.180
16	63.5	7.0	ML	50.0	120.0	Clay	6523	2560	1.39	1.00	1.00	1.00	9.70	0.91	8.83	5.61	14.44	0.734	0.170
17	68.5	5.0	ML	50.0	120.0	Clay	7123	2848	1.39	1.00	1.00	1.00	6.93	0.86	5.93	5.61	11.54	0.712	0.162
18	73.5	13.0	ML	50.0	120.0	Clay	7723	3136	1.39	1.00	1.00	1.00	18.01	0.84	15.18	5.61	20.79	0.691	0.155
19	78.5	100.0	SM	15.0	120.0	Clay	8323	3424	1.39	1.00	1.00	1.00	138.50	0.88	122.03	3.26	125.29	0.672	0.149
20	83.5	5.0	SM	15.0	120.0	Clay	8923	3712	1.39	1.00	1.00	1.00	6.93	0.73	5.05	3.26	8.31	0.654	0.143
21	88.5	8.0	SM	15.0	120.0	Clay	9523	4000	1.39	1.00	1.00	1.00	11.08	0.71	7.92	3.26	11.18	0.639	0.138
22	93.5	8.0	SM	15.0	120.0	Clay	10123	4288	1.39	1.00	1.00	1.00	11.08	0.69	7.62	3.26	10.88	0.625	0.134
23	98.5	8.0	SM	15.0	120.0	Clay	10723	4576	1.39	1.00	1.00	1.00	11.08	0.66	7.34	3.26	10.60	0.613	0.131
24	103.5	14.0	SM	15.0	120.0	Clay	11323	4864	1.39	1.00	1.00	1.00	19.39	0.67	13.07	3.26	16.33	0.603	0.128
25	108.5	8.0	SM	15.0	120.0	Clay	11923	5152	1.39	1.00	1.00	1.00	11.08	0.62	6.85	3.26	10.12	0.596	0.125
26	113.5	7.0	SM	15.0	120.0	Clay	12523	5440	1.39	1.00	1.00	1.00	9.70	0.59	5.75	3.26	9.01	0.590	0.124
27	118.5	7.0	SM	15.0	120.0	Clay	13123	5728	1.39	1.00	1.00	1.00	9.70	0.57	5.57	3.26	8.84	0.587	0.122
28	123.5	6.0	SM	15.0	120.0	Clay	13723	6016	1.39	1.00	1.00	1.00	8.31	0.55	4.59	3.26	7.85	0.586	0.122
29	128.5	6.0	SM	15.0	120.0	Clay	14323	6304	1.39	1.00	1.00	1.00	8.31	0.54	4.46	3.26	7.72	0.588	0.121
30	133.5	13.0	ML	50.0	120.0	Clay	14923	6592	1.39	1.00	1.00	1.00	18.01	0.58	10.48	5.61	16.10	0.592	0.122
31	138.5	11.0	ML	50.0	120.0	Clay	15523	6880	1.39	1.00	1.00	1.00	15.24	0.56	8.49	5.61	14.11	0.598	0.123
32	143.5	11.0	SM	15.0	120.0	Clay	16123	7168	1.39	1.00	1.00	1.00	15.24	0.53	8.02	3.26	11.28	0.607	0.124
33	148.5	10.0	SM	15.0	120.0	Clay	16723	7456	1.39	1.00	1.00	1.00	13.85	0.51	7.04	3.26	10.30	0.618	0.126
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.12	1.01	1.10	0.090	0.100	2.00
1.17	1.01	1.10	0.112	0.125	0.50
1.21	1.01	1.10	0.123	0.138	0.57
1.09	1.01	1.10	0.061	0.068	0.28
1.12	1.01	1.10	0.086	0.096	0.40
1.09	1.01	1.09	0.066	0.072	0.31
1.12	1.01	1.09	0.089	0.098	2.00
1.12	1.01	1.07	0.089	0.097	2.00
1.12	1.01	1.06	0.089	0.095	2.00
1.15	1.01	1.05	0.101	0.108	2.00
1.17	1.01	1.04	0.112	0.118	2.00
1.23	1.02	1.03	0.131	0.137	0.65
1.13	1.01	1.02	0.096	0.099	0.48
1.22	1.01	1.01	0.128	0.130	2.00
1.24	1.02	0.99	0.135	0.136	2.00
1.30	1.02	0.98	0.151	0.151	2.00
1.22	1.02	0.97	0.129	0.127	2.00
1.53	1.04	0.95	0.216	0.212	2.00
2.20	1.08	0.86	2.000	1.856	2.00
1.16	1.01	0.95	0.107	0.103	2.00
1.22	1.01	0.94	0.126	0.120	2.00
1.21	1.01	0.93	0.124	0.118	2.00
1.20	1.01	0.93	0.122	0.115	2.00
1.36	1.02	0.90	0.168	0.155	2.00
1.19	1.01	0.92	0.119	0.110	2.00
1.17	1.01	0.92	0.111	0.103	2.00
1.17	1.01	0.91	0.110	0.102	2.00
1.15	1.01	0.91	0.104	0.095	2.00
1.15	1.01	0.91	0.103	0.094	2.00
1.35	1.02	0.87	0.166	0.147	2.00
1.29	1.02	0.87	0.149	0.133	2.00
1.22	1.01	0.88	0.127	0.114	2.00
1.20	1.01	0.88	0.120	0.107	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.000	0.00	16.45
2	1.8	0.039	0.83	16.45
4	2.0	0.036	0.86	15.62
6	2.0	0.105	2.51	14.76
8	3.8	0.052	2.36	12.25
13.5	5.3	0.081	5.09	9.89
18.5	5.0	0.000	0.00	4.80
23.5	5.0	0.000	0.00	4.80
28.5	5.0	0.000	0.00	4.80
33.5	5.0	0.000	0.00	4.80
38.5	5.0	0.000	0.00	4.80
43.5	5.0	0.034	2.03	4.80
48.5	5.0	0.046	2.78	2.78
53.5	5.0	0.000	0.00	0.00
58.5	5.0	0.000	0.00	0.00
63.5	5.0	0.000	0.00	0.00
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.0	0.000	0.00	0.00
103.5	5.0	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	5.0	0.000	0.00	0.00
128.5	5.0	0.000	0.00	0.00
133.5	5.0	0.000	0.00	0.00
138.5	5.0	0.000	0.00	0.00
143.5	5.0	0.000	0.00	0.00
148.5	4.0	0.000	0.00	0.00
151.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:51 PM
Boring Designation:	B-10
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	-2
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	7
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.14
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	0.5	0	SC	41	100		
2	2.0	0	SC	41	100		
3	4.0	6	SC	41	100		
4	6.0	2	SP-SM	8	100		
5	8.0	2	SP-SM	8	100		
6	10.0	2	ML	57	95		Clay
7	13.0	0	ML	57	95		Clay
8	18.0	0	ML	57	95		Clay
9	23.0	0	ML	57	95		Clay
10	28.5	0	ML	57	95		Clay
11	33.5	0	ML	57	95		Clay
12	38.5	1	ML	57	95		Clay
13	44.0	6	SP-SM	6	100		
14	49.0	17	SP-SM	6	100		
15	54.5	3	SM	31	120		Clay
16	59.5	6	SM	31	120		Clay
17	64.5	5	SM	31	120		Clay
18	69.5	8	SM	31	120		Clay
19	74.5	7	SM	15	120		Clay
20	79.5	11	SM	15	120		Clay
21	84.5	13	SM	15	120		Clay
22	89.5	16	SM	15	120		Clay
23	94.5	7	SM	15	120		Clay
24	99.5	11	SM	15	120		Clay
25	104.5	7	SM	15	120		Clay
26	109.5	7	SM	15	120		Clay
27	114.5	9	SM	15	120		Clay
28	119.5	6	SM	15	120		Clay
29	124.5	3	SM	15	120		Clay
30	128.0	6	SM	15	120		Clay
31	133.0	5	SM	15	120		Clay
32	140.0	8	SM	15	120		Clay
33	145.0	13	SM	15	120		Clay
34	150.0	10	SM	15	120		Clay
35	155.5	7	SM	15	120		Clay
36	160.0	7	SM	15	120		Clay
37	165.0	16	SM	15	120		Clay
38	170.0	9	SM	15	120		Clay
39	175.0	10	SM	15	120		Clay
40	180.0	18	SM	15	120		Clay
41	185.0	37	SM	15	120		Clay
42	189.5	10	SM	15	120		Clay
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
									IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	0.0	SC	41.0	100.0		175	19	1.39	1.00	0.75	1.00	0.00	1.70	0.00	5.58	5.58	1.005	0.851
2	2.0	0.0	SC	41.1	100.0		325	75	1.39	1.00	0.75	1.00	0.00	1.70	0.00	5.59	5.59	1.002	0.394
3	4.0	6.0	SC	41.0	100.0		525	150	1.39	1.00	0.80	1.00	6.65	1.70	11.30	5.58	16.89	0.997	0.316
4	6.0	2.0	SP-SM	7.9	100.0		725	226	1.39	1.00	0.80	1.00	2.22	1.70	3.77	0.34	4.11	0.991	0.290
5	8.0	2.0	SP-SM	8.0	100.0		925	301	1.39	1.00	0.85	1.00	2.35	1.70	4.00	0.37	4.37	0.985	0.276
6	10.0	2.0	ML	57.0	95.0	Clay	1115	366	1.39	1.00	0.85	1.00	2.35	1.70	4.00	5.61	9.61	0.978	0.271
7	13.0	0.0	ML	57.0	95.0	Clay	1400	464	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.61	5.61	0.968	0.266
8	18.0	0.0	ML	57.2	95.0	Clay	1875	627	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.61	5.61	0.949	0.258
9	23.0	0.0	ML	57.0	95.0	Clay	2350	790	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.61	5.61	0.928	0.251
10	28.5	0.0	ML	57.0	95.0	Clay	2872	969	1.39	1.00	1.00	1.00	0.00	1.60	0.00	5.61	5.61	0.903	0.244
11	33.5	0.0	ML	57.0	95.0	Clay	3347	1132	1.39	1.00	1.00	1.00	0.00	1.46	0.00	5.61	5.61	0.879	0.237
12	38.5	1.0	ML	57.0	95.0	Clay	3822	1295	1.39	1.00	1.00	1.00	1.39	1.33	1.84	5.61	7.44	0.855	0.230
13	44.0	6.0	SP-SM	6.0	100.0		4372	1502	1.39	1.00	1.00	1.00	8.31	1.20	10.00	0.03	10.03	0.827	0.219
14	49.0	17.0	SP-SM	6.0	100.0		4872	1690	1.39	1.00	1.00	1.00	23.55	1.09	25.73	0.03	25.76	0.803	0.211
15	54.5	3.0	SM	31.0	120.0	Clay	5532	2007	1.39	1.00	1.00	1.00	4.16	1.03	4.28	5.40	9.68	0.776	0.195
16	59.5	6.0	SM	31.0	120.0	Clay	6132	2295	1.39	1.00	1.00	1.00	8.31	0.96	7.98	5.40	13.38	0.752	0.183
17	64.5	5.0	SM	31.0	120.0	Clay	6732	2583	1.39	1.00	1.00	1.00	6.93	0.90	6.24	5.40	11.64	0.729	0.173
18	69.5	8.0	SM	31.0	120.0	Clay	7332	2871	1.39	1.00	1.00	1.00	11.08	0.86	9.55	5.40	14.95	0.708	0.164
19	74.5	7.0	SM	15.0	120.0	Clay	7932	3159	1.39	1.00	1.00	1.00	9.70	0.81	7.85	3.26	11.11	0.687	0.157
20	79.5	11.0	SM	15.0	120.0	Clay	8532	3447	1.39	1.00	1.00	1.00	15.24	0.79	12.03	3.26	15.29	0.668	0.151
21	84.5	13.0	SM	15.0	120.0	Clay	9132	3735	1.39	1.00	1.00	1.00	18.01	0.77	13.81	3.26	17.07	0.651	0.145
22	89.5	16.0	SM	15.0	120.0	Clay	9732	4023	1.39	1.00	1.00	1.00	22.16	0.75	16.69	3.26	19.96	0.636	0.140
23	94.5	7.0	SM	15.0	120.0	Clay	10332	4311	1.39	1.00	1.00	1.00	9.70	0.68	6.59	3.26	9.85	0.622	0.136
24	99.5	11.0	SM	15.0	120.0	Clay	10932	4599	1.39	1.00	1.00	1.00	15.24	0.68	10.33	3.26	13.59	0.611	0.132
25	104.5	7.0	SM	15.0	120.0	Clay	11532	4887	1.39	1.00	1.00	1.00	9.70	0.63	6.12	3.26	9.39	0.602	0.129
26	109.5	7.0	SM	15.0	120.0	Clay	12132	5175	1.39	1.00	1.00	1.00	9.70	0.61	5.92	3.26	9.18	0.594	0.127
27	114.5	9.0	SM	15.0	120.0	Clay	12732	5463	1.39	1.00	1.00	1.00	12.47	0.60	7.53	3.26	10.79	0.589	0.125
28	119.5	6.0	SM	15.0	120.0	Clay	13332	5751	1.39	1.00	1.00	1.00	8.31	0.57	4.71	3.26	7.98	0.587	0.124
29	124.5	3.0	SM	15.0	120.0	Clay	13932	6039	1.39	1.00	1.00	1.00	4.16	0.53	2.20	3.26	5.47	0.586	0.123
30	128.0	6.0	SM	15.0	120.0	Clay	14352	6240	1.39	1.00	1.00	1.00	8.31	0.54	4.48	3.26	7.75	0.587	0.123
31	133.0	5.0	SM	15.0	120.0	Clay	14952	6528	1.39	1.00	1.00	1.00	6.93	0.52	3.59	3.26	6.85	0.591	0.123
32	140.0	8.0	SM	15.0	120.0	Clay	15792	6932	1.39	1.00	1.00	1.00	11.08	0.52	5.75	3.26	9.01	0.600	0.124
33	145.0	13.0	SM	15.0	120.0	Clay	16392	7220	1.39	1.00	1.00	1.00	18.01	0.54	9.65	3.26	12.91	0.610	0.126
34	150.0	10.0	SM	15.0	120.0	Clay	16992	7508	1.39	1.00	1.00	1.00	13.85	0.51	7.01	3.26	10.27	0.622	0.128
35	155.5	7.0	SM	15.0	120.0	Clay	17652	7824	1.39	1.00	1.00	1.00	9.70	0.48	4.61	3.26	7.87	0.639	0.131
36	160.0	7.0	SM	15.0	120.0	Clay	18192	8084	1.39	1.00	1.00	1.00	9.70	0.47	4.52	3.26	7.78	0.655	0.134
37	165.0	16.0	SM	15.0	120.0	Clay	18792	8372	1.39	1.00	1.00	1.00	22.16	0.51	11.28	3.26	14.54	0.675	0.138
38	170.0	9.0	SM	15.0	120.0	Clay	19392	8660	1.39	1.00	1.00	1.00	12.47	0.46	5.71	3.26	8.97	0.697	0.142
39	175.0	10.0	SM	15.0	120.0	Clay	19992	8948	1.39	1.00	1.00	1.00	13.85	0.45	6.30	3.26	9.56	0.722	0.147
40	180.0	18.0	SM	15.0	120.0	Clay	20592	9236	1.39	1.00	1.00	1.00	24.93	0.49	12.26	3.26	15.53	0.750	0.152
41	185.0	37.0	SM	15.0	120.0	Clay	21192	9524	1.39	1.00	1.00	1.00	51.25	0.60	30.98	3.26	34.24	0.780	0.158
42	189.5	10.0	SM	15.0	120.0	Clay	21732	9783	1.39	1.00	1.00	1.00	13.85	0.43	5.96	3.26	9.22	0.808	0.163
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.12	1.01	1.10	0.090	0.099	0.12
1.12	1.01	1.10	0.090	0.099	0.25
1.38	1.03	1.10	0.173	0.195	0.62
1.11	1.01	1.10	0.081	0.090	0.31
1.11	1.01	1.10	0.083	0.091	0.33
1.18	1.01	1.10	0.115	0.128	2.00
1.12	1.01	1.10	0.090	0.099	2.00
1.12	1.01	1.09	0.090	0.099	2.00
1.12	1.01	1.08	0.090	0.097	2.00
1.12	1.01	1.06	0.090	0.096	2.00
1.12	1.01	1.05	0.090	0.095	2.00
1.15	1.01	1.04	0.101	0.106	2.00
1.19	1.01	1.03	0.118	0.124	0.56
1.76	1.05	1.04	0.309	0.337	1.60
1.18	1.01	1.00	0.116	0.118	2.00
1.27	1.02	0.99	0.143	0.144	2.00
1.23	1.02	0.98	0.130	0.129	2.00
1.32	1.02	0.97	0.156	0.154	2.00
1.21	1.01	0.96	0.126	0.123	2.00
1.33	1.02	0.95	0.159	0.153	2.00
1.38	1.03	0.93	0.175	0.167	2.00
1.49	1.03	0.91	0.205	0.194	2.00
1.19	1.01	0.93	0.117	0.111	2.00
1.28	1.02	0.92	0.145	0.135	2.00
1.18	1.01	0.92	0.114	0.107	2.00
1.17	1.01	0.92	0.112	0.105	2.00
1.21	1.01	0.91	0.124	0.114	2.00
1.15	1.01	0.91	0.104	0.097	2.00
1.12	1.01	0.92	0.089	0.082	2.00
1.15	1.01	0.91	0.103	0.094	2.00
1.14	1.01	0.91	0.097	0.089	2.00
1.17	1.01	0.89	0.111	0.101	2.00
1.26	1.02	0.87	0.139	0.124	2.00
1.20	1.01	0.88	0.120	0.107	2.00
1.15	1.01	0.89	0.104	0.093	2.00
1.15	1.01	0.89	0.103	0.092	2.00
1.30	1.02	0.85	0.152	0.132	2.00
1.17	1.01	0.87	0.111	0.098	2.00
1.18	1.01	0.87	0.115	0.101	2.00
1.33	1.02	0.83	0.161	0.137	2.00
2.20	1.08	0.62	0.952	0.640	2.00
1.18	1.01	0.86	0.113	0.098	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.050	0.75	7.60
2	1.8	0.050	1.05	6.85
4	2.0	0.026	0.63	5.79
6	2.0	0.057	1.36	5.16
8	2.0	0.055	1.33	3.80
10	2.5	0.000	0.00	2.47
13	4.0	0.000	0.00	2.47
18	5.0	0.000	0.00	2.47
23	5.3	0.000	0.00	2.47
28.5	5.3	0.000	0.00	2.47
33.5	5.0	0.000	0.00	2.47
38.5	5.3	0.000	0.00	2.47
44	5.3	0.037	2.35	2.47
49	5.3	0.002	0.12	0.12
54.5	5.3	0.000	0.00	0.00
59.5	5.0	0.000	0.00	0.00
64.5	5.0	0.000	0.00	0.00
69.5	5.0	0.000	0.00	0.00
74.5	5.0	0.000	0.00	0.00
79.5	5.0	0.000	0.00	0.00
84.5	5.0	0.000	0.00	0.00
89.5	5.0	0.000	0.00	0.00
94.5	5.0	0.000	0.00	0.00
99.5	5.0	0.000	0.00	0.00
104.5	5.0	0.000	0.00	0.00
109.5	5.0	0.000	0.00	0.00
114.5	5.0	0.000	0.00	0.00
119.5	5.0	0.000	0.00	0.00
124.5	4.3	0.000	0.00	0.00
128	4.3	0.000	0.00	0.00
133	6.0	0.000	0.00	0.00
140	6.0	0.000	0.00	0.00
145	5.0	0.000	0.00	0.00
150	5.3	0.000	0.00	0.00
155.5	5.0	0.000	0.00	0.00
160	4.8	0.000	0.00	0.00
165	5.0	0.000	0.00	0.00
170	5.0	0.000	0.00	0.00
175	5.0	0.000	0.00	0.00
180	5.0	0.000	0.00	0.00
185	4.8	0.000	0.00	0.00
189.5	3.8	0.000	0.00	0.00
192.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:52 PM
Boring Designation:	B-11
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	-22
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	27
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.14
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	0.5	0	ML	50	95		Clay
2	2.0	1	ML	50	95		Clay
3	4.0	0	SM	18	100		
4	6.0	0	CL	52	95		Clay
5	8.0	0	SM	15	100		
6	14.5	0	MH	94	95		Clay
7	20.0	0	MH	94	95		Clay
8	25.5	2	SM	15	100		
9	31.5	7	SM	15	100		
10	36.0	6	ML	50	120		Clay
11	41.5	5	ML	50	120		Clay
12	46.5	7	ML	50	120		Clay
13	51.5	7	ML	50	120		Clay
14	56.5	23	SM	15	120		Clay
15	61.0	6	SM	45	120		Clay
16	65.5	5	SM	15	120		Clay
17	70.5	5	SM	15	120		Clay
18	75.0	6	SM	15	120		Clay
19	78.0	5	SM	15	120		Clay
20	82.5	27	SM	15	120		Clay
21	85.0	1	SM	15	120		Clay
22	90.0	8	SM	15	120		Clay
23	98.5	9	SM	15	120		Clay
24	104.0	11	SM	15	120		Clay
25	110.0	8	SM	15	120		Clay
26	115.5	10	SM	15	120		Clay
27	121.5	8	SM	15	120		Clay
28	125.5	10	SM	15	120		Clay
29	132.0	9	SM	15	120		Clay
30	137.0	10	SM	15	120		Clay
31	141.5	12	SM	15	120		Clay
32	146.0	10	SM	15	120		Clay
33	150.5	8	SM	15	120		Clay
34	155.0	19	SM	15	120		Clay
35	159.5	10	SM	15	120		Clay
36	164.0	9	SM	15	120		Clay
37	168.5	9	SM	15	120		Clay
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	0.0	ML	50.0	95.0	Clay	1420	16	1.39	1.00	0.95	1.00	0.00	1.70	0.00	5.61	5.61	1.005	7.972
2	2.0	1.0	ML	50.0	95.0	Clay	1563	65	1.39	1.00	0.95	1.00	1.32	1.70	2.24	5.61	7.85	1.002	2.185
3	4.0	0.0	SM	18.1	100.0		1763	140	1.39	1.00	0.95	1.00	0.00	1.70	0.00	4.11	4.11	0.997	1.139
4	6.0	0.0	CL	52.1	95.0	Clay	1953	206	1.39	1.00	1.00	1.00	0.00	1.70	0.00	5.61	5.61	0.991	0.856
5	8.0	0.0	SM	15.3	100.0		2153	281	1.39	1.00	1.00	1.00	0.00	1.70	0.00	3.36	3.36	0.985	0.687
6	14.5	0.0	MH	93.7	95.0	Clay	2770	493	1.39	1.00	1.00	1.00	0.00	1.70	0.00	5.50	5.50	0.962	0.492
7	20.0	0.0	MH	94.0	95.0	Clay	3293	672	1.39	1.00	1.00	1.00	0.00	1.70	0.00	5.50	5.50	0.941	0.419
8	25.5	2.0	SM	15.0	100.0		3843	879	1.39	1.00	1.00	1.00	2.77	1.65	4.57	3.26	7.83	0.917	0.365
9	31.5	7.0	SM	15.0	100.0		4443	1104	1.39	1.00	1.00	1.00	9.70	1.36	13.18	3.26	16.44	0.889	0.325
10	36.0	6.0	ML	50.0	120.0	Clay	4983	1364	1.39	1.00	1.00	1.00	8.31	1.23	10.25	5.61	15.87	0.867	0.288
11	41.5	5.0	ML	50.0	120.0	Clay	5643	1680	1.39	1.00	1.00	1.00	6.93	1.12	7.78	5.61	13.39	0.840	0.257
12	46.5	7.0	ML	50.0	120.0	Clay	6243	1968	1.39	1.00	1.00	1.00	9.70	1.04	10.04	5.61	15.65	0.815	0.235
13	51.5	7.0	ML	50.0	120.0	Clay	6843	2256	1.39	1.00	1.00	1.00	9.70	0.97	9.40	5.61	15.01	0.790	0.218
14	56.5	23.0	SM	15.0	120.0	Clay	7443	2544	1.39	1.00	1.00	1.00	31.86	0.94	29.91	3.26	33.17	0.766	0.204
15	61.0	6.0	SM	45.3	120.0	Clay	7983	2804	1.39	1.00	1.00	1.00	8.31	0.87	7.20	5.61	12.81	0.745	0.193
16	65.5	5.0	SM	15.0	120.0	Clay	8523	3063	1.39	1.00	1.00	1.00	6.93	0.81	5.64	3.26	8.90	0.725	0.184
17	70.5	5.0	SM	15.0	120.0	Clay	9123	3351	1.39	1.00	1.00	1.00	6.93	0.77	5.36	3.26	8.62	0.703	0.174
18	75.0	6.0	SM	15.0	120.0	Clay	9663	3610	1.39	1.00	1.00	1.00	8.31	0.75	6.20	3.26	9.46	0.685	0.167
19	78.0	5.0	SM	15.0	120.0	Clay	10023	3783	1.39	1.00	1.00	1.00	6.93	0.72	4.99	3.26	8.25	0.674	0.162
20	82.5	27.0	SM	15.0	120.0	Clay	10563	4042	1.39	1.00	1.00	1.00	37.40	0.80	29.99	3.26	33.25	0.658	0.156
21	85.0	1.0	SM	15.0	120.0	Clay	10863	4186	1.39	1.00	1.00	1.00	1.39	0.65	0.90	3.26	4.16	0.650	0.153
22	90.0	8.0	SM	15.0	120.0	Clay	11463	4474	1.39	1.00	1.00	1.00	11.08	0.67	7.43	3.26	10.70	0.634	0.148
23	98.5	9.0	SM	15.0	120.0	Clay	12483	4964	1.39	1.00	1.00	1.00	12.47	0.64	7.95	3.26	11.22	0.613	0.140
24	104.0	11.0	SM	15.0	120.0	Clay	13143	5280	1.39	1.00	1.00	1.00	15.24	0.63	9.57	3.26	12.83	0.602	0.136
25	110.0	8.0	SM	15.0	120.0	Clay	13863	5626	1.39	1.00	1.00	1.00	11.08	0.59	6.51	3.26	9.77	0.594	0.133
26	115.5	10.0	SM	15.0	120.0	Clay	14523	5943	1.39	1.00	1.00	1.00	13.85	0.58	8.05	3.26	11.31	0.589	0.131
27	121.5	8.0	SM	15.0	120.0	Clay	15243	6288	1.39	1.00	1.00	1.00	11.08	0.55	6.09	3.26	9.35	0.586	0.129
28	125.5	10.0	SM	15.0	120.0	Clay	15723	6519	1.39	1.00	1.00	1.00	13.85	0.55	7.62	3.26	10.89	0.586	0.129
29	132.0	9.0	SM	15.0	120.0	Clay	16503	6893	1.39	1.00	1.00	1.00	12.47	0.53	6.56	3.26	9.82	0.590	0.129
30	137.0	10.0	SM	15.0	120.0	Clay	17103	7181	1.39	1.00	1.00	1.00	13.85	0.52	7.20	3.26	10.46	0.596	0.129
31	141.5	12.0	SM	15.0	120.0	Clay	17643	7440	1.39	1.00	1.00	1.00	16.62	0.52	8.66	3.26	11.92	0.603	0.130
32	146.0	10.0	SM	15.0	120.0	Clay	18183	7700	1.39	1.00	1.00	1.00	13.85	0.50	6.90	3.26	10.16	0.612	0.132
33	150.5	8.0	SM	15.0	120.0	Clay	18723	7959	1.39	1.00	1.00	1.00	11.08	0.48	5.28	3.26	8.54	0.624	0.133
34	155.0	19.0	SM	15.0	120.0	Clay	19263	8218	1.39	1.00	1.00	1.00	26.32	0.53	14.00	3.26	17.27	0.637	0.136
35	159.5	10.0	SM	15.0	120.0	Clay	19803	8477	1.39	1.00	1.00	1.00	13.85	0.47	6.51	3.26	9.77	0.653	0.139
36	164.0	9.0	SM	15.0	120.0	Clay	20343	8736	1.39	1.00	1.00	1.00	12.47	0.46	5.68	3.26	8.94	0.670	0.142
37	168.5	9.0	SM	15.0	120.0	Clay	20883	8996	1.39	1.00	1.00	1.00	12.47	0.45	5.58	3.26	8.84	0.690	0.146
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.12	1.01	1.10	0.090	0.100	2.00
1.15	1.01	1.10	0.104	0.115	2.00
1.11	1.01	1.10	0.081	0.090	0.08
1.12	1.01	1.10	0.090	0.100	2.00
1.10	1.01	1.10	0.077	0.085	0.12
1.12	1.01	1.10	0.089	0.099	2.00
1.12	1.01	1.09	0.089	0.098	2.00
1.15	1.01	1.07	0.103	0.112	0.31
1.36	1.02	1.08	0.169	0.186	0.57
1.34	1.02	1.05	0.164	0.176	2.00
1.27	1.02	1.02	0.143	0.149	2.00
1.34	1.02	1.01	0.162	0.167	2.00
1.32	1.02	0.99	0.156	0.158	2.00
2.20	1.08	0.96	0.782	0.809	2.00
1.26	1.02	0.97	0.139	0.137	2.00
1.17	1.01	0.97	0.111	0.108	2.00
1.16	1.01	0.96	0.109	0.105	2.00
1.18	1.01	0.95	0.114	0.110	2.00
1.16	1.01	0.95	0.106	0.102	2.00
2.20	1.08	0.85	0.792	0.725	2.00
1.11	1.01	0.95	0.081	0.078	2.00
1.21	1.01	0.93	0.123	0.116	2.00
1.22	1.01	0.92	0.127	0.118	2.00
1.26	1.02	0.91	0.139	0.128	2.00
1.19	1.01	0.91	0.116	0.107	2.00
1.22	1.01	0.90	0.127	0.116	2.00
1.18	1.01	0.90	0.114	0.104	2.00
1.21	1.01	0.89	0.124	0.113	2.00
1.19	1.01	0.89	0.117	0.106	2.00
1.20	1.01	0.89	0.121	0.109	2.00
1.23	1.02	0.88	0.132	0.117	2.00
1.19	1.01	0.88	0.119	0.106	2.00
1.16	1.01	0.88	0.108	0.097	2.00
1.39	1.03	0.84	0.176	0.152	2.00
1.19	1.01	0.87	0.116	0.103	2.00
1.17	1.01	0.87	0.111	0.098	2.00
1.17	1.01	0.87	0.110	0.097	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.000	0.00	9.12
2	1.8	0.000	0.00	9.12
4	2.0	0.057	1.36	9.12
6	2.0	0.000	0.00	7.75
8	4.3	0.061	3.11	7.75
14.5	6.0	0.000	0.00	4.64
20	5.5	0.000	0.00	4.64
25.5	5.8	0.043	2.95	4.64
31.5	5.3	0.027	1.69	1.69
36	5.0	0.000	0.00	0.00
41.5	5.3	0.000	0.00	0.00
46.5	5.0	0.000	0.00	0.00
51.5	5.0	0.000	0.00	0.00
56.5	4.8	0.000	0.00	0.00
61	4.5	0.000	0.00	0.00
65.5	4.8	0.000	0.00	0.00
70.5	4.8	0.000	0.00	0.00
75	3.8	0.000	0.00	0.00
78	3.8	0.000	0.00	0.00
82.5	3.5	0.000	0.00	0.00
85	3.8	0.000	0.00	0.00
90	6.8	0.000	0.00	0.00
98.5	7.0	0.000	0.00	0.00
104	5.8	0.000	0.00	0.00
110	5.8	0.000	0.00	0.00
115.5	5.8	0.000	0.00	0.00
121.5	5.0	0.000	0.00	0.00
125.5	5.3	0.000	0.00	0.00
132	5.8	0.000	0.00	0.00
137	4.8	0.000	0.00	0.00
141.5	4.5	0.000	0.00	0.00
146	4.5	0.000	0.00	0.00
150.5	4.5	0.000	0.00	0.00
155	4.5	0.000	0.00	0.00
159.5	4.5	0.000	0.00	0.00
164	4.5	0.000	0.00	0.00
168.5	3.8	0.000	0.00	0.00
171.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:38 PM
Boring Designation:	B-12
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	-33
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	38
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.12
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	0.5	1	CL	50	95		Clay
2	2.0	4	CL	50	95		Clay
3	4.0	3	SM	24	100		
4	6.0	9	SC	15	100		
5	8.0	4	SP	0	100		
6	12.5	5	SP-SM	10	100		
7	17.5	7	SM	48	120		Clay
8	23.0	8	SM	48	120		Clay
9	28.0	4	SM	48	120		Clay
10	36.5	6	SM	48	120		Clay
11	42.0	9	SM	48	120		Clay
12	47.0	6	SM	47	120		Clay
13	53.0	8	SM	47	120		Clay
14	58.0	12	SM	15	120		Clay
15	63.5	11	SM	50	120		Clay
16	69.0	9	SM	15	120		Clay
17	73.5	12	SM	15	120		Clay
18	77.5	8	SM	15	120		Clay
19	82.5	5	SM	15	120		Clay
20	87.5		SM	15	120		Clay
21	92.5	14	SM	15	120		Clay
22	97.5	12	SM	15	120		Clay
23	102.5	7	SM	15	120		Clay
24	108.0	12	SM	15	120		Clay
25	115.5	8	SM	15	120		Clay
26	118.5	11	SM	15	120		Clay
27	122.5	9	SM	15	120		Clay
28	127.0	19	SM	15	120		Clay
29	132.0	10	SM	15	120		Clay
30	137.0	8	SM	15	120		Clay
31	141.5	20	SM	15	120		Clay
32	147.0		SM	15	120		Clay
33	152.5	12	SM	15	120		Clay
34	157.5	8	SM	15	120		Clay
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	1.0	CL	50.0	95.0	Clay	2107	16	1.39	1.00	1.00	1.00	1.39	1.70	2.35	5.61	7.97	1.005	10.136
2	2.0	4.0	CL	50.0	95.0	Clay	2249	65	1.39	1.00	1.00	1.00	5.54	1.70	9.42	5.61	15.03	1.002	2.696
3	4.0	3.0	SM	23.8	100.0		2449	140	1.39	1.00	1.00	1.00	4.16	1.70	7.06	4.97	12.03	0.997	1.356
4	6.0	9.0	SC	15.0	100.0		2649	216	1.39	1.00	1.00	1.00	12.47	1.70	21.19	3.26	24.45	0.991	0.950
5	8.0	4.0	SP	0.0	100.0		2849	291	1.39	1.00	1.00	1.00	5.54	1.70	9.42	0.00	9.42	0.985	0.753
6	12.5	5.0	SP-SM	10.4	100.0		3299	460	1.39	1.00	1.00	1.00	6.93	1.70	11.77	1.33	13.11	0.970	0.542
7	17.5	7.0	SM	48.0	120.0	Clay	3899	748	1.39	1.00	1.00	1.00	9.70	1.57	15.22	5.61	20.83	0.951	0.387
8	23.0	8.0	SM	48.0	120.0	Clay	4559	1065	1.39	1.00	1.00	1.00	11.08	1.35	14.95	5.61	20.56	0.928	0.310
9	28.0	4.0	SM	48.0	120.0	Clay	5159	1353	1.39	1.00	1.00	1.00	5.54	1.26	6.96	5.61	12.58	0.905	0.269
10	36.5	6.0	SM	48.0	120.0	Clay	6179	1842	1.39	1.00	1.00	1.00	8.31	1.07	8.90	5.61	14.51	0.865	0.226
11	42.0	9.0	SM	48.0	120.0	Clay	6839	2159	1.39	1.00	1.00	1.00	12.47	0.99	12.35	5.61	17.96	0.837	0.207
12	47.0	6.0	SM	46.6	120.0	Clay	7439	2447	1.39	1.00	1.00	1.00	8.31	0.93	7.72	5.61	13.33	0.813	0.193
13	53.0	8.0	SM	47.0	120.0	Clay	8159	2793	1.39	1.00	1.00	1.00	11.08	0.87	9.69	5.61	15.30	0.783	0.178
14	58.0	12.0	SM	15.0	120.0	Clay	8759	3081	1.39	1.00	1.00	1.00	16.62	0.84	13.95	3.26	17.22	0.759	0.168
15	63.5	11.0	SM	49.7	120.0	Clay	9419	3398	1.39	1.00	1.00	1.00	15.24	0.80	12.26	5.61	17.87	0.734	0.159
16	69.0	9.0	SM	15.0	120.0	Clay	10079	3714	1.39	1.00	1.00	1.00	12.47	0.75	9.35	3.26	12.61	0.710	0.150
17	73.5	12.0	SM	15.0	120.0	Clay	10619	3974	1.39	1.00	1.00	1.00	16.62	0.74	12.27	3.26	15.53	0.691	0.144
18	77.5	8.0	SM	15.0	120.0	Clay	11099	4204	1.39	1.00	1.00	1.00	11.08	0.70	7.70	3.26	10.96	0.676	0.139
19	82.5	5.0	SM	15.0	120.0	Clay	11699	4492	1.39	1.00	1.00	1.00	6.93	0.65	4.51	3.26	7.77	0.658	0.134
20	87.5	0.0	SM	15.0	120.0	Clay	12299	4780	1.39	1.00	1.00	1.00	0.00	0.59	0.00	3.26	3.26	0.642	0.129
21	92.5	14.0	SM	15.0	120.0	Clay	12899	5068	1.39	1.00	1.00	1.00	19.39	0.66	12.79	3.26	16.05	0.628	0.125
22	97.5	12.0	SM	15.0	120.0	Clay	13499	5356	1.39	1.00	1.00	1.00	16.62	0.63	10.45	3.26	13.71	0.615	0.121
23	102.5	7.0	SM	15.0	120.0	Clay	14099	5644	1.39	1.00	1.00	1.00	9.70	0.58	5.62	3.26	8.89	0.605	0.118
24	108.0	12.0	SM	15.0	120.0	Clay	14759	5961	1.39	1.00	1.00	1.00	16.62	0.59	9.84	3.26	13.10	0.596	0.115
25	115.5	8.0	SM	15.0	120.0	Clay	15659	6393	1.39	1.00	1.00	1.00	11.08	0.54	6.03	3.26	9.29	0.589	0.112
26	118.5	11.0	SM	15.0	120.0	Clay	16019	6566	1.39	1.00	1.00	1.00	15.24	0.55	8.44	3.26	11.70	0.587	0.112
27	122.5	9.0	SM	15.0	120.0	Clay	16499	6796	1.39	1.00	1.00	1.00	12.47	0.53	6.62	3.26	9.88	0.586	0.111
28	127.0	19.0	SM	15.0	120.0	Clay	17039	7055	1.39	1.00	1.00	1.00	26.32	0.58	15.24	3.26	18.50	0.587	0.111
29	132.0	10.0	SM	15.0	120.0	Clay	17639	7343	1.39	1.00	1.00	1.00	13.85	0.51	7.10	3.26	10.36	0.590	0.111
30	137.0	8.0	SM	15.0	120.0	Clay	18239	7631	1.39	1.00	1.00	1.00	11.08	0.49	5.42	3.26	8.68	0.596	0.111
31	141.5	20.0	SM	15.0	120.0	Clay	18779	7890	1.39	1.00	1.00	1.00	27.70	0.55	15.25	3.26	18.51	0.603	0.112
32	147.0	0.0	SM	15.0	120.0	Clay	19439	8207	1.39	1.00	1.00	1.00	0.00	0.42	0.00	3.26	3.26	0.615	0.114
33	152.5	12.0	SM	15.0	120.0	Clay	20099	8524	1.39	1.00	1.00	1.00	16.62	0.48	7.98	3.26	11.24	0.629	0.116
34	157.5	8.0	SM	15.0	120.0	Clay	20699	8812	1.39	1.00	1.00	1.00	11.08	0.45	4.96	3.26	8.22	0.645	0.118
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.15	1.01	1.10	0.104	0.116	2.00
1.32	1.02	1.10	0.156	0.176	2.00
1.24	1.02	1.10	0.133	0.148	0.11
1.69	1.05	1.10	0.278	0.320	0.34
1.18	1.01	1.10	0.114	0.127	0.17
1.26	1.02	1.10	0.141	0.158	0.29
1.53	1.04	1.10	0.216	0.247	2.00
1.52	1.04	1.09	0.213	0.241	2.00
1.25	1.02	1.05	0.137	0.145	2.00
1.30	1.02	1.02	0.152	0.157	2.00
1.42	1.03	1.00	0.183	0.188	2.00
1.27	1.02	0.98	0.143	0.143	2.00
1.33	1.02	0.97	0.159	0.157	2.00
1.39	1.03	0.95	0.176	0.172	2.00
1.41	1.03	0.94	0.182	0.177	2.00
1.25	1.02	0.94	0.137	0.131	2.00
1.33	1.02	0.93	0.161	0.153	2.00
1.21	1.01	0.93	0.125	0.118	2.00
1.15	1.01	0.94	0.103	0.098	2.00
1.10	1.01	0.94	0.077	0.073	2.00
1.35	1.02	0.90	0.165	0.152	2.00
1.28	1.02	0.90	0.146	0.134	2.00
1.17	1.01	0.91	0.110	0.102	2.00
1.26	1.02	0.89	0.141	0.128	2.00
1.18	1.01	0.90	0.113	0.103	2.00
1.23	1.02	0.89	0.130	0.118	2.00
1.19	1.01	0.89	0.117	0.106	2.00
1.43	1.03	0.85	0.189	0.165	2.00
1.20	1.01	0.88	0.121	0.108	2.00
1.17	1.01	0.89	0.109	0.098	2.00
1.44	1.03	0.83	0.189	0.162	2.00
1.10	1.01	0.91	0.077	0.070	2.00
1.22	1.01	0.87	0.127	0.111	2.00
1.16	1.01	0.88	0.106	0.094	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.000	0.00	4.57
2	1.8	0.000	0.00	4.57
4	2.0	0.033	0.80	4.57
6	2.0	0.019	0.46	3.77
8	3.3	0.039	1.51	3.31
12.5	4.8	0.032	1.80	1.80
17.5	5.3	0.000	0.00	0.00
23	5.3	0.000	0.00	0.00
28	6.8	0.000	0.00	0.00
36.5	7.0	0.000	0.00	0.00
42	5.3	0.000	0.00	0.00
47	5.5	0.000	0.00	0.00
53	5.5	0.000	0.00	0.00
58	5.3	0.000	0.00	0.00
63.5	5.5	0.000	0.00	0.00
69	5.0	0.000	0.00	0.00
73.5	4.3	0.000	0.00	0.00
77.5	4.5	0.000	0.00	0.00
82.5	5.0	0.000	0.00	0.00
87.5	5.0	0.000	0.00	0.00
92.5	5.0	0.000	0.00	0.00
97.5	5.0	0.000	0.00	0.00
102.5	5.3	0.000	0.00	0.00
108	6.5	0.000	0.00	0.00
115.5	5.3	0.000	0.00	0.00
118.5	3.5	0.000	0.00	0.00
122.5	4.3	0.000	0.00	0.00
127	4.8	0.000	0.00	0.00
132	5.0	0.000	0.00	0.00
137	4.8	0.000	0.00	0.00
141.5	5.0	0.000	0.00	0.00
147	5.5	0.000	0.00	0.00
152.5	5.3	0.000	0.00	0.00
157.5	4.0	0.000	0.00	0.00
160.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:39 PM
Boring Designation:	B-13
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	-28
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	33
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.12
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"	
1	0.5	1	SM	23	100			
2	2.0	3	SM	23	100			
3	4.0	3	SM	23	100			
4	6.0	3	SM	23	100			
5	8.0	1	SC	15	100			
6	14.5	1	CL	64	95		Clay	
7	19.5	0	CL	64	95		Clay	
8	24.5	2	ML	65	95			
9	30.0	6	SC	44	120		Clay	*Assumes Marl/Limestone NonLiq
10	35.5	4	SC	44	120		Clay	
11	41.0	6	SC	44	120		Clay	
12	48.5	6	ML	50	120		Clay	
13	53.5	7	ML	50	120		Clay	
14	58.5	4	ML	50	120		Clay	
15	62.5	23	ML	50	120		Clay	
16	66.5	7	ML	50	120		Clay	
17	71.5	7	ML	50	120		Clay	
18	76.0	10	ML	50	120		Clay	
19	81.0	6	ML	50	120		Clay	
20	88.5	6	ML	50	120		Clay	
21	93.5	12	ML	50	120		Clay	
22	99.0	11	ML	50	120		Clay	
23	104.5	7	ML	50	120		Clay	
24	110.0	9	ML	50	120		Clay	
25	118.0	8	ML	50	120		Clay	
26	120.0	8	ML	50	120		Clay	
27	124.5	7	ML	50	120		Clay	
28	129.0	8	ML	50	120		Clay	
29	134.0	10	ML	50	120		Clay	
30	138.5	9	ML	50	120		Clay	
31	144.0	12	ML	50	120		Clay	
32	149.5	7	ML	50	120		Clay	
33	155.5	13	ML	50	120		Clay	
34	161.0	17	ML	50	120		Clay	
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								
46								
47								
48								
49								
50								

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	1.0	SM	23.0	100.0		1797	19	1.39	1.00	1.00	1.00	1.39	1.70	2.35	4.88	7.24	1.005	7.497
2	2.0	3.0	SM	23.0	100.0		1947	75	1.39	1.00	1.00	1.00	4.16	1.70	7.06	4.88	11.95	1.002	2.023
3	4.0	3.0	SM	22.8	100.0		2147	150	1.39	1.00	1.00	1.00	4.16	1.70	7.06	4.86	11.93	0.997	1.110
4	6.0	3.0	SM	23.0	100.0		2347	226	1.39	1.00	1.00	1.00	4.16	1.70	7.06	4.88	11.95	0.991	0.804
5	8.0	1.0	SC	15.0	100.0		2547	301	1.39	1.00	1.00	1.00	1.39	1.70	2.35	3.26	5.62	0.985	0.650
6	14.5	1.0	CL	64.2	95.0	Clay	3165	513	1.39	1.00	1.00	1.00	1.39	1.70	2.35	5.59	7.95	0.962	0.463
7	19.5	0.0	CL	64.0	95.0	Clay	3640	676	1.39	1.00	1.00	1.00	0.00	1.70	0.00	5.59	5.59	0.943	0.396
8	24.5	2.0	ML	65.3	95.0		4115	839	1.39	1.00	1.00	1.00	2.77	1.65	4.56	5.59	10.15	0.921	0.352
9	30.0	6.0	SC	44.0	120.0	Clay	4775	1156	1.39	1.00	1.00	1.00	8.31	1.33	11.05	5.60	16.65	0.896	0.289
10	35.5	4.0	SC	43.9	120.0	Clay	5435	1472	1.39	1.00	1.00	1.00	5.54	1.21	6.68	5.60	12.28	0.869	0.250
11	41.0	6.0	SC	44.0	120.0	Clay	6095	1789	1.39	1.00	1.00	1.00	8.31	1.09	9.02	5.60	14.62	0.842	0.224
12	48.5	6.0	ML	50.0	120.0	Clay	6995	2221	1.39	1.00	1.00	1.00	8.31	0.98	8.11	5.61	13.73	0.805	0.198
13	53.5	7.0	ML	50.0	120.0	Clay	7595	2509	1.39	1.00	1.00	1.00	9.70	0.92	8.92	5.61	14.53	0.781	0.184
14	58.5	4.0	ML	50.0	120.0	Clay	8195	2797	1.39	1.00	1.00	1.00	5.54	0.86	4.77	5.61	10.38	0.757	0.173
15	62.5	23.0	ML	50.0	120.0	Clay	8675	3028	1.39	1.00	1.00	1.00	31.86	0.89	28.23	5.61	33.85	0.738	0.165
16	66.5	7.0	ML	50.0	120.0	Clay	9155	3258	1.39	1.00	1.00	1.00	9.70	0.80	7.80	5.61	13.42	0.720	0.158
17	71.5	7.0	ML	50.2	120.0	Clay	9755	3546	1.39	1.00	1.00	1.00	9.70	0.77	7.47	5.61	13.08	0.699	0.150
18	76.0	10.0	ML	50.0	120.0	Clay	10295	3805	1.39	1.00	1.00	1.00	13.85	0.76	10.48	5.61	16.09	0.681	0.144
19	81.0	6.0	ML	50.0	120.0	Clay	10895	4093	1.39	1.00	1.00	1.00	8.31	0.71	5.88	5.61	11.50	0.663	0.138
20	88.5	6.0	ML	50.0	120.0	Clay	11795	4525	1.39	1.00	1.00	1.00	8.31	0.67	5.57	5.61	11.18	0.639	0.130
21	93.5	12.0	ML	50.0	120.0	Clay	12395	4813	1.39	1.00	1.00	1.00	16.62	0.68	11.31	5.61	16.93	0.625	0.126
22	99.0	11.0	ML	50.0	120.0	Clay	13055	5130	1.39	1.00	1.00	1.00	15.24	0.65	9.95	5.61	15.57	0.612	0.121
23	104.5	7.0	ML	50.0	120.0	Clay	13715	5447	1.39	1.00	1.00	1.00	9.70	0.61	5.91	5.61	11.53	0.602	0.118
24	110.0	9.0	ML	50.0	120.0	Clay	14375	5764	1.39	1.00	1.00	1.00	12.47	0.60	7.51	5.61	13.12	0.594	0.116
25	118.0	8.0	ML	50.0	120.0	Clay	15335	6224	1.39	1.00	1.00	1.00	11.08	0.57	6.33	5.61	11.95	0.587	0.113
26	120.0	8.0	ML	50.0	120.0	Clay	15575	6340	1.39	1.00	1.00	1.00	11.08	0.57	6.27	5.61	11.88	0.587	0.112
27	124.5	7.0	ML	50.0	120.0	Clay	16115	6599	1.39	1.00	1.00	1.00	9.70	0.55	5.30	5.61	10.92	0.586	0.112
28	129.0	8.0	ML	50.0	120.0	Clay	16655	6858	1.39	1.00	1.00	1.00	11.08	0.54	6.00	5.61	11.61	0.588	0.111
29	134.0	10.0	ML	50.0	120.0	Clay	17255	7146	1.39	1.00	1.00	1.00	13.85	0.54	7.48	5.61	13.10	0.592	0.112
30	138.5	9.0	ML	50.0	120.0	Clay	17795	7405	1.39	1.00	1.00	1.00	12.47	0.52	6.53	5.61	12.14	0.598	0.112
31	144.0	12.0	ML	50.0	120.0	Clay	18455	7722	1.39	1.00	1.00	1.00	16.62	0.53	8.78	5.61	14.40	0.608	0.113
32	149.5	7.0	ML	50.0	120.0	Clay	19115	8039	1.39	1.00	1.00	1.00	9.70	0.49	4.73	5.61	10.35	0.621	0.115
33	155.5	13.0	ML	50.0	120.0	Clay	19835	8384	1.39	1.00	1.00	1.00	18.01	0.51	9.19	5.61	14.80	0.639	0.118
34	161.0	17.0	ML	50.0	120.0	Clay	20495	8701	1.39	1.00	1.00	1.00	23.55	0.52	12.31	5.61	17.92	0.658	0.121
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.14	1.01	1.10	0.100	0.111	0.01
1.23	1.02	1.10	0.132	0.148	0.07
1.23	1.02	1.10	0.132	0.147	0.13
1.23	1.02	1.10	0.132	0.148	0.18
1.12	1.01	1.10	0.090	0.100	0.15
1.15	1.01	1.10	0.104	0.116	2.00
1.12	1.01	1.09	0.090	0.098	2.00
1.19	1.01	1.09	0.119	0.131	0.37
1.37	1.03	1.07	0.171	0.187	2.00
1.24	1.02	1.04	0.135	0.142	2.00
1.31	1.02	1.02	0.153	0.159	2.00
1.28	1.02	0.99	0.146	0.148	2.00
1.30	1.02	0.98	0.152	0.152	2.00
1.20	1.01	0.97	0.121	0.119	2.00
2.20	1.08	0.91	0.883	0.871	2.00
1.27	1.02	0.95	0.143	0.139	2.00
1.26	1.02	0.95	0.141	0.136	2.00
1.35	1.02	0.93	0.166	0.158	2.00
1.22	1.02	0.94	0.129	0.122	2.00
1.22	1.01	0.93	0.126	0.119	2.00
1.38	1.03	0.90	0.173	0.160	2.00
1.33	1.02	0.90	0.161	0.148	2.00
1.22	1.02	0.91	0.129	0.119	2.00
1.26	1.02	0.90	0.141	0.129	2.00
1.23	1.02	0.89	0.132	0.120	2.00
1.23	1.02	0.89	0.132	0.119	2.00
1.21	1.01	0.89	0.125	0.113	2.00
1.23	1.02	0.88	0.130	0.116	2.00
1.26	1.02	0.87	0.141	0.125	2.00
1.24	1.02	0.87	0.134	0.119	2.00
1.30	1.02	0.86	0.151	0.133	2.00
1.20	1.01	0.88	0.121	0.107	2.00
1.31	1.02	0.85	0.154	0.134	2.00
1.41	1.03	0.83	0.183	0.155	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.044	0.67	7.87
2	1.8	0.034	0.70	7.20
4	2.0	0.034	0.81	6.50
6	2.0	0.034	0.80	5.69
8	4.3	0.050	2.55	4.89
14.5	5.8	0.000	0.00	2.33
19.5	5.0	0.000	0.00	2.33
24.5	5.3	0.037	2.33	2.33
30	5.5	0.000	0.00	0.00
35.5	5.5	0.000	0.00	0.00
41	6.5	0.000	0.00	0.00
48.5	6.3	0.000	0.00	0.00
53.5	5.0	0.000	0.00	0.00
58.5	4.5	0.000	0.00	0.00
62.5	4.0	0.000	0.00	0.00
66.5	4.5	0.000	0.00	0.00
71.5	4.8	0.000	0.00	0.00
76	4.8	0.000	0.00	0.00
81	6.3	0.000	0.00	0.00
88.5	6.3	0.000	0.00	0.00
93.5	5.3	0.000	0.00	0.00
99	5.5	0.000	0.00	0.00
104.5	5.5	0.000	0.00	0.00
110	6.8	0.000	0.00	0.00
118	5.0	0.000	0.00	0.00
120	3.3	0.000	0.00	0.00
124.5	4.5	0.000	0.00	0.00
129	4.8	0.000	0.00	0.00
134	4.8	0.000	0.00	0.00
138.5	5.0	0.000	0.00	0.00
144	5.5	0.000	0.00	0.00
149.5	5.8	0.000	0.00	0.00
155.5	5.8	0.000	0.00	0.00
161	4.3	0.000	0.00	0.00
164				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:44 PM
Boring Designation:	B-14
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.12
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	0.5	1	SM	14	100		
2	2.0	2	SM	14	100		
3	4.0	4	SM	14	100		
4	6.0	25	SM	14	120		
5	8.0	3	SM	14	100		
6	13.5	16	SM	14	120		
7	18.5	5	SM	14	100		
8	23.5	9	SM	18	100		
9	28.5	2	SM	44	100		
10	33.5	4	ML	52	95		Clay
11	38.5	2	ML	52	95		Clay
12	43.5	2	ML	52	95		Clay
13	48.5	4	SM	30	100		
14	53.5	9	ML	50	120		Clay
15	58.5	4	ML	50	120		Clay
16	63.0	7	ML	50	120		Clay
17	68.0	7	ML	50	120		Clay
18	72.5	7	ML	50	120		Clay
19	77.5	13	SC	15	120		Clay
20	83.5	9	SC	15	120		Clay
21	88.5	5	SC	15	120		Clay
22	93.5	26	SC	15	120		Clay
23	98.5	8	ML	50	120		Clay
24	104.0	4	ML	50	120		Clay
25	108.5	5	ML	50	120		Clay
26	113.5	6	ML	50	120		Clay
27	118.5	9	ML	50	120		Clay
28	123.5	8	SM	15	120		Clay
29	128.5	6	SM	15	120		Clay
30	133.0	5	SM	15	120		Clay
31	138.0	11	SM	15	120		Clay
32	142.5	9	SM	15	120		Clay
33	148.5	8	SM	15	120		Clay
34	153.5	9	SM	15	120		Clay
35	158.5	9	SM	15	120		Clay
36	163.5	7	SM	15	120		Clay
37	168.5	8	SM	15	120		Clay
38	173.5	8	SM	15	120		Clay
39	178.5	6	SM	15	120		Clay
40	183.5	8	SM	15	120		Clay
41	188.5	6	SM	15	120		Clay
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	1.0	SM	14.0	100.0		50	19	1.39	1.00	0.75	1.00	1.04	1.70	1.77	2.91	4.67	1.005	0.209
2	2.0	2.0	SM	14.0	100.0		200	75	1.39	1.00	0.75	1.00	2.08	1.70	3.53	2.91	6.44	1.002	0.208
3	4.0	4.0	SM	14.0	100.0		400	150	1.39	1.00	0.75	1.00	4.16	1.70	7.06	2.91	9.97	0.997	0.207
4	6.0	25.0	SM	14.0	120.0		640	266	1.39	1.00	0.80	1.00	27.70	1.70	47.09	2.91	50.00	0.991	0.186
5	8.0	3.0	SM	13.8	100.0		840	341	1.39	1.00	0.80	1.00	3.32	1.70	5.65	2.83	8.48	0.985	0.189
6	13.5	16.0	SM	14.0	120.0		1500	658	1.39	1.00	0.85	1.00	18.84	1.51	28.48	2.91	31.39	0.966	0.172
7	18.5	5.0	SM	14.0	100.0		2000	846	1.39	1.00	0.95	1.00	6.58	1.59	10.44	2.91	13.35	0.947	0.175
8	23.5	9.0	SM	17.6	100.0		2500	1034	1.39	1.00	0.95	1.00	11.84	1.37	16.22	4.00	20.21	0.926	0.175
9	28.5	2.0	SM	43.7	100.0		3000	1222	1.39	1.00	1.00	1.00	2.77	1.35	3.75	5.60	9.35	0.903	0.173
10	33.5	4.0	ML	52.0	95.0	Clay	3475	1385	1.39	1.00	1.00	1.00	5.54	1.24	6.88	5.61	12.50	0.879	0.172
11	38.5	2.0	ML	52.0	95.0	Clay	3950	1548	1.39	1.00	1.00	1.00	2.77	1.19	3.29	5.61	8.91	0.855	0.170
12	43.5	2.0	ML	52.0	95.0	Clay	4425	1711	1.39	1.00	1.00	1.00	2.77	1.13	3.12	5.61	8.73	0.830	0.167
13	48.5	4.0	SM	30.1	100.0		4925	1899	1.39	1.00	1.00	1.00	5.54	1.06	5.87	5.37	11.23	0.805	0.163
14	53.5	9.0	ML	50.0	120.0	Clay	5525	2187	1.39	1.00	1.00	1.00	12.47	0.99	12.28	5.61	17.89	0.781	0.154
15	58.5	4.0	ML	50.0	120.0	Clay	6125	2475	1.39	1.00	1.00	1.00	5.54	0.92	5.10	5.61	10.71	0.757	0.146
16	63.0	7.0	ML	50.0	120.0	Clay	6665	2734	1.39	1.00	1.00	1.00	9.70	0.88	8.54	5.61	14.16	0.736	0.140
17	68.0	7.0	ML	50.0	120.0	Clay	7265	3022	1.39	1.00	1.00	1.00	9.70	0.84	8.11	5.61	13.73	0.714	0.134
18	72.5	7.0	ML	50.0	120.0	Clay	7805	3281	1.39	1.00	1.00	1.00	9.70	0.80	7.78	5.61	13.39	0.695	0.129
19	77.5	13.0	SC	15.0	120.0	Clay	8405	3569	1.39	1.00	1.00	1.00	18.01	0.78	14.13	3.26	17.39	0.676	0.124
20	83.5	9.0	SC	15.0	120.0	Clay	9125	3915	1.39	1.00	1.00	1.00	12.47	0.73	9.09	3.26	12.35	0.654	0.119
21	88.5	5.0	SC	15.0	120.0	Clay	9725	4203	1.39	1.00	1.00	1.00	6.93	0.68	4.69	3.26	7.95	0.639	0.115
22	93.5	26.0	SC	15.0	120.0	Clay	10325	4491	1.39	1.00	1.00	1.00	36.01	0.76	27.51	3.26	30.77	0.625	0.112
23	98.5	8.0	ML	50.0	120.0	Clay	10925	4779	1.39	1.00	1.00	1.00	11.08	0.66	7.33	5.61	12.94	0.613	0.109
24	104.0	4.0	ML	50.0	120.0	Clay	11585	5095	1.39	1.00	1.00	1.00	5.54	0.61	3.41	5.61	9.02	0.602	0.107
25	108.5	5.0	ML	50.0	120.0	Clay	12125	5355	1.39	1.00	1.00	1.00	6.93	0.60	4.18	5.61	9.80	0.596	0.105
26	113.5	6.0	ML	50.0	120.0	Clay	12725	5643	1.39	1.00	1.00	1.00	8.31	0.59	4.92	5.61	10.53	0.590	0.104
27	118.5	9.0	ML	50.0	120.0	Clay	13325	5931	1.39	1.00	1.00	1.00	12.47	0.59	7.39	5.61	13.01	0.587	0.103
28	123.5	8.0	SM	15.0	120.0	Clay	13925	6219	1.39	1.00	1.00	1.00	11.08	0.55	6.13	3.26	9.39	0.586	0.102
29	128.5	6.0	SM	15.0	120.0	Clay	14525	6507	1.39	1.00	1.00	1.00	8.31	0.53	4.37	3.26	7.63	0.588	0.102
30	133.0	5.0	SM	15.0	120.0	Clay	15065	6766	1.39	1.00	1.00	1.00	6.93	0.51	3.51	3.26	6.77	0.591	0.103
31	138.0	11.0	SM	15.0	120.0	Clay	15665	7054	1.39	1.00	1.00	1.00	15.24	0.53	8.10	3.26	11.36	0.597	0.103
32	142.5	9.0	SM	15.0	120.0	Clay	16205	7313	1.39	1.00	1.00	1.00	12.47	0.51	6.33	3.26	9.59	0.605	0.105
33	148.5	8.0	SM	15.0	120.0	Clay	16925	7659	1.39	1.00	1.00	1.00	11.08	0.49	5.41	3.26	8.67	0.618	0.107
34	153.5	9.0	SM	15.0	120.0	Clay	17525	7947	1.39	1.00	1.00	1.00	12.47	0.48	6.02	3.26	9.28	0.632	0.109
35	158.5	9.0	SM	15.0	120.0	Clay	18125	8235	1.39	1.00	1.00	1.00	12.47	0.47	5.89	3.26	9.15	0.649	0.111
36	163.5	7.0	SM	15.0	120.0	Clay	18725	8523	1.39	1.00	1.00	1.00	9.70	0.45	4.37	3.26	7.63	0.668	0.115
37	168.5	8.0	SM	15.0	120.0	Clay	19325	8811	1.39	1.00	1.00	1.00	11.08	0.45	4.96	3.26	8.22	0.690	0.118
38	173.5	8.0	SM	15.0	120.0	Clay	19925	9099	1.39	1.00	1.00	1.00	11.08	0.44	4.86	3.26	8.12	0.715	0.122
39	178.5	6.0	SM	15.0	120.0	Clay	20525	9387	1.39	1.00	1.00	1.00	8.31	0.42	3.48	3.26	6.74	0.741	0.126
40	183.5	8.0	SM	15.0	120.0	Clay	21125	9675	1.39	1.00	1.00	1.00	11.08	0.42	4.68	3.26	7.94	0.771	0.131
41	188.5	6.0	SM	15.0	120.0	Clay	21725	9963	1.39	1.00	1.00	1.00	8.31	0.40	3.35	3.26	6.61	0.802	0.136
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.11	1.01	1.10	0.084	0.093	0.45
1.13	1.01	1.10	0.095	0.105	0.51
1.19	1.01	1.10	0.118	0.131	0.64
2.20	1.08	1.10	2.000	2.000	2.00
1.16	1.01	1.10	0.108	0.120	0.63
2.08	1.07	1.10	0.587	0.693	2.00
1.27	1.02	1.10	0.143	0.159	0.91
1.50	1.03	1.10	0.208	0.236	1.35
1.18	1.01	1.05	0.114	0.121	0.70
1.25	1.02	1.04	0.136	0.144	2.00
1.17	1.01	1.03	0.111	0.115	2.00
1.17	1.01	1.02	0.109	0.113	2.00
1.22	1.01	1.01	0.127	0.130	0.80
1.41	1.03	1.00	0.183	0.187	2.00
1.21	1.01	0.99	0.123	0.123	2.00
1.29	1.02	0.97	0.149	0.148	2.00
1.28	1.02	0.96	0.146	0.143	2.00
1.27	1.02	0.95	0.143	0.139	2.00
1.39	1.03	0.94	0.178	0.171	2.00
1.24	1.02	0.94	0.135	0.129	2.00
1.15	1.01	0.94	0.104	0.099	2.00
2.04	1.07	0.84	0.537	0.484	2.00
1.26	1.02	0.92	0.140	0.130	2.00
1.17	1.01	0.92	0.111	0.104	2.00
1.19	1.01	0.91	0.117	0.108	2.00
1.20	1.01	0.91	0.122	0.112	2.00
1.26	1.02	0.89	0.140	0.127	2.00
1.18	1.01	0.90	0.114	0.104	2.00
1.15	1.01	0.91	0.102	0.093	2.00
1.14	1.01	0.91	0.097	0.088	2.00
1.22	1.01	0.88	0.128	0.114	2.00
1.18	1.01	0.89	0.115	0.104	2.00
1.17	1.01	0.89	0.109	0.098	2.00
1.18	1.01	0.88	0.113	0.101	2.00
1.17	1.01	0.88	0.112	0.100	2.00
1.15	1.01	0.88	0.102	0.091	2.00
1.16	1.01	0.88	0.106	0.094	2.00
1.16	1.01	0.87	0.105	0.093	2.00
1.14	1.01	0.88	0.097	0.086	2.00
1.15	1.01	0.87	0.104	0.092	2.00
1.13	1.01	0.87	0.096	0.085	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.054	0.81	10.92
2	1.8	0.047	0.99	10.10
4	2.0	0.037	0.90	9.12
6	2.0	0.000	0.00	8.22
8	3.8	0.041	1.84	8.22
13.5	5.3	0.000	0.00	6.37
18.5	5.0	0.029	1.73	6.37
23.5	5.0	0.004	0.23	4.65
28.5	5.0	0.039	2.33	4.42
33.5	5.0	0.000	0.00	2.09
38.5	5.0	0.000	0.00	2.09
43.5	5.0	0.000	0.00	2.09
48.5	5.0	0.035	2.09	2.09
53.5	5.0	0.000	0.00	0.00
58.5	4.8	0.000	0.00	0.00
63	4.8	0.000	0.00	0.00
68	4.8	0.000	0.00	0.00
72.5	4.8	0.000	0.00	0.00
77.5	5.5	0.000	0.00	0.00
83.5	5.5	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.3	0.000	0.00	0.00
104	5.0	0.000	0.00	0.00
108.5	4.8	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	5.0	0.000	0.00	0.00
128.5	4.8	0.000	0.00	0.00
133	4.8	0.000	0.00	0.00
138	4.8	0.000	0.00	0.00
142.5	5.3	0.000	0.00	0.00
148.5	5.5	0.000	0.00	0.00
153.5	5.0	0.000	0.00	0.00
158.5	5.0	0.000	0.00	0.00
163.5	5.0	0.000	0.00	0.00
168.5	5.0	0.000	0.00	0.00
173.5	5.0	0.000	0.00	0.00
178.5	5.0	0.000	0.00	0.00
183.5	5.0	0.000	0.00	0.00
188.5	4.0	0.000	0.00	0.00
191.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:45 PM
Boring Designation:	B-15
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.12
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	0.5	0	SP-SM	5	100		
2	2.0	2	SP-SM	5	100		
3	4.0	16	SP-SM	8	120		
4	6.0	17	SP-SM	5	120		
5	8.0	14	SP-SM	5	120		
6	13.5	25	SP-SM	6	120		
7	18.5	7	SM	18	100		
8	23.5	7	SM	18	100		
9	28.5	4	SM	18	100		
10	33.5	4	SM	18	100		
11	38.5	0	CL	50	95		Clay
12	43.5	0	SM	21	100		
13	48.5	9	SM	21	100		
14	53.5	14	SM	21	100		
15	58.5	2	SM	21	100		
16	63.5	6	SM	21	100		
17	68.5	8	SM	15	120		Clay
18	73.5	10	SM	15	120		Clay
19	78.5	23	SM	15	120		Clay
20	83.5	9	SM	15	120		Clay
21	88.5	27	SM	15	120		Clay
22	93.5	17	SM	15	120		Clay
23	98.5	8	SM	15	120		Clay
24	103.5	16	SM	15	120		Clay
25	108.5	10	SM	15	120		Clay
26	113.5	5	SM	15	120		Clay
27	118.5	6	SM	15	120		Clay
28	123.5	5	SM	15	120		Clay
29	128.5	7	SM	15	120		Clay
30	133.5	8	SM	15	120		Clay
31	138.5	8	SM	15	120		Clay
32	143.5	9	ML	50	120		Clay
33	148.5	12	SM	15	120		Clay
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
									IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	0.0	SP-SM	5.0	100.0		50	19	1.39	1.00	0.75	1.00	0.00	1.70	0.00	0.00	0.00	1.005	0.209
2	2.0	2.0	SP-SM	5.0	100.0		200	75	1.39	1.00	0.75	1.00	2.08	1.70	3.53	0.00	3.53	1.002	0.208
3	4.0	16.0	SP-SM	8.2	120.0		440	190	1.39	1.00	0.75	1.00	16.62	1.70	28.25	0.43	28.68	0.997	0.180
4	6.0	17.0	SP-SM	5.1	120.0		680	306	1.39	1.00	0.80	1.00	18.84	1.70	32.02	0.00	32.02	0.991	0.172
5	8.0	14.0	SP-SM	5.0	120.0		920	421	1.39	1.00	0.80	1.00	15.51	1.70	26.37	0.00	26.37	0.985	0.168
6	13.5	25.0	SP-SM	5.5	120.0		1580	738	1.39	1.00	0.85	1.00	29.43	1.37	40.24	0.01	40.25	0.966	0.161
7	18.5	7.0	SM	17.5	100.0		2080	926	1.39	1.00	0.95	1.00	9.21	1.47	13.51	3.97	17.48	0.947	0.166
8	23.5	7.0	SM	18.0	100.0		2580	1114	1.39	1.00	0.95	1.00	9.21	1.35	12.47	4.09	16.56	0.926	0.167
9	28.5	4.0	SM	18.0	100.0		3080	1302	1.39	1.00	1.00	1.00	5.54	1.29	7.16	4.09	11.25	0.903	0.167
10	33.5	4.0	SM	18.0	100.0		3580	1490	1.39	1.00	1.00	1.00	5.54	1.21	6.68	4.09	10.77	0.879	0.165
11	38.5	0.0	CL	50.0	95.0	Clay	4055	1653	1.39	1.00	1.00	1.00	0.00	1.16	0.00	5.61	5.61	0.855	0.164
12	43.5	0.0	SM	20.7	100.0		4555	1841	1.39	1.00	1.00	1.00	0.00	1.09	0.00	4.59	4.59	0.830	0.160
13	48.5	9.0	SM	21.0	100.0		5055	2029	1.39	1.00	1.00	1.00	12.47	1.02	12.71	4.63	17.34	0.805	0.156
14	53.5	14.0	SM	21.0	100.0		5555	2217	1.39	1.00	1.00	1.00	19.39	0.98	19.02	4.63	23.66	0.781	0.153
15	58.5	2.0	SM	21.0	100.0		6055	2405	1.39	1.00	1.00	1.00	2.77	0.93	2.57	4.63	7.21	0.757	0.149
16	63.5	6.0	SM	21.0	100.0		6555	2593	1.39	1.00	1.00	1.00	8.31	0.90	7.48	4.63	12.12	0.734	0.145
17	68.5	8.0	SM	15.0	120.0	Clay	7155	2881	1.39	1.00	1.00	1.00	11.08	0.85	9.47	3.26	12.73	0.712	0.138
18	73.5	10.0	SM	15.0	120.0	Clay	7755	3169	1.39	1.00	1.00	1.00	13.85	0.82	11.36	3.26	14.62	0.691	0.132
19	78.5	23.0	SM	15.0	120.0	Clay	8355	3457	1.39	1.00	1.00	1.00	31.86	0.84	26.64	3.26	29.91	0.672	0.127
20	83.5	9.0	SM	15.0	120.0	Clay	8955	3745	1.39	1.00	1.00	1.00	12.47	0.75	9.31	3.26	12.57	0.654	0.122
21	88.5	27.0	SM	15.0	120.0	Clay	9555	4033	1.39	1.00	1.00	1.00	37.40	0.80	30.01	3.26	33.27	0.639	0.118
22	93.5	17.0	SM	15.0	120.0	Clay	10155	4321	1.39	1.00	1.00	1.00	23.55	0.73	17.24	3.26	20.51	0.625	0.115
23	98.5	8.0	SM	15.0	120.0	Clay	10755	4609	1.39	1.00	1.00	1.00	11.08	0.66	7.31	3.26	10.57	0.613	0.112
24	103.5	16.0	SM	15.0	120.0	Clay	11355	4897	1.39	1.00	1.00	1.00	22.16	0.68	15.13	3.26	18.39	0.603	0.109
25	108.5	10.0	SM	15.0	120.0	Clay	11955	5185	1.39	1.00	1.00	1.00	13.85	0.63	8.70	3.26	11.97	0.596	0.107
26	113.5	5.0	SM	15.0	120.0	Clay	12555	5473	1.39	1.00	1.00	1.00	6.93	0.58	4.00	3.26	7.26	0.590	0.106
27	118.5	6.0	SM	15.0	120.0	Clay	13155	5761	1.39	1.00	1.00	1.00	8.31	0.57	4.71	3.26	7.97	0.587	0.105
28	123.5	5.0	SM	15.0	120.0	Clay	13755	6049	1.39	1.00	1.00	1.00	6.93	0.54	3.76	3.26	7.03	0.586	0.104
29	128.5	7.0	SM	15.0	120.0	Clay	14355	6337	1.39	1.00	1.00	1.00	9.70	0.54	5.25	3.26	8.51	0.588	0.104
30	133.5	8.0	SM	15.0	120.0	Clay	14955	6625	1.39	1.00	1.00	1.00	11.08	0.53	5.90	3.26	9.17	0.592	0.104
31	138.5	8.0	SM	15.0	120.0	Clay	15555	6913	1.39	1.00	1.00	1.00	11.08	0.52	5.75	3.26	9.02	0.598	0.105
32	143.5	9.0	ML	50.0	120.0	Clay	16155	7201	1.39	1.00	1.00	1.00	12.47	0.53	6.63	5.61	12.25	0.607	0.106
33	148.5	12.0	SM	15.0	120.0	Clay	16755	7489	1.39	1.00	1.00	1.00	16.62	0.52	8.62	3.26	11.88	0.618	0.108
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.09	1.01	1.10	0.061	0.067	0.32
1.10	1.01	1.10	0.078	0.086	0.42
1.92	1.06	1.10	0.414	0.483	2.00
2.12	1.08	1.10	0.647	0.766	2.00
1.79	1.05	1.10	0.327	0.379	2.00
2.20	1.08	1.10	2.000	2.000	2.00
1.40	1.03	1.10	0.179	0.202	1.22
1.37	1.02	1.08	0.170	0.187	1.12
1.22	1.01	1.05	0.127	0.135	0.81
1.21	1.01	1.03	0.123	0.129	0.79
1.12	1.01	1.02	0.090	0.092	2.00
1.11	1.01	1.01	0.084	0.085	0.53
1.39	1.03	1.01	0.177	0.183	1.17
1.65	1.04	0.99	0.261	0.271	1.78
1.14	1.01	0.99	0.099	0.099	0.67
1.24	1.02	0.98	0.133	0.133	0.92
1.25	1.02	0.97	0.138	0.136	2.00
1.31	1.02	0.96	0.153	0.149	2.00
1.99	1.07	0.90	0.479	0.461	2.00
1.25	1.02	0.94	0.137	0.131	2.00
2.20	1.08	0.85	0.796	0.729	2.00
1.51	1.03	0.90	0.212	0.198	2.00
1.20	1.01	0.93	0.122	0.115	2.00
1.43	1.03	0.89	0.188	0.173	2.00
1.23	1.02	0.91	0.132	0.122	2.00
1.14	1.01	0.92	0.100	0.093	2.00
1.15	1.01	0.91	0.104	0.096	2.00
1.14	1.01	0.91	0.098	0.091	2.00
1.16	1.01	0.90	0.108	0.099	2.00
1.17	1.01	0.90	0.112	0.102	2.00
1.17	1.01	0.89	0.111	0.101	2.00
1.24	1.02	0.88	0.134	0.120	2.00
1.23	1.02	0.87	0.132	0.117	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.118	1.77	16.41
2	1.8	0.060	1.26	14.64
4	2.0	0.000	0.00	13.38
6	2.0	0.000	0.00	13.38
8	3.8	0.000	0.00	13.38
13.5	5.3	0.000	0.00	13.38
18.5	5.0	0.005	0.33	13.38
23.5	5.0	0.007	0.45	13.05
28.5	5.0	0.035	2.09	12.60
33.5	5.0	0.036	2.15	10.51
38.5	5.0	0.000	0.00	8.37
43.5	5.0	0.054	3.27	8.37
48.5	5.0	0.006	0.38	5.10
53.5	5.0	0.001	0.05	4.72
58.5	5.0	0.045	2.67	4.67
63.5	5.0	0.033	1.99	1.99
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.0	0.000	0.00	0.00
103.5	5.0	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	5.0	0.000	0.00	0.00
128.5	5.0	0.000	0.00	0.00
133.5	5.0	0.000	0.00	0.00
138.5	5.0	0.000	0.00	0.00
143.5	5.0	0.000	0.00	0.00
148.5	4.0	0.000	0.00	0.00
151.5				

Project:	Harbor River Bridge
Owner:	SC DOT
Job Number:	18461-007-00
Analysis by:	ZAS
Date/Time:	9/29/17 5:43 PM
Boring Designation:	B-16
Checked by:	CDL

Sampling Information

Depth to Groundwater (ft):	0
SPT Liner (Yes/No):	No
Hammer Energy, %:	83.1
Distance from sample hammer to ground surface (ft):	5
Borehole Diameter (in)	4

Earthquake Information

Max Acceleration (g) :	0.12
Earthquake Magnitude:	7.30

SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Thickness of Liquefiable Unit (ft)	Flag "Clay" "Unsaturated" "Unreliable"
1	0.5	0	SM	15	100		
2	2.0	5	SM	15	100		
3	4.0	28	SP	2	120		
4	6.0	22	SP	2	120		
5	8.0	15	SP	2	120		
6	13.5	29	SP	2	120		
7	18.5	8	SM	14	100		
8	23.5	5	SM	14	100		
9	28.5	10	SM	14	100		
10	33.5	4	SM	14	100		
11	38.5	2	SC	47	100		
12	43.5	3	SM	15	100		
13	48.5	1	MH	91	100		Clay
14	53.5	2	MH	91	100		Clay
15	58.5	5	SM	15	100		
16	63.5	8	SM	15	100		
17	68.5	3	CL	50	95		Clay
18	73.5	6	SM	15	120		Clay
19	78.5	27	SM	15	120		Clay
20	83.5	11	SM	15	120		Clay
21	88.5	5	SM	15	120		Clay
22	93.5	28	SM	15	120		Clay
23	98.5	15	SM	15	120		Clay
24	103.5	10	SM	15	120		Clay
25	108.5	6	SM	15	120		Clay
26	113.5	9	SM	15	120		Clay
27	118.5	8	SM	15	120		Clay
28	123.5	9	SM	15	120		Clay
29	128.5	7	SM	15	120		Clay
30	133.5	6	SM	15	120		Clay
31	138.5	7	SM	15	120		Clay
32	143.5	12	SM	15	120		Clay
33	148.5	11	SM	15	120		Clay
34							Clay
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							

*Assumes Marl/Limestone NonLiq

									C_E	C_B	C_R	C_S	N_{60}	C_N	$N_{1,60}$	Fines Correction	N1,60cs	r_d	CSR
SPT Sample Number	Depth (ft)	Measured N	Soil Type	Fines Content (%)	Unit Weight (pcf)	Flag "Clay" "Unsaturated" "Unreliable"	σ_v (psf)	σ_v' (psf)	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
1	0.5	0.0	SM	15.0	100.0		50	19	1.39	1.00	0.75	1.00	0.00	1.70	0.00	3.26	3.26	1.005	0.209
2	2.0	5.0	SM	15.0	100.0		200	75	1.39	1.00	0.75	1.00	5.19	1.70	8.83	3.26	12.09	1.002	0.208
3	4.0	28.0	SP	2.0	120.0		440	190	1.39	1.00	0.75	1.00	29.09	1.70	49.44	0.00	49.44	0.997	0.180
4	6.0	22.0	SP	2.1	120.0		680	306	1.39	1.00	0.80	1.00	24.38	1.70	41.44	0.00	41.44	0.991	0.172
5	8.0	15.0	SP	2.0	120.0		920	421	1.39	1.00	0.80	1.00	16.62	1.70	28.25	0.00	28.25	0.985	0.168
6	13.5	29.0	SP	2.1	120.0		1580	738	1.39	1.00	0.85	1.00	34.14	1.33	45.25	0.00	45.25	0.966	0.161
7	18.5	8.0	SM	14.0	100.0		2080	926	1.39	1.00	0.95	1.00	10.53	1.46	15.35	2.91	18.25	0.947	0.166
8	23.5	5.0	SM	13.9	100.0		2580	1114	1.39	1.00	0.95	1.00	6.58	1.39	9.17	2.87	12.04	0.926	0.167
9	28.5	10.0	SM	14.0	100.0		3080	1302	1.39	1.00	1.00	1.00	13.85	1.24	17.15	2.91	20.06	0.903	0.167
10	33.5	4.0	SM	14.0	100.0		3580	1490	1.39	1.00	1.00	1.00	5.54	1.21	6.71	2.91	9.62	0.879	0.165
11	38.5	2.0	SC	46.6	100.0		4080	1678	1.39	1.00	1.00	1.00	2.77	1.14	3.15	5.61	8.76	0.855	0.162
12	43.5	3.0	SM	15.0	100.0		4580	1866	1.39	1.00	1.00	1.00	4.16	1.07	4.46	3.26	7.73	0.830	0.159
13	48.5	1.0	MH	91.0	100.0	Clay	5080	2054	1.39	1.00	1.00	1.00	1.39	1.02	1.41	5.51	6.92	0.805	0.155
14	53.5	2.0	MH	91.0	100.0	Clay	5580	2242	1.39	1.00	1.00	1.00	2.77	0.97	2.68	5.51	8.19	0.781	0.152
15	58.5	5.0	SM	15.0	100.0		6080	2430	1.39	1.00	1.00	1.00	6.93	0.93	6.42	3.26	9.68	0.757	0.148
16	63.5	8.0	SM	15.0	100.0		6580	2618	1.39	1.00	1.00	1.00	11.08	0.90	9.95	3.26	13.21	0.734	0.144
17	68.5	3.0	CL	50.0	95.0	Clay	7055	2781	1.39	1.00	1.00	1.00	4.16	0.86	3.57	5.61	9.19	0.712	0.141
18	73.5	6.0	SM	15.0	120.0	Clay	7655	3069	1.39	1.00	1.00	1.00	8.31	0.82	6.80	3.26	10.06	0.691	0.134
19	78.5	27.0	SM	15.0	120.0	Clay	8255	3357	1.39	1.00	1.00	1.00	37.40	0.86	32.16	3.26	35.42	0.672	0.129
20	83.5	11.0	SM	15.0	120.0	Clay	8855	3645	1.39	1.00	1.00	1.00	15.24	0.77	11.69	3.26	14.95	0.654	0.124
21	88.5	5.0	SM	15.0	120.0	Clay	9455	3933	1.39	1.00	1.00	1.00	6.93	0.70	4.88	3.26	8.14	0.639	0.120
22	93.5	28.0	SM	15.0	120.0	Clay	10055	4221	1.39	1.00	1.00	1.00	38.78	0.79	30.75	3.26	34.01	0.625	0.116
23	98.5	15.0	SM	15.0	120.0	Clay	10655	4509	1.39	1.00	1.00	1.00	20.78	0.71	14.68	3.26	17.95	0.613	0.113
24	103.5	10.0	SM	15.0	120.0	Clay	11255	4797	1.39	1.00	1.00	1.00	13.85	0.66	9.09	3.26	12.36	0.603	0.110
25	108.5	6.0	SM	15.0	120.0	Clay	11855	5085	1.39	1.00	1.00	1.00	8.31	0.61	5.08	3.26	8.34	0.596	0.108
26	113.5	9.0	SM	15.0	120.0	Clay	12455	5373	1.39	1.00	1.00	1.00	12.47	0.61	7.60	3.26	10.86	0.590	0.107
27	118.5	8.0	SM	15.0	120.0	Clay	13055	5661	1.39	1.00	1.00	1.00	11.08	0.59	6.49	3.26	9.75	0.587	0.106
28	123.5	9.0	SM	15.0	120.0	Clay	13655	5949	1.39	1.00	1.00	1.00	12.47	0.57	7.16	3.26	10.42	0.586	0.105
29	128.5	7.0	SM	15.0	120.0	Clay	14255	6237	1.39	1.00	1.00	1.00	9.70	0.55	5.30	3.26	8.56	0.588	0.105
30	133.5	6.0	SM	15.0	120.0	Clay	14855	6525	1.39	1.00	1.00	1.00	8.31	0.53	4.36	3.26	7.63	0.592	0.105
31	138.5	7.0	SM	15.0	120.0	Clay	15455	6813	1.39	1.00	1.00	1.00	9.70	0.52	5.02	3.26	8.28	0.598	0.106
32	143.5	12.0	SM	15.0	120.0	Clay	16055	7101	1.39	1.00	1.00	1.00	16.62	0.54	8.90	3.26	12.16	0.607	0.107
33	148.5	11.0	SM	15.0	120.0	Clay	16655	7389	1.39	1.00	1.00	1.00	15.24	0.52	7.88	3.26	11.14	0.618	0.109
34						Clay													
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			

MSF		Ksig	CRR	Corrected CRR	Factor of Safety
IB (MSFmax)	IB	IB	IB	IB	IB
1.10	1.01	1.10	0.077	0.085	0.41
1.24	1.02	1.10	0.133	0.149	0.72
2.20	1.08	1.10	2.000	2.000	2.00
2.20	1.08	1.10	2.000	2.000	2.00
1.89	1.06	1.10	0.394	0.460	2.00
2.20	1.08	1.10	2.000	2.000	2.00
1.43	1.03	1.10	0.186	0.211	1.27
1.24	1.02	1.06	0.133	0.143	0.86
1.50	1.03	1.06	0.207	0.227	1.36
1.18	1.01	1.03	0.115	0.121	0.73
1.17	1.01	1.02	0.110	0.113	0.70
1.15	1.01	1.01	0.103	0.105	0.66
1.14	1.01	1.00	0.098	0.099	2.00
1.16	1.01	1.00	0.106	0.106	2.00
1.18	1.01	0.99	0.116	0.116	0.78
1.27	1.02	0.98	0.142	0.141	0.98
1.18	1.01	0.98	0.112	0.111	2.00
1.19	1.01	0.97	0.118	0.116	2.00
2.20	1.08	0.88	1.212	1.148	2.00
1.32	1.02	0.94	0.156	0.149	2.00
1.16	1.01	0.95	0.106	0.101	2.00
2.20	1.08	0.83	0.911	0.816	2.00
1.41	1.03	0.91	0.183	0.171	2.00
1.24	1.02	0.92	0.135	0.126	2.00
1.16	1.01	0.92	0.107	0.100	2.00
1.21	1.01	0.91	0.124	0.115	2.00
1.19	1.01	0.91	0.116	0.107	2.00
1.20	1.01	0.90	0.121	0.111	2.00
1.16	1.01	0.91	0.108	0.099	2.00
1.15	1.01	0.91	0.102	0.093	2.00
1.16	1.01	0.90	0.106	0.097	2.00
1.24	1.02	0.88	0.134	0.119	2.00
1.22	1.01	0.88	0.126	0.113	2.00

Temporary Depth Number	ΔH_i	ε_v	ΔS_i (in)	Cummulative Settlement (in)
0.5	1.3	0.062	0.92	14.64
2	1.8	0.033	0.70	13.72
4	2.0	0.000	0.00	13.02
6	2.0	0.000	0.00	13.02
8	3.8	0.000	0.00	13.02
13.5	5.3	0.000	0.00	13.02
18.5	5.0	0.005	0.28	13.02
23.5	5.0	0.033	2.00	12.74
28.5	5.0	0.004	0.22	10.74
33.5	5.0	0.038	2.29	10.52
38.5	5.0	0.040	2.42	8.22
43.5	5.0	0.043	2.58	5.81
48.5	5.0	0.000	0.00	3.23
53.5	5.0	0.000	0.00	3.23
58.5	5.0	0.038	2.28	3.23
63.5	5.0	0.016	0.94	0.94
68.5	5.0	0.000	0.00	0.00
73.5	5.0	0.000	0.00	0.00
78.5	5.0	0.000	0.00	0.00
83.5	5.0	0.000	0.00	0.00
88.5	5.0	0.000	0.00	0.00
93.5	5.0	0.000	0.00	0.00
98.5	5.0	0.000	0.00	0.00
103.5	5.0	0.000	0.00	0.00
108.5	5.0	0.000	0.00	0.00
113.5	5.0	0.000	0.00	0.00
118.5	5.0	0.000	0.00	0.00
123.5	5.0	0.000	0.00	0.00
128.5	5.0	0.000	0.00	0.00
133.5	5.0	0.000	0.00	0.00
138.5	5.0	0.000	0.00	0.00
143.5	5.0	0.000	0.00	0.00
148.5	4.0	0.000	0.00	0.00
151.5				

APPENDIX G
Ground Improvement Analyses

LTP Catenary Design

	W3		W4		E1	
Embankment Height (ft) =	14		18		17	
Embankment Fill Friction Angle (deg) =	38		38		38	
Embankment Fill Unit Weight (pcf) =	125		125		125	
Spacing (ft) =	7		5		5	
Diameter (in) =	10		10		10	
Tensile Force for Lateral Spreading						
Ka =	0.24		0.24		0.24	
q (psf) =	400		400		400	
Tls (lb/ft) =	3580		5674		5106	
Catenary Method (British Standard)						
frs =	1.30		1.30		1.30	
fq =	1.30		1.30		1.30	
σ_c' (psf) =	2795		3445		3283	
End-Bearing Columns Cc =	32.58		41.94		39.60	
Frictional Columns Cc =	25.13		32.33		30.53	
Pc'/σ_c' =	3.76		3.77		3.77	
Pc' (psf) =	10512		12988		12369	
Fc' (kips) =	6		7		7	
Wt (Equation 19-34) =	18788		15862		15114	
Wt (Equation 19-35) =	9431		4364		4365	
Wt (lb/ft) =	9431		4364		4365	
		Strain		Strain		Strain
Trp (lb/ft) =	89340	0.03	45862	0.01	45864	0.01
	79314	0.04	33334	0.02	33336	0.02
	72636	0.05	27937	0.03	27938	0.03
	67821	0.06	24801	0.04	24803	0.04
	64160	0.07	22713	0.05	22715	0.05
Maximum Design Tensile Force		Strain		Strain		Strain
Longitudinal Tmax =	89340	0.03	45862	0.01	45864	0.01
	79314	0.04	33334	0.02	33336	0.02
	72636	0.05	27937	0.03	27938	0.03
	67821	0.06	24801	0.04	24803	0.04
	64160	0.07	22713	0.05	22715	0.05
		Strain		Strain		Strain
Transverse Tmax =	92921	0.03	51535	0.01	50970	0.01
	82894	0.04	39008	0.02	38442	0.02
	76217	0.05	33610	0.03	33044	0.03
	71401	0.06	30475	0.04	29908	0.04
	67740	0.07	28387	0.05	27820	0.05

GeoTextile Deformation Calculation

Strain	7	%
Pile Diameter	10	inches

Spacing (ft)	Unsupported Length (in)	Strained Length (in)	Deformed Angle (rad)	Settlement (in)
3	26	27.8	0.36	4.9
4	38	40.7	0.36	7.2
5	50	53.5	0.36	9.5
6	62	66.3	0.36	11.8
7	74	79.2	0.36	14.1
8	86	92.0	0.36	16.4
9	98	104.9	0.36	18.7
10	110	117.7	0.36	20.9

Strain	3	%
Pile Diameter	10	inches

Spacing (ft)	Unsupported Length (in)	Strained Length (in)	Deformed Angle (rad)	Settlement (in)
3	26	26.8	0.24	3.2
4	38	39.1	0.24	4.7
5	50	51.5	0.24	6.2
6	62	63.9	0.24	7.7
7	74	76.2	0.24	9.1
8	86	88.6	0.24	10.6
9	98	100.9	0.24	12.1
10	110	113.3	0.24	13.6

APPENDIX H
Report Limitations and Guidelines for Use

APPENDIX H
REPORT LIMITATIONS AND GUIDELINES FOR USE

Geotechnical Services Are Performed For Specific Purposes, Persons And Projects

This report is for the use by UIG-ICE Design Build Team and the SCDOT for design and construction of the US 21 over Harbor River Bridge Replacement project in Beaufort County, South Carolina. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. This report should not be applied for any purpose or project except the one originally contemplated.

A Geotechnical Engineering Or Geologic Report Is Based On A Unique Set Of Project-Specific Factors

This data report has been prepared for UIG-ICE Design Build Team and the SCDOT for design and construction of the US 21 over Harbor River Bridge Replacement project in Beaufort County, South Carolina. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, and slope

instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

Most Geotechnical And Geologic Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Geotechnical Engineering Report Recommendations Are Not Final

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A Geotechnical Engineering Report Or Geologic Report Could Be Subject To Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.

Do Not Redraw The Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

Give Contractors A Complete Report And Guidance

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes

of bid development and that the report's accuracy is limited; encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

Contractors Are Responsible For Site Safety On Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

Read These Provisions Closely

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical, Geologic And Environmental Reports Should Not Be Interchanged

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

Have we delivered World Class Client Service?

Please let us know by visiting **www.geoengineers.com/feedback**.

GeoEngineers