

Geotechnical Subsurface Exploration and Laboratory Testing Data Report

2016-1A Emergency Bridge Replacement Package SCDOT PIN P031819 S-19 (Highway 19 East) Bridge over Bug Swamp Horry County, South Carolina F&R Project No. 65U-0177

Prepared For:



South Carolina Department of Transportation Design Build Section

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Prepared By:

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December 11, 2016

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December 11, 2016

Mr. Trapp Harris, PE South Carolina Department of Transportation Design Build Section 955 Park Street Columbia, South Carolina 29201

Subject: Geotechnical Subsurface Exploration and Laboratory Testing Data Report

2016-1A Emergency Bridge Replacement Package

SCDOT PIN P031819, S-19 (Highway 19 East) Bridge over Bug Swamp

Horry County, South Carolina F&R Project No. 65U-0177

Dear Mr. Harris:

The purpose of this data report is to present the results of the subsurface exploration program and laboratory testing undertaken by Froehling & Robertson, Inc. (F&R) in connection with the 2016-1A Emergency Bridge Package which includes the S-19 (Highway 19 East) Bridge over Bug Swamp in Horry County, South Carolina. Our services were performed in general accordance with your work order Number FR#10-18-P031819 emailed to F&R on November 22, 2016, and as authorized by your office per our On-Call Contract with SCDOT (Contract Number S-147-14). The attached report presents our understanding of the project, reviews our exploration procedures, describes existing site and general subsurface conditions, and presents the results of our laboratory tests.



We have enjoyed working with you on this project. Please contact us if you have any questions regarding this report or if we may be of further service.

Sincerely,

FROEHLING & ROBERTSON, INC.

Benedictus K. Azumah, PE Geotechnical Engineer SC PE License No. 33654



Marving L. Farmer, PE Senior Geotechnical Engineer SC PE License No. 32386

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1.0 PURPOSE & SCOPE OF SERVICES

The purpose of the subsurface exploration and soil laboratory testing was to obtain preliminary subsurface condition information for use as geotechnical baseline information in connection with the proposed bridge replacement, a design build project.

F&R's scope of services included the following:

- Coordination of underground utility clearance with SC 811;
- Review of readily available geologic and subsurface information relative to the project site;
- Completion of two soil test borings to a depth of approximately 100 feet below the existing ground surface;
- Preparation of typed boring logs presented on SCDOT soil test boring log template along with raw electronic data files in gINT format;
- Performing laboratory testing including up to eight natural moisture content tests, up to eight amount finer than No. 200 Sieve, and up to four Atterberg Limit tests on selected soil samples;
- Completion of two cone penetration tests to a depth of approximately 50 feet below the existing ground surface;
- Preparation of graphically illustrated CPT sounding logs and raw electronic CPT data files.
 We have provided these electronic data files in dot DAT, Comma-Separated Values (.CSV) and gINT (.GPJ) formats;
- Completion of one geophysical test at the bridge site using a Multi-Channel Analysis of Surface Waves (MASW) method.
- Completion of field surveys of subsurface test location to include stations, offsets, GPS
 coordinates in horizontal state plane coordinates (northings and eastings), and ground
 surface elevations at each test hole location.
- Preparation of this geotechnical data report by professional engineers.

F&R's geotechnical services did not include development of quantity estimates, preparation of plans and specifications, or the identification and evaluation of wetlands or other environmental aspects of the project site.



2.0 PROJECT INFORMATION

2.1 Site and Project Description

The project site is on South Carolina Highway S-19 (Highway 19 East) at the culvert over Bug Swamp in Horry County, South Carolina. Highway S-19 is an asphalt paved two-lane highway. The area around the culvert and roadway is generally swampy, wooded or partly covered with brush. The ground surface elevation on the paved area ranges from approximately EL 51 to EL 54 and the elevations around the river banks and the immediately adjacent areas range from approximately El 49 to El 52. A site vicinity map is shown as Figure No. 1 and included in Appendix I of this report.

As a result of recent storm events, damage to the culvert and roadway has occurred and therefore replacement of the existing culvert is planned. For this purpose, subsurface exploration at the culvert site is required.

F&R performed our subsurface exploration in accordance with the scope of services as described in your work order request to F&R which you submitted to us on November 22, 2016. F&R obtained the site location information from the Emergency Bridge Package 7 dot KMZ file dated November 21, 2016 which we received from your office on the same date. The project development information was provided to us through our communication with you and included in the work order request referenced above. Additional site details were obtained through our site visit.

2.2 Location Control

The SPT borings, CPT soundings and geophysical testing locations were staked in the field by F&R personnel at locations close to the existing culvert. After completion of the subsurface explorations our licensed surveying subcontractor, Chao and Associates, Inc. of Columbia, South Carolina obtained the station, offset, GPS coordinates: horizontal state plane coordinates (northings and eastings), and ground surface elevations at each test hole location. All surveying was performed in accordance with the rules and regulations governing the practice of surveying in the State of South Carolina. Horizontal datum was referenced to SCSPCS and Vertical datum was referenced to NGVD88. These locations and elevations should be considered no more accurate that the methods and plans used to obtain them.



3.0 SUBSURFACE EXPLORATION PROCEDURES

3.1 Soil Test Borings

The soil test borings were conducted by our drilling subcontractor, William Walker Environmental Services LLC of West Columbia, South Carolina. The drilling was performed from December 7th through December 9th, 2016. The Standard Penetration Test (SPT) was performed at the boring locations in general accordance with ASTM D1586.

The drill rig used for this project was a truck-mounted CME-45B equipped with a safety hammer. The test holes were advanced using the mud rotary drilling technique.

The subsurface exploration program included two Standard Penetration Test (SPT) borings, each located as close as possible to opposite sides of the existing culvert. The borings are designated as Soil Test Borings STB-401 and STB-402. The SPT tests were performed continuously from approximately 2 feet below the existing ground surface to a depth of 10 feet and at approximate 5-foot intervals thereafter until termination at a depth of approximately 100 feet below the existing ground surface. Approximate boring locations are identified on Figure No. 2 - Location Plan included in Appendix I of this report. Photographic documentation of the locations of STB-401 and STB-402 are also included in Appendix I and presented as Figure No. 3 and 4, respectively.

Soil samples were obtained with a standard 2" O.D. and 30" long split-spoon sampler with each SPT being driven with a 140-lb automatic hammer falling 30 inches. The number of blows required to drive the sampler each 6-inch increment of penetration was recorded and are shown on the boring logs. The first six-inch increment is used to seat the sampler with the sum of the second and third penetration increments being termed the SPT N-value. A representative portion of each disturbed split-spoon sample was collected with each SPT, placed in a bag, and returned to our laboratory for review.

The recovered split-spoon samples were visually classified by F&R engineers in general accordance with the ASTM D2488. The boring logs provided in Appendix II show the subsurface conditions encountered on the dates and at the approximate locations indicated. Groundwater observations at the time of drilling and after 24 hours are recorded on the boring logs.



By the nature of the work performed, the drilling activities result in disturbances to the site. The completed boreholes performed were backfilled with on-site soils. The borehole backfill may subside at some time following our work. F&R assumes no responsibility for borehole subsidence after completion of the field exploration and departing the site. For continued safety, the boreholes should be occasionally observed by others with any needed additional backfilling then being performed. The test boring logs are included with this report and presented in Appendix II.

3.2 Cone Penetration Testing

The Cone Penetration Test (CPT) soundings conducted for our subsurface exploration were performed by our sub-contractor Palmetto Insitu, LLC of Charleston, South Carolina on November 30, 2016. The two CPTs were performed close to each of the existing culvert in general accordance with ASTM D5778. The CPTs are designated as CPT-401 and CPT-402 and are identified on Figure No. 2 - Location Plan included in Appendix I of this report.

The equipment used for the exploration includes an electronic 15 cm2 Vertek seismic cone, hydraulically advanced into the soil using a Vertek S4 Scorpian CPT rig capable of 20 tons of thrust. The collected raw data was processed by Palmetto Insitu, LLC using Bentley's gINT V8i SS2 software (version 08.30.04.206) and Dataforensics, RapidCPT software (version 4.2.2.0). The legend used for the SBT correlations is based on Robertson and Campanella: 1990 and is included with the CPT results provided in Appendix III. An electronic file (in .CSV file format) containing the CPT results will be provided via email along with this report. Photographic documentation of the CPT rig in operation at the locations of CPT-401 and CPT-402 are included in Appendix I and presented as Figures No. 5 and 6, respectively.

3.3 Geophysical Testing

A Refraction Microtremor (ReMi) survey was performed at one location (array) longitudinal to the road and just to the north side of the culvert. The ReMi survey was conducted to provide estimated measurements of the soil shear wave velocity in the upper 100 feet. The dispersive characteristic of Rayleigh waves when traveling through a layered medium is measured from the surface, which makes the method nondestructive and nonintrusive. A seismic source (ambient "noise") is applied at the ground surface where vertical transducers record the propagation of surface waves. By analyzing the phase information for each frequency contained in the wave train, the Rayleigh and shear wave velocity can be determined. The data was processed using SeisOpt® ReMi™ software to reveal a one-dimensional average shear-wave (S-wave) velocity



structure for the array. The survey was performed to provide the average shear wave velocity to a depth of 100 feet used to determine the seismic Site Classification in accordance with Chapter 16 of the 2015 International Building Code (IBC). The result of the geophysical test is included in Appendix IV of this report.

4.0 LABORATORY TESTING

4.1 Laboratory Testing

Laboratory testing consisted of eight natural moisture content test (ASTM D2216), eight amount finer than No. 200 Sieve tests (ASTM D1140), and four Atterberg Limit tests (ASTM D4318) on several samples obtained from the borings.

Laboratory test results were not available at the time of this reporting and will be provided in a subsequent Revision of this report.

5.0 LIMITATIONS

This report has been prepared for the exclusive use of South Carolina Department of Transportation – Design Build Section or their agent, for specific application to the S-19 (Highway 19 East) Bridge over Bug Swamp project, in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made. Our investigation is based on site location information furnished to us; and generally accepted geotechnical engineering practice. The subsurface investigation logs included herein, do not reflect variations in subsurface conditions which could exist intermediate of the boring locations or in unexplored areas of the site. Should such variations become apparent during construction, it will be necessary to perform additional subsurface exploration based upon on-site observations of the conditions.



APPENDIX I





Horry County, South Carolina











APPENDIX II



KEY TO SOIL CLASSIFICATION

Correlation of Penetration Resistance with Relative Density and Consistency

<u>els</u>	Silts and Clays	
Relative	No. of	
<u>Density</u>	Blows, N	Consistency
Very loose	0 - 2	Very soft
Loose	3 - 4	Soft
Medium dense	5 - 8	Firm
Dense	9 - 15	Stiff
Very dense	16 - 30	Very stiff
	31 - 50	Hard
	Over 50	Very hard
	Density Very loose Loose Medium dense Dense	Relative No. of Density Blows, N Very loose 0 - 2 Loose 3 - 4 Medium dense 5 - 8 Dense 9 - 15 Very dense 16 - 30 31 - 50

Particle Size Identification

(Unified Classification System)

Boulders: Diameter exceeds 12-in. (300-mm)

Cobbles: 3-in. (75-mm) to 12-in. (300-mm) diameter

Gravel: Coarse - ¾-in. (19-mm) to 3 in. (75-mm) diameter

Fine - No. 4 (4.75-mm) sieve to ¾-in. (19-mm) diameter

Sand: <u>Coarse</u> – No. 10 (2.0-mm) to No. 4 (4.76 mm) sieve

<u>Medium</u> – No. 40 (0.425-mm) to No. 10 (2.0-mm) sieve <u>Fine</u> - No. 200 (0.075-mm) to No. 40 (0.425-mm) sieve

Silt and Clay: Less than No. 200 (0.075-mm) sieve

Modifiers

The modifiers provide our estimate of the amount of silt, clay or sand size particles in the soil sample.

Approximate Content ≤ 5%:	Modifiers Trace
5 to 10%:	Few
15 to 25%:	Little
30 to 45%:	Some
50 to 100%	Mostly

	Field Moisture
	<u>Description</u>
Dry	Absence of moisture, dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

SOIL CLASSIFICATION CHART

	A 100 00/00	IONO	SYM	BOLS	TYPICAL
M	AJOR DIVIS		GRAPH	LETTER	DESCRIPTIONS
	GRAVEL AND	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	GRAVELLY SOILS	(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
COARSE GRAINED SOILS	MORE THAN 50% OF COARSE FRACTION	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
	RETAINED ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS	SAND AND	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
LARGER THAN NO. 200 SIEVE SIZE	SANDY SOILS	(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
	PASSING ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
				ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
33.23				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE				МН	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		СН	INORGANIC CLAYS OF HIGH PLASTICITY
				ОН	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
н	GHLY ORGANIC S	SOILS	71 71 71 71 71 7 7 7 7 7 7 7 7 7	РТ	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

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		Munsell = Munsell Col LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index NMC = Natural Moistu %#200 = Percent Pass	, w#200 or Chart Designation re Content sing #200 Sieve																
		Rock Description (Lithologic description: texture, grain size, folia strength with k , I , m , n r , Munsell , R RMR Munsell = Munsell Col RQD = Rock Quality D %REC = Percent Reck RMR = Rock Mass Ra	rock type, color, ation, weathering and																

Figure 6-10, SCDOT Soil Test Boring Log

6-26 August 2008

a -	Relative Density / C	onsistency Ter	ms		Consistency ²		
	Descriptive Term	Relativ	e Density	SPT Blow Count	Descriptive Term	Unconfined Compression Strength (q _u) (tsf)	SPT Blow Count
	Very Loose Loose Medium Dense Dense Very Dense	16 t 36 t 66 t	0 15% 0 35% 0 65% 0 85% 0 100%	< 4 5 to 10 11 to 30 31 to 50 >51	Very Soft Soft Firm Stiff Very Stiff Hard	<0.25 0.26 to 0.50 0.51 to 1.00 1.01 to 2.00 2.01 to 4.00 >4.01	<2 3 to 4 5 to 8 9 to 15 16 to 30 > 31
b	Moisture Condition	É					
	Moist	<u>Criteria</u> Absence of moi Damp but no vi Visible free wa	sible water	lry to the touch	ow the water table		
с	Color Describe the sample	color while sam	ple is still moi	st, using Munsell color	chart.		
d	Angularity ¹						
	Descriptive Term Angular Subangular Subrounded Rounded	Parti Parti	icles have shar icles are simila icles have near	p edges and relatively p ar to angular description ly plane sides but have othly curved sides and r	but have rounded edge well-rounded corners a	S	
е	HCl Reaction ³						
_	None Reactive	<u>Criteria</u> No visible react Some reaction, Violent reaction	with bubbles t	forming slowly s forming immediately			
f	Cementation ³						
	Descriptive Term Weakly Cemented Moderately Cemente Strongly Cemented	d Crumbles	or breaks with	n handling or little finger n considerable finger pre ak with finger pressure			
g	Particle-Size Range	1					
	Gravel mm	Sieve s	size	Sand	mm	Sieve siz	re
	Fine 4.76 to Coarse 19.1 to	19.1 #4 to 3		Fine Medium Coarse	0.074 to 0.42 0.42 to 2.00 4.00 to 4.76	#200 to # #40 to # #10 to #4	#40 10
h	Primary Soil Type ¹ The primary soil type		in all capital l	etters			
i	USCS Soil Designat Indicate USCS soil d		fined in AST!	M D-2487 and D-2488			
j	AASHTO Soil Desig	7	1.7	ASHTO M-145 and AS	TTM (TS 2000		

Figure 6-11, SCDOT Soil Test Boring Log Descriptors - Soil

6-27 August 2008



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Site De	scripti	on:	2016-1A	Emergen	cy Brid	lge P	ackage	Э								Rout	te: S-	19	
3oring	No.:	STB-4	01 B o	ring Locat	tion:		-		(Offs	et:	6	.00	ft LT	Alig	nme	nt:	Existin	g
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	achine:		-45B	Drill Met		RW	94.44.		Hamme						-		Ratio		
ore Si		N/A	. 100	Driller:			, LLC		Ground	_	-	ГОВ	_	3 ft			4HR	5.51	
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Elevation (ft)	₽ _						Graphic Log	the second	Sample No./Type		<u>.</u> 9 E		N Value		PL ×	-	MC —	$\overset{LL}{\longrightarrow}$	
eva (ft)	Depth (ft)	MA	ATERIAL	_ DESCRI	PTION		Log	Sample Depth	am T.C		2nd/3rd 6"		/a		A F	INES	CONTE	NT (%)	
ă							၂ ^ၒ	S	ωž	1st 6"	2nd	4th 6"	Z	0 10			50 6		
7									7					:					
+									+						:				
4	38.0	Firm to s	oft moist	 , dark gray (0	GI FV1			38.0	+					:		: :			
4		3/10GY)	, FAT CLA	Y (CH/A-7-6	3), conta	ains			SS-11	4	3/3	6	6	•	PP=	3.0 ts	f		
11.0-		wood fra	gments ar	nd trace she	ll fragme	ents			+					H	<u> </u>	<u> </u>			
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٦	1							. 3.0		_] [<u>:</u> _	: :			
7									SS-12	3	2/2	4	4		PP:	=2.5 ts	ST :		
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4	48.0							48.0							:				
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1.0-		SAND (S	SC/A-6) , co	ontains ceme	ented sa	and					ψ, . · ·		.,						
1.0		lenses a	nd few to	little shell fra	gments	;					_					: :			
7	1								7					:	:	: :	: :	: :	
7								53.0	7										
4	-							33. 0	+						:	: :			
4	-								SS-14	5	7/13	19	20		٠				
-4.0	-								+							: :	- : :		
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	58.0							58.0] :	:				
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	1	(CH/A-7	, FAT CLA ·6), trace s	AY WITH SA shell fragmer	טאו טאו				33-15	4	3/3	8	10		, PP	=2.5 t	: اه :		
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7									7						:				
4	-								-					:	:	: :			
4	-							63.0	+					1					
4	-								SS-16	6	8/10	13	18	:	● PF	P=2.5	tsf		
-14.0														:	- :	: :	- : :		
_									_						:	: :			
														:	:	: :			
	68.0							68.0							:				
		BLACK	CREEK FO	ORMATION,	mediun	n_		- 3.0		_	4 = 1 : :] :					
-		dense, w	et, light g	reenish gray irse grained	(GLEY	2 v			SS-17	3	12/11	15	23		•				
		<u> </u>	iiie io coa	iise grained	OLATE	1	<u> </u>	GENI	5					<u> </u>	•	· · ·	ntinue	d Nev	t F
			SAMPLER	R TYPE				J LIVE				DF	RILLIN	IG M	ETHO		, itiii lu C	G 116X	
	Split Spo			NQ - Rock C		7/8"			SA - Hollo			er		- 1	₹W -	Rotar	y Wash		
	Shelby T	ube re, 1-1/8"		CU - Cutting CT - Contin					A - Conti			Aug	jers		RC -	KOCK	Core		



File No			ject No. (PIN):		1819		unty:	Ho	rry Co	unty		Eng	./Geo.		Azumah
Site De			-1A Emergenc		аскад	е		Offse		6.00	ffl7	ΛI	Route gnmen		
Boring Elev.:			Boring Locati		- Longi	huda.		.955			π L ι Stai		_		xisting /2016
Elev.: Total D			ge: 33.9 Soil Depth:	100 ft		tuae: ore De		N/A			Star				/2016
		meter (in):	-	pler Confi					quirec					Used:	
Drill Ma			Drill Meth				Hamme				' (Ratio:	
Core Si		N/A	Driller:	WWES			Ground			OB	6 ft			HR	5.5 ft
00.00	.20.	14// (21111011	TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT	· LLG		<u> </u>	arrace	J I.		0 10				0.010
Elevation (ft)	Depth (ft)	MATER	IAL DESCRIP	TION	Graphic Log	Sample Depth	Sample No./Type	1st 6"	2nd/3rd 6"	N Value		ŕ	PL	N VALU MC ⊖ CONTEI	LL ×
		CAND (CC/A C	C)t-i		77.77	1	2	\$	2 4	} <u> </u>	0 1	0 20	30 40	50 60	70 80 9
-24.0	- - - - -	sands, trace we little shell fragn	-6), contains cem ood fragments an nents	iented ad few to		73.0	- SS-18	2	9/12 1	7 21		•			
-	78.0_	 Medium dense	to dense, moist,			78.0	_								
-29.0	-	greenish gray (medium graine	GLEY 2 5/10G), d CLAYEY SANI ce wood fragmen	fine to			SS-19	5	7/9 1	1 16		•			
- - -	- - - -					83.0	- - - SS-20	4	8/7 1	3 15		•			
-34.0 - - -						88.0									
-39.0	_					00.0	- SS-21	11 1	14/20 1	6 34			•		
- -	93.0_					93.0	_								
-44.0	<u> </u>	(GLEY 2 5/10G	, wet, light greeni b), fine to coarse D (SC/A-2-6), son	grained			- SS-22	10 1	12/15 2	2 27			•		
-	-	ŭ				98.0	-					:			
-49.0	100.0						- SS-23	13 1	18/20 2	2 38		:	•		
- - -	- - - -		ted at 100 feet. B soil after 24-hour ed.			- - -									
					1 =	GENI	<u> </u>					:	: :	<u> </u>	: :
ST - S	Split Spo Shelby T	on	LER TYPE NQ - Rock Co CU - Cuttings		LE	HS	SA - Hollo FA - Conti					RW -	DD Rotary Rock C		



ile No.			•	o. (PIN)			31819	_	unty:	H	orry (Cour	nty	E	ng./C			zuma	<u>ah</u>
ite Des						dge I	Package	Э								oute:			
Boring I		STB-402		g Locat			-			Offs						ment:		isting	_
lev.:	54.0 f				97345		Longit			_	5116			Starte			12/8/2		
otal De	epth:	100 ft	Soil E	epth:	10	00 ft	Co	re De	epth:	N/	Α ft	1	Date	Com	oleted	l:	12/9/2	2016	
ore Ho	ole Dia	meter (in):	4	Sar	npler	Conf	figuratio	on	Line	r Re	equi	red:	Y	(N)	L	iner U	sed:	Υ	(
Prill Ma			D	rill Metl		RW			Hamme				ety		Ene	rgy Ra	atio:	100%	
ore Siz	ze:	N/A		riller:	W		. LLC		Ground		_	TOI		8 ft		24H	_	5.7 ft	
															•	SPT N	VALUE	•	
Elevation (ft)	Depth (ft)	MATEF	RIAL D	ESCRIF	PTION	1	Graphic Log	Sample Depth	Sample No./Type	1st 6"	2nd/3rd 6"	4th 6"	l Value		PL X	M NES CC		 —× T (%)	
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	0.7	8 inches asph	a <u>lt</u>					0.5						-			:		
٦	1.0	ີ∖Dense graded	aggreg	ate base	coarse)		2.0	SS-1					:	: :	: :	:	: :	
_	-	FILL , medium (2.5Y 5/4), fine	dense, to med	moist, lig lium grai	ht brov	 vn _ TY		2.0	- SS-2	9	13/15	5 17	28		•				
-	4.0_	SAND (SM/A-2 Loose, moist,	2-4)				- 7///	4.0						-					
49.0	-	▼5/2), fine to me SAND (SC/A-2	edium g					6.0	- SS-3	4	3/2	3	5						_
-	- 8.0	,	,					8.0	SS-4	4	4/5	4	9						
]	-	ALLUVIUM, lo 4/3), fine to me	edium g	rained, C	LAYE			2.0	- SS-5	1	2/6	3	8	•					
44.0	_	SAND (SC/A-2	2-7) , few	organics	8														
7														:			:		
7	13.0							13.0	7										
7	13.0_	Medium dense						13.0						1		: :	:	: :	
+	_	5/2), fine to me	edium g	rained, P					- SS-6	3	4/7	6	11	•			:		
39.0-	-	(SP-SC/A-1-b)		CLAT					+				1		: :	: :	:	: :	_
4	-	, : · · · · · · · · · · · · · · · · · ·							+							: :	:		
4	-								4										
4	18.0_		NAA T. C	N 6	- 1:55			18.0	+				1	1			:		
4	_	PEE DEE FOR moist, dark gra	KIVIA (TIO AV (GIF	N , TIRM to Y 1 3/10	Stiff, GY). F /	ΑT			- SS-7	4	2/4	5	6		P	P=1.5 i	tsf :		
34.0		CLAY (CH/A-7	'-6) , trad	ce sand	~·/, • •				1 .	<u> </u>			<u> </u>						
_ ٠٠٠٠																: :	:		
7																	i		
7	_							23.0	7								:		
1	_							20.0						1 :			:		
+	-								- SS-8	3	5/7	6	12		- 1	PP=2.2	5 tsf	<u> </u>	
29.0	_								+				1		: :	: :	:	: :	_
4	_								+					:			:	<u> </u>	
4	_								+								:		
4	28.0_	Ctiff made 1						28.0					1	!	: :		:		
	_	Stiff, moist, da 5/10G), FAT C	rk greei	ıısıı gray ITH S∆N	(GLEY D	2			- SS-9	3	4/7	7	11		P	P=2.5 ts	sf :	<u> </u>	
24.0		(CH/A-7-6)	••		_							-	1						
24.0									_						: :	: :	:		
7																	:		
1	_							33.0	1								:		
+	_							აპ.0	+				1	1 !					
+	_								SS-10	2	5/8	7	13		P	P=2.5 ts	sf :		
							LE(GENE)	<u> </u>			1	<u> :</u>	: :	Conti	nued	Next	_ P
			PLER T										RILLI	NG ME					_
SS - S	plit Spc	on ube	NG CL) - Rock C		7/8"			SA - Hollo FA - Conti			ıger				otary W ock Cor			



File No.		3 011			No. (F			P03	1819	Co	unty:	Н	orry	Сош	ntv	F	ng./G	eo .	R A	zumah	_
Site Des		n. (Package	_	arity.		Olly	Oou	ity			oute:	S-19		
Boring		STB-40			ing L	_	•	ige i	ackage			Offs	ot:		6 00	ft LT				isting	
	54.0 ft		atitud		ilig L		7345	1	- Longit	udo	 7		5116			Starte			2/8/2		
		100 ft			Dept			00 ft					/A ft	-						2016	
Total De	•				рері					re De					Date	Comp					
		meter (in	•	4	D.::!!!		•		iguratio	on 			equi			N		ner Us			<u>N</u>
Drill Ma			-45B		Drill I			RW			Hamn					0 (1	Ene	rgy Ra		100%	
Core Siz	ze:	N/A			Drille	er:	VVV	VES.	LLC		Grour	iawa	iter:	ТО	В	8 ft		24HF	(5.7 ft	
																	• 9	SPT N V	ALUE	•	
Elevation (ft)	Depth (ft)	MA	TERI	IAL I	DESC	CRIP	TION	I	Graphic Log	Sample Depth	Sample No./Type	1st 6"	2nd/3rd 6"	4th 6"	N Value			MC O	NTEN		
_	-											-	N	4		0 10	20 30	40 50	60	70 80 9	0
_	1										1					:					
+	70.0									00.0	. 🕇					:			:		
+	38.0	Stiff, mois	 st. darl	k ara	v (GI F	EY1 3	 /10GY			38.0	'+					1 !					
4	4	FAT CLA	Y (CH	/A-7-	6) , tra	ce sar	nd and	í'			- SS-1	1 4	5/7	10	12	•	F	P=2.75	tsf		
14.0-	4	shell frag	ments								+	+				1 :	: :	: :	- :-	<u> </u>	<u>:</u>
4	4										4							: :			:
_											4					:					
										43.0	<u> </u>	\perp			1	1			:		
											- SS-12	2 5	6/9	12	15		: : : :	P=2.5 ts	f		
	7										33-1	_ 3	0/9	12	13			ı –∠.ɔ (S	'' : :		
9.0-	1										1							: :	:		-
7	7										1					:					
+	+									40.0	,†							: :	:		:
+	4	Changes	to con	ntains	ittle s	shell fi	raame	ents		48.0	'+				+	1 :		: :	:		
4	4		5011								SS-1	3 5	7/7	12	14		P	P=2.75	tsf:		
4.0-	4										+	+				:	: :	- : :	:	: :	<u>: </u>
4	4										-					:			:		
	4										4					:			Ė		:
										53.0	1					1 !			:		
											- SS-14	4 4	5/8	11	13		; ; D:	: ⊃=3.0 ts	, :		
4.0]													'		:	: F1	-J.U IS	<u>.</u>		
-1.0	7																	: :	:		:
1	1										1							: :			
1	58.0									58.0	Ţ								:		:
+	50.0	Stiff, mois								50.0						1 :		: :	:		
+	4	CLAY WI	TH SA								SS-1	5 5	4/6	11	10	•	: PI	P=2.5 ts	f :		:
-6.0	+	fragment	5								+				1	1 :	<u> </u>		:		-
4	4										+							: :			:
4	4										4							: :			
4	4									63.0	+	+			1	4 :		: :	÷		:
											- SS-16	5 5	6/9	12	15		: : PI	P=2.25 t	sf :		
-11.0											1				1	1				<u>: :</u>	:
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7	68.0									68.0	,]					:		: :	÷	<u>:</u>	:
1	30.0	BLACK (REEK	FOF	RMAT	ION, d	dense	to	-4///	55.0						1 :			:		
+	-	medium o	dense,	mois	st, ligh	t gree	nish g	ray			- SS-1	7 8	19/14	4 42	33	:			:		
		(GLEY 2	<u>5/10G</u>	<u>), TIN</u>	e to m	<u>ealum</u>	ı grain	<u>ed</u>	<i>\///\</i> LE(GENI	 D					<u> </u>	<u>. :</u>	Contin	ued	Next P	<u> —</u>
			SAMPL			, -		- 15 "							RILLI	NG ME	THOD				<u> </u>
SS - S ST - S	Split Spo Shelby To	on ube			IQ - Ro CU - Co			7/8"			SA - Hol FA - Cor				iders			otary Wa ock Core			
AWG-R	Rock Cor	e, 1-1/8"					, ous Tu	ıbe			Dri\			,	5						



File No.				ct No. (31819 Deekse		ounty:	H	orry (ouر	nty			/Geo.		Azur	nah
Site De	-					y Bridge	Раскад⊦ ⊤	<u>e</u>		O#-	-4-		0.00	4 I T		Rout		19	
Boring	NO.: 54.0 f	STB-40		oring L	1		-			Offs		_	6.00 Date			nmei		Existi 3/201	
lev.:		100 ft	atitude.		1	73454 100 ft	Longit		epth:		5116 /A ft	_	Date Date			54·	_	9/201	
Total Depth:100 ftSoil Depth:100 ftBore Hole Diameter (in):4Sampler Config									Liner Required						r Used				
Orill Ma			,		Metho				Hamn								Ratio		
Core Si		N/A		Drille		WWES			Grour		_	ТО	_	3 ft			4HR	5.7	
				'							'					'		_	
Elevation (ft)	Depth (ft)	MA	MATERIAL DESCRIPTION			Graphic Log	Sample Depth	(π) Sample No./Type	1st 6"	1st 6" 2nd/3rd 6"	4th 6"	N Value	● SPT N VALUE ● PL MC LL ★ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90						
		CLAYEY SAND (SC/A-2-6), contains								-		4	-	0 10	20	30 40	50 6) /() 	30 8
- - -	- - -	cemented	d sands,					73.0			0/40	07	04	_					
-21.0									SS-18	3 7	9/12	27	21					:	:
-	-																	:	
	78.0					 -		78.0		\perp				!	:			:	
-26.0 - -	-	Medium (3/10GY), (SC/A-2-	fine gra	ined CL	AYEY S	SAND			SS-19	5	4/9	14	13		•			:	
	- - -	(00)74-2-1	-, oone		5,1104 3	- ATTMO													
-31.0	-	Changes	to conta	ains trac	e shell t	fragments		83.0	SS-20	0 6	7/10	12	17	1	•				
-31.0- - -	- - -																		
-	88.0_	(GLEY 2	fine to c	t, light greenish gray ne to coarse grained C/A-2-6), some shell		<i>\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\</i>	88.0	- SS-2 ⁻	1 12	10/16	32	26	-	•			:		
-36.0 - - - -	-	fragment		3U/A-Z-	و ن , som	e snell											: : : : : : : : : : : : : : : : : : :		
	-							93.0	SS-22	2 10	13/17	7 39	30]		•			
-41.0 - - - -	+																	:	:
	-							98.0	<u> </u>										
-46.0 - - - -	100.0	Boring terminated at 100 feet. Boring backfilled with soil after 24-hour water level reading obtained.							- SS-23	3 50/6	;"		100	:				:	
	- - -								-										
								OE."						:	:	: :	: :	:	<u>:</u>
			SAMPLE	R TYPE			LE	GENI	ט			Г	RILLIN	IC M	=TH∩	D			
ST - S	Split Spo Shelby T Rock Co	on	OAMPLE	NQ - F	Rock Co Cuttings	ore, 1-7/8" ous Tube		CF	SA - Holl FA - Cor C - Driv	ntinuo	us Flig	ıger		F	RW -		Wash Core		



APPENDIX III



Geotechnical Exploration

Thank you for your trust in PalmettoINSITU, LLC to perform your field exploration.

Test Methods:

PalmettoINSITU performs in-situ testing in general accordance with the currently published ASTM procedures along with generally acceptable industry practices. Applicable procedures include:

- Piezo Cone Penetration Tests (CPTu): D5778-xx
- Marchetti Flat Plate Dilatometer (DMT): ASTM D6635-xx
- Seismic Piezo Cone Penetration Tests (SCPTu) ASTM D7400-xx

Instrumentation:

- All of PalmettoINSITU's probes are manufactured and are calibrated at least annually by Vertek.
- The equipment used for the exploration includes electronic 15 cm2 cones with serial numbers listed within the electronic file.
- PalmettoINSITU's Marchetti Flat Plate Dilatometer equipment is provided by GPE, Inc and is calibrated at least annually.

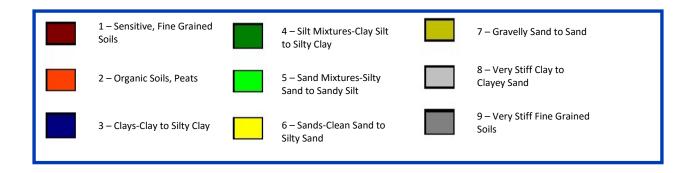
Rig:

• PalmettoINSITU uses a Vertek S4 Scorpion rig capable of 20 tons of thrust. The push system is conveyed and hydraulically powered by a Bobcat T770.

Software:

- PalmettoINSITU uses Bentley's, gINT and Dataforensic's, RapidCPT to process and output the raw data collected.
- Currently, PalmettoINSITU is using version of gINT is V8i SS2 Version 08.30.04.206 and our current version of RapidCPT is 4.2.2.0.

SBT Material Correlations Legend (Robertson and Campanella: 1990):





S-19 Horry County, SC Project Number :16-126

Cone Penetration Test

CPT-401

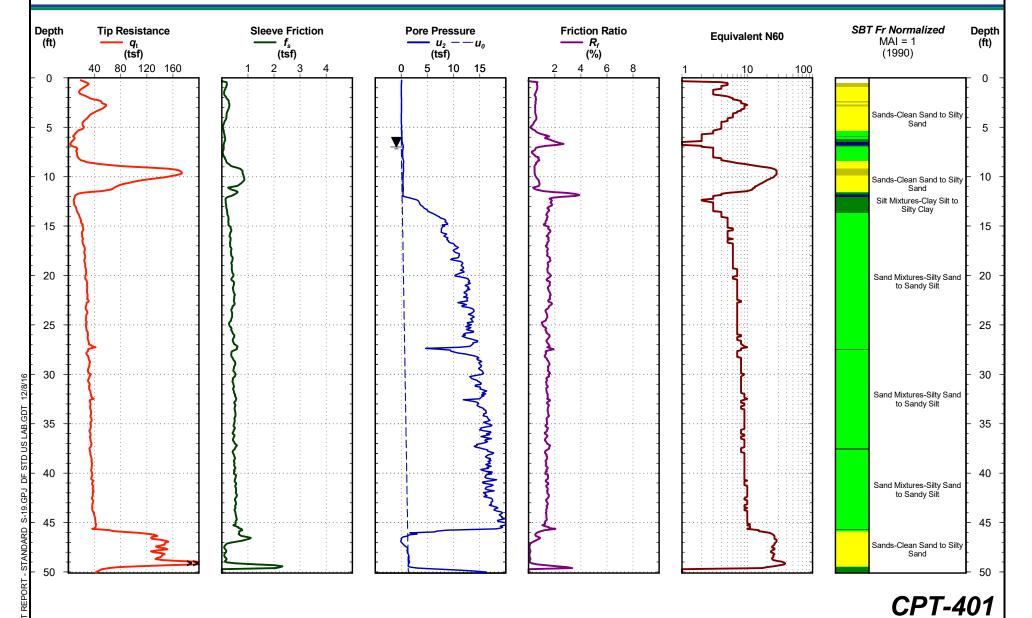
Date: Nov. 30, 2016

Estimated Water Depth: 7 ft

Rig/Operator: M. Cox | J. Croom

Northing: Easting: Elevation: Total Depth: 50.1 ft
Termination Criteria: Target Depth

Cone Size: 1.75



Page 1 of 1

Electronic File Name: B30N1603C.DAT



S-19 Horry County, SC Project Number :16-126

Cone Penetration Test

CPT-402

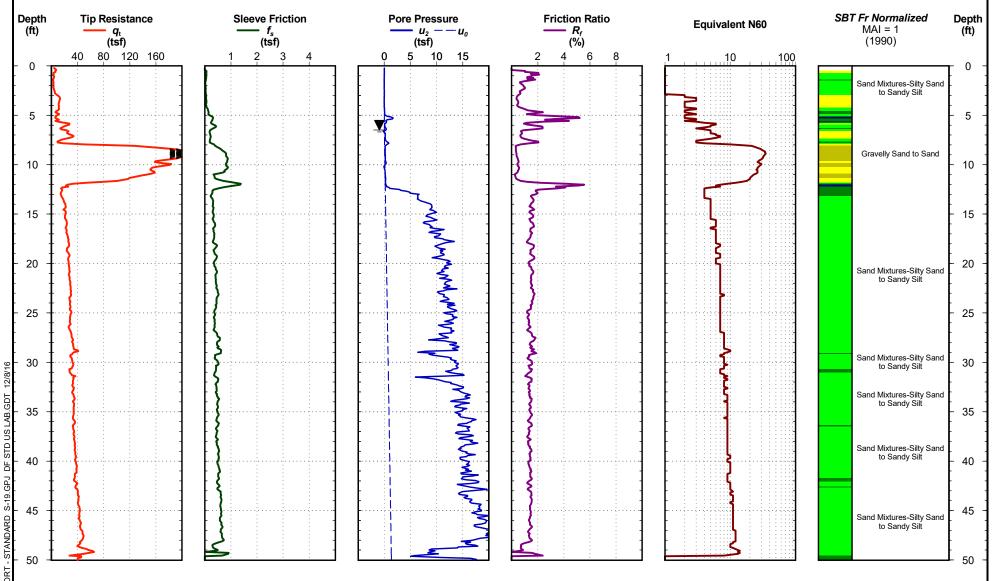
Date: Nov. 30, 2016

Estimated Water Depth: 6.5 ft

Rig/Operator: M. Cox | J. Croom

Northing: Easting: Elevation: Total Depth: 50.0 ft
Termination Criteria: Target Depth

Cone Size: 1.75



CPT-402

Electronic File Name: B30N1601C.DAT



APPENDIX IV

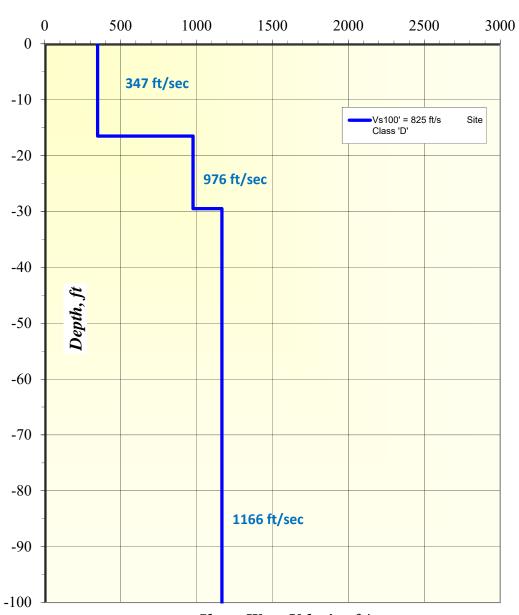
SINCE

FROEHLING & ROBERTSON, INC.

Refraction Microtremor (REMI) Results

Project: 2016-1A Emergency Bridge PackageS-19, Horry Co. SCReport Date:12/1/16Client: SCDOT Geotechnical Design GroupTest Date: 12/2/2016Record No.:65U-0177

Vs Model



Shear-Wave Velocity, ft/s

