GEOTECHNICAL SUBSURFACE DATA REPORT

SC-41 REPLACEMENT BRIDGE OVER MAIDEN DOWN SWAMP

MARION COUNTY, SOUTH CAROLINA

PREPARED FOR

Mr. Joshua Meetze, E.I.T.
RPG-2 GDS
South Carolina Department of Transportation
955 Park Street
Columbia, South Carolina 29201

PREPARED BY

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OCTOBER 1, 2015

SCDOT Project ID. P027059
F&ME Project No. G5500.04

F&ME
CONSULTANTS

October 1, 2015

Mr. Joshua Meetze, E.I.T.
RPG-2 GDS
South Carolina Department of Transportation
955 Park Street
Columbia, South Carolina 29201

Re: Geotechnical Subsurface Data Report
SC-41 Replacement Bridge over Maiden Down Swamp
Marion County, South Carolina
SCDOT Project ID: P027059
F&ME Project No.: G5500.04

Dear Mr. Meetze:

Submitted herein is F&ME's Geotechnical Subsurface Data Report (GSDR) for the SC-41 Replacement Bridge over Maiden Down Swamp. This report contains findings from our subsurface field investigation and soil laboratory testing program.

It has been a pleasure working with you on this project and we appreciate the opportunity to be of service. Please notify us if there are any questions or if we may be of further assistance.

Sincerely,

F&ME CONSULTANTS

Alex M. Abernethy
Geotechnical Staff Professional

Jason P. Stewart, P.E.
Project Engineer

Enclosures

3112 Devine Street Columbia, South Carolina 29205 P 803.254.4540 F 803.254.4542 www.fmecol.com

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APPENDIX

I. INTRODUCTION

A. General

The SC-41 Replacement Bridge over Maiden Down Swamp is located in Marion County, South Carolina. We understand that the primary objective for the project is to replace the existing bridge on alignment. The total length for the new bridge structure is approximately 100 feet with additional roadway improvements. A Site Location Plan is presented as Figure 1 in Appendix A of this report.

B. Scope

F&ME performed a geotechnical subsurface investigation and laboratory testing for the bridge and roadway portion of the SC-41 Replacement Bridge over Maiden Down Swamp. The South Carolina Department of Transportation (SCDOT) request and scope for the geotechnical subsurface investigation was issued on June 8, 2015, and a subsequent laboratory testing scope was issued on August 21, 2015. Copies of these requests can be found in Appendix E.

The field investigation included soil test borings (STB), electro-piezocone soundings (CPT), shear wave velocity measurements using downhole methods (SW), and obtaining a bulk sample (BS). Laboratory testing was performed on soil samples collected from the test borings and bulk soil sample. All exploration methods and laboratory procedures were conducted in accordance with the most recent American Association of State Highway and Transportation Officials (AASHTO), American Society of Testing and Materials (ASTM) Standards, and the SCDOT Geotechnical Design Manual (GDM). This report was prepared in general accordance with the 2010 SCDOT Geotechnical Design Manual (GDM), Version 1.1.

II. FIELD INVESTIGATION SUMMARY

From August 11 through 19, 2015, F&ME performed five (5) soil test borings (STB), two (2) electro-piezocone soundings (CPT), one (1) downhole seismic test (SW), and obtained one (1) bulk sample (BS) at locations along the length of the proposed roadway improvements and bridge replacement. MicroStation files with the roadway plans and stationing, as well as test boring locations and test hole number designations, were provided by the SCDOT.

The soil test borings were advanced using a CME 550 ATV mounted drill rig with an automatic standard penetration test (SPT) hammer system. Soil test borings were advanced to the individual target depths provided by the SCDOT. Rotary wash drilling techniques were used to maintain a stable borehole. Borings were advanced with standard split-spoon sampling to the boring termination depths requested by the SCDOT or to auger refusal. Details of each boring are included on the individual Soil Test Boring Logs in Appendix B.

A. Soil Test Borings (STB)

The following table is a summary of the soil test boring designations, depths, locations, and surface elevations.

SOIL TEST BORINGS (STB)									
Test Hole No.	**Soil Depth (ft.)**	**Surface Condition**	**Total Air Gap Depth (ft.)**	**Total Boring Depth (ft.)**	**Station**	**Offset Distance (ft.)**	**Latitude**	**Longitude**	**TOB Elev. (ft.-MSL)**
B-1	20	Asphalt Roadway	N/A	20	684+49	6'-RT	34.2544128	79.2664853	70.2
B-2	80	Asphalt Roadway	N/A	80	685+50	6'-RT	34.2541426	79.2664181	70.2
B-3	100	Concrete Bridge Deck	17.0	117	686+00	6'-RT	34.2540063	79.2663848	70.1
B-4	120	Grass Shoulder	N/A	120	686+50	14'-RT	34.2538676	79.2663782	69.9
B-5	20	Asphalt Roadway	N/A	20	687+47	6'-RT	34.2536112	79.2662879	70.2
Totals	**340.0**		**17.0**	**357.0**					

B. Electro-Piezocone Soundings (CPT)

The following table is a summary of the electro-piezocone sounding designations, depths, locations, and surface elevations. CPT testing was performed on the bridge approach embankments at each end of the bridge. CPT-1 and CPT-2 were both terminated due to refusal. CPT locations are shown on Figure 2 in Appendix A. Detailed descriptions of each CPT are shown in Appendix B of this report. A CD with an electronic copy of the spreadsheet meeting SCDOT requirements for CPT will be delivered with the report.

ELECTRO-PIEZOCONE SOUNDINGS (CPT)							
Test Hole No.	**Soil Depth (ft.)**	**Surface Condition**	**Station**	**Offset Distance (ft.)**	**Latitude**	**Longitude**	**TOB Elev. (ft.-MSL)**
CPT-1	29.3	Grass Shoulder	685+41	12'-RT	34.2541623	79.2664447	70.1
CPT-2	31.6	Grass Shoulder	686+60	12'-RT	34.2538425	79.2663657	70.1
Totals	**60.9**						

C. Downhole Seismic Tests (SW)

The following table is a summary of the downhole seismic test designation, depth, location, and surface elevation. One (1) downhole seismic shear-wave test was performed in soil test boring B-4. The downhole seismic test was designated as SW-1. Soil test boring B-4 was drilled to a depth of one hundred and twenty (120) feet below the existing ground surface. Two (2) inch PVC casing was installed in the boring to a depth of one hundred and seventeen (117) feet below the existing ground surface. Prior to performing the downhole seismic test for SW-1, the location needed to be dewatered in order to obtain accurate results. A report outlining the test methodology and results of the downhole seismic shear wave investigation are included in Appendix D of this report.

	DOWNHOLE SEISMIC TESTS (SW)							
Test Hole No.	**Soil Test Boring I.D.**	**Soil Depth (ft.)**	**Casing Depth (ft.)**	**Station**	**Offset Distance (ft.)**	**Latitude**	**Longitude**	**TOB Elev. (ft.-MSL)**
SW-1	B-4	120	117	686+50	14'-RT	34.2538676	79.2663782	69.9
Totals		**120**	117					

D. Bulk Sample (BS)

F&ME was requested to obtain one (1) bulk sample from the auger cuttings within the upper 5 feet from soil test boring B-2. SCDOT required rotary wash drilling to be performed for the soil test borings. Auger cuttings were not available due to rotary wash drilling techniques. F&ME performed an offset boring approximately five (5) feet from soil test boring B-2 within the existing bridge approach embankment. A manual auger boring was performed in order to obtain the bulk soil sample. The bulk sample location and depth was selected by the SCDOT.

BULK SAMPLE (BS)							
Bulk Sample	**Surface Condition**	**Sample Depth (ft.)**	**Station**	**Offset Distance (ft.)**	**Latitude**	**Longitude**	**Elev. (ft.-MSL)**
BS-1 (Offset from B-2)	Grass Shoulder	0.0 – 5.0	685+50	11'-RT	34.2541383	79.2664357	70.1

E. Groundwater

Groundwater depth measurements were made at the time of boring for all borings, and are noted on the individual Soil Test Boring Logs in Appendix B. Groundwater measurements were also made twenty-four (24) hours following boring completion for soil test borings B-2, B-3, and B-4. Soil test borings B-1 and B-5 were backfilled following completion of drilling due to the borings being located within the existing roadway. Twenty-four (24) hour groundwater tables were not recorded in soil test borings B-1, and B-5.

The following table is a summary of the groundwater measurements for the soil test borings at time of boring (TOB) and twenty-four (24) hours following boring completion. Groundwater measurements for electro-piezocone soundings were interpreted from the cone penetration testing logs.

GROUNDWATER DEPTH			
Boring No.	**Date of TOB Groundwater Measurement**	**TOB Groundwater Depth (ft.)**	**24-hr. Groundwater Depth (ft.)**
B-1	08-13-15	13.0	Backfilled at Completion of Drilling
B-2	08-12-15	13.0	10.0
B-3	08-11-15	11.9	11.9
B-4	08-12-15	9.0	9.0
B-5	08-13-15	9.0	Backfilled at Completion of Drilling
CPT-1	08-11-15	10.5	Backfilled at Completion of Drilling
CPT-2	08-11-15	10.0	Backfilled at Completion of Drilling

III. SOIL LABORATORY TESTING

Following completion of F&ME's field investigation, preliminary soil test boring logs were prepared and submitted to the SCDOT. Based on the data represented in these logs, soil samples were selected by the SCDOT for laboratory testing. The selected samples were tested in F&ME's laboratory to determine applicable physical and engineering properties. This included split-spoon samples and one (1) composite bulk sample. All laboratory testing was performed in accordance with procedures set forth in the most recently published AASHTO and ASTM standards.

The laboratory testing performed for the split-spoon samples are detailed in the table below. Data sheets containing the results of the laboratory testing are provided in Appendix C, Section 1 of this report.

LABORATORY SOIL TESTING (SPLIT-SPOON SAMPLES)		
Type of Test	**Quantity**	**Procedure**
Wash #200	25	AASHTO T11
Grain Size w/ Wash #200	3	AASHTO T88
Atterberg Limits	21	AASHTO T89/T90
Moisture Content	28	ASTM D2216
Organic Content	3	AASHTO T267
pH	1	AASHTO T289
Chloride Content	1	AASHTO T291
Sulfate Content	1	AASHTO T290
Resistivity	1	AASHTO T288

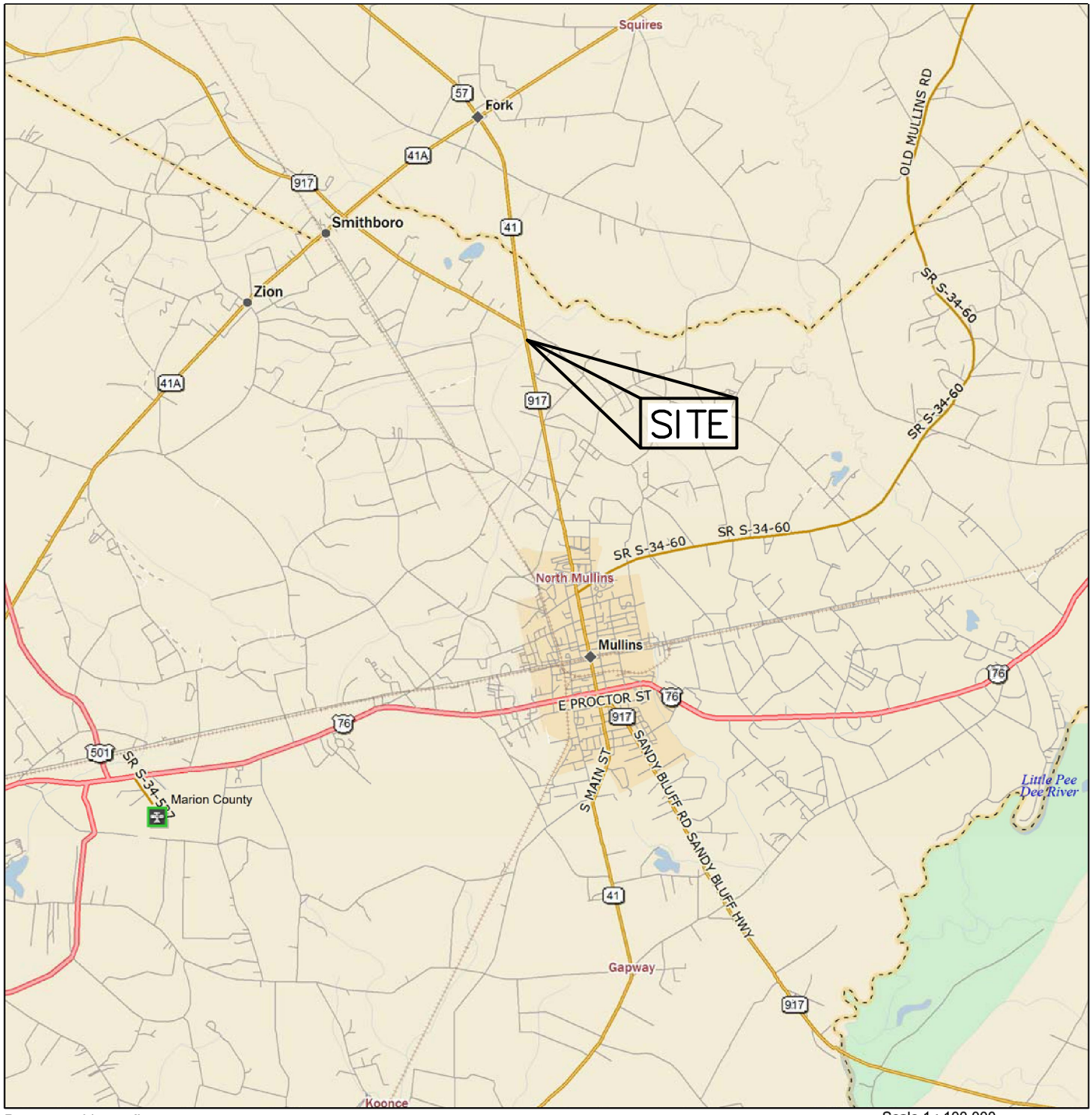
On August 21, 2015, F&ME received the laboratory testing request from SCDOT for the bulk soil sample. The laboratory testing performed for the bulk sample is detailed in the table below and data sheets containing the results are provided in Appendix C, Section 2 of this report.

LABORATORY SOIL TESTING (BULK SAMPLE)		
Type of Test	**Quantity**	**Procedure**
Atterberg Limits	1	AASHTO T89/T90
Moisture Content	1	ASTM D2216
Grain Size Analysis with Hydrometer	1	AASHTO T88
Standard Proctor	1	AASHTO T99
CU Triaxial	1	AASHTO T236

APPENDIX A

LOCATION PLANS

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	MARION	P027059	SC 41	



TN
MN (8.4°W)

Scale 1 : 100,000

1" = 1.58 mi Data Zoom 11-0

F&ME CONSULTANTS
GEOTECHNICAL – ENVIRONMENTAL – MATERIALS
COLUMBIA, SOUTH CAROLINA

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO. _____ DATE _____
DWG. CTC DATE 8/18/2015 GROUP ___ - ___
R/W _____ DATE _____

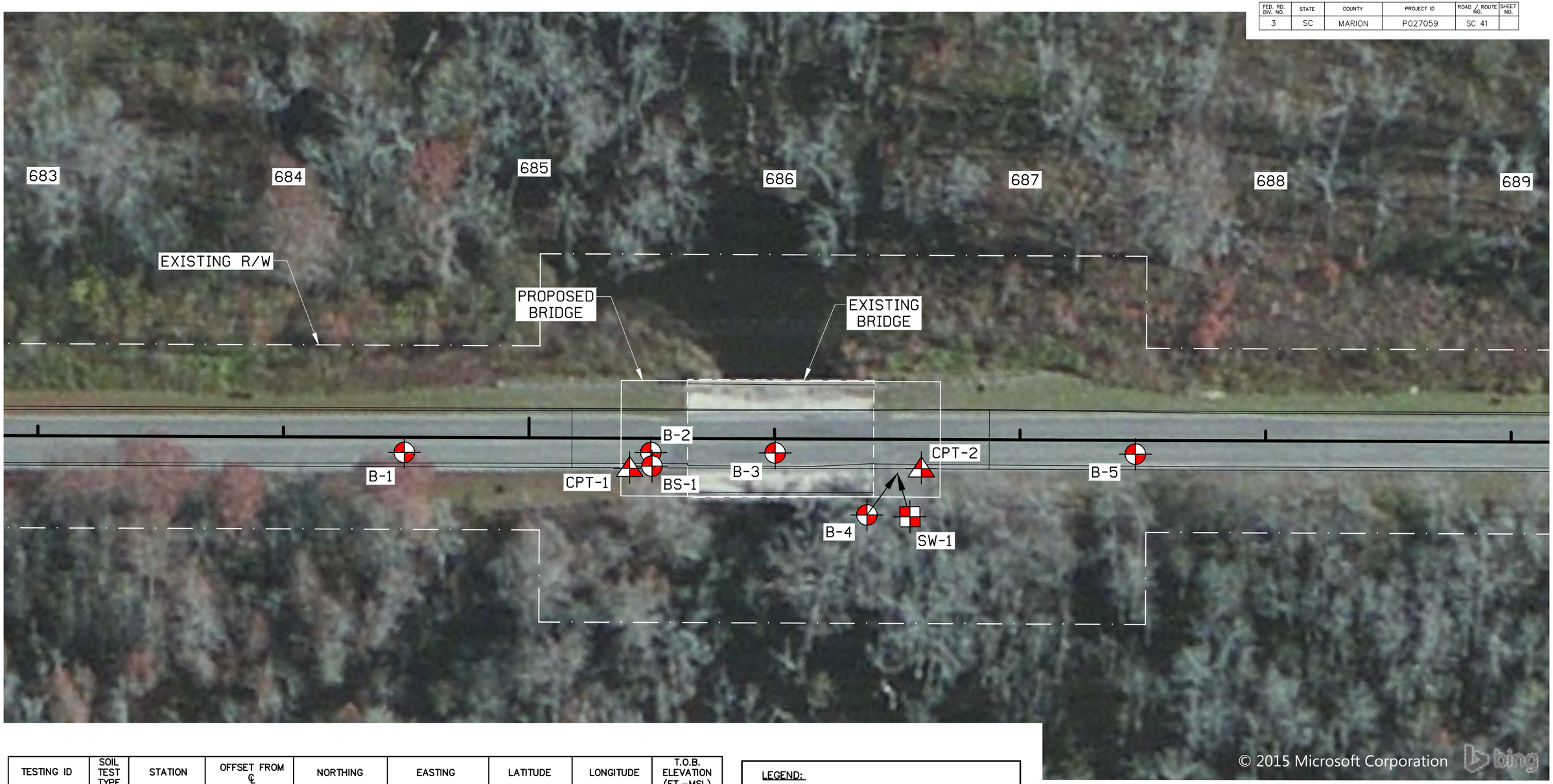
SC 41 BRIDGE OVER MAIDEN DOWN SWAMP

SITE LOCATION PLAN

HRZ SCALE = NTS

FIGURE 1

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	MARION	P027059	SC 41	



TESTING ID	SOIL TEST TYPE	STATION	OFFSET FROM ℄	NORTHING	EASTING	LATITUDE	LONGITUDE	T.O.B. ELEVATION (FT.–MSL)
B–1	SPT	684+49	6'–RT	885268.052	2523750.715	34.2544128	79.2664853	70.2
B–2	SPT	685+50	6'–RT	885170.008	2523772.688	34.2541426	79.2664181	70.2
B–3	SPT	686+00	6'–RT	885120.582	2523783.606	34.2540063	79.2663848	70.1
B–4	SPT	686+50	14'–RT	885070.154	2523786.431	34.2538676	79.2663782	69.9
B–5	SPT	687+47	6'–RT	884977.321	2523815.290	34.2536112	79.2662879	70.2
BS–1	HA	685+50	11'–RT	885168.334	2523767.402	34.2541383	79.2664357	70.1
CPT–1	CPT	685+41	12'–RT	885177.029	2523764.530	34.2541623	79.2664447	70.1
CPT–2	CPT	686+60	12'–RT	885061.079	2523790.373	34.2538425	79.2663657	70.1
SW–1	SW	686+50	14'–RT	885070.154	2523786.431	34.2538676	79.2663782	69.9

LEGEND:

- SOIL TEST BORING LOCATION
- CONE PENETRATION TEST LOCATION
- DOWNHOLE SEISMIC TEST LOCATION

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO. _____ DATE _____
DWG. CTC DATE 8/18/2015 GROUP ___ - ___
R/W _____ DATE _____

F&ME CONSULTANTS
GEOTECHNICAL – ENVIRONMENTAL – MATERIALS
COLUMBIA, SOUTH CAROLINA

SC 41 BRIDGE OVER MAIDEN DOWN SWAMP

SOIL TEST BORING LOCATION PLAN

HRZ SCALE = NTS

FIGURE 2

APPENDIX B

SUBSURFACE EXPLORATION

SCDOT Soil Test Log

Project ID:	P027059			**County:**	Marion	**Boring No.:**	B-1
Site Description:	SC 41 Bridge Over Maiden Down Swamp					**Route:**	SC-41
Eng./Geo.:	M. Touchberry	**Boring Location:**	684+49	**Offset:**	6' RT	**Alignment:**	On
Elev.:	70.2 ft	**Latitude:**	34.2544128	**Longitude:**	79.2664853	**Date Started:**	8/13/2015
Total Depth:	20 ft	**Soil Depth:**	20 ft	**Core Depth:**	0 ft	**Date Completed:**	8/13/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	D. Harris	**Groundwater:**	**TOB** 13 ft	**24HR**	NR

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	SPT N VALUE / FINES CONTENT (%)
	0.0	Roadway								
	0.3	ASHPALT (4")		0.5						
		FILL Medium Dense, Dry to Moist, Light Olive Brown, None to Low Plasticity, Clayey Fine to Coarse SAND (SC), Munsell=2.5Y 5/6			SS-1	10	14	12	26	● 4th 6" = 26 Blows
		=> Strong Brown, Munsell=7.5YR 5/8		2.0	SS-2	7	7	9	16	● 4th 6" = 8 Blows
	4.0			4.0						
65.2		Loose to Medium Dense, Moist to Wet, Stong Brown, Medium Plasticity, Silty Fine to Coarse SAND (SM), Munsell=7.5YR 5/8 LL=37, PL=25, PI=12, NMC=18.8%, %#200=43.2			SS-3	3	3	4	7	● ○ × × ▲ 4th 6" = 8 Blows
				6.0	SS-4	4	5	5	10	● 4th 6" = 6 Blows
				8.0	SS-5	3	5	6	11	● 4th 6" = 6 Blows
60.2		=> Olive Gray, Fine to Medium Sand, Munsell=5Y 5/2		10.0	SS-6	2	3	4	7	● 4th 6" = 5 Blows
	12.5			12.0						
		▽**ALLUVIUM** Loose to Medium Dense, Moist, Very Dark Gray, Non-Plastic, Silty Fine to Coarse SAND (SM), with Trace of Organics, Munsell=5Y 3/1			SS-7	4	4	3	7	× ● ▲ ○ 4th 6" = 3 Blows
55.2		LL=NP, PL=NP, PI=NP, NMC=41.5%, %#200=29.3		14.0	SS-8	9	7	8	15	● ○ 4th 6" = 12 Blows
		=> Wet, Light Gray, Non-Plastic, with Wood Fragments, Munsell=5Y 7/1 NMC=32.2%, %#200=14.5, Organics=0.6%								
		=> with Gravel		18.5	SS-9	7	10	12	22	● 4th 6" = 22 Blows
50.2	20.0	Boring Terminated at 20.0 feet								

SC_DOT G5500.04 - SC 41 RBO MAIDEN SWAMP.GPJ SCDOT DATA TEMPLATE_12_30_2014.GDT 10/1/15

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:	P027059	**County:**	Marion	**Boring No.:**	B-2		
Site Description:	SC 41 Bridge Over Maiden Down Swamp			**Route:**	SC-41		
Eng./Geo.:	M. Touchberry	**Boring Location:**	685+50	**Offset:**	6' RT	**Alignment:**	On
Elev.:	70.2 ft	**Latitude:**	34.2541426	**Longitude:**	79.2664181	**Date Started:**	8/12/2015
Total Depth:	80 ft	**Soil Depth:**	80 ft	**Core Depth:**	0 ft	**Date Completed:**	8/12/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	D. Harris	**Groundwater:**	**TOB** 13 ft	**24HR**	10 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	● SPT N VALUE ● PL MC LL ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
	0.0	Roadway								
	0.2	ASPHALT (2")								
	0.5	RECYCLED ASPHALT PAVEMENT (4")		0.5	SS-1	5	7	8	15	
		FILL Medium Dense to Loose, Moist, Yellowish Brown, Low Plasticity, Silty, Clayey Fine to Coarse SAND (SC-SM), Munsell=10YR 5/6		2.0	SS-2	5	6	5	11	4th 6" = 7 Blows
		=> Yellowish Red, Munsell=5YR 5/8		4.0						
		=> Strong Brown, Munsell=7.5YR 5/8 LL=26, PL=21, PI=5, NMC=13.0%, %#200=19.6			SS-3	2	3	4	7	4th 6" = 5 Blows
65.2	7.0			6.0	SS-4	3	4	2	6	4th 6" = 2 Blows
		Loose, Moist, Yellowish Brown, Medium Plasticity, Silty Fine SAND (SM), Munsell=10YR 5/6 LL=38, PL=26, PI=12, NMC=21.7%, %#200=41.8		8.0	SS-5	1	2	4	6	4th 6" = 4 Blows
	9.5	Firm, Moist to Wet, Light Olive Brown, Low Plasticity, Fine Sandy SILT (ML), Munsell=2.5Y 5/4		10.0						
60.2		LL=36, PL=26, PI=10, NMC=21.5%, %#200=52.6			SS-6	4	4	4	8	4th 6" = 4 Blows
	12.0			12.0						
	13.0	Very Loose, Wet, Light Olive Brown, Non-Plastic, Silty Fine to Medium SAND (SM), Munsell=2.5Y 5/4			SS-7	3	2	2	4	4th 6" = 2 Blows
		ALLUVIUM		14.0						
	14.0	Very Loose, Wet, Black, Non-Plastic, Silty Fine to Medium SAND (SM), with Few Organics, Munsell=2.5Y 2.5/1								
55.2	15.0	LL=NP, PL=NP, PI=NP, NMC=39.0%, %#200=41.0, Organics=7.2%			SS-8	4	6	8	14	4th 6" = 12 Blows
		Medium Dense, Wet, Very Dark Grayish Brown, None to Low Plasticity, Clayey Fine to Medium SAND (SC), Munsell= 2.5Y 3/2								
		Medium Dense, Wet, Gray, Non-Plastic, Silty Fine to Medium SAND (SM), Munsell=2.5Y 5/1		18.5						
		=> Dark Grayish Brown, with Gravel, Munsell=2.5Y 4/2			SS-9	3	7	11	18	
50.2										

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:	P027059	**County:**	Marion	**Boring No.:**	B-2		
Site Description:	SC 41 Bridge Over Maiden Down Swamp			**Route:**	SC-41		
Eng./Geo.:	M. Touchberry	**Boring Location:**	685+50	**Offset:**	6' RT	**Alignment:**	On
Elev.:	70.2 ft	**Latitude:**	34.2541426	**Longitude:**	79.2664181	**Date Started:**	8/12/2015
Total Depth:	80 ft	**Soil Depth:**	80 ft	**Core Depth:**	0 ft	**Date Completed:**	8/12/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	D. Harris	**Groundwater:**	**TOB** 13 ft	**24HR**	10 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	● SPT N VALUE ● PL MC LL ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		Medium Dense, Wet, Dark Grayish Brown, Non-Plastic, Silty Fine to Medium SAND (SM), Munsell=2.5Y 4/2								
		=> White, Munsell=2.5Y 8/1		23.5						
		NMC=64.9%, %#200=12.4			SS-10	4	4	13	17	▲● ○
45.2		=> Brownish Yellow, 10YR 6/8								
		=> Greenish Gray, with Gravel, Munsell=GLEY1 5/N		28.5						
	29.5				SS-11	13	9	10	19	●
40.2		Very Stiff, Wet, Greenish Black, Low Plasticity, CLAY (CL), with Fine Sand, Munsell=GLEY1 2.5/10GY								
	34.0			33.5						
35.2		Medium Dense to Dense, Moist to Wet, Gray, Non-Plastic, Fine to Medium SAND (SP-SM), with Silt, Munsell=GLEY1 5/N			SS-12	6	6	12	18	●
		LL=NP, PL=NP, PI=NP, NMC=26.3%, %#200=10.9		38.5						
					SS-13	22	19	27	46	▲ ○ ●
30.2										

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:	P027059	**County:**	Marion	**Boring No.:**	B-2		
Site Description:	SC 41 Bridge Over Maiden Down Swamp			**Route:**	SC-41		
Eng./Geo.:	M. Touchberry	**Boring Location:**	685+50	**Offset:**	6' RT	**Alignment:**	On
Elev.:	70.2 ft	**Latitude:**	34.2541426	**Longitude:**	79.2664181	**Date Started:**	8/12/2015
Total Depth:	80 ft	**Soil Depth:**	80 ft	**Core Depth:**	0 ft	**Date Completed:**	8/12/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	D. Harris	**Groundwater:**	**TOB** 13 ft	**24HR**	10 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
		Dense, Moist to Wet, Gray, Non-Plastic, Fine to Medium SAND (SP-SM), with Silt, Munsell=GLEY1 5/N		43.5					
		=> Brownish Yellow, Munsell=10YR 6/8			SS-14	9	18	24	42
	44.5								
25.2		Hard, Moist to Wet, Greenish Black, Low Plasticity, CLAY (CL), Munsell=GLEY1 2.5/5GY							
	48.5			48.5					
		Dense, Wet, Gray, Non-Plastic, Fine to Medium SAND (SP), Munsell=GLEY1 5/N			SS-15	16	13	19	32
20.2									
				53.5					
	54.5				SS-16	6	16	24	40
15.2		Hard, Wet, Greenish Black, Low Plasticity, CLAY (CL), with Fine Sand, Munsell=GLEY1 2.5/10Y							
	58.5			58.5					
		Medium Dense, Wet, Greenish Gray, None to Low Plasticity, Clayey Fine to Coarse SAND (SC), with Wood Fragments			SS-17	6	9	10	19
	59.8								
10.2		Very Stiff, Wet, Greenish Black, Very Plastic, Elastic SILT (MH), with Fine Sand, Munsell=GLEY1 2.5/10Y							

SPT N VALUE

PL MC LL

FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

LEGEND

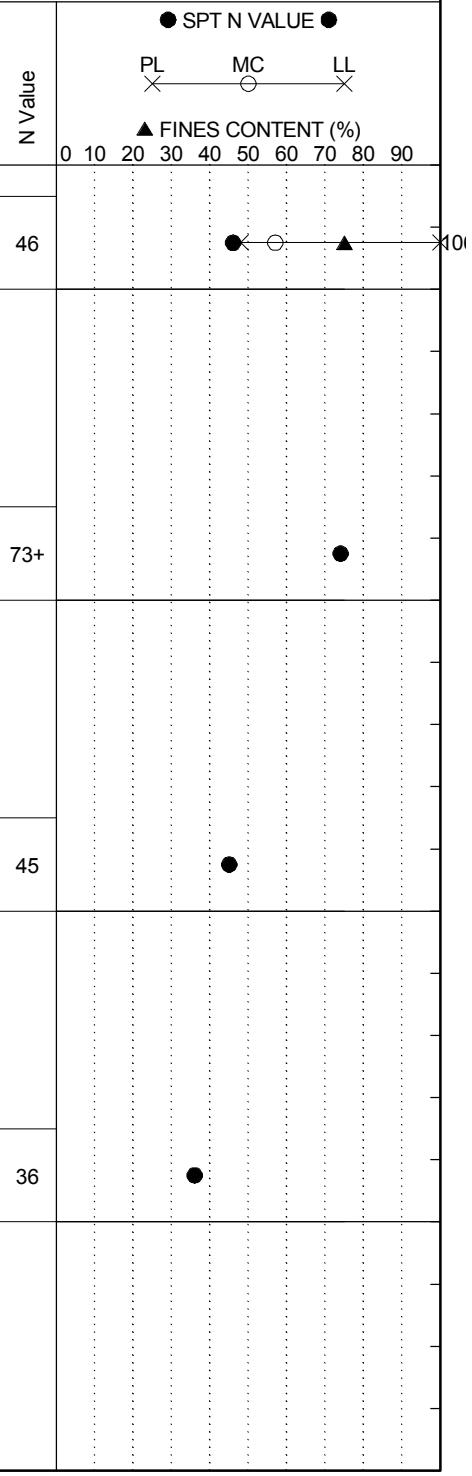
Continued Next Page

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:	P027059	**County:**	Marion	**Boring No.:**	B-2		
Site Description:	SC 41 Bridge Over Maiden Down Swamp			**Route:**	SC-41		
Eng./Geo.:	M. Touchberry	**Boring Location:**	685+50	**Offset:**	6' RT	**Alignment:**	On
Elev.:	70.2 ft	**Latitude:**	34.2541426	**Longitude:**	79.2664181	**Date Started:**	8/12/2015
Total Depth:	80 ft	**Soil Depth:**	80 ft	**Core Depth:**	0 ft	**Date Completed:**	8/12/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	D. Harris	**Groundwater:**	**TOB** 13 ft	**24HR**	10 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
		Hard, Wet, Greenish Black, Very Plastic, Elastic SILT (MH), with Fine Sand, Munsell=GLEY1 2.5/10Y		63.5					
		LL=106, PL=48, PI=58, NMC=57.4%, %#200=74.6			SS-18	15	25	21	46
5.2									
				68.5					
					SS-19	12	23	50/3"	73+
0.2									
				73.5					
					SS-20	13	14	31	45
-4.8									
				78.5					
					SS-21	11	14	22	36
-9.8	80.0	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:	P027059	**County:**	Marion	**Boring No.:**	B-3		
Site Description:	SC 41 Bridge Over Maiden Down Swamp			**Route:**	SC-41		
Eng./Geo.:	M. Touchberry	**Boring Location:**	686+00	**Offset:**	6'RT	**Alignment:**	On
Elev.:	70.1 ft	**Latitude:**	34.2540063	**Longitude:**	79.2663848	**Date Started:**	8/11/2015
Total Depth:	117 ft	**Soil Depth:**	100 ft	**Core Depth:**	0 ft	**Date Completed:**	8/11/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	D. Harris	**Groundwater:**	**TOB** 11.9 ft	**24HR**	11.9 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%)
	0.0	Bridge Deck								
	1.0	ASPHALT/CONCRETE (1.0')								
		AIR GAP (17.0')								
65.1										
60.1										
	11.9	▼ Top of Water								
55.1										
	17.0	Very Loose, Wet, Very Dark Gray, Medium Plasticity, Silty Fine to Coarse SAND (SM), with Organics, Munsell=10YR 3/1		17.0	SS-1	2	1	2	3	4th 6" = 1 Blow
50.1		NMC=21.4%, %#200=12.7		19.0	SS-2	8	10	10	20	4th 6" = 8 Blows
		NMC=22.5%, %#200=13.6		21.0	SS-3	8	10	19	29	4th 6" = 19 Blows
		=> Medium Dense to Dense, Moist to Wet, Light Greenish Gray, Munsell=GLEY1 7/10Y		23.0	SS-4	7	11	18	29	4th 6" = 19 Blows
		NMC=26.2%, %#200=21.2		25.0	SS-5	21	26	31	57	4th 6" = 42 Blows
45.1		=> Olive Yellow, Munsell=2.5Y 6/8								
		=> Bluish Gray, Munsell=GLEY2 5/5PB								
40.1		=> Bluish Black, Munsell=GLEY2 2.5/10BG		30.5	SS-6	12	8	10	18	
		LL=50, PL=35, PI=15, NMC=46.9%, %#200=49.3								
35.1				35.5	SS-7	6	8	23	31	
	36.8	Dense, Moist to Wet, Olive Yellow, Non-Plastic, Fine to Medium SAND (SP), Munsell=2.5Y 6/8								
30.1				40.5	SS-8	12	17	14	31	

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:	P027059	**County:**	Marion	**Boring No.:**	B-3		
Site Description:	SC 41 Bridge Over Maiden Down Swamp			**Route:**	SC-41		
Eng./Geo.:	M. Touchberry	**Boring Location:**	686+00	**Offset:**	6'RT	**Alignment:**	On
Elev.:	70.1 ft	**Latitude:**	34.2540063	**Longitude:**	79.2663848	**Date Started:**	8/11/2015
Total Depth:	117 ft	**Soil Depth:**	100 ft	**Core Depth:**	0 ft	**Date Completed:**	8/11/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	D. Harris	**Groundwater:**	**TOB** 11.9 ft	**24HR**	11.9 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
25.1	45.5	Dense, Moist to Wet, Olive Yellow, Non-Plastic, Fine to Medium SAND (SP), Munsell=2.5Y 6/8		45.5					
		Dense to Medium Dense, Wet, Olive Yellow, Very Plastic, Silty Fine to Medium SAND (SM), Munsell=2.5Y 6/8			SS-9	17	18	25	43
20.1		NMC=41.5%, %#200=21.7		50.5	SS-10	4	10	14	24
15.1		=> Dark Greenish Gray, Munsell=GLEY1 4/N		55.5	SS-11	9	11	22	33
10.1		=> Moist, Greenish Black, Munsell=GLEY1 2.5/10Y LL=101, PL=59, PI=42, NMC=24.1%, %#200=12.4		60.5	SS-12	8	14	17	31
5.1				65.5	SS-13	10	19	26	45
0.1	70.5	Hard, Moist, Greenish Black, Low Plasticity, Fine Sandy CLAY (CL), Munsell=GLEY1 2.5/10Y		70.5	SS-14	22	50/4.5"		100+
-4.9				75.5	SS-15	12	18	25	43
-9.9				80.5	SS-16	13	19	25	44

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:	P027059	**County:**	Marion	**Boring No.:**	B-3		
Site Description:	SC 41 Bridge Over Maiden Down Swamp			**Route:**	SC-41		
Eng./Geo.:	M. Touchberry	**Boring Location:**	686+00	**Offset:**	6'RT	**Alignment:**	On
Elev.:	70.1 ft	**Latitude:**	34.2540063	**Longitude:**	79.2663848	**Date Started:**	8/11/2015
Total Depth:	117 ft	**Soil Depth:**	100 ft	**Core Depth:**	0 ft	**Date Completed:**	8/11/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	D. Harris	**Groundwater:**	**TOB** 11.9 ft	**24HR**	11.9 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
-14.9		Hard, Moist, Greenish Black, Low Plasticity, Fine Sandy CLAY (CL), Munsell=GLEY1 2.5/10Y		85.5	SS-17	13	20	28	48
-19.9				90.5	SS-18	15	22	27	49
-24.9				95.5	SS-19	13	21	27	48
-29.9				100.5	SS-20	14	23	29	52
-34.9				105.5	SS-21	14	21	32	53
-39.9	110.5	Dense to Very Dense, Moist to Wet, Dark Greenish Gray, Non-Plastic, Fine to Medium SAND (SP), Munsell=GLEY1 4/5GY		110.5	SS-22	14	22	17	49
-44.9				115.5	SS-23	18	50/6"		100+
	117.0	Boring Terminated at 117.0 feet							
-49.9									
-54.9									

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	

SCDOT Soil Test Log

Project ID:	P027059	**County:**	Marion	**Boring No.:**	B-4		
Site Description:	SC 41 Bridge Over Maiden Down Swamp			**Route:**	SC-41		
Eng./Geo.:	M. Touchberry	**Boring Location:**	686+50	**Offset:**	14' RT	**Alignment:**	On
Elev.:	69.9 ft	**Latitude:**	34.2538676	**Longitude:**	79.2663782	**Date Started:**	8/12/2015
Total Depth:	120 ft	**Soil Depth:**	120 ft	**Core Depth:**	0 ft	**Date Completed:**	8/13/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	D. Harris	**Groundwater:**	**TOB** 9 ft	**24HR**	9 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
	0.0	Grass Mat								
		FILL		0.5						
	1.5	Stiff, Dry to Moist, Olive, Low Plasticity, Fine			SS-1	3	5	5	10	4th 6" = 5 Blows
	2.0	to Coarse Sandy CLAY (CL), Munsell=5Y 5/4		2.0	SS-2	3	3	4	7	4th 6" = 4 Blows
		Loose, Dry to Moist, Brownish Yellow, Non-Plastic, Fine to Coarse SAND (SP), Munsell=10YR 6/8		4.0	SS-3	2	3	4	7	4th 6" = 3 Blows
64.9		Loose to Very Loose, Moist to Wet, Yellowish Brown, Low to Medium Plasticity, Clayey Fine to Coarse SAND (SC), Munsell=10YR 5/6		6.0	SS-4	3	3	3	6	4th 6" = 3 Blows
		=> Yellowish Brown, Munsell=10YR 5/6		8.0	SS-5	2	2	2	4	4th 6" = 2 Blows
		LL=25, PL=17, PI=8, NMC=16.9%, %#200=33.3								
59.9		LL=37, PL=18, PI=19, NMC=23.7%, %#200=48.0		10.0	SS-6	3	3	3	6	4th 6" = 3 Blows
	11.0	=> Pale Brown, Munsell=10YR 6/3		12.0	SS-7	3	3	2	5	4th 6" = 4 Blows
		LL=31, PL=19, PI=12, NMC=24.2%, %#200=49.6								
	13.5	Loose, Wet, Dark Gray, None to Low Plasticity, Silty Fine to Medium SAND (SM), with Trace of Organics, Munsell=2.5Y 4/1		14.0	SS-8	3	5	14	19	4th 6" = 17 Blows
54.9	15.0	LL=NP, PL=NP, PI=NP, NMC=29.2%, %#200=30.6, Organics=4.4%								
		ALLUVIUM		18.5	SS-9	4	5	8	13	
		Firm, Wet, Black, Low Plasticity, Silty CLAY (CL-ML), with Trace of Organics, Munsell=2.5Y 2.5/1								
49.9		=> Very Stiff								
		Medium Dense to Dense, Wet, Light Gray, Non-Plastic, Fine to Coarse SAND (SP), Munsell=2.5Y 7/1		23.5	SS-10	8	17	22	39	
		=> With Gravel								
44.9		NMC=17.6%, %#200=3.4								
		=> Yellow, Fine to Medium, Munsell=10YR 7/8		28.5	SS-11	9	9	13	22	
39.9		=> Light Gray, Munsell=GLEY1 7/N								
	33.5			33.5						

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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:	P027059	**County:**	Marion	**Boring No.:**	B-4		
Site Description:	SC 41 Bridge Over Maiden Down Swamp			**Route:**	SC-41		
Eng./Geo.:	M. Touchberry	**Boring Location:**	686+50	**Offset:**	14' RT	**Alignment:**	On
Elev.:	69.9 ft	**Latitude:**	34.2538676	**Longitude:**	79.2663782	**Date Started:**	8/12/2015
Total Depth:	120 ft	**Soil Depth:**	120 ft	**Core Depth:**	0 ft	**Date Completed:**	8/13/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	D. Harris	**Groundwater:**	**TOB** 9 ft	**24HR**	9 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
34.9		Very Stiff, Moist, Black, Low Plasticity, Fine Sandy Elastic SILT (MH), Munsell=GLEY1 2.5/N			SS-12	5	8	11	19
		LL=52, PL=42, PI=10, NMC=42.4%, %#200=53.5							
	38.5			38.5					
		Very Dense to Dense, Wet to Moist, Strong Brown, Non-Plastic, Fine SAND (SP), Munsell=7.5YR 5/8			SS-13	14	24	40	64
29.9									
				43.5	SS-14	24	21	17	38
24.9									
				48.5					
		=> Olive Yellow, Munsell=2.5Y 6/6			SS-15	5	10	28	38
19.9									
				53.5					
		=> Gray, Munsell=GLEY1 6/N			SS-16	7	21	21	42
	54.8								
14.9		Hard, Wet to Moist, Black, Low Plasticity, CLAY (CL), with Fine Sand Lenses, Munsell=GLEY1 2.5/N							
	58.5			58.5					
	59.0	Dense, Moist, Dark Gray, Non-Plastic, Fine to Medium SAND (SP), Munsel=GLEY1 4/N			SS-17	15	18	17	35
9.9		Hard to Very Stiff, Moist, Black, Very Plastic, Elastic SILT (MH), Munsell=GLEY1 2.5/N							
				63.5					
		LL=108, PL=58, PI=50, NMC=62.5%, %#200=94.3			SS-18	8	12	14	26
4.9									

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:	P027059	**County:**	Marion	**Boring No.:**	B-4		
Site Description:	SC 41 Bridge Over Maiden Down Swamp			**Route:**	SC-41		
Eng./Geo.:	M. Touchberry	**Boring Location:**	686+50	**Offset:**	14' RT	**Alignment:**	On
Elev.:	69.9 ft	**Latitude:**	34.2538676	**Longitude:**	79.2663782	**Date Started:**	8/12/2015
Total Depth:	120 ft	**Soil Depth:**	120 ft	**Core Depth:**	0 ft	**Date Completed:**	8/13/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	D. Harris	**Groundwater:**	**TOB** 9 ft	**24HR**	9 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
		Very Stiff to Hard, Moist, Black, Very Plastic, Elastic SILT (MH), Munsell=GLEY1 2.5/N		68.5					
-0.1					SS-19	9	12	17	29
				73.5					
					SS-20	18	50/1.5"		100+
-5.1		=> Trace of Organics							
				78.5					
					SS-21	14	27	41	68
-10.1									
				83.5					
					SS-22	12	17	25	42
-15.1									
				88.5					
					SS-23	14	19	26	45
-20.1									
				93.5					
					SS-24	13	20	30	50
-25.1									
				98.5					
					SS-25	14	22	31	53
-30.1									

● SPT N VALUE ●

PL MC LL

▲ FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

LEGEND

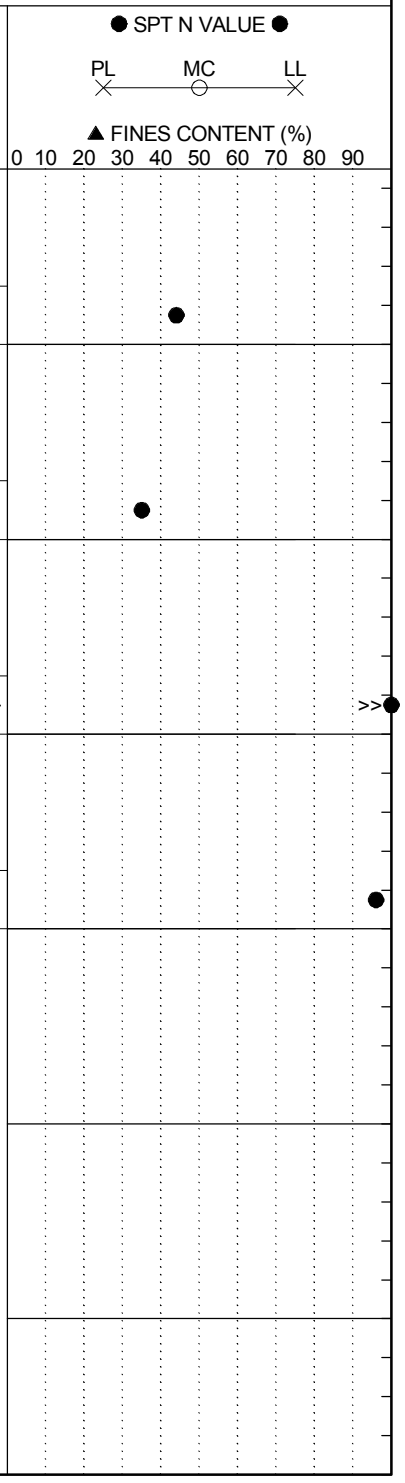
Continued Next Page

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	

SCDOT Soil Test Log

Project ID:	P027059			**County:**	Marion	**Boring No.:**	B-4
Site Description:	SC 41 Bridge Over Maiden Down Swamp					**Route:**	SC-41
Eng./Geo.:	M. Touchberry	**Boring Location:**	686+50	**Offset:**	14' RT	**Alignment:**	On
Elev.:	69.9 ft	**Latitude:**	34.2538676	**Longitude:**	79.2663782	**Date Started:**	8/12/2015
Total Depth:	120 ft	**Soil Depth:**	120 ft	**Core Depth:**	0 ft	**Date Completed:**	8/13/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	D. Harris	**Groundwater:**	**TOB** 9 ft	**24HR**	9 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
		Hard, Moist, Black, Very Plastic, Elastic SILT (MH), with Fine Sand Lenses, Munsell=GLEY1 2.5/N		103.5					
					SS-26	13	18	26	44
-35.1									
	108.5			108.5					
		Dense, Wet, Gray, Non-Plastic, Fine to Medium SAND (SP), Munsell=GLEY1 5/N			SS-27	20	15	20	35
-40.1									
	113.5			113.5					
		Very Dense, Wet, Dark Greenish Gray, Non-Plastic, Fine to Medium SAND (SP-SC), with Clay, Munsell=GLEY1 4/10GY			SS-28	31	50/3.5"		100+
-45.1									
				118.5					
					SS-39	30	46	50/5.5"	96+
	120.0								
-50.1		Boring Terminated at 120.0 feet							
-55.1									
-60.1									



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:	P027059			**County:**	Marion	**Boring No.:**	B-5
Site Description:	SC 41 Bridge Over Maiden Down Swamp					**Route:**	SC-41
Eng./Geo.:	M. Touchberry	**Boring Location:**	687+47	**Offset:**	6' RT	**Alignment:**	On
Elev.:	70.2 ft	**Latitude:**	34.2536112	**Longitude:**	79.2662879	**Date Started:**	8/13/2015
Total Depth:	20 ft	**Soil Depth:**	20 ft	**Core Depth:**	0 ft	**Date Completed:**	8/13/2015
Bore Hole Diameter (in):	4	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	D. Harris	**Groundwater:**	**TOB** 9 ft	**24HR**	NR

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
	0.0	Roadway								
	0.5	ASPHALT (6")		0.5						
		Medium Dense to Loose, Moist, Light Yellowish Brown, Low Plasticity, Clayey Fine to Medium SAND (SC), Munsell=10YR 6/4			SS-1	5	6	6	12	●
		LL=30, PL=21, PI=9, NMC=14.6%, %#200=32.9		2.0						
					SS-2	3	3	6	9	● ○ ×→×▲ 4th 6" = 7 Blows
				4.0						
	4.5									
65.2		Stiff, Moist, Olive Gray, Low Plasticity, Fine to Coarse Sandy CLAY (CL), Munsell=5Y 4/2			SS-3	5	6	6	12	● 4th 6" = 6 Blows
				6.0						
	7.0				SS-4	6	7	6	13	● 4th 6" = 6 Blows
		Medium Dense, Moist, Olive Gray, None to Low Plasticity, Clayey Fine to Coarse SAND (SC), Munsell=5Y 5/2								
	8.0			8.0						
		▽Loose, Wet, Olive Gray, Low Plasticity, Silty, Clayey Fine to Coarse SAND (SC-SM), Munsell=5Y 5/2			SS-5	2	4	6	10	●○ ×→×▲ 4th 6" = 9 Blows
60.2	10.0	LL=24, PL=20, PI=4, NMC=13.6%, %#200=27.2		10.0						
		Loose to Very Loose, Wet, Pale Olive, None to Low Plasticity, Silty Fine to Medium SAND (SM), Munsell=5Y 6/3			SS-6	4	4	3	7	× ● ○ ▲4th 6" = 3 Blows
		LL=NP, PL=NP, PI=NP, NMC=19.6%, %#200=25.0		12.0						
					SS-7	2	1	2	3	● ×→× ○ ▲4th 6" = 2 Blows
	14.0	LL=22, PL=19, PI=3, NMC=32.2%, %#200=38.1		14.0						
55.2		=> Very Dark Gray, with Trace of Organics, Munsell=5Y 8/1			SS-8	4	8	10	18	● 4th 6" = 8 Blows
		Medium Dense, Wet, Dark Grayish Brown, Low Plasticity, Fine to Coarse SAND (SP), Munsell=2.5Y 4/2								
	18.5			18.5						
		Medium Dense, Wet, Gray, Non-Plastic, Silty Fine to Coarse SAND (SM), Munsell=5Y 5/1			SS-9	6	8	9	17	× ●○
50.2	20.0	LL=NP, PL=NP, PI=NP, NMC=21.1%, %#200=17.3								
		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 G5500.04 - SC 41 RBO MAIDEN SWAMP.GPJ SCDOT DATA TEMPLATE_12_30_2014.GDT 10/1/15

PalmettoINSITU
Geotechnical Exploration

SC-41 RBO Maiden Down Swamp
Mullins, SC
Project Number :15-053

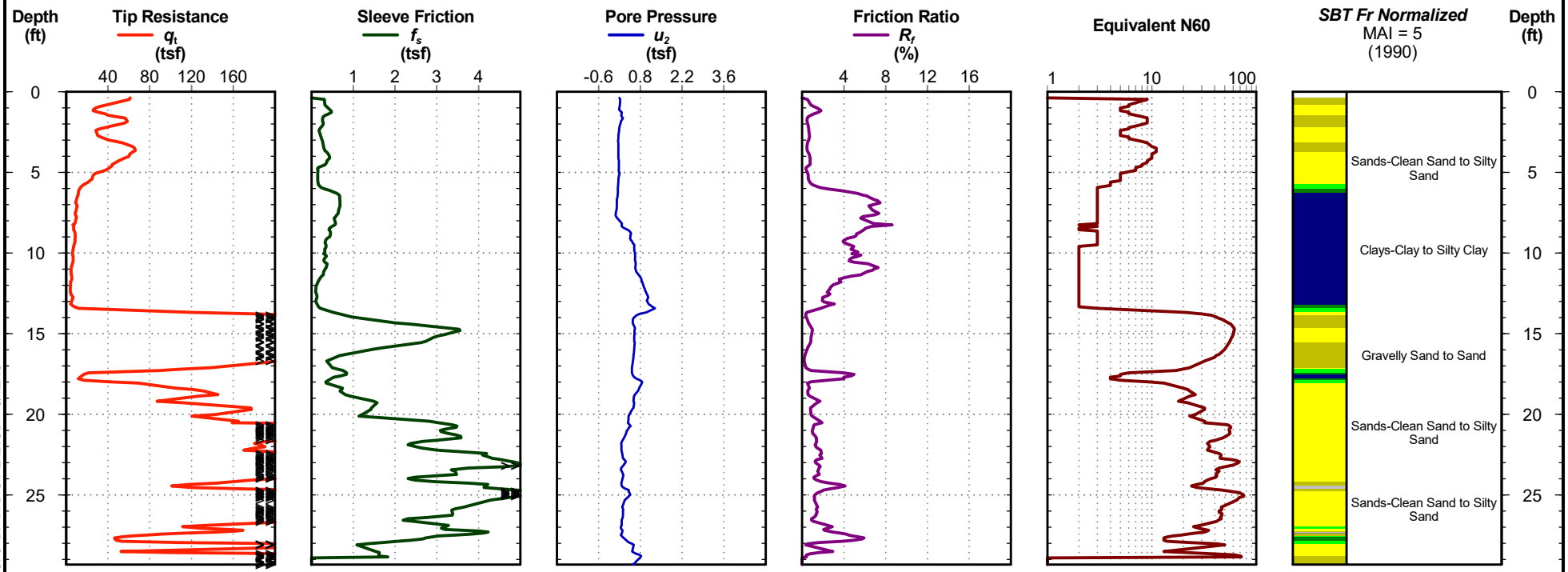
Cone Penetration Test

C-1

Date: Aug. 11, 2015
Estimated Water Depth: 10.5 ft
Rig/Operator: M. Cox | J Croom

Northing: 34.2541623
Easting: 79.2664447
Elevation: 70.1

Total Depth: 29.3 ft
Termination Criteria: Maximum Reaction Force
Cone Size: 1.75



CPT REPORT - STANDARD HWY 41 RBO MADIEN DOWN SWAMP.GPJ DF STD US LAB.GDT 8/12/15

Electronic File Name: A11G1501C.DAT

C-1

PalmettoINSITU
Geotechnical Exploration

SC-41 RBO Maiden Down Swamp
Mullins, SC
Project Number :15-053

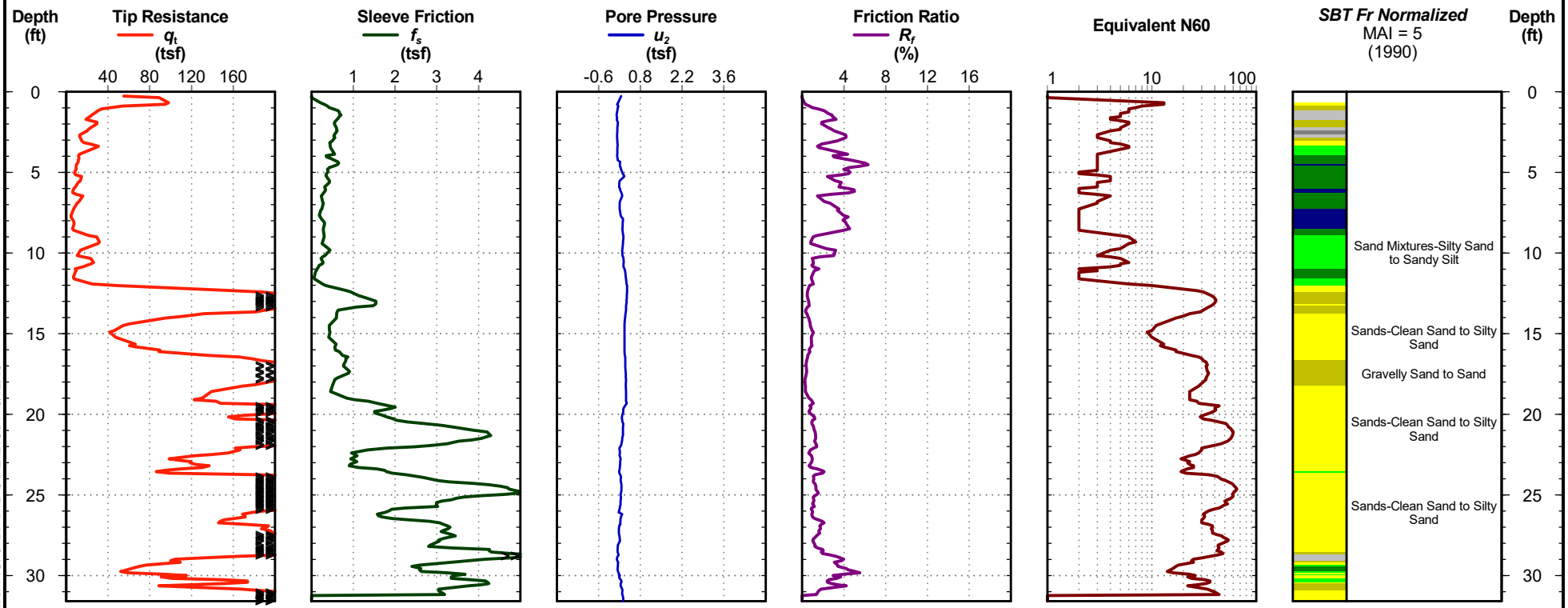
Cone Penetration Test

C-2

Date: Aug. 11, 2015
Estimated Water Depth: 10 ft
Rig/Operator: M. Cox | J Croom

Northing: 34.2538425
Easting: 79.2663657
Elevation: 70.1

Total Depth: 31.6 ft
Termination Criteria: Maximum Reaction Force
Cone Size: 1.75



CPT REPORT - STANDARD HWY 41 RBO MADIEN DOWN SWAMP.GPJ DF STD US LAB.GDT 8/12/15

Electronic File Name: A11G1502C.DAT

C-2

APPENDIX C
SECTION 1

LABORATORY TESTING
(SPLIT-SPOON SAMPLES)

SUMMARY OF LABORATORY RESULTS

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-1	6.0	37	25	12	0.075	43	SM	18.8			
B-1	14.0	NP	NP	NP	0.075	29	SM	41.5			
B-1	16.0				0.075	15	SM	32.2			
B-2	6.0	26	21	5	0.075	20	SC-SM	13.0			
B-2	10.0	38	26	12	0.075	42	SM	21.7			
B-2	12.0	36	26	10	0.075	53	ML	21.5			
B-2	14.0	NP	NP	NP	0.075	41	SM	39.0			
B-2	25.0				0.075	12	SM	64.9			
B-2	40.0	NP	NP	NP	0.075	11	SP-SM	26.3			
B-2	65.0	106	48	58	0.075	75	MH	57.4			
B-3	19.0				19.1	13	SM	21.4			
B-3	21.0				19.1	14	SM	22.5			
B-3	23.0				9.52	21	SM	26.2			
B-3	32.0	50	35	15	0.075	49	SM	46.9			
B-3	52.0				0.075	22	SM	41.5			
B-3	62.0	101	59	42	0.075	12	SM	24.1			
B-4	8.0	25	17	8	0.075	33	SC	16.9			
B-4	10.0	37	18	19	0.075	48	SC	23.7			
B-4	12.0	31	19	12	0.075	50	SC	24.2			
B-4	14.0	NP	NP	NP	0.075	31	SM	29.2			
B-4	20.0				0.075	3	SP	17.6			
B-4	35.0	52	42	10	0.075	54	MH	42.4			
B-4	65.0	108	58	50	0.075	94	MH	62.5			
B-5	4.0	30	21	9	0.075	33	SC	14.6			
B-5	10.0	24	20	4	0.075	27	SC-SM	13.6			
B-5	12.0	NP	NP	NP	0.075	25	SM	19.6			
B-5	14.0	22	19	3	0.075	38	SM	32.2			
B-5	20.0	NP	NP	NP	0.075	17	SM	21.1			

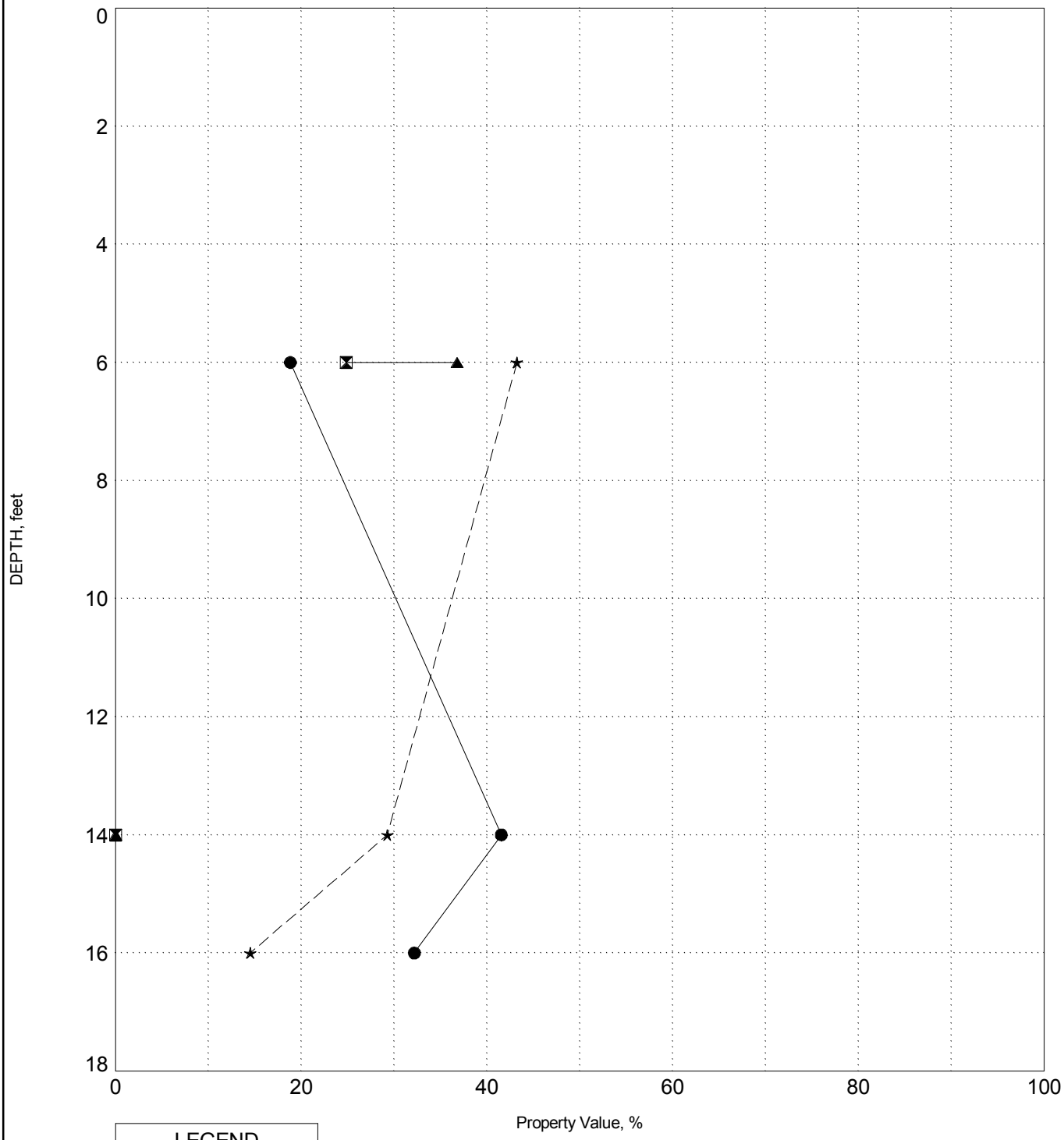
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion

BORING B-1

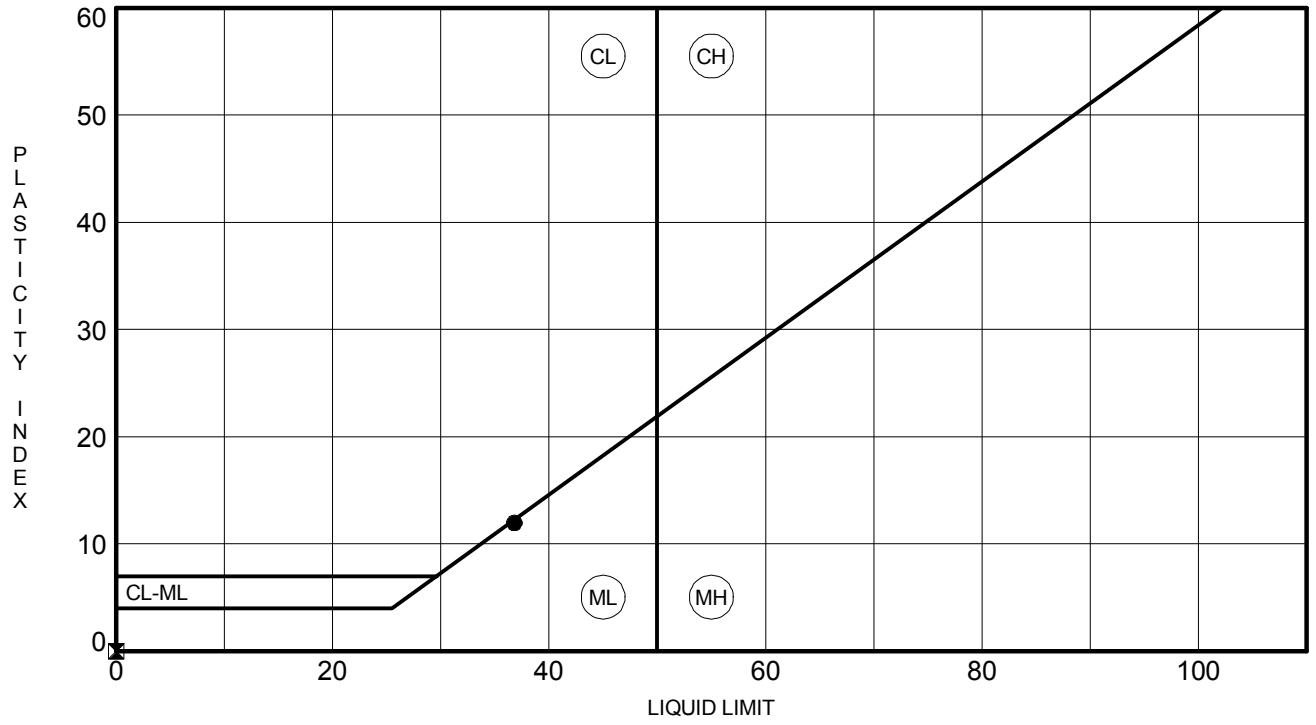
SURFACE ELEVATION: 70.2



ATTERBERG LIMITS' RESULTS

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion

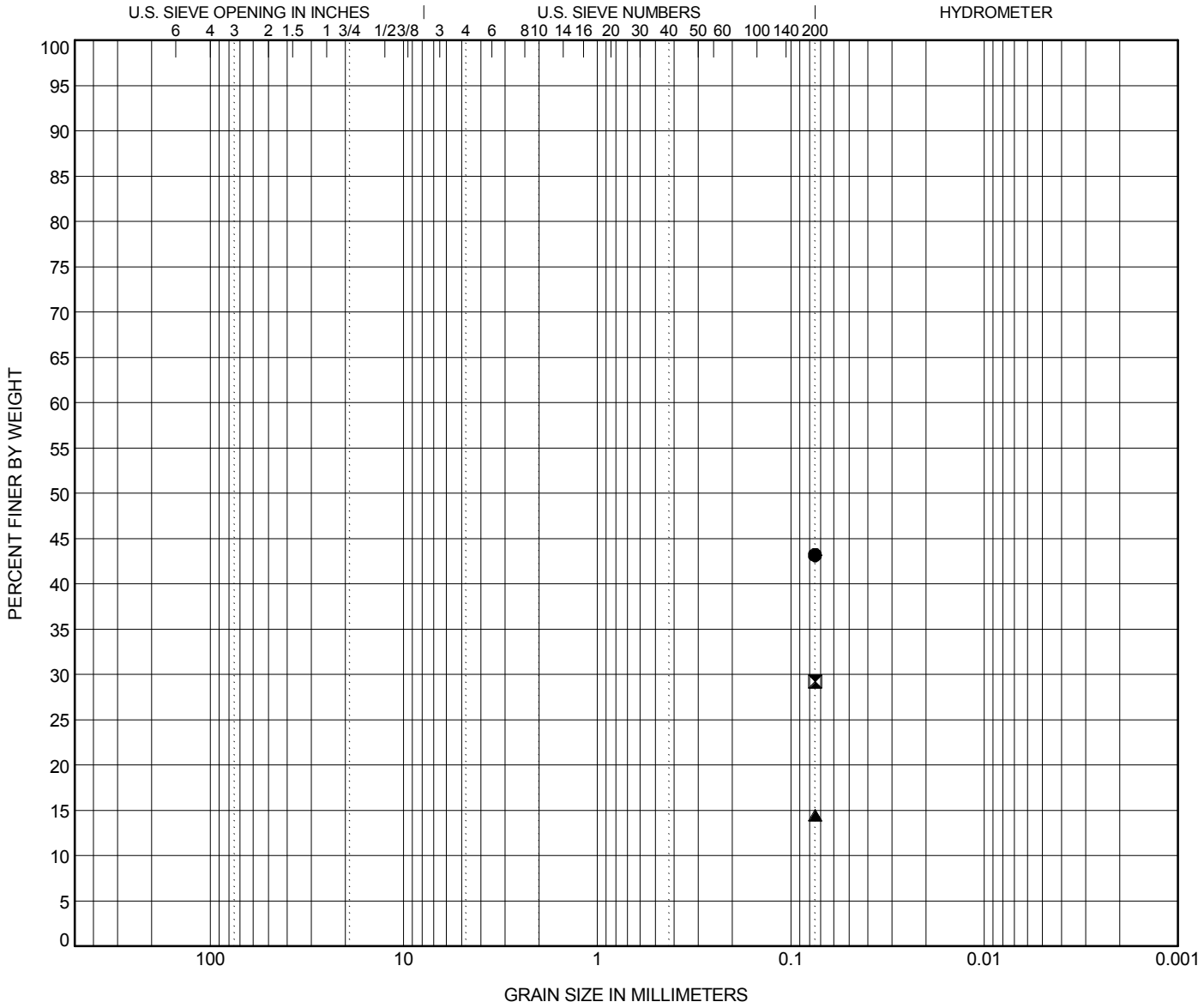


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-1**	**6.0**	**37**	**25**	**12**	**43**	**Silty SAND (SM)**
⧓	**B-1**	**14.0**	**NP**	**NP**	**NP**	**29**	**Silty SAND (SM)**

GRAIN SIZE DISTRIBUTION

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-1**	**6.0**	**Silty SAND (SM)**	**37**	**25**	**12**		
⧓	**B-1**	**14.0**	**Silty SAND (SM)**	**NP**	**NP**	**NP**		
▲	**B-1**	**16.0**	**Silty SAND (SM)**					

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-1**	**6.0**	**0.075**						**43.2**	
⧓	**B-1**	**14.0**	**0.075**						**29.3**	
▲	**B-1**	**16.0**	**0.075**						**14.5**	

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

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC41 Bridge over Maiden Down Swamp	**PROJECT NO.:**	G5500.04
SAMPLE NUMBER:	15-1233/B-1	**DATE SAMPLE RECEIVED:**	8/26/2015
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MM	**DATE OF TESTING:**	8/26/2015
		DATE OF WEIGHING:	8/27/2015

BORING NO.	B-1	B-1	B-1		
SAMPLE NO.	15-1233C	15-1233F	15-1233H		
SAMPLE DEPTH	4.0-6.0'	12.0-14.0'	14.0-16.0'		
WATER CONTENT, W%	18.8	41.5	32.2		

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%					

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Columbia, South Carolina 29205

ORGANIC IMPURITIES DETERMINATION
(AASHTO T267)

PROJECT:	SC-41 Bridge over Maiden Down Swamp	**PROJECT NO.:**	G5500.04
SAMPLE NUMBER:	15-1233I B-1	**DATE SAMPLE RECEIVED:**	8/26/2015
DESCRIPTION OF SOIL:	Silty SAND (SM)		
TESTED BY:	JH	**DATE OF TESTING:**	8/31/2015
		DATE OF WEIGHING:	8/31/2015

BORING NO.	B-1				
SAMPLE NO.	15-1233I				
SAMPLE DEPTH	14.0'-16.0'				
WT. OF CRUCIBLE + DRY SOIL (BEFORE IGNITION) (GRAMS)	154.59				
WT. OF CRUCIBLE + DRY SOIL (AFTER IGNITION) (GRAMS)	154.37				
WT. OF CRUCIBLE (GRAMS)	114.59				
WT. OF DRY SOIL (BEFORE IGNITION) (GRAMS)	40.00				
WT. OF DRY SOIL (AFTER IGNITION) (GRAMS)	39.78				
IGNITION LOSS (GRAMS)	0.22				
ORGANIC IMPURITIES %	0.55				

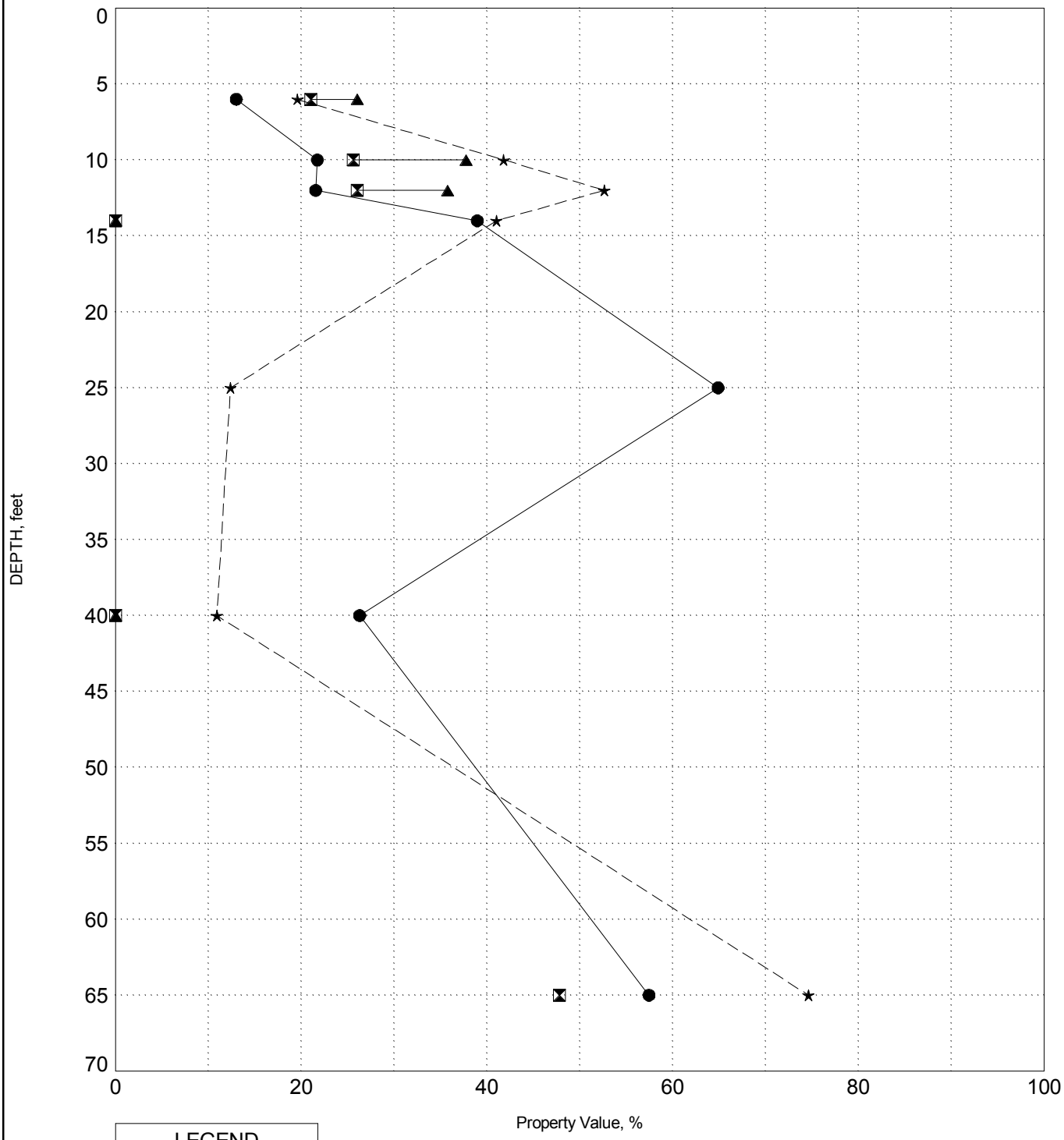
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion

BORING B-2

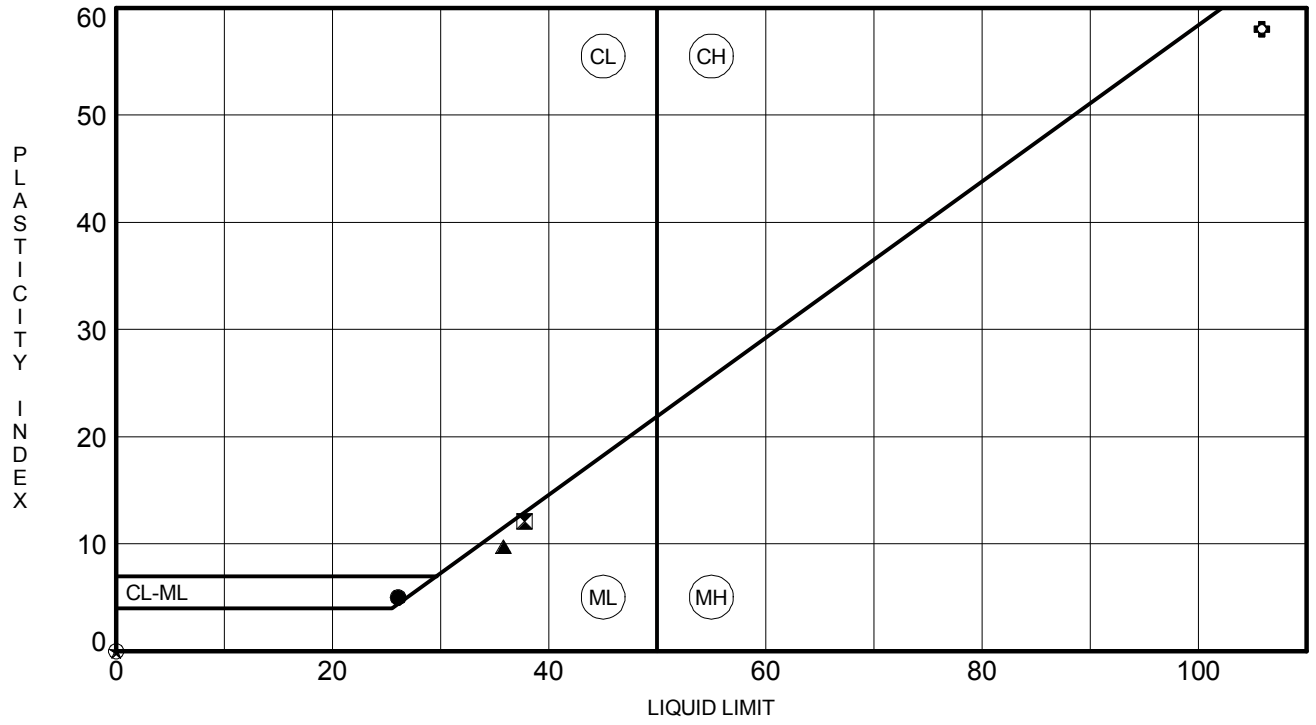
SURFACE ELEVATION: 70.2



ATTERBERG LIMITS' RESULTS

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion

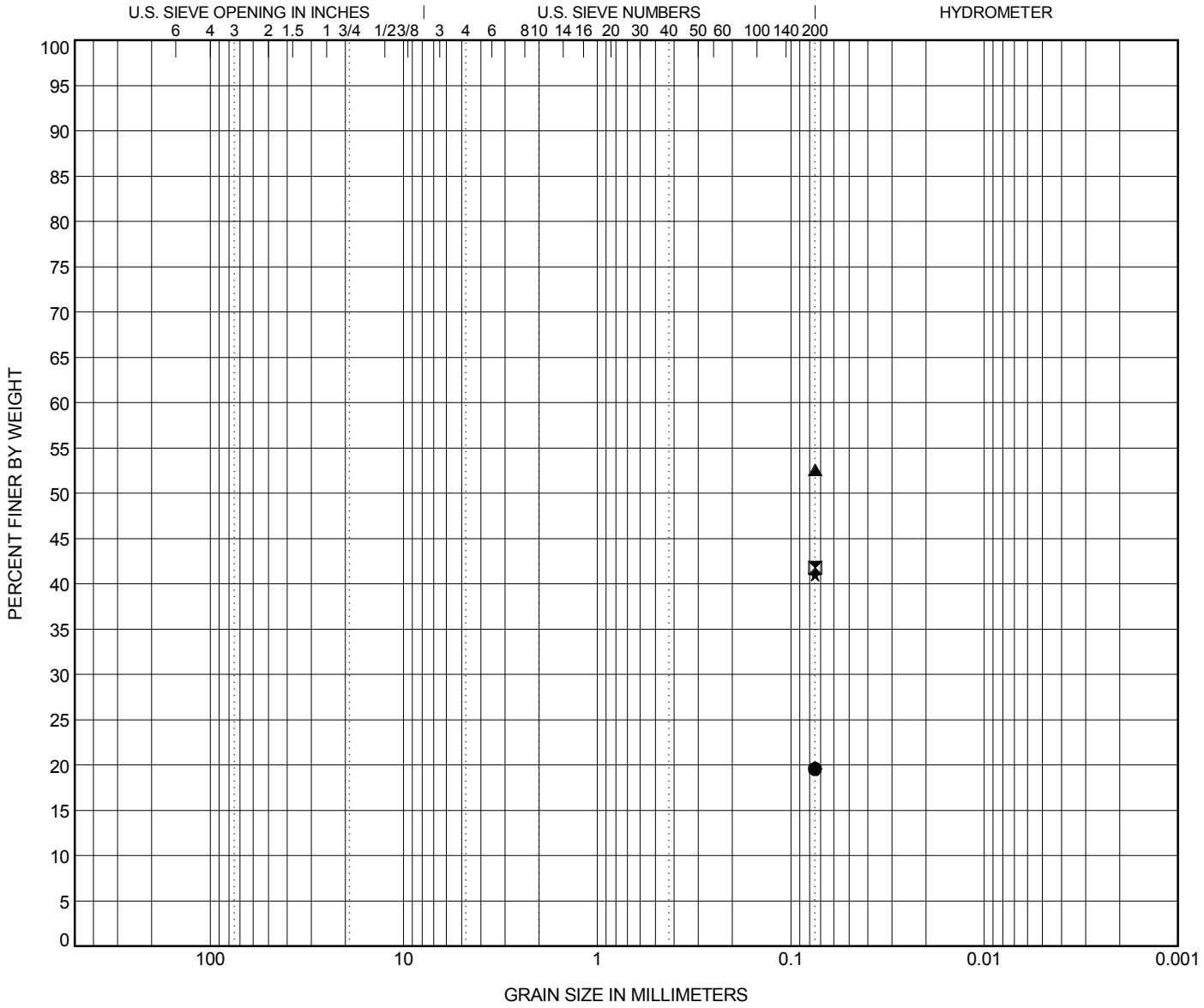


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-2**	**6.0**	**26**	**21**	**5**	**20**	**Silty, Clayey SAND (SC-SM)**
⊠	**B-2**	**10.0**	**38**	**26**	**12**	**42**	**Silty SAND (SM)**
▲	**B-2**	**12.0**	**36**	**26**	**10**	**53**	**Sandy SILT (ML)**
★	**B-2**	**14.0**	**NP**	**NP**	**NP**	**41**	**Silty SAND (SM)**
⊙	**B-2**	**40.0**	**NP**	**NP**	**NP**	**11**	**SAND (SP-SM) with Silt**
✿	**B-2**	**65.0**	**106**	**48**	**58**	**75**	**Elastic SILT (MH) with Sand**

GRAIN SIZE DISTRIBUTION

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

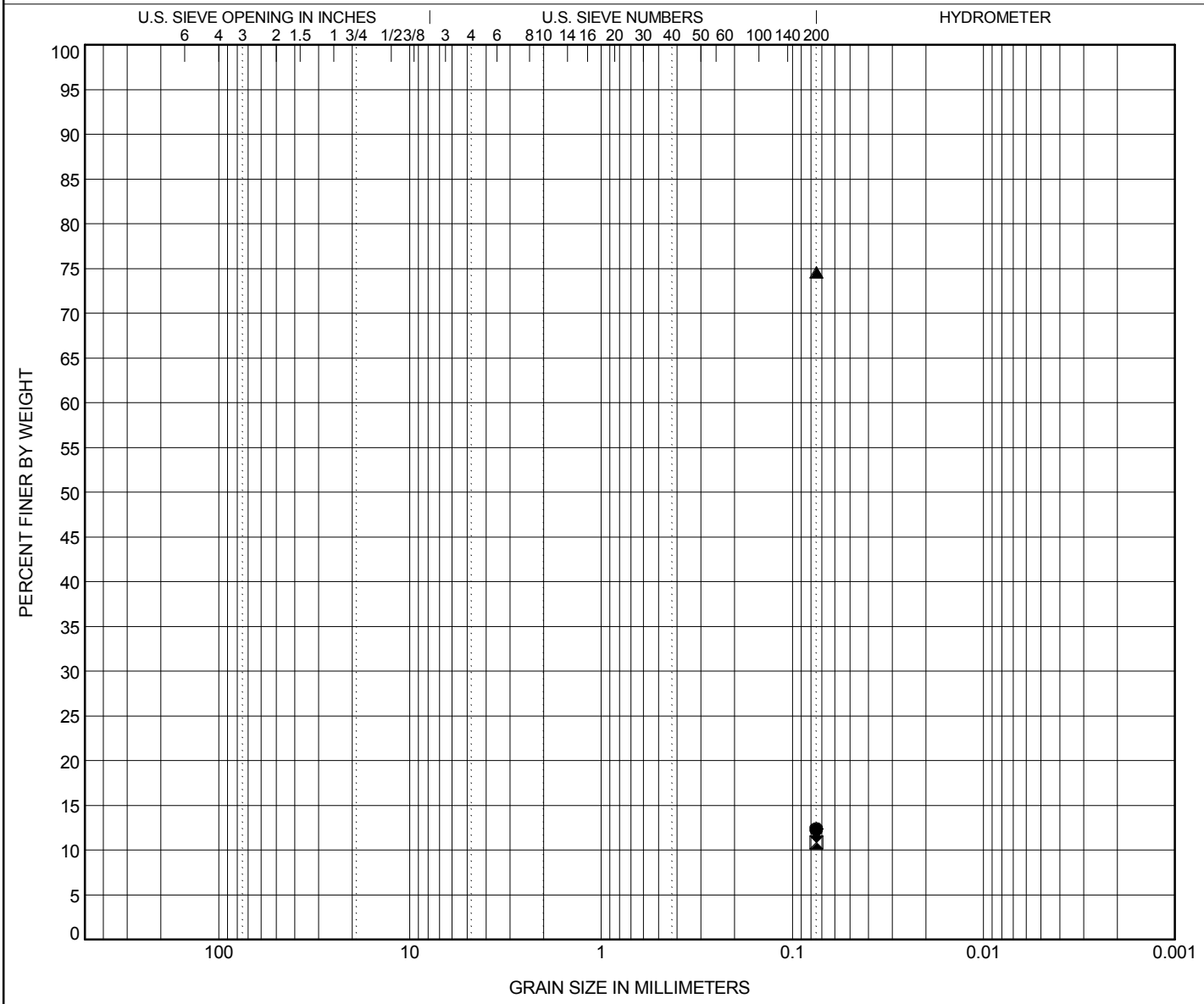
	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-2**	**6.0**	**Silty, Clayey SAND (SC-SM)**	**26**	**21**	**5**		
⧓	**B-2**	**10.0**	**Silty SAND (SM)**	**38**	**26**	**12**		
▲	**B-2**	**12.0**	**Sandy SILT (ML)**	**36**	**26**	**10**		
★	**B-2**	**14.0**	**Silty SAND (SM)**	**NP**	**NP**	**NP**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-2**	**6.0**	**0.075**						**19.6**	
⧓	**B-2**	**10.0**	**0.075**						**41.8**	
▲	**B-2**	**12.0**	**0.075**						**52.6**	
★	**B-2**	**14.0**	**0.075**						**41.0**	

GRAIN SIZE DISTRIBUTION

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE		DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-2**	**25.0**	**Silty SAND (SM)**					
⧓	**B-2**	**40.0**	**SAND (SP-SM) with Silt**	**NP**	**NP**	**NP**		
▲	**B-2**	**65.0**	**Elastic SILT (MH) with Sand**	**106**	**48**	**58**		

BOREHOLE		DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-2**	**25.0**	**0.075**						**12.4**	
⧓	**B-2**	**40.0**	**0.075**						**10.9**	
▲	**B-2**	**65.0**	**0.075**						**74.6**	

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Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC41 Bridge over Maiden Down Swamp	**PROJECT NO.:**	G5500.04
SAMPLE NUMBER:	15-1234/B-2	**DATE SAMPLE RECEIVED:**	8/26/2015
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MM	**DATE OF TESTING:**	8/26/2015
		DATE OF WEIGHING:	8/27/2015

BORING NO.	B-2	B-2	B-2	B-2	B-2
SAMPLE NO.	15-1234C	15-1234F	15-1234I	15-1234L	15-1234N
SAMPLE DEPTH	4.0-6.0'	8.0-10.0'	10.0-12.0'	12.0-14.0'	23.5-25.0'
WATER CONTENT, W%	13.0	21.7	21.5	39.0	64.9

BORING NO.	B-2	B-2			
SAMPLE NO.	15-1234Q	15-1234T			
SAMPLE DEPTH	38.5-40.0'	63.5-65.0'			
WATER CONTENT, W%	26.3	57.4			

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

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

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3112 Devine Street
Columbia, South Carolina 29205

ORGANIC IMPURITIES DETERMINATION
(AASHTO T267)

PROJECT:	SC-41 Bridge over Maiden Down Swamp	**PROJECT NO.:**	G5500.04
SAMPLE NUMBER:	15-1234U B-2	**DATE SAMPLE RECEIVED:**	8/26/2015
DESCRIPTION OF SOIL:	Silty SAND (SM)		
TESTED BY:	JH	**DATE OF TESTING:**	8/31/2015
		DATE OF WEIGHING:	8/31/2015

BORING NO.	B-2				
SAMPLE NO.	15-1234U				
SAMPLE DEPTH	12.0'-14.0'				
WT. OF CRUCIBLE + DRY SOIL (BEFORE IGNITION) (GRAMS)	177.12				
WT. OF CRUCIBLE + DRY SOIL (AFTER IGNITION) (GRAMS)	174.25				
WT. OF CRUCIBLE (GRAMS)	137.12				
WT. OF DRY SOIL (BEFORE IGNITION) (GRAMS)	40.00				
WT. OF DRY SOIL (AFTER IGNITION) (GRAMS)	37.13				
IGNITION LOSS (GRAMS)	2.87				
ORGANIC IMPURITIES %	7.18				

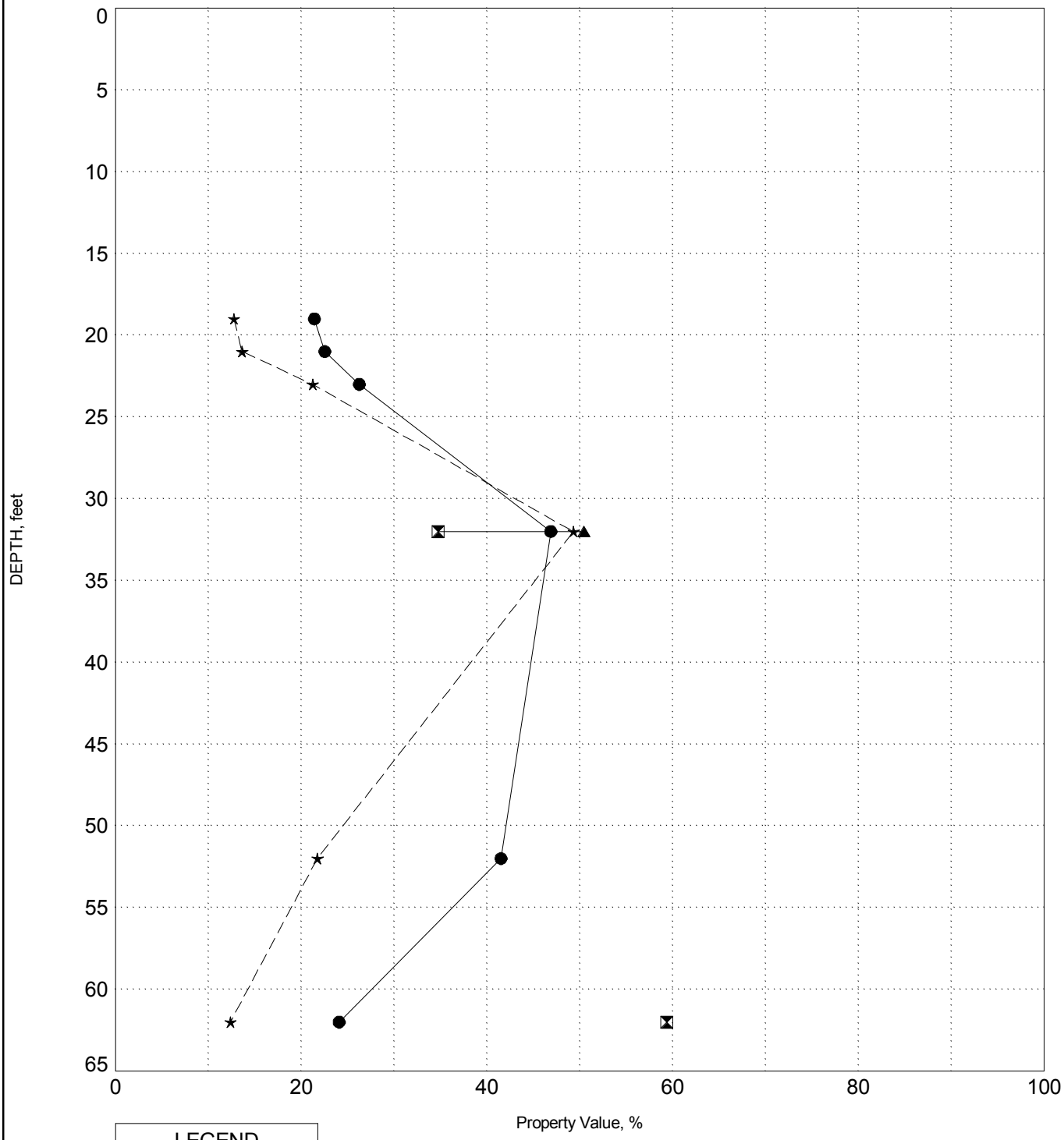
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion

BORING B-3

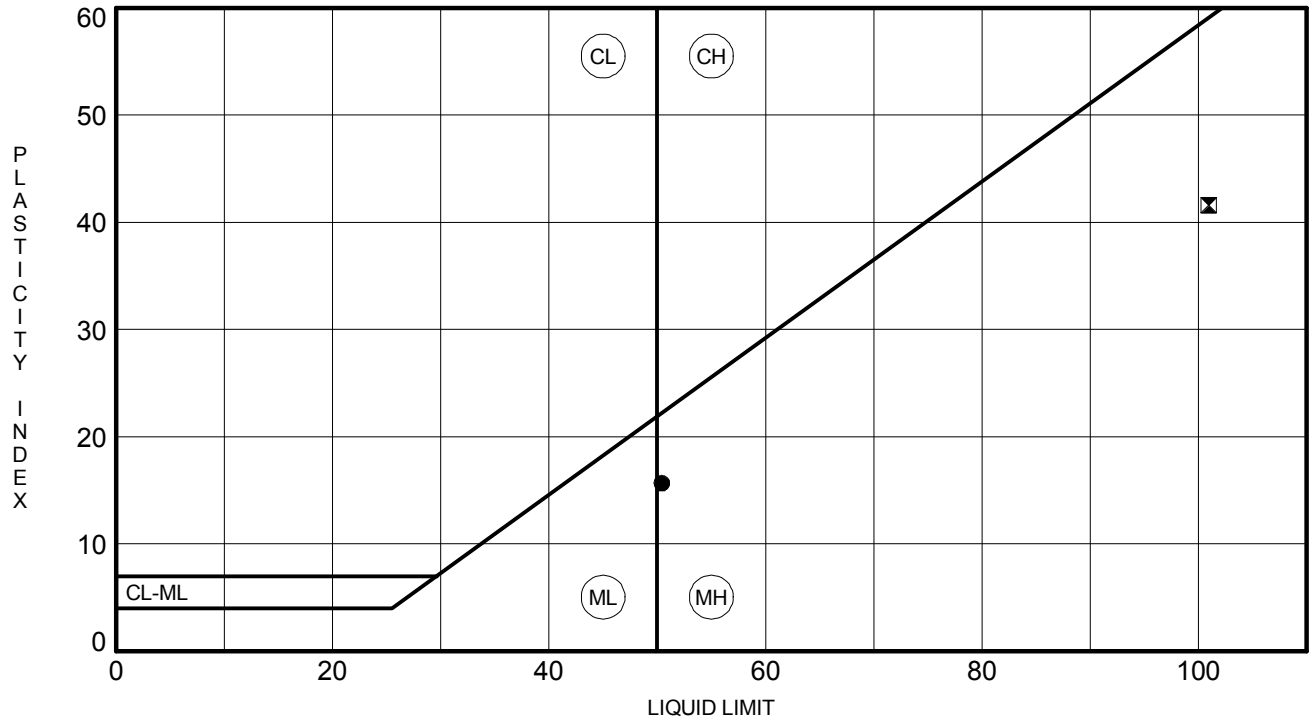
SURFACE ELEVATION: 70.1



ATTERBERG LIMITS' RESULTS

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion

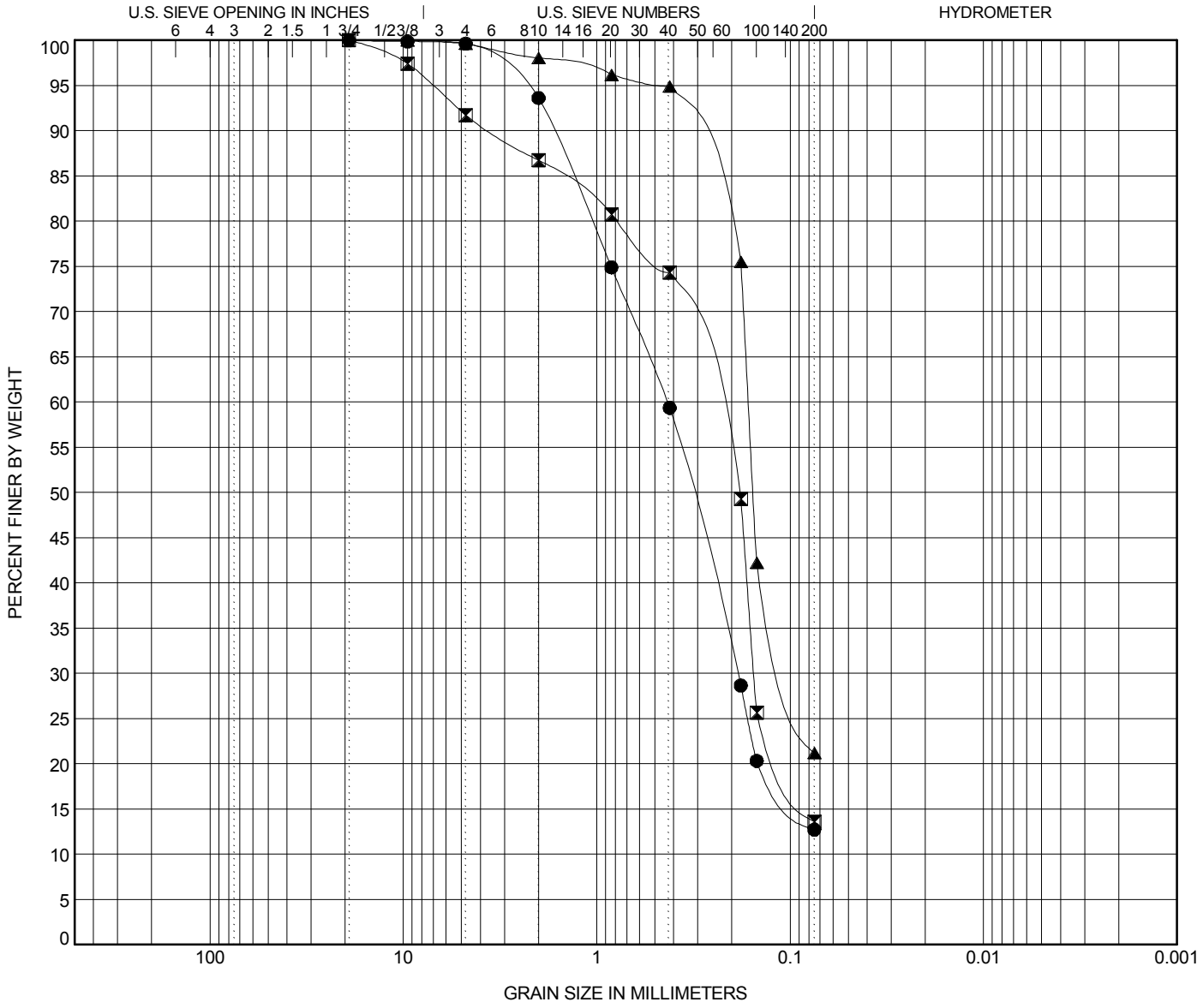


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-3**	**32.0**	**50**	**35**	**15**	**49**	**Silty SAND (SM)**
⧓	**B-3**	**62.0**	**101**	**59**	**42**	**12**	**Silty SAND (SM)**

GRAIN SIZE DISTRIBUTION

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

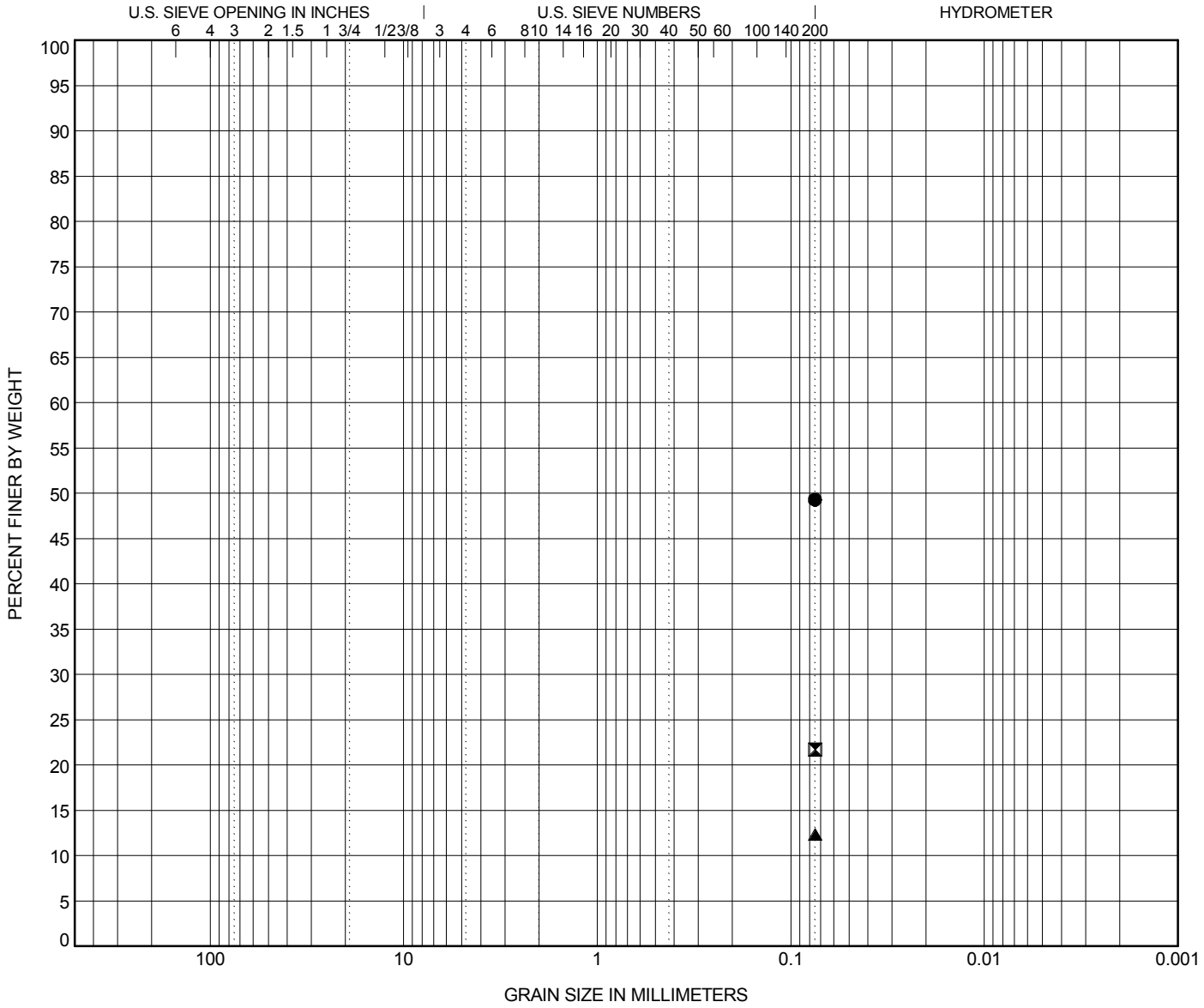
BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● B-3	19.0	**Silty SAND (SM)**					
⧓ B-3	21.0	**Silty SAND (SM)**					
▲ B-3	23.0	**Silty SAND (SM)**					

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-3	**19.0**	**19.1**	**0.432**	**0.187**		**0.4**	**86.9**	**12.7**	
⧓ B-3	**21.0**	**19.1**	**0.258**	**0.154**		**8.3**	**78.1**	**13.6**	
▲ B-3	**23.0**	**9.52**	**0.165**	**0.1**		**0.4**	**78.4**	**21.2**	

GRAIN SIZE DISTRIBUTION

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-3**	**32.0**	**Silty SAND (SM)**	**50**	**35**	**15**		
⊠	**B-3**	**52.0**	**Silty SAND (SM)**					
▲	**B-3**	**62.0**	**Silty SAND (SM)**	**101**	**59**	**42**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-3**	**32.0**	**0.075**						**49.3**	
⊠	**B-3**	**52.0**	**0.075**						**21.7**	
▲	**B-3**	**62.0**	**0.075**						**12.4**	

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3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC41 Bridge over Maiden Down Swamp	**PROJECT NO.:**	G5500.04
SAMPLE NUMBER:	15-1235/B-3	**DATE SAMPLE RECEIVED:**	8/26/2015
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MM	**DATE OF TESTING:**	8/26/2015
		DATE OF WEIGHING:	8/27/2015

BORING NO.	B-3	B-3	B-3	B-3	B-3
SAMPLE NO.	15-1235B	15-1235D	15-1235F	15-1235I	15-1235K
SAMPLE DEPTH	17.0-19.0'	19.0-21.0'	21.0-23.0'	30.5-32.0'	50.5-52.0'
WATER CONTENT, W%	21.4	22.5	26.2	46.9	41.5

BORING NO.	B-3				
SAMPLE NO.	15-1235N				
SAMPLE DEPTH	60.5-62.0'				
WATER CONTENT, W%	24.1				

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

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

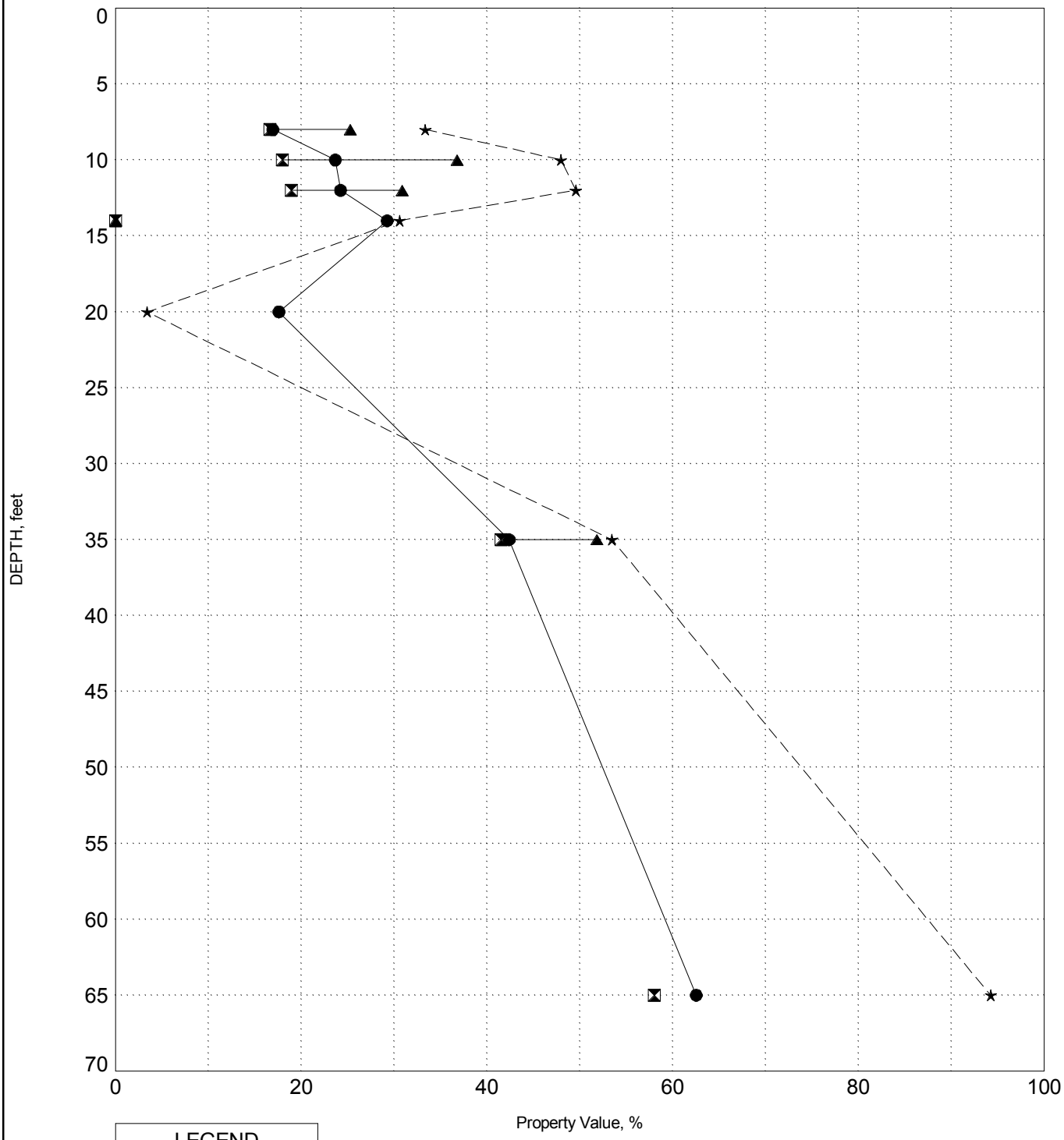
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion

BORING B-4

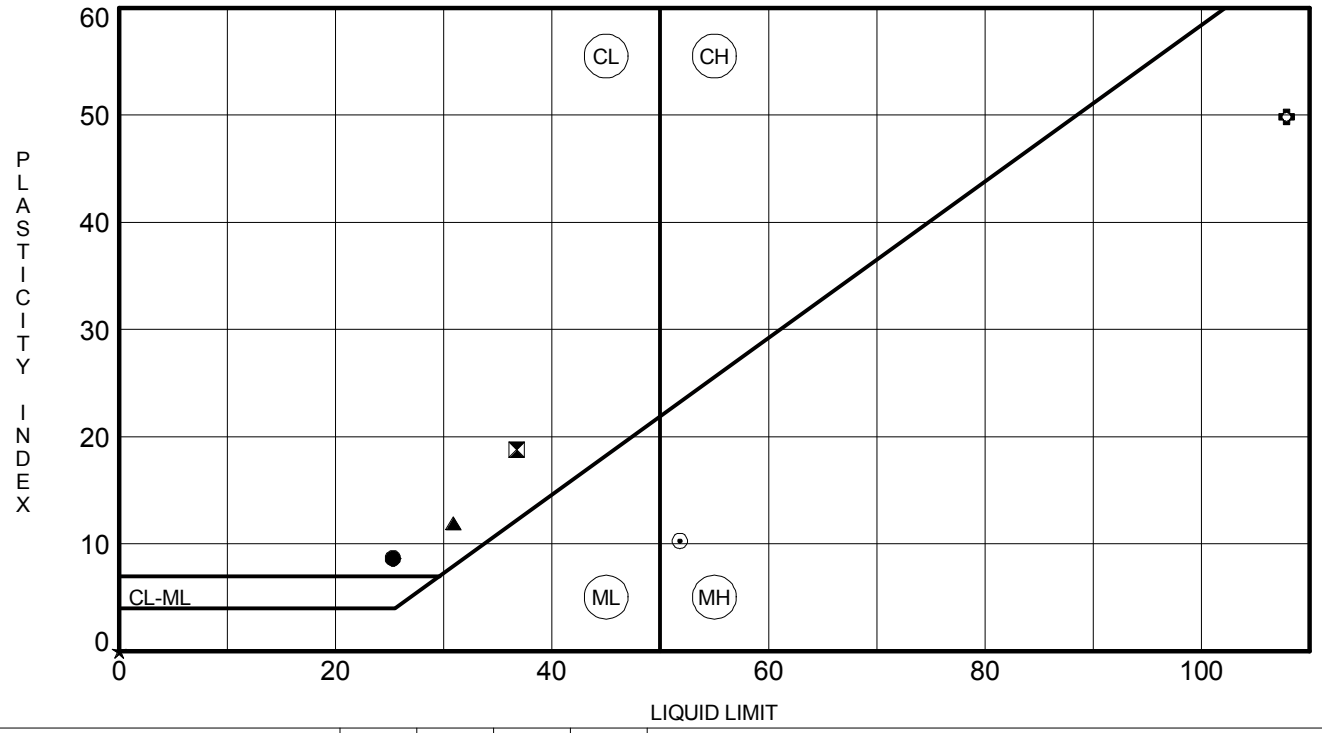
SURFACE ELEVATION: 69.9



ATTERBERG LIMITS' RESULTS

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion

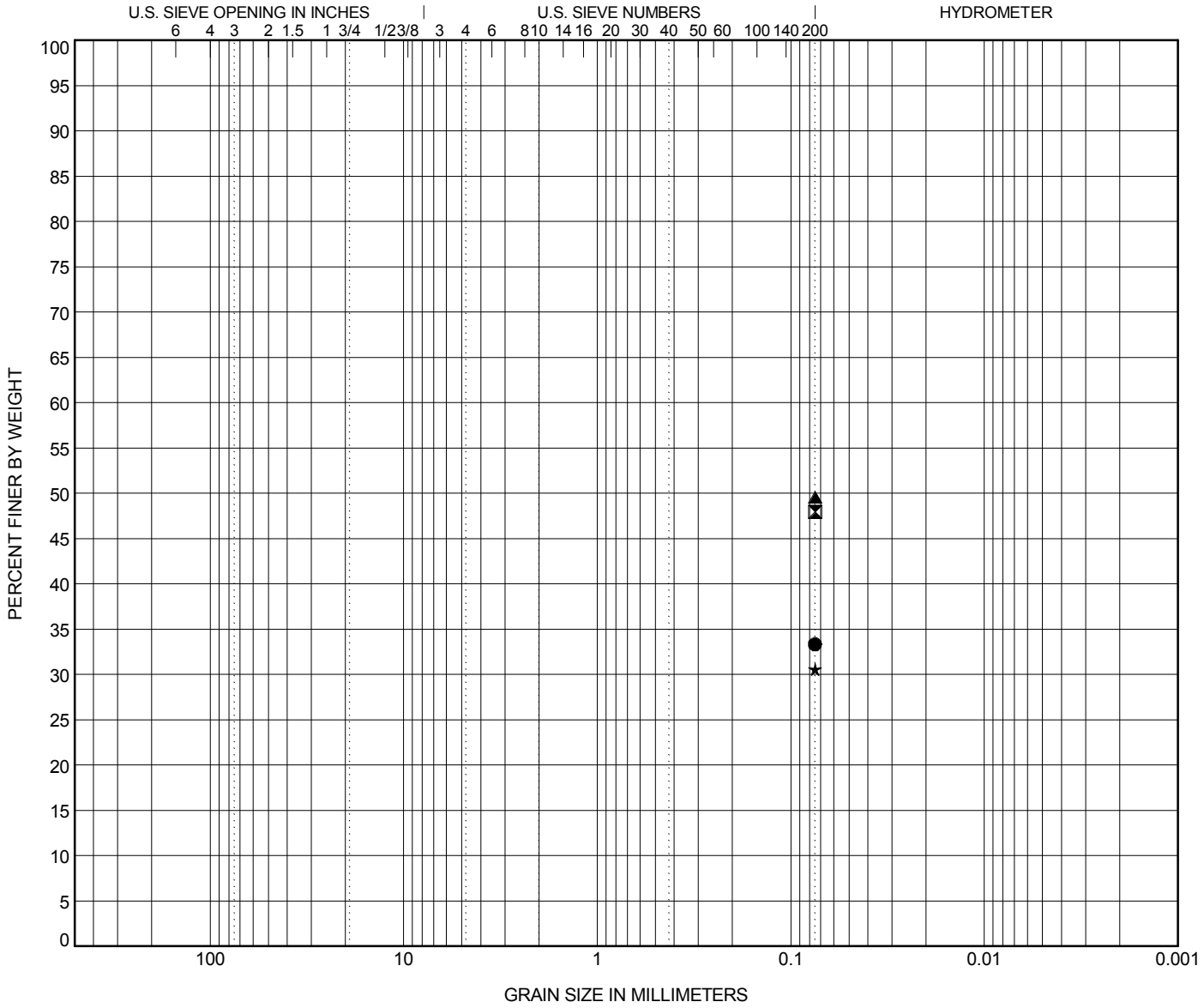


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-4**	**8.0**	**25**	**17**	**8**	**33**	**Clayey SAND (SC)**
⊠	**B-4**	**10.0**	**37**	**18**	**19**	**48**	**Clayey SAND (SC)**
▲	**B-4**	**12.0**	**31**	**19**	**12**	**50**	**Clayey SAND (SC)**
★	**B-4**	**14.0**	**NP**	**NP**	**NP**	**31**	**Silty SAND (SM)**
⊙	**B-4**	**35.0**	**52**	**42**	**10**	**54**	**Sandy Elastic SILT (MH)**
✿	**B-4**	**65.0**	**108**	**58**	**50**	**94**	**Elastic SILT (MH)**

GRAIN SIZE DISTRIBUTION

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

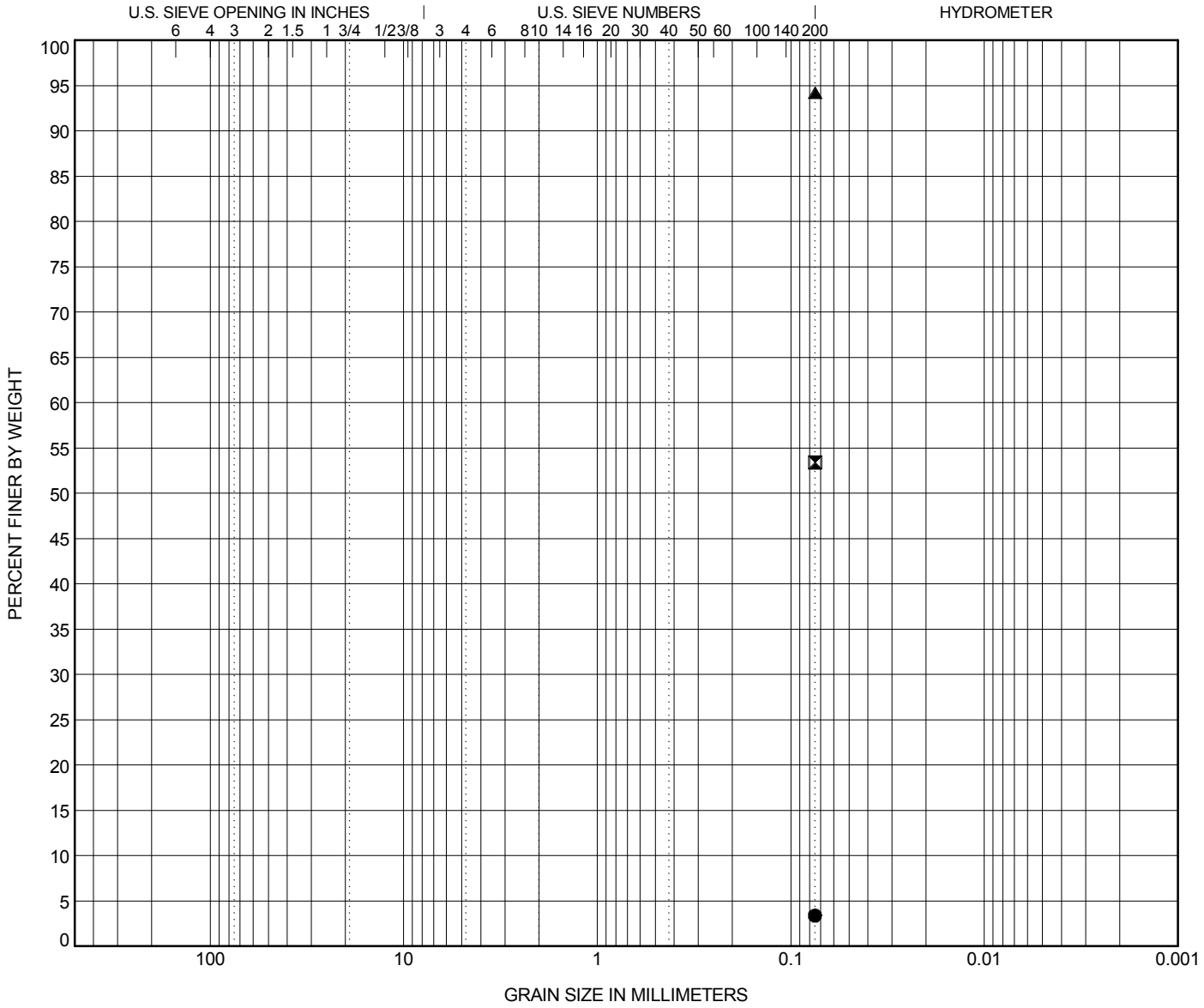
	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-4**	**8.0**	**Clayey SAND (SC)**	**25**	**17**	**8**		
⧓	**B-4**	**10.0**	**Clayey SAND (SC)**	**37**	**18**	**19**		
▲	**B-4**	**12.0**	**Clayey SAND (SC)**	**31**	**19**	**12**		
★	**B-4**	**14.0**	**Silty SAND (SM)**	**NP**	**NP**	**NP**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-4**	**8.0**	**0.075**						**33.3**	
⧓	**B-4**	**10.0**	**0.075**						**48.0**	
▲	**B-4**	**12.0**	**0.075**						**49.6**	
★	**B-4**	**14.0**	**0.075**						**30.6**	

GRAIN SIZE DISTRIBUTION

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-4**	**20.0**	**SAND (SP)**					
⧓	**B-4**	**35.0**	**Sandy Elastic SILT (MH)**	**52**	**42**	**10**		
▲	**B-4**	**65.0**	**Elastic SILT (MH)**	**108**	**58**	**50**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-4**	**20.0**	**0.075**						**3.4**	
⧓	**B-4**	**35.0**	**0.075**						**53.5**	
▲	**B-4**	**65.0**	**0.075**						**94.3**	

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

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC41 Bridge over Maiden Down Swamp	**PROJECT NO.:**	G5500.04
SAMPLE NUMBER:	15-1236/B-4	**DATE SAMPLE RECEIVED:**	8/26/2015
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MM	**DATE OF TESTING:**	8/26/2015
		DATE OF WEIGHING:	8/27/2015

BORING NO.	B-4	B-4	B-4	B-4	B-4
SAMPLE NO.	15-1236C	15-1236F	15-1236I	15-1236L	15-1236N
SAMPLE DEPTH	6.0-8.0'	8.0-10.0'	10.0-12.0'	12.0-14.0'	18.5-20.0'
WATER CONTENT, W%	16.9	23.7	24.2	29.2	17.6

BORING NO.	B-4	B-4			
SAMPLE NO.	15-1236Q	15-1236T			
SAMPLE DEPTH	33.5-35.0'	63.5-65.0'			
WATER CONTENT, W%	42.4	62.5			

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

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

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Columbia, South Carolina 29205

ORGANIC IMPURITIES DETERMINATION
(AASHTO T267)

PROJECT:	SC-41 Bridge over Maiden Down Swamp	**PROJECT NO.:**	G5500.04
SAMPLE NUMBER:	15-1236U B-4	**DATE SAMPLE RECEIVED:**	8/26/2015
DESCRIPTION OF SOIL:	Silty SAND (SM)		
TESTED BY:	JH	**DATE OF TESTING:**	8/31/2015
		DATE OF WEIGHING:	8/31/2015

BORING NO.	B-4				
SAMPLE NO.	15-1236U				
SAMPLE DEPTH	12.0'-14.0'				
WT. OF CRUCIBLE + DRY SOIL (BEFORE IGNITION) (GRAMS)	174.66				
WT. OF CRUCIBLE + DRY SOIL (AFTER IGNITION) (GRAMS)	172.89				
WT. OF CRUCIBLE (GRAMS)	134.66				
WT. OF DRY SOIL (BEFORE IGNITION) (GRAMS)	40.00				
WT. OF DRY SOIL (AFTER IGNITION) (GRAMS)	38.23				
IGNITION LOSS (GRAMS)	1.77				
ORGANIC IMPURITIES %	4.43				

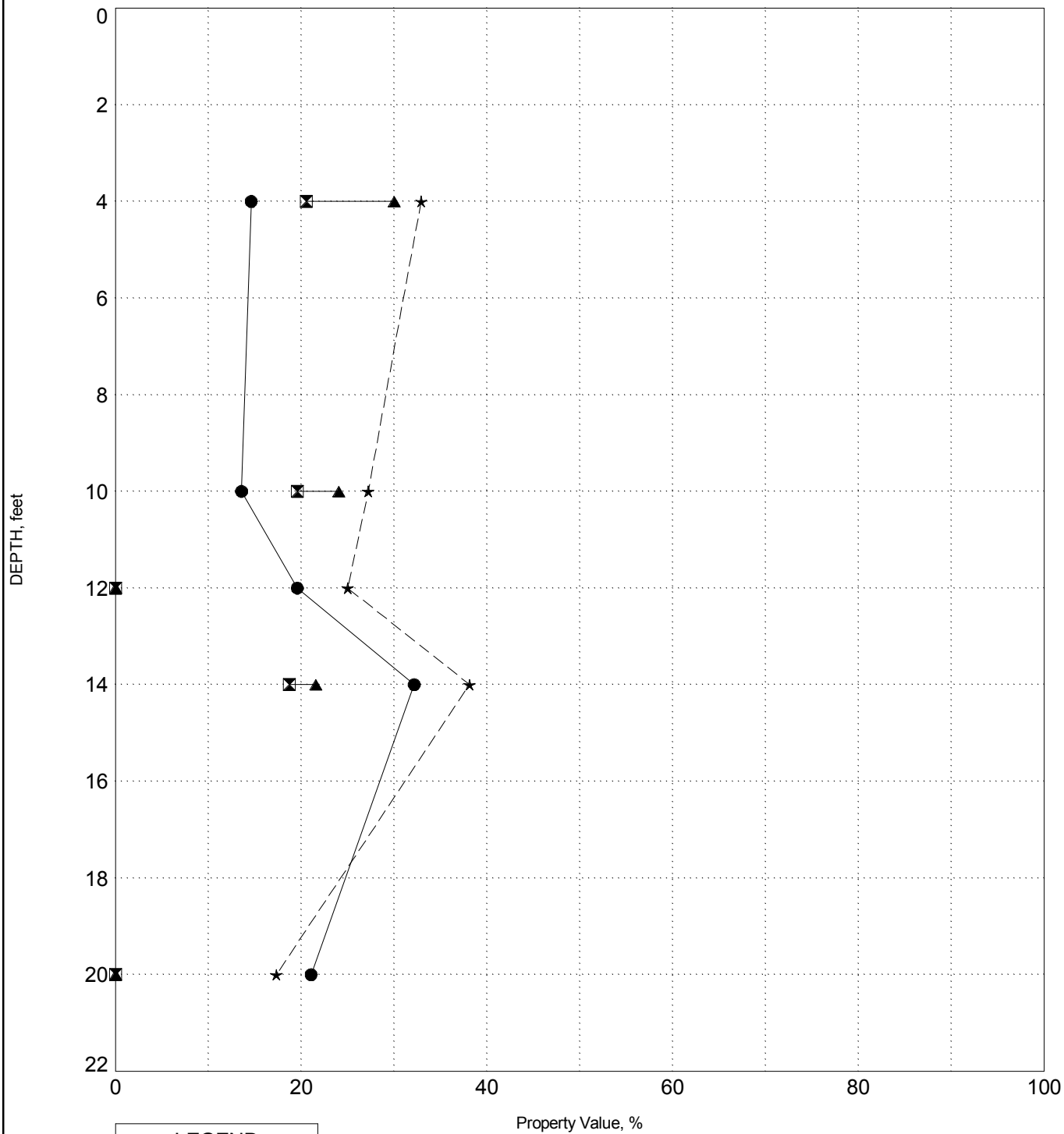
INDEX PROPERTIES VERSUS DEPTH

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion

BORING B-5

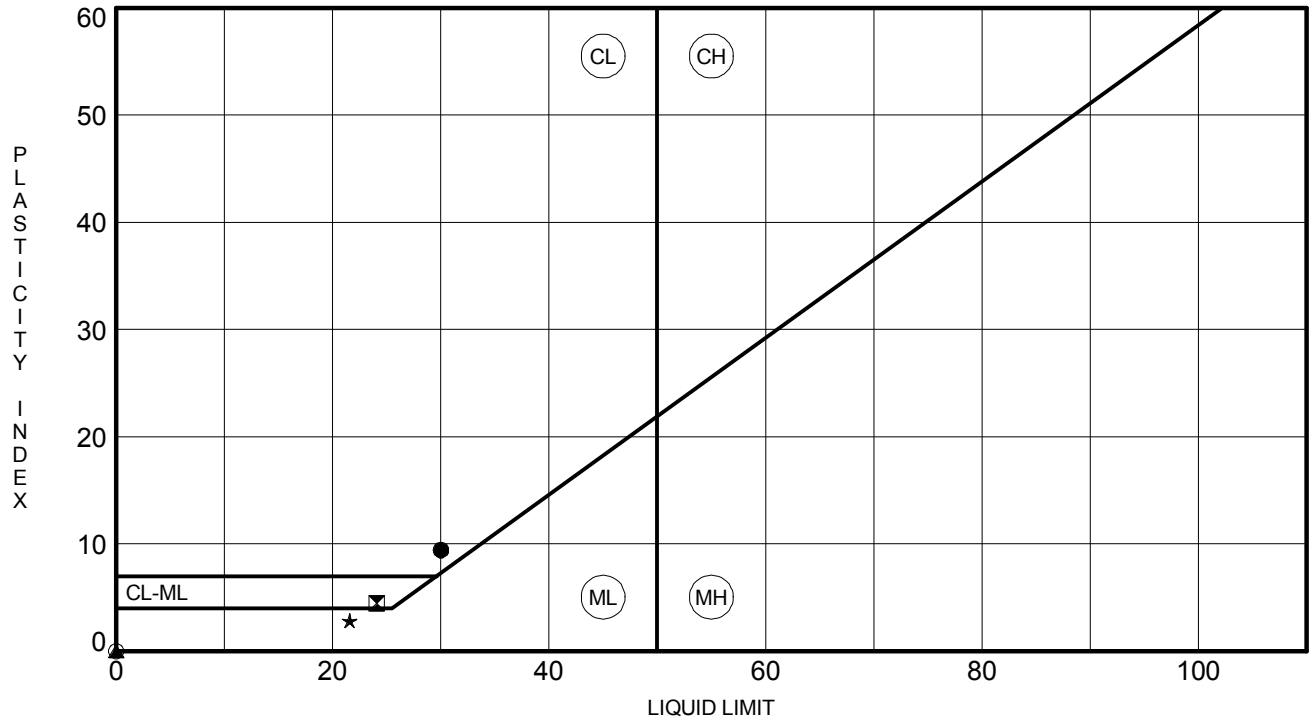
SURFACE ELEVATION: 70.2



ATTERBERG LIMITS' RESULTS

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion

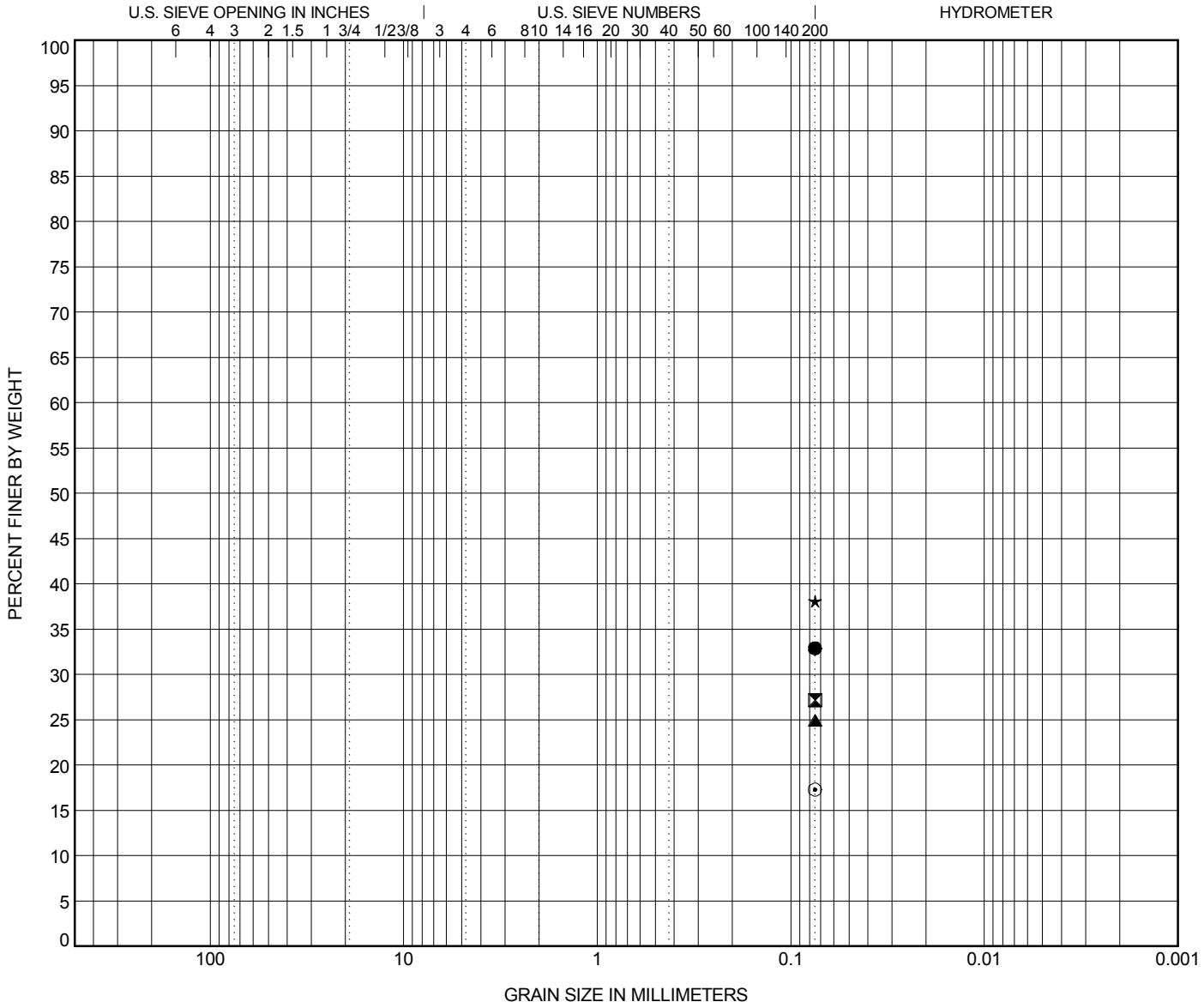


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-5**	**4.0**	**30**	**21**	**9**	**33**	**Clayey SAND (SC)**
⊠	**B-5**	**10.0**	**24**	**20**	**4**	**27**	**Silty, Clayey SAND (SC-SM)**
▲	**B-5**	**12.0**	**NP**	**NP**	**NP**	**25**	**Silty SAND (SM)**
★	**B-5**	**14.0**	**22**	**19**	**3**	**38**	**Silty SAND (SM)**
⊙	**B-5**	**20.0**	**NP**	**NP**	**NP**	**17**	**Silty SAND (SM)**

GRAIN SIZE DISTRIBUTION

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-5**	**4.0**	**Clayey SAND (SC)**	**30**	**21**	**9**		
⊠	**B-5**	**10.0**	**Silty, Clayey SAND (SC-SM)**	**24**	**20**	**4**		
▲	**B-5**	**12.0**	**Silty SAND (SM)**	**NP**	**NP**	**NP**		
★	**B-5**	**14.0**	**Silty SAND (SM)**	**22**	**19**	**3**		
⊙	**B-5**	**20.0**	**Silty SAND (SM)**	**NP**	**NP**	**NP**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-5**	**4.0**	**0.075**						**32.9**	
⊠	**B-5**	**10.0**	**0.075**						**27.2**	
▲	**B-5**	**12.0**	**0.075**						**25.0**	
★	**B-5**	**14.0**	**0.075**						**38.1**	
⊙	**B-5**	**20.0**	**0.075**						**17.3**	

F&ME CONSULTANTS
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Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC41 Bridge over Maiden Down Swamp	**PROJECT NO.:**	G5500.04
SAMPLE NUMBER:	15-1237/B-5	**DATE SAMPLE RECEIVED:**	8/26/2015
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	MM	**DATE OF TESTING:**	8/26/2015
		DATE OF WEIGHING:	8/27/2015

BORING NO.	B-5	B-5	B-5	B-5	B-5
SAMPLE NO.	15-1237C	15-1237F	15-1237I	15-1237L	15-1237O
SAMPLE DEPTH	2.0-4.0'	8.0-10.0'	10.0-12.0'	12.0-14.0'	18.5-20.0'
WATER CONTENT, W%	14.6	13.6	19.6	32.2	21.1

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%					

SEPTEMBER 2015

1524908.07
G5500.04

F&ME/SC-41 RBO MAIDEN DOWN SWAMP/SC
SUMMARY OF SOIL DATA

Sample Identification	Sample Type	Sample Depth	Soil Classi-fication	Received Moisture Content (%)	Atterberg Limits				Grain Size Distribution			Compaction		pH	Resistivity of Soil		Additional Tests Conducted (See Notes)
					L.L.	P.L.	P.I.	L.I.	% Finer No. 4 Sieve	% Finer No. 200 Sieve	% Finer .005 mm	Maximum Dry Density (lb/cuft)	Optimum Moisture %		Moisture Content %	Lowest Resistivity (ohm-cm)	
15-1234V	Bag	-	(ML)	22.2	-	-	-	-	-	-	-	-	-	-	42.3	6,500	-
15-1234U	-	-	-	-	-	-	-	-	-	-	-	-	-	4.9	-	-	-
15-1234X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Sulfate (ACL)
15-1234Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Chloride (ACL)

ABBREVIATIONS: LIQUID LIMIT (LL)
PLASTIC LIMIT (PL)
PLASTICITY INDEX (PI)
LIQUIDITY INDEX (LI)
SPECIFIC GRAVITY (Gs)
MOISTURE (Mc)

NOTES: T = TRIAXIAL TEST
U = UNCONFINED COMPRESSION TEST
C = CONSOLIDATION TEST
DS = DIRECT SHEAR TEST
O = ORGANIC CONTENT
P = pH

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

PROJECT TITLE	**F&ME/SC-41 RBO MAIDEN DOWN SWAMP/SC**	**SAMPLE ID**	**15-1234U**
PROJECT NO.	**1524908.07**	**SAMPLE TYPE**	**Bag**
REMARKS	**F&ME Project No. G5500.04**	**SAMPLE DEPTH**	**-**

SAMPLE PREPARATION

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

Trial	pH	Temperature
1	4.94	19.2
2	4.91	19.3
3	4.89	19.4
AVERAGE	4.91	19.3

Description sandy SILT; grayish brown and red.

USCS (ML)

TECH	TJ
DATE	9/17/15
CHECK	DA
REVIEW	MM
APPROVE	

Determining Minimum Laboratory Soil Resistivity
AASHTO T 288

PROJECT TITLE	F&ME/SC-41 RBO MAIDEN DOWN SWAMP/SC	SAMPLE ID	15-1234V
PROJECT NO.	1524908.07	SAMPLE TYPE	Bag
REMARKS	F&ME Project No. G5500.04	SAMPLE DEPTH	-

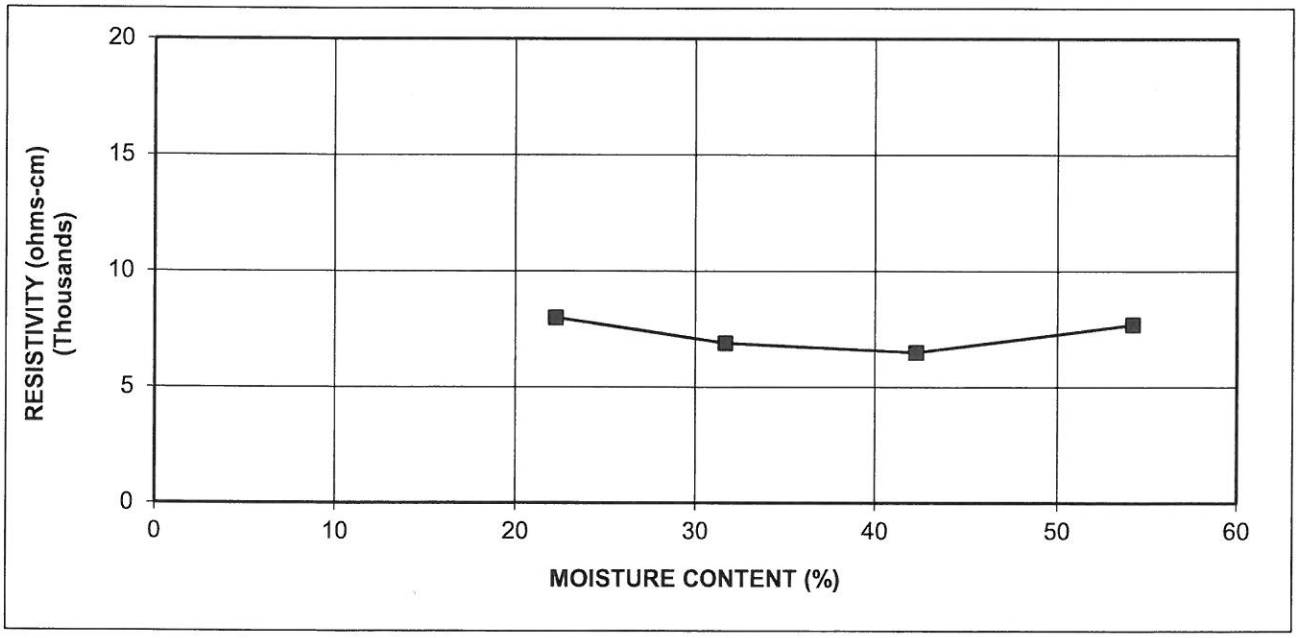
SAMPLE PREPARATION	Sieved through the #10 Sieve	Yes
TEST APPARATUS	Miller Soilbox and Nilsson 400 Soil Resistance Meter.	

Identification: Lowest resistivity

SPECIMEN (Point)	1	2	3	4	5
RESISTIVITY (ohms-cm)	-	8,000	6,900	6,500	7,700

MOISTURE CONTENT — As-Received Moisture

WET WEIGHT & TARE	172.85	172.85	212.35	194.89	438.37
DRY WEIGHT & TARE	149.30	149.30	173.95	152.09	302.16
TARE WEIGHT	43.29	43.29	52.84	50.91	50.79
WEIGHT OF MOISTURE (gm)	23.55	23.55	38.40	42.80	136.21
WEIGHT OF DRY SOIL (gm)	106.01	106.01	121.11	101.18	251.37
MOISTURE CONTENT (%)	22.21	22.21	31.71	42.30	54.19



Description: sandy SILT; grayish brown and red.

USCS: (ML)

TECH	TJ
DATE	9/16/15
CHECK	DA
REVIEW	
APPROVE	

ACL

ADVANCED CHEMISTRY LABS, INC.

Phone: (770) 409-1444
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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 #: 68350
Date Received: 09/16/2015
Date Reported: 09/25/2015

Contact: Mr. Henry Mock

Sample ID: 15-1234 **Matrix:** Soil

ACL #: 307588 **Date/Time Sampled:** 09/16/2015

Analyte (Method)	Result	PQL	Units	DF	Prep Date/Time	Analysis Date/Time	Analyst
Sol. Chloride (9252A)*	62	10	mg/kg	1	09/17/2015 10:20	09/17/2015 10:20	MM
Sol. Sulfate (9038)*	62	50	mg/kg	5	09/18/2015 9:45	09/18/2015 9:45	MM

APPENDIX C
SECTION 2

LABORATORY TESTING
(BULK SAMPLE)

SUMMARY OF LABORATORY RESULTS

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

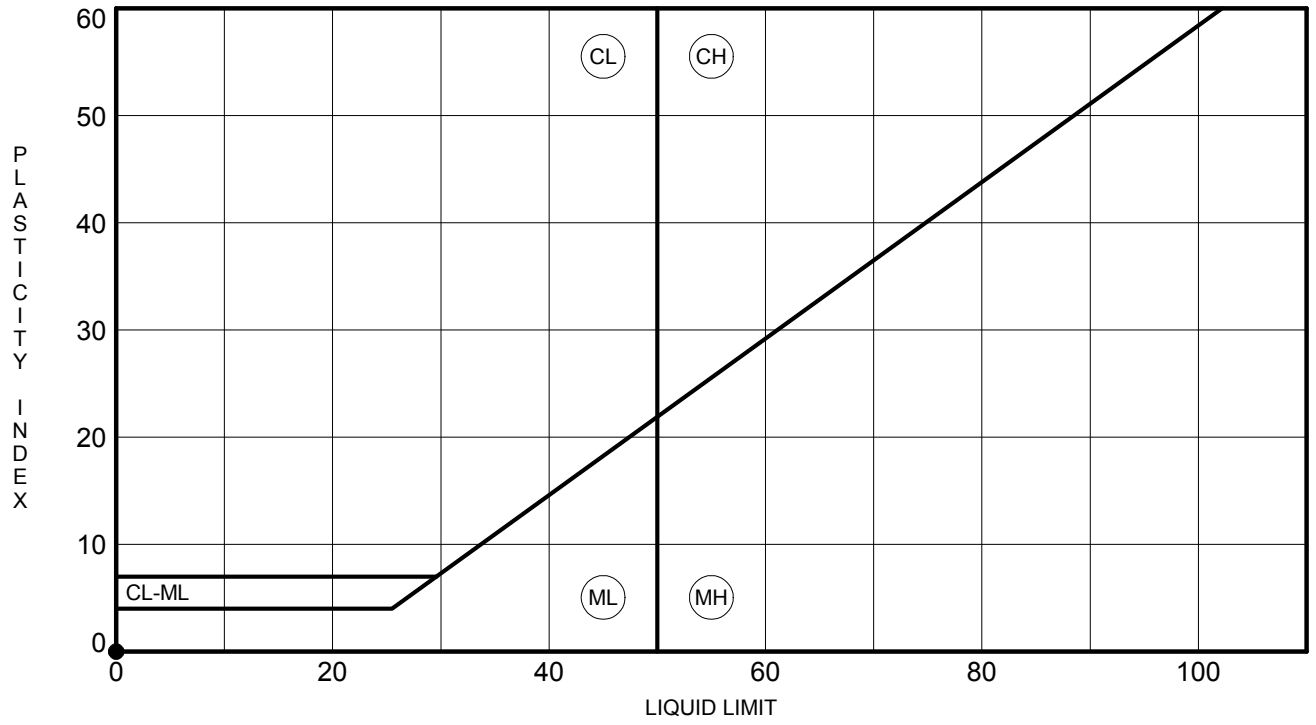
PROJECT COUNTY Marion

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
BS-1	5.0	NP	NP	NP	2	35	SM	9.6			

ATTERBERG LIMITS' RESULTS

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion

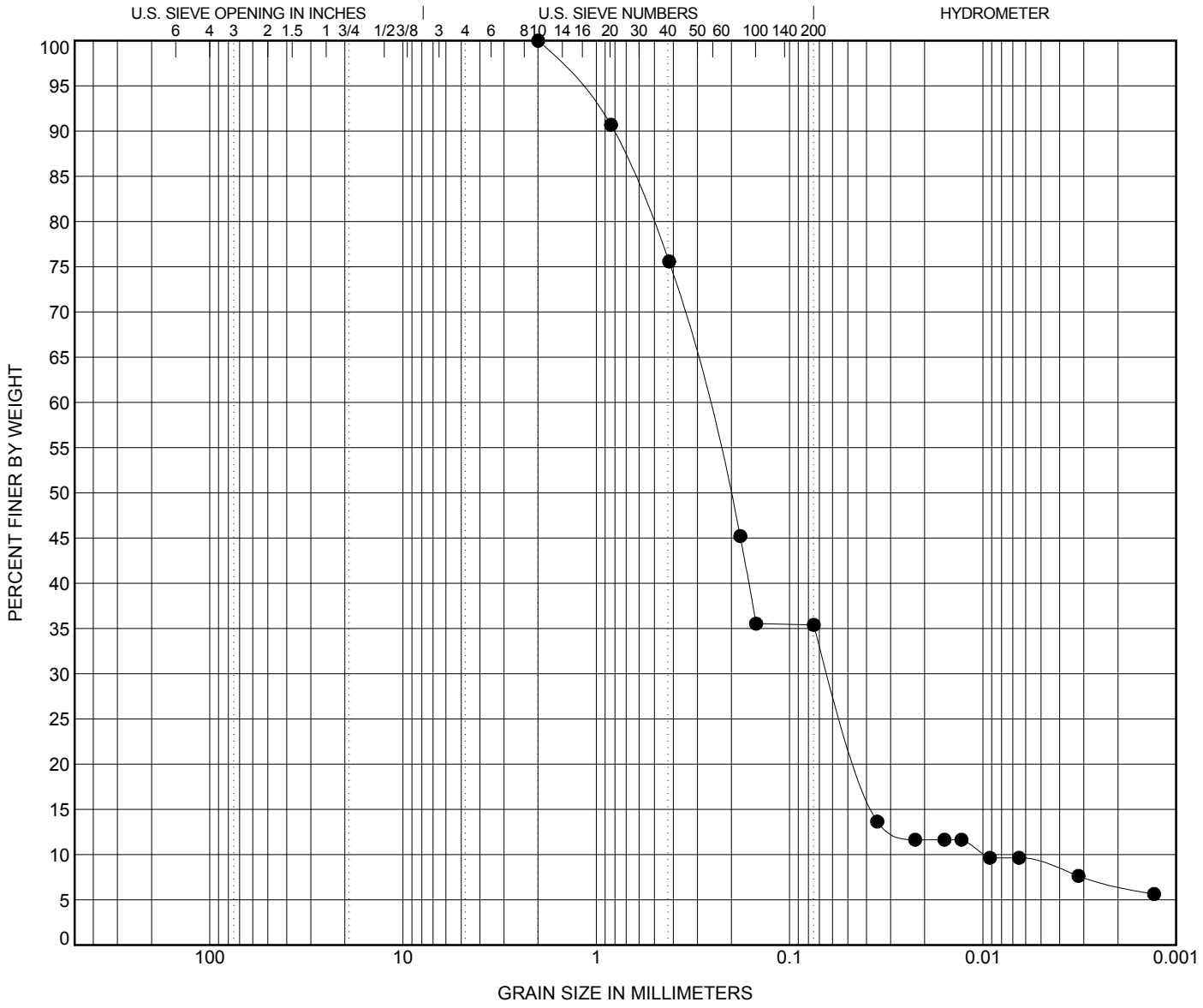


	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**BS-1**	**5.0**	**NP**	**NP**	**NP**	**35**	**Silty F/M SAND (SM) A-2-4**

GRAIN SIZE DISTRIBUTION

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**BS-1**	**5.0**	**Silty F/M SAND (SM) A-2-4**	**NP**	**NP**	**NP**	**1.45**	**27.84**

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BS-1**	**5.0**	**2**	**0.272**	**0.062**	**0.01**	**0.0**	**64.6**	**26.5**	**8.9**

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

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	SC41 Bridge over Maiden Down Swamp	**PROJECT NO.:**	G5500.04
SAMPLE NUMBER:	15-1238/BS-1	**DATE SAMPLE RECEIVED:**	8/26/2015
DESCRIPTION OF SOIL:	Silty F/M SAND (SM) A-2-4		
TESTED BY:	MM	**DATE OF TESTING:**	8/26/2015
		DATE OF WEIGHING:	8/28/2015

BORING NO.	BS-1				
SAMPLE NO.	15-1238D				
SAMPLE DEPTH	0.0-5.0'				
WATER CONTENT, W%	9.6				

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

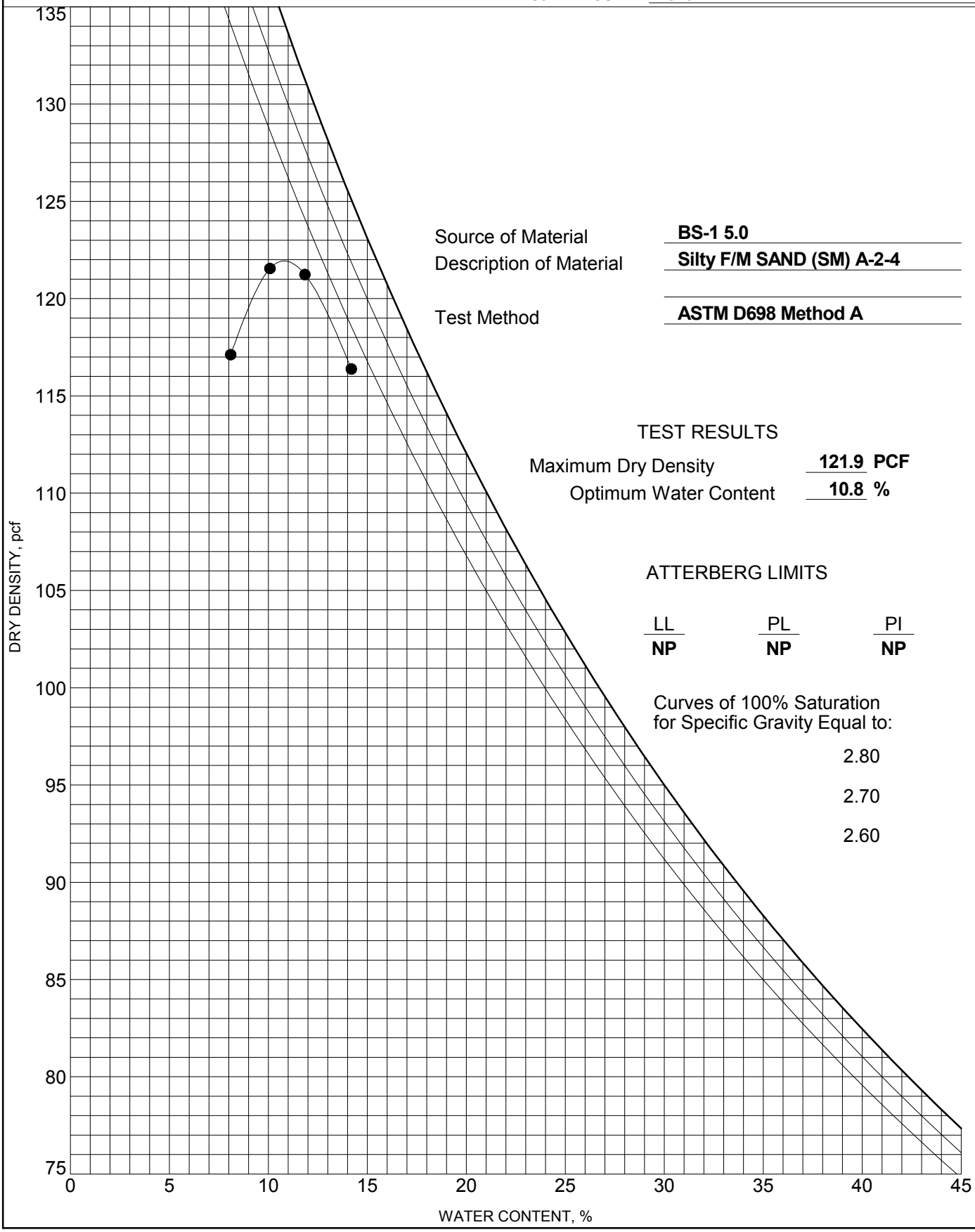
BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

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

MOISTURE-DENSITY RELATIONSHIP

PROJECT ID P027059 **PROJECT NAME** SC 41 Bridge Over Maiden Down Swamp

PROJECT COUNTY Marion



Source of Material **BS-1 5.0**

Description of Material **Silty F/M SAND (SM) A-2-4**

Test Method **ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density **121.9** **PCF**

Optimum Water Content **10.8** **%**

ATTERBERG LIMITS

LL	PL	PI
NP	**NP**	**NP**

Curves of 100% Saturation for Specific Gravity Equal to:

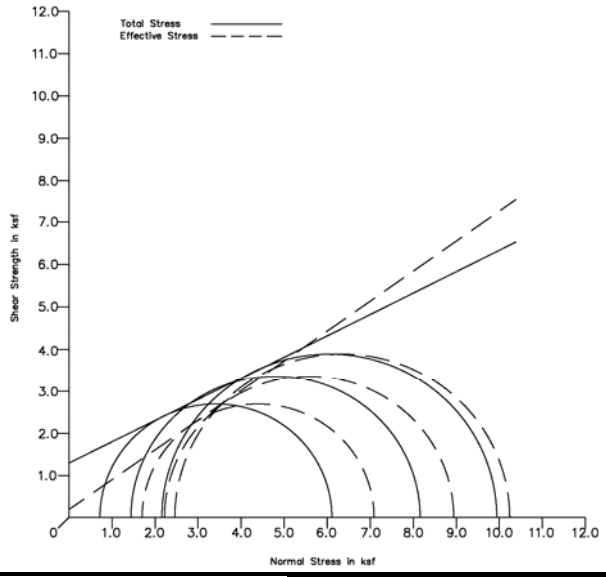
2.80

2.70

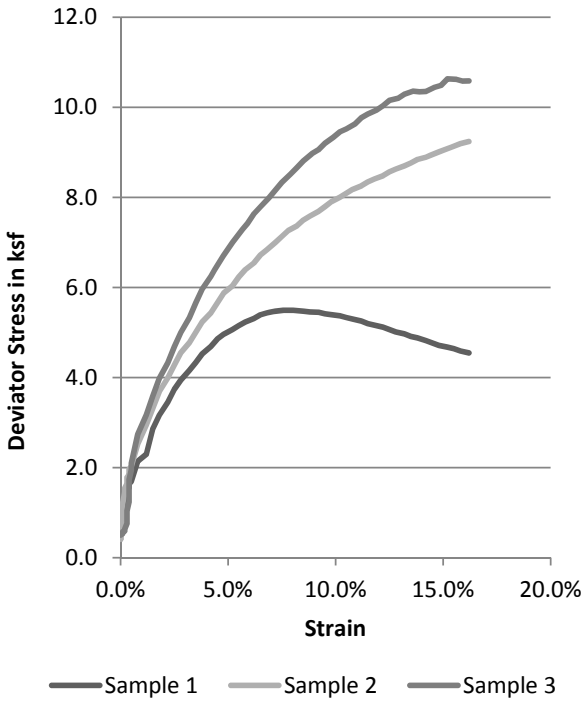
2.60

COMPACTION G5500.04 - SC 41 RBO MAIDEN SWAMP.GPJ GINT STD US LAB.GDT 9/11/15

TRIAXIAL SHEAR TEST REPORT
ASTM D4767 / AASHTO T297



Stress-Strain Curves



		Sample 1	Sample 2	Sample 3
Initial	Water Content, %	13.8%	12.0%	12.6%
	Void Ratio	0.44	0.43	0.42
	Diameter, in.	2.78	2.79	2.79
	Height, in.	6.00	6.00	5.98
	Volume, in^3	36.42	36.74	36.46
Final	Water Content, %	16.9%	16.0%	15.9%
	Void Ratio	0.43	0.43	0.39
	Diameter, in.	2.78	2.79	2.79
	Height, in.	5.98	5.94	5.82
	Volume, in^3	36.28	36.35	35.49
	Saturation, %	100.0%	98.8%	100.0%
Dry Density, PCF		115.7	116.0	119.3
Cell Pressure (ksf)		6.48	7.20	7.20
Sample Pressure (ksf)		5.76	5.76	5.04
Stress at Failure (ksf)		5.39	6.72	7.78
Strain at Failure, %		6.5%	6.5%	6.5%
σ_1 at Failure (ksf)		6.11	8.16	9.94
σ_3 at Failure (ksf)		0.72	1.44	2.16
σ'_1 at Failure (ksf)		7.09	8.94	10.24
σ'_3 at Failure (ksf)		1.70	2.22	2.46

Project Name: SC 41 Bridge over Maiden Down Swamp

Project Number: G5500.04 Date: 9/17/2015

SCDOT Project ID #: P027059

Sample/Location: Bulk 1 / Sta. 685+50

Depth/Elevation: 0' - 5'

Type of Test : Consolidated Undrained

Sample Type : Remolded

Description: Brown Silty Fine to Medium SAND (SM), A-2-4

PI= NP % Fines= 35.4

C= 1.29 ksf C'= 0.19 ksf

ϕ= 27° ϕ'= 34°

F&ME CONSULTANTS

3112 Devine Street Columbia, SC 29205

Geotechnical · Environmental · Materials

APPENDIX D

DOWNHOLE SHEAR WAVE VELOCITY TESTING

August 26, 2015

Mr. Jason P. Stewart, P.E.
F&ME Consultants
3112 Devine Street
Columbia, SC 29205

Subject: Results of Downhole Seismic Shear-Wave Investigation
SC-41 RBO Maiden Down Swamp
Marion County, South Carolina

Dear Mr. Stewart:

As requested, GeoWave Solutions, Inc. has completed a downhole seismic shear-wave investigation at the proposed bridge upgrade of SC-41 over the Maiden Down Swamp in Marion County, South Carolina. The study was conducted to augment drilling for determination of IBC seismic shear-wave soil classifications for the proposed bridge project. This report summarizes our downhole testing method and presents the shear-wave velocity results.

Site Description

The area of investigation is the SC-41 bridge crossing over the Maiden Down Swamp north of Mullins, South Carolina. The test boring was installed prior to our visit in the grassy right-of-way at the southern bridge abutment adjacent to the southbound lane of traffic. The boring was drilled to approximately 110 feet in depth and was grouted with 2-inch diameter PVC casing. The borehole was dewatered right before testing began to ensure no standing water was present.

Downhole Shear-Wave Testing Method

Seismic shear-wave data for the downhole testing were collected by recording data directly with a downhole geophone receiver. A 24-channel Geometrics Geode seismograph along with a three-component GeoStuff BHG-3 borehole geophone and control box were used to record shear-waves generated from a sixteen-pound sledgehammer horizontally striking an 8.5-foot long railroad cross tie with aluminum strike plates affixed to the ends. Measurements were taken starting at the bottom of the borehole (maximum of 105 feet for our testing) and continued at 2.5-foot intervals as the geophone was raised to the ground surface. Each interval included two separate recordings from energy sources designed to enhance specific properties of the wave: 1) positive shear (western end of beam hammer blow), 2) negative shear (eastern end of beam hammer blow). Additionally a third compression wave recording was collected for the primary wave but was not essential for the analysis phase for this study.

Unfortunately, equipment problems were encountered while attempting to collect the data. The clamping mechanism on the downhole tool that firmly attaches the tool to the borehole casing failed to operate while in the hole. After numerous troubleshooting attempts, the clamp was configured on the surface to act more as a spring clamp than a mechanical clamp. The clamp was opened wide enough to keep the borehole tool snug with the inside of the casing, but loose enough to allow the tool to drop down the borehole under its own weight. Results from this equipment adaptation did not appear to affect the quality of the data.

Analysis and Results

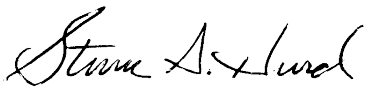
Data collected from the downhole testing were plotted with a positive-negative shear overlay to aid in identifying shear-wave arrivals within the waveform. These arrival times were then correlated to determine interval velocities between adjacent waveforms. The results from these data are in the attached seismic velocity model and table that display shear-wave velocities from 2.5 to 105 feet.

The resulting shear-wave data from this investigation produced a Vs100 value of 775.1 ft/sec which falls in the site class D range.

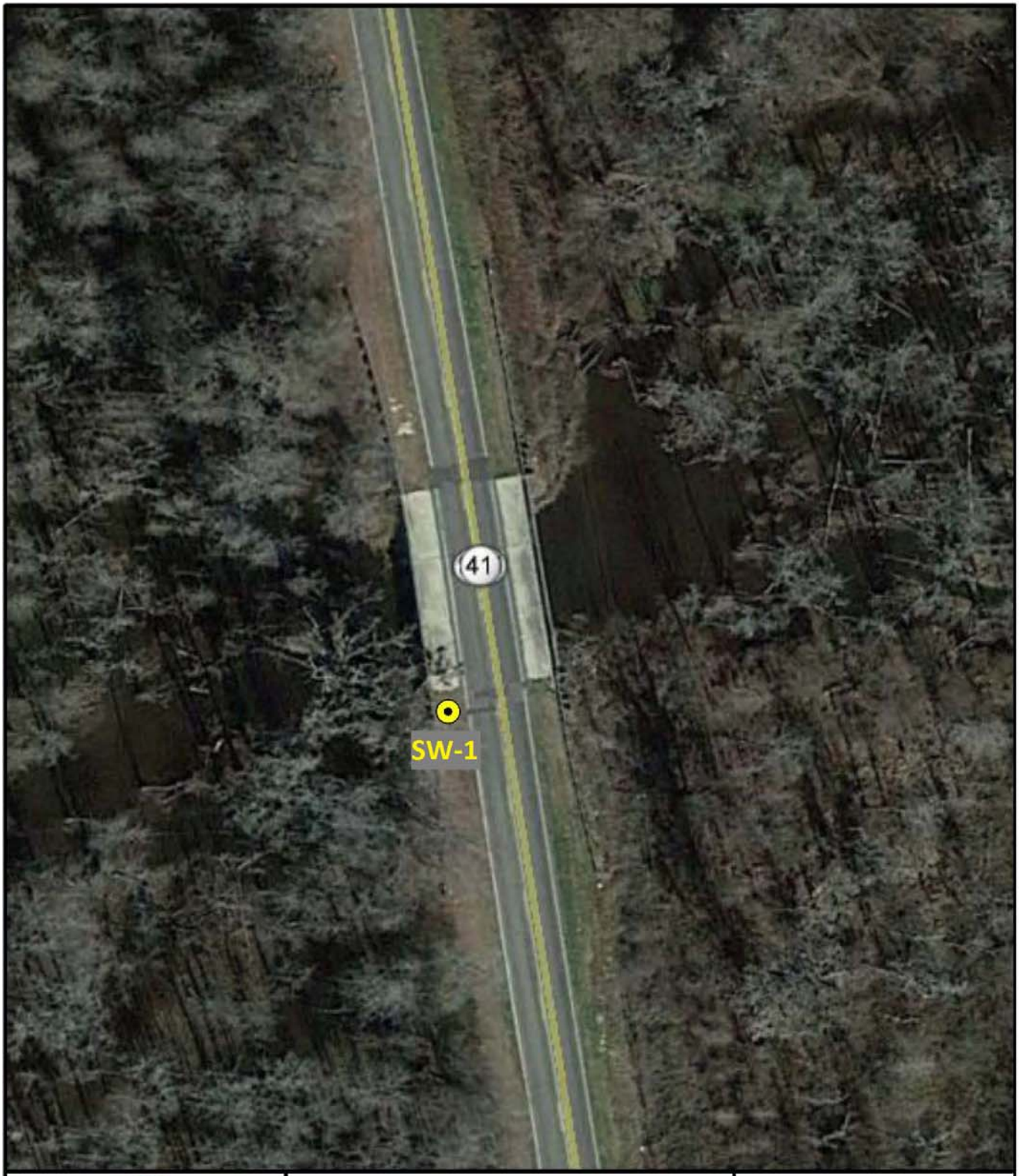
This study reports one-dimensional, subsurface shear-wave results at the test location. Because abrupt changes can occur in the subsurface, the attached seismic velocity model may not be representative of subsurface conditions across the entire bridge area.

If you have any questions about the findings of this study or the data contained in this report, or if you require any further services, please feel free to call us. We appreciate the opportunity to offer these consulting services and look forward to working with you again on future projects.

Sincerely,



Steven A. Hurd, P.G.
GeoWave Solutions, Inc.



GeoWave Solutions, Inc.
www.geowavesolutions.com

SC-41 RBO Maiden Down Swamp

F&ME Consultants

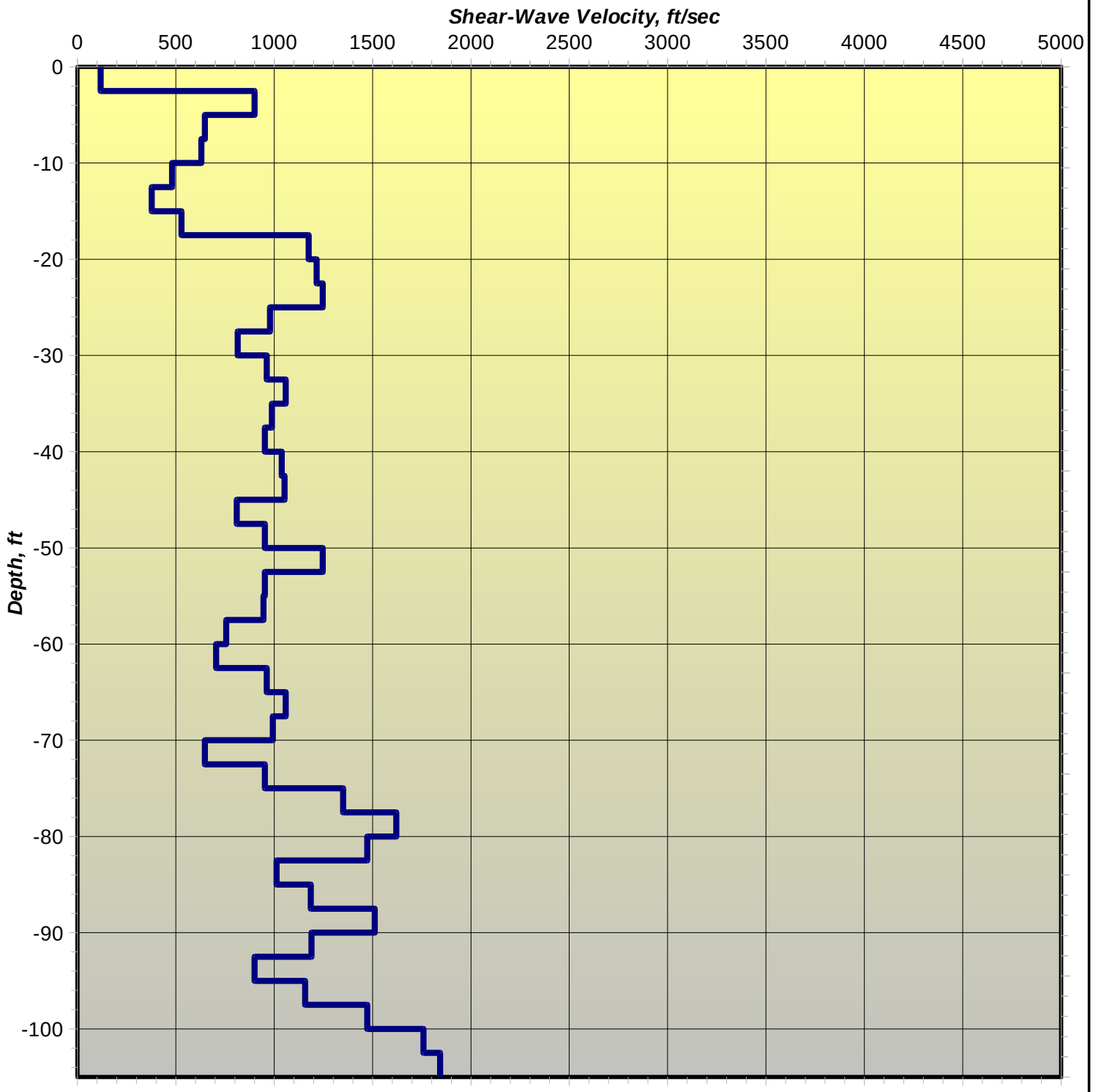
Marion County, South Carolina

Downhole Seismic
Shear-Wave Investigation

August 26, 2015

Project Manager: S. Hurd

SW-1



Average Vs (100 feet) = 775.1 ft/sec

GeoWave Solutions, Inc.
4575 Ansley Lane
Cumming, Georgia 30040
Tel: 770-886-3776
Fax: 770-886-7212
www.geowavesolutions.com

SC-41 RBO Maiden Down Swamp

F&ME Consultants

Downhole Seismic Shear-Wave Investigation

Project Manager: S. Hurd

August 26, 2015

SW-1

Depth (ft)	Vs (ft/sec)
-2.5	117.4
-5.0	900.0
-7.5	648.0
-10.0	630.1
-12.5	481.0
-15.0	377.9
-17.5	529.0
-20.0	1175.4
-22.5	1215.7
-25.0	1246.2
-27.5	979.1
-30.0	813.8
-32.5	961.9
-35.0	1058.0
-37.5	988.2
-40.0	952.9
-42.5	1037.9
-45.0	1052.5
-47.5	810.0
-50.0	952.9
-52.5	1246.2
-55.0	952.9
-57.5	945.5
-60.0	755.7
-62.5	705.4
-65.0	961.5
-67.5	1058.4
-70.0	993.2
-72.5	648.0
-75.0	952.9
-77.5	1350.0
-80.0	1620.0
-82.5	1472.7
-85.0	1012.5
-87.5	1186.2
-90.0	1511.5
-92.5	1189.0
-95.0	900.0
-97.5	1157.1
-100.0	1472.7
-102.5	1758.5
-105.0	1843.5

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SC-41 RBO Maiden Down Swamp

F&ME Consultants

Downhole Seismic Shear-Wave Investigation

Project Manager: S. Hurd

August 26, 2015

APPENDIX E

REQUEST FOR SUBSURFACE EXPLORATION AND LABORATORY TESTING

South Carolina
Department of Transportation

To:	F&ME, Inc.
From:	Pee Dee Region Geotechnical Design Section
Date:	June 8, 2015
Subject:	Request for Preliminary Subsurface Exploration and Laboratory Testing

County:	Marion
Road:	SC 41
Project ID:	P027059
Project Name:	SC 41 Bridge over Maiden Down Swamp
Location:	Mullins, SC
Charge Code:	34P027059B2.M231.2
Program Manager:	Brian Dix (803-737-1085)

Attached is one (1) set of a proposed soil boring location plan for the SC 41 Bridge over Maiden Down Swamp. The scope of work required is described herein. *The majority of the work will include five (5) Soil Test Borings (STB), two (2) electro-piezocone soundings, and one (1) shear wave velocity measurement using downhole methods.*

1. Important Site Information

The SC 41 Bridge over Maiden Down Swamp project consists of the replacement of the existing bridge over Maiden Down Swamp along SC 41. The project is located approximately 3.4 miles north of Mullins, South Carolina.

The project is still at an early stage and final horizontal and vertical alignments are not yet defined. It is our understanding that the existing bridge will be removed and the replacement bridge will be built on the same alignment.

2. Subsurface Exploration

The test hole locations are to be conducted within the existing SCDOT Right-of-Way. If the intended test hole locations impact existing foundation elements, utilities, or the safety of the drillers and/or their equipment may be compromised, the test hole may be offset as close as possible to the intended testing locations where existing foundation elements or utilities will not be damaged by drilling operations. Proposed test holes that need to be relocated shall be confirmed with the RPG-2 Geotechnical Design Section (GDS) prior to drilling the offset hole.

The STBs shall be advanced using rotary wash drilling techniques and include Standard Penetration Tests (SPT) within the STBs. SPTs shall be performed as indicated in the latest Geotechnical On-Call Consultant Agreement; on 2-foot intervals in the upper 10 feet and on 5-foot intervals thereafter to the boring termination depth. For borings B-1, B-2, B-4, and B-5, continuous sampling on 2-foot intervals shall be extended past the standard upper 10 feet until a depth of 16 feet has been reached. Make note of the depth of existing fill, if

encountered. *Please obtain the groundwater depth at the completion of drilling operations and approximately 24 hours after completing, if practical.*

Each as-drilled test location shall be located by a licensed surveyor. The station, offset, GPS coordinates (latitude and longitude) and ground elevations shall be provided for each test location. Please see Section 4.3 of the GDM for further details on subsurface exploration.

Test holes are required as described in Table 1. Please coordinate drilling operations and traffic control with the Resident Maintenance Engineer, Harold Coleman (843-431-1130). Perform five (5) STBs and two (2) CPTs at the proposed station locations as indicated in Table 1. Collect one (1) bulk sample from the auger cuttings within the upper 5 feet of boring B-2. Advance STBs to the depth indicated in Table 1. The Consultant shall contact the RPG-2 GDS if a soft (N-value <4 bpf) cohesive layer is encountered in any of the borings. In this event, up to two (2) undisturbed (UD) samples may be taken within a companion wash boring at a 1-foot offset from the STB. A shear wave velocity measurement using downhole methods is to be performed at SW-1. Boring B-4 shall be used for the downhole test. The downhole method shall be performed to obtain shear wave velocities (V_s) to a depth of at least 120 feet.

Table 1: Test Hole Locations

Road	Test Hole No.	Station[1]	Offset Distance (ft.)[1]	Depth (ft.)[2]
SC 41	B-1	684+50	6-R	20
SC 41	CPT-1	685+40	6-R	50
SC 41	B-2	685+50	6-R	80
SC 41	B-3	686+00	6-R	100
SC 41	B-4	686+50	20-R	120
SC 41	CPT-2	686+60	20-R	50
SC 41	B-5	687+50	6-R	20
SC 41	SW-1	686+50	20-R	120

1. Stations provided are existing stations. Offsets provided are from the existing centerline.
2. For borings performed through the existing embankment, depth shall be taken from existing ground surface. For borings performed through the existing bridge deck, depth shall be taken from natural ground surface/existing mud line.

Once we have received a draft version of each STB log, laboratory index testing will be requested for specified soil samples. Please refer to the following section, “Soil Laboratory Testing”, for the number of tests that may be requested.

3. Soil Laboratory Testing

The number of tests that will be requested from the STBs may consist of the following:

- Wash No. 200 = 46
- Atterberg Limits = 46
- Natural Moisture Content = 46
- Triaxial Shear Test (Consolidated Undrained with pore pressure measurement) = 3
- Unconfined Compression Strength of Cohesive Soil = 2
- Consolidation Test = 2
- Organic Content = 3
- Corrosion Series (pH, Resistivity, Chloride, Sulfate) = 1
- Full Grain Size Analysis with Wash #200 = 6

Please e-mail the draft logs for the STBs and data files for the CPTs to Nathalia R. Chandler as soon as they are available. Soil samples that are to be tested will be chosen upon receiving the draft logs. Once soil laboratory testing is complete, please e-mail an electronic copy and forward a hard copy of the final data report to the RPG-2 GDS. If you require any additional information, feel free to contact Nathalia R. Chandler at 803-737-2278 or Joshua Meetze at 803-737-9967.

Joshua Meetze

Joshua H. Meetze, E.I.T.
Geotechnical Professional

South Carolina
Department of Transportation

Date: August 21, 2015

To: Jason Stewart, P.E.

From: Pee Dee Geotechnical Design Section

Re: Soil Laboratory Testing

Soil laboratory testing of soil samples is requested for the following project:

County:	Marion
Road:	SC 41
Project ID:	P027059
Project Name:	SC 41 Bridge over Maiden Down Swamp
Location:	Mullins, SC
Charge Code:	34P027059B2.M231.2
Program Manager:	Brian Dix (803-737-1085)

For the following soil test borings, please perform the index tests indicated in the table below:

Boring Number	Sample Depth (ft)	Sample Number	Wash #200	Grain Size With Wash #200	Atterberg Limits	Natural Moisture Content
B-1	4.0 – 6.0	SS-3	X		X	X
	12.0 – 14.0	SS-7	X		X	X
	14.0 – 16.0	SS-8	X			X
B-2	4.0 – 6.0	SS-3	X		X	X
	8.0 – 10.0	SS-5	X		X	X
	10.0 – 12.0	SS-6	X		X	X
	12.0 – 14.0	SS-7	X		X	X
	23.5 – 25.0	SS-10	X			X
	38.5 – 40.0	SS-13	X		X	X
	63.5 – 65.0	SS-18	X		X	X
B-3	17.0 – 19.0	SS-1		X		X
	19.0 – 21.0	SS-2		X		X
	21.0 – 23.0	SS-3		X		X
	30.5 – 32.0	SS-6	X		X	X
	50.5 – 52.0	SS-10	X			X
	60.5 – 62.0	SS-12	X		X	X
B-4	6.0 – 8.0	SS-4	X		X	X
	8.0 – 10.0	SS-5	X		X	X
	10.0 – 12.0	SS-6	X		X	X
	12.0 – 14.0	SS-7	X		X	X
	18.5 – 20.0	SS-9	X			X
	33.5 – 35.0	SS-12	X		X	X
	63.5 – 65.0	SS-18	X		X	X
B-5	2.0 – 4.0	SS-2	X		X	X
	8.0 – 10.0	SS-5	X		X	X
	10.0 – 12.0	SS-6	X		X	X
	12.0 – 14.0	SS-7	X		X	X
	18.5 – 20.0	SS-9	X		X	X

In addition to the requested index tests listed in the above table, please perform the following laboratory test:

Boring Number	Sample Depth (ft)	Sample Number	Organic Content
B-1	14.0 – 16.0	SS-8	X
B-2	12.0 – 14.0	SS-7	X
B-4	12.0 – 14.0	SS-7	X

For the bulk sample that was obtained from Boring B-2 please perform the following tests:

- Moisture-density relationship determination (Standard Proctor)
- Moisture-plasticity relationship determination (Atterberg Limits)
- Grain-size distribution with Hydrometer
- Natural moisture content
- Triaxial compression on specimens remolded to 95% of the standard Proctor value (Consolidated undrained with pore pressure measurement)

Once the soil index testing is completed, please update the soil test boring logs. If you require any additional information, or if you have any questions or comments, feel free to contact me at (803) 737-9967.

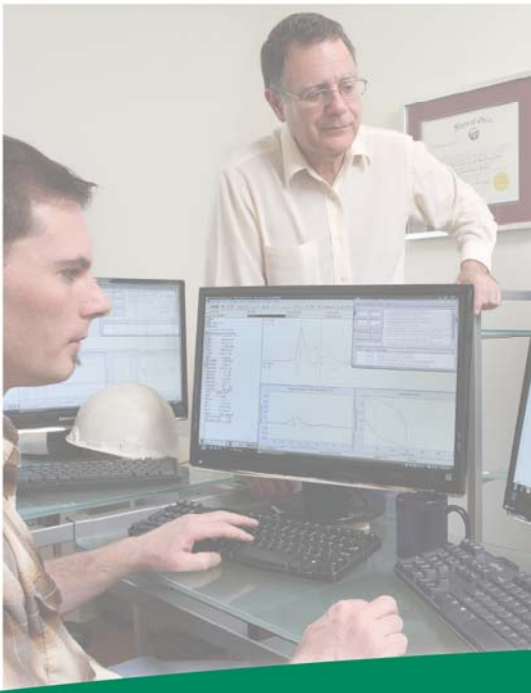
Requested by:

Joshua Meetze

Joshua Meetze, E.I.T.
Geotechnical Professional

APPENDIX F

SPT HAMMER CALIBRATION



GRL engineers, inc.

Dynamic Measurements and Analyses

Job No. 1159002-1

Report on: Standard Penetration Test Energy Measurements
Iron Station, NC

Prepared for Ameridrill

By Scott Webster, P.E. and Karen Webster

January 16, 2014

January 16, 2015

Ms. Debra Meatyard
Ameridrill
P.O. Box 2755
Huntersville, NC 28070

Re: Standard Penetration Test Energy Measurements
Iron Station, NC
GRL Job No. 159002-1

Dear Ms. Meatyard,

This report presents results of energy measurements obtained on January 9, 2015 during Standard Penetration Test (SPT) sampling. Three automatic hammers were tested. Two of the hammers were mounted on CME 550X ATV drill rigs and one of the hammers was mounted on a CME 55 truck drill rig. All dynamic tests were performed on AWJ drill rods. GRL Engineers, Inc. obtained the dynamic measurements with an instrumented AWJ subsection and a Model PAX Pile Driving Analyzer®. This report describes the testing procedures and summarizes the test results. Appendix A describes our measurement and analysis methods, Appendix B contains calibration information for the gages and equipment used, and Appendix C is a summary of the field data.

PURPOSE AND SCOPE OF WORK

At the request of Ameridrill, GRL conducted SPT energy measurements at a site in Iron Station, NC. The SPT energy measurements were obtained in accordance with ASTM D4633-10. Specifically, we recorded SPT energy measurements at 5-foot sample intervals between approximately 23.5 and 45.0 to 50.0 feet below the existing ground surface. In general, blank drilling was performed to a depth of approximately 23.5 feet where the first sample was collected. SPT samples were then collected continuously until the boring depth of approximately 45.0 or 50.0 feet was reached.

EQUIPMENT

Drilling and SPT Hammer Equipment

CME 550X (Serial # 269553)

SPT energy measurements were made on an automatic hammer mounted on a CME 550X ATV drill rig operated by Mr. Don Harris. The drilling method used to advance the boring was the hollow stem auger method. Energy measurements for this drill rig were collected at a dummy borehole location to a boring termination depth of 45.0 feet below grade. SPT energy measurement tests were performed at 5-foot sampling penetrations beginning at 23.5 feet. A total of five energy measurement events were monitored for this drill rig.

CME 550X (Serial # 249533)

SPT energy measurements were made on an automatic hammer mounted on a CME 550X ATV drill rig operated by Mr. Brian Boyce. The drilling method used to advance the boring was the hollow stem auger method. Energy measurements for this drill rig were collected at a dummy borehole location to a boring termination depth of 45.0 feet below grade. SPT energy measurement tests were performed at 5-foot sampling penetrations beginning at 23.5 feet. A total of five energy measurement events were monitored for this drill rig.

CME 55 (Serial # 306515)

SPT energy measurements were made on an automatic hammer mounted on a CME 55 truck drill rig operated by Mr. Chris Meatyard. The drilling method used to advance the boring was the hollow stem auger method. Energy measurements for this drill rig were collected at a dummy borehole location to a boring termination depth of 50.0 feet below grade. SPT energy measurement tests were performed at 5-foot sampling penetrations beginning at 23.5 feet. A total of six energy measurement events were monitored for this drill rig.

Instrumentation

A Model PAX Pile Driving Analyzer (PDA) data acquisition system (SN# 3797L) was used to collect and process the dynamic measurements of force and velocity. The data was collected using a two-foot long section of AWJ rod subsection (SN# 168AWJ) with a cross sectional area of 1.18 square inches and instrumented with two full bridge foil resistance strain gages and two piezoresistive accelerometers mounted in the midpoint location of the instrumented rod.

Analog signals from the strain gages and accelerometers were conditioned, digitized, stored and processed with the PDA. The sampling frequency used during the SPT testing was 50 kHz. Selected output from the PDA for each recorded impact included the energy transfer ratio (ETR), maximum rod top velocity (VMX), maximum energy transfer (EFV), maximum rod top force (FMX), and the hammer operating rate (BPM).

MEASUREMENTS AND CALCULATIONS

FV Method (EFV)

Energy transfer to the PDA gage location, EFV, was computed by the PDA using force, F(t), and velocity, v(t), records as follows:

$$EFV = \int_a^b F(t) \cdot v(t) dt$$

The time "a" corresponds to the start of the record when the energy transfer begins, and "b" is the time at which energy transferred to the rod reaches a maximum value. The FV Method is currently recognized in ASTM D4633-10, and is the theoretically correct result; therefore, no other energy calculation methods are reported.

Corrected SPT number (N_{60})

While the primary purpose of SPT energy testing is to calculate the maximum transferred energy (ETR) of each hammer blow, the overall average EFV value can be used to calculate the corrected SPT number (N_{60}). To adjust the SPT N-values for hammer performance, the following correction as suggested by Seed for N-value adjustment to 60% transfer efficiency (e.g. 210 ft-pounds) was used:

$$N_{60} = \left(\frac{E_m}{210} \right) N_m$$

Where:

N_{60} = Corrected N-value
E_m = overall average measured energy transfer (EFV)
N_m =number of blows for last 12 inches of sampler penetration

A general introduction to dynamic SPT testing methods is included in this report as Appendix A. References for more detailed descriptions of our testing and analysis methods are available upon request.

Any cross-sectional area difference between the GRL rod subsection and the drill rods, any loose connections or changes in area at section joints, or any cross-sectional area differences between the individual drill rod sections will result in stress wave reflections that can potentially influence the energy transfer. The EFV transferred energy calculation method, utilizing both force and velocity records, is theoretically correct and gives energy transfer results that are not adversely affected by cross-sectional area changes or loose connectors. The EFV results are included in Appendix C for all records collected and accepted after checking them for consistency.

RESULTS

Upon return to the office, the records collected by the PDA were checked for consistency and accuracy. For example, records from very weak startup or final impacts were not included in average results. Appendix C contains a representative plot of force and normalized velocity versus time, as well as plots and tables of PDA results for all hammer blows at each dynamically monitored sampling depth. The results include the EFV (transferred energy by the FV method, as recommended by ASTM D4633-10), ETR (energy transfer efficiency for the EFV method), BPM (hammer operating rate), DMX (maximum rod displacement), and VMX (maximum rod top velocity). The plots show

each calculated PDA result versus split-spoon penetration, while the tables show statistical summaries for each 6 inch increment. At the end of each table is a statistical evaluation of the results which include the average and standard deviation of the entire measurement sample.

The table below and Table 1 summarize the average transferred energy values calculated by the EFV method. The records consist of averaged hammer blows from the last 12 inches (i.e. N value) at each dynamically monitored sampling depth. The "energy transfer ratio" (ETR) is defined as the ratio of maximum transferred energy EFV divided by the theoretical hammer potential energy of 350 ft-lbs (i.e., computed per the 140 lb SPT hammer and the standard 30 inch drop as specified by ASTM D1586-08). The average hammer operating rate is reported in blows per minute (BPM). A summary of the dynamic measurements of the energy transfer to the drill rods using the EFV equation is provided in the table below.

Drill Rig	Avg. EFV (ft-lbs)	Avg ETR (%)	Range of EFV (ft-lbs)	Range of ETR (%)
CME 550 269553	258	74	245 – 268	70 - 77
CME 550 249533	291	83	289 – 296	83 - 85
CME 55 306515	302	87	296 – 316	85 - 90

CONCLUSIONS

Based upon the dynamic test data obtained, the following conclusions are presented:

1. Loose connections in the drill string were sometimes observed in the force and velocity records. However, energy transfer values calculated using the EFV equation are not adversely affected by the connectors and therefore are considered a better indication of transferred energy.

2. Dynamic measurements of the transferred energy to the drill rods using the EFV equation ranged from 245 to 268 ft-lbs for the CME 550X 269553 drill rig. This corresponds to a transfer efficiency ranging from 70 to 77% of the SPT hammer energy of 350 ft-lbs.

3. Dynamic measurements of the transferred energy to the drill rods using the EFV equation ranged from 289 to 296 ft-lbs for the CME 550X 249533 drill rig. This corresponds to a transfer efficiency ranging from 83 to 85% of the SPT hammer energy of 350 ft-lbs.

4. Dynamic measurements of the transferred energy to the drill rods using the EFV equation ranged from 296 to 316 ft-lbs for the CME 55 306515 drill rig. This corresponds to a transfer efficiency ranging from 85 to 90% of the SPT hammer energy of 350 ft-lbs.

Please review both ASTM D4633-10 and ASTM D1586-08 prior to applying these test results. The energy calibrations reported herein are valid for the same hammer/drill rig, with the same drill operator, same anvil dimensions, and same drilling methods.

We appreciate the opportunity to be of assistance to you on this project. Please contact our office should you have any questions regarding this submittal, require additional information, or if we may be of further service.

Sincerely,

GRL Engineers, Inc.

Karen Webster

Karen Webster

Scott D. Webster

Scott Webster, P.E.

SDW:KW:dms

TABLE 1: Summary of SPT Energy Measurements
Ameridrill SPT Calibration January 9, 2015
CME 550X ATV Serial # 269553

Soil Sample	Reported Sample Depth (feet)	Reported Rod Length (feet)	Reported Blow Count (blows/6")	SPT Field N Value	Avg. Energy Transferred FV Method (ft-lbs)	Energy Transfer Efficiency1 (%)	Blow per Minute (bpm)	N_{60}
SS-1	23.5 - 25.0	29.0	5,6,7	13	245	70	46	15
SS-2	28.5 - 30.0	34.0	3,5,6	11	257	73	48	13
SS-3	33.5 - 35.0	39.0	4,4,5	9	260	74	46	11
SS-4	38.5 - 40.0	44.0	2,5,9	14	268	77	49	18
SS-5	43.5 - 45.0	49.0	2,3,5	8	261	75	49	10
Average(2)					**258**	**74**	**48**	
Standard Dev.(2)					**8**	**3**	**2**	

Notes: 1 - Energy transfer efficiency is the energy calculated by the FV method divided by the SPT hammer potential energy of 140 lbs times 2.5 foot drop height or 350 ft-lbs.

2 - Average and standard deviation are calculated using averaged data from SPT hammer blows from the last two six inch increments (i.e. N value) from all sampling depths tested.

TABLE 2: Summary of SPT Energy Measurements
Ameridrill SPT Calibration January 9, 2015
CME 550X ATV Serial # 249533

Soil Sample	Reported Sample Depth (feet)	Reported Rod Length (feet)	Reported Blow Count (blows/6")	SPT Field N Value	Avg. Energy Transferred FV Method (ft-lbs)	Energy Transfer Efficiency1 (%)	Blow per Minute (bpm)	N_{60}
SS-1	23.5 - 25.0	29.0	7,8,11	19	291	83	51	26
SS-2	28.5 - 30.0	34.0	3,6,9	15	289	83	52	21
SS-3	33.5 - 35.0	39.0	3,6,7	13	290	83	51	18
SS-4	38.5 - 40.0	44.0	3,3,4	7	290	83	52	10
SS-5	43.5 - 45.0	49.0	3,5,6	11	296	85	50	16
Average(2)					**291**	**83**	**51**	
Standard Dev.(2)					**3**	**1**	**1**	

Notes: 1 - Energy transfer efficiency is the energy calculated by the FV method divided by the SPT hammer potential energy of 140 lbs times 2.5 foot drop height or 350 ft-lbs.

2 - Average and standard deviation are calculated using averaged data from SPT hammer blows from the last two six inch increments (i.e. N value) from all sampling depths tested.

TABLE 3: Summary of SPT Energy Measurements
Ameridrill SPT Calibration January 9, 2015
CME 55 Truck Serial # 306515

Soil Sample	Reported Sample Depth (feet)	Reported Rod Length (feet)	Reported Blow Count (blows/6")	SPT Field N Value	Avg. Energy Transferred FV Method (ft-lbs)	Energy Transfer Efficiency1 (%)	Blow per Minute (bpm)	N_{60}
SS-1	23.5 - 25.0	29.0	3,5,6	11	296	85	55	16
SS-2	28.5 - 30.0	34.0	4,6,7	13	301	86	54	19
SS-3	33.5 - 35.0	39.0	1,3,5	8	300	86	53	11
SS-4	38.5 - 40.0	44.0	1,3,5	8	304	87	56	12
SS-5	43.5 - 45.0	49.0	3,5,5	10	296	85	54	14
SS-5	48.5 - 50.0	54.0	3,3,6	9	316	90	56	14
Average(2)					**302**	**87**	**55**	
Standard Dev.(2)					**7**	**2**	**1**	

Notes: 1 - Energy transfer efficiency is the energy calculated by the FV method divided by the SPT hammer potential energy of 140 lbs times 2.5 foot drop height or 350 ft-lbs.

2 - Average and standard deviation are calculated using averaged data from SPT hammer blows from the last two six inch increments (i.e. N value) from all sampling depths tested.