REPORT OF GEOTECHNICAL BRIDGE INVESTIGATION

SR 87 OVER CLEAR CREEK
CONNECTOR BRIDGE PD&E STUDY
SANTA ROSA COUNTY, FLORIDA
FPID: 416748-3-22-01

Prepared For:

FLORIDA DEPARTMENT OF TRANSPORTATION
DISTRICT THREE
1074 HIGHWAY 90 EAST
CHIPLEY, FLORIDA 32428

Prepared By:

ENVIRONMENTAL AND GEOTECHNICAL SPECIALISTS, INC.
104 NORTH MAGNOLIA DRIVE
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December 2012
70-11-12-01

EGS

ENVIRONMENTAL AND GEOTECHNICAL SPECIALISTS, INC.

December 14, 2012

EGS File Number: 70-11-12-01

Florida Department of Transportation District III.
1074 Highway 90 East
Chipley, Florida 32428

ATTN: David Whittington
Contract Manager

SUBJECT: Report of Geotechnical Bridge Investigation
SR 87 over Clear Creek Connector Bridge PD&E Study
Santa Rosa County, Florida
FPID: 416748-3-22-01

Dear David:

Attached is a copy of the Report of Geotechnical Investigation for the above referenced project. Presented in this Report is a summary of the geotechnical investigation and subsurface materials encountered, environmental classification of the subsoils, preliminary geotechnical foundation design parameters, and foundation recommendations.

Environmental and Geotechnical Specialists, Inc. (**EGS**) appreciates the opportunity to be of service on this project. If you have any questions concerning the enclosed Report, please do not hesitate to call.

Sincerely,

Environmental and Geotechnical Specialists, Inc.
Florida Certificate of Engineering Authorization 6222

12/14/12

Derwood C. Sheppard, Jr., P.E.
Consulting Geotechnical Engineer
FL P.E. No. 69228

Enclosure

104 NORTH MAGNOLIA DRIVE / TALLAHASSEE, FL 32301 / (850) 386-1253 / FAX (850) 385-8050

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1.0 INTRODUCTION

Environmental and Geotechnical Specialists, Inc. (**EGS**) has completed the Preliminary Geotechnical Bridge Investigation associated with the State Road 87 Connector Project Development and Environmental (**PD&E**) Study. The intent of this investigation is to provide data for a preliminary development of the proposed SR 87 over Clear Creek Bridge. This Report contains a summary of the geotechnical investigation and subsurface materials encountered, the subsoil parameters needed for a scour analysis, preliminary geotechnical foundation design parameters, and foundation recommendations.

2.0 GENERAL SITE CONDITIONS

This investigation is part of the SR 87 Connector **PD&E** project which is proposed to provide a bypass for SR 87 around the city of Milton, Florida. The proposed bridge location is located approximately three (3) miles northeast of the city of Milton in the central portion of Santa Rosa County, Florida. A Project Location Map has been provided as **Figure 1**.

A copy of the United States Geological Survey (**USGS**) Topographic Map of the project area has been included as **Figure 2**. As can be seen in **Figure 2**, Clear Creek is surrounded by low lying wetlands and flows south where it discharges into the Blackwater River approximately one and one-half (1½) miles to the south.

The general existing site conditions are shown on an aerial photograph of the project location included as **Figure 3**, which also shows the location of the soil boring installed for this investigation. The site is surrounded by heavily forested wetland areas consisting of mature hardwoods, pines, and heavy underbrush. Furthermore, a long range power transmission corridor is located directly south of the proposed bridge alignment.

3.0 PROPOSED STRUCTURE

The existing SR 87 roadway is a four (4) lane rural section, which receives moderate to high volumes of traffic and is a primary north-south corridor. To divert traffic around the city of Milton the corridor will cross the Blackwater River and Clear Creek watershed basins. **EGS** understands the **PD&E** Study is considering a new multi-span concrete bridge structure. Although the proposed structure has not yet been designed, it is likely that the bridge will be founded on pile supported bent caps or piers. In addition, the Clear Creek channel may be realigned at the bridge crossing.

4.0 SUBSURFACE INVESTIGATION

The subsurface investigation for this project was conducted by **EGS** during the month of December 2012. Holt Jones, E.I. of **EGS** served as the field/staff engineer, and Derwood Sheppard, P.E. served as the Geotechnical Project Engineer.

One (1) soil boring was installed for this investigation, and has been labeled as Soil Boring **CC-1**. The boring number, depth, and State Plane coordinates (i.e. northing/easting) are provided in **TABLE 1**. The soil boring for this investigation was installed as close as possible to the center of the proposed bridge location provided by Metric Engineering, Inc (**Metric**). However, due to wet site conditions, heavy vegetation, and very soft saturated soils that prevented equipment access, the soil boring was offset.

In order to evaluate the relative strength and uniformity of the subsurface materials, Standard Penetration Tests (**SPT**) were conducted on two and one-half (2 ½) feet intervals from the ground surface to the boring termination depth. All **SPT** samples were collected using an automatic hammer in accordance with ASTM D1586.

The laboratory testing included water contents, Atterberg Limits, and grain-size distributions. The subsurface soils were classified with respect to both the Unified Soil Classification System (**UNIFIED**) and the American Association of State Highway and Transportation Officials (**AASHTO**) Soil Classification System.

A summary of the field and laboratory testing can be seen on the Report of Core Boring Sheet provided as **APPENDIX A**. Copies of the Soil Boring Logs and Soil Classification Data have been provided in **APPENDICES B** and **C**, respectively.

5.0 SUBSURFACE CONDITIONS

5.1 Soils

The "general" subsurface soil conditions encountered, as can be seen on the Report of Core Boring Plan Sheet provided in **APPENDIX A**, are as follows:

Soil Boring B-1

- 0.0 - 25.0 feet – Loose to Medium Dense Medium to Silty Fine Sand (**SM**)
- 25.0 - 33.0 feet – Medium Dense to Dense Silty Medium Sand with Gravel (**SM**)
- 33.0 - 40.0 feet – Dense Fine Sand (**SP-SM**)
- 40.0 - 75.0 feet – Medium Dense Fine to Silty Fine Sand (**SP-SM** to **SM**)
- 75.0 - 100.0 feet – Very Dense Fine to Silty Fine Sand (**SP-SM** to **SM**)
- 100.0 - 110.0 feet – Medium Dense Silty Fine Sand (**SM**)

Significant gravel was encountered in the sandy soils between a depth of 25.0 feet to 33.0 feet below the existing ground surface. This gravel layer in addition to the Dense to Very Dense Sands encountered throughout the soil boring may create difficult driving conditions for high displacement piles such as square prestressed concrete. Additionally, based on field observations and knowledge of the area, it is likely that highly organic soils or "**MUCK**" may exist to depths up to approximately 10 feet below the ground surface near Clear Creek.

5.2 Groundwater Conditions

At the location of the soil borings installed for this investigation, **EGS** encountered ground water at a depth of seven and one-half (7 ½) feet below the existing ground surface. **EGS estimates** that the "normal" seasonal high groundwater is at or above the existing ground surface throughout the surrounding area for much of the year.

5.3 Environmental Classification

One (1) soil sample was collected from soil boring **CC-1** and one (1) water sample was collected from Clear Creek to analyze their aggressiveness with respect to corrosion. The results of the corrosivity tests are summarized in **TABLE 2**. As can be seen in **TABLE 2**, the substructure environmental classification of this site is **EXTREMELY AGGRESSIVE** with respect to the corrosion of steel and **MODERATELY AGGRESSIVE** with respect to the corrosion of concrete.

5.4 Scour Considerations

To assist with the evaluation of the scourability of the channel sediments, **EGS** conducted laboratory tests on representative samples of the soil collected from Soil Boring **CC-1**. This testing included grain-size distribution determinations. Copies of the grain-size distribution curves have been provided as **APPENDIX D** along with the pertinent grain-size parameters needed for a scour analysis summarized in **TABLE 3**.

6.0 FOUNDATION OPTIONS

There are generally two (2) basic foundation options available for this type of project. One (1) option would be a shallow foundation option which would distribute the bridge loads to the near surface soils, provided that scour is insignificant or can be mitigated. However, the relatively loose nature of the surficial soils as well as potential for scour around and beneath a shallow foundation makes spread footings unacceptable for use with this bridge.

The other basic type of foundation is a deep foundation structure that would distribute the structural loads below any potential scourable or loose soils and found the bridge structure on underlying dense sands. For this type of project, a deep foundation would consist of either drilled shafts or driven piles.

6.1 Drilled Shafts

Drilled shafts are used when high axial loads and/or lateral capacities are needed or the subsurface materials make pile installation difficult or expensive. A drilled shaft can be installed through the subsurface materials to rest, or be "socketed," into limestone. However, a limestone bearing stratum was not encountered within 110 feet of the existing ground surface nor are the axial and lateral loads for this bridge expected to be sufficiently high to warrant the additional costs associated with a drilled shaft. Therefore, **EGS does not believe that drilled shafts are a cost-effective foundation option for this project**.

6.2 Driven Piles

Driven piles generally consist of either square prestressed concrete or steel piling for a structure of this type. Precast concrete piles are a widely used foundation option by the **FDOT** and normally more cost-effective than steel pipe or steel H-piles. However, *dense sands and gravel encountered below a depth of 25 feet may cause difficult driving conditions; therefore, preforming or jetting may be required to install concrete piles to the required tip elevations.*

Steel piles, consisting of either open-ended pipe piles or H-piles, are frequently used throughout north Florida where the site conditions are highly variable or prohibit the use of high displacement concrete piles. Driven open-ended pipe piles and H-piles produce significantly less vibrations than concrete piles, and can be more easily adapted to variable subsurface conditions because of the ease and reliability of pile splicing. However, steel pilings are generally more expensive than concrete piles driven to the same capacity.

Steel H-piles have a considerably lower load carrying capacity than either open-ended pipe piles or displacement piles. It is likely that an H-pile would need to be driven significantly deeper than pipe piles or prestressed concrete piles to achieve comparable load capacities. Therefore, **EGS does not believe that steel H-piles are cost-effective for this project**.

6.3 Recommended Foundation

Based on the soil conditions encountered in this preliminary investigation, **EGS believes** that a deep foundation bridge with square prestressed concrete piles will be the most appropriate and cost-effective foundation option.

7.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

7.1 Geotechnical Design Parameters

EGS developed Preliminary Geotechnical Design Parameters to facilitate in the design of a driven pile foundation. The Geotechnical Design Parameters calculated for this Geotechnical Investigation are provided in **TABLE 4** and based on the Design Figure provided as **Figure D-1**. Sample calculations used to develop **TABLE 4** are provided in **APPENDIX E**.

7.2 Driven Pile Axial Capacities

For the purposes of this Preliminary Geotechnical Investigation and for comparison, **EGS** has provided an Axial Capacity analysis for HP 14X73 H-piles, 20-inch "open-ended" steel pipe piles, 24-inch "open-ended" steel pipe piles, 18-inch square concrete, and 24-inch square concrete driven piles. The axial capacities were determined using the Computer Program **FB-Deep** and the **SPT N**-Values obtained during this subsurface investigation.

Based on the results from **FB-Deep**, **EGS** prepared graphs which include the Estimated Davisson Capacity (Nominal Bearing Resistance, **NBR**) versus embedment depth for each of the pile sizes/types. These graphs are provided as **Figure 4**. The **FB-Deep** computer "outputs" are included in **APPENDIX F**.

It should be noted that the mobilized end bearing predicted for both 20-inch and 24-inch "open-ended" steel pipe piles using **FB-Deep** has been neglected. This is believed to be reasonable based on data from several **FDOT** projects where "open-ended" pipe piles have been driven and dynamically tested.

7.3 Driven Pile Lateral Capacities

EGS did not provide Lateral Load Capacities for the pile sizes included in this Report. **EGS understands** that the project's Structural Engineer will be performing the lateral stability analysis using the preliminary Geotechnical Design Parameters included in **TABLE 4**.

7.4 Downdrag

EGS does not believe that significant downdrag will be applied to the abutment piles for this project. This is due to the sandy nature of the soils encountered; and therefore, no significant long-term settlement would be anticipated.

8.0 CLOSURE

The data and results presented in this Geotechnical Investigation Report are intended for the use of the **Florida Department of Transportation** for the preliminary design of the SR 87 Connector over Clear Creek **PD&E** Study, as identified herein. This Report is not intended for any other use and will likely not be applicable. The data and recommendations presented in this Report are based on the soil borings installed at the specific locations and depths noted. Subsurface conditions at other locations may vary significantly from those presented herein. Should data become available which is different from the data presented herein, **Environmental and Geotechnical Specialists, Inc.** requests the opportunity to review the data and make any modifications to the design recommendations that may be appropriate.

9.0 SIGNATURE

ENVIRONMENTAL AND GEOTECHNICAL SPECIALISTS, INC.
Florida Certification of Engineering Authorization Number: 6222

12/14/12

Derwood C. Sheppard, Jr., P.E.
Geotechnical Project Engineer
FL PE Number 69228

TABLES

TABLE 1
SOIL BORING LOCATION DATA
SR 87 OVER CLEAR CREEK
CONNECTOR BRIDGE PD&E STUDY
SANTA ROSA COUNTY, FLORIDA

BORING NUMBER	BORING DEPTH [1] (FEET)	ELEVATION OF GROUND SURFACE [2] (FEET)	STATE PLANE COORDINATES		GLOBAL POSITIONING SATELLITE (GPS) COORDINATES SYSTEM			
			NORTHING	EASTING	LATITUDE		LONGITUDE	
					DEG (º)	MIN (')	DEG (º)	MIN (')
CC-1	110.0	N/A	615719	1181187	30	40.155	87	0.260

NOTES: 1. DEPTH IS BELOW EXISTING GROUND SURFACE.
2. ELEVATIONS WERE NOT AVAILABLE AT THE TIME OF THIS PRELIMINARY INVESTIGATION.

TABLE 2
ENVIRONMENTAL CLASSIFICATION DATA
SR 87 OVER CLEAR CREEK
CONNECTOR BRIDGE PD&E STUDY
SANTA ROSA COUNTY, FLORIDA

MATERIAL	LOCATION	pH	RESISTIVITY (OHM-CM)	SULFATES (PPM)	CHLORIDES (PPM)	CLASSIFICATION	
						STEEL	CONCRETE
SOIL	CC-1 7.5' - 9.0'	7.3	7,600	51	180	**SLIGHTLY AGGRESSIVE**	**SLIGHTLY AGGRESSIVE**
WATER	CLEAR CREEK	5.5	42,000	< 1	41	**EXTREMELY AGGRESSIVE**	**MODERATELY AGGRESSIVE**
SUBSTRUCTURE						**EXTREMELY AGGRESSIVE**	**MODERATELY AGGRESSIVE**
SUPERSTRUCTURE						**SLIGHTLY AGGRESSIVE**	**SLIGHTLY AGGRESSIVE**

TABLE 3
GRAIN-SIZE DATA FOR SCOUR CONSIDERATION
SR 87 OVER CLEAR CREEK
CONNECTOR BRIDGE PD&E STUDY
SANTA ROSA COUNTY, FLORIDA

DEPTH BELOW GROUND SURFACE (FEET)	GRAIN-SIZE PARAMETER	RECOMMENDED VALUE	MATERIAL CLASSIFICATION
0.0 - 7.5	D_{10}	0.03	SM / A-2-4 (LOOSE)
	D_{50}	0.17	
	D_{60}	0.21	
	D_{85}	0.43	
	C_u	6.80	
7.5 - 25.0	D_{10}	0.04	SM / A-2-4 (MEDIUM DENSE)
	D_{50}	0.30	
	D_{60}	0.36	
	D_{85}	0.52	
	C_u	9.00	

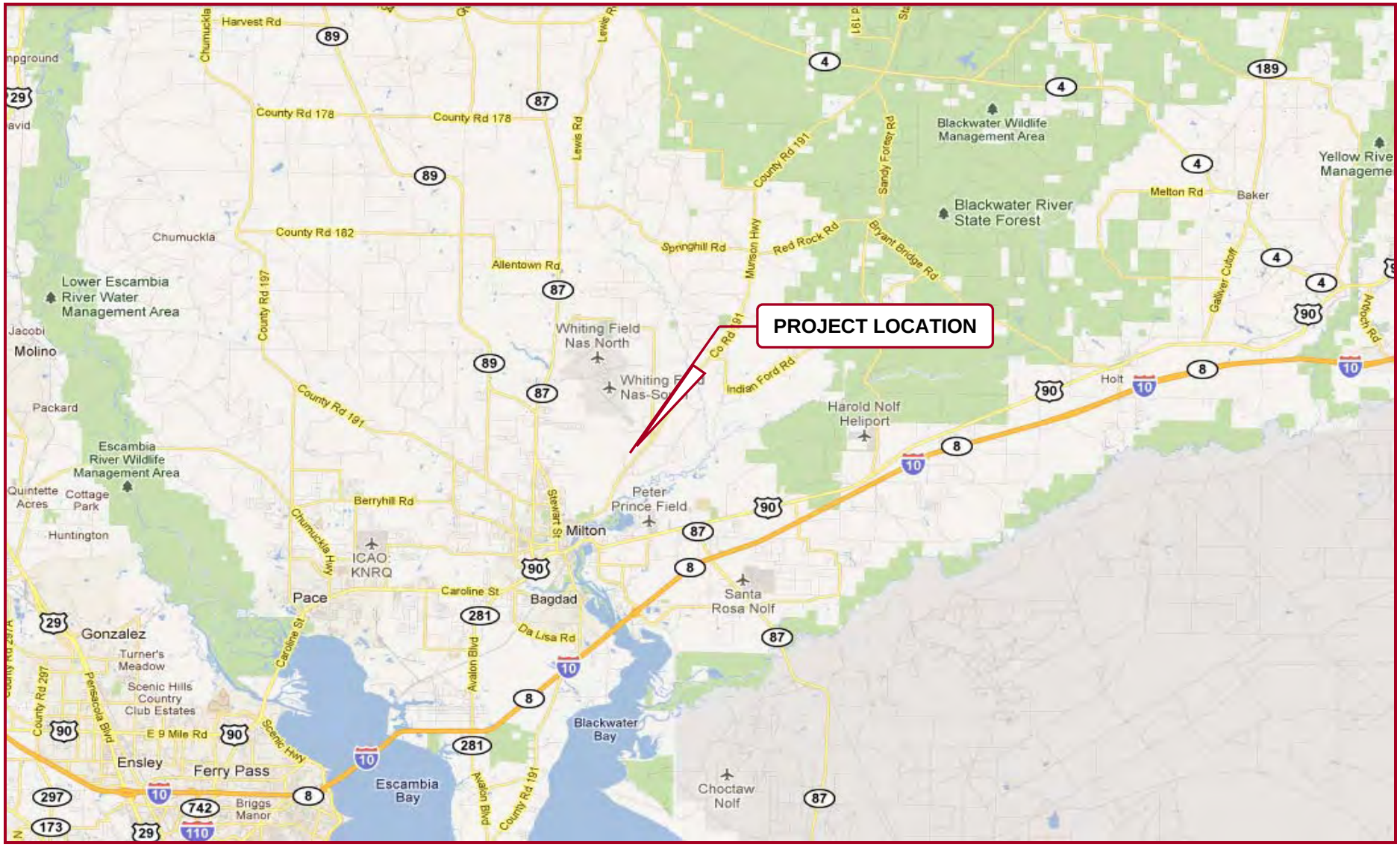
TABLE 4
GEOTECHNICAL DESIGN PARAMETERS
SR 87 OVER CLEAR CREEK
CONNECTOR BRIDGE PD&E STUDY
SANTA ROSA COUNTY, FLORIDA
SOIL BORING: CC-1

FOUNDATION TYPE	DRIVEN
SIZE (in)	24
BASE AREA (ft^2)	4.0
GROUND SURFACE ELEVATION (ft)	N/A
GROUND WATER TABLE DEPTH (ft)	0.0

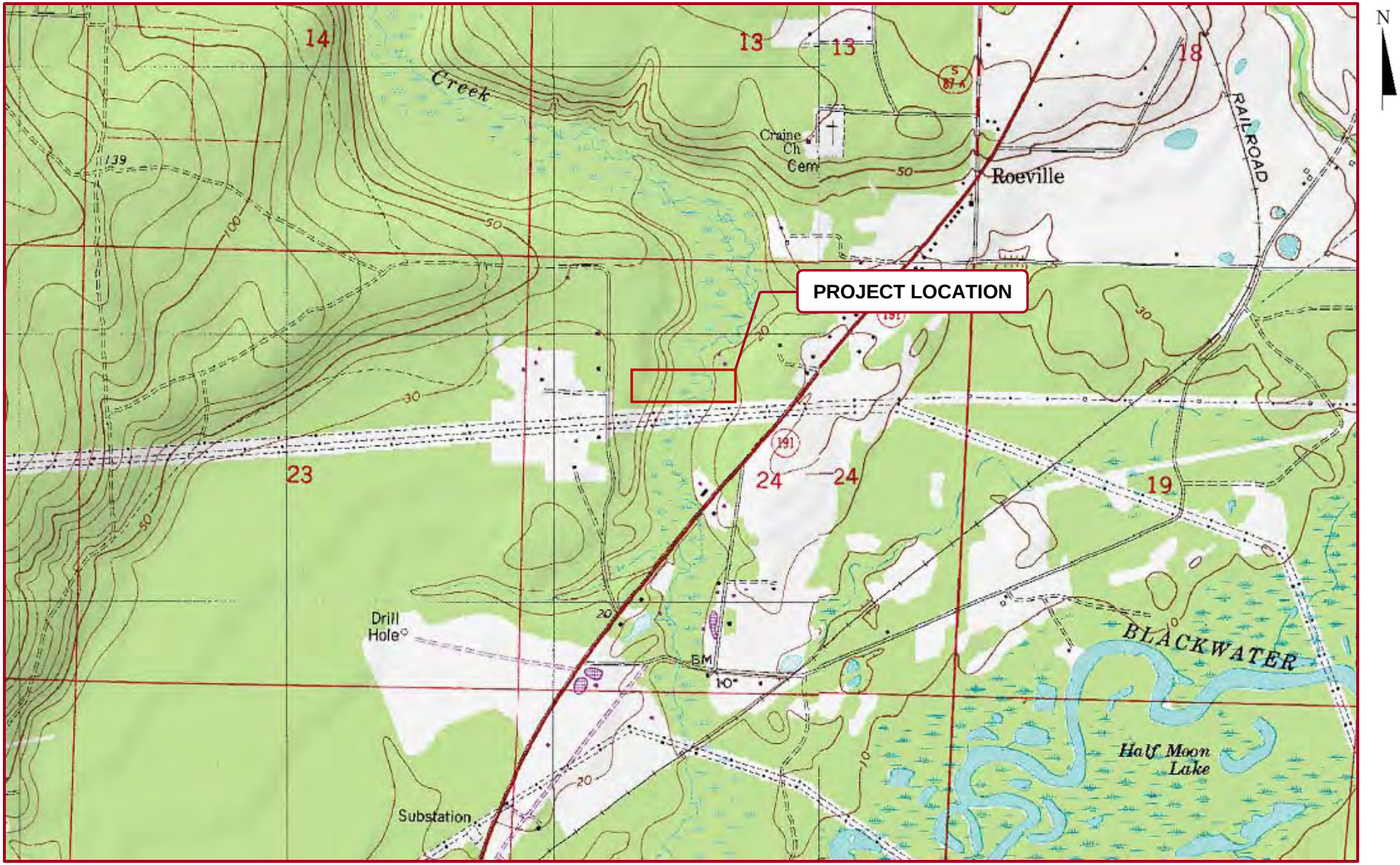
LAYER NO.	1	2	3	4	5	6
SOIL DESCRIPTION	MEDIUM TO FINE SAND (SM)	SILTY MEDIUM SAND WITH GRAVEL (SM)	FINE SAND (SP-SM)	FINE TO SILTY FINE SAND (SP-SM TO SM)	FINE TO SILTY FINE SAND (SP-SM TO SM)	SILTY FINE SAND (SM)
SOIL TYPE	COHESIONLESS	COHESIONLESS	COHESIONLESS	COHESIONLESS	COHESIONLESS	COHESIONLESS
TOP OF LAYER DEPTH (ft)	0.0	25.0	32.5	40.0	75.0	100.0
BOTTOM OF LAYER DEPTH (ft)	25.0	32.5	40.0	75.0	100.0	110.0
AVERAGE SPT N-VALUE (blows/ft)	15	19	46	16	62	14

LATERAL	SOIL MODEL	SAND (REESE)	SAND (REESE)	SAND (O'NIELL'S)	SAND (REESE)	SAND (O'NIELL'S)	SAND (REESE)
	INTERNAL FRICTION ANGLE	31°	32°	35°	32°	36°	31°
	TOTAL UNIT WEIGHT (pcf)	115	115	120	115	120	115
	LATERAL SOIL MODULUS (pci)	160	180	370	200	530	320
	UNDRAINED SHEAR STRENGTH (psf)	- -	- -	- -	- -	- -	- -
	MAJOR PRINCIPAL STRAIN @ 50%	0.03	0.03	0.02	0.03	0.02	0.03
	UNCONFINED COMPRESSIVE STRENGTH (psf)	- -	- -	- -	- -	- -	- -
AXIAL	SOIL MODEL	DRIVEN PILE (SAND)	DRIVEN PILE (SAND)	DRIVEN PILE (SAND)	DRIVEN PILE (SAND)	DRIVEN PILE (SAND)	DRIVEN PILE (SAND)
	TOTAL UNIT WEIGHT (pcf)	115	115	120	115	120	115
	SHEAR MODULUS (ksi)	8	10	20	8	20	7
	POISSON'S RATIO	0.25	0.25	0.20	0.25	0.20	0.25
	VERTICAL FAILURE SHEAR STRESS (psf)	570	720	1,750	610	2,360	530
	UNDRAINED SHEAR STRENGTH (psf)	- -	- -	- -	- -	- -	- -
	ULTIMATE UNIT SKIN FRICTION (psf)	570	720	1,750	610	2,360	530
	MASS MODULUS (ksi)	- -	- -	- -	- -	- -	- -
	MODULUS RATIO	- -	- -	- -	- -	- -	- -
	SURFACE (ROUGH/SMOOTH)	- -	- -	- -	- -	- -	- -
	UNCONFINED COMPRESSIVE STRENGTH (psf)	- -	- -	- -	- -	- -	- -
	SPLIT TENSILE STRENGTH (psf)	- -	- -	- -	- -	- -	- -
TORSIONAL	SOIL MODEL	HYPERBOLIC	HYPERBOLIC	HYPERBOLIC	HYPERBOLIC	HYPERBOLIC	HYPERBOLIC
	TOTAL UNIT WEIGHT (pcf)	115	115	120	115	120	115
	INTERNAL FRICTION ANGLE	31°	32°	35°	32°	36°	31°
	UNDRAINED SHEAR STRENGTH (psf)	- -	- -	- -	- -	- -	- -
	SHEAR MODULUS (ksi)	8	10	20	8	20	7
	TORSIONAL SHEAR STRESS (psf)	570	720	1,750	610	2,360	530
TIP	SOIL MODEL	SAND (REESE)	SAND (REESE)	SAND (O'NIELL'S)	SAND (REESE)	SAND (O'NIELL'S)	SAND (REESE)
	SHEAR MODULUS (ksi)	8	10	20	8	20	7
	POISSON'S RATIO	0.25	0.25	0.20	0.25	0.20	0.25
	UNIT END BEARING (ksi)	0.67	0.84	2.04	0.71	2.76	0.62
	UNCORRECTED SPT N-VALUE (blows/ft)	9	12	37	14	59	17
	UNDRAINED SHEAR STRENGTH (psf)	- -	- -	- -	- -	- -	- -
	IGM MASS MODULUS (ksi)	- -	- -	- -	- -	- -	- -

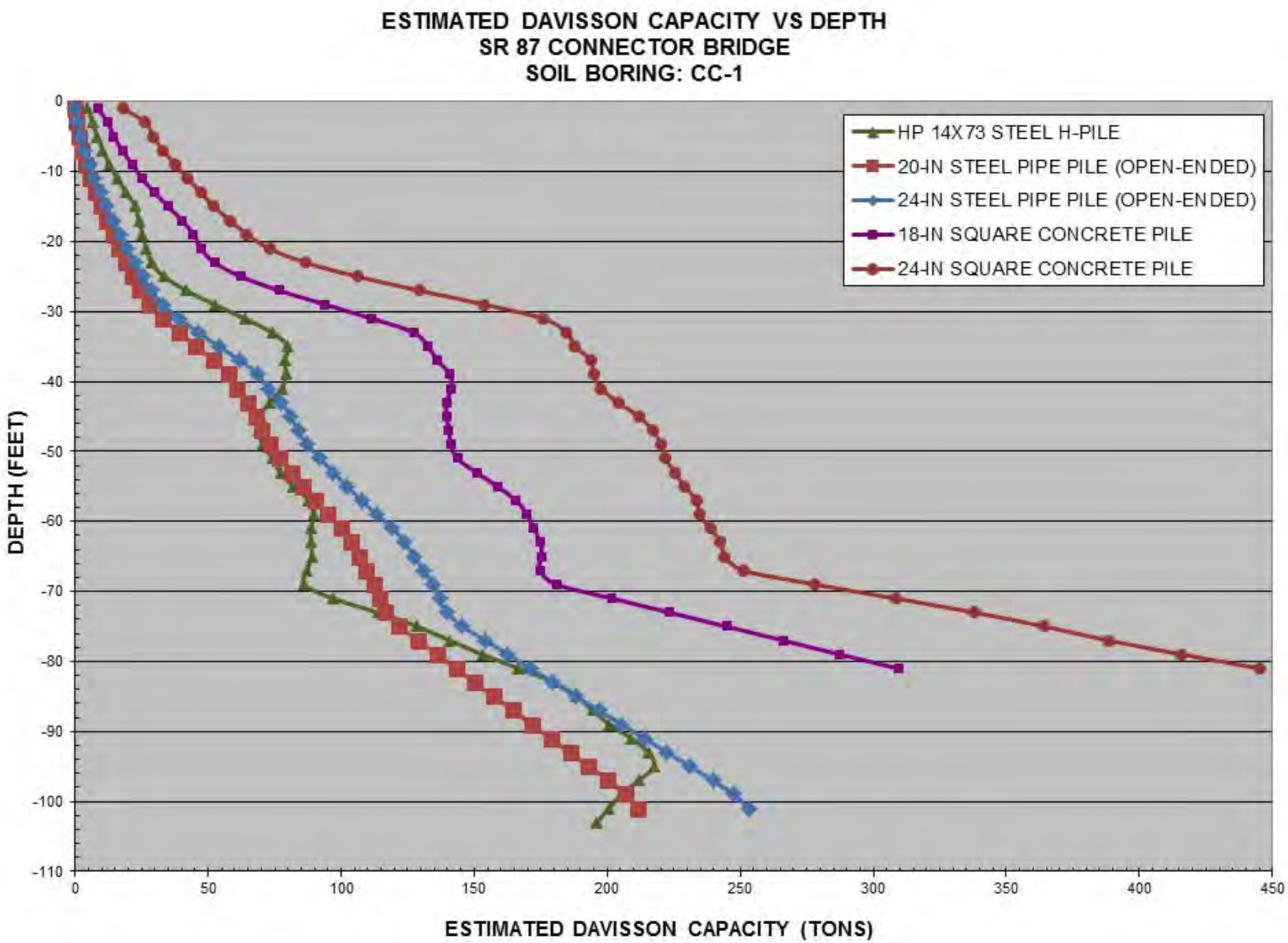
FIGURES



DRAWN: K. CRONIN, E.I.	CHECKED: M. HAYDEN, P.E.	**EGS**	TITLE: PROJECT LOCATION MAP SR 87 OVER CLEAR CREEK CONNECTOR BRIDGE PD&E STUDY SANTA ROSA COUNTY, FLORIDA	
ENGINEER: D. SHEPPARD, P.E.		Environmental & Geotechnical Specialists, Inc. 104 North Magnolia Drive Tallahassee, Florida 32301 Office #: (850) 386-1253 Fax #: (850) 385-8050		
CLIENT: FDOT DISTRICT THREE				
PROJ. NO.: 70-11-12-01	SCALE:		DATE: DECEMBER 2012	FIGURE NO.: 1



DRAWN: Z. BRANNON	CHECKED: D. SHEPPARD, P.E.	**EGS** Environmental & Geotechnical Specialists, Inc. 104 North Magnolia Drive Tallahassee, Florida 32301 Office #: (850) 386-1253 Fax #: (850) 385-8050	TITLE: USGS TOPOGRAPHIC MAP SR 87 OVER CLEAR CREEK CONNECTOR BRIDGE PD&E STUDY SANTA ROSA COUNTY, FLORIDA	
ENGINEER: D. SHEPPARD, P.E.				
CLIENT: FDOT DISRICT THREE				
PROJ. NO.: 70-11-12-01	SCALE:		DATE: DECEMBER 2012	FIGURE NO.: 2



DRAWN BY: H. JONES, E.I.	CHECKED: M. HAYDEN, P.E.	**EGS** Environmental & Geotechnical Specialists, Inc. 104 North Magnolia Drive Tallahassee, Florida 32301 Office #: (850) 386-1253 Fax #: (850) 385-8050	TITLE: ESTIMATED DAVISSON CAPACITY VS. DEPTH SOIL BORING CC-1 SR 87 OVER CLEAR CREEK CONNECTOR BRIDGE PD&E STUDY SANTA ROSA COUNTY, FLORIDA
ENGINEER: D. SHEPPARD, P.E.			
CLIENT: FDOT DISTRICT THREE			
PROJECT NO.: 70-11-12-01	SCALE:		DATE: DECEMBER 2012 / FIGURE NO.: 4

APPENDIX A

REPORT OF CORE BORINGS

NOTES

1. NUMBERS LEFT OF THE BORING INDICATE STANDARD PENETRATION TEST (SPT) N-VALUES FOR 12 IN. PENETRATION (UNLESS OTHERWISE NOTED)
2. WATER ELEVATION SHOWN IS THE WATER ELEVATION ENCOUNTERED. FLUCTUATIONS IN THE ELEVATION OF WATER SHOULD BE EXPECTED.
3. SOIL DESCRIPTIONS, TEST DATA, AND STANDARD PENETRATION VALUES SHOWN ARE FOR THE SOIL BORING ONLY AND MAY NOT APPLY TO ANY OTHER LOCATIONS EXCEPT AT THE LOCATION OF THE SOIL BORING. EXTRAPOLATION OF THE SOIL BORING DATA TO OTHER LOCATIONS IS THE SOLE RESPONSIBILITY OF THE PERSON PERFORMING THE EXTRAPOLATION.

SPLIT-SPOON: INSIDE DIAMETER: 1.375 in.
OUTSIDE DIAMETER: 2.0 in.
AVG. HAMMER DROP: 30.0 in.
HAMMER WEIGHT: 140 lbs.

Granular Materials Relative Density	SPT (blows/12 in.)	Silts and Clays Consistency	SPT (blows/12 in.)
Very Loose	Less than 3	Very Soft	Less than 1
Loose	3 - 8	Soft	1 - 3
Medium Dense	8 - 24	Firm	3 - 6
Dense	24 - 40	Stiff	6 - 12
Very Dense	Greater than 40	Very Stiff	12 - 24
		Hard	Greater than 24

LEGEND

MEASURED GROUNDWATER ▼

LABORATORY TESTING RESULTS

WATER CONTENT Wc=
-200 SIEVE -200=
LIQUID LIMIT LL=
PLASTIC INDEX PI=

(SM) UNIFIED SOIL CLASSIFICATION GROUP SYMBOL

FINE SAND (SP-SM)

SILTY MEDIUM SAND WITH GRAVEL (SM)

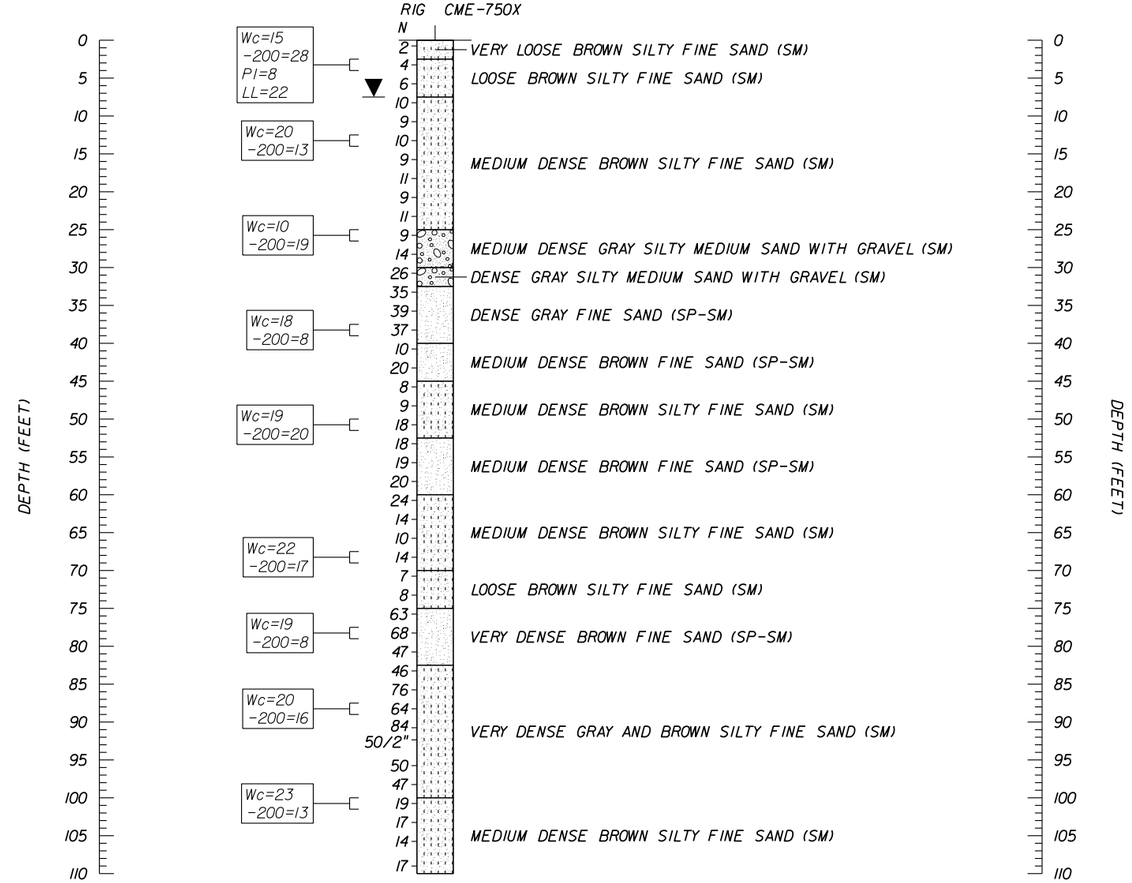
SILTY FINE SAND (SM)

ENVIRONMENTAL CLASSIFICATION

SUPERSTRUCTURE: SLIGHTLY AGGRESSIVE FOR STEEL
SLIGHTLY AGGRESSIVE FOR CONCRETE

SUBSTRUCTURE: EXTREMELY AGGRESSIVE FOR STEEL (pH = 5.5)
MODERATELY AGGRESSIVE FOR CONCRETE

BOR # CC-1
NORTHING 615719
EASTING 1181187
DATE 12/5/2012
DRILLER W. DUNLAP
HAMMER AUTOMATIC
RIG CME-750X



BORING TERMINATED AT DEPTH 110.0 FEET

NOTICE: THE OFFICIAL RECORD OF THIS SHEET IS THE ELECTRONIC FILE SIGNED AND SEALED UNDER RULE 61G15-23.003, F.A.C.

REVISIONS

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

DERWOOD C. SHEPPARD, P.E. P.E. NO.: 69228
Environmental & Geotechnical Specialists, Inc.
EGS
104 North Magnolia Drive
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Office : (850) 386-1253
Fax : (850) 385-8050
Certificate of Authorization: 6222

DRAWN BY: ZLB 12-12
CHECKED BY: EHJ 12-12
DESIGNED BY: DCS 12-12
CHECKED BY: DCS 12-12

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 87	SANTA ROSA	416748-3-22-01

SHEET TITLE: REPORT OF CORE BORING

PROJECT NAME: SR 87 OVER CLEAR CREEK CONNECTOR BRIDGE

REF. DWG. NO.

SHEET NO.

APPENDIX B

SOIL BORING LOGS

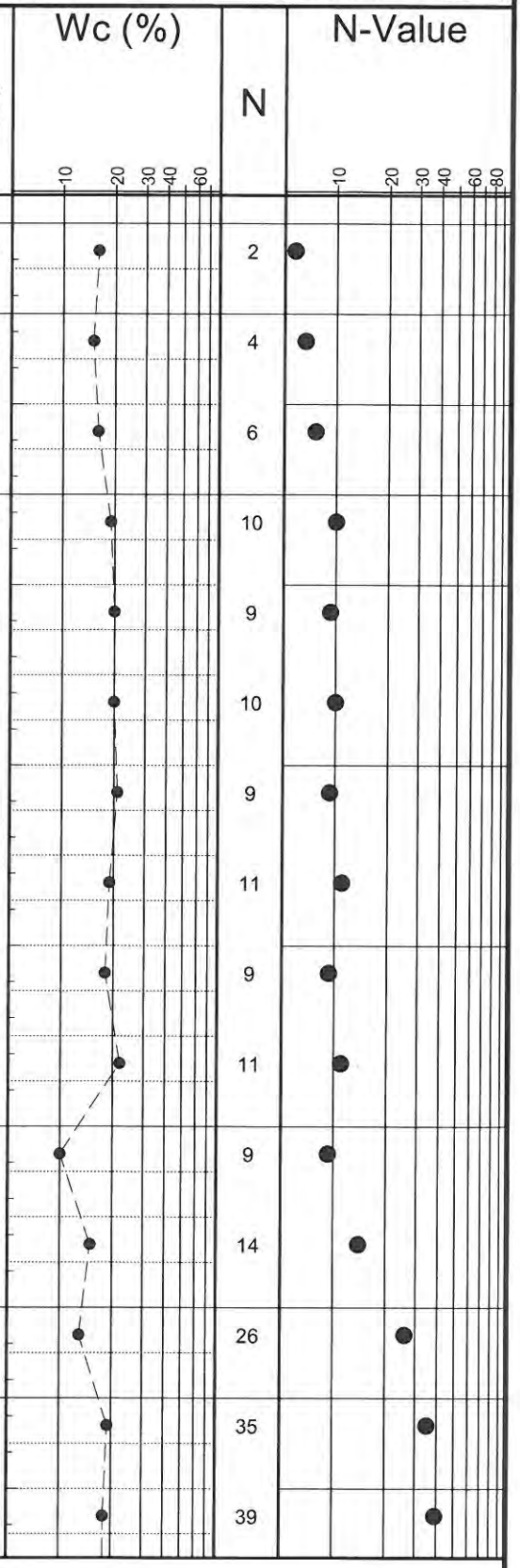
EGS

ENVIRONMENTAL AND GEOTECHNICAL SPECIALISTS, INC.

PROJECT:	SR 87 CONNECTOR BRIDGE	**HAMMER TYPE:**	AUTOMATIC
CLIENT:	FDOT DISTRICT THREE	**NORTHING:**	615719
PROJECT NO.:	70-11-12-01	**EASTING:**	1181187
PROJECT LOCATION:	SANTA ROSA COUNTY, FLORIDA	**ELEVATION (FEET):**	N/A
BORING NO.:	CC-1	**DATE:**	12/5/2012
DRILLER:	R. MOORE/ W. DUNLAP	**FLUID LOSS:**	NONE
DEPTH TO WATER: INITIAL:	7.5'	**24 HR:**	N/M
CAVING>	NONE		

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

DEPTH (METERS)	DEPTH (FEET)	SAMPLE	SYMBOL	DESCRIPTION	USCS/ AASHTO	TEST RESULTS	Wc (%)	N
0	0			VERY LOOSE BROWN SILTY FINE SAND	SM A-2-4		16	2
						-200%=28 LL=22 PI=8	15	4
	5			LOOSE BROWN SILTY FINE SAND	SM A-2-4		16	6
2.5							19	10
	10						20	9
						-200%=13	20	10
	15			MEDIUM DENSE BROWN SILTY FINE SAND	SM A-2-4		21	9
5							19	11
	20						18	9
							22	11
7.5	25					-200%=19	10	9
				MEDIUM DENSE GRAY SILTY MEDIUM SAND WITH GRAVEL	SM A-1-b		15	14
	30			DENSE GRAY SILTY MEDIUM SAND WITH GRAVEL	SM A-1-b		13	26
10							19	35
	35			DENSE GRAY FINE SAND	SP-SM A-3		18	39



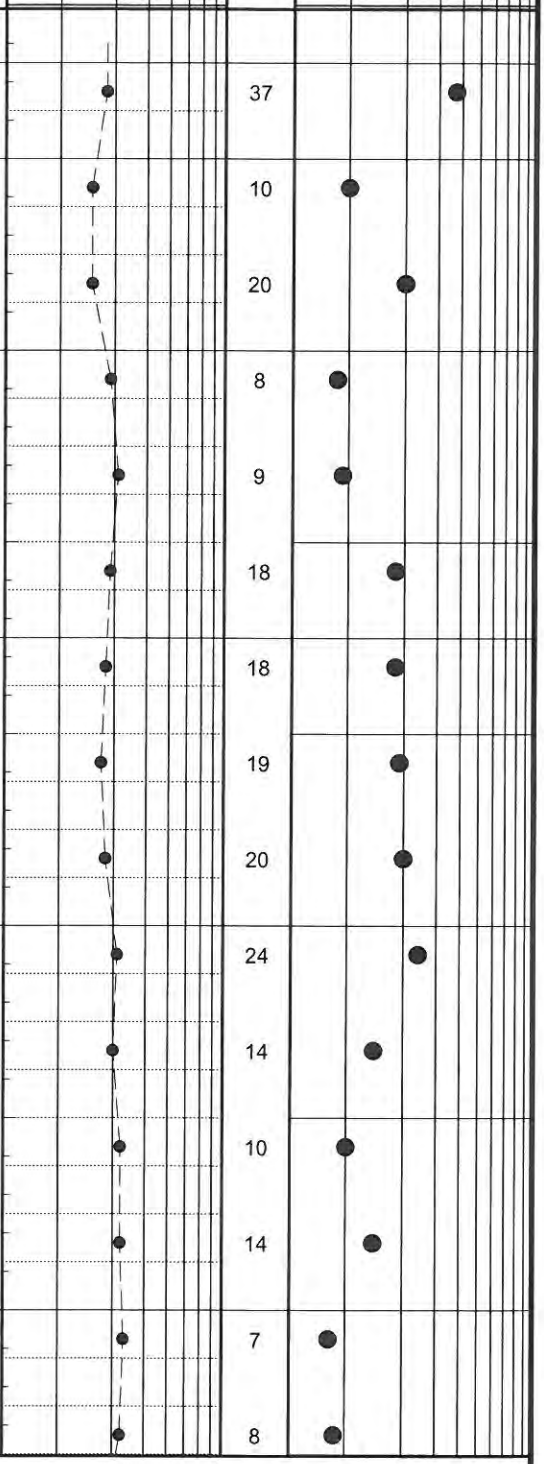
NOTE: N/M MEANS NOT MEASURED

EGS
ENVIRONMENTAL AND GEOTECHNICAL SPECIALISTS, INC.

PROJECT:	SR 87 CONNECTOR BRIDGE	**HAMMER TYPE:**	AUTOMATIC
CLIENT:	FDOT DISTRICT THREE	**NORTHING:**	615719
PROJECT NO.:	70-11-12-01	**EASTING:**	1181187
PROJECT LOCATION:	SANTA ROSA COUNTY, FLORIDA	**ELEVATION (FEET):**	N/A
BORING NO.:	CC-1	**DATE:**	12/5/2012
DRILLER:	R. MOORE/ W. DUNLAP	**FLUID LOSS:**	NONE
DEPTH TO WATER: INITIAL:	7.5'	**24 HR:**	N/M
CAVING>	NONE		

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

DEPTH (METERS)	DEPTH (FEET)	SAMPLE	SYMBOL	DESCRIPTION	USCS/ AASHTO	TEST RESULTS	Wc (%)	N
				DENSE GRAY FINE SAND	SP-SM A-3	-200%=8	18	37
12.5	40			MEDIUM DENSE BROWN FINE SAND	SP-SM A-3		15	10
							15	20
15	45			MEDIUM DENSE BROWN SILTY FINE SAND	SM A-2-4		19	8
							21	9
	50					-200%=20	19	18
17.5	55			MEDIUM DENSE BROWN FINE SAND	SP-SM A-3		18	18
							17	19
							18	20
20	60			MEDIUM DENSE BROWN SILTY FINE SAND	SM A-2-4		21	24
							20	14
	65						22	10
						-200%=17	22	14
	70			LOOSE BROWN SILTY FINE SAND	SM A-2-4		23	7
							22	8



NOTE: N/M MEANS NOT MEASURED

EGS

ENVIRONMENTAL AND GEOTECHNICAL SPECIALISTS, INC.

PROJECT:	SR 87 CONNECTOR BRIDGE	**HAMMER TYPE:**	AUTOMATIC
CLIENT:	FDOT DISTRICT THREE	**NORTHING:**	615719
PROJECT NO.:	70-11-12-01	**EASTING:**	1181187
PROJECT LOCATION:	SANTA ROSA COUNTY, FLORIDA	**ELEVATION (FEET):**	N/A
BORING NO.:	CC-1	**DATE:**	12/5/2012
DRILLER:	R. MOORE/ W. DUNLAP	**FLUID LOSS:**	NONE
DEPTH TO WATER: INITIAL:	7.5'	**24 HR:**	N/M
CAVING>	NONE		

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

DEPTH (METERS)	DEPTH (FEET)	SAMPLE	SYMBOL	DESCRIPTION	USCS/ AASHTO	TEST RESULTS	Wc (%)	N
22.5	75			VERY DENSE BROWN FINE SAND	SP-SM A-3	-200%=8	18	63
							19	68
	80						16	47
25				VERY DENSE GRAY AND BROWN SILTY FINE SAND	SM A-2-4	-200%=16	19	46
	85						21	76
							20	64
27.5	90						22	84
							19	50/2"
	95						22	50
30							23	47
	100			MEDIUM DENSE BROWN SILTY FINE SAND	SM A-2-4	-200%=13	23	19
							22	17
	105						24	14
32.5							21	17
	110							

Wc (%): 10, 20, 30, 40, 60

N-Value: 10, 20, 30, 40, 60, 80

NOTE: N/M MEANS NOT MEASURED

APPENDIX C
SOIL CLASSIFICATION DATA

SOIL CLASSIFICATION DATA

Project: SR 87 CONNECTOR BRIDGE

Client: FDOT DISTRICT THREE **Project No.: 70-11-12-01**

Boring: CC-1 **Location: SANTA ROSA COUNTY, FLORIDA**

DEPTH (FEET)	Wc (%)	-4 (%)	-10 (%)	-20 (%)	-40 (%)	-60 (%)	-100 (%)	-200 (%)	LL	PI	Org. (%)	N Value	USCS	AASHTO	Description
0.0-1.5	16											2	SM	A-2-4	VERY LOOSE BROWN SILTY FINE SAND
2.5-4.0	15	100	99	97	85	68	47	28	22	8		4	SM	A-2-4	LOOSE BROWN SILTY FINE SAND
5.0-6.5	16											6	SM	A-2-4	LOOSE BROWN SILTY FINE SAND
7.5-9.0	19											10	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
10.0-11.5	20											9	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
12.5-14.0	20	100	100	96	73	40	21	13				10	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
15.0-16.5	21											9	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
17.5-19.0	19											11	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
20.0-21.5	18											9	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
22.5-24.0	22											11	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
25.0-26.5	10	86	72	53	41	31	23	19				9	SM	A-1-b	MEDIUM DENSE GRAY

SOIL CLASSIFICATION DATA

Project: SR 87 CONNECTOR BRIDGE

Client: FDOT DISTRICT THREE **Project No.: 70-11-12-01**

Boring: CC-1 **Location: SANTA ROSA COUNTY, FLORIDA**

DEPTH (FEET)	Wc (%)	-4 (%)	-10 (%)	-20 (%)	-40 (%)	-60 (%)	-100 (%)	-200 (%)	LL	PI	Org. (%)	N Value	USCS	AASHTO	Description
															SILTY MEDIUM SAND WITH GRAVEL
27.5-29.0	15											14	SM	A-1-b	MEDIUM DENSE GRAY SILTY MEDIUM SAND WITH GRAVEL
30.0-31.5	13											26	SM	A-1-b	DENSE GRAY SILTY MEDIUM SAND WITH GRAVEL
32.5-34.0	19											35	SP-SM	A-3	DENSE GRAY FINE SAND
35.0-36.5	18											39	SP-SM	A-3	DENSE GRAY FINE SAND
37.5-39.0	18	100	100	95	59	29	14	8				37	SP-SM	A-3	DENSE GRAY FINE SAND
40.0-41.5	15											10	SP-SM	A-3	MEDIUM DENSE BROWN FINE SAND
42.5-44.0	15											20	SP-SM	A-3	MEDIUM DENSE BROWN FINE SAND
45.0-46.5	19											8	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
47.5-49.0	21											9	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
50.0-51.5	19	100	99	90	66	41	25	20				18	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
52.5-54.0	18											18	SP-SM	A-3	MEDIUM DENSE BROWN

SOIL CLASSIFICATION DATA

Project: SR 87 CONNECTOR BRIDGE

Client: FDOT DISTRICT THREE **Project No.: 70-11-12-01**

Boring: CC-1 **Location: SANTA ROSA COUNTY, FLORIDA**

DEPTH (FEET)	Wc (%)	-4 (%)	-10 (%)	-20 (%)	-40 (%)	-60 (%)	-100 (%)	-200 (%)	LL	PI	Org. (%)	N Value	USCS	AASHTO	Description
															FINE SAND
55.0-56.5	17											19	SP-SM	A-3	MEDIUM DENSE BROWN FINE SAND
57.5-59.0	18											20	SP-SM	A-3	MEDIUM DENSE BROWN FINE SAND
60.0-61.5	21											24	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
62.5-64.0	20											14	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
65.0-66.5	22											10	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
67.5-69.0	22	100	100	99	91	54	20	17				14	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
70.0-71.5	23											7	SM	A-2-4	LOOSE BROWN SILTY FINE SAND
72.5-74.0	22											8	SM	A-2-4	LOOSE BROWN SILTY FINE SAND
75.0-76.5	18											63	SP-SM	A-3	VERY DENSE BROWN FINE SAND
77.5-79.0	19	100	100	97	81	37	12	8				68	SP-SM	A-3	VERY DENSE BROWN FINE SAND
80.0-81.5	16											47	SP-SM	A-3	VERY DENSE BROWN

SOIL CLASSIFICATION DATA

Project: SR 87 CONNECTOR BRIDGE

Client: FDOT DISTRICT THREE **Project No.: 70-11-12-01**

Boring: CC-1 **Location: SANTA ROSA COUNTY, FLORIDA**

DEPTH (FEET)	Wc (%)	-4 (%)	-10 (%)	-20 (%)	-40 (%)	-60 (%)	-100 (%)	-200 (%)	LL	PI	Org. (%)	N Value	USCS	AASHTO	Description
															FINE SAND
82.5-84.0	19											46	SM	A-2-4	VERY DENSE GRAY AND BROWN SILTY FINE SAND
85.0-86.5	21											76	SM	A-2-4	VERY DENSE GRAY AND BROWN SILTY FINE SAND
87.5-89.0	20	100	100	99	95	54	26	16				64	SM	A-2-4	VERY DENSE GRAY AND BROWN SILTY FINE SAND
90.0-91.5	22											84	SM	A-2-4	VERY DENSE GRAY AND BROWN SILTY FINE SAND
92.5-93.2	19											50/2"	SM	A-2-4	VERY DENSE GRAY AND BROWN SILTY FINE SAND
95.0-96.5	22											50	SM	A-2-4	VERY DENSE GRAY AND BROWN SILTY FINE SAND
97.5-99.0	23											47	SM	A-2-4	VERY DENSE GRAY AND BROWN SILTY FINE SAND
100.0-101.5	23	100	100	99	96	60	24	13				19	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
102.5-104.0	22											17	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
105.0-106.5	24											14	SM	A-2-4	MEDIUM DENSE BROWN SILTY FINE SAND
108.0-110.0	21											17	SM	A-2-4	MEDIUM DENSE BROWN

SOIL CLASSIFICATION DATA

Project: SR 87 CONNECTOR BRIDGE

Client: FDOT DISTRICT THREE **Project No.: 70-11-12-01**

Boring: CC-1 **Location: SANTA ROSA COUNTY, FLORIDA**

DEPTH (FEET)	Wc (%)	-4 (%)	-10 (%)	-20 (%)	-40 (%)	-60 (%)	-100 (%)	-200 (%)	LL	PI	Org. (%)	N Value	USCS	AASHTO	Description
															SILTY FINE SAND

APPENDIX D

GRAIN-SIZE DISTRIBUTION CURVES

MECHANICAL GRAIN-SIZE ANALYSIS
(ASTM D1140-54)

Project No: 70-11-12-01 Date: 12/10/12

Boring No: CC-1 Depth: 2.5 - 4.0 (FEET)

Soil Description BROWN SILTY FINE SAND
(SM / A-2-4)

Sieve No.	Diameter (Millimeters)	Percent Passing (%)
4	4.750	100
10	2.000	99
20	0.840	97
40	0.425	85
60	0.250	68
100	0.150	47
200	0.075	28

D_{10} 0.031 mm

D_{50} 0.17 mm

D_{60} 0.21 mm

D_{85} 0.43 mm

Cu 6.8

Where:

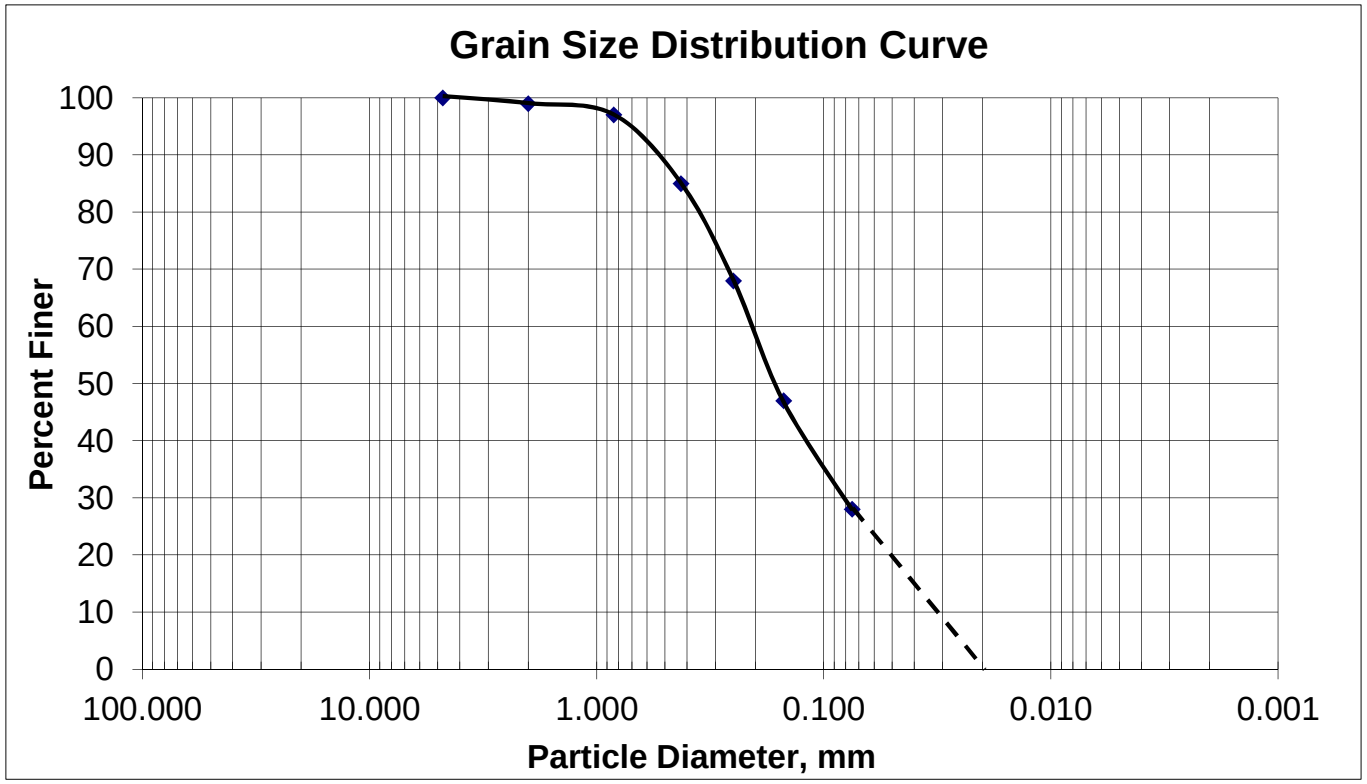
Cu= Coefficient Of Uniformity

MECHANICAL GRAIN-SIZE ANALYSIS
(ASTM D1140-54)

Project No: 70-11-12-01 Date: 12/10/12

Boring No: CC-1 Depth: 2.5 - 4.0 (FEET)

Soil Description BROWN SILTY FINE SAND
(SM / A-2-4)



MECHANICAL GRAIN-SIZE ANALYSIS
(ASTM D1140-54)

Project No: 70-11-12-01 Date: 12/10/12

Boring No: CC-1 Depth: 12.5-14.0 (FEET)

Soil Description BROWN SILTY FINE SAND
(SM / A-2-4)

Sieve No.	Diameter (Millimeters)	Percent Passing (%)
4	4.750	100
10	2.000	100
20	0.840	96
40	0.425	73
60	0.250	40
100	0.150	21
200	0.075	13

D_{10} 0.040 mm

D_{50} 0.30 mm

D_{60} 0.36 mm

D_{85} 0.52 mm

Cu 9.0

Where:

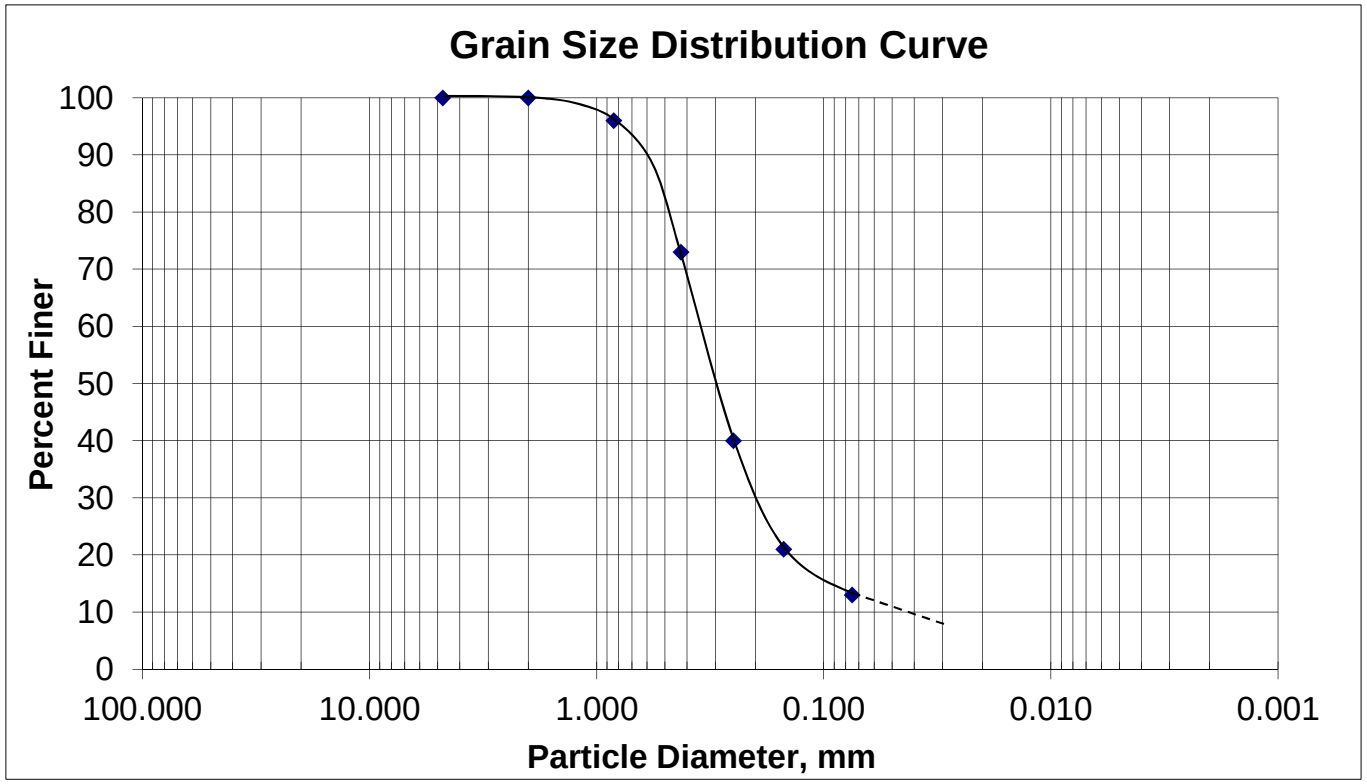
Cu= Coefficient Of Uniformity

MECHANICAL GRAIN-SIZE ANALYSIS
(ASTM D1140-54)

Project No: 70-11-12-01 Date: 12/10/12

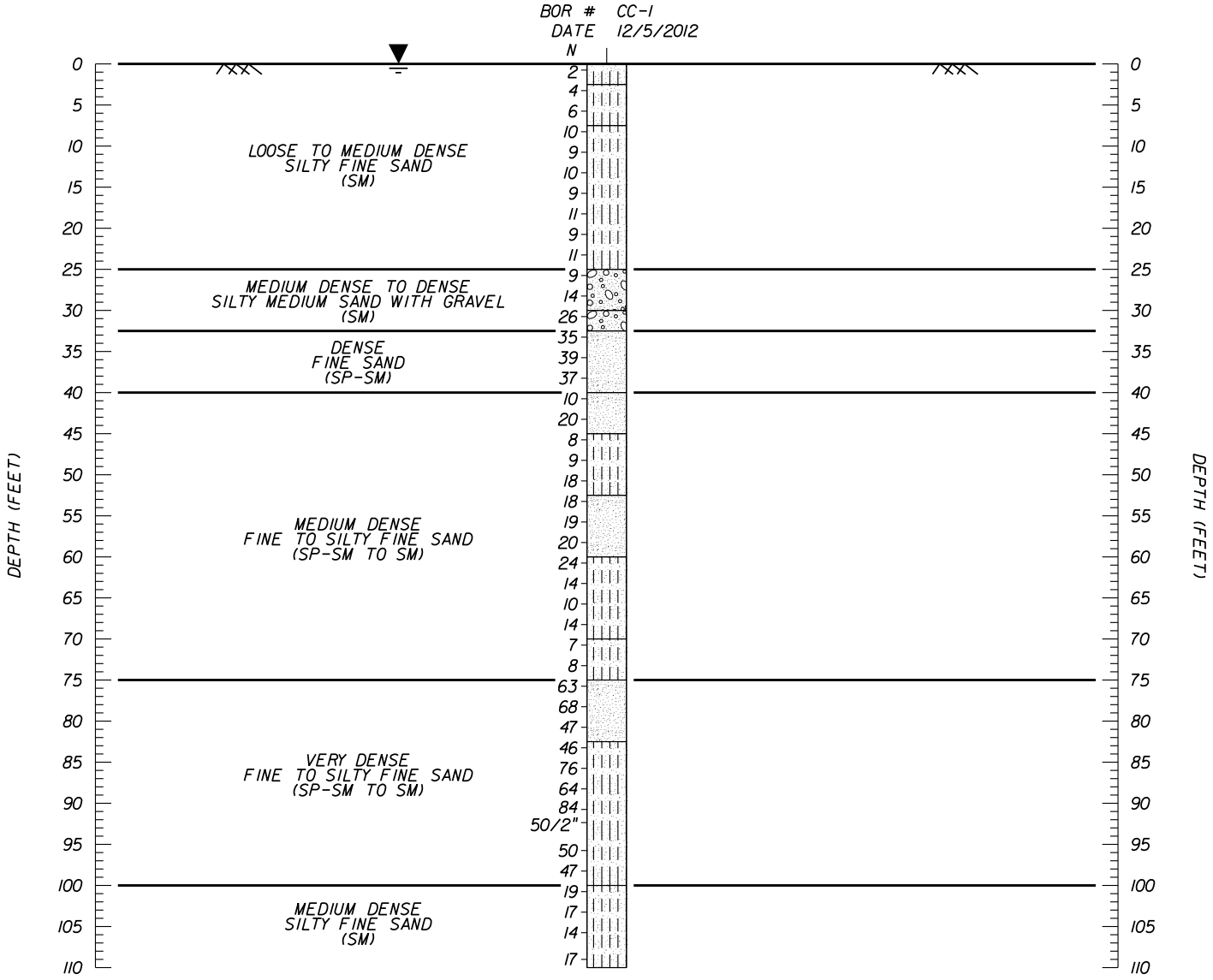
Boring No: CC-1 Depth: 12.5-14.0 (FEET)

Soil Description BROWN SILTY FINE SAND
(SM / A-2-4)



APPENDIX E

SAMPLE CALCULATIONS



LEGEND

DESIGN GROUNDWATER

NOTE: DESIGN GROUNDWATER ASSUMED AT GROUND SURFACE FOR DESIGN.

DRAWN: Z. BRANNON	CHECKED: D. SHEPPARD, P.E.	EGS Environmental & Geotechnical Specialists, Inc. 104 North Magnolia Drive Tallahassee, Florida 32301 Office : (850) 386-1253 Fax : (850) 385-8050	DESIGN FIGURE SR 87 OVER CLEAR CREEK CONNECTOR BRIDGE PD&E STUDY SANTA ROSA COUNTY, FLORIDA
ENGINEER: D. SHEPPARD, P.E.			
CLIENT: FDOT DISTRICT THREE			
PROJ. NO.: 70-11-12-01	SCALE: 1" = 20'		DATE: DECEMBER 2012 / FIGURE NO.: E-1

f = COEFFICIENT OF VARIATION OF LATERAL SUBGRADE REACTION WITH DEPTH
B = BASE WIDTH
z = DEPTH
E_S = MODULUS OF ELASTICITY
μ = POISSON'S RATIO

SOIL BORING: CC-1

LAYER 1

DEPTH 0.0 to 25.0 FEET

LOOSE TO MEDIUM DENSE - SILTY FINE SAND (SM)

$N_{cor} := 15$ $\phi := 31 \cdot deg$ $\gamma_1 := 52.6 \cdot \frac{lb}{ft^3}$ $K_a := \frac{1 - \sin(\phi)}{1 + \sin(\phi)}$ $K_a = 0.32$ $K_p := \frac{1 + \sin(\phi)}{1 - \sin(\phi)}$ $K_p = 3.12$

$B := 24 \cdot in$ $f_1 := 17.0 \cdot tcf$ $y_1 := 25.0 \cdot ft$ $z_1 := 12.5 \cdot ft$ $E_S := 20(N_{cor}) \cdot ksf$ $\mu_1 := 0.25$

$k_{s_bowles} := \frac{3 \cdot (E_S)}{B}$ $k_{s_bowles} = 260 \frac{lb}{in^3}$ **<~ BOWLES**

$k_{s_navfac} := \frac{f_1 \cdot z_1}{2 \cdot B}$ $k_{s_navfac} = 61 \frac{lb}{in^3}$ **<~ NAVFAC**

OVERBURDEN PRESSURE: $\sigma := \gamma_1 \cdot z_1$ $\sigma = 4.6 \frac{lb}{in^2}$

$k_{s_flpier} := 155 \cdot \frac{lb}{in^3}$ **<~ FL PIER**

$k_{s_design} := \frac{k_{s_bowles} + k_{s_navfac} + 2 \cdot k_{s_flpier}}{4}$ $k_{s_design} = 158 \frac{lb}{in^3}$

SHEAR MODULUS

$G_S := 0.5 \cdot N_{cor} \cdot \frac{kip}{in^2}$ $G_S = 8 \frac{kip}{in^2}$

VERTICAL SHEAR STRESS

$\tau_S := 38 N_{cor} \cdot psf$ $\tau_S = 570 \frac{lb}{ft^2}$

ULTIMATE END BEARING

$Q_{tip} := 3.2 \cdot N_{cor} \cdot \frac{ton}{ft^2}$ $Q_{tip} = 0.67 \frac{kip}{in^2}$

RECOMMENDED FBPIER SOIL TYPE

REESE COX KOOP - SAND

f = COEFFICIENT OF VARIATION OF LATERAL SUBGRADE REACTION WITH DEPTH
B = BASE WIDTH
z = DEPTH
E_S = MODULUS OF ELASTICITY
μ = POISSON'S RATIO

SOIL BORING: CC-1

LAYER 2

DEPTH 25.0 to 32.5 FEET MEDIUM DENSE TO DENSE - SILTY MEDIUM SAND WITH GRAVEL (SM)

$N_{cor} := 19$ $\phi := 32 \cdot deg$ $\gamma_2 := 52.6 \cdot \frac{lb}{ft^3}$ $K_a := \frac{1 - \sin(\phi)}{1 + \sin(\phi)}$ $K_a = 0.31$ $K_p := \frac{1 + \sin(\phi)}{1 - \sin(\phi)}$ $K_p = 3.25$

$B := 24 \cdot in$ $f_2 := 21.0 \cdot tcf$ $y_2 := 7.5 \cdot ft$ $z_2 := 3.75 \cdot ft$ $E_s := 20(N_{cor}) \cdot ksf$ $\mu_2 := 0.25$

$k_{s_bowles} := \frac{3 \cdot (E_s)}{B}$ $k_{s_bowles} = 330 \frac{lb}{in^3}$ **<~ BOWLES**

$k_{s_navfac} := \frac{f_1 \cdot y_1}{2 \cdot B} + \frac{f_2 \cdot z_2}{2 \cdot B}$ $k_{s_navfac} = 146 \frac{lb}{in^3}$ **<~ NAVFAC**

OVERBURDEN PRESSURE: $\sigma := \gamma_1 \cdot y_1 + \gamma_2 \cdot z_2$ $\sigma = 10.5 \frac{lb}{in^2}$

$k_{s_flpier} := 130 \cdot \frac{lb}{in^3}$ **<~ FL PIER**

$k_{s_design} := \frac{k_{s_bowles} + k_{s_navfac} + 2 \cdot k_{s_flpier}}{4}$ $k_{s_design} = 184 \frac{lb}{in^3}$

SHEAR MODULUS

$G_s := 0.5 \cdot N_{cor} \cdot \frac{kip}{in^2}$ $G_s = 10 \frac{kip}{in^2}$

VERTICAL SHEAR STRESS

$\tau_s := 38 N_{cor} \cdot psf$ $\tau_s = 722 \frac{lb}{ft^2}$

ULTIMATE END BEARING

$Q_{tip} := 3.2 \cdot N_{cor} \cdot \frac{ton}{ft^2}$ $Q_{tip} = 0.84 \frac{kip}{in^2}$

RECOMMENDED FBPIER SOIL TYPE

REESE COX KOOP - SAND

f = COEFFICIENT OF VARIATION OF LATERAL SUBGRADE REACTION WITH DEPTH

B = BASE WIDTH

z = DEPTH

E_S = MODULUS OF ELASTICITY

μ = POISSON'S RATIO

SOIL BORING: CC-1

LAYER 3

DEPTH 32.5 to 40.0 FEET

DENSE - FINE SAND (SP-SM)

$N_{cor} := 46$ $\phi := 35 \cdot deg$ $\gamma_3 := 57.6 \cdot \frac{lb}{ft^3}$ $K_a := \frac{1 - \sin(\phi)}{1 + \sin(\phi)}$ $K_a = 0.27$ $K_p := \frac{1 + \sin(\phi)}{1 - \sin(\phi)}$ $K_p = 3.69$

$B := 24 \cdot in$ $f_3 := 48.0 \cdot tcf$ $y_3 := 7.5 \cdot ft$ $z_3 := 3.75 \cdot ft$ $E_s := 20(N_{cor}) \cdot ksf$ $\mu_3 := 0.20$

$k_{s_bowles} := \frac{3 \cdot (E_s)}{B}$ $k_{s_bowles} = 799 \frac{lb}{in^3}$ **<~ BOWLES**

$k_{s_navfac} := \frac{f_1 \cdot y_1}{2 \cdot B} + \frac{f_2 \cdot y_2}{2 \cdot B} + \frac{f_3 \cdot z_3}{2 \cdot B}$ $k_{s_navfac} = 221 \frac{lb}{in^3}$ **<~ NAVFAC**

OVERBURDEN PRESSURE: $\sigma := \gamma_1 \cdot y_1 + \gamma_2 \cdot y_2 + \gamma_3 \cdot z_3$ $\sigma = 13.4 \frac{lb}{in^2}$

$k_{s_flpier} := 225 \cdot \frac{lb}{in^3}$ **<~ FL PIER**

$k_{s_design} := \frac{k_{s_bowles} + k_{s_navfac} + 2 \cdot k_{s_flpier}}{4}$ $k_{s_design} = 367 \frac{lb}{in^3}$

SHEAR MODULUS

$G_s := 0.5 \cdot N_{cor} \cdot \frac{kip}{in^2}$ $G_s := 20 \frac{kip}{in^2}$

VERTICAL SHEAR STRESS

$\tau_s := 38 N_{cor} \cdot psf$ $\tau_s = 1748 \frac{lb}{ft^2}$

ULTIMATE END BEARING

$Q_{tip} := 3.2 \cdot N_{cor} \cdot \frac{ton}{ft^2}$ $Q_{tip} = 2.04 \frac{kip}{in^2}$

RECOMMENDED FBPIER SOIL TYPE

O'NIELL'S - SAND

f = COEFFICIENT OF VARIATION OF LATERAL SUBGRADE REACTION WITH DEPTH
B = BASE WIDTH
z = DEPTH
E_S = MODULUS OF ELASTICITY
μ = POISSON'S RATIO

SOIL BORING: CC-1

LAYER 4

DEPTH 40.0 to 75.0 FEET

MEDIUM DENSE - FINE TO SILTY FINE SAND (SP-SM TO SM)

$N_{cor} := 16$ $\phi := 32 \cdot deg$ $\gamma_4 := 52.6 \cdot \frac{lb}{ft^3}$ $K_a := \frac{1 - \sin(\phi)}{1 + \sin(\phi)}$ $K_a = 0.31$ $K_p := \frac{1 + \sin(\phi)}{1 - \sin(\phi)}$ $K_p = 3.25$

$B := 24 \cdot in$ $f_4 := 18.0 \cdot tcf$ $y_4 := 35 \cdot ft$ $z_4 := 17.5 \cdot ft$ $E_s := 20(N_{cor}) \cdot ksf$ $\mu_4 := 0.25$

$k_{s_bowles} := \frac{3 \cdot (E_s)}{B}$ $k_{s_bowles} = 278 \frac{lb}{in^3}$ **<~ BOWLES**

$k_{s_navfac} := \frac{f_1 \cdot y_1}{2 \cdot B} + \frac{f_2 \cdot y_2}{2 \cdot B} + \frac{f_3 \cdot y_3}{2 \cdot B} + \frac{f_4 \cdot z_4}{2 \cdot B}$ $k_{s_navfac} = 364 \frac{lb}{in^3}$ **<~ NAVFAC**

OVERBURDEN PRESSURE: $\sigma := \gamma_1 \cdot y_1 + \gamma_2 \cdot y_2 + \gamma_3 \cdot y_3 + \gamma_4 \cdot z_4$ $\sigma = 21.3 \frac{lb}{in^2}$

$k_{s_flpier} := 75 \cdot \frac{lb}{in^3}$ **<~ FL PIER**

$k_{s_design} := \frac{k_{s_bowles} + k_{s_navfac} + 2 \cdot k_{s_flpier}}{4}$ $k_{s_design} = 198 \frac{lb}{in^3}$

SHEAR MODULUS

$G_s := 0.5 \cdot N_{cor} \cdot \frac{kip}{in^2}$ $G_s = 8 \frac{kip}{in^2}$

VERTICAL SHEAR STRESS

$\tau_s := 38 N_{cor} \cdot psf$ $\tau_s = 608 \frac{lb}{ft^2}$

ULTIMATE END BEARING

$Q_{tip} := 3.2 \cdot N_{cor} \cdot \frac{ton}{ft^2}$ $Q_{tip} = 0.71 \frac{kip}{in^2}$

RECOMMENDED FBPIER SOIL TYPE

REESE COX KOOP - SAND

f = COEFFICIENT OF VARIATION OF LATERAL SUBGRADE REACTION WITH DEPTH
B = BASE WIDTH
z = DEPTH
E_S = MODULUS OF ELASTICITY
μ = POISSON'S RATIO

SOIL BORING: CC-1

LAYER 5

DEPTH 75.0 to 100.0 FEET

VERY DENSE FINE TO SILTY FINE SAND (SP-SM TO SM)

$N_{cor} := 62$ $\phi := 36 \cdot deg$ $\gamma_5 := 57.6 \cdot \frac{lb}{ft^3}$ $K_a := \frac{1 - \sin(\phi)}{1 + \sin(\phi)}$ $K_a = 0.26$ $K_p := \frac{1 + \sin(\phi)}{1 - \sin(\phi)}$ $K_p = 3.85$

$B := 24 \cdot in$ $f_5 := 64.0 \cdot tcf$ $y_5 := 25 \cdot ft$ $z_5 := 12.5 \cdot ft$ $E_s := 20(N_{cor}) \cdot ksf$ $\mu_5 := 0.2$

$k_{s_bowles} := \frac{3 \cdot (E_s)}{B}$ $k_{s_bowles} = 1076 \frac{lb}{in^3}$ **<~ BOWLES**

$k_{s_navfac} := \frac{f_1 \cdot y_1}{2 \cdot B} + \frac{f_2 \cdot y_2}{2 \cdot B} + \frac{f_3 \cdot y_3}{2 \cdot B} + \frac{f_4 \cdot y_4}{2 \cdot B} + \frac{f_5 \cdot z_5}{2 \cdot B}$ $k_{s_navfac} = 686 \frac{lb}{in^3}$ **<~ NAVFAC**

OVERBURDEN PRESSURE: $\sigma := \gamma_1 \cdot y_1 + \gamma_2 \cdot y_2 + \gamma_3 \cdot y_3 + \gamma_4 \cdot y_4 + \gamma_5 \cdot z_5$ $\sigma = 32.7 \frac{lb}{in^2}$

$k_{s_flpier} := 180 \cdot \frac{lb}{in^3}$ **<~ FL PIER**

$k_{s_design} := \frac{k_{s_bowles} + k_{s_navfac} + 2 \cdot k_{s_flpier}}{4}$ $k_{s_design} = 531 \frac{lb}{in^3}$

SHEAR MODULUS

$G_s := 0.5 \cdot N_{cor} \cdot \frac{kip}{in^2}$ $G_s := 20 \cdot \frac{kip}{in^2}$

VERTICAL SHEAR STRESS

$\tau_s := 38 N_{cor} \cdot psf$ $\tau_s = 2356 \frac{lb}{ft^2}$

ULTIMATE END BEARING

$Q_{tip} := 3.2 \cdot N_{cor} \cdot \frac{ton}{ft^2}$ $Q_{tip} = 2.76 \frac{kip}{in^2}$

RECOMMENDED FBPIER SOIL TYPE

O'NIELL'S - SAND

f = COEFFICIENT OF VARIATION OF LATERAL SUBGRADE REACTION WITH DEPTH
B = BASE WIDTH
z = DEPTH
E_S = MODULUS OF ELASTICITY
μ = POISSON'S RATIO

SOIL BORING: CC-1

LAYER 6

DEPTH 100.0 to 110.0 FEET

MEDIUM DENSE SILTY FINE SAND (SM)

$N_{cor} := 14$ $\phi := 31 \cdot deg$ $\gamma_6 := 52.6 \cdot \frac{lb}{ft^3}$ $K_a := \frac{1 - \sin(\phi)}{1 + \sin(\phi)}$ $K_a = 0.32$ $K_p := \frac{1 + \sin(\phi)}{1 - \sin(\phi)}$ $K_p = 3.12$

$B := 24 \cdot in$ $f_6 := 16.0 \cdot tcf$ $y_6 := 10 \cdot ft$ $z_6 := 5.0 \cdot ft$ $E_s := 20(N_{cor}) \cdot ksf$ $\mu_6 := 0.25$

$k_{s_bowles} := \frac{3 \cdot (E_s)}{B}$ $k_{s_bowles} = 243 \frac{lb}{in^3}$ **<~ BOWLES**

$k_{s_navfac} := \frac{f_1 \cdot y_1}{2 \cdot B} + \frac{f_2 \cdot y_2}{2 \cdot B} + \frac{f_3 \cdot y_3}{2 \cdot B} + \frac{f_4 \cdot y_4}{2 \cdot B} + \frac{f_5 \cdot y_5}{2 \cdot B} + \frac{f_6 \cdot z_6}{2 \cdot B}$ $k_{s_navfac} = 941 \frac{lb}{in^3}$ **<~ NAVFAC**

OVERBURDEN PRESSURE: $\sigma := \gamma_1 \cdot y_1 + \gamma_2 \cdot y_2 + \gamma_3 \cdot y_3 + \gamma_4 \cdot y_4 + \gamma_5 \cdot y_5 + \gamma_6 \cdot z_6$ $\sigma = 39.5 \frac{lb}{in^2}$

$k_{s_flpier} := 50 \cdot \frac{lb}{in^3}$ **<~ FL PIER**

$k_{s_design} := \frac{k_{s_bowles} + k_{s_navfac} + 2 \cdot k_{s_flpier}}{4}$ $k_{s_design} = 321 \frac{lb}{in^3}$

SHEAR MODULUS

$G_s := 0.5 \cdot N_{cor} \cdot \frac{kip}{in^2}$ $G_s = 7 \frac{kip}{in^2}$

VERTICAL SHEAR STRESS

$\tau_s := 38 N_{cor} \cdot psf$ $\tau_s = 532 \frac{lb}{ft^2}$

ULTIMATE END BEARING

$Q_{tip} := 3.2 \cdot N_{cor} \cdot \frac{ton}{ft^2}$ $Q_{tip} = 0.62 \frac{kip}{in^2}$

RECOMMENDED FBPIER SOIL TYPE

REESE COX KOOP - SAND

APPENDIX F

AXIAL CAPACITY ANALYSIS
FB DEEP "OUTPUTS"

HP 14X73 H-PILES

SOIL BORING: CC-1
HP 14X73 STEEL H-PILE

TEST PILE LENGTH (FT)	PILE TIP DEPTH (FT)	ULTIMATE SIDE FRICTION (TONS)	MOBILIZED END BEARING (TONS)	ESTIMATED DAVISSON CAPACITY (**DC**) (TONS)
1.0	-1.0	0.05	4.69	4.74
3.0	-3.0	0.34	6.24	6.58
5.0	-5.0	0.69	7.60	8.29
7.0	-7.0	1.24	9.20	10.44
9.0	-9.0	2.02	10.85	12.88
11.0	-11.0	2.83	12.95	15.77
13.0	-13.0	3.77	15.41	19.18
15.0	-15.0	4.81	17.77	22.57
17.0	-17.0	6.00	17.94	23.94
19.0	-19.0	7.28	18.13	25.41
21.0	-21.0	8.47	18.27	26.74
23.0	-23.0	9.78	18.84	28.63
25.0	-25.0	11.03	22.34	33.37
27.0	-27.0	12.41	29.33	41.74
29.0	-29.0	14.42	37.96	52.38
31.0	-31.0	17.45	46.24	63.70
33.0	-33.0	21.35	52.62	73.97
35.0	-35.0	25.80	54.09	79.89
37.0	-37.0	30.38	48.28	78.66
39.0	-39.0	34.19	45.08	79.26
41.0	-41.0	36.01	41.72	77.73
43.0	-43.0	38.28	34.75	73.03
45.0	-45.0	40.00	29.59	69.59
47.0	-47.0	41.19	27.94	69.13
49.0	-49.0	42.69	27.66	70.35
51.0	-51.0	44.91	29.12	74.03
53.0	-53.0	47.25	29.80	77.05
55.0	-55.0	49.65	32.26	81.91
57.0	-57.0	52.15	35.52	87.68
59.0	-59.0	54.84	34.84	89.67
61.0	-61.0	57.74	30.89	88.63
63.0	-63.0	59.86	28.74	88.60
65.0	-65.0	61.42	27.49	88.92
67.0	-67.0	62.99	24.25	87.24
69.0	-69.0	64.64	21.62	86.26
71.0	-71.0	65.74	31.03	96.76
73.0	-73.0	66.95	46.73	113.68
75.0	-75.0	71.01	57.43	128.44
77.0	-77.0	77.05	63.75	140.80
79.0	-79.0	83.08	69.89	152.97
81.0	-81.0	89.03	77.52	166.54
83.0	-83.0	94.89	85.08	179.97
85.0	-85.0	100.89	87.54	188.43
87.0	-87.0	106.99	87.54	194.53
89.0	-89.0	113.10	87.60	200.70
91.0	-91.0	121.30	87.81	209.11
93.0	-93.0	127.49	87.92	215.40
95.0	-95.0	133.68	83.86	217.54
97.0	-97.0	139.83	71.97	211.79
99.0	-99.0	145.10	60.41	205.51
101.0	-101.0	147.95	52.54	200.49
103.0	-103.0	150.26	45.84	196.10

General Information:
==========
Input file: .....dge\Report\Appendices\APX E - FB Deep\CC-1 - HP 14X73 Pile.spc
Project number: 70-11-12-01
Job name: SR 87 CONNECTOR BRIDGE
Engineer: DERWOOD SHEPPARD, P.E.
Units: English

Analysis Information:
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Analysis Type: SPT

Soil Information:
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Boring date: 12/5/2012, Boring Number: CC-1
Station number: Offset:

Ground Elevation: 0.000(ft)

Hammer type: Automatic Hammer, Correction factor = 1.25

ID	Depth (ft)	No. of Blows (Blows/ft)	Soil Type
1	0.00	2.00	3- Clean sand
2	2.50	4.00	3- Clean sand
3	5.00	6.00	3- Clean sand
4	7.50	10.00	3- Clean sand
5	10.00	9.00	3- Clean sand
6	12.50	10.00	3- Clean sand
7	15.00	9.00	3- Clean sand
8	17.50	11.00	3- Clean sand
9	20.00	9.00	3- Clean sand
10	22.50	11.00	3- Clean sand
11	25.00	9.00	3- Clean sand
12	27.50	14.00	3- Clean sand
13	30.00	26.00	3- Clean sand
14	32.50	35.00	3- Clean sand
15	35.00	39.00	3- Clean sand
16	37.50	37.00	3- Clean sand
17	40.00	10.00	3- Clean sand
18	42.50	20.00	3- Clean sand
19	45.00	8.00	3- Clean sand
20	47.50	9.00	3- Clean sand
21	50.00	18.00	3- Clean sand
22	52.50	18.00	3- Clean sand
23	55.00	19.00	3- Clean sand
24	57.50	20.00	3- Clean sand
25	60.00	24.00	3- Clean sand
26	62.50	14.00	3- Clean sand
27	65.00	10.00	3- Clean sand
28	67.50	14.00	3- Clean sand
29	70.00	7.00	3- Clean sand
30	72.50	8.00	3- Clean sand
31	75.00	63.00	3- Clean sand
32	77.50	68.00	3- Clean sand

33	80.00	47.00	3- Clean sand
34	82.50	46.00	3- Clean sand
35	85.00	76.00	3- Clean sand
36	87.50	64.00	3- Clean sand
37	90.00	84.00	3- Clean sand
38	92.50	100.00	3- Clean sand
39	95.00	50.00	3- Clean sand
40	97.50	47.00	3- Clean sand
41	100.00	19.00	3- Clean sand
42	102.50	17.00	3- Clean sand
43	105.00	14.00	3- Clean sand
44	108.00	17.00	3- Clean sand

Blowcount Average Per Soil Layer

Layer Num.	Starting Elevation (ft)	Bottom Elevation (ft)	Thickness (ft)	Average Blowcount (Blows/ft)	Soil Type
1	0.00	-108.00	108.00	26.34	3-Clean Sand

Driven Pile Data:
==========
Pile unit weight = 490.00(pcf), Section Type: H-Section

Driven Pile Capacity:
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Test Pile Length (ft)	Pile Width (in)	Ultimate Side Friction (tons)	Mobilized End Bearing (tons)	Estimated Davisson Capacity (tons)	Allowable Pile Capacity (tons)	Ultimate Pile Capacity (tons)
1.00	14.6	0.05	4.69	4.74	2.37	9.43
3.00	14.6	0.34	6.24	6.58	3.29	12.82
5.00	14.6	0.69	7.60	8.29	4.14	15.89
7.00	14.6	1.24	9.20	10.44	5.22	19.64
9.00	14.6	2.02	10.85	12.88	6.44	23.73
11.00	14.6	2.83	12.95	15.77	7.89	28.72
13.00	14.6	3.77	15.41	19.18	9.59	34.58
15.00	14.6	4.81	17.77	22.57	11.29	40.34
17.00	14.6	6.00	17.94	23.94	11.97	41.88
19.00	14.6	7.28	18.13	25.41	12.71	43.54
21.00	14.6	8.47	18.27	26.74	13.37	45.01
23.00	14.6	9.78	18.84	28.63	14.31	47.47
25.00	14.6	11.03	22.34	33.37	16.68	55.71
27.00	14.6	12.41	29.33	41.74	20.87	71.08
29.00	14.6	14.42	37.96	52.38	26.19	90.33
31.00	14.6	17.45	46.24	63.70	31.85	109.94
33.00	14.6	21.35	52.62	73.97	36.99	126.59
35.00	14.6	25.80	54.09	79.89	39.94	133.98
37.00	14.6	30.38	48.28	78.66	39.33	126.94
39.00	14.6	34.19	45.08	79.26	39.63	124.34
41.00	14.6	36.01	41.72	77.73	38.87	119.45
43.00	14.6	38.28	34.75	73.03	36.51	107.78
45.00	14.6	40.00	29.59	69.59	34.79	99.18
47.00	14.6	41.19	27.94	69.13	34.56	97.07
49.00	14.6	42.69	27.66	70.35	35.18	98.02

HP 14X73

51.00	14.6	44.91	29.12	74.03	37.02	103.15
53.00	14.6	47.25	29.80	77.05	38.52	106.85
55.00	14.6	49.65	32.26	81.91	40.95	114.17
57.00	14.6	52.15	35.52	87.68	43.84	123.20
59.00	14.6	54.84	34.84	89.67	44.84	124.51
61.00	14.6	57.74	30.89	88.63	44.31	119.52
63.00	14.6	59.86	28.74	88.60	44.30	117.35
65.00	14.6	61.42	27.49	88.92	44.46	116.41
67.00	14.6	62.99	24.25	87.24	43.62	111.49
69.00	14.6	64.64	21.62	86.26	43.13	107.89
71.00	14.6	65.74	31.03	96.76	48.38	127.79
73.00	14.6	66.95	46.73	113.68	56.84	160.41
75.00	14.6	71.01	57.43	128.44	64.22	185.87
77.00	14.6	77.05	63.75	140.80	70.40	204.55
79.00	14.6	83.08	69.89	152.97	76.49	222.87
81.00	14.6	89.03	77.52	166.54	83.27	244.06
83.00	14.6	94.89	85.08	179.97	89.99	265.05
85.00	14.6	100.89	87.54	188.43	94.21	275.97
87.00	14.6	106.99	87.54	194.53	97.26	282.07
89.00	14.6	113.10	87.60	200.70	100.35	288.30
91.00	14.6	121.30	87.81	209.11	104.55	296.91
93.00	14.6	127.49	87.92	215.40	107.70	303.32
95.00	14.6	133.68	83.86	217.54	108.77	301.40
97.00	14.6	139.83	71.97	211.79	105.90	283.76
99.00	14.6	145.10	60.41	205.51	102.76	265.92
101.00	14.6	147.95	52.54	200.49	100.25	253.03
103.00	14.6	150.26	45.84	196.10	98.05	241.95

NOTES
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1. MOBILIZED END BEARING IS 1/3 OF THE ORIGINAL RB-121 VALUES.

2. DAVISSON PILE CAPACITY IS AN ESTIMATE BASED ON FAILURE CRITERIA, AND EQUALS ULTIMATE SIDE FRICTION PLUS MOBILIZED END BEARING.

3. ALLOWABLE PILE CAPACITY IS 1/2 THE DAVISSON PILE CAPACITY.

4. ULTIMATE PILE CAPACITY IS ULTIMATE SIDE FRICTION PLUS 3 x THE MOBILIZED END BEARING.
   EXCEPTION: FOR H-PILES TIPPED IN SAND OR LIMESTONE, THE ULTIMATE PILE CAPACITY IS ULTIMATE SIDE FRICTION PLUS 2 x THE MOBILIZED END BEARING.

20-IN STEEL PIPE PILES

SOIL BORING: CC-1
20-IN STEEL PIPE PILE (OPEN-ENDED)

TEST PILE LENGTH (FT)	PILE TIP DEPTH (FT)	ULTIMATE SIDE FRICTION (TONS)	MOBILIZED END BEARING (TONS)	ESTIMATED DAVISSON CAPACITY (**DC**) (TONS)
1.0	-1.0	0.09	0.00	0.09
3.0	-3.0	0.66	0.00	0.66
5.0	-5.0	1.42	0.00	1.42
7.0	-7.0	2.56	0.00	2.56
9.0	-9.0	4.17	0.00	4.17
11.0	-11.0	5.83	0.00	5.83
13.0	-13.0	7.70	0.00	7.70
15.0	-15.0	9.62	0.00	9.62
17.0	-17.0	11.90	0.00	11.90
19.0	-19.0	14.34	0.00	14.34
21.0	-21.0	16.60	0.00	16.60
23.0	-23.0	19.10	0.00	19.10
25.0	-25.0	21.47	0.00	21.47
27.0	-27.0	24.08	0.00	24.08
29.0	-29.0	27.75	0.00	27.75
31.0	-31.0	32.91	0.00	32.91
33.0	-33.0	38.97	0.00	38.97
35.0	-35.0	45.44	0.00	45.44
37.0	-37.0	52.03	0.00	52.03
39.0	-39.0	57.70	0.00	57.70
41.0	-41.0	60.88	0.00	60.88
43.0	-43.0	64.94	0.00	64.94
45.0	-45.0	68.03	0.00	68.03
47.0	-47.0	70.22	0.00	70.22
49.0	-49.0	72.97	0.00	72.97
51.0	-51.0	77.00	0.00	77.00
53.0	-53.0	81.24	0.00	81.24
55.0	-55.0	85.58	0.00	85.58
57.0	-57.0	90.08	0.00	90.08
59.0	-59.0	94.83	0.00	94.83
61.0	-61.0	99.87	0.00	99.87
63.0	-63.0	103.71	0.00	103.71
65.0	-65.0	106.62	0.00	106.62
67.0	-67.0	109.53	0.00	109.53
69.0	-69.0	112.60	0.00	112.60
71.0	-71.0	114.60	0.00	114.60
73.0	-73.0	116.73	0.00	116.73
75.0	-75.0	121.80	0.00	121.80
77.0	-77.0	128.89	0.00	128.89
79.0	-79.0	135.98	0.00	135.98
81.0	-81.0	143.10	0.00	143.10
83.0	-83.0	150.22	0.00	150.22
85.0	-85.0	157.35	0.00	157.35
87.0	-87.0	164.48	0.00	164.48
89.0	-89.0	171.62	0.00	171.62
91.0	-91.0	178.76	0.00	178.76
93.0	-93.0	185.91	0.00	185.91
95.0	-95.0	193.07	0.00	193.07
97.0	-97.0	200.23	0.00	200.23
99.0	-99.0	206.81	0.00	206.81
101.0	-101.0	211.54	0.00	211.54

24-IN STEEL PIPE PILES

SOIL BORING: CC-1
24-IN STEEL PIPE PILE (OPEN-ENDED)

TEST PILE LENGTH (FT)	PILE TIP DEPTH (FT)	ULTIMATE SIDE FRICTION (TONS)	MOBILIZED END BEARING (TONS)	ESTIMATED DAVISSON CAPACITY (**DC**) (TONS)
1.0	-1.0	0.11	0	0.11
3.0	-3.0	0.89	0	0.89
5.0	-5.0	1.91	0	1.91
7.0	-7.0	3.37	0	3.37
9.0	-9.0	5.36	0	5.36
11.0	-11.0	7.27	0	7.27
13.0	-13.0	9.48	0	9.48
15.0	-15.0	11.75	0	11.75
17.0	-17.0	14.1	0	14.1
19.0	-19.0	16.92	0	16.92
21.0	-21.0	19.62	0	19.62
23.0	-23.0	22.61	0	22.61
25.0	-25.0	25.45	0	25.45
27.0	-27.0	28.58	0	28.58
29.0	-29.0	32.96	0	32.96
31.0	-31.0	39.12	0	39.12
33.0	-33.0	46.35	0	46.35
35.0	-35.0	54.08	0	54.08
37.0	-37.0	61.96	0	61.96
39.0	-39.0	68.74	0	68.74
41.0	-41.0	72.55	0	72.55
43.0	-43.0	77.42	0	77.42
45.0	-45.0	81.13	0	81.13
47.0	-47.0	83.77	0	83.77
49.0	-49.0	87.07	0	87.07
51.0	-51.0	91.9	0	91.9
53.0	-53.0	96.98	0	96.98
55.0	-55.0	102.19	0	102.19
57.0	-57.0	107.58	0	107.58
59.0	-59.0	113.28	0	113.28
61.0	-61.0	119.31	0	119.31
63.0	-63.0	123.91	0	123.91
65.0	-65.0	127.41	0	127.41
67.0	-67.0	130.91	0	130.91
69.0	-69.0	134.59	0	134.59
71.0	-71.0	137	0	137
73.0	-73.0	139.57	0	139.57
75.0	-75.0	145.64	0	145.64
77.0	-77.0	154.13	0	154.13
79.0	-79.0	162.63	0	162.63
81.0	-81.0	171.15	0	171.15
83.0	-83.0	179.69	0	179.69
85.0	-85.0	188.23	0	188.23
87.0	-87.0	196.77	0	196.77
89.0	-89.0	205.33	0	205.33
91.0	-91.0	213.89	0	213.89
93.0	-93.0	222.46	0	222.46
95.0	-95.0	231.03	0	231.03
97.0	-97.0	239.63	0	239.63
99.0	-99.0	247.51	0	247.51
101.0	-101.0	253.19	0	253.19

18-IN SQUARE CONCRETE PILES

SOIL BORING: CC-1
18-IN SQUARE CONCRETE PILE

TEST PILE LENGTH (FT)	PILE TIP DEPTH (FT)	ULTIMATE SIDE FRICTION (TONS)	MOBILIZED END BEARING (TONS)	ESTIMATED DAVISSON CAPACITY (**DC**) (TONS)
1.0	-1.0	0.11	8.47	8.59
3.0	-3.0	0.79	11.46	12.25
5.0	-5.0	1.62	12.97	14.59
7.0	-7.0	2.83	14.91	17.74
9.0	-9.0	4.50	16.90	21.40
11.0	-11.0	6.24	18.86	25.10
13.0	-13.0	8.06	21.77	29.83
15.0	-15.0	10.02	24.85	34.87
17.0	-17.0	12.27	27.91	40.18
19.0	-19.0	14.93	29.56	44.49
21.0	-21.0	17.50	29.77	47.27
23.0	-23.0	20.31	32.04	52.35
25.0	-25.0	23.00	39.24	62.24
27.0	-27.0	25.98	50.78	76.76
29.0	-29.0	30.26	63.67	93.93
31.0	-31.0	36.72	74.77	111.48
33.0	-33.0	45.02	82.24	127.26
35.0	-35.0	54.49	78.07	132.56
37.0	-37.0	64.28	71.91	136.19
39.0	-39.0	72.42	68.50	140.91
41.0	-41.0	76.38	64.99	141.38
43.0	-43.0	81.27	58.30	139.58
45.0	-45.0	85.01	54.63	139.64
47.0	-47.0	87.64	52.87	140.50
49.0	-49.0	90.90	50.24	141.14
51.0	-51.0	95.70	47.92	143.61
53.0	-53.0	100.74	50.17	150.90
55.0	-55.0	105.93	52.80	158.73
57.0	-57.0	111.34	54.22	165.56
59.0	-59.0	117.13	52.75	169.88
61.0	-61.0	123.38	48.94	172.32
63.0	-63.0	127.97	46.89	174.86
65.0	-65.0	131.38	43.88	175.26
67.0	-67.0	134.78	39.79	174.57
69.0	-69.0	138.36	42.54	180.91
71.0	-71.0	140.76	60.96	201.72
73.0	-73.0	143.40	79.89	223.29
75.0	-75.0	152.15	92.59	244.74
77.0	-77.0	165.15	100.84	265.98
79.0	-79.0	178.12	109.22	287.34
81.0	-81.0	190.92	118.39	309.31

24-IN SQUARE CONCRETE PILES

SOIL BORING: CC-1
24-IN SQUARE CONCRETE PILE

TEST PILE LENGTH (FT)	PILE TIP DEPTH (FT)	ULTIMATE SIDE FRICTION (TONS)	MOBILIZED END BEARING (TONS)	ESTIMATED DAVISSON CAPACITY (**DC**) (TONS)
1.0	-1.0	0.15	18.00	18.15
3.0	-3.0	1.25	25.17	26.42
5.0	-5.0	2.58	26.63	29.22
7.0	-7.0	4.39	28.71	33.10
9.0	-9.0	6.78	30.80	37.58
11.0	-11.0	9.01	33.32	42.33
13.0	-13.0	11.58	35.61	47.19
15.0	-15.0	14.18	38.00	52.17
17.0	-17.0	16.76	41.48	58.24
19.0	-19.0	19.75	44.89	64.64
21.0	-21.0	22.20	50.73	72.94
23.0	-23.0	24.56	61.93	86.49
25.0	-25.0	27.37	78.67	106.04
27.0	-27.0	31.26	98.07	129.33
29.0	-29.0	36.74	116.97	153.72
31.0	-31.0	44.93	130.84	175.78
33.0	-33.0	55.46	129.25	184.71
35.0	-35.0	67.50	120.39	187.88
37.0	-37.0	80.01	113.87	193.88
39.0	-39.0	90.53	104.18	194.71
41.0	-41.0	95.85	101.90	197.75
43.0	-43.0	102.32	101.73	204.05
45.0	-45.0	107.35	104.43	211.78
47.0	-47.0	110.96	106.15	217.11
49.0	-49.0	115.38	104.89	220.26
51.0	-51.0	121.74	100.24	221.97
53.0	-53.0	128.41	96.85	225.25
55.0	-55.0	135.28	93.79	229.07
57.0	-57.0	142.43	91.08	233.50
59.0	-59.0	150.08	84.54	234.62
61.0	-61.0	158.32	80.44	238.76
63.0	-63.0	164.43	78.18	242.62
65.0	-65.0	169.02	75.18	244.21
67.0	-67.0	173.61	77.45	251.05
69.0	-69.0	178.42	99.68	278.10
71.0	-71.0	181.70	126.69	308.39
73.0	-73.0	185.29	152.57	337.86
75.0	-75.0	196.78	167.41	364.19
77.0	-77.0	213.77	174.71	388.48
79.0	-79.0	230.75	185.27	416.02
81.0	-81.0	247.52	197.83	445.36