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Geotechnical Exploration and Evaluation Report

JEA Large Diameter Pipe Evaluation and Replacement Program
Silversmith Creek Crossing
Jacksonville, Florida

CSI Geo Project No.: 71-17-135-11
Arcadis Project No.: 06442003.0001
Work Authorization No.: JEA-003

Prepared by

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Prepared for

Arcadis US, Inc.

February 10, 2017

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February 10, 2017

Mr. James Wood, P.E.
Arcadis US, Inc.
2434 North Pearl Street
Jacksonville, Florida 32206

RE: JEA Large Diameter Pipe Evaluation and Replacement Program
Silversmith Creek Crossing
Jacksonville, Florida

Subject: Geotechnical Exploration and Evaluation Report
CSI Geo Project No.: 71-17-135-11
Arcadis Project No.: 06442003.0001
Work Authorization No.: JEA-003

Dear Mr. Wood:

CSI Geo, Inc. has performed the authorized geotechnical exploration and evaluation for the proposed JEA Large Diameter Pipe Evaluation and Replacement Program at the Silversmith Creek Crossing in Jacksonville, Florida. This report presents our understanding of the subsurface conditions along with our engineering evaluation and recommendations.

We have enjoyed working with you on this project and look forward to working with you on future projects. If you have any questions concerning this report, please contact our office.

Sincerely,

CSI Geo, Inc.

Nader Amer, Ph.D
Project Engineer

Bruce Khosrozadeh
2017.02.10
12:46:51-05'00'

Bruce Khosrozadeh, P.E.
Senior Geotechnical and
Materials Engineer
Registered, Florida No. 45273

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APPENDIX

1.0 PROJECT INFORMATION

1.1 General Project Information

This Geotechnical Exploration and Evaluation Report has been prepared for the proposed JEA large diameter pipe evaluation and replacement at the Silversmith Creek crossing in Jacksonville, Florida. The purpose of this geotechnical exploration program was to develop information concerning the subsurface conditions in order to evaluate the site with respect to the proposed replacement of the existing aerial pipe crossing over Silversmith Creek. We understand that the proposed pipe replacement will be installed via horizontal directional drilling (HDD) methods. This report discusses the project background information, the geotechnical investigation program, geotechnical-related findings, engineering evaluation and recommendations.

Information regarding this project was provided to CSI Geo, Inc. (CSI Geo) by Mr. James Wood, P.E. of Arcadis, U.S., Inc. (Arcadis).

1.2 Existing Conditions and Project Description

The project site is located just north of SR 10 (Atlantic Blvd.) between Almeria Avenue and Johnston Avenue. A Site Location Map is included in the **Appendix**. The existing aerial crossing is supported on timber pilings clad in concrete. Based on the information provided to us, we understand that the existing timber pile supports are failing and therefore, a new pipe crossing will be installed by means of Horizontal Directional Drilling (HDD) as a replacement.

Photo 01 - Existing Aerial Pipe Crossing

2.0 GEOTECHNICAL EXPLORATION

2.1 Field Exploration

The areas of pipe installation by HDD method were explored by means of two Standard Penetration Test (SPT) borings B-1 and B-2, each drilled to a depth of 40 feet below the existing grades. The test borings were located and drilled approximately 300 feet away from each side of the creek. The boring locations were determined by Arcadis and located in the field by personnel from CSI Geo. Soil samples collected were visually classified in the field and then transported to our laboratory for re-classification and testing. In this presentation, soil strata encountered by the borings are classified using the Unified Soil Classification System (USCS). The approximate locations of the soil borings are shown on the Field Exploration Plan sheet included in the **Appendix**.

The stratification lines and depth designations on the Report of SPT Borings represent the approximate boundary between the various soils encountered, and the transition from one stratum to the next should be considered approximate. When reviewing the Report of SPT Borings and the subsurface conditions outlined below, it should be understood that the soil conditions may vary between boring locations, and that the transition between soil strata may be gradual. A brief discussion of the drilling, sampling, and field testing techniques used during the field investigation program are provided in the Field and Laboratory Test Procedures sheets presented in the **Appendix**.

2.2 Laboratory Testing

Quantitative laboratory testing was performed on representative soil samples recovered from the field exploration. These tests were performed to better define the physical properties of the soils encountered. The laboratory tests were performed to determine percent fines (-200 sieve), percent organics, natural moisture content, full gradation and Atterberg Limits of the soil samples. The Summary of Laboratory Test Results, and Field and Laboratory Test Procedures are included in the **Appendix**.

3.0 GENERAL SUBSURFACE CONDITIONS

3.1 Subsurface Conditions

Review of test borings B-1 and B-2 indicates that the area is generally underlain by inter-bedded deposits of very loose to medium dense sands (SP), slightly silty sands (SP-SM), silty sands (SM), soft to stiff plastic clayey sands (SC), sandy clays (CL) clays (CL/CH), and lenses of highly weathered limestone until the boring termination depth of 40 feet below the existing ground surface.

3.2 Groundwater Level

The groundwater level was measured and recorded as encountered at the time of drilling. The depth of the groundwater level at the test locations are marked on the Report of SPT Borings sheet presented in the **Appendix**. The depth of groundwater level measured at the time of drilling ranged from 6 to 7 feet below the existing ground surface. It should be anticipated that the groundwater level will fluctuate due to water fluctuations in Silversmith Creek, seasonal climate variations, surface water runoff patterns, tidal effects, nearby bodies of water, and other related factors.

4.0 DESIGN RECOMMENDATIONS

4.1 General

Our geotechnical evaluation of the site and the subsurface conditions is based on our understanding of the proposed project, our observations, and results of field and laboratory testing. If the project location is changed or if field conditions encountered during construction are different from those presented in this report, the information should be provided to CSI Geo for evaluation. We also recommend that CSI Geo be given the opportunity to review the design plans and specifications to ensure that our recommendations have been properly included and implemented.

4.2 Horizontal Directional Drilling Design Soil Parameters

We recommend that soil parameters and assumptions to be used for the project should include the following:

Recommended Design Soil Parameters for Horizontal Directional Drilling (HDD)
Boring B-1

Soil Parameter	Loose Sands	Medium Dense Sand	Very Loose Clayey Sands	Soft Limestone	Hard Limestone
Depth (ft)	0.0 – 12.0	12.0 – 23.0	23.0 – 28.0	28.0 – 37.0	37.0 – 40.0
Saturated unit weight (pcf)	105	110	90	105	145
Effective unit weight for input purposes (pcf)	43	48	28	43	83
Estimated friction angle ϕ (degrees)	30	32	---	32	38
Cohesion – C (psf)	---	---	300	---	---
At Rest Pressure Coefficient (K_o)	0.50	0.47	1.0	0.47	0.38
Active Pressure Coefficient (K_a)	0.33	0.31	1.0	0.31	0.24
Passive Pressure Coefficient (K_p)	3.00	3.25	1.0	3.25	4.20

Recommended Design Soil Parameters for Horizontal Directional Drilling (HDD)
Boring B-2

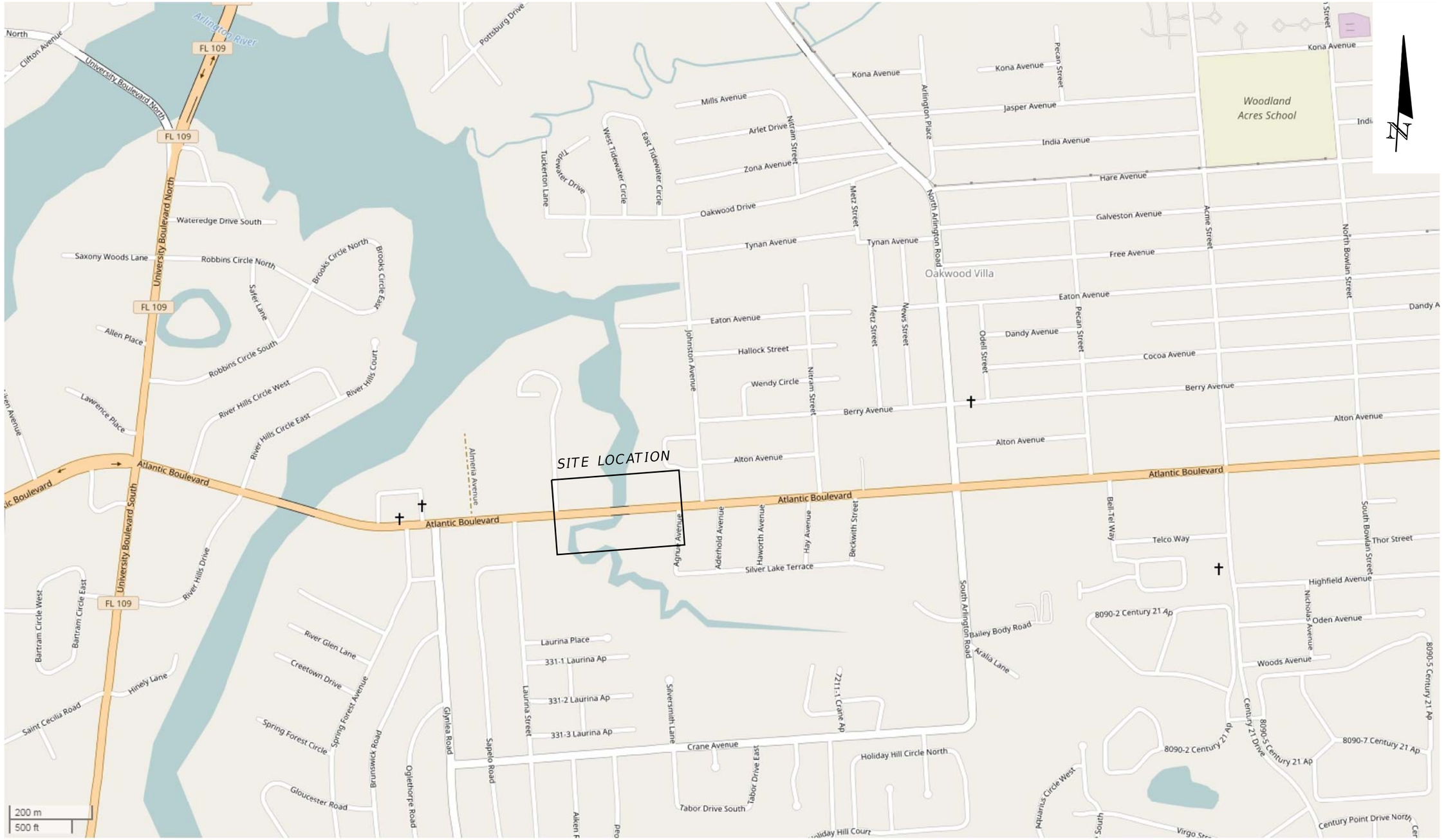
Soil Parameter	Medium Dense Sands	Soft to Firm Clayey Sands	Firm Clays	Loose Silty Sands	Soft Limestone
Depth (ft)	0.0 – 5.0	5.0 – 13.0	13.0 – 29.0	29.0 – 38.0	38.0 – 40.0
Saturated unit weight (pcf)	115	100	95	100	130
Effective unit weight for input purposes (pcf)	53	38	33	38	68
Estimated friction angle ϕ (degrees)	34	---	---	27	34
Cohesion – C (psf)	---	1,000	800	---	---
At Rest Pressure Coefficient (K_o)	0.44	1.0	1.0	0.55	0.44
Active Pressure Coefficient (K_a)	0.28	1.0	1.0	0.38	0.28
Passive Pressure Coefficient (K_p)	3.54	1.0	1.0	2.66	3.54

6.0 REPORT LIMITATIONS

The subsurface exploration program including our evaluation and recommendations was performed in general accordance of accepted geotechnical engineering principles and standard practices. CSI Geo is not responsible for any independent conclusions, opinions, or interpretations made by others based on the data presented in this report.

This report does not reflect any variations that may occur adjacent or between soil borings. The discovery of any site or subsurface condition during construction that deviates from the findings and data as presented in this report should be reported to CSI Geo for evaluation. If the location of the proposed project was changed, our office should be contacted so our recommendations can be re-evaluated. We recommend that CSI Geo be given the opportunity to review the final design drawings and specifications to ensure that our recommendations are properly included and implemented.

APPENDIX



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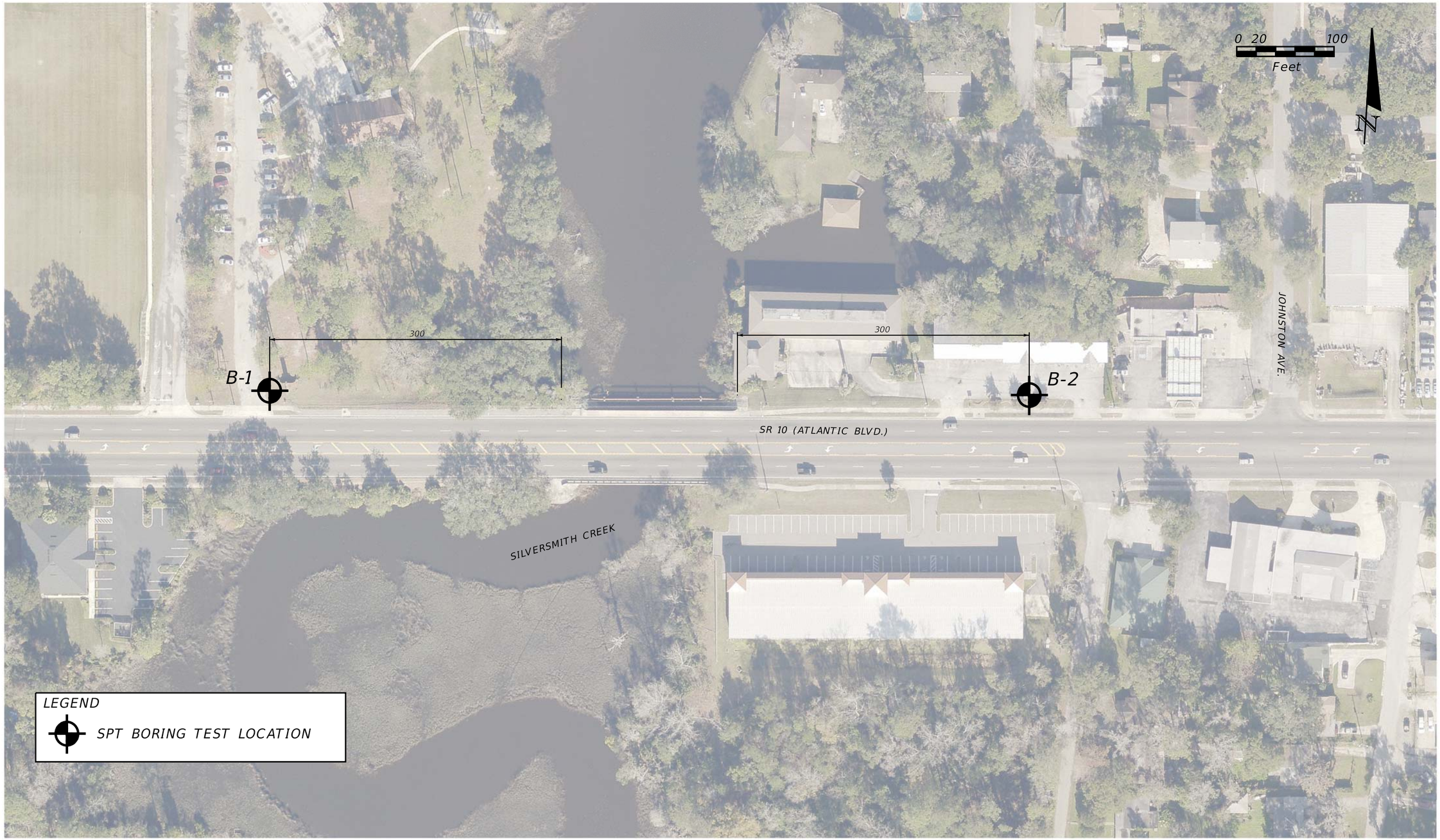
SITE LOCATION MAP

JEA LARGE DIAMETER PIPE EVALUATION AND REPLACEMENT
PROGRAM AT SILVERSMITH CREEK CROSSING
JACKSONVILLE, FLORIDA



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FIELD EXPLORATION PLAN

JEA LARGE DIAMETER PIPE EVALUATION AND REPLACEMENT
PROGRAM AT SILVERSMITH CREEK CROSSING
JACKSONVILLE, FLORIDA

LEGEND

FINE SAND (SP);
SLIGHTLY SILTY FINE SAND (SP–SM);

CLAYEY FINE SAND (SC)

LIMEROCK

SILTY FINE SAND (SM)

LIMESTONE

SANDY CLAY (CL)

CLAY (CH)

ASPHALT

(SP) USCS (UNIFIED SOIL CLASSIFICATION SYSTEM)

GROUND WATER LEVEL AT TIME OF DRILLING

B.T. BORING TERMINATION

50/X" NUMBER OF BLOWS TO DRIVE SAMPLER X INCHES

W NATURAL MOISTURE CONTENT (%)
−200 FINES PASSING NO. 200 SIEVE (%)
OC% ORGANIC CONTENT PERCENT (%)
LL LIQUID LIMIT
PI PLASTICITY INDEX

H.A. HAND AUGER

N STANDARD PENETRATION RESISTANCE IN BLOWS PER FT UNLESS OTHERWISE NOTED, NUMBERS TO THE LEFT OF BORING INDICATE N–VALUES.

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N–VALUE (BLOWS/FT)
VERY LOOSE	LESS THAN 3
LOOSE	3–8
MEDIUM DENSE	8–24
DENSE	24–40
VERY DENSE	GREATER THAN 40

SILT AND CLAYS

CONSISTENCY	AUTOMATIC HAMMER SPT N–VALUE (BLOWS/FT)
VERY SOFT	LESS THAN 1
SOFT	1–3
FIRM	3–6
STIFF	6–12
VERY STIFF	12–24
HARD	GREATER THAN 24

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA. 1.44 INCHES
SPOON OUTSIDE DIA. 2.0 INCHES
ASTM STANDARD DROP HAMMER, AUTO.

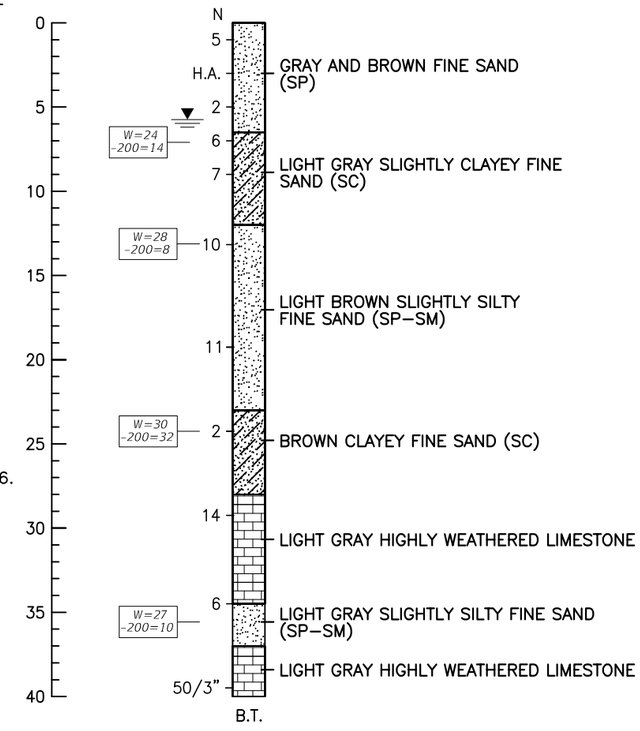
AVG. HAMMER DROP 30.0 INCHES
HAMMER WEIGHT 140.0 LBS

NOTES:

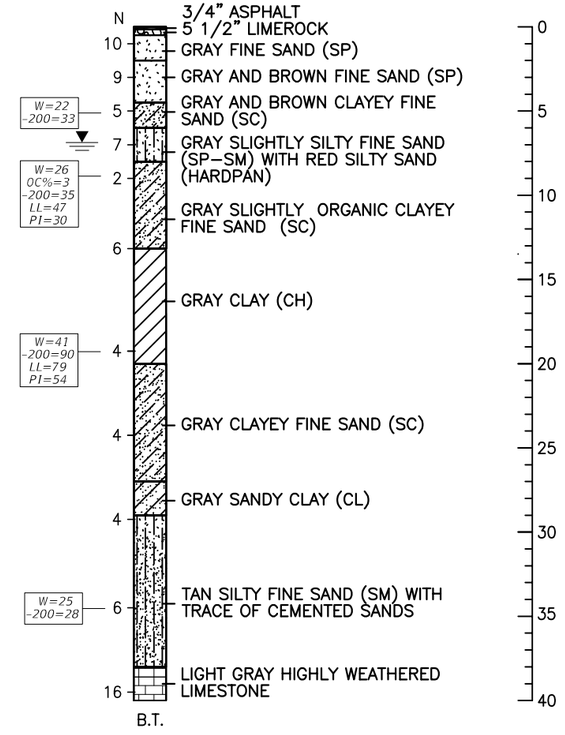
1) DRILL AND PENETRATION TESTING WAS PERFORMED IN ACCORDANCE WITH ASTM D–1586.

2) LAYER BOUNDARIES ARE APPROXIMATE AND MAY VARY BETWEEN OR AWAY FROM BORING LOCATIONS.

B–1
LAT: 30°18'46.81"N
LONG: 81°35'19.15"W
DATE: 1–24–17
HAMMER AUTO



B–2
LAT: 30°18'47.32"N
LONG: 81°35'10.26"W
DATE: 1–24–17
HAMMER AUTO



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REPORT OF SPT BORINGS

JEA LARGE DIAMETER PIPE EVALUATION AND REPLACEMENT PROGRAM AT SILVERCREEK CROSSING
JACKSONVILLE, FLORIDA

SUMMARY OF LABORATORY TEST RESULTS

JEA Large Diameter Pipe Evaluation and Replacement Program
Silversmith Creek Crossing
Jacksonville, Florida

Boring No.	Sample No.	Approximate Depth (ft)	Natural Moisture Content (%)	Organic Content (%)	Percent Passing Sieve Size (%)						Atterberg Limits		Soil Classification Symbol
					#4	#10	#40	#60	#100	#200	LL	PI	
B-1	4	6.5 - 8.5	24		100	100	100	99	65	14			SC
B-1	6	13.5 - 15.0	28		100	100	100	99	59	8			SP-SM
B-1	8	23.5 - 25.0	30							32			SC
B-1	10	34.5 - 35.0	27		100	96	69	45	16	10			SP-SM
B-2	3	4.5 - 6.0	22							33			SC
B-2	5	8.0 - 10.0	26	3						35	47	30	SC
B-2	7	18.5 - 20.0	41							90	79	54	CH
B-2	10	33.5 - 35.0	25							28			SM

KEY TO SOIL CLASSIFICATION

Correlation of Penetration Resistance with Relative Density and Consistency

Granular Materials		Silts and Clays	
Relative Density	**Automatic Hammer SPT N-Value (Blows/foot)**	**Consistency**	**Automatic Hammer SPT N-Value (Blows/foot)**
Very Loose	Less than 3	Very Soft	Less than 1
Loose	3 – 8	Soft	1 – 3
Medium	8 - 24	Firm	3 - 6
Dense	24 - 40	Stiff	6 - 12
Very Dense	Greater than 40	Very Stiff	12 - 24
		Hard	Greater than 24

Particle Size Identification (Unified Soil Classification System)

Boulders:	Diameter exceeds 8 inches
Cobbles:	3 to 8 inches diameter
Gravel:	Coarse - 3/4 to 3 inches in diameter
	Fine - 4.76 mm to 3/4 inch in diameter
Sand:	Coarse - 2.0 mm to 4.76 mm in diameter
	Medium - 0.42 mm to 2.0 mm in diameter
	Fine - 0.074 mm to 0.42 mm in diameter

Modifiers

These modifiers provide our estimate of the amount of fines (silt or clay size particles) in soil samples.

Approximate Fines Content	Modifiers
5% Fines 12%	Slightly silty or slightly clayey
12% Fines 30%	Silty or clayey
30% Fines 50%	Very silty or very clayey

These modifiers provide our estimate of shell, rock fragments, or roots in the soil sample.

Approximate Content, By Weight	Modifiers
< 5%	Trace
5% to 10%	Few
15% to 25%	Little
30% to 45%	Some
50% to 100%	Mostly

These modifiers provide our estimate of organic content in the soil sample.

Organic Content	Modifiers
1% to 3%	Trace
3% to 5%	Slightly Organic
5% to 20%	Organic
20% to 75%	Highly Organic (Muck)
> 75%	Peat

FIELD AND LABORATORY TEST PROCEDURES

FIELD TEST PROCEDURES

Standard Penetration Test (SPT) Borings – The soil penetration test borings were made in general accordance with ASTM D1586, "Penetration Test and Split-Barrel Sampling of Soils". The borings were advanced by continuous driving the split spoon sampler to a depth of 10 feet below the existing ground surface. Below 10 feet and until boring termination depths, split spoon sampling was performed at a spacing of 5 feet. Bentonite drilling fluid was used below the ground water level to stabilize the sides and to flush the cuttings. At the sampling intervals, the drilling tools were removed and soil samples were obtained with a standard 1.4 inch I.D., 2.0 inch O.D., split-tube sampler. The sampler was first seated six inches and then driven an additional foot with blows of a 140 pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot is designated the "Penetration Resistance". The penetration resistance, when properly interpreted, is an index to the soil strength and density.

Representative portions of the soil samples, obtained from the sampler, were placed in glass jars and transported to our laboratory. The samples were then examined by a geotechnical engineer to confirm the field classifications.

LABORATORY TEST PROCEDURES

Percent Organic Content – This test is based on the percent of organics by weight of the total sample. This test was conducted in accordance with FM I - T 267.

Percent Fines Content – To determine the percentage of soils finer than No. 200 sieve, the dried samples were washed over a 200 mesh sieve. The material retained on the sieve was oven dried and then weighed and compared with the unwashed dry weight in order to determine the weight of the fines. The percentage of fines in the soil sample was then determined as the percentage of weight of fines in the sample to the weight of the unwashed sample. This test was conducted in accordance with ASTM D 1140.

Natural Moisture Content – The water content is the ratio, expressed as a percentage, of the weight of water in a given mass of soil to the weight of the solid particles. This test was conducted in the general accordance with FM 1-T 265.

Grain Size Distribution – The grain size tests were performed to determine the particle size and distribution of the samples tested. Each sample was dried, weighed, and washed over a No. 200 mesh sieve. The dried sample was then passed through a standard set of nested sieves to determine the grain size distribution of the soil particles coarser than the No. 200 sieve. This test is similar to that described by FM I - T 088.

Plasticity (Atterberg Limits) – The soil's Plastic Index (PI) is bracketed by the Liquid Limit (LL) and Plastic Limit (PL). The LL is the moisture content at which the soil flows as a heavy viscous fluid and is determined in general accordance with FM 1-T 089. The PL is the moisture content at which the soil begins to crumble when rolled into a small thread and is also determined in general accordance with FM 1-T 090. The water-plasticity ratio is computed from the above test data. This ratio is an expression comparing the relative natural state of soil with its liquid and plastic consolidation characteristics.

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