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Geotechnical Exploration and Evaluation Report
Revision No. 01

Main Street from Sara Drive to Noah Road
Force Main Replacement
Duval County, Florida

CSI Geo Project No.: 71-16-339-01
Constantine Project No.: 100433.01

Prepared by

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Prepared for

Constantine Engineering, Inc.

January 13, 2017

CSI Geo

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January 13, 2017

Mr. Ted Hortenstine, P.E.
Constantine Engineering, Inc.
311 State Road 16
St. Augustine, FL 32084

RE: Main Street from Sara Drive to Noah Road Force Main Replacement
Duval County, Florida

Subject: Geotechnical Exploration and Evaluation Report (Revision No. 01)
CSI Geo Project No.: 71-16-339-01
Constantine Project No.: 100433.01

Dear Mr. Hortenstine:

CSI Geo, Inc. has performed the authorized geotechnical exploration and laboratory testing program for the proposed force main replacement in Duval County, Florida. Our last geotechnical exploration and evaluation report was prepared and submitted on December 13, 2016. Since that submittal, additional geotechnical exploration was requested to perform one auger boring and one pavement core near Sara Drive. This revised geotechnical exploration and evaluation 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
Geotechnical Engineer

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

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1.0 PROJECT INFORMATION

1.1 General Project Information

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 force main along Main St. N. from Sara Drive to Noah Road in Duval County, Florida. Our last geotechnical exploration and evaluation report was prepared and submitted on December 13, 2016. Since that submittal, additional geotechnical exploration was requested to perform one auger boring and one pavement core near Sara Drive.

This revised geotechnical exploration and evaluation report presents our understanding of the subsurface conditions along with our engineering evaluation and recommendations. The subsurface soil and groundwater conditions are presented in this report along with general site preparation recommendations and soil parameters for the proposed construction.

Information regarding this project was provided to CSI Geo, Inc. (CSI Geo) by Mr. Ted Hortenstine, P.E. of Constantine Engineering, Inc.

1.2 Existing Conditions and Project Description

The proposed force main will consist of 3,300 feet of 16-inch diameter PVC pipe that will replace an aging 16-inch ductile iron force main. The existing 16-inch ductile iron main has reached the end of its service life and will be placed out of service upon completion of the new force main. The new force main will connect to a newly installed 20-inch PVC force main along Noah Road.

The force main alignment, which begins at Sara Drive and extends to west of Noah Road, crosses a CSX railway single rail spur and associated right-of-way just north of Eastport Road. Based on the information provided to us, we understand that the force main will be installed by means of open-cut pipe installation method. Pipe installation across the CSX right-of-way will be performed by means of horizontal directional drilling (HDD).

2.0 GEOTECHNICAL EXPLORATION

2.1 Field Exploration

The pipe areas where open-cut method will be utilized were initially explored by means of a total of nine auger borings (A-1 through A-9) drilled to a depth of 10 feet below the existing ground surface. Based on updated design limits and requirements, an additional auger boring (A-1a) was performed south of Sara Drive to a depth of 10 feet below the existing ground surface. The pipe area where HDD will be utilized was explored by means of two Standard Penetration Test (SPT) borings (B-1 and B-2) and drilled to a depth of 30 and 35 feet below the existing ground surface. The field exploration also included four pavement cores (C-1, C-1a, C-2, and C-3) taken along Sara Drive and Eastport Road in order to evaluate the existing pavement system thicknesses.

The boring locations were spaced at approximately 400 feet intervals, 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. The approximate locations of the soil borings and pavement cores are shown on the Field Exploration Plan sheets included in the **Appendix**.

2.2 Laboratory Testing

Representative soil samples obtained during our field exploration program were visually classified using the American Association of State Highway and Transportation Officials (AASHTO) Soil Classification System. Quantitative laboratory testing was performed on representative soil samples to better define their composition. Laboratory tests performed were percent fines, natural moisture content, and Atterberg limits. A Summary of Laboratory Test Results, and Field and Laboratory Test Procedures are included in the **Appendix**.

3.0 GENERAL SUBSURFACE CONDITIONS

3.1 General

An illustrated representation of the subsurface conditions encountered in the proposed construction areas are shown on the General Subsurface Profiles sheets presented in the **Appendix**. The General Subsurface Profiles and the soil conditions outlined below highlight the major subsurface stratifications. The General Subsurface Profiles in the **Appendix** should be consulted for a detailed description of the subsurface conditions encountered at each boring location. When reviewing the General Subsurface Profiles, it should be understood that soil conditions may vary outside of the explored area.

3.2 Soil Conditions

Open-Cut Excavation Areas

Review of test borings A-1a and A-1 through A-9 indicates that the explored areas are generally underlain by inter-bedded deposits of sands and slightly silty sands (A-3) until the boring termination depth of 10 feet below the existing grades. Silty sands (A-2-4) were encountered in borings A-1a and A-2 between the depths of 8 and 10 feet below existing grades.

Horizontal Directional Drilling (HDD) Area

Review of test boring B-1, performed to the south of the CSX railroad crossing, indicates that this area is generally underlain by loose to dense sands and slightly silty sands (A-3) until the boring termination depth of 30 feet below the existing grades.

Test boring B-2, performed to the north of the CSX railroad crossing, indicates that this area is generally underlain by very loose to medium dense sands (A-3) to a depth of 16 feet below existing grades. Beneath the sandy soils, very soft to firm sandy clays (A-7) followed by medium dense sands (A-3) were encountered until the boring termination depth of 35 feet below the existing grades. Boring B-2 was extended to a depth of 35 feet in order to penetrate through the soft clayey soils.

3.3 Groundwater Conditions

The groundwater level was measured and recorded as encountered at the time of drilling. The depths of the groundwater level and estimated seasonal high water level at the test location are marked on the General Subsurface Profiles sheets presented in the **Appendix**. The depth of groundwater level measured at the time of drilling ranged from 5.5 to 9.5 feet below the existing ground surface. It should be anticipated that the groundwater level will fluctuate due to seasonal climate variations, surface water runoff patterns, construction operations, tidal effects, and other related factors.

3.4 Existing Pavement System Thickness

Four pavement cores (C-1, C-1a, C-2, and C-3) were conducted to determine the existing pavement system thickness at the intersections of Main St. N. with Sara Drive and Eastport Road. The cores show that the pavement section consists of 5 to 15 inches of asphalt underlain by 10 to 15 inches of limerock. There was no limerock base encountered at the core performed at C-1. Complete results of the existing pavement system thickness are included in the **Appendix**.

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. The recommendations provided in this report present construction methods and techniques that are appropriate for the proposed construction. 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.

In general, we consider the subsurface soil conditions at the site to be favorable for support of the proposed pipes over a properly prepared and compacted subgrade, provided that the site preparation and earthwork construction recommendations in this report are performed.

4.2 Open-Cut Excavations

The A-3 type soils are considered Select material. Silty sands (A-2-4) can be treated as Select material; however, they may contain excess moisture and may be difficult to dry and to compact.

We anticipate that the buried pipe lines will exert little downward pressure on the subgrade soils. In areas where the surrounding groundwater level is above the pipe invert elevation, the line should be designed to resist lateral earth pressures and hydrostatic uplift pressures appropriate to its depth below the existing grade and the seasonal high water level.

4.3 Design Soil Parameters for Horizontal Directional Drilling

We understand that the force main will be installed deeper at the CSX railroad crossing to provide proper vertical separation. Due to the deeper installation, horizontal directional drilling will be utilized. We recommend that soil parameters and assumptions for the horizontal directional drilling design follow Tables 1 and 2 below:

TABLE 1 – RECOMMENDED SOIL PARAMETERS FOR HDD DESIGN
Based on Boring B-1 (South of CSX Crossing)

Soil Parameter	Loose Sand	Medium Dense Sand
Depth (ft)	0 to 12	12 to 30
Saturated unit weight (pcf)	105	115
Effective unit weight for input purposes (pcf)	43	53
Estimated friction angle ϕ (degrees)	31	33
At Rest Pressure Coefficient (K_o)	0.48	0.46
Active Pressure Coefficient (K_a)	0.32	0.29
Passive Pressure Coefficient (K_p)	3.12	3.39

TABLE 2 – RECOMMENDED SOIL PARAMETERS FOR HDD DESIGN
Based on Boring B-2 (North of CSX Crossing)

Soil Parameter	Very Loose Sand	Medium Dense Sand	Very Soft to Firm Clay	Loose Sand
Depth (ft)	0 to 12	12 to 16	16 to 32	32 to 35
Saturated unit weight (pcf)	100	120	95	105
Effective unit weight for input purposes (pcf)	38	58	33	43
Estimated friction angle ϕ (degrees)	28	34	---	30
Cohesion (psf)	---	---	400	---
At Rest Pressure Coefficient (K_o)	0.53	0.44	1.0	0.50
Active Pressure Coefficient (K_a)	0.36	0.28	1.0	0.33
Passive Pressure Coefficient (K_p)	2.77	3.54	1.0	3.00

5.0 SITE PREPARATION & EARTHWORK RECOMMENDATIONS

5.1 Existing Utilities

The locations of existing utilities should be established prior to construction. Provisions should be made to relocate utilities interfering with the proposed alignments and construction, as needed. Underground pipes that are not operational should be either removed or plugged otherwise they may become conduits for subsurface erosion and cause settlements.

5.2 Temporary Groundwater Control

Groundwater level was encountered at the time of drilling at a depth ranging from 5.5 to 8.5 feet below the existing ground surface. Therefore, groundwater control should be anticipated. The groundwater level should be maintained at a minimum of two feet below the subgrade of the proposed inverts. Dewatering may be achieved by conventional open pumping using ditches graded to a sump or by using a well point system. Dewatering should continue until sufficient weight is placed over the proposed pipes to resist uplift.

5.3 Excavation Protection

All excavations should meet OSHA Excavation Standard Subpart P regulations for Type C soils. A trench box or braced sheet pile structure may be required to support the open excavations. The soil support system shall be designed by a Florida registered Professional Engineer.

5.4 Pipe Backfill and Compaction of Pipe Backfill

As stated earlier, the A-3 type soils are considered Select material. Silty sands (A-2-4) can be treated as Select material; however, they may contain excess moisture and may be difficult to dry and to compact.

Clayey sands (A-2-6) and sandy clays (A-6/A-7) were not encountered along the open-cut excavation pipe alignment. If encountered during construction, they should be considered plastic materials and excavated to a minimum depth of one foot below the design invert elevations and replaced with suitable A-3 fill material. Organic soils (A-8) should be considered as muck and not suitable for use as backfill. If A-8 materials are encountered beneath the force main or other proposed structures they should be removed in their entirety.

The backfill material within the excavation should be placed in thin loose lifts not exceeding 6 or 12 inches in thickness as required by JEA. The backfill material shall be compacted by the use of hand-operated equipment. The backfill material shall be granular (A-3) fill with less than 10 percent material passing the no. 200 mesh sieve and containing less than 3 percent organic matter. The backfill material should be compacted to a minimum density of 98% or 95% of maximum dry density obtained from the Modified Proctor compaction test (ASTM D1557), as required by JEA. The moisture content during compaction shall be maintained within $\pm$ 3 percent of the optimum moisture content as obtained from the Modified Proctor compaction test.

Hand held compaction equipment shall be used for the backfill placed around the pipe and to a height of 2 feet above the pipe. Heavier equipment may be used on the remaining backfill lifts placed above the 2 feet above the pipe. However, care shall be taken not to damage the pipe below. The pipe shall be designed to withstand the anticipated dead (overburden) and live loads.

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 features change, 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

Site Location Map

Field Exploration Plan

General Subsurface Profiles

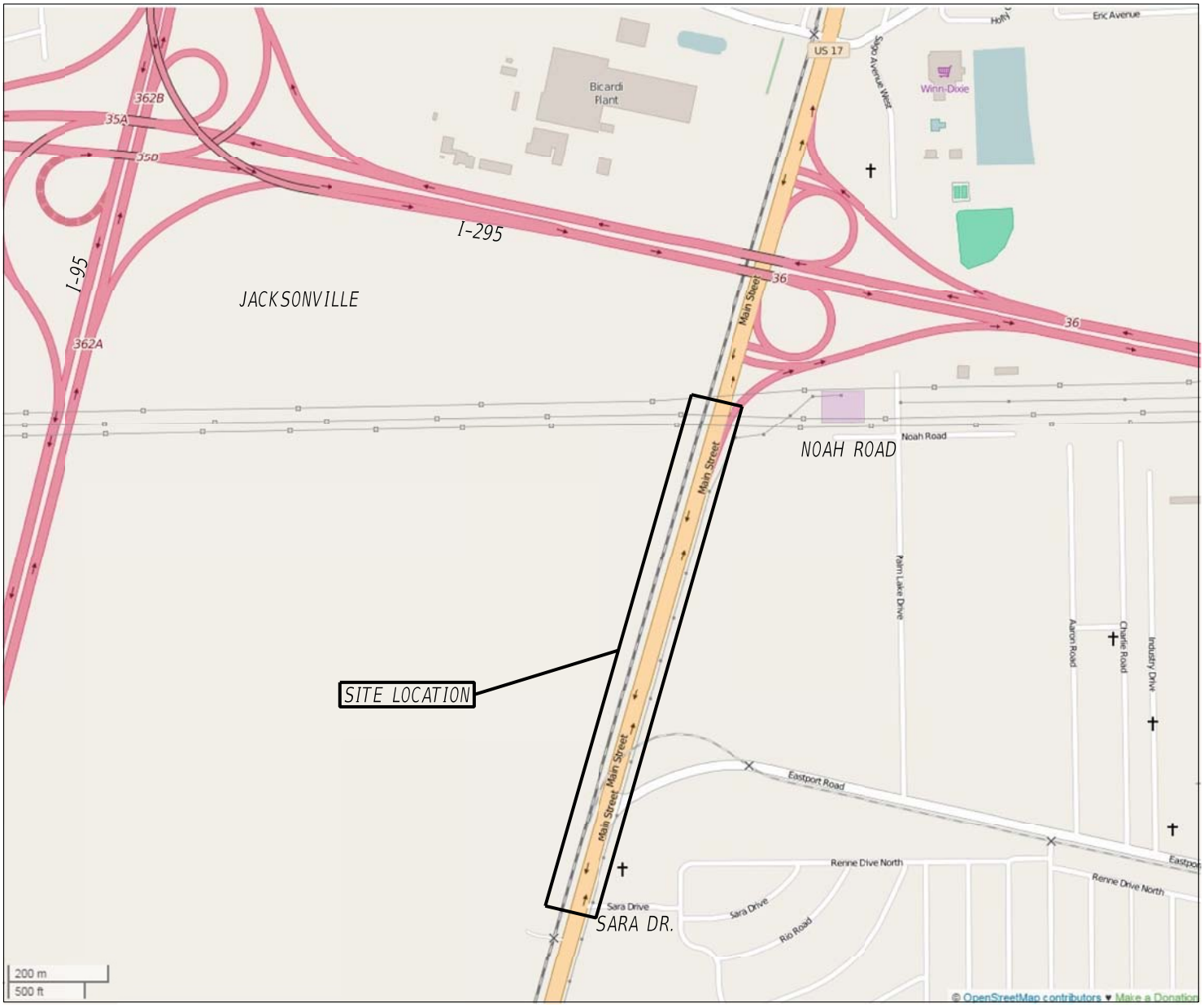
Summary of Laboratory Testing Results

Existing Pavement System Thickness

Key to Soil Classification

Field and Laboratory Test Procedures

Site Location Map



CSI GEO, INC. 2394 ST. JOHNS BLUFF ROAD S., SUITE 200 JACKSONVILLE, FLORIDA 32246	SITE LOCATION MAP MAIN STREET FROM SARA DRIVE TO NOAH ROAD FORCE MAIN REPLACEMENT DUVAL COUNTY, FLORIDA

Field Exploration Plan

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FIELD EXPLORATION PLAN

MAIN STREET FROM SARA DRIVE TO NOAH ROAD
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FIELD EXPLORATION PLAN

MAIN STREET FROM SARA DRIVE TO NOAH ROAD
FORCE MAIN REPLACEMENT
DUVAL COUNTY, FLORIDA

General Subsurface Profiles

LEGEND

FINE SAND;
SLIGHTLY SILTY FINE SAND (A–3)

SILTY FINE SAND (A–2–4)

SANDY CLAY (A–7)

(A–3) AASHTO SOIL CLASSIFICATION SYSTEM

A.T. AUGER BORING TERMINATION

B.T. STANDARD PENETRATION TEST BORING TERMINATION

GROUND WATER LEVEL AT TIME OF DRILLING

H.A. HAND AUGER

ESTIMATED SEASONAL HIGH GROUND WATER LEVEL

W.O.H. WEIGHT OF HAMMER

W
–200
LL
PI

NATURAL MOISTURE CONTENT (%)
FINES PASSING NO. 200 SIEVE (%)
LIQUID LIMIT
PLASTICITY INDEX

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

SILTS 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

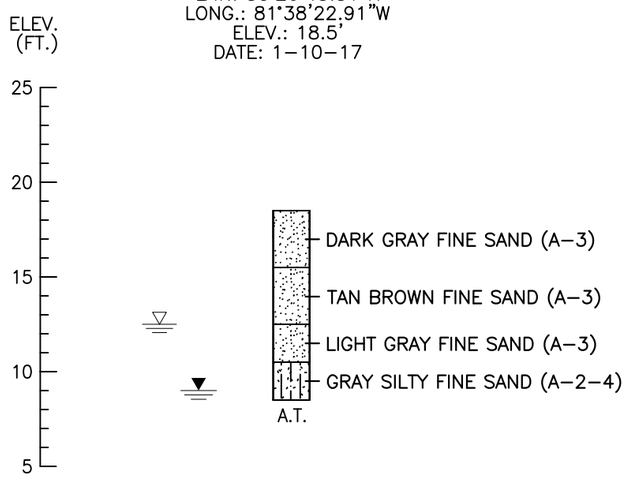
SPOON INSIDE DIA.	1.44 INCHES
SPOON OUTSIDE DIA.	2.0 INCHES
ASTM STANDARD DROP HAMMER, MANUAL.	
AVG. HAMMER DROP	30.0 INCHES
HAMMER WEIGHT	140.0 LBS

NOTES:

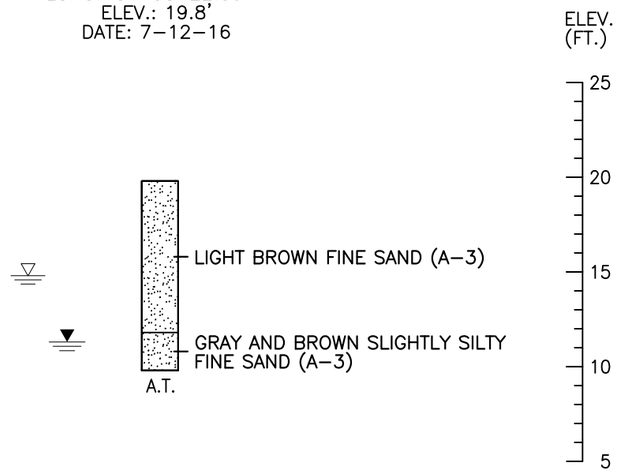
1) DRILL AND PENETRATION TESTING WAS PERFORMED IN ACCORDANCE WITH ASTM D–1586.

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

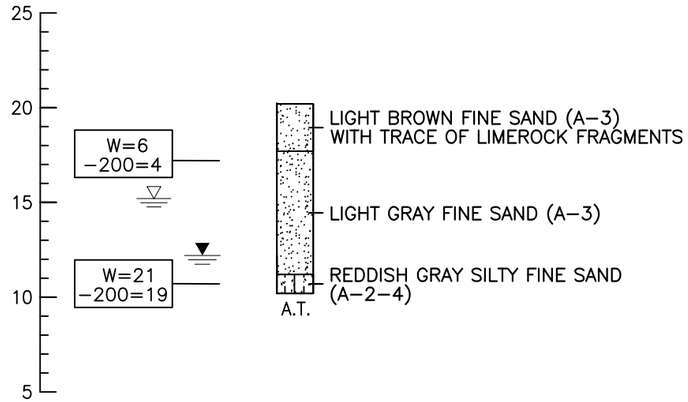
A–1a
LAT.: 30°26'43.51"N
LONG.: 81°38'22.91"W
ELEV.: 18.5'
DATE: 1–10–17



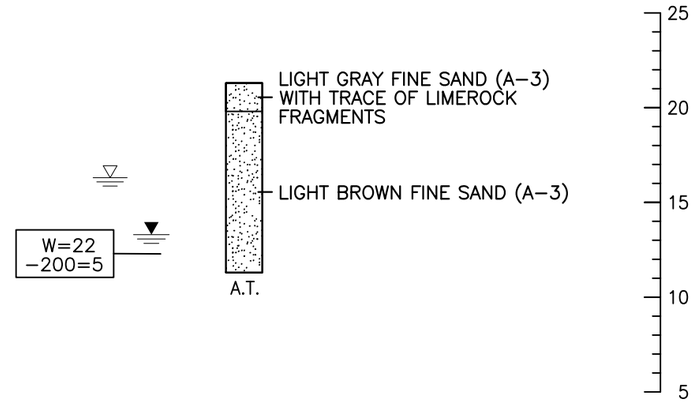
A–1
LAT.: 30° 26' 44.75"N
LONG.: 81° 38' 22.59"W
ELEV.: 19.8'
DATE: 7–12–16



A–2
LAT.: 30° 26' 48.07"N
LONG.: 81° 38' 21.46"W
ELEV.: 20.2'
DATE: 7–12–16



A–3
LAT.: 30° 26' 50.84"N
LONG.: 81° 38' 20.53"W
ELEV.: 21.3'
DATE: 7–12–16



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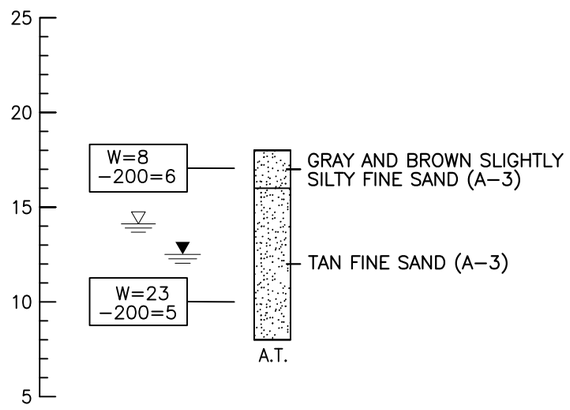
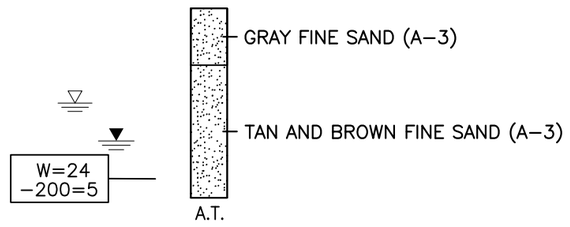
GENERAL SUBSURFACE PROFILES

MAIN STREET FROM SARA DRIVE TO NOAH ROAD
FORCE MAIN REPLACEMENT
DUVAL COUNTY, FLORIDA

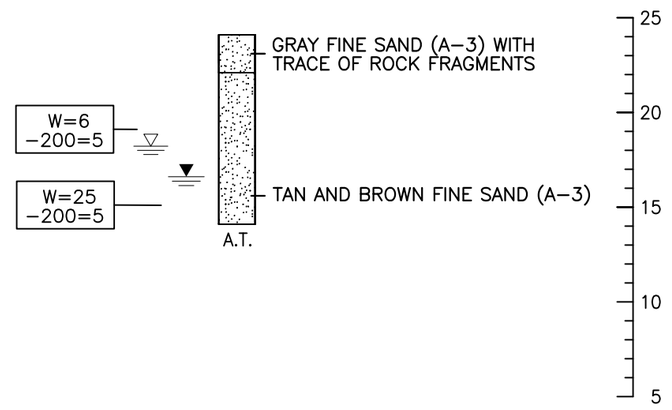
A–4
LAT.: 30° 26' 56.20"N
LONG.: 81° 38' 18.78"W
ELEV.: 18.0'
DATE: 7–13–16



A–5
LAT.: 30° 26' 59.84"N
LONG.: 81° 38' 17.56"W
ELEV.: 21.8'
DATE: 7–13–16



A–6
LAT.: 30° 27' 3.11"N
LONG.: 81° 38' 16.48"W
ELEV.: 24.1'
DATE: 7–13–16



A–7
LAT.: 30° 27' 7.04"N
LONG.: 81° 38' 15.21"W
ELEV.: 26.5'
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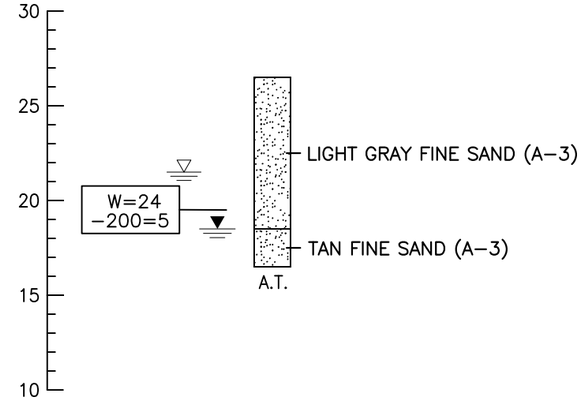
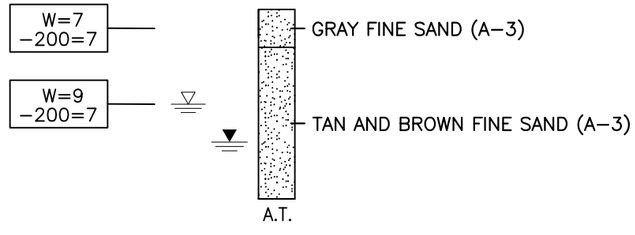
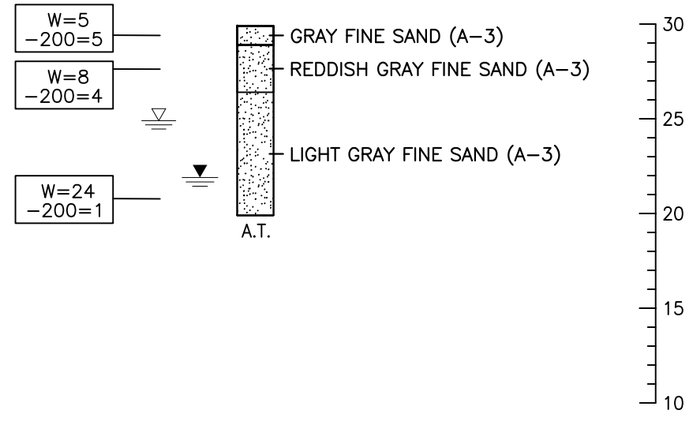


A–8
LAT.: 30° 27' 10.93"N
LONG.: 81° 38' 13.92"W
ELEV.: 28.5'
DATE: 7–13–16



A–9
LAT.: 30° 27' 14.85"N
LONG.: 81° 38' 12.27"W
ELEV.: 29.9'
DATE: 7–13–16



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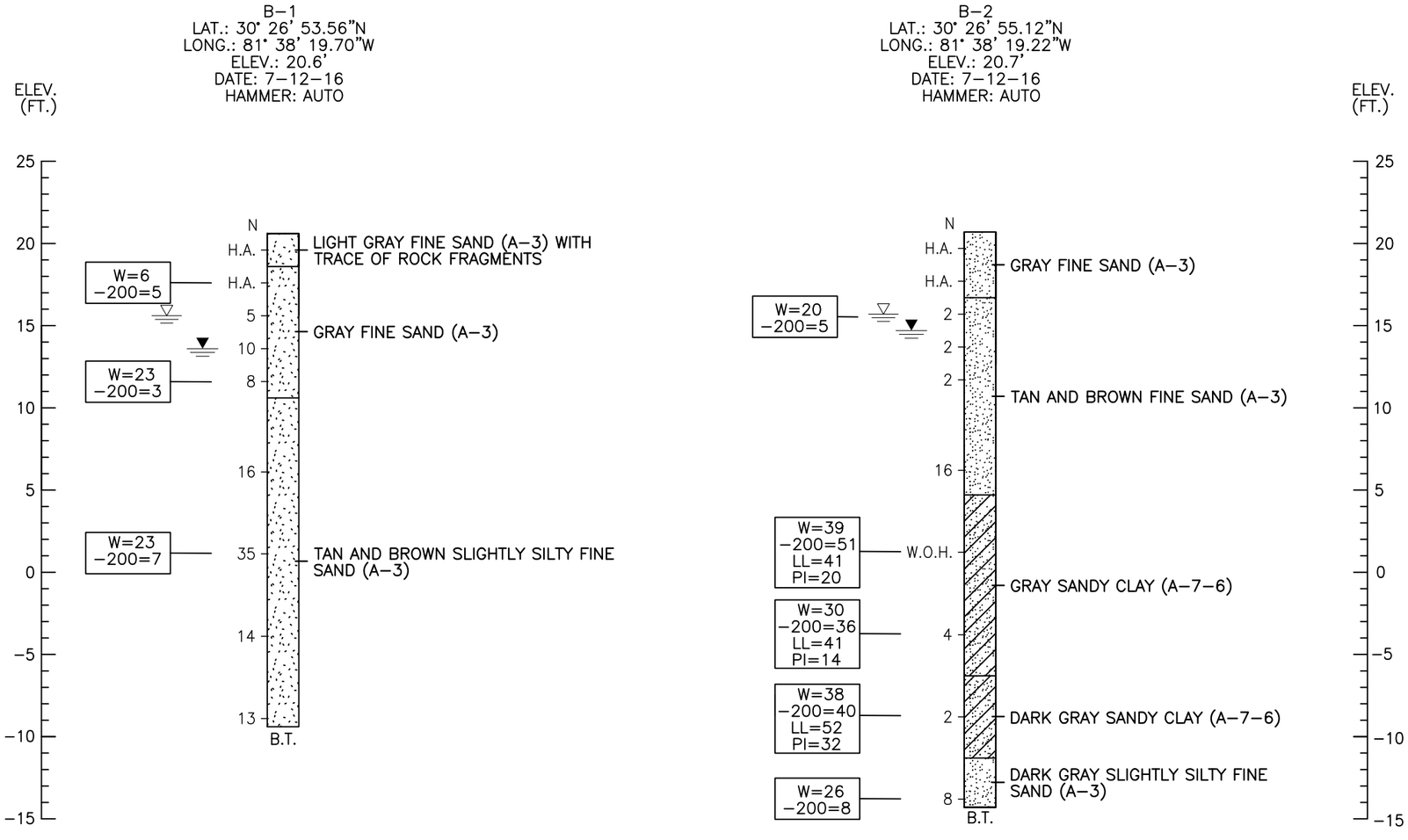

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GENERAL SUBSURFACE PROFILES

MAIN STREET FROM SARA DRIVE TO NOAH ROAD
FORCE MAIN REPLACEMENT
DUVAL COUNTY, FLORIDA

Summary of Laboratory Testing Results

SUMMARY OF LABORATORY TEST RESULTS

Main Street from Sara Drive to Noah Road Force Main Replacement
Duval County, 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	
A-2	2	2.0 - 4.0	6							4			A-3
A-2	5	9.0 - 10.0	21							19	NP	NP	A-2-4
A-3	5	8.0 - 10.0	22							5			A-3
A-4	1	0.0 - 2.0	8							6			A-3
A-4	4	7.0 - 9.0	23							5			A-3
A-5	5	8.0 - 10.0	24							5			A-3
A-6	3	4.0 - 6.0	6							5			A-3
A-6	5	8.0 - 10.0	25							5			A-3
A-7	4	6.0 - 8.0	23							5			A-3
A-8	1	0.0 - 2.0	7							7			A-3
A-8	3	4.0 - 6.0	9							7			A-3
A-9	1	0.0 - 2.0	5							5			A-3
A-9	2	2.0 - 3.0	8							4			A-3
A-9	5	8.0 - 10.0	24							1			A-3
B-1	2	2.0 - 4.0	6							5			A-3
B-1	5	8.0 - 10.0	23							3			A-3
B-1	7	18.5 - 20.0	23							7			A-3
B-2	3	4.0 - 6.0	20							5			A-3
B-2	7	18.5 - 20.0	39							51	41	20	A-7-6
B-2	8	23.5 - 25.0	30							36	41	14	A-7-6
B-2	9	28.5 - 30.0	38							40	52	32	A-7-6
B-2	10	33.5 - 35.0	26							8			A-3

Note: NP - Not Plastic

Existing Pavement System Thickness

EXISTING PAVEMENT SYSTEM THICKNESS

Main Street from Sara Drive to Noah Road Force Main Replacement
Duval County, Florida

Road Name	Core No.	Approximate Location		Material Layer Thickness		Description & AASHTO Classification of Soil Beneath Pavement / Base
		Lat.	Long.	Asphalt (in)	Limerock (in)	
Sara Drive (in eastbound lane just east of N. Main St.)	C-1a	30°26'44.13"N	81°38'22.76"W	5	10	Gray Fine SAND (A-3)
Main St. (north of Sara Drive)	C-1	30°26'44.78"N	81°38'22.79"W	8	-	Light Brown Fine SAND (A-3)
Eastport Road (in turn lane to southbound of N. Main St.)	C-2	30°26'50.94"N	81°38'20.47"W	15	12	Light Gray Fine SAND (A-3)
Eastport Road (in turn lane to northbound of N. Main St.)	C-3	30°26'51.55"N	81°38'20.07"W	8	15	Gray Fine SAND (A-3)

Key to Soil Classification

KEY TO SOIL CLASSIFICATION

Correlation of Penetration Resistance with Relative Density and Consistency

Granular Materials	
Relative Density	**Auto Hammer SPT N-Value (Blows/foot)**
Very Loose	Less than 3
Loose	3 – 8
Medium Dense	8 - 24
Dense	24 - 40
Very Dense	Greater than 40

Silts and Clays	
Consistency	**Auto Hammer SPT N-Value (Blows/foot)**
Very Soft	Less than 1
Soft	1 – 3
Firm	3 - 6
Stiff	6 - 12
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 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.

Auger Borings – The auger borings were advanced by the use of a truck mounted auger drill rig. The soils encountered were identified in the field from the cuttings brought to the surface by the augering process. Representative soil samples were placed in glass jars and transported to our laboratory where they were examined by a geotechnical engineer to confirm field classifications.

LABORATORY TEST PROCEDURES

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.

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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