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Geotechnical Exploration and Evaluation Report

King Street and Shircliff Way Watermain Replacements
Jacksonville, Florida

CSI Geo Project No.: 71-18-329-08
Client Project No.: 09302-053-01
JEA Contract No.: 154589
Purchase Order: 17607

Prepared by

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Prepared for

Jones Edmunds & Associates, Inc.

September 28, 2018

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September 28, 2018

Dr. Harold Bridges, Ph.D, P.E.
Jones Edmunds & Associates, Inc.
8657 Baypine Road, Suite 300
Jacksonville, FL 32256-8634

RE: King Street and Shircliff Way Watermain Replacements
Jacksonville, Florida

Subject: Geotechnical Exploration and Evaluation Report
CSI Geo Project No.: 71-18-329-08
Client Project No.: JEA 09302-053-01
JEA Contract No.: 154589
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Dear Dr. Bridges:

CSI Geo, Inc. has performed the authorized geotechnical exploration and laboratory testing program for the proposed water main replacements along King Street and Shircliff Way 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
Geotechnical Engineer

Digitally signed by Bruce Khosrozadeh
Date: 2018.09.28 15:39:23-04'00'

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 water main replacements along King Street and Shircliff Way in Jacksonville, Florida.

This report describes the field and laboratory testing activities performed and presents the findings. The subsurface soil and groundwater conditions are presented in this report along with site preparation and construction recommendations.

Information regarding this project was provided to CSI Geo, Inc. (CSI Geo) by Dr. Harold Bridges, Ph.D, P.E, and Mr. Kenneth A. Fraser, P.E. of Jones Edmunds & Associates, Inc. (Jones Edmunds). To this date we have received the following documents regarding this project:

- King Street and Shircliff Scope of Work
  Prepared by: JEA
  Prepared: May 25, 2018

1.2 Existing Conditions and Project Description

The existing site is in an urban area with moderate traffic on adjacent side streets to St. Vincent's Medical Center Riverside in Jacksonville, Florida. We understand that the existing water main pipes along Shircliff way from Oak Street to St. Johns Court, and along King St. from St. Johns Avenue to the entrance of the River House Parking Garage will be replaced with new water main pipes. The replacement water main pipes will be installed by means of open-cut excavation.

2.0 GEOTECHNICAL EXPLORATION

2.1 Field Exploration

The areas of the new water main pipes were explored by means of a total of five (5) Standard Penetration Test (SPT) borings B-1 through B-5. Test borings B-1 through B-3 were performed along Shircliff Way, and borings B-4 and B-5 were performed along King Street. The approximate locations of the soil borings are shown on the Field Exploration Plan sheet included in the **Appendix**. All borings were drilled to a depth of 15 feet below the existing grades. Boring B-1 was extended to a depth of 20 feet to penetrate soft soils encountered at a depth of 15 feet below the existing grade.

The boring locations were located in the field by personnel from CSI Geo and spaced generally at 500-foot intervals along the proposed pipeline alignment. Soil samples collected were visually classified in the field and then transported to our laboratory for re-classification and 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.

2.2 Laboratory Testing

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 Report of SPT Borings sheet presented in the **Appendix**. The Report of SPT Borings and the soil conditions outlined below highlight the major subsurface stratification. The Report of SPT Borings in the **Appendix** should be consulted for a detailed description of the subsurface conditions encountered at each boring location. When reviewing the Report of SPT Borings, it should be understood that soil conditions may vary outside of the explored area.

3.2 Soil Conditions

Review of SPT borings B-1 through B-4 indicates that the water main alignments are generally underlain by loose sands (A-3, AASHTO), loose to medium dense plastic clayey sands (A-2-6) and firm to very stiff highly plastic clays (A-7-6) and isolated deposit of silty sands (A-2-4) until the boring termination depths of 15 and 20 feet below the existing grades.

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 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 3.5 to 7 feet below the existing ground surface. The estimated seasonal high groundwater table for the borings performed ranged from 2.5 to 5.0 feet below the existing grades. With the presence of clayey sand and clay soils throughout the site, perched groundwater might be encountered during construction.

Determination of the estimated seasonal high groundwater table was made using the methodology described by the United States Department of Agriculture (USDA) Soil Conservation Service (SCS). In sandy soils the method involves examining soil cuttings from the borings for subtle changes in root content and soil coloration. These subtle changes are indicators of the highest level the groundwater level has been for a prolonged period.

Fluctuations of the groundwater level should be anticipated as a result of the close proximity to the St. Johns River, urbanization/development, topographic changes, seasonal climatic variations, surface water runoff patterns, fluctuations of adjacent water bodies, construction activities, and other factors. During seasonal high precipitation, groundwater levels can be expected to rise. Therefore, design drawings and specifications should account for the possibility of groundwater level variations, and construction planning should be based on the assumption that such variations will occur.

3.4 Existing Pavement System Thickness

Pavement cores were performed at each of the test boring locations to determine the thickness of the existing pavement system. Generally, the existing pavement system was found to consist of 3 to 9 ½ inches of asphalt over 5 to 8 inches of limerock base course. The results of the pavement cores 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 or installation method 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 Open Cut Excavations

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.

Review of test borings B-1 through B-5 indicates that the water main alignments are generally underlain by sands and slightly silty sands (A-3), silty sands (A-2-4), clayey sands (A-2-6), and clays (A-7-6).

The A-3 type soils are considered select material. The A-2-4 soils can retain excess moisture and can be difficult to dry and compact. Therefore, silty soils occurring within the excavation should be removed in a similar manner as required for plastic and highly plastic materials. Clayey sands (A-2-6) and sandy clays (A-6/A-7) are considered plastic and highly plastic materials and should be excavated to a minimum depth of one foot below the design invert elevations and replaced with suitable A-3 fill material.

The presence of A-2-4, A-2-6 and A-6/A-7 type soils should be expected throughout the site at varying depths below the existing grades. It is cautioned that these soils tend to have poor infiltration characteristics which may cause groundwater to perch beneath and near the pavement base, saturating the pavement base material and therefore, causing pavement system failure.

Depending on the depth of excavation, it is very likely that the excavated suitable soils may get mixed with silty sands and plastic soils during excavation activities. Therefore, we recommend that allowances be made for possible overruns in quantities of subsoil removal and replacement with select backfill.

If encountered, organic soils (A-8) should be considered as muck and should be removed in their entirety if encountered beneath the water main or other proposed structures. Organic soils are not suitable for use as backfill.

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.

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 grouted in place 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 3.5 to 7 feet below the existing grades. 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. If needed, trench box or braced sheet pile structures may be used where deep installation is required. The soil support system should be designed by a Florida registered Professional Engineer.

5.4 Pipe Backfill and Compaction of Pipe Backfill

If the excavated suitable soils get mixed with unsuitable soils during construction, then the excavated material should be regarded as unsuitable for backfill purposes. We recommend that allowance be made for overruns in quantities of subsoil removal and replacement with select (A-3) backfill.

The backfill material within the excavation should be placed in thin loose lifts not exceeding 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 locations of the proposed features are 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

Site Location Map

Field Exploration Plan

Report of SPT Borings

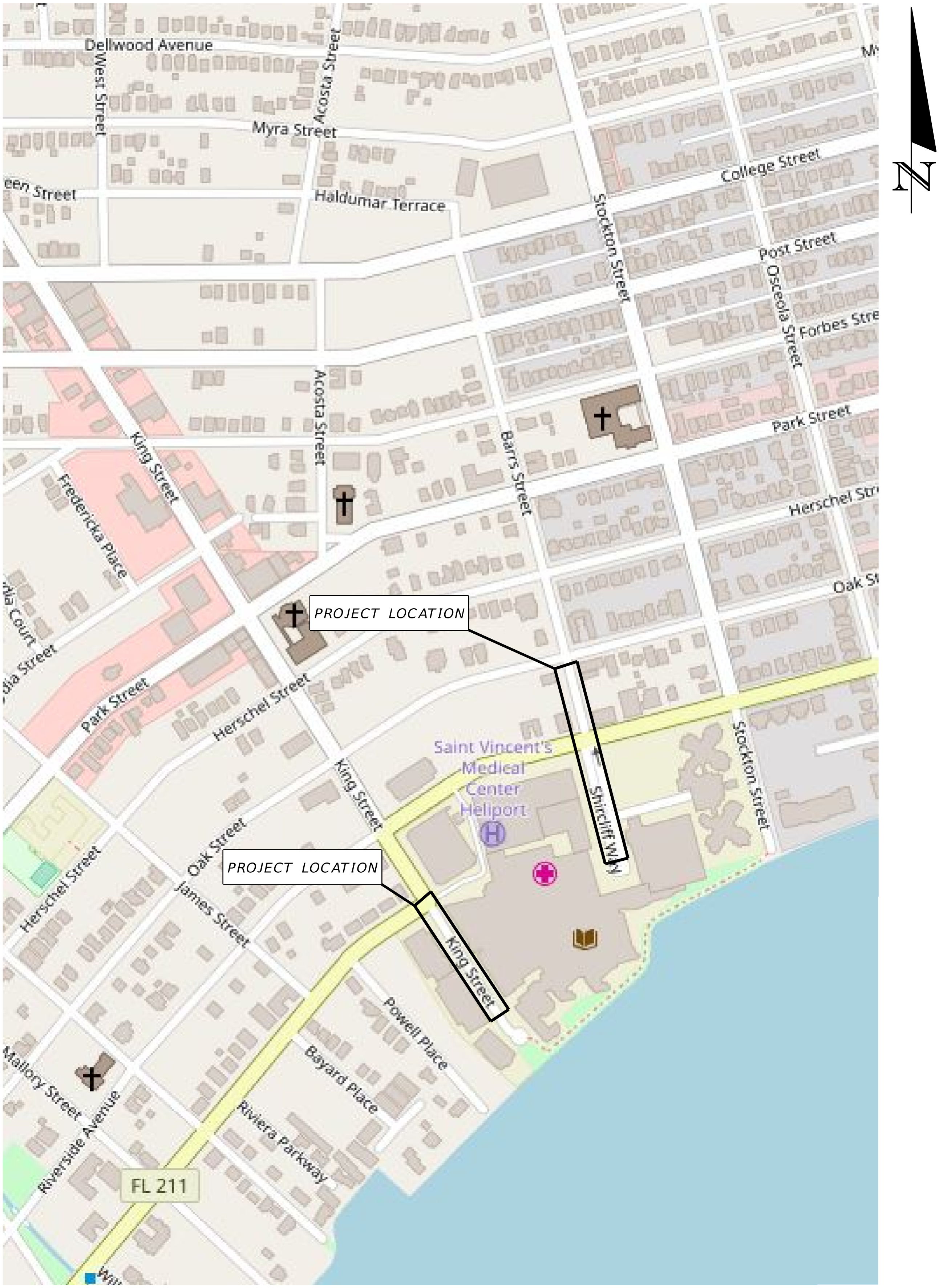
Summary of Laboratory Testing Results

Existing Pavement System Thickness

Key to Soil Classification

Field and Laboratory Test Procedures

Site Location Map



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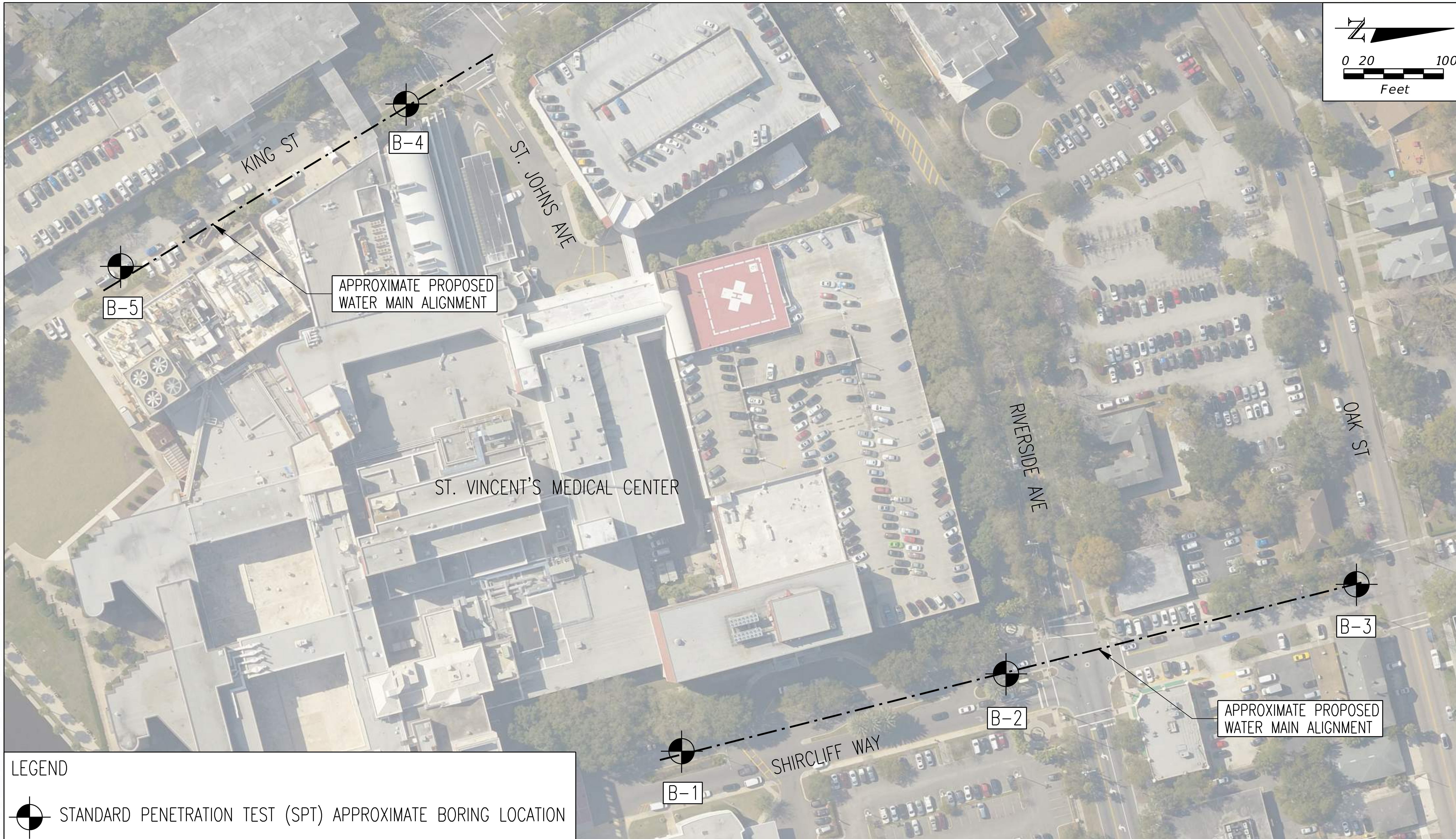
SITE LOCATION MAP
KING STREET AND SHIRCLIFF WAY WATER MAIN REPLACEMENTS
JACKSONVILLE, FLORIDA

Field Exploration Plan



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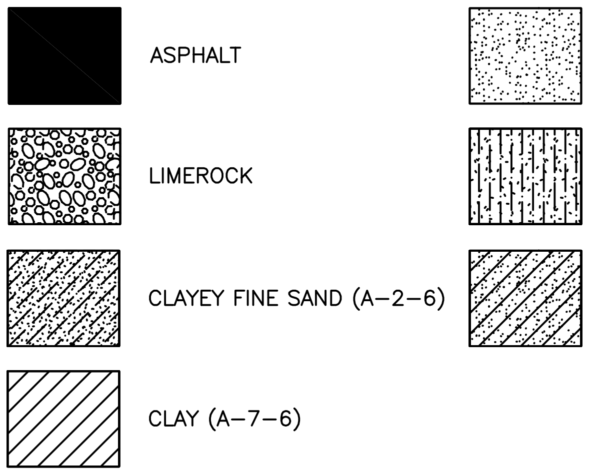
GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

FIELD EXPLORATION PLAN

KING STREET AND SHIRCLIFF WAY
WATER MAIN REPLACEMENTS
JACKSONVILLE, FLORIDA

Report of SPT Borings

LEGEND



(A-3) AASHTO SOIL CLASSIFICATION SYSTEM

ESTIMATED SEASONAL HIGH GROUND WATER LEVEL

GROUND WATER LEVEL AT TIME OF DRILLING

W — NATURAL MOISTURE CONTENT (%)
-200 — FINES PASSING NO. 200 SIEVE (%)
LL — LIQUID LIMIT
PI — PLASTICITY INDEX

B.T. STANDARD PENETRATION TEST BORING TERMINATION

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

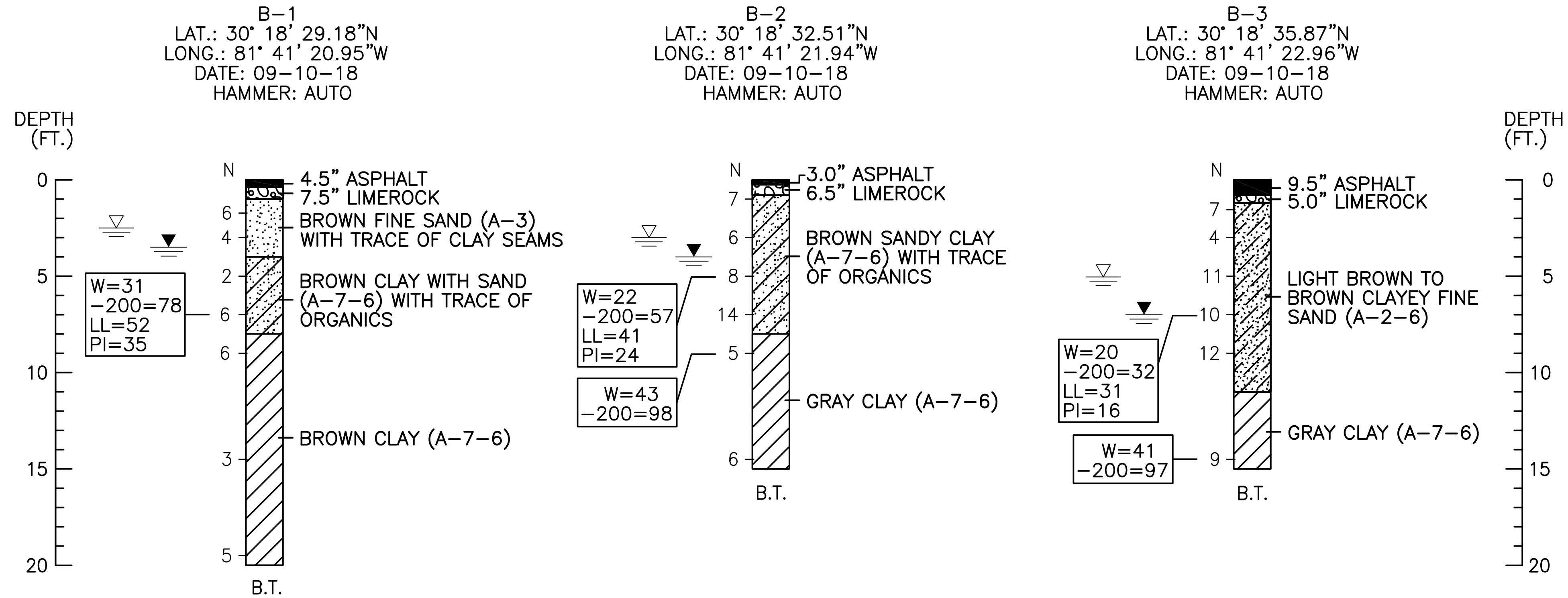
STANDARD PENETRATION TEST DATA

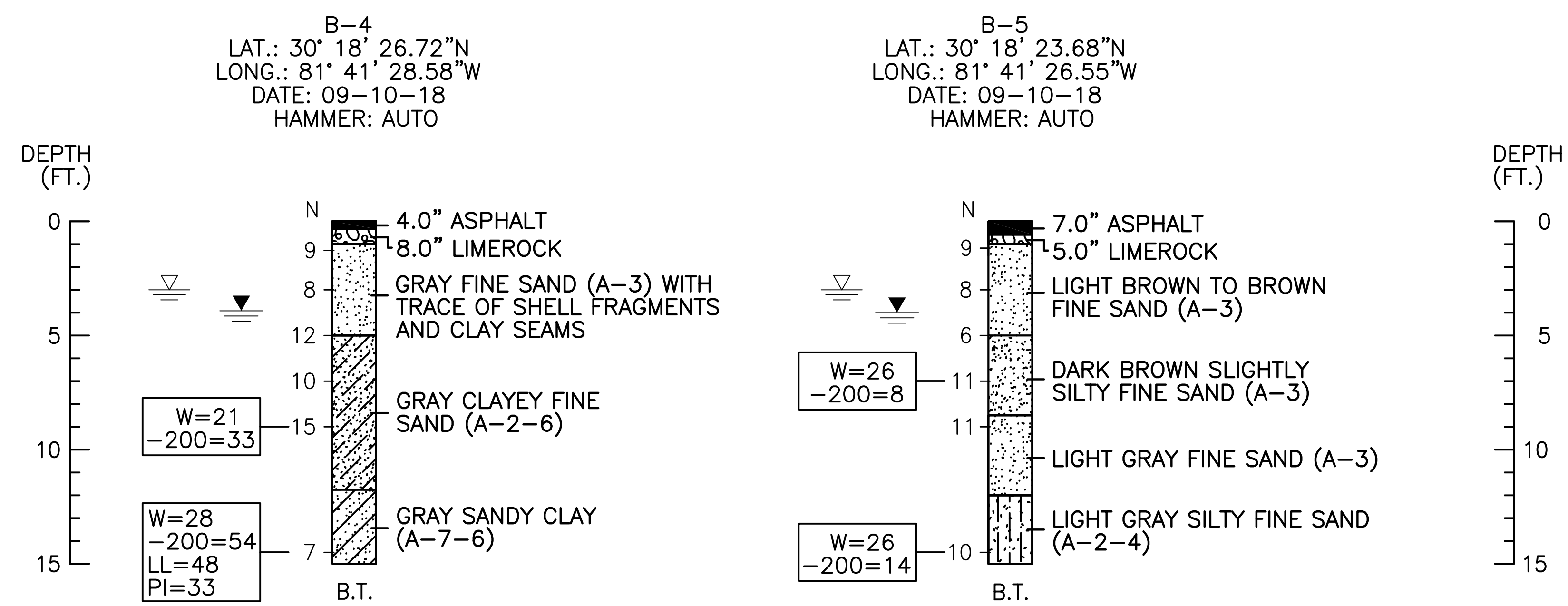
SPOON INSIDE DIA.	1.44 INCHES
SPOON OUTSIDE DIA.	2.0 INCHES
ASTM STANDARD DROP HAMMER	
AVG. HAMMER DROP	30.0 INCHES
HAMMER WEIGHT	140.0 LBS

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.





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GEOTECHNICAL ENGINEERING
CONSTRUCTION MATERIAL TESTING
CONSTRUCTION ENGINEERING INSPECTION

REPORT OF SPT BORINGS

KING STREET AND SHIRCLIFF WAY
WATER MAIN REPLACEMENTS
JACKSONVILLE, FLORIDA

Summary of Laboratory Testing Results

SUMMARY OF LABORATORY TEST RESULTS

King Street and Shircliff Way Water Main Replacements
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	6.0 - 8.0	31							78	52	35	A-7-6
B-2	3	4.0 - 6.0	22							57	41	24	A-7-6
B-2	5	8.5 - 10.0	43							98			A-7-6
B-3	4	6.0 - 8.0	20							32	31	16	A-2-6
B-3	6	13.5 - 15.0	41							97			A-7-6
B-4	5	8.0 - 10.0	21							33			A-2-6
B-4	6	13.5 - 15.0	28							54	48	33	A-7-6
B-5	4	6.0 - 8.0	26							8			A-3
B-5	6	13.5 - 15.0	26							14			A-2-4

Existing Pavement System Thickness

EXISTING PAVEMENT SYSTEM THICKNESS

King Street and Shircliff Way Water Main Replacements
Jacksonville, Florida

Core No.	Location		Material Layer Thickness		Description & AASHTO Classification of Soil Beneath Pavement / Base
	Lat.	Long.	Asphalt (in)	Limerock (in)	
B-1	30°18'29.16"N	81°41'21.03"W	4 1/2	7 1/2	Brown Fine SAND (A-3)
B-2	30°18'32.51"N	81°41'21.94"W	3	6 1/2	Brown Sandy Clay (A-7-6)
B-3	30°18'36.02"N	81°41'23.02"W	9 1/2	5	Light Brown Clayey Fine SAND (A-2-6)
B-4	30°18'26.45"N	81°41'28.56"W	4	8	Gray Fine SAND (A-3)
B-5	30°18'23.68"N	81°41'26.55"W	7	5	Light Brown 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 D-1586, "Penetration Test and Split-Barrel Sampling of Soils". The borings were advanced by continuously driving the split spoon sampler to a depth of 10 feet below the existing ground surface. 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

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 ASTM D2216.

Percent Fine 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.

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.