OMI, Inc.

SUBSURFACE EXPLORATION AND
GEOTECHNICAL ENGINEERING STUDY
Spring Branch Greenway Pedestrian Bridge
Brahan Spring Park
Huntsville, Alabama

OMI Job No. 8730

June 28, 2019

5151 Research Drive, N.W., Suite A Huntsville, AL 35805 Tel: (256) 837-7664 Fax: (256) 837-7677 E-mail: omi@omi-eng.com

OMI, Inc.

June 28, 2019

4Site, Inc.
7500 Memorial Parkway SW, Suite 209
Huntsville, Alabama 35802

ATTN: Mr. Tom Cunningham

SUBJECT: Report of Geotechnical Engineering Study
Spring Branch Greenway Pedestrian Bridge
Brahan Spring Park
Drake Avenue
Huntsville, Alabama
OMI Job No. 8730

Ladies & Gentlemen:

OMI, Inc., has completed a subsurface exploration and geotechnical engineering study for the referenced project. Enclosed is the report of the findings as well as recommendations for foundation design and construction, site preparation, and other geotechnically related site activities. This work was authorized on May 19, 2019, by Mr. Jerry M. Cargile, P.E. of 4Site, Inc.

OMI, Inc., appreciates the opportunity to be of service to 4Site, Inc, and looks forward to continued involvement with the construction monitoring phase of this project. Please direct any questions concerning this report to the undersigned.

Respectfully submitted,

OMI, Inc.

Liz Parsons
Staff Engineer

John W. Corbell, P. E.
Senior Engineer

Distribution: 1 Copy to Addressee

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APPENDICES

1.0 EXECUTIVE SUMMARY

The proposed structure may be supported by a conventional shallow foundation system bearing on residual soils. Soils were generally low plastic silty sandy clay and very stiff across the site. Specific recommendations for foundation design and site earthwork are given in the body of this report.

2.0 INTRODUCTION

OMI, Inc., has completed a design geotechnical engineering study for the proposed Spring Branch Greenway Pedestrian Bridge. This report outlines the scope of services provided and presents comments and recommendations based on professional opinions formed during the course of this study. This work was authorized on May 19, 2019, by Jerry M. Cargile, P.E. of 4Site, Inc. The work was performed in general accordance with OMI Proposal No. P-5314.

Assessment of the environmental aspects of this site, including previous land use or the determination of the presence of any chemical, industrial, or hazardous waste is beyond the scope of this study. However, OMI can provide these services if desired.

3.0 EXPLORATION METHODS

The procedures used by OMI for field and laboratory testing are in general accordance with ASTM procedures and established engineering practice. Brief descriptions of the procedures used in this exploration are contained in the Appendix of this report.

Four soil test borings to 25-ft each were performed during this study. Boring locations are shown on the appended Boring Location Plan. A member of the OMI professional staff directed the drilling and logged the soils in the field. Subsequently, each sample was sealed and transported to the office. Selected samples were tested to determine the natural moisture content and Atterberg limits of the soil. These tests assist in confirming the visual classifications as well as provide an index of certain engineering properties. The soil classifications, field testing data, and the results of the laboratory tests are provided on the Soil Boring Records in the Appendix of this report.

4.0 SITE CONDITIONS

The site for the proposed Spring Branch Greenway Pedestrian Bridge is located in Huntsville, Alabama, on Drake Avenue Southwest and is part of Brahan Spring Park. Currently Brahan Spring Park has a greenway that connects the Brahan Spring South Lagoon and Huntsville Spring Branch, with some paved parking near Drake Ave SW to the north. Brahan Spring South Lagoon is a man-made pond that covers approximately 25-acres. The spillway for the pond is located to the south and drains to Merrimac Branch. The water surface elevation of the pond appears to be about 588-ft MSL. The proposed bridge location is located to the south of Brahan Spring South Lagoon and is proposed to cross Merrimac Branch.

Topographically, surface waters draining through Merrimac Branch flow to the east towards Huntsville Spring Branch. The following topographic information is based on the City of Huntsville Interactive Maps website. At the location of the proposed bridge, Merrimac Branch has a width of about 11-ft, and a depth of about 10-ft. The bottom elevation of Merrimac Branch is about 580-ft MSL. Vegetation in the vicinity of the proposed bridge, on both sides of Merrimac Branch, consists of hardwood trees.

5.0 SUBSURFACE CONDITIONS

Borings encountered topsoil, fill, and residual soils. Topsoil was encountered in borings B-3 and B-4 and averaged around 3 inches.

Low plastic fill soils were encountered in borings B-3 and B-4. The fill soils consisted of a dark red to red, black, and tan very stiff silty sandy clay. Standard Penetration Test (SPT) values ranged from 8 to 10 bpf (blows per foot) and averaged 9 bpf. Pocket penetrometer tests ranged from 1.75 to 2.5 tsf (tons per square foot) and averaged 2.12 tsf. Moisture contents ranged from 17 to 20 percent and averaged 18.5 percent.

A low plastic residual soil was encountered in all borings. The low plastic residual soil consisted of a red to tan silty sandy clay. SPT values ranged from 7 to 21 bpf and averaged 12 bpf. Pocket penetrometer tests ranged from 1.5 to 4.5 tsf and averaged 2.75 tsf. Moisture contents ranged from 13 to 22 percent and averaged 17 percent. An Atterberg limits test was conducted on the 3.5 to 5-ft sample in boring B-2, and indicated a liquid limit of 35, plastic limit of 16, and plasticity index of 19.

A highly plastic residual soil was encountered under the layer of low plastic silty sandy clay in all borings to boring termination of 25-ft. The highly plastic soil consisted of a light red to gray silty sandy clay, with around 10 percent chert gravel. SPT values ranged from 7 to 29 bpf and averaged 16 bpf. Pocket penetrometer tests ranged from 1.0 to 4.5 tsf and averaged 3.0 tsf. Moisture contents ranged from 18 to 41 percent and averaged 30 percent.

Groundwater was observed between 12-ft below the ground surface in borings B-1 and B-2, 23-ft in boring B-3, and 25-ft in boring B-4 during drilling. For safety reasons the borings were filled after drilling; therefore, extended water levels were not taken.

Because of the geology of this region, the groundwater levels are generally a function of seasonal precipitation and locally heavy rainfall events. Consequently, the groundwater levels can and do fluctuate with time.

6.0 SITE GEOLOGY

Tuscumbia Limestone

Published geologic information indicates the proposed site is underlain by the Tuscumbia Limestone.

The Tuscumbia Limestone formation is of Mississippian age (310 to 345 million years). In the vicinity of the site, the Tuscumbia limestone is composed of light gray to light brownish-gray, fine to coarse grained, fossiliferous limestone containing chert lenses and nodules. Soils derived from the in-place weathering of the Tuscumbia Limestone are moderately red to reddish-orange clay with variable amounts of chert.

Sinkhole Activity

Sinkholes have occurred in this formation within the vicinity of this site. However, surface observations and the subsurface exploration did not disclose evidence of sinkhole activity on this site. This exploration does not, nor was it intended to, address the possibility of future sinkhole development.

7.0 PROJECT INFORMATION

OMI understands that the planned construction will consist of a pedestrian bridge. The pedestrian bridge will be located near the southern boundary of Brahan Spring Park in Huntsville, Alabama. The bridge will traverse Merrimac Branch which is a tributary to Huntsville Spring Branch. Surface drainage through Merrimac Branch flows to the east towards Huntsville Spring Branch.

OMI understands that the proposed bridge will be for pedestrian traffic only. Construction type is unknown but is expected to be a single span of about 63 feet. Maximum loads on each abutment are expected to be less than 50-kips.

8.0 BASIS FOR RECOMMENDATIONS

The following recommendations are based in part on the preceding project information. This study has utilized the subsurface data, historical information regarding the structural performance of similar structures, and past experience with similar geologic environments to develop professional opinions on which the recommendations are based. Because the structural elements of the design greatly influence the design recommendations, OMI must be provided the opportunity to review the following comments and recommendations in light of changes in building location, elevation, or structural loading.

Standard practice in geotechnical engineering is that all but a few special structures will tolerate 1-in of settlement. Therefore, 1-in is assumed acceptable. Unless otherwise stated, the recommendations in this report are intended to keep post-construction settlement to less than 1-in.

9.0 DESIGN RECOMMENDATIONS

9.1 Foundation Design

Provided the site is prepared in accordance with the recommendations contained in this text, the proposed structure may be supported by a shallow spread foundation system bearing on the stiff to very stiff residual soils. Footings should be designed based on a maximum allowable bearing pressure of 2,000 psf. These pressures include a factor of safety of at least three against general shear failure. To allow for minor inconsistencies in the soil subgrade footings should have a minimum width of 24-in regardless of loading.

The footings should bear at least 1-ft below the scour depth. The ground surface around the bridge should be graded to provide positive drainage away from the foundations.

Lateral loads applied to the foundation may be resisted by friction and adhesion along the base of the footing and passive resistance against the face of the footing, provided the footings are cast neat against the side of the excavation. The friction coefficient between the soil and the base of the concrete footing may be taken as 0.3 and the passive resistance can be estimated using an equivalent fluid weight of 125 pcf. If large lateral loads are present, OMI can provide additional recommendations or specific design analysis. Scour depth should be considered when calculating lateral capacity.

9.2 Seismic Classification

OMI has reviewed the soils at the site with respect to the criteria for seismic classification. In accordance with Section 1613, Table 1613.5.2 of the 2009 International Building Code, OMI judges the soil to be Site Class D.

9.3 Fill Soils

Fill soils should be clayey soils free of organics, deleterious debris, or rocks larger than 3-in in diameter. The soil should have a plasticity index (PI) of less than 30 and a maximum dry density of at least 95 pcf as determined by the standard Proctor (ASTM D698). The fill should be compacted to at least 98 percent of the soil's standard Proctor maximum dry density, SPMDD. The on-site soil interval meets the guideline set forth above.

10.0 CONSTRUCTION CONSIDERATIONS

10.1 Site Preparation

To prepare the site for construction, the construction area should be stripped of trees, topsoil, large root zones, and other organic or soft soil. Stripping should extend at least 10-ft beyond the limits of construction cut and fill. Subsequently, the construction area should be reviewed by a geotechnical engineer. Any areas judged to be unsuitable should be undercut to a stable soil horizon. Such over-excavation must be backfilled with structural fill placed as described below.

10.2 Estimated Topsoil Removal

The depth of topsoil varies across the site. OMI believes that the stripping depth to remove the topsoil will average about 3-in. Close observation by OMI personnel during construction can allow the disturbed but only slightly organic soils to be compacted in-place or to be used as engineered fill.

10.3 Fill Placement

After the site has been reviewed by a geotechnical engineer, placement of structural fill may begin, as necessary. Specific requirements of the soil properties are discussed previously. The soil should be placed in loose lifts, not exceeding 8-in in thickness, and systematically compacted to at least 98 percent of the soil's standard Proctor maximum dry density (ASTM D698).

10.4 Density Testing

Field density testing should be performed on each lift prior to placement of additional lifts. Test locations should be evenly distributed throughout the fill area and should be performed at the frequencies shown on the following table.

Area	Method of Placement and Compaction	Initial Test Frequency	Retest Frequency
General Site	Large self-propelled equipment	1 test per 5000-ft^2, minimum 3 tests per lift	1 test per failed test
Isolated Areas	Hand-guided equipment	1 test per lift	1 test per failed test
Trench backfill and behind retaining walls	Hand-guided equipment	1 test per 50 linear feet per 6-in of fill	1 test per failed test

Test frequencies may be increased during the early stages of earthwork construction. Compaction requirements should apply to all excavation/backfill operations conducted on the proposed development property.

10.5 Footing Observations

The footing excavation process generates a disturbed layer of soft soil in the excavation bottoms. This soft compressible layer should be removed prior to placement of concrete. Each foundation excavation should be observed by a member of OMI's professional staff to check for local variations in the soil strength as well as the removal of the disturbed layer.

10.6 Foundation Construction

The deeper soils at this site are moderately to highly plastic. Exposing the soils to excessive wetting or drying during construction can cause problems such as heaving or settlement due to shrinking and swelling of the clay. The foundations should be excavated, hand cleaned, checked, and concrete placed as expeditiously as possible. Footing excavations that will be left open for more than 8 hours should be covered for protection.

10.7 Construction Monitoring

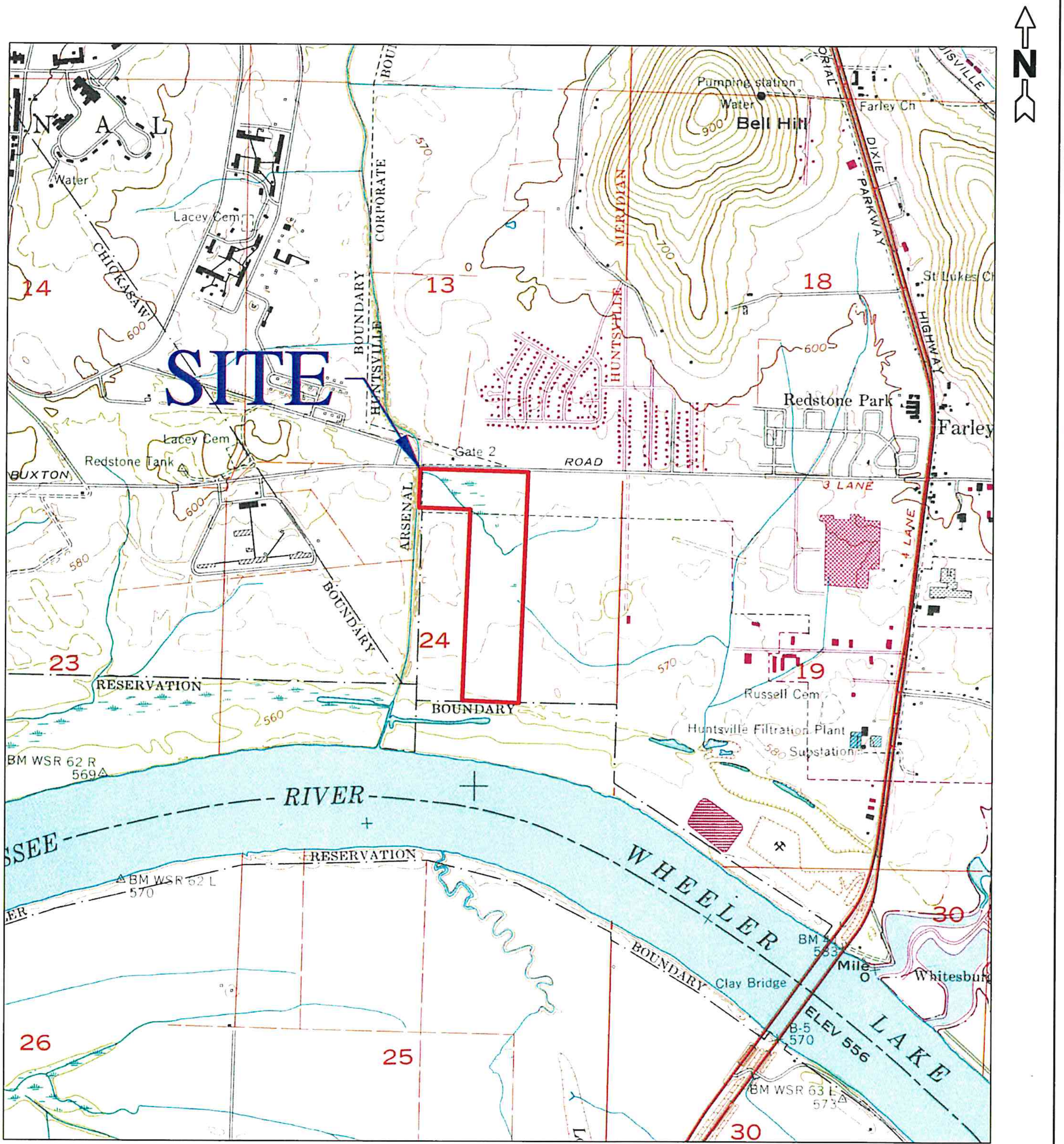
The foundation and site preparation recommendations contained in this report are based on the conditions encountered during the subsurface exploration and past experience in this geologic setting. Because subsurface conditions may vary from the anticipated, it is important to have a well-rounded quality control program. Construction monitoring on a project of this nature can serve as an economical means to achieve the best possible foundation system and reduce the potential for future problems. The involvement in the subsurface exploration portion of this project uniquely qualifies OMI, Inc., to provide these services as a party responsible to the Owner. OMI, Inc., strongly recommends that all construction monitoring be performed under contract with the Owner or the Owner's representative.

OMI, Inc.

5151 Research Dr. NW
Huntsville, AL 35805

PH: (256) 837 - 7664

FAX: (256) 837 - 7677



FARLEY QUAD
7.5 MINUTE SERIES
TOPOGRAPHIC
1964 REVISED 1982

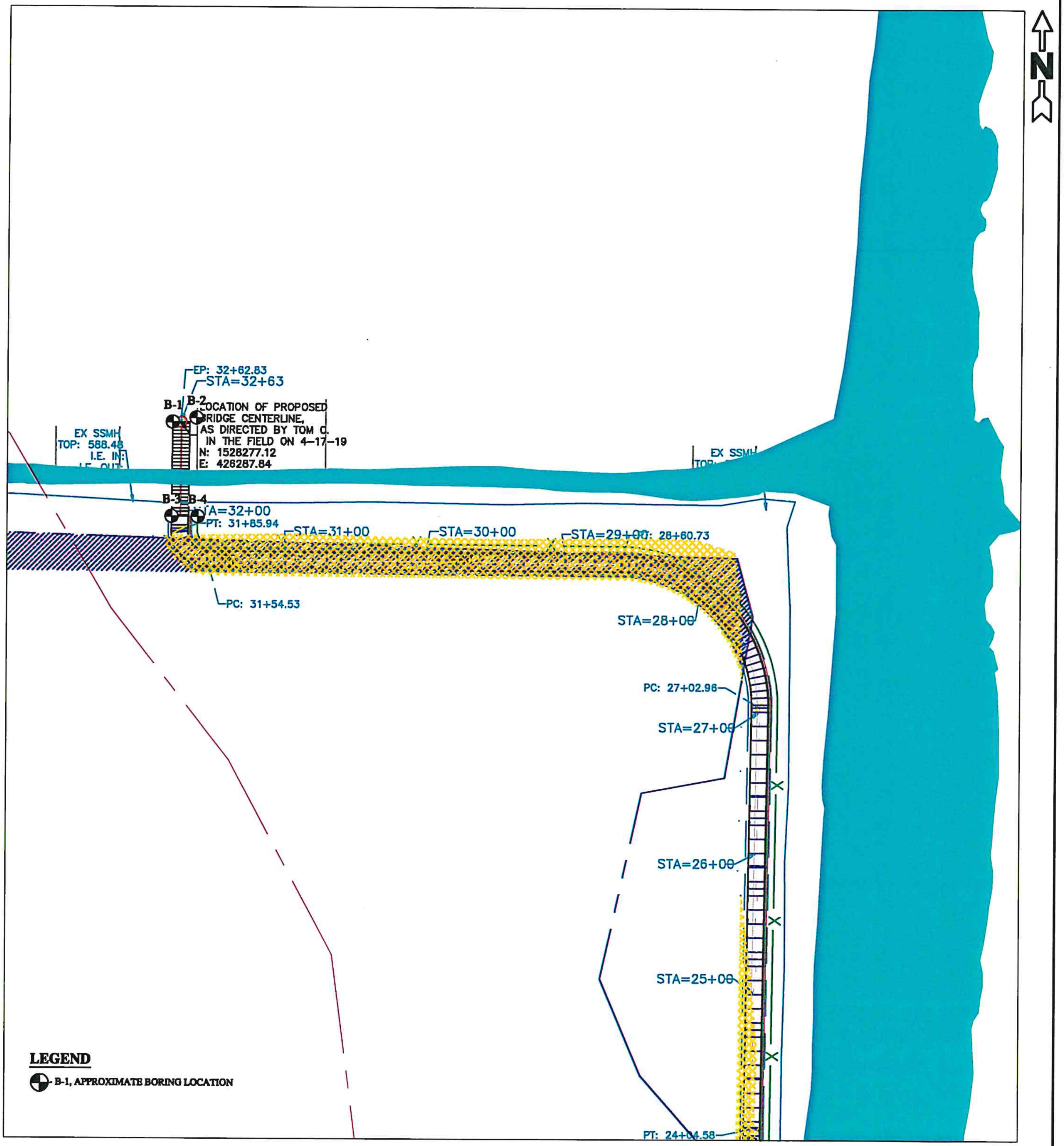
JOB NAME: SPRING BRANCH GREENWAY BRIDGE HUNTSVILLE, ALABAMA	SITE LOCATION MAP DRAWING NO: 8730 - 1	JOB N0: 8730 DATE: 06-28-2019 SCALE: 1"= 2000' DRAWN BY: DAH

OMI, Inc.

5151 Research Dr. NW
Huntsville, AL 35805

PH: (256) 837 - 7664

FAX: (256) 837 - 7677



JOB NAME: SPRING BRANCH GREENWAY BRIDGE HUNTSVILLE, ALABAMA	BORING LOCATION PLAN DRAWING NO: 8730 - 1	JOB N0: 8730 DATE: 6-28-2019 SCALE: 1"= 100' DRAWN BY: DAH

OMI, Inc.

5151 Research Drive, N.W., Suite A Huntsville, AL 35805

JOB NO.: 8730 JOB: Spring Branch Greenway Pedestrian Bridge LOG OF BORING: B-1

Driller: South Bros. Drill Model: Mobile B-45 Hammer Type: Auto Hammer Efficiency: 97%

Logged By: L. Parsons Boring Location:

City: Huntsville County: Madison State: Alabama

DEPTH, FT	ELEVATION	DESCRIPTION	N-VALUE (Uncorrected)	NATURAL MOISTURE	POCKET PENETROMETER TSF	LIQUID LIMIT	Plastic Limit	Percent Passing No. 200	Rock Core Recovery (in/%)	Rock Quality Designation (%)	Fractures per Foot
0		SILTY SANDY CLAY with trace organics and oxides, 25% fine to medium sand, 75% fines, low plasticity, red, very stiff, moist, residuum, CL	8	15	2.0						
			8	13	4.5						
5		SILTY SANDY CLAY with trace chert gravel, 25% fine to medium sand, 75% fines, low plasticity, red, very stiff, moist, residuum, CL	8	15	3.0						
			8	20	2.5						
10		SILTY SANDY CLAY, 25% fine to medium sand, 75% fines, low plasticity, light tan and tan mottled, very stiff, moist, residuum, CL	9	20	2.5						
15		SILTY SANDY CLAY, 25% fine to medium sand, 75% fines, low plasticity, red, gray, and black mottled, very stiff, moist, residuum, CL	17	19	3.0						
		SILTY SANDY CLAY, 10% chert gravel, 25% fine sand, 65% fines, low plasticity, red, gray, and black mottled, very stiff, moist, residuum, CL	15	31	4.5						
20		SILTY SANDY CLAY, 10% chert gravel, 25% fine sand, 65% fines, high plasticity, light gray and red, very stiff, moist, residuum, CH	9	39	2.5						
25		BORING TERMINATED @ 25-ft									
30											
35											

COMPLETION DEPTH: 25 DEPTH TO INITIAL WATER: 12'

DATE: 6-10-19 DEPTH TO EXTENDED WATER: on

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OMI, Inc.

5151 Research Drive, N.W., Suite A Huntsville, AL 35805

JOB NO.: 8730 JOB: Spring Branch Greenway Pedestrian Bridge LOG OF BORING: B-2

Driller: South Bros. Drill Model: Mobile B-45 Hammer Type: Auto Hammer Efficiency: 97%

Logged By: L. Parsons Boring Location:

City: Huntsville County: Madison State: Alabama

DEPTH, FT	ELEVATION	SAMPLES	GRAPHIC	DESCRIPTION	N-VALUE (Uncorrected)	NATURAL MOISTURE	POCKET PENETROMETER TSF	LIQUID LIMIT	Plastic Limit	Percent Passing No. 200	Rock Core Recovery (in/%)	Rock Quality Designation (%)	Fractures per Foot
0				SILTY SANDY CLAY with trace oxides, 25% fine to medium sand, 75% fines, low plasticity, red, stiff, moist, residuum, CL	7	16	3.0						
					12	14	4.0						
5				SILTY SANDY CLAY with trace oxides, 25% fine to medium sand, 75% fines, low plasticity, red and black mottled, very stiff, moist, residuum, CL	11	15	4.0	35	16				
				SILTY SANDY CLAY with trace oxides, 20% fine sand, 80% fines, low plasticity, red, gray, and black mottled, very stiff, moist, residuum, CL	14	16	2.5			90.5			
10					9	22	2.0						
	▽ (12')			SILTY SANDY CLAY with trace oxides, 20% fine sand, 80% fines, low plasticity, red, gray, and black mottled, very stiff, moist, residuum, CL									
15				SILTY SANDY CLAY with trace chert gravel, 20% fine sand, 80% fines, low plasticity, red, gray, and black mottled, very stiff, moist, residuum, CL	11	15	2.0						
20				SILTY SANDY CLAY with trace chert gravel, 20% fine sand, 80% fines, high plasticity, red and tan, very stiff, moist, residuum, CH	16	28	4.0						
					10	31	4.5						
25				BORING TERMINATED @ 25-ft									
30													
35													

COMPLETION DEPTH: 25 DEPTH TO INITIAL WATER: 12' ▽

DATE: 6-10-19 DEPTH TO EXTENDED WATER: ______ on ______ ▼

OMI,Inc.

OMI, Inc.

5151 Research Drive, N.W., Suite A   Huntsville, AL 35805

JOB NO.: 8730   JOB: Spring Branch Greenway Pedestrian Bridge   LOG OF BORING: B-3

Driller: South Bros.   Drill Model: Mobile B-45   Hammer Type: Auto   Hammer Efficiency: 97%

Logged By: L. Parsons   Boring Location:

City: Huntsville   County: Madison   State: Alabama

DEPTH, FT	ELEVATION	SAMPLES	GRAPHIC	DESCRIPTION	N-VALUE (Uncorrected)	NATURAL MOISTURE	POCKET PENETROMETER TSF	LIQUID LIMIT	Plastic Limit	Percent Passing No. 200	Rock Core Recovery (in/%)	Rock Quality Designation (%)	Fractures per Foot
0				TOPSOIL	8	20	2.5						
				SILTY SANDY CLAY with trace chert gravel and organics, 20% fine sand, 80% fines, low plasticity, red, black, and tan, very stiff, moist, FILL, CL	15	20	2.0						
					8	19	3.0						
5				SILTY SANDY CLAY, 20% fine sand, 80% fines, low plasticity, tan, very stiff, moist, residuum, CL	16	14	3.0						
10				SILTY SANDY CLAY, 25% fine sand, 75% fines, low plasticity, red, black, and gray mottled, very stiff, moist, residuum, CL	7	31	3.25						
15				SILTY SANDY CLAY with trace chert gravel, 25% fine sand, 75% fines, low plasticity, red, black, and gray mottled, very stiff, moist, residuum, CL	10	18	3.5						
20				SILTY SANDY CLAY, 25% fine sand, 75% fines, high plasticity, red and gray, stiff to very stiff, moist, residuum, CH	12	23	2.25						
25				SILTY SANDY CLAY, 10% chert gravel, 20% fine to medium sand, 70% fines, high plasticity, red,very stiff, wet, residuum, CH	12	41	1.0						
				BORING TERMINATED @ 25-ft									
30													
35													

COMPLETION DEPTH: 25   DEPTH TO INITIAL WATER: 23'

DATE: 6-10-19   DEPTH TO EXTENDED WATER: ______ on ______

OMI,Inc.

OMI, Inc.

5151 Research Drive, N.W., Suite A Huntsville, AL 35805

JOB NO.: 8730 JOB: Spring Branch Greenway Pedestrian Bridge LOG OF BORING: B-4

Driller: South Bros. Drill Model: Mobile B-45 Hammer Type: Auto Hammer Efficiency: 97%

Logged By: L. Parsons Boring Location:

City: Huntsville County: Madison State: Alabama

DEPTH, FT	ELEVATION	SAMPLES	GRAPHIC	DESCRIPTION	N-VALUE (Uncorrected)	NATURAL MOISTURE	POCKET PENETROMETER TSF	LIQUID LIMIT	Plastic Limit	Percent Passing No. 200	Rock Core Recovery (in/%)	Rock Quality Designation (%)	Fractures per Foot
0				TOPSOIL	10	17	1.75						
				SILTY SANDY CLAY, 10% chert gravel, 20% fine to medium sand, 70% fines, low plasticity, dark red, very stiff, moist, FILL, CL	5	21	1.5						
					7	14	3.0						
5				SILTY SANDY CLAY, 20% fine to medium sand, 80% fines, low plasticity, light tan, stiff, moist, residuum, CL	9	16	3.25						
10				SILTY SANDY CLAY, 20% fine to medium sand, 80% fines, low plasticity, light tan and black, stiff, moist, residuum, CL	11	18	2.0						
				SILTY SANDY CLAY, 10% chert gravel, 20% medium to coarse sand, 70% fines, low plasticity, light gray, stiff, moist, residuum, CL	12	29	4.0						
15				SILTY SANDY CLAY, 10% chert gravel, 20% medium to coarse sand, 70% fines, high plasticity, light red, stiff, moist, residuum, CH									
20					9	26	3.0						
25				SILTY SANDY CLAY with trace chert, 20% medium to coarse sand, 80% fines, high plasticity, light red, stiff, moist, residuum, CH	5	25	1.5						
30													
35													

COMPLETION DEPTH: 25 DEPTH TO INITIAL WATER: 25'

DATE: 6-10-19 DEPTH TO EXTENDED WATER: on

BORING LEGEND

SOIL SYMBOLS

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAIN SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVELS 50% OR MORE OF COARSE FRACTION RETAINED ON #4 SIEVE	CLEAN GRAVELS	GW	WELL-GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN 50% OF COARSE FRACTION PASSES #4 SIEVE	CLEAN SANDS	SW	WELL-GRADED SANDS AND GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS AND GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAIN SOILS 50% OR MORE PASSES NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT 50% OR LESS	ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50%	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDS OR SILTS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS			PT	PEAT, MUCK AND OTHER HIGHLY ORGANIC SOILS

ABBREVIATIONS:

SS– SPLIT SPOON SAMPLE

UD– UNDISTURBED SAMPLE

REC–SAMPLE RECOVERY

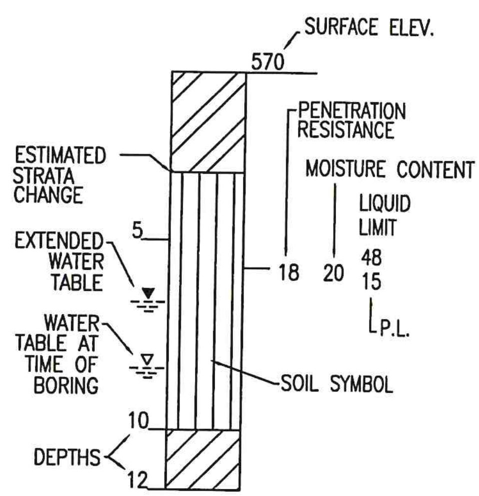
USC–VISUAL UNIFIED SOIL CLASSIFICATION

POCKET PENET– POCKET PENETROMETER READING, TSF

RQD–ROCK QUALITY DESIGNATION

FF– FRACTURE FREQUENCY PER FOOT OF CORE

KEY TO BORING RECORDS OR PROFILES



ROCK SYMBOLS

SANDSTONE

SHALE

GNEISS OR SCHIST

CONGLOMERATE

LIMESTONE OR DOLOMITE

OMI,INC.

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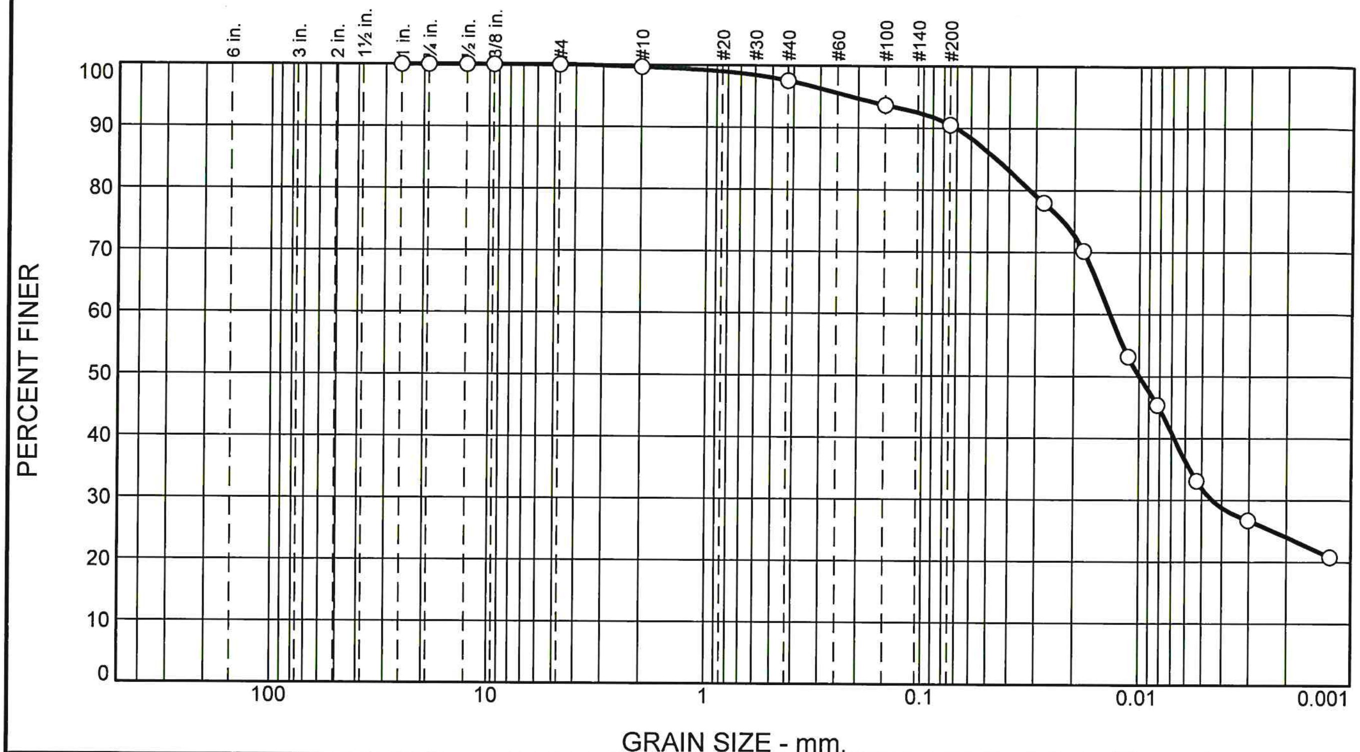
Huntsville, AL 35805

Particle Size Distribution Report



% +3"	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
0.0	0.3	2.2	7.0	66.5	24.0

Test Results (AASHTO T 27 & ASTM C 117)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.00	100.0		
0.750	100.0		
0.500	100.0		
0.375	100.0		
#4	100.0		
#10	99.7		
#40	97.5		
#100	93.7		
#200	90.5		
0.0277 mm.	78.0		
0.0181 mm.	70.2		
0.0112 mm.	53.2		
0.0082 mm.	45.4		
0.0053 mm.	33.1		
0.0030 mm.	26.7		
0.0013 mm.	20.8		

* (no specification provided)

Material Description

SILTY SANDY CLAY with trace oxides, 20% fine sand, 80% fines, low plasticity, red, gray, and black mottled, very stiff, moist, residuum, CL

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= 0.0706 D_{85}= 0.0458 D_{60}= 0.0136
D_{50}= 0.0100 D_{30}= 0.0044 D_{15}=
D_{10}= C_u= C_c=

Remarks

Tested on 6/25/2019

Date Received: **Date Tested:** 6/25/2019

Tested By: THS

Checked By: JS

Title:

Source of Sample: B-2 **Depth:** 6 **Date Sampled:**

OMI, Inc.

Huntsville, AL

Client: 4 Site, Inc.

Project: Spring Branch Greenway Pedestrian Bridge

Project No: 8730 **Figure**

FIELD TEST PROCEDURES

OMI, Inc., generally follows field and laboratory testing procedures as outlined by the American Society for Testing and Materials (ASTM) and the U. S. Army Corps of Engineers. Field procedures are outlined and an overview description is provided in ASTM Standard D-420, "Standard Guide to Site Characterization for Engineering, Design, and Construction Purposes." This document is a guide to the selection of various standards for investigating soil, rock, and ground water for earth related construction. Applicable procedures include geophysical, in-situ, and boring methods. A summary of each procedure used during this study is presented below.

SOIL DRILLING PROCEDURES

Several techniques are used to advance borings for collection of soil, rock, or ground water samples. Different techniques are used, depending on the samples desired and the soil and water conditions. Depths for sample intervals, strata changes, and boring termination or refusal are recorded to the nearest 1/10 of a foot. The project utilized the following.

<u>Soil Borings</u>

A) Solid stem continuous flight augers (ASTM D-1452)

B) Hollow stem continuous flight augers (ASTM D-1452)

C) Rotary drilling techniques using roller cone bits or drag bits and water with or without drilling mud or other additives to flush the hole

D) Hand augers

E) Backhoes or other excavating equipment.

Rock Borings

A) Core borings with diamond bits with double or triple core barrels (ASTM D-2113)

B) Rock borings with roller cone bit

C) Rotary hammer drilling.

Hollow and Solid Stem Auger: An auger is a center post with a continuous spiral flange wrapped around it. The post is called the stem. Augers are usually constructed in 5-foot long sections that can be coupled together. As the auger is turned and advanced into the ground; the soil "cuttings" are brought to the surface. Solid stem augers have a solid core and have to be removed from the boring to allow access for sampling tools. Hollow stem augers have the spiral flange connected to a hollow tube (stem). Sampling tools can access the bottom of the boring without removing the augers from the hole.

Rotary Borings: Rotary drilling involves the use of roller cone or drag type drill bits attached to the end of hollow drill rods. A flushing medium, normally water or bentonite slurry, is pumped through the rods to clear the cuttings from the bit face and flush them to the surface. Casing is sometimes set behind the advancing bit to prevent the hole from collapsing and to restrict the penetration of the drilling fluid into the surrounding soils. Cuttings returned to the surface by the drilling fluid are usually collected in a settling tank to allow the fluid to be re-circulated.

Hand Auger Borings: Hand auger borings are advanced by manually twisting a 4-inch diameter steel bucket auger into the ground and withdrawing it when filled to observe the sample collected. Other equipment such as post-hole diggers is sometimes used in lieu of augers to obtain shallow soil samples. Occasionally, these hand auger borings are used for driving 3-inch diameter steel tubes to obtain intact soil samples.

Test Pits: A backhoe or other construction equipment is sometimes used to excavate into soils to observe the soil and collect samples.

Core Drilling: Soil drilling methods are not normally capable of penetrating through hard cemented soil, weathered rock, coarse gravel or boulders, thin rock seams, or sound continuous rock. Material which cannot be penetrated by auger or rotary soil drilling methods at a reasonable rate is designated as "refusal material." Core drilling procedures are required to penetrate and sample refusal materials.

Prior to coring, casing may be set in the drilled hole through the overburden soils to keep the hole from caving and to prevent excessive water loss. The refusal materials are then cored according to ASTM D-2113 using a diamond bit fastened to the end of a hollow, double, or triple tube core barrel. This device is rotated at high speeds and the cuttings are brought to the surface by circulating water. Core samples of the material penetrated are protected and retained in the swivel-mounted inner tube. Upon completion of each drill run, the core is brought to the surface, recovery is measured, and the core is sequentially placed in boxes and transported to our laboratory for review and storage.

SAMPLING AND TESTING IN BOREHOLES

Several techniques are used to obtain samples and data in soils; however, the following methods were utilized in this project:

A) Standard Penetration Testing
B) Undisturbed Sampling
C) Dynamic Cone Penetration Testing
D) Pocket Penetrometer Testing
E) Hand-Held Static Cone Penetrometer
F) Water Level Readings.

These procedures are presented below. Any additional testing techniques employed during this exploration are contained in other sections of the Appendix.

Standard Penetration Testing: At regular intervals, the drilling tools are removed and soil samples are obtained with a standard 2-inch diameter split tube or "split spoon" sampler connected to a drill rod. The sampler is first seated 6 inches to penetrate any loose cuttings then driven an additional 12 inches with blows of a 140 pound safety hammer falling 30 inches. Generally, the number of hammer blows required to drive the sampler the final 12 inches is designated the "penetration resistance" or "N" value, defined in blows per foot (bpf). The split spoon sampler is designed to retain the soil penetrated so it may be returned to the surface for observation. Representative portions of the soil samples obtained from each split spoon sample are placed in jars, sealed, and transported to the laboratory.

The standard penetration test, when properly evaluated, provides an indication of the soil strength and compressibility. The tests are conducted according to ASTM Standard D-1586. The depths and N-values of standard penetration tests are shown on the Boring Records. Split spoon samples are suitable for visual observation and classification tests, but generally are not sufficiently intact for quantitative laboratory testing.

Undisturbed Sampling: Relatively undisturbed samples are obtained by pushing 3 inch outside diameter (OD), 30 inch long steel tubes with hydraulic pressure supplied by the drill rig into the soil at the desired sampling levels (ASTM Standard D-1587). These tubes are also known as Shelby tubes. Each tube, together with the encased soil, is removed from the ground, sealed, and transported to the laboratory. Locations and depths of undisturbed samples are shown on the Boring Records.

Dynamic Cone Penetrometer: The dynamic cone is a hand-operated penetrometer used in hand auger borings and observation pits. This test is intended to provide data that can be correlated to the standard penetration test. A 1.5-inch OD cone is seated to penetrate any loose cuttings, and then driven for 3 intervals of 1.75 inch with blows from a 15-pound weight falling 20 inches. The average number of blows required to drive the cone over 1 increment is an index to soil strength and compressibility.

Pocket Penetrometer Testing: The pocket penetrometer is a hand operated penetrometer used in test pits and on split spoon and undisturbed samples. This test is intended to provide data that can be correlated to the unconfined compressive strength test. A ¼-in diameter shaft is pressed into the soil ¼-in deep. The shaft pushes against a spring with a constant of 12 pounds per inch to provide a compressive strength value in tons per square foot. The penetrometer is capable of providing readings between 0.25 tons per square foot and 4.5 tons per square foot.

Water Level Readings: Water table readings are normally taken in the borings and are recorded on the Boring Records. In sandy soils, these readings indicate the approximate location of the hydrostatic water table at the time of the field exploration. In clayey soils, the rate of water seepage into the borings is low and it is generally not possible to establish the location of the hydrostatic water table through short-term water level readings. Also, fluctuation in the water table should be expected with variations in precipitation, surface run-off, evaporation, and other factors. For long-term monitoring of water levels, it is necessary to install piezometers.

The water level reported on the Boring Records is determined by field crews immediately after the drilling tools are removed, and again several hours after the borings are completed, if possible. The time lag is intended to permit stabilization of the ground water table which may have been disrupted by the drilling operation.

Occasionally, the borings will cave in, preventing water level readings from being obtained or trapping drilling water above the cave-in zone. The cave-in depth is measured and recorded on the Boring Records.

BORING RECORDS

The subsurface conditions encountered during drilling are reported on a Boring Record. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of coarse gravel, cobbles, etc., and observations of ground water. It also contains the driller's and the geotechnical engineer's interpretation of soil conditions between samples. Therefore, these boring records contain both factual and interpretative information. A geotechnical engineer visually classifies the soil samples and prepares the Boring Records which are the basis for all evaluations and recommendations.

LABORATORY TEST PROCEDURES

OMI, Inc., generally follows laboratory testing procedures as outlined by the American Society for Testing and Materials (ASTM), the U. S. Army Corps of Engineers, and other applicable procedures. All work is initiated and supervised by qualified engineers. Laboratory tests are performed by technicians trained to perform the work according to the appropriate procedures. The equipment is well maintained and inspected and calibrated annually or as specified by ASTM.

A description of the procedures used during this exploration or study are included in this Appendix.

SOIL CLASSIFICATION

Classification of soils provides a record and general guide to the engineering properties of the soils encountered during this study. Samples obtained during the field testing (drilling) operations are visually examined and classified by the geotechnical engineer. OMI, Inc., generally follows ASTM procedure No. D-2488 "Visual-Manual Procedure for Classifying Soils." Soil consistency and relative density is based on the number of blows from the standard penetration test. Representative or special samples are then selected for laboratory testing. Soil Boring Records are developed which present the data from the field testing as well as the soil description, water level information, and other data.

MOISTURE CONTENT

Moisture content values, when used in conjunction with other data, can be a useful and inexpensive tool to the engineer as an indicator of the engineering characteristics and parameters of the soil when compared to other data. Moisture content is performed by weighing a moist sample, drying, then re-weighing the dry sample. The moisture content is expressed as a percent of the dry weight of the soil. ASTM Method D-2216 is used to determine the moisture content of soil.

ATTERBERG LIMITS

Atterberg limits include the liquid limit (LL), plastic limit (PL), and shrinkage limit (SL) tests. These tests are performed to aid in the classification of soils and to determine the plasticity and volume change characteristics of the soil. The liquid limit is the minimum moisture content at which the soil will flow as a heavy viscous fluid. The plastic limit is the minimum moisture content at which the soil behaves as a plastic material. The shrinkage limit is the moisture content below which no further volume change will occur with continued drying. The plasticity index (PI) is the difference between the liquid limit and the plastic limit. The PI is the range of moisture at which the soil remains plastic. Many engineering characteristics have been correlated to the Atterberg limits. These are ASTM procedures D-4318, D-4943, and D-427.

STANDARD PROCTOR COMPACTION TEST

This test is used to establish a curve that predicts the effect of moisture and compactive effort on the dry density of the soil sample. It is useful as a comparative value in monitoring contractors' efforts during fill placement and compaction during construction. Also, correlations of engineering parameters such as strength, compressibility, and permeability are related to the percent compaction and soil type.

A representative sample of the proposed fill material (soil or stone) is collected. The sample is divided into four or more samples. Each sample is then brought to a different moisture content about 2% apart. Each sample is then placed in a standard 4-inch diameter mold in 3 equal layers with each layer being compacted with 25 blows from a 5.5-pound hammer falling 12 inches. The sample is trimmed to a known volume of 1/30 cubic foot then weighed. The moisture content of the sample is determined and the dry density is calculated. A graph of dry density (pcf) versus moisture content is developed. The maximum density and its corresponding moisture content known as the optimum moisture content are derived from the curve. A graph of the moisture-density relationship is given in the Appendix. ASTM D-698 describes the procedure.

UNCONFINED COMPRESSION TESTS - ROCK CORES

The strength of rock is important in many engineering applications. This strength is usually desired and reported as the unconfined or simple shear strength. Selected samples of rock cores are cut using a diamond saw. The cores are usually cut to a length equal to about twice the core diameter. The capped length and diameter of each core is measured and recorded. The cores are then loaded to failure in a compression machine. The unconfined compressive strength is calculated by dividing the cross-sectional area of the core into the maximum load required to crush the sample. If the length to diameter ratio is less than 2.0, then the maximum strength is adjusted mathematically. The results are reported in psi. This procedure is similar to ASTM D-2938.

CONSOLIDATION TESTING

The consolidation test provides data for estimating the settlement and time rate of settlement of the soil in response to the applied loads. Representative soil samples are collected from undisturbed samples, trimmed into a disk about 2.5 inches in diameter and 1 inch thick, then placed in the consolidometer. The disk is confined in a brass ring and sandwiched by porous stones on the top and bottom. The sample ring and stones are placed in a testing device, inundated, then loaded in increments. The sample height is measured as each load caused it to compress. The resulting loads and deformations are reduced to a graph which is presented in the Appendix. These results may be presented in load versus percent strain or load versus void ration. This procedure is described in ASTM D-2435.