OMI, Inc.

SUBSURFACE EXPLORATION AND
GEOTECHNICAL ENGINEERING STUDY
Proposed
StoreEase Storage Buildings
Roundbar Drive and Highway 431
Huntsville, Alabama

OMI Job No. 9673

October 21, 2021

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.

October 21, 2021

Engineering Design Group, LLC
120 Bishop Circle, Suite 300
Pelham, Alabama 35124

ATTN: Mr. Ethan Fisher, P.E.

SUBJECT: Report of Geotechnical Engineering Study
Proposed StorEase Storage Buildings
Roundbar Drive and Highway 431
Huntsville, Alabama
OMI Job No. 9673

Ladies and 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 September 15, 2021, by Mr. Wade Lowery of Engineering Design Group, LLC.

OMI, Inc. appreciates the opportunity to be of service to Engineering Design Group 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.

Wes McKay, E.I.
Staff Engineer

ALABAMA LICENSED No. 32763 PROFESSIONAL ENGINEER JOHN MITCHELL OZIER

John M. Ozier, P.E.
Senior Engineer

Distribution via email to: fisher@edgalabama.com

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1.0 EXECUTIVE SUMMARY

Layers of weak soil (alluvium) and isolated areas of fill were encountered at the surface. Depending on the time of year, undercutting may possibly be avoided. If the soils cannot be dried and compacted in-place after stripping, then undercutting will be necessary. Anticipated undercut depths generally range from 2-ft to 5-ft below the surface. The soil itself appears to be suitable for use as structural fill. Groundwater is also anticipated to be near the surface during such over-excavation. Dewatering and/or stone stabilization layers should be expected in such cases.

If the site is prepared as described in the text, OMI recommends a typical shallow foundation system to support the proposed storage buildings. 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 StorEase storage buildings. 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 September 15, 2021, by Mr. Wade Lowery of Engineering Design Group, LLC. The work was performed in general accordance with OMI Proposal No. P-6346.

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 has been retained to provide a Phase I Environmental Site Assessment as OMI Job No. 9678.

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.

Twelve soil test borings were drilled to 15-ft or refusal during this study. Boring locations are shown on the appended Boring Location Map. Borings were drilled using a truck-mounted mobile Drill B-47 with an automatic SPT (Standard Penetration Test) sampling hammer (approximately 93 percent efficiency). 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

OMI understands that a multi-building storage facility is proposed for two adjacent parcels in southeast Huntsville, Alabama, at the north corner of Roundbar Drive and Highway 431. Currently, the two irregularly-shaped parcels occupy an approximate total of 3.4-acres and contain mowed field grasses and isolated mature hardwoods. A utility easement is located in a north-to-south orientation between the parcels and a billboard is also in the southern end of the western parcel. City of Huntsville Interactive Maps show contours ranging from 706-ft in the middle of the western parcel to 702-ft in the south end of the east parcel where surface waters appear to be directed to a culvert.

5.0 SUBSURFACE CONDITIONS

Marginal strength soils, including possible fill and alluvium, were encountered in the upper depths of the borings. Stronger residual clays were encountered underneath the weaker strata. Topsoil thicknesses ranged from 3-in to 6-in and averaged about 5-in.

Possible fill was encountered in Borings B-2, B-3, B-4, B-6, B-7, and B-12 extending to depths ranging from 1.5-ft to 5-ft. Automatic hammer SPT (Standard Penetration Test) values ranged from 3 to 10 bpf (blows per foot) and averaged 6 bpf with a hammer efficiency of 93 percent. Pocket penetrometer values averaged 2.25 tsf (tons per square foot). Moisture contents in this soil ranged from 11 to 23 percent and averaged 16 percent.

Possible alluvium was encountered in Borings B-1, B-3, B-8, B-9, B-10, B-11, and B-12. While the alluvium generally extended to about 2-ft to 3-ft below the surface, the alluvium was present below the 5-ft of possible fill in Boring B-3. Automatic hammer SPT values in the alluvium ranged from 3 to 6 bpf and averaged 5 bpf. Pocket penetrometer values averaged 1.75 tsf (tons per square foot). Moisture contents in this soil ranged from 15 to 26 percent and averaged 18 percent. Atterberg limits testing indicated a liquid limit of 27, a plastic limit of 14, and a plasticity index of 13.

Low to medium plastic residual clays were encountered to termination. Automatic hammer SPT values in the alluvium ranged from 6 to 26 bpf and averaged 16 bpf. Pocket penetrometer values averaged 4.25 tsf (tons per square foot). Moisture contents in this soil ranged from 13 to 25 percent and averaged 20 percent.

Auger refusal was encountered between 11-ft and 12-ft in Borings B-3, B-9, and B-11. All other borings were terminated at 15-ft. Groundwater was observed at 14-ft below the surface in B-2 while all other borings were dry during drilling. Extended water readings were taken in Borings B-2 and B-6. Extended water readings were 3-ft and 3.5-ft, respectively. This elevation is anticipated to be true regional groundwater and not just "perched" water. 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, and do occur in this formation. 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

A preliminary layout provided by Mr. Fisher shows three storage buildings ranging from 18,800 to 26,800 square feet in size. Asphalt pavement is shown accessing the storage buildings from Highway 431 and connecting to Roundbar Drive on the east end of the layout. Structures are expected to be single-story, steel stud-framed construction with concrete slab floors. OMI expects that wall loads will be approximately 1 klf and floor loads will be no more than 100 psf. The finished floor of the structures is expected to be approximately at the existing grades (within about 2-ft of existing ground surface).

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 conventional shallow foundation system bearing on the in-place soils or on engineered fill, as applicable. Footings should be designed based on a maximum allowable bearing pressure of 1,200 psf. This pressure includes a factor of safety of at least three against general shear failure. To allow for minor inconsistencies in the soil subgrade, individual and continuous footings should have minimum widths of 24-in and 18-in, respectively, regardless of loading. Perimeter footings, and those within unheated areas, should bear at least 2-ft below finished exterior grade to provide adequate confinement and protection against frost and movement due to moisture fluctuations. Interior footings should bear at least 1-ft below the soil subgrade. The ground surface around the building area should be graded to provide positive drainage away from the building.

9.2 Seismic Classification

OMI has reviewed the soils at the site with respect to the criteria for seismic classification. In accordance with Section 1615.1, Table 1615.1.1 of the 2003 International Building Code, OMI judges the soil to be Site Class D.

9.3 Floor Slabs

The slab thickness, reinforcing, and stone base thickness are all a function of the traffic weight, loading frequency, and the soil subgrade strength. A typically loaded storage building floor slab, where the design floor loads are less than 100 psf, should be placed on a 4-in thick layer of open-graded compacted gravel such as ASTM No. 57 stone. The aggregate layer will distribute the floor load from the slab to the soil and provide protection against the migration of moisture upward through the floor slab. A vapor barrier may be placed beneath the floor slab stone to provide additional protection against moisture migration.

9.4 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 95 percent of the soil's standard Proctor maximum dry density, SPMDD. The top 1-ft beneath the building and pavement areas should be compacted to 100 percent SPMDD. The on-site soil interval appears to meet the requirements set forth above.

9.5 Pavement Areas

Based on traffic and frequency of heavy vehicles such as waste removal trucks or delivery vehicles, parking and drive areas are expected to require different materials or thicknesses in different areas. OMI has formed recommendations for both flexible (asphalt) and rigid (concrete) sections as found below.

Flexible Pavement Design

Surface parking and entrance drive areas should be prepared in accordance with the general recommendations for stripping and fill placement stated elsewhere in this text, except the upper 1-ft must be compacted to at least 100 percent of the standard Proctor maximum dry density. Topsoil stripping depths may be reduced within flexible pavement areas to leave some slightly organic soil in place. Close monitoring will be required to achieve this cost savings. The pavement sections provided were based on a CBR of 4. Specific traffic frequency and loading information has not been provided; however, assuming that the paved areas can be broken into two categories with the listed frequencies and loading being acceptable, the following pavement sections may be used.

AUTOMOBILE PARKING -	Maximum 1000 vehicles per day (VPD) consisting of automobile traffic and less than five percent medium truck traffic. No heavy trucks.
TRUCK PARKING/DOCKS -	Maximum 3000 VPD including not more than two heavy trucks per day.

FLEXIBLE PAVEMENT DESIGN

PAVEMENT MATERIAL	AUTOMOBILE	TRUCK
ASPHALT SURFACE COURSE (Hot Mix) ALDOT No. 424A, 1/2-in Max. Agg. Size, ESAL Range A/B	2.0 inches	2.0 inches
ASPHALT BINDER COURSE ALDOT No. 424B, ¾-in Max. Agg. Size, ESAL Range A/B	—	2.5 inches
STONE BASE COURSE ALDOT No. 825 B (Compacted to 100% Standard Proctor as per AASHTO T-99)	6.0 inches	6.0 inches
TOTAL THICKNESS	8.0 inches	10.5 inches

All pavement materials and construction methods should conform to the guidelines and requirements of the Alabama Department of Transportation. During placement of the aggregate base and asphalt courses, density tests and thickness measurements should be performed to compare the design section to the constructed section. The soil subgrade should be graded to provide a smooth transition from one pavement section to another. It is imperative that truck traffic be limited to areas specifically designed to carry those vehicles.

Immediately prior to placement of the aggregate base, the subgrade must be proofrolled to judge the stability of the soil. The soil may require recompaction. The stone base course should only be applied to a stable, compact soil subgrade. Asphalt paving should proceed closely after stone placement. If lengthy delays between stone and asphalt paving occur, the stability of the stone and soil subgrade should be checked prior to paving.

Rigid Pavement Design

Some areas may require concrete for parking and drive areas. This is called a "rigid" pavement. Design of the pavements assumes the site is prepared as recommended in this report. Also, the top 1-ft must be compacted to at least 100 percent of the soil's standard Proctor maximum dry density (SPMDD).

The pavement design assumes the paved areas can be divided into two general categories. These categories are passenger vehicle and light truck traffic and parking as well as major traffic/heavy truck traffic and parking. OMI has also assumed the same traffic frequencies in the afore mentioned flexible pavement design.

RIGID PAVEMENT DESIGN

PAVEMENT MATERIAL	AUTOMOBILE	TRUCK
CONCRETE WITH A FLEXURAL STRENGTH OF 650 PSI	5.0 inches	6.0 inches
STONE BASE COURSE ALDOT No. 825 B (Compacted to 100% Standard Proctor as per AASHTO T-99)	6.0 inches	6.0 inches

This design is based on a flexural strength of 650 psi and a soil subgrade modulus of 150 pci. Proper design of the joints and joint spacings is important for the service life of the pavement. OMI recommends flexural beams be molded during concrete placement. Flexural strength and compressive strength should be tested and used as acceptance criteria.

Uniformity of support is critical to the performance of rigid pavements. Construction activity often disturbs and compacts areas of the site during the building construction. This creates hard and soft spots that can result in cracked pavements or early failure. OMI recommends the parking and pavement areas be recompacted and shaped just prior to pouring.

10.0 CONSTRUCTION CONSIDERATIONS

10.1 Site Preparation Overview

Upper layers of weak soil will need to be allowed to dry and subsequently compacted in-place prior to proofrolling. In wetter months of the year, the soils will likely not be able to dry out and undercutting will be necessary. Additionally, groundwater is expected to be near the surface. Dewatering methods and/or stabilization layers may allow for proper compaction of backfill soils. Conversely, scheduling earthwork to begin in dryer periods will be advantageous to help dry out over-excavated soils and to reduce the chances of undercut.

10.2 Site Preparation – Wetter Months of the Year

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 areas approximately at grade or to receive fill should be observed by the geotechnical engineer. Undercutting should then be directed as necessary until stable soil horizons are encountered. Estimated undercut amounts are described later.

Groundwater infiltration into undercut areas should be expected. If perimeter ditches and sumps are not able dry the excavated areas to allow proper compaction of fill, a stone stabilization layer comprised of layers of compacted open-graded stone can allow subsequent fill soil to achieve proper compaction.

Once target subgrade is reached, the area should be proofrolled in the presence of a geotechnical engineer. Proofrolling is performed by repeated passes of a heavy rubber-tired vehicle, such as a loaded dump truck. Any areas judged to deflect excessively during proofrolling should be undercut to a stable soil horizon. Such over-excavation must be backfilled with structural fill placed as described below.

10.3 Site Preparation – Dry Months (Typically July through October)

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. The exposed soil should then be scarified and allowed to dry to the optimum moisture content. In-place compaction of the soils may then begin. Subsequently, the areas approximately at grade or to receive fill should be proofrolled in the presence of the geotechnical engineer to identify areas that will still need to be over-excavated as described earlier.

It should be understood that scheduling work for the dryer months of the year will not guarantee an avoidance of undercutting but OMI believes that undercut depths can be reduced, especially with prolonged periods of dry weather.

10.4 Estimated Topsoil Removal

The depth of topsoil varies across the site. OMI believes that the stripping depth to remove the topsoil will range from 3-in to 6-in and average about 5-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.

10.5 Estimated Soil Undercut

If undercutting of the site is necessary, undercut depths are expected to range from roughly 2-ft in the vicinity of Boring B-8 to 5-ft in Boring B-3. The undercut depths vary across the site.

Anticipated undercut depths are presented on the Boring Location Map. The soil should be over-excavated until stable soil horizons are encountered.

10.6 Fill Placement

After proofrolling is complete and any necessary undercutting has been performed, 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 95 percent of the soil's standard Proctor maximum dry density (ASTM D698) except the top 1-ft should be compacted to 100 percent SPMDD.

10.7 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.

10.8 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.

10.9 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.

10.10 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.

APPENDICES

APPENDIX A

OMI, Inc.

5151 Research Dr. NW
Huntsville, AL 35805

PH: (256) 837 - 7664

FAX: (256) 837 - 7677

LEGEND

- B-1, APPROXIMATE BORING LOCATION

0' - ANTICIPATED UNDERCUT DEPTH (FROM EXISTING GRADE)

3' - 24 HR WATER LEVEL (BELOW EXISTING GRADE)

NOTE: THIS DRAWING HAS BEEN REDRAWN FROM A DRAWING PROVIDED BY: ENGINEERING DESIGN GROUP, LLC, HUNTSVILLE, ALABAMA.

JOB NAME: STOREASE ROUNDBAR DRIVE HUNTSVILLE, ALABAMA	BORING LOCATION MAP DRAWING NO: 9673 - 1	JOB N0: 9673 DATE: 10-21-2021 SCALE: 1"= 100' DRAWN BY: DAH

APPENDIX B

OMI, Inc.

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

Soil Boring Record

JOB NO.: 9673 JOB: Roundbar Dr. StorEase LOG OF BORING: B-1

Driller: South Bros Drill Model: Mobile Drill B47 Hammer Type: Auto Hammer Efficiency: 93%

Logged By: MW McKay 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									
				SANDY SILTY CLAY with trace oxides, 20% fine sand, 80% fines, low plasticity, olive tan, firm to stiff, moist, alluvium, CL	5	16	1.25						
2.5					6	15	2.75						
				SANDY CLAY, 25% fine sand, 75% fines, medium plasticity, orange, tan, and gray, very stiff, moist, residuum, CL	16	22	4.5						
5													
7.5					16	23	4.5						
10					19	22	4.5						
12.5													
					20	25	3.25						
15				BORING TERMINATED AT 15-FT.									

COMPLETION DEPTH: 15 DEPTH TO INITIAL WATER: Dry

DATE: 9/30/2021 DEPTH TO EXTENDED WATER: on

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Soil Boring Record

JOB NO.: 9673   JOB: Roundbar Dr. StorEase   LOG OF BORING: B-2

Driller: South Bros   Drill Model: Mobile Drill B47   Hammer Type: Auto   Hammer Efficiency: 93%

Logged By: MW McKay   Boring Location:

City: Huntsville   County: Madison   State: Alabama

DEPTH, FT	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									
	GRAVELLY SAND, 20% gravel, 70% sand, 10% fines, low plasticity, tan, red, and brown, stiff, moist, FILL, SW-SC	8	11	2.5						
		6	23	0.5						
2.5	SANDY CLAY, 30% fine sand, 70% fines, gray, very stiff, moist, residuum, CL									
		23	13	4.5						
5	SANDY CLAY, 30% fine sand, 70% fines, medium plasticity, gray and tan, stiff to very stiff, moist, residuum, CL									
		15	19	4.0						
7.5										
		6	21	1.75						
10										
12.5										
		16	20	3.5						
15	BORING TERMINATED AT 15-FT.									

COMPLETION DEPTH: 15   DEPTH TO INITIAL WATER: 14-FT.

DATE: 9/30/2021   DEPTH TO EXTENDED WATER: 3-FT. on 10/1/2021

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Soil Boring Record

JOB NO.: 9673   JOB: Roundbar Dr. StorEase   LOG OF BORING: B-3

Driller: South Bros   Drill Model: Mobile Drill B47   Hammer Type: Auto   Hammer Efficiency: 93%

Logged By: MW McKay   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									
				SANDY SILTY CLAY with trace oxides, 20% fine sand, 80% fines, low plasticity, tan and gray, firm, moist, FILL, CL	4	20	--						
2.5					3	17	1.0						
				NOTE: Layer of organics (grass) encountered at 4.5-ft.	5	17	1.5						
5				SANDY SILTY CLAY with trace oxides, 20% fine sand, 80% fines, low plasticity, olive gray, firm, moist, alluvium, CL	4	26	1.0						
7.5				SANDY CLAY, 25% fine sand, 75% fines, medium plasticity, orange, tan, and gray, very stiff, moist, residuum, CL	13	23	4.5						
10													
12.5				AUGER REFUSAL AT 12-FT.									
15													

COMPLETION DEPTH: 12   DEPTH TO INITIAL WATER: Dry

DATE: 9/30/2021   DEPTH TO EXTENDED WATER: ______ on ______

OMI, Inc.

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

Soil Boring Record

JOB NO.: 9673   JOB: Roundbar Dr. StorEase   LOG OF BORING: B-4

Driller: South Bros   Drill Model: Mobile Drill B47   Hammer Type: Auto   Hammer Efficiency: 93%

Logged By: MW McKay   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									
				SANDY SILTY CLAY with trace oxides, 20% fine sand, 80% fines, low plasticity, orangish brown, stiff, moist, FILL, CL	6	16	3.75						
2.5				SANDY CLAY, 25% fine sand, 75% fines, low plasticity, orange, tan, and gray, firm, moist, possible alluvium, CL	3	15	1.25	27	14				
5				SANDY CLAY, 25% fine sand, 75% fines, low plasticity, orange, tan, and gray, firm, moist, possible alluvium, CL	17	19	4.5						
7.5					18	20	4.5						
10					16	20	4.5						
12.5					18	23	4.5						
15				BORING TERMINATED AT 15-FT.									

COMPLETION DEPTH: 15   DEPTH TO INITIAL WATER: Dry

DATE: 9/30/2021   DEPTH TO EXTENDED WATER: on

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

Soil Boring Record

JOB NO.: 9673 JOB: Roundbar Dr. StorEase LOG OF BORING: B-5

Driller: South Bros Drill Model: Mobile Drill B47 Hammer Type: Auto Hammer Efficiency: 93%

Logged By: MW McKay 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									
				SANDY CLAY, 30% fine sand, 70% fines, medium plasticity, orange, tan, and gray, firm, moist, residuum, CL	4	16	1.75						
2.5					3	17	2.0						
				SANDY CLAY, 30% fine sand, 70% fines, medium plasticity, orange, tan, and gray, very stiff, moist, residuum, CL	14	17	3.75						
5													
7.5					17	16	4.5						
10					17	22	4.5						
12.5													
					16	23	--						
15				BORING TERMINATED AT 15-FT.									

COMPLETION DEPTH: 15 DEPTH TO INITIAL WATER: Dry

DATE: 9/30/2021 DEPTH TO EXTENDED WATER: on

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Soil Boring Record

JOB NO.: 9673   JOB: Roundbar Dr. StorEase   LOG OF BORING: B-6

Driller: South Bros   Drill Model: Mobile Drill B47   Hammer Type: Auto   Hammer Efficiency: 93%

Logged By: MW McKay   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				SANDY CLAY with trace gravel and organics, 30% fine sand, 70% fines, low plasticity, brown and orange, stiff to very stiff, moist, FILL, CL	7	13	3.5						
					10	11	3.75						
2.5				SANDY CLAY, 25% fine sand, 75% fines, medium plasticity, orange, tan, and gray, very stiff, moist, residuum, CL	10	21	4.25						
5					13	19	4.5						
7.5					13	19	4.5						
10													
12.5					23	18	4.5						
15				BORING TERMINATED AT 15-FT.									

COMPLETION DEPTH: 15   DEPTH TO INITIAL WATER: Dry

DATE: 9/30/2021   DEPTH TO EXTENDED WATER: 3.5-FT. on 10/1/2021

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Soil Boring Record

JOB NO.: 9673 JOB: Roundbar Dr. StorEase LOG OF BORING: B-7

Driller: South Bros Drill Model: Mobile Drill B47 Hammer Type: Auto Hammer Efficiency: 93%

Logged By: MW McKay 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									
				SANDY CLAY with trace gravel and organics, 30% fine sand, 70% fines, low plasticity, brown and orange, moist, FILL, CL	4	15	3.75						
2.5					4	17	1.25						
				SANDY CLAY, 25% fine sand, 75% fines, medium plasticity, orange, tan, and gray, moist, residuum, CL	25	19	4.5						
5													
					15	20	4.5						
7.5													
					16	18	4.5						
10													
12.5													
					20	20	3.75						
15				BORING TERMINATED AT 15-FT.									

COMPLETION DEPTH: 15 DEPTH TO INITIAL WATER: Dry

DATE: 9/30/2021 DEPTH TO EXTENDED WATER: ____ on ____

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Soil Boring Record

JOB NO.: 9673 JOB: Roundbar Dr. StorEase LOG OF BORING: B-8

Driller: South Bros Drill Model: Mobile Drill B47 Hammer Type: Auto Hammer Efficiency: 93%

Logged By: MW McKay 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									
				SANDY SILTY CLAY with trace oxides, 20% fine sand, 80% fines, low plasticity, olive tan, firm, moist, alluvium, CL	4	16	2.5						
2.5				SANDY CLAY, 25% fine sand, 75% fines, medium plasticity, orange, tan, and gray, stiff to very stiff, moist, residuum, CL	6	16	2.0						
					11	24	4.5						
5													
					23	23	4.5						
7.5													
					20	25	4.5						
10													
12.5													
					12	23	4.5						
15				BORING TERMINATED AT 15-FT.									

COMPLETION DEPTH: 15 DEPTH TO INITIAL WATER: Dry

DATE: 9/30/2021 DEPTH TO EXTENDED WATER: on

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Soil Boring Record

JOB NO.: 9673   JOB: Roundbar Dr. StorEase   LOG OF BORING: B-9

Driller: South Bros   Drill Model: Mobile Drill B47   Hammer Type: Auto   Hammer Efficiency: 93%

Logged By: MW McKay   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									
				SANDY SILTY CLAY with trace oxides, 20% fine sand, 80% fines, low plasticity, olive tan, moist, alluvium, CL	4	15	2.25						
2.5					4	18	2.25						
				SANDY CLAY, 25% fine sand, 75% fines, medium plasticity, orange, tan, and gray, moist, residuum, CL	14	20	4.5						
5					21	15	4.5						
7.5					50/2	20	4.5						
10													
				AUGER REFUSAL AT 11-FT.									
12.5													
15													

COMPLETION DEPTH: 11   DEPTH TO INITIAL WATER: Dry

DATE: 9/30/2021   DEPTH TO EXTENDED WATER: on

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Soil Boring Record

JOB NO.: 9673   JOB: Roundbar Dr. StorEase   LOG OF BORING: B-10

Driller: South Bros   Drill Model: Mobile Drill B47   Hammer Type: Auto   Hammer Efficiency: 93%

Logged By: MW McKay   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				SANDY SILTY CLAY with trace oxides, 20% fine sand, 80% fines, low plasticity, olive tan, moist, alluvium, CL	6	16	3.5						
2.5					4	23	1.5						
				SANDY CLAY, 25% fine sand, 75% fines, medium plasticity, orange, tan, and gray, moist, residuum, CL	6	20	3.5						
5													
7.5					26	18	4.5						
10					15	17	4.5						
12.5													
					19	19	4.5						
15				BORING TERMINATED AT 15-FT.									

COMPLETION DEPTH: 15   DEPTH TO INITIAL WATER: Dry

DATE: 9/30/2021   DEPTH TO EXTENDED WATER: on

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Soil Boring Record

JOB NO.: 9673 JOB: Roundbar Dr. StorEase LOG OF BORING: B-11

Driller: South Bros Drill Model: Mobile Drill B47 Hammer Type: Auto Hammer Efficiency: 93%

Logged By: MW McKay Boring Location:

City: Huntsville County: Madison State: Alabama

DEPTH, FT	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									
	SANDY SILTY CLAY with trace oxides, 20% fine sand, 80% fines, low plasticity, olive tan, firm, moist, alluvium, CL	5	17	1.5						
2.5		5	22	0.75						
		5	22	1.0						
5	SANDY CLAY, 25% fine sand, 75% fines, medium plasticity, orange, tan, and gray, stiff to very stiff, moist, residuum, CL									
		7	22	2.5						
7.5										
		19	18							
10										
12.5	AUGER REFUSAL AT 12-FT.									
15										

COMPLETION DEPTH: 12 DEPTH TO INITIAL WATER: Dry

DATE: 9/30/2021 DEPTH TO EXTENDED WATER: on

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Soil Boring Record

JOB NO.: 9673 JOB: Roundbar Dr. StorEase LOG OF BORING: B-12

Driller: South Bros Drill Model: Mobile Drill B47 Hammer Type: Auto Hammer Efficiency: 93%

Logged By: MW McKay 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									
				GRAVELLY SAND, 20% gravel, 70% sand, 10% fines, low plasticity, tan, red, and brown, stiff, moist, FILL, SW-SC	10	13	--						
2.5				SANDY SILTY CLAY with trace oxides, 20% fine sand, 80% fines, low plasticity, olive tan, firm, moist, alluvium, CL	3	18	2.75						
				SANDY CLAY, 25% fine sand, 75% fines, medium plasticity, orange, tan, and gray, very stiff to hard, moist, residuum, CL	17	22	4.5						
5													
7.5					19	24	4.5						
10					19	24							
12.5													
					50/2	21							
15				BORING TERMINATED AT 15-FT.									

COMPLETION DEPTH: 15 DEPTH TO INITIAL WATER: Dry

DATE: 9/30/2021 DEPTH TO EXTENDED WATER: on

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APPENDIX C

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

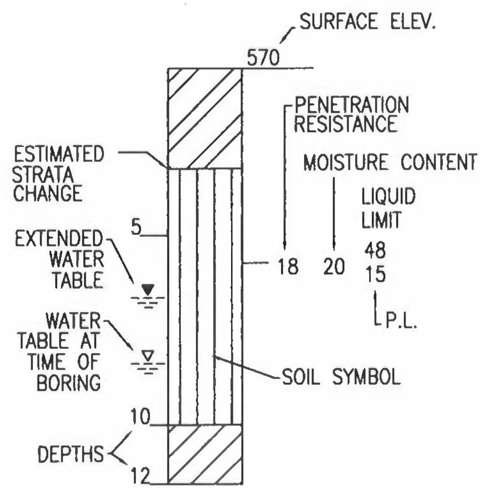
USC-VISUAL UNIFIED SOIL CLASSIFICATION

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

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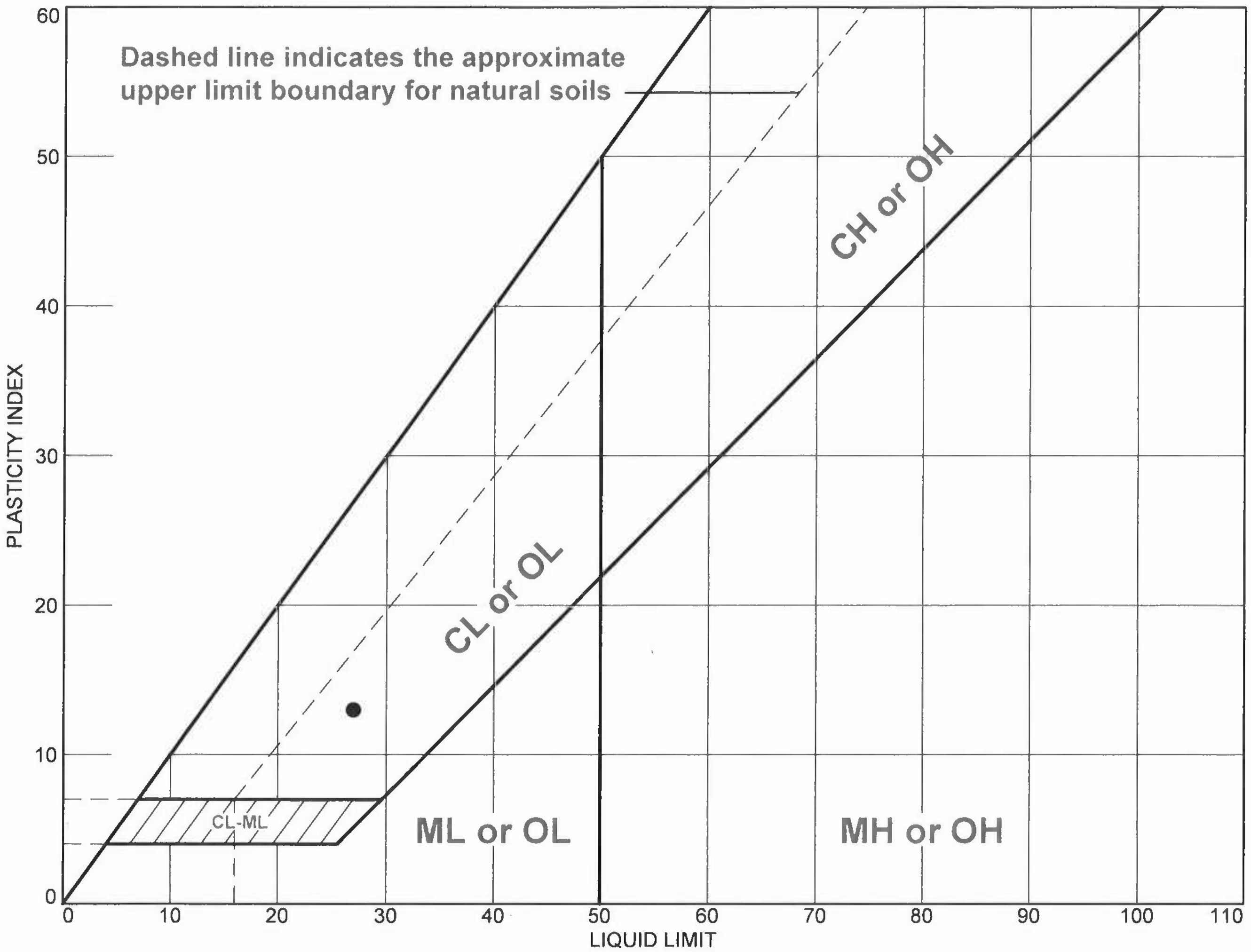
APPENDIX D

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	SANDY SILTY CLAY with trace oxides, 20% fine sand, 80% fines, low plasticity, orangish brown, moist,	27	14	13			

Project No. 9673 **Client:** Engineering Design Group

Project: Roundbar Dr. StorEase

● **Source of Sample:** B-4 **Depth:** 1.5

Remarks:

OMI, Inc.

Huntsville, AL

Figure

Tested By: JRC **Checked By:** MWM

APPENDIX E

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.

Soil Borings

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.

APPENDIX F

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.