

**GEOTECHNICAL ASSESSMENT
PARKING LOT AND ROADWAY UPGRADE – PHASE I
VA 636A6 – 11 - 301**

**Veterans Administration Medical Campus
Des Moines, Iowa**

**Aquaterra Project No. 4963.10
October 2011**

AQUATERRA
ENVIRONMENTAL SOLUTIONS, INC.

Prepared for:

 **21 Delta
Engineers**

**21 Delta Engineers, LLC
3824 N. 108th Street
Omaha, Nebraska 68164**

AQUATERRA
ENVIRONMENTAL SOLUTIONS, INC.

November 7, 2011

Mr. Paul Mattern
21 Delta Engineers
3824 N. 108th Street
Omaha, NE 68164

Re: **Geotechnical Assessment**
Parking Lot and Roadway Upgrade – Phase I (VA 636A6 – 11 – 301)
Veterans Administrative Medical Campus
Des Moines, Iowa

Dear Mr. Mattern:

Aquaterra Environmental Solutions, Inc. has completed the geotechnical assessment of Phase I of the Parking Lot and Roadway Upgrade project for the Veterans Administration Medical Campus in Des Moines, Iowa (Project # VA 636A6 – 11 – 301). We have attached here with our report of the observations and testing results for this project as well as our findings and recommendations. It was a great pleasure to be of assistance on this project, and we hope you find that this reports serves your needs.

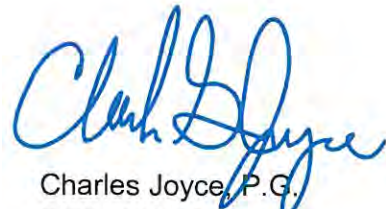
Should you or any of your other sub-consultants have questions please feel free to contact us at the below listed contact information.

Sincerely,

Aquaterra Environmental Solutions, Inc.



John F. Hartwell, PE, CHMM
Senior Consultant



Charles Joyce, P.G.
Project Geologist

TABLE OF CONTENTS

1.0	INTRODUCTION	1
2.0	PROJECT SCOPE	2
3.0	SUBSURFACE EXPLORATION	3
4.0	LABORATORY TESTING	4
5.0	SUBSURFACE CONDITIONS	5
5.1	Site Soil Profile.....	5
5.2	Groundwater Conditions	5
6.0	CONCLUSIONS AND RECOMMENDATIONS.....	6
6.1	Pavement Subgrade Preparation	6
6.2	Pavement Design Considerations	6
7.0	GENERAL COMMENTS	8

LIST OF APPENDICES

- Appendix A Boring Location Plan
- Appendix B Boring Logs

**GEOTECHNICAL ASSESSMENT
PARKING LOT AND ROADWAY UPGRADE – PHASE I
DES MOINES, IOWA
OCTOBER 2011**

1.0 INTRODUCTION

This report presents the findings, observations, conclusions and recommendations related to the geotechnical assessment performed by Aquaterra Environmental Solutions, Inc. (Aquaterra) for the Parking Lot and Roadway Upgrade – Phase I Project (VA 636A6 – 11 – 301) at the Veterans Administration Medical Campus (VAMC) located at 3600 30th Street in Des Moines, Iowa.

The assessment consisted of four (4 ea.) borings, soils laboratory analysis, data evaluation and this report. The scope of the assessment did not include an environmental assessment for the presence or absence of hazardous or toxic materials in the soil or groundwater on or near the site. Aquaterra performed this assessment consistent with the professional standard of care, which is the level of professional care normally practiced by a professional engineer for a project of this nature in this locale and at this time.

2.0 PROJECT SCOPE

Our understanding of this project is based upon conversations with 21 Delta and Lamp Rynerson Associates (LRA). We understand that the roadways abutting and connecting Parking Lots A and B located in the northwest quadrant of the VA campus will be reconfigured at or near the existing grade with little additional fill or cut being necessary. In the event that subgrade fill is necessary, we further understand that available borrow will be obtained from the parking lot in which Borings B-7, B-8 and B-9 were performed. Further additional pavement rerouting will likely occur near Lot C which is located in the southwest quadrant of the campus, although at the time of the preparation of this report the precise alignment for the improvement of the hairpin curve just west of the Lockers and mechanical Building #13. We understand that in the case of Lots A and B pavement and parking area alignment and configuration will be adjusted without substantial changes in vertical grade. Grade changes in vicinity of Building 13 or the building just east (#9) is unknown at the time of this report.

3.0 SUBSURFACE EXPLORATION

The field exploration was performed on 14 October 2011. The boring program consisted of drilling four (4 ea) shallow borings near Lots A and B and near Lot C and Buildings #9 and #13. These borings were completed to depth ranging from 5 to 15 ft below ground surface (bgs). The borings were advanced with a track mounted Geoprobe drill rig using AW rods, a 2 inch diameter continuous split barrel acrylic lined 4 ft long sampler for obtaining soil characterization samples. Where relatively undisturbed soil samples were required samples were obtained using 3 in diameter thin walled 30 inch long Shelby tubes. Each of these samples was obtained by hydraulically pushing the sampling device over the noted sampling interval.

The Aquaterra drill crew obtained samples while drilling at the intervals noted on the boring logs in Appendix B.

4.0 LABORATORY TESTING

The recovered samples were labeled and sealed with taped end caps prior to transport to the geotechnical testing laboratory, Alpha - Ω mega Geotech, Inc. ($A\Omega$). Laboratory testing performed on the undisturbed samples included strength testing (Q_p – hand penetrameter), moisture content, density, and visual classification according to the Unified Soil Classification System (USCS). Laboratory testing results are depicted on the boring logs in Appendix B.

5.0 SUBSURFACE CONDITIONS

The project site is located in the Des Moines Glacial Lobe and is positioned on the upland surface of the nearby Des Moines River. The predominant soil is glacial drift laid down during the Wisconsin glacial period. Glacial soils typically are encountered in the uppermost 15 feet of the upland surface and consist primarily of varying compositions of relatively low plasticity silty sandy clay (CL) with inter-bedded silt or sand seams. Loess soils consisting of silt was laid down beneath the most recent glacial deposits.

5.1 Site Soil Profile

Moist grayish to dusky brown fine sandy lean clay were encountered at ground surface in Borings B-1, B-2 and B-3A to 3 to 5 feet bgs. Boring #B-3B somewhat anomalous compared the other three borings as slightly moist light brown fine sandy silt with clay (ML-CL) was encountered at ground surface from ground surface to a depth of 4 ft bgs. Thereafter, similar lean clay (CL) with varying coloration and percentages of fine sand continued to the bottom of each boring at depths of 5 ft, 5 ft, 15 ft and 12 ft bgs respectively. Soils generally above a depth of 12 ft bgs were slightly moist with consistency of medium to stiff and soft and moist from 12 to 15 ft bgs (as noted in B-3A).

5.2 Groundwater Conditions

No free water was encountered within the depth of the borings performed while the boreholes were open.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Pavement Subgrade Preparation

We understand the reconfigured pavement in Parking Lots A and B and the adjoining roadway will not experience significant grade changes and that the new configuration will be founded on existing shallow soils or limited thicknesses of compacted fill. Long-term pavement performance is dependent on relatively uniform subgrade support. We therefore, recommend that following stripping, grubbing and cutting operations and prior to placement of additional fill intended to provide support for paved surfaces, and the placement of pavement in the event that no added fill is required to achieve design subgrade that exposed subgrades be proof rolled. Proof rolling is intended to delineate soft or unstable zones in the exposed subgrade. Proof rolling should be accomplished with a heavily loaded piece of construction equipment which will impart high contact pressure to the subgrade such as a fully loaded tandem axle, dump truck weighing at least 20 tons.

Where soft, organic or unsuitable soils are encountered we recommend over-excavation to at least 2.5 feet below the finish subgrade elevation or until completely removed which ever is shallower. The over-excavation procedure should be carried downward and outward at a slope of 1 horizontal to 1 vertical beyond the design edge of pavement. Over-excavated zones should be filled with non-cohesive properly compacted soil in maximum 8 inch thick loose lifts.

We recommend that following proof-rolling the suitable / stable (non-rutting or pumping surface be scarified to a minimum depth of 12 inches. The moisture should be adjusted as required and recompacted prior to placement of new fill or pavement. Soil compacted or suitable low plasticity (CL, ML-CL or ML) cohesive soil free of organics and other deleterious material should be compacted in maximum 8 inch loose lifts to a minimum of 95 percent of the materials maximum laboratory dry density as determined by the Standard Proctor method (ASTM D-698). The compacted soils should be placed and compacted within ± 2 percent of the optimum moisture content.

6.2 Pavement Design Considerations

Based on laboratory testing recommend using a California Bering Ratio (CBR) of 5.0 be used in designing the pavement section for a properly prepared and compacted low plasticity cohesive soil subgrade. This recommendation is based on testing performed on soil samples obtained from borings performed in support of The Parking Lot and Roadway Upgrade – Phase 2 - Project # VA 636A6 – 11 – 301 with the understanding that should

Geotechnical Assessment
Parking Lot and Roadway Upgrade – Phase I
VA 636A6 – 11 - 301

borrow soil be required for completion of this phase, this material will originate from the cut generated in the vicinity of borings B-7 through B-9. In the event that spoil is not required and the pavement is founded on scarified and recompact subgrade, it is our belief that the properly recompact subgrade will exhibit similar subgrade support properties and a value of 5.0 would still be appropriate for design purposes. Please note that we recommend using the saturated CBR value as reported and presented herein in the attachments as the basis for design as the pavement will be exposed to high moisture conditions over the life of the pavement.

7.0 GENERAL COMMENTS

The analyses, conclusions, and recommendations contained in this report are based on the site conditions and project layout described herein and further assume that the conditions observed in the exploratory borings are representative of the subsurface conditions throughout the site, i.e., the subsurface conditions elsewhere on the site are the same as those disclosed by the borings. If, during construction, subsurface conditions different from those encountered in the exploratory borings are observed or appear to be present beneath excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary.

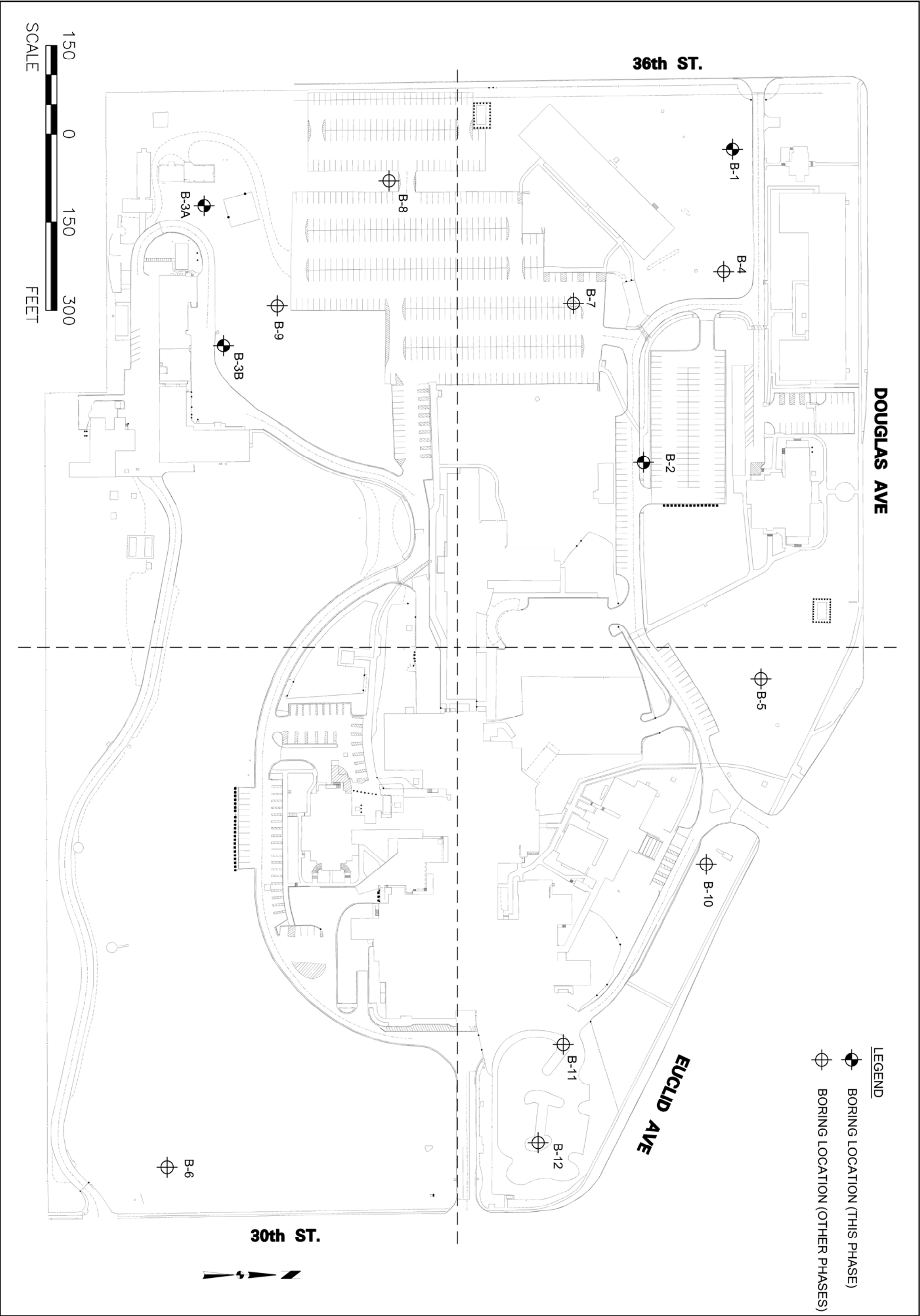
If there is a substantial lapse in time between the submittal of this report and the start of work at the site, or if conditions or the project layout have changed due to natural causes or construction operations at or adjacent to the site, we recommend this report be reviewed to determine the applicability of conclusions and recommendations considering the changed conditions and time lapse.

We recommend that we be retained to review the project layout and those portions of plans and specifications which pertain to foundations and earthwork to determine if they are consistent with our findings and recommendations. In addition, we are available to observe construction, particularly site grading, earthwork, and foundation construction. We would be available to make other field observations as may be necessary.

The scope of our services did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors noted or unusual or suspicious items or conditions observed are strictly for the information of our client.

This report was prepared for the exclusive use of the Owner, Architect, and Engineer for evaluating the design of the project as it relates to the geotechnical aspects discussed herein. It should be made available to prospective contractors for information on factual data only and not as a warranty of subsurface conditions included in the report. Unanticipated soil conditions may require that additional expense be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

APPENDIX A
BORING LOCATION PLAN



BORING LOCATION MAP PARKING LOT AND ROADWAY UPGRADE PH 1 VA 636A6-11-301				CLIENT: VA MEDICAL CAMPUS 3600 30TH STREET DES MOINES, IOWA		AQUATERRA ENVIRONMENTAL SOLUTIONS, INC. 14755 Grover Street Omaha, Nebraska 68144		R5	-	5BY	-
REV: 0				DRAWN BY: IG		DESIGNED BY: CJ		R4	-	4BY	-
DRAWING NUMBER: 1				PROJECT MGR: JFH		DATE: 10/12/11		R3	-	3BY	-
PROJECT NUMBER: 4963.10				ELECTRONIC FILE NAME: SHEET 1.DWG				R2	-	2BY	-
SHT. 1 OF 1								R1	-	1BY	-
								R0	-	0BY	-
								REV.	DATE	BY	DESCRIPTION

APPENDIX B

BORING LOGS

ENVIRONMENTAL SOLUTIONS, INC.

Project No.	4963.10
Logger	C. Joyce
Rig Type	Geoprobe 54 DT
Drilling Method	Macro Core Sampler
Weather	Mostly Cloudy
Project Name	Des Moines V.A. Hospital, Phase
Location	On Stake
Personnel	Hughes, Joyce, Martin

Hole No.	B-1	TAG ID #	
Sheet	1	of	1
Total Depth	5.5		
Elevation			
Date Begun	7 October 2011		
Date Completed		7-Oct-11	

Water Level			
Depth	Not Encountered		
Time			
Date			

[illegible]

ENVIRONMENTAL SOLUTIONS, INC.

Project No.	4963.10
Logger	C. Joyce
Rig Type	Geoprobe 54 DT
Drilling Method	Macro Core Sampler
Weather	
Project Name	Des Moines V.A. Hospital, Phase
Location	On Stake
Personnel	Hughes, Joyce, Martin

Hole No.	B-2	TAG ID #	
Sheet	1	of	1
Total Depth	5.0		
Elevation			
Date Begun	7 October 2011		
Date Completed		7-Oct-11	

Water Level			
Depth	Not Encountered		
Time			
Date			

[illegible]

Lithology: Sand, Silt, Gravel, Clay, Shale, Sandstone, Limestone
Test type: SS - Split Spoon, Sh - Shelby Tube, G-Grab, MC-Core, T-Texas Cone

Moisture: dry sl.mst. Mst. V.mst. Wet
Plasticity: np tr low med high
Density: v.loose loose med.dense dense v.dense
Stiffness: v.soft soft med.stiff stiff v.stiff hard

Sandy lean clay, grayish brown, 5 YR 3/2, moist, medium stiff

Sandy lean clay, mottled, moderate yellowish brown, 10YR5/4, dark yellowish brown, 10YR4/2, pale yellow brown, 10YR6/2, moist, hematite nodules

5.0 End of Boring

Project No.	4963.10
Logger	C. Joyce
Rig Type	Geoprobe 54 DT
Drilling Method	Macro Core Sampler
Weather	
Project Name	Des Moines V.A. Hospital, Phase
Location	
Personnel	Hughes, Joyce, Martin

Water Level			
Depth	Not Encountered		
Time			
Date			

[illegible]

ENVIRONMENTAL SOLUTIONS, INC.

Project No.	4963.10
Logger	C. Joyce
Rig Type	Geoprobe 54 DT
Drilling Method	Macro Core Sampler
Weather	
Project Name	Des Moines V.A. Hospital, Phase
Location	
Personnel	Hughes, Joyce, Martin

Hole No.	B-7	TAG ID #	
Sheet	1	of	2
Total Depth	7.0		
Elevation			
Date Begun	7 October 2011		
Date Completed		7-Oct-11	

Water Level			
Depth	Not Encountered		
Time			
Date			

[illegible]

Lithology: Sand, Silt, Gravel, Clay, Shale, Sandstone, Limestone
Test type: SS - Split Spoon, Sh - Shelby Tube, G-Grab, MC-Core, T-Texas Cone

Moisture: dry sl.mst. Mst. V.mst. Wet

Plasticity: np tr low med high

Density: v.loose loose med.dense dense v.dense

Stiffness: v.soft soft med.stiff stiff v.stiff hard

Asphalt 4" thick, base aggregate to 6" below ground surface

Lean clay, grayish brown, 5 YR 3/2, moist, stiff

Fine sandy lean clay, moderate yellow brown 10 YR 5/4, moist, firm

7.0 End of Boring

****NOTE**

Composite sample of subgrade borrow from B-7, B-8 and B-9;

Proctor D-698 $\gamma_d=109.9$ pcf $MC(opt)=15.1\%$

CBR D-1893 dry=9.0 (0.2in) wet=4.9 (0.2in)

AQUATERRA

ENVIRONMENTAL SOLUTIONS, INC.

Project No.	4963.10
Logger	C. Joyce
Rig Type	Geoprobe 54 DT
Drilling Method	Macro Core Sampler
Weather	
Project Name	Des Moines V.A. Hospital, Phase
Location	
Personnel	Hughes, Joyce, Martin

Hole No.	B-8	TAG ID #	
Sheet	1	of	1
Total Depth	7.0		
Elevation			
Date Begun	7 October 2011		
Date Completed		7-Oct-11	

Water Level			
Depth	Not Encountered		
Time			
Date			

Sampling

Lithology: Sand, Silt, Gravel, Clay, Shale, Sandstone, Limestone
Test type: SS - Split Spoon, Sh - Shelby Tube, G-Grab, MC-Core, T-Texas Cone

Moisture: dry sl.mst. Mst. V.mst. Wet
Plasticity: np tr low med high
Density: v.loose loose med.dense dense v.dense
Stiffness: v.soft soft med.stiff stiff v.stiff hard

Moisture: dry sl.mst. Mst. V.mst. Wet

Plasticity: no tr low med high

Density: v.loose loose med.dense dense v.dense

Stiffness: v.soft soft med.stiff stiff v.stiff hard

Silty fine sand, dark yellow brown, 10 YR 4/2, slightly moist, dry

Fine sandy lean clay, mottled, moderate yellow brown, 10 YR 5/4, moderate brown, 5 YR 3/4, dusky brown, 5 YR 2/2, slightly moist

7.0 End of Boring

****NOTE: See Hole No. B-7**

COPY

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Symbols and Group Names Using Laboratory Tests^A

Criteria for Assigning Symbols and Group Names Using Laboratory Tests ^A					Soil Classification			
					Group Symbol	Group Name ^B		
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels	$C_u \geq 4$ and $1 \leq C_c \leq 3^E$		GW	Well-graded Gravel ^F		
		Less than 5% fines ^c	$C_u < 4$ and/or $1 > C_c > 3^E$		GP	Poorly-graded Gravel ^F		
		Gravels with Fines	Fines classify as ML or MH		GM	Silty Gravel ^{F, G, H}		
		More than 12% fines ^c	Fines classify as CL or CH		GC	Clayey Gravel ^{F, G, H}		
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands	$C_u \geq 6$ and $1 \leq C_c \leq 3^E$		SW	Well-graded Sand ^F		
		Less than 5% fines ^c	$C_u < 6$ and/or $1 > C_c > 3^E$		SP	Silty Sand ^I		
		Sands with Fines	Fines classify as ML or MH		SM	Poorly Sand ^{G, H, I}		
		More than 12% fines ^c	Fines classify as CL or CH		SC	Clayey Sand ^{G, H, I}		
		Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	$PI > 7$ and plots on or above the "A" line ^J	CL	Lean clay ^{K, L, M}	
					$PI < 4$ or plots below the "A" line ^J	ML	Silt ^{K, L, M}	
			Silts and Clays Liquid limit 50 or more	Organic	Liquid limit - oven dried	< 0.75	OL	Organic clay ^{K, L, M, N}
					Liquid limit - not dried			Organic silt ^{K, L, M, O}
Inorganic	PI plots on or above the "A" line			CH	Fat clay ^{K, L, M}			
	PI plots below the "A" line			MH	Elastic silt ^{K, L, M}			
Highly organic soils	Primarily organic matter, dark in color, and organic odor			< 0.75	OH	Organic clay ^{K, L, M, P}		
						Liquid limit - not dried	Organic silt ^{K, L, M, O}	

^A Based on the material passing the 3-in. (75-mm) sieve.

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravel with 5 to 12% fines require dual symbols:

GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly-graded gravel with silt
GP-GC poorly-graded gravel with clay

^D Sand with 5 to 12% fines require dual symbols:

SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly-graded sand with silt
SP-SC poorly-graded sand with clay

For Classification of fine-grained soils and fine-grained fraction of coarse-grained soils.

Equation of "A" - line

Horizontal at $PI = 4$ to $LL = 25.5$

Then $PI = 0.73 (LL - 20)$

Equation of "U" - Line

Vertical at $LL = 16$ to $PI = 7$,

then $PI = 0.9 (LL - 8)$

$$C_u = D_{60}/D_{10} \quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

^F If soil contains $> 15\%$ sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, ass "with organic fines" to group name.

^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is CL-ML, Silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

^L If soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

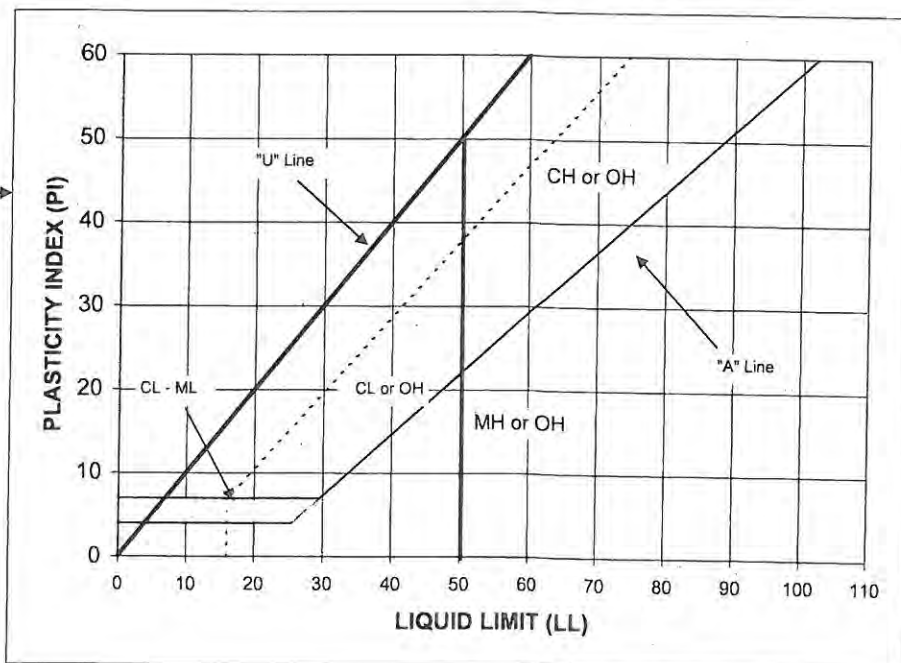
^M If soil contains $\geq 30\%$ plus No. 200 predominantly gravel, add "gravelly" to group name.

^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.



AQUATERRA

GENERAL NOTES

DRILLING NOTES

WATER LEVEL MEASUREMENTS

Water levels indicated on the boring logs are levels measured in the borings at the times indicated. In permeable materials, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels is not possible with only short-term observations.

WATER LEVEL OBSERVATION DESIGNATION

W.D.	While Drilling
A.B.	After Boring
B.C.R.	Before Casing Removal
A.C.R.	After Casing Removal
24 hr.	Water level taken approximately 24 hrs. after boring completion

DRILLING AND SAMPLING SYMBOLS

AS	Auger Sample
CS	Continuous Sampler
DB	Diamond Bit -NX unless otherwise noted
HA	Hand Auger
HS	Hollow Stem Auger
PA	Power Auger
RB	Rock Bit
SS*	Split-Barrel
ST	Shelby Tube - 2" (51mm) unless otherwise noted
WB	Wash Bore

*The Standard Penetration Test is conducted in conjunction with the split-barrel sampling procedure. The "N" value corresponds to the number of blows required to drive the last 1 foot (0.3m) of an 18 in. (0.46m) long, 2 in. (51mm) O.D. split-barrel sampler with a 140 lb. (63.5 kg) hammer falling a distance of 30 in. (0.76m). The Standard Penetration Test is carried out according to ASTM D-1586. (See "N" Value below.)

SOIL PROPERTIES AND DESCRIPTIONS

TEXTURE		COMPOSITION		Soil descriptions are based on the Unified Soil Classification System (USCS) as outlined in ASTM Designations D-2487 and D-2488. The USCS group symbol shown on the boring logs correspond to the group names listed below. The description includes soil constituents, consistency, relative density, color and other appropriate descriptive terms. Geologic description of bedrock, when encountered, also is shown in the description column.					
PARTICLE	SIZE	SAND & GRAVEL		GROUP SYMBOL GROUP NAME GROUP SYMBOL GROUP NAME					
Clay	< 0.002 mm	<u>Description</u> trace with modifier	<u>% by Dry Weight</u> < 15 15 - 29 > 30	GW	Well Graded Gravel	CL	Lean Clay		
Silt	< #200 Sieve			GP	Poorly Graded Gravel	ML	Silt		
Sand	#4 to #200 Sieve			GM	Silty Gravel	OL	Organic Clay or Silt		
Gravel	3 in. to #4 Sieve			GC	Clayey Gravel	CH	Fat Clay		
Cobbles	12 in. to 3 in.	FINES		<u>Description</u> trace with modifier	<u>% by Dry Weight</u> < 5 5 - 12 > 12	SW	Well Graded Sand	MH	Elastic Silt
Boulders	> 12 in.					SP	Poorly Graded Sand	OH	Organic Clay or Silt
				SM	Silty Sand	PT	Peat		
				SC	Clayey Sand	CL-CH	Lean to Fat Clay		

COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (Qu)	PLASTICITY
	(psi)	(kPa)
Very Soft	< 500	< 24
Soft	500 - 1000	(24 - 48)
Medium	1001 - 2000	(48 - 96)
Stiff	2001 - 4000	(96 - 192)
Very Stiff	4001 - 8000	(192 - 383)
Hard	> 8001	(> 383)

COHESIONLESS SOILS

RELATIVE DENSITY	"N" VALUE*
Very Loose	0 - 3
Loose	4 - 9
Medium Dense	10 - 29
Dense	30 - 49
Very Dense	≥ 50

BEDROCK PROPERTIES AND DESCRIPTIONS

ROCK QUALITY DESIGNATION (RQD**)

DESCRIPTION OF ROCK QUALITY	RQD (%)
Very Poor	0 - 25
Poor	25 - 50
Fair	50 - 75
Good	75 - 90
Excellent	90 - 100

**RQD is defined as the total length of sound core pieces, 4 inches (102mm) or greater in length, expressed as a percentage of the total length cored. RQD provides an indication of the integrity of the rock mass and relative extent of seams and bedding planes.

DEGREE OF WEATHERING

Slightly Weathered	Slight decomposition of parent material in joints and seams.
Weathered	Well-developed and decomposed joints and seams.
Highly Weathered	Rock highly decomposed, may be extremely broken.

SOLUTION AND VOID CONDITIONS

Solid	Contains no voids.
Vuggy	Containing small pits or cavities < 1/2" (13mm).
Porous	Containing numerous voids which may be interconnected.
Cavernous	Containing cavities, sometimes quite large.

When classification of rock materials has been estimated from disturbed samples, core samples and petrographic analysis may reveal other rock types.

HARDNESS & DEGREE OF CEMENTATION

LIMESTONE	
Hard	Difficult to scratch with knife.
Moderately Hard	Can scratch with knife but not with fingernail.
Soft	Can be scratched with fingernail.
SHALE	
Hard	Can scratch with knife but not with fingernail.
Moderately Hard	Can be scratched with fingernail.
Soft	Can be molded easily with fingers.
SANDSTONE	
Well Cemented	Capable of scratching a knife blade.
Cemented	Can be scratched with knife.
Poorly Cemented	Can be broken apart easily with fingers.

BEDDING CHARACTERISTICS

TERM	THICKNESS (inches)	THICKNESS (mm)
Very Thick Bedded	> 36	> 915
Thick Bedded	12 - 36	305 - 915
Medium Bedded	4 - 12	102 - 305
Thin Bedded	1 - 4	25 - 102
Very Thin Bedded	0.4 - 1	10 - 25
Laminated	0.1 - 0.4	2.5 - 10
Thinly Laminated	< 0.1	< 2.5
Bedding Planes	Planes dividing the individual layers, beds or strata of rocks.	
Joint	Fracture in rock, generally more or less vertical or transverse to the bedding.	
Seam	Applies to bedding plane with an unspecified degree of weathering.	

AQUATERRA

Summary of Laboratory Testing

SLT 22205

Alpha-Omega Geotech, Inc.

1701 State Avenue
Kansas City, KS 66102
Office: (913) 371-0000 Fax: (913) 371-6710
Website: www.omega-geotech.com



PROJECT NAME: VA Center Road Upgrade & Storm Water Project PROJECT NUMBER: 11-363T
PROJECT LOCATION: Des Moines, IA DATE: 11/3/2011

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits LL PL PI	USCS % Passing Class. No. 200	Unconfined Compression PSF	%e	% Swell	Remarks
B-4	ST	3' - 5'	Dark brown, mottled black LEAN CLAY with trace of sand & gravel	25.5	96.0						Please see the attached Permeability Test Report.
B-1	ST	3' - 5'	Dark brown, mottled gray, spotted reddish brown sandy LEAN / FAT CLAY with trace of gravel & organics	11.2	119.2			9176	11.2		
B-2	ST	3' - 5'	Olive brown, mottled gray, speckled black & reddish brown LEAN / FAT CLAY with sand & organics (root's)	18.2	104.4			2554	2.8		
B-3A	ST	3' - 5'	Brown, speckled reddish brown LEAN CLAY	19.3	97.3			3481	4.7		
B-3A	AC	8' - 10'	Light brown, speckled reddish brown LEAN CLAY	25.3	101.7			1538	15.3		
B-3A	ST	13' - 15'	Light brown, speckled reddish brown LEAN CLAY with iron stains	24.3	101.5			1649	9.2		
B-3B	ST	3' - 5'	Brown, mottled light brown, spotted gray, speckled reddish brown & black LEAN CLAY with organics (root's)	17.1	91.3			4843	2.2		
B-7	ST	3' - 5'	Brown, mottled dark brown LEAN CLAY with sand & brick fragments (old fill)	16.5	109.2						
B-8	ST	3' - 5'	Brown LEAN / FAT CLAY with sand & trace of gravel	13.7	101.2			4806	2.1		
B-9	ST	3' - 5'	Brown LEAN CLAY with sand & trace of gravel	17.8	111.1			5021	14.2		

SLT 22205

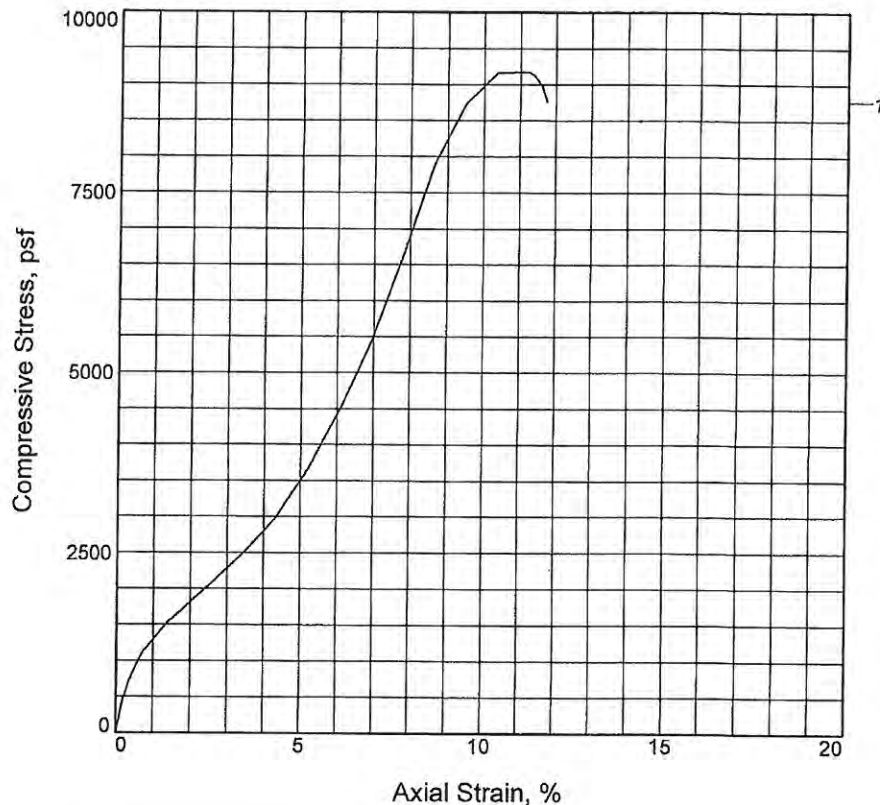
Website: www.annentech.com



PROJECT NAME:
PROJECT LOCATION:

11-3637 S

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	9176			
Undrained shear strength, psf	4588			
Failure strain,	11.2			
Strain rate, in./min.	0.075			
Water content, %	11.2			
Wet density, pcf	132.6			
Dry density, pcf	119.2			
Saturation, %	73.1			
Void ratio	0.4139			
Specimen diameter, in.	2.850			
Specimen height, in.	5.780			
Height/diameter ratio	2.03			

Description: Dark brown, mottled gray, spotted reddish brown sandy LEAN / FAT CLAY with trace of gravel & organics

LL = PL = PI = Assumed GS= 2.7 Type: Undisturbed

Project No.: 11-363T

Date: 10/29/2011

Remarks:

Client: AQUATERRA Environmental Solutions, Inc.

Project: VA Center Road Upgrade and Storm Water Project

Sample Number: B-1, ST

Depth: 3' - 5'



Alpha-Omega Geotech, Inc.

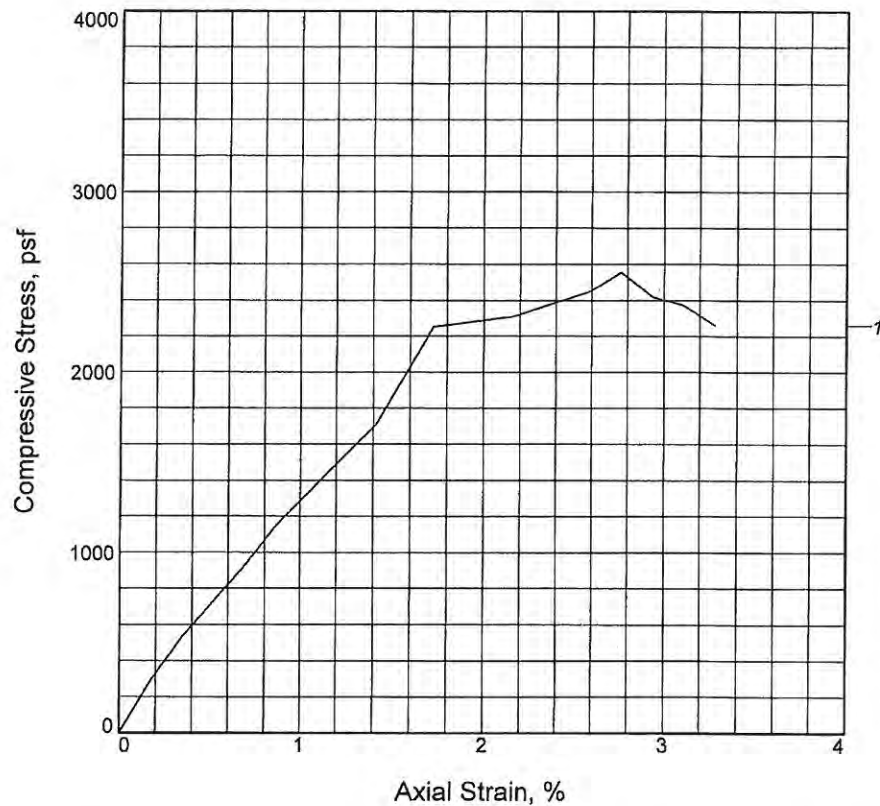
(913) 371-0000

Figure 1 of 1

Tested By: T.J.B.

Checked By: T.J.B.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	2554			
Undrained shear strength, psf	1277			
Failure strain,	2.8			
Strain rate, in./min.	0.075			
Water content, %	18.2			
Wet density, pcf	123.5			
Dry density, pcf	104.4			
Saturation, %	80.2			
Void ratio	0.6139			
Specimen diameter, in.	2.870			
Specimen height, in.	5.790			
Height/diameter ratio	2.02			

Description: Olive brown, mottled gray, speckled black & reddish brown LEAN / FAT CLAY with sand & organics (root's)

LL = **PL =** **PI =** **Assumed GS= 2.7** **Type:** Undisturbed

Project No.: 11-363T

Date: 10/29/2011

Remarks:

Client: AQUATERRA Environmental Solutions, Inc.

Project: VA Center Road Upgrade and Storm Water Project

Sample Number: B-2, ST

Depth: 3' - 5'



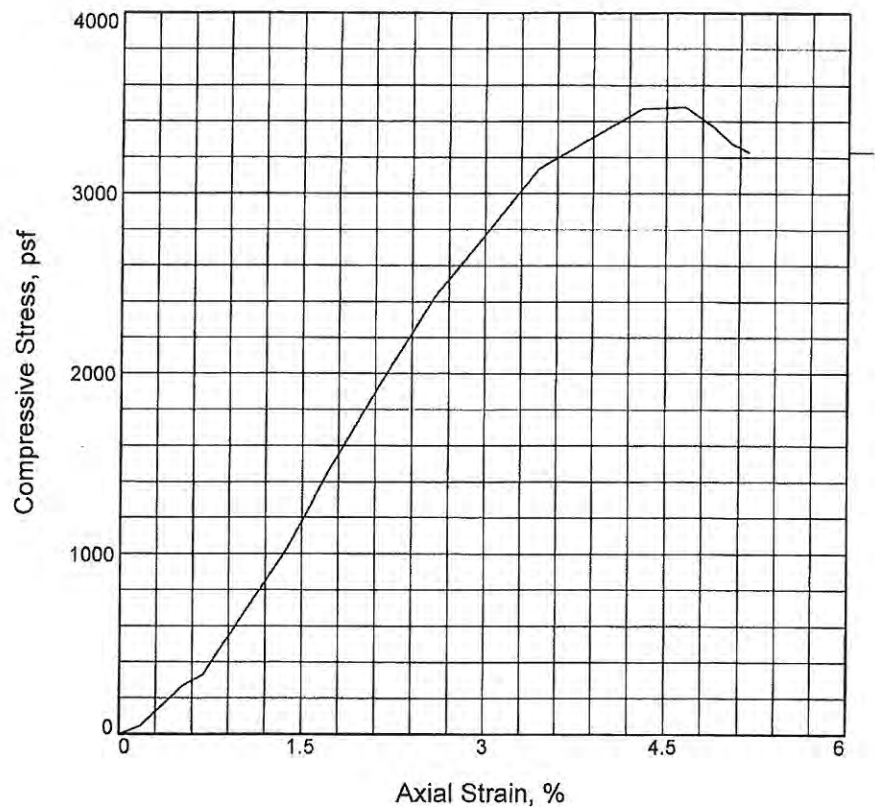
Alpha-Omega Geotech, Inc.

(913) 371-0000

Figure 1 of 1

Tested By: T.J.B. **Checked By:** T.J.B.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	3481			
Undrained shear strength, psf	1740			
Failure strain,	4.7			
Strain rate, in./min.	0.075			
Water content, %	19.3			
Wet density, pcf	116.1			
Dry density, pcf	97.3			
Saturation, %	71.2			
Void ratio	0.7325			
Specimen diameter, in.	2.870			
Specimen height, in.	5.800			
Height/diameter ratio	2.02			

Description: Brown, speckled reddish brown LEAN CLAY

LL = PL = PI = Assumed GS= 2.7 Type: Undisturbed

Project No.: 11-363T

Date: 10/29/2011

Remarks:

Client: AQUATERRA Environmental Solutions, Inc.

Project: VA Center Road Upgrade and Storm Water Project

Sample Number: B-3A, ST

Depth: 3' - 5'

Figure 1 of 1



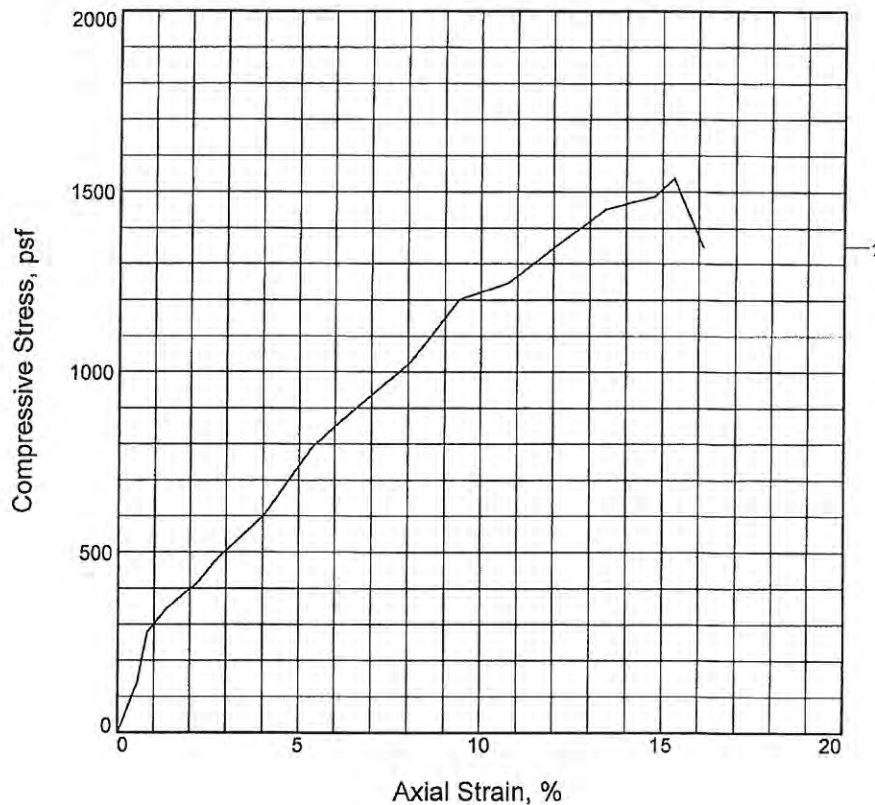
Alpha-Omega Geotech, Inc.

(913) 371-0000

Tested By: T.J.B.

Checked By: T.J.B.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	1538			
Undrained shear strength, psf	769			
Failure strain,	15.3			
Strain rate, in./min.	0.042			
Water content, %	25.3			
Wet density, pcf	127.4			
Dry density, pcf	101.7			
Saturation, %	104.0			
Void ratio	0.6574			
Specimen diameter, in.	1.620			
Specimen height, in.	3.720			
Height/diameter ratio	2.30			

Description: Light brown, speckled reddish brown LEAN CLAY

LL =	PL =	PI =	Assumed GS= 2.7	Type: Undisturbed
------	------	------	-----------------	-------------------

Project No.: 11-363T

Date: 10/28/2011

Remarks:

Client: AQUATERRA Environmental Solutions, Inc.

Project: VA Center Road Upgrade and Storm Water Project

Sample Number: B-3A, AC

Depth: 8' - 10'

Figure 1 of 1



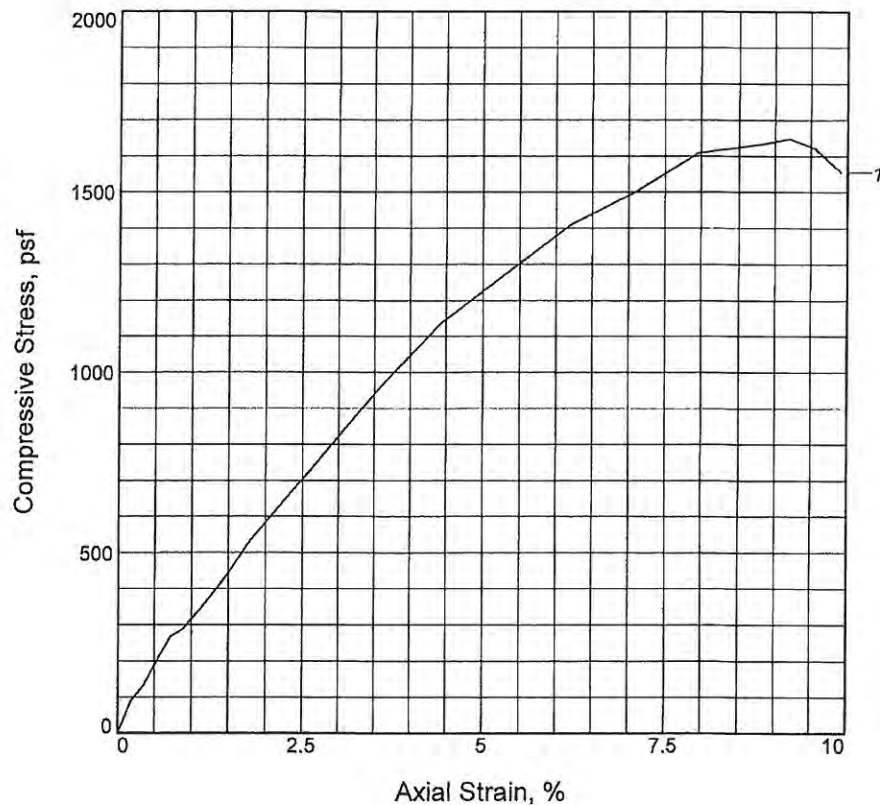
Alpha-Omega Geotech, Inc.

(913) 371-0000

Tested By: T.J.B.

Checked By: T.J.B.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	1649			
Undrained shear strength, psf	824			
Failure strain,	9.2			
Strain rate, in./min.	0.075			
Water content, %	24.3			
Wet density, pcf	126.1			
Dry density, pcf	101.5			
Saturation, %	99.1			
Void ratio	0.6612			
Specimen diameter, in.	2.860			
Specimen height, in.	5.650			
Height/diameter ratio	1.98			

Description: Light brown, speckled reddish brown LEAN CLAY with iron stains

LL =	PL =	PI =	Assumed GS= 2.70	Type: Undisturbed
------	------	------	------------------	-------------------

Project No.: 11-363T

Date: 10/28/2011

Remarks:

Client: AQUATERRA Environmental Solutions, Inc.

Project: VA Center Road Upgrade and Storm Water Project

Sample Number: B-3A, ST

Depth: 13' - 15'

Figure 1 of 1



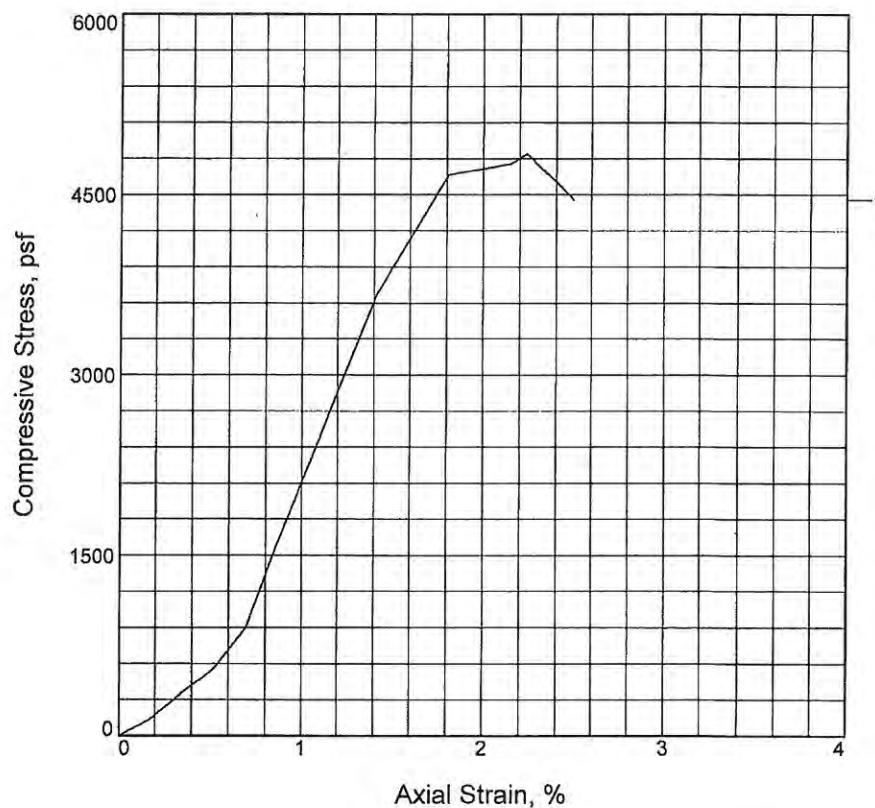
Alpha-Omega Geotech, Inc.

(913) 371-0000

Tested By: T.J.B.

Checked By: T.J.B.

UNCONFINED COMPRESSION TEST



Sample No.	1		
Unconfined strength, psf	4843		
Undrained shear strength, psf	2421		
Failure strain,	2.2		
Strain rate, in./min.	0.075		
Water content, %	17.1		
Wet density, pcf	106.9		
Dry density, pcf	91.3		
Saturation, %	54.4		
Void ratio	0.8466		
Specimen diameter, in.	2.860		
Specimen height, in.	5.800		
Height/diameter ratio	2.03		

Description: Brown, mottled light brown, spotted gray, speckled reddish brown & black LEAN CLAY with organics (root's)

LL = PL = PI = Assumed GS= 2.70 Type: Undisturbed

Project No.: 11-363T

Date: 10/28/2011

Remarks:

Client: AQUATERRA Environmental Solutions, Inc.

Project: VA Center Road Upgrade and Storm Water Project

Sample Number: B-3B, ST

Depth: 3' - 5'



Alpha-Omega Geotech, Inc.

(913) 371-0000

Figure 1 of 1

Tested By: T.J.B. Checked By: T.J.B.

COMPACTION TEST REPORT

Curve No.: 1 of 1

Project No.: 11-363T

Date: 10/22/2011

Project: VA Center Road Upgrade & Storm Water Project

Location:

Elev./Depth: 3' - 5'

Sample No. Comp. B-7,8 & 9

Remarks:

MATERIAL DESCRIPTION

Description: Dark brown LEAN CLAY with trace of sand and organics (roots)

Classifications -

USCS:

AASHTO:

Nat. Moist. =

Sp.G. =

Liquid Limit =

Plasticity Index =

% > No.4 = %

% < No.200 =

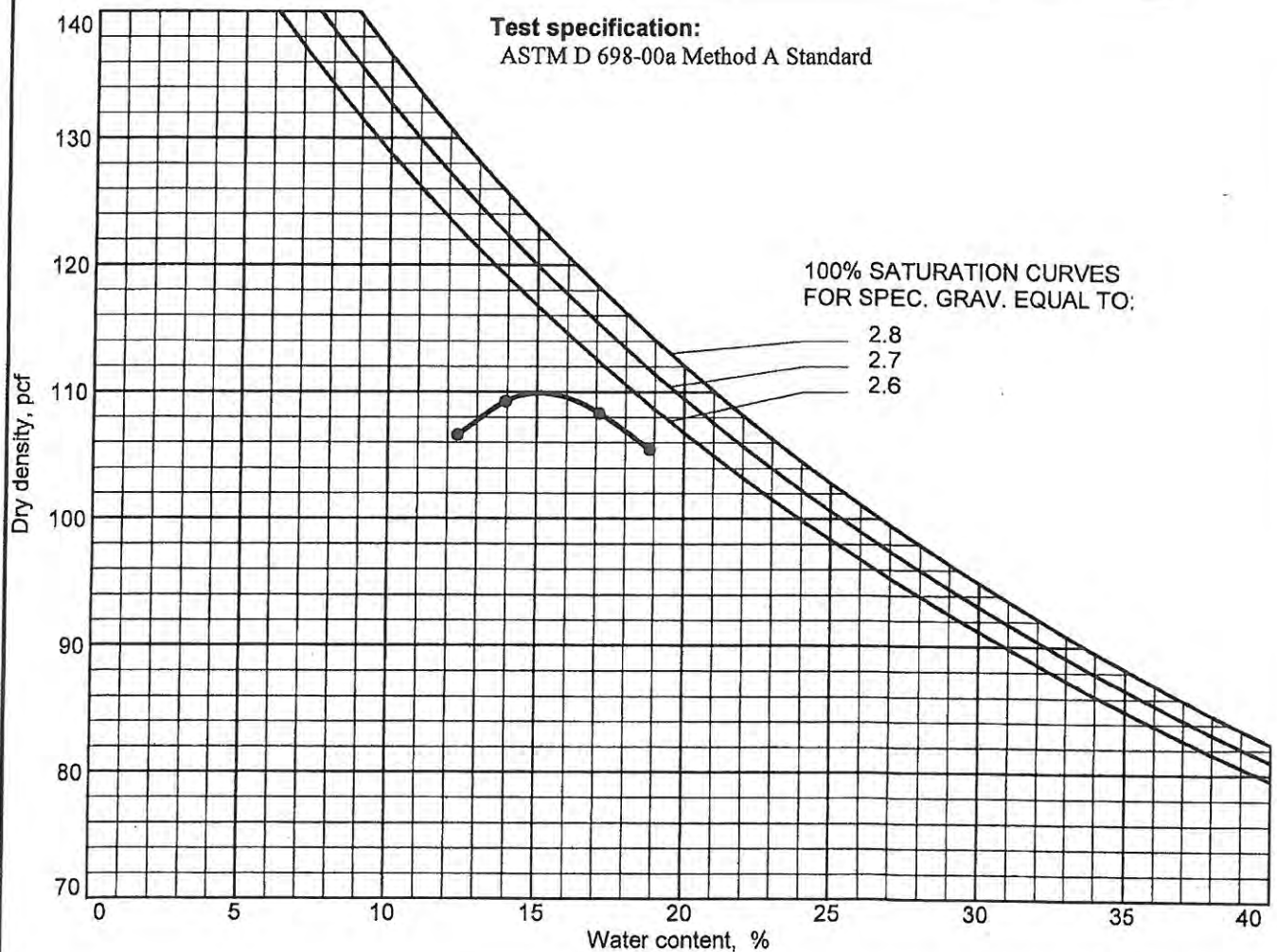
TEST RESULTS

Maximum dry density = 109.9 pcf

Optimum moisture = 15.1 %

Test specification:

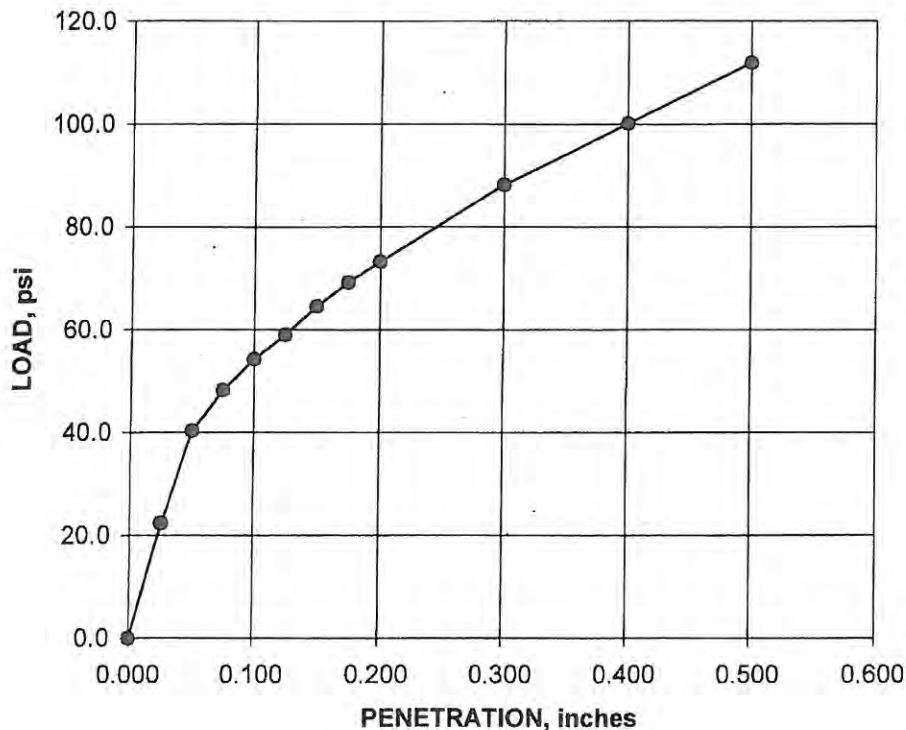
ASTM D 698-00a Method A Standard



COPY

CBR TEST REPORT

PROJECT: VA Center Road Upgrade & Storm Water Project PROJECT NO.: 11-363T
 SAMPLE NO.: Composite:B-7, 8 & 9 DEPTHS: 3' - 5'
 SAMPLE DESCRIPTION: Dark brown LEAN CLAY with trace of sand and organics (root's)
 LIQUID LIMIT: _____ PLASTIC LIMIT: _____ PLASTICITY INDEX: _____
 COMPACTION METHOD: 698A TEST METHOD: ASTM D1883
 CONDITION OF SAMPLE: SOAKED X UNSOAKED _____
 DRY DENSITY BEFORE SOAKING (pcf): 104.3
 DRY DENSITY AFTER SOAKING (pcf): 101.9
 MOISTURE CONTENT AFTER COMPACTION (%): 15.4
 MOISTURE CONTENT AFTER TESTING, TOP 1 INCH (%): 19.1
 MOISTURE CONTENT AFTER TESTING, AVERAGE (%): 18.6
 SURCHARGE: 10lb CBR (0.1"): 5.4 % SWELL 0.4
 CBR (0.2"): 4.9
 CBR: 5.4



PENETRATION (IN.)	LOAD (PSI)
0.000	0.0
0.025	22.4
0.050	40.4
0.075	48.2
0.100	54.3
0.125	59.0
0.150	64.5
0.175	69.2
0.200	73.2
0.300	88.2
0.400	100.1
0.500	111.9

ALPHA-OMEGA GEOTECH, INC.
 1701 State Avenue
 Kansas City, Kansas 66102
 (913)371-0000

COPY

CBR TEST REPORT

PROJECT: VA Center Road Upgrade & Storm Water Project PROJECT NO.: 11-363T

SAMPLE NO.: Composite:B-7, 8 & 9 DEPTHS: 3' - 5'

SAMPLE DESCRIPTION: Dark brown LEAN CLAY with trace of sand and organics (root's)

LIQUID LIMIT: _____ PLASTIC LIMIT: _____ PLASTICITY INDEX: _____

COMPACTION METHOD: 698A TEST METHOD: ASTM D1883

CONDITION OF SAMPLE: SOAKED UNSOAKED X

DRY DENSITY BEFORE SOAKING (pcf): 104.3

DRY DENSITY AFTER SOAKING (pcf): 101.9

MOISTURE CONTENT AFTER COMPACTION (%): 15.4

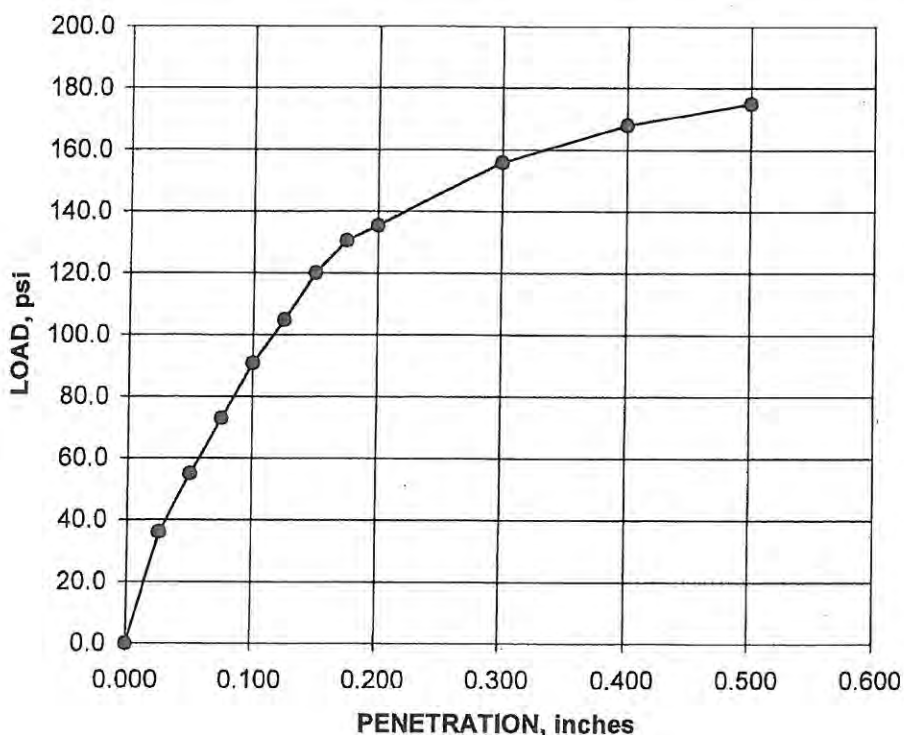
MOISTURE CONTENT AFTER TESTING, TOP 1 INCH (%): 19.1

MOISTURE CONTENT AFTER TESTING, AVERAGE (%): 18.6

SURCHARGE: 10lb CBR (0.1"): 9.1 % SWELL 0.4

CBR (0.2"): 9.0

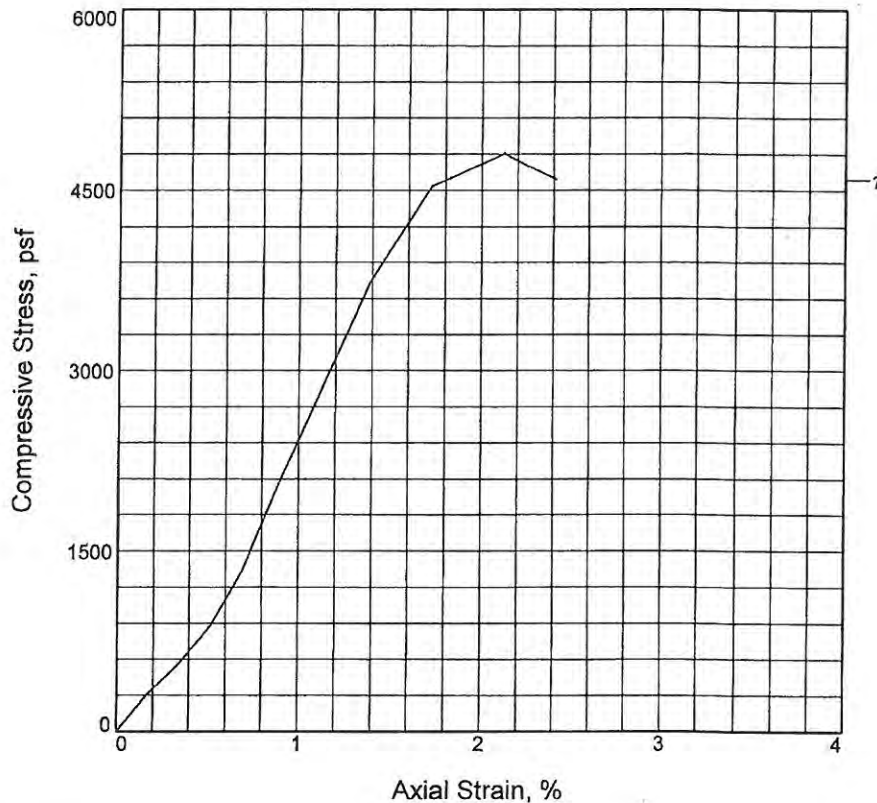
CBR: 9.1



PENETRATION (IN.)	LOAD (PSI)
0.000	0.0
0.025	36.0
0.050	55.0
0.075	73.0
0.100	90.9
0.125	104.8
0.150	120.1
0.175	130.6
0.200	135.5
0.300	156.0
0.400	168.0
0.500	175.0

ALPHA-OMEGA GEOTECH, INC.
1701 State Avenue
Kansas City, Kansas 66102
(913)371-0000

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	4806			
Undrained shear strength, psf	2403			
Failure strain,	2.1			
Strain rate, in./min.	0.075			
Water content, %	13.7			
Wet density, pcf	115.0			
Dry density, pcf	101.2			
Saturation, %	55.5			
Void ratio	0.6661			
Specimen diameter, in.	2.840			
Specimen height, in.	5.790			
Height/diameter ratio	2.04			

Description: Brown LEAN / FAT CLAY with sand and trace of gravel

LL = PL = PI = Assumed GS= 2.70 Type: Undisturbed

Project No.: 11-363T

Date: 10/28/2011

Remarks:

Client: AQUATERRA Environmental Solutions, Inc.

Project: VA Center Road Upgrade and Storm Water Project

Sample Number: B-8, ST

Depth: 3' - 5'

Figure 1 of 1



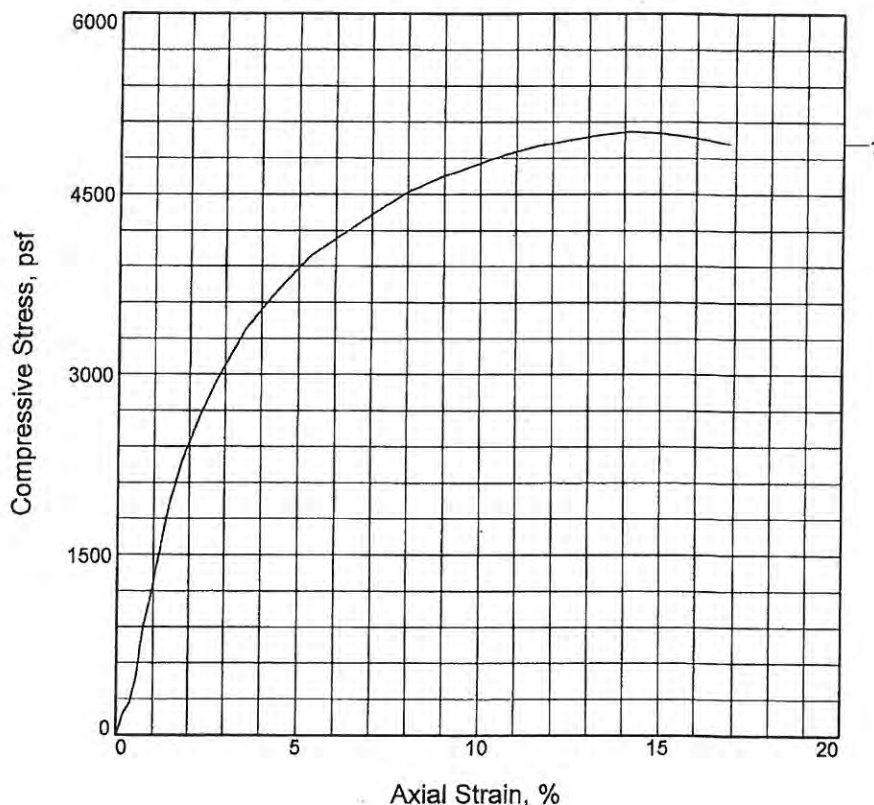
Alpha-Omega Geotech, Inc.

(913) 371-0000

Tested By: T.J.B.

Checked By: T.J.B.

UNCONFINED COMPRESSION TEST



Sample No.	1		
Unconfined strength, psf	5021		
Undrained shear strength, psf	2510		
Failure strain,	14.2		
Strain rate, in./min.	0.075		
Water content, %	17.8		
Wet density, pcf	130.8		
Dry density, pcf	111.1		
Saturation, %	92.8		
Void ratio	0.5174		
Specimen diameter, in.	2.860		
Specimen height, in.	5.640		
Height/diameter ratio	1.97		

Description: Brown LEAN CLAY with sand and trace of gravel

LL = PL = PI = Assumed GS= 2.70 Type: Undisturbed

Project No.: 11-363T

Date: 10/27/2011

Remarks:

Client: AQUATERRA Environmental Solutions, Inc.

Project: VA Center Road Upgrade and Storm Water Project

Sample Number: B-9, ST

Depth: 3' - 5'

Figure 1 of 1



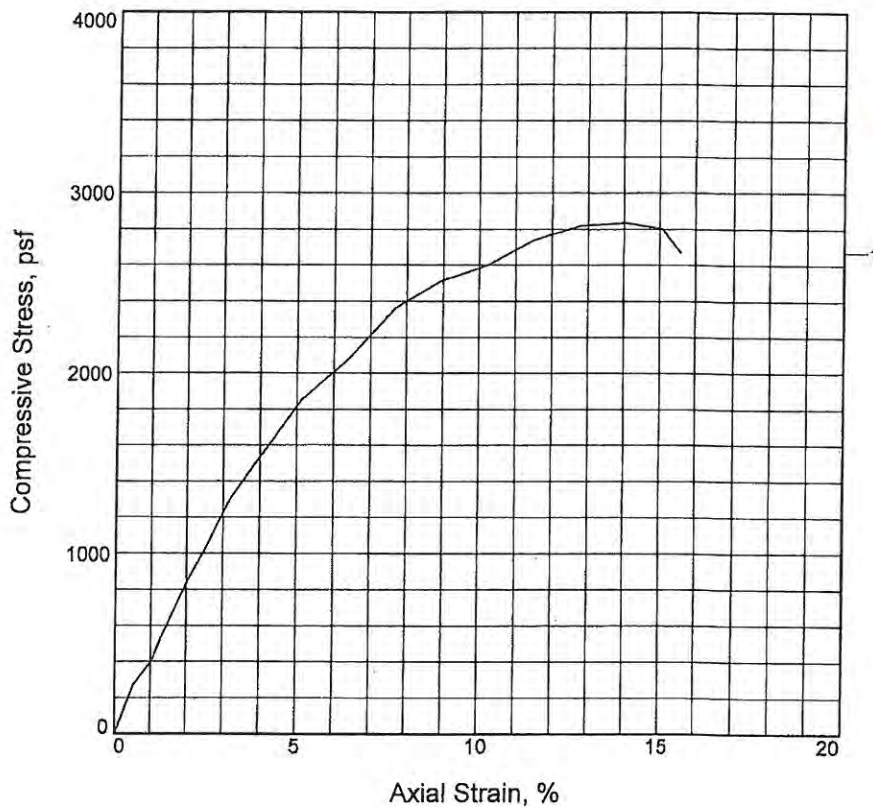
Alpha-Omega Geotech, Inc.

(913) 371-0000

Tested By: T.J.B.

Checked By: T.J.B.

UNCONFINED COMPRESSION TEST



COPY

Sample No.	1			
Unconfined strength, psf	2836			
Undrained shear strength, psf	1418			
Failure strain,	14.1			
Strain rate, in./min.	0.042			
Water content, %	19.0			
Wet density, pcf	128.5			
Dry density, pcf	108.0			
Saturation, %	91.5			
Void ratio	0.5610			
Specimen diameter, in.	1.650			
Specimen height, in.	3.910			
Height/diameter ratio	2.37			

Description: Brown, speckled black and reddish brown LEAN CLAY with trace of sand

LL = PL = PI = Assumed GS= 2.70 Type: Undisturbed

Project No.: 11-363T

Date: 10/28/2011

Remarks:

Client: AQUATERRA Environmental Solutions, Inc.

Project: VA Center Road Upgrade and Storm Water Project

Sample Number: B-9, AC

Depth: 8' - 10'



Alpha-Omega Geotech, Inc.

(913) 371-0000

Figure 1 of 1

Tested By: T.J.B.

Checked By: T.J.B.