



**GEOTECHNICAL STUDY  
FORT SAM HOUSTON CEMETERY RESTROOM  
SAN ANTONIO, TEXAS**

**Submitted to:**

National Cemetery Administration, 5E425  
425 I Street, NW,  
Washington, DC 20001

Attention: Mr. Stephen Davis

**Submitted by:**

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April 2012  
AMEC Project No. 6151120084.01

April 3, 2012  
AMEC Project No. 6151120084.001

National Cemetery Administration, 5E425  
425 I Street, NW  
Washington, DC 20001

Attn.: Mr. Stephen Davis

**RE: Geotechnical Study  
Fort Sam Houston Cemetery Restrooms  
San Antonio, Texas**


AMEC Environment & Infrastructure, Inc. (AMEC) submits this Geotechnical Report for the above referenced project. The report includes the results of test drilling and laboratory analyses and presents recommendations for foundation design, slab support and related earthwork.

Should any questions arise concerning this report, we would be pleased to discuss them with you.

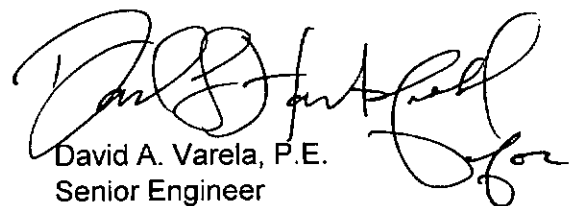
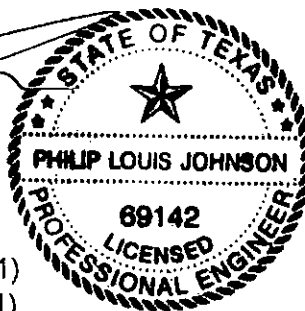
Respectfully submitted,

**AMEC Environment & Infrastructure, Inc.**  
*Texas Registered Engineering Firm F-0012  
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## **1.0 INTRODUCTION**

This report is submitted pursuant to a geotechnical study completed by AMEC Environment & Infrastructure, Inc. (AMEC) for the proposed new restroom structure at the existing Fort Sam Houston Cemetery in San Antonio, Texas. The objective of this study was to evaluate the physical properties of the soils underlying the site to provide recommendations for foundation design, slab support and related earthwork.

This report was prepared with the assumption that the design will be in accordance with applicable standards and codes, regulations of authorities having jurisdiction, and good engineering practices. Further, the recommendations and opinions expressed in this report are only applicable to the subject project. There should also be an ongoing liaison with AMEC during both the design and construction phases of the project to ensure that the recommendations in this report have been interpreted and implemented correctly. Also, if any further clarification and/or elaboration are needed concerning the geotechnical aspects of this project, AMEC should be contacted immediately. The ASFE organization has prepared important information regarding studies of the type performed, and this is included in Appendix D for your review.

## **2.0 PROPOSED CONSTRUCTION**

It is our understanding that the project consists of an approximately 1,500 square foot, single-story structure in the newly developed eastern portion of the cemetery. The approximate location and layout of the proposed structure is shown on Figure 1 in Appendix A of this report.

Foundation loads for the proposed building have not been provided at this time, but are anticipated to be light to moderate. For the purposes of this analysis, it has been assumed that the maximum loads will not exceed 1.5 kips per lineal foot for grade beams or 30 kips for isolated columns.

Should final design details vary significantly from those outlined above, AMEC should be notified for review and possible modification of recommendations.

## **3.0 SOIL STUDY**

### **3.1 SUBSURFACE EXPLORATION**

Two (2) exploratory borings were advanced at the project site to a depth of 15 feet below existing grades. The borings were completed using a Mobile B-47 truck-mounted drill rig equipped with 6-inch O.D. solid stem augers. The soils encountered at the boring locations were sampled using Shelby Tube Sampling methods (ASTM D 1587) continuously in the upper 10 feet and at 5 foot intervals thereafter.

During the field study, the soils encountered were examined, visually classified and logged. Results of the field study are presented in Appendix A, which includes a brief description of drilling and sampling equipment and procedures, a site plan showing the boring locations and the logs of the test borings.

The boring logs and related information included in this report are indicators of subsurface conditions only at the specific locations and times noted. Subsurface conditions, including groundwater levels, at other locations on the subject site may differ significantly from conditions which exist at the boring locations.

### **3.2 LABORATORY ANALYSIS**

To aid in soil classification and evaluate the engineering properties of the soil, selected soil samples were tested for moisture content, unconfined compression and Atterberg limits. Laboratory tests were performed in general accordance with test standards ASTM D 2216, ASTM D 2166 and ASTM D 4318. The moisture content and Atterberg limits test results are shown on the boring logs presented in Appendix A. A summary of the test results is provided in tabular format in Appendix B.

The soil encountered during the field study was classified in general accordance with the Unified Soil Classification System. The soil classification symbols appear on the boring logs and are briefly described in Appendix A.

## **4.0 SITE CONDITIONS & GEOTECHNICAL PROFILE**

### **4.1 SITE CONDITIONS**

The project site is located within a grass landscape area in a newly developed area in the eastern portion of the existing cemetery. The topography at the proposed structure location is nearly level with slight grades to the west and south for drainage purposes. An "S" shaped sidewalk roughly bisects the site in a north-south orientation.

### **4.2 GEOTECHNICAL PROFILE**

The soils at the boring locations generally consist of two strata, with an upper zone of clay and a lower zone of silty clay. The individual strata are discussed separately below.

An upper stratum of dark brown clay with scattered gravel extends from the surface to a depth of approximately 6 feet below existing grades. The soil in the upper stratum has a high plasticity and is brown, moist and very stiff to hard. Atterberg Limits testing on two representative samples from this stratum indicates liquid limits of 66 and 71 and plasticity indices of 42 and 48. Based on these measured properties, the soil in the upper stratum is considered to be moisture sensitive and has a high potential for volumetric changes with varying moisture conditions.

Underlying the upper zone is a lower stratum of silty clay with scattered weak calcareous nodules that extends to the full depth of the borings (15 feet). The silty clay is light orange brown, damp and very stiff to hard. Atterberg Limits testing on a representative sample from this stratum indicates a liquid limit of 39 and a plasticity index of 22. Based on these measured properties, the soil in the lower stratum is considered to be moisture sensitive and has a low to moderate potential for volumetric changes with varying moisture conditions.

### **4.3 SOIL MOISTURE AND GROUNDWATER CONDITION**

At the time of our field study, no groundwater was observed within the total exploration depths at the two borings. However, temporary perched groundwater is common and may be encountered, especially during periods of wet weather or related to irrigation effects upgradient of the site.

The moisture contents of the native soils were observed to be damp to moist at the time of the field study, with moisture contents varying from approximately 15 to 24 percent on the samples tested, with an average moisture content of 21 percent.

## **5.0 DISCUSSION AND RECOMMENDATIONS**

### **5.1 ANALYSIS OF RESULTS**

As discussed above, the proposed building area is typically underlain by an upper stratum of expansive clay, followed by a lower stratum of silty clay that has a lesser expansion potential. The upper clay stratum has a relatively high plasticity index and is considered to have a high expansion potential. The potential vertical rise (PVR) for the site was estimated using the Texas Department of Transportation (TxDOT) Procedure Tex 124-E. Based on the TxDOT Procedure, it is estimated the in-situ materials identified in the areas of the proposed structure has a PVR of approximately 2.0 inches.

The following Section 5.2 provides recommendations for site improvements for a shallow foundation system for the proposed structure. Other foundation systems and methods may be acceptable at this site and will be addressed if required by the design team.

It should be noted that a risk is involved with the use of shallow foundations. Should a broken water line or other source of moisture occur, some movement of slabs and foundations is possible beyond the provided PVR estimate. Therefore, it is critical that the recommendations for site preparation and moisture protection presented in Section 5.3 are completed. In order to further reduce the risk of future foundation and slab movements, a belled pier foundation system with a structural slab may be used to support the proposed structure. Recommendations for a deep foundation system can be provided upon request.

### **5.2 SHALLOW FOUNDATIONS**

To reduce the PVR to less than 1 inch, it is recommended that the native soils below the entire building area and foundations be excavated to a minimum depth of 30 inches below existing grades.

The recommended soil improvements consist of excavating and replacing native soils with select fill below the structure and foundations. Prior to placement of select fill in the over excavations, the exposed native soils should be scarified to a depth of 8 inches, moisture adjusted to within plus or minus 3 percent of optimum, and compacted. Select fill should then be added back in compaction controlled lifts to final grade. Compaction of the native soils should be accomplished by mechanical

means to obtain a density of not less than 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined in accordance with ASTM D 698.

Following completion of the recommended soil improvements, the proposed structure may be constructed using a monolithic, grid-type beam and slab foundation system. The shallow monolithic type foundation system for the structure should be designed for a net allowable bearing capacity of 2,000 pounds per square foot. This bearing pressure applies to full dead plus realistic live loads and can be safely increased by one-third for temporary loads including wind or seismic forces. Total settlement of the foundations should not exceed one inch. Footings should be founded at a minimum depth of 24 inches below final grade and should be a minimum of 12 inches in width.

Select fill, as discussed in this report, should consist of a crushed limestone base material meeting the requirements presented in the Texas Department of Transportation (TxDOT) Standard Specification for Construction of Roadways and Bridges, Item 247, Type A, Grades 1, 2 or 3. In lieu of the recommended structural fill, other fill materials, including pit run materials, may be used for structural fill for the project following approval by the geotechnical engineer. The proposed materials or test results (sieve analysis and Atterberg limits) on the materials should be submitted to the geotechnical engineer for review and possible approval.

In addition, select fill should have a plasticity index of 10 to 18, have no particles sizes larger than 1 inch in diameter and be free of vegetation, debris and deleterious materials. Select fill should be placed in maximum 8-inch lifts and compacted to 95 percent of maximum density within plus or minus 2 percentage points of optimum moisture as determined by ASTM D 698.

The horizontal limits of select fill areas, including the recommended over excavation and replacement, should be limited to those areas where a reduction in potential soil movements is desired, plus an additional 2 feet beyond all sides where the surfacing is appropriately sealed. These may include flatwork located adjacent to the structure, such as at doorways. Select fill should not extend outside the limits of the building in areas that will not be sealed with flatwork or pavement.

Heavily loaded slabs cast directly on compacted fill as recommended previously should be designed using a modulus of subgrade reaction value of 250 pounds per cubic inch.

A vapor barrier membrane is recommended beneath floor slabs to retard moisture migration through the slab. At a minimum, the vapor barrier should consist of 6-mil polyethylene.

### **5.3 SITE DRAINAGE AND MOISTURE PROTECTION**

As discussed above, moisture sensitive soils are present within the project area and any moisture increases in the soils supporting foundations would reduce their support value and increase movements. In addition, moisture variations in the subgrade soils due to poor drainage, leaking utilities, etc. could induce volumetric changes in excess of PVR estimates provided above. Therefore, positive site drainage should be provided during construction and carefully maintained for the life of the structure.

Where slabs or pavements do not immediately adjoin the proposed structure, the ground surface should be sloped away from the perimeter of the structure in a manner to allow flow along the drainage lines at a minimum grade of 5 percent to points at least 15 feet away. Positive drainage should be provided from these points to streets or natural water courses. In no case should long-term ponding of water be allowed around the perimeter of the structure.

Additionally, trees should not be used as landscaping around the perimeter of the structure as the root systems can lead to desiccation, and subsequent shrinkage, of the clay subgrade soil. Trees should be planted so that the drip line of the fully mature trees will not extend over the footprint of the structure.

Roof drains should be designed and constructed to discharge storm water directly onto paved areas that will carry the water rapidly away from the structure. No storm water from roof drains should be allowed to discharge onto or accumulate in unpaved areas close to the structure.

Utility trenches that are excavated within 5 feet of the structure should be backfilled with select fill material. Select fill should consist of material placed and compacted as described in Appendix C. Concrete cut-off collars and/or clay plugs should be used to prevent free water flow through porous pipe bedding and trench backfill into the building subgrade soil. It is recommended that flexible utility connections be used for the structure capable of withstanding the total estimated vertical movement.

#### **5.4 LATERAL LOADS**

The pressure exerted on retaining walls will depend on their degree of restraint. Rigid, restrained walls with horizontal backfill meeting select fill requirements as presented in Appendix C of the geotechnical report, should be designed using an "at rest" equivalent fluid pressure of 58 pounds per cubic foot (pcf). Walls allowed to rotate around their bases at a distance of 0.001 times their height or more, at the top, should be designed using an "active" equivalent fluid pressure of 69 pcf. The passive soil resistance against the edges of footings, stem walls, etc. with properly compacted backfill, should be considered as being equal to forces exerted by a fluid of 200 pounds per cubic foot unit weight. A coefficient of friction of 0.30 is recommended for computing lateral resistance between the bases of the footing and slabs and the soil in analyzing lateral loads.

The equivalent fluid pressures do not include any lateral component due to either hydrostatic or surcharge loads. The retaining walls at this site should be designed with a drainage system to prevent the build up of hydrostatic forces behind the wall. If a drain system is not provided, then an additional 62.4 pcf must be added to the lateral forces acting on the wall. Special care should be taken not to over compact the backfill material to reduce the potential for the build up of residual compaction pressures against the retaining walls.

The equivalent fluid pressures provided above do not include a factor of safety, however, we recommend that a minimum factor of safety of 1.5 be used for the design of retaining walls against overturning and sliding. Surcharge loads, such as vehicular wheel loads, to the area adjacent to the



retaining wall can add additional horizontal components of lateral earth pressures to this wall. The magnitude of these components will depend on the loads and locations of these loads relative to the retaining wall.

## **5.5 CONSTRUCTION OBSERVATION AND TESTING**

Recommendations presented in previous sections of this report are predicated on the fact that there will be continuous observation and testing by the geotechnical engineer during earthwork operations. Verification of recommended site grading and required degree of compaction should be performed in accordance with "Guide Specifications for Earthwork," Appendix C.

## **6.0 REPORT LIMITATIONS**

The conclusions and recommendations given in this report are based on information determined at the points of exploration. The subsurface information and conclusions herein in no way reflect on the environmental aspects of the project. Subsurface and ground water conditions beyond the boring locations may differ from those encountered at the locations explored, and conditions, which could not be detected or anticipated at the time of the exploration and study, may become apparent during construction. The geotechnical engineer of record should be retained during the grading and construction to document that subsurface conditions across the site do not deviate materially from those encountered at the locations explored. Topographic, survey or benchmark elevations illustrated on the appended Plan should be verified by consultation with the site civil firm prior to being used for construction or layout purposes.

The design recommendations conveyed in this document are applicable only to the project described in the text, and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to confirm that the design is consistent with our recommendations, and that assumptions made in our study are valid.

The comments presented herein relating to potential construction problems and possible methods or sequencing of construction are intended only for the guidance of the designer. The number of borings may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of overburden or existing topsoil may vary markedly and unpredictably. Contractors should make their own interpretation of the factual information presented, and draw their own conclusions as to how the subsurface conditions may affect the work.

This study has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

## **7.0 CLOSURE**

This report is prepared for the exclusive use of the National Cemetery Administration and their consultants for the site and criteria stipulated herein. Questions or interpretation regarding any portion of the report should be addressed directly by the geotechnical engineer. Reliance upon, usage, or implementation of the information or recommendations stated in this report by any



member of the project team should not be undertaken without direct consultation of the National Cemetery Administration and the geotechnical engineer. AMEC Environment & Infrastructure, Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. The Owner is advised to read the ASFE flyer included in Appendix D of this report

## **TEST DRILLING EQUIPMENT & PROCEDURES**

**SAMPLING PROCEDURES** - Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D-1586 procedures. In most cases, 2" O.D., 1 $\frac{3}{8}$ " I.D. samplers are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soil are often obtained with 3" O.D. samplers lined with 2.42" I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140 pound, 30-inch free fall drop hammer required to advance the samplers in 6-inch increments. However, in stratified soil, driving resistance is sometimes recorded in 2 or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per foot on the logs. "Undisturbed" sampling of softer soil is sometimes performed with thin walled Shelby tubes (ASTM D-1587). Where samples of rock are required, they are obtained in NX diamond core drilling (ASTM D-2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings.

**CONTINUOUS PENETRATION TESTS** - Continuous penetration tests are performed by driving a 2" O.D. blunt nosed penetrometer adjacent to or in the bottom of borings. The penetrometer is attached to 1 $\frac{3}{8}$ " O.D. drill rods to provide clearance to minimize side friction so that penetration values are recorded as the number of blows of a 140 pound, 30-inch free fall drop hammer required to advance the penetrometer in one foot increments or less.

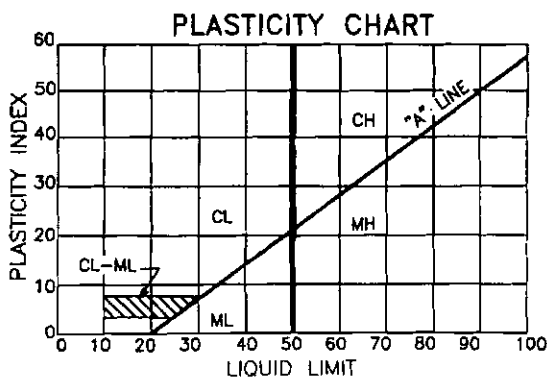
**BORING RECORDS** - Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares boring logs. Soil is visually classified in accordance with the Unified Soil Classification System (ASTM D-2487), with appropriate group symbols being shown on the logs.

# UNIFIED SOIL CLASSIFICATION SYSTEM

Soils are visually classified by the Unified Soil Classification System on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System", Corp of Engineers, US Army Technical Memorandum No. 3-357 (Revised April 1960) or ASTM Designation: D2487-93T.

MAJOR DIVISIONS			GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)		GW	Well graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
				GP	Poorly graded gravels, gravel-sand mixtures or sand-gravel-cobble mixtures
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	"A" Limits plot below line or hatched zone on plasticity chart	GM	Silty gravels, gravel-sand-silt mixtures
			"A" Limits plot above line & hatched zone on plasticity chart	GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)		SW	Well graded sands, gravelly sands
				SP	Poorly graded sands, gravelly sands
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	"A" Limits plot below line or hatched zone on plasticity chart	SM	Silty sands, sand-silt mixtures
			"A" Limits plot above line & hatched zone on plasticity chart	SC	Clayey sands, sand-clay mixtures
		SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50%)		ML	Inorganic silts, clayey silts with slight plasticity
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50%)		MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS Limits plot above "A" line or hatched zone on plasticity chart				
	CLAYS Limits plot above "A" line or hatched zone on plasticity chart	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50%)		CL	Inorganic clays of low to medium plasticity; gravelly clays, sandy clays, silty clays, lean clays
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50%)		CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity

**NOTE:** Coarse grained soils with between 5% & 12% passing the No. 200 sieve and fine grained soils with limits plotting in the hatched zone on the plasticity chart to have double symbol.



## DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
COBBLES	Above 3 inches
GRAVEL	3 inches to No. 4 sieve
Coarse Gravel	3 inches to 3/4 inch
Fine Gravel	3/4 inch to No. 4 sieve
SAND	No. 4 sieve to No. 200
Coarse	No. 4 sieve to No. 10
Medium	No. 10 sieve to No. 40
Fine	No. 40 sieve to No. 200
FINES (SILT or CLAY)	Below No. 200 sieve

## TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY CONSISTENCY, OR FIRMNESS OF SOIL

The terminology used on the boring logs to describe the relative density, consistency or firmness of soil relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blow per foot is obtained by ASTM D-1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

**RELATIVE DENSITY:** Terms for description of relative density of cohesionless, uncemented sand and sand-gravel mixtures.

<u>N</u>	<u>RELATIVE DENSITY</u>
0-4	Very Loose
5-10	Loose
11-30	Medium Dense
31-50	Dense
50+	Very Dense

**RELATIVE CONSISTENCY:** Terms for the description of clay which is saturated or near saturation.

<u>N</u>	<u>RELATIVE CONSISTENCY</u>	<u>REMARKS</u>
0-2	Very Soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium Stiff	Can be penetrated several inches with thumb moderate effort.
9-15	Stiff	Readily indented with thumb but penetrated only with great effort.
16-30	Very Stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

**RELATIVE FIRMNESS:** Terms for the descriptions of partially saturated and/or cemented soil which commonly occurs in the Southwest including clay, cemented granular materials, silt and silty and clayey granular soil:

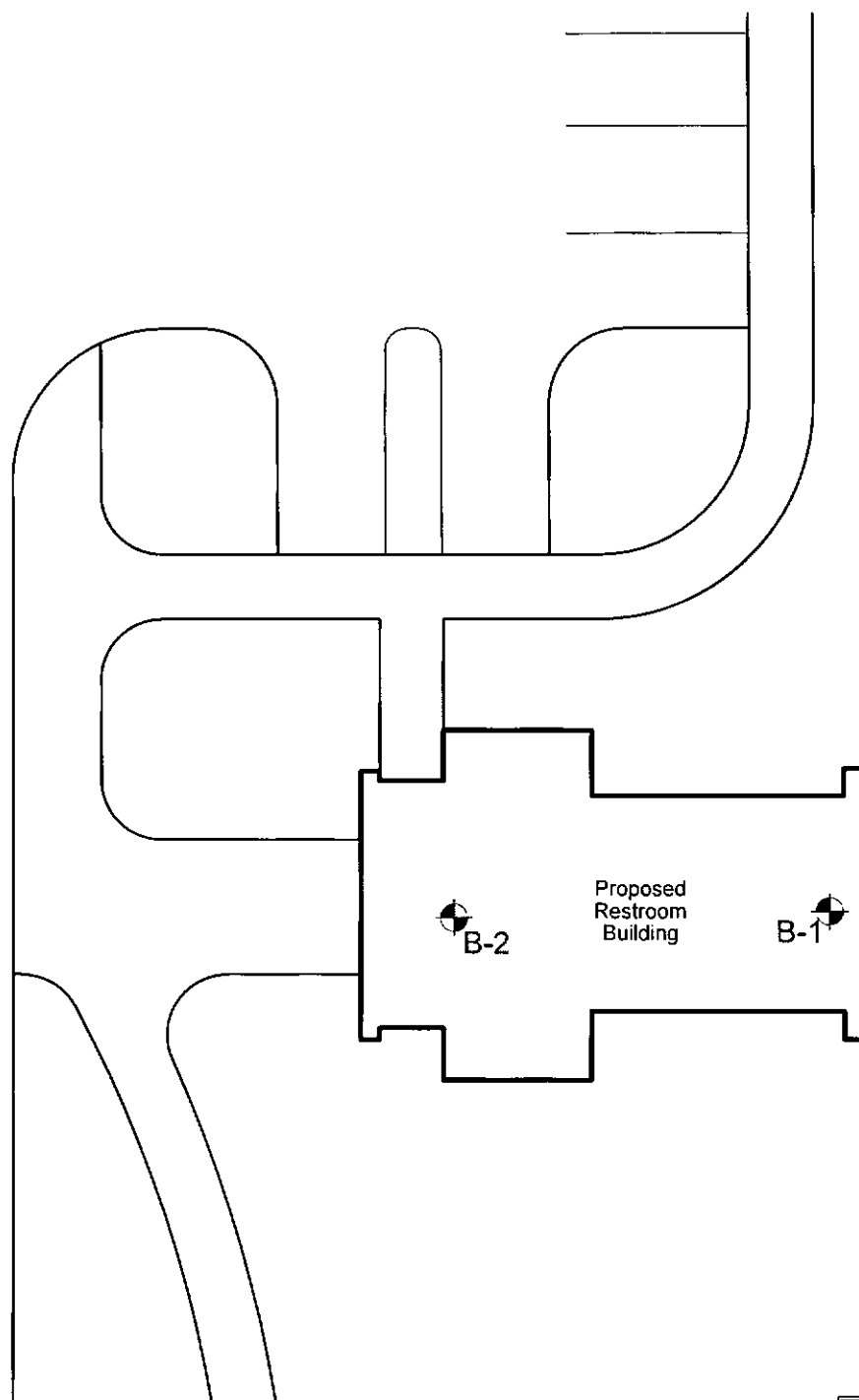
<u>N</u>	<u>RELATIVE DENSITY</u>
0-4	Very Soft
5-8	Soft
9-15	Moderately Firm
16-30	Firm
31-50	Very Firm
50+	Hard

## SOIL MOISTURE CLASSIFICATION

MOISTURE CONDITION	FIELD IDENTIFICATION	ESTIMATED RANGE OF MOISTURE	
		Group A (%)	Group B (%)
Dry	Absence of moisture, dusty. Dry to the touch.	0-4	0-8
Damp	Grains appear slightly darkened, but no visible water. Silt/clay may clump. Sand will not bulk. Soils are below plastic limits.	4-8	8-16
Moist	Grains appear darkened, but no visible water. Silt/clay will clump. Sand will bulk. Soils are often at or near plastic limits.	8-16	16-30
Wet	Visible water on larger grain surfaces. Sand and cohesionless silt exhibit dilatancy. Cohesive silt/clay can be readily remolded. "Wet" indicates that the soil is much wetter than the optimum moisture content and above the plastic limit (APL).	>16	>30
Water Bearing	A water-producing formation.	N/A	N/A

**Group A -** Coarse Grained Soils, nonplastic to plasticity index <7.  
Includes: SM, SP-SM, SP, SW, GM, GP, and GW.

**Group B -** Fine Grained Soils to clayey sands & gravels with a plasticity index >7.  
Includes: GC, SC, ML, MH, CL, and CH.



Not To Scale

Legend



Approximate Boring Location

Geotechnical Study  
Fort Sam Houston Cemetery Restroom  
San Antonio, Texas  
AMEC Ref. No. 6151120084.001

Figure 1  
March 2011

**amec** Environment & Infrastructure, Inc.

Drawing by: C. Gallegos  
Checked by: P. Johnson  
File No.: 6151120084.001 Figure 1 Site Plan

LOG OF TEST BORING NO. B-1

PROJECT Fort Sam Cemetery Restrooms

JOB NO. 6151120084.001      DATE 3/16/2012

SHEET 1 OF 1



RIG TYPE	<u>Mobile B-47</u>	LOGGED	<u>PLJ</u>
BORING TYPE	<u>6" OD SFA</u>	DWG BY	<u>CG</u>
SURFACE ELEV.	<u>          </u>	CHECKED BY	<u>DAV</u>
DATUM	<u>          </u>	DRILLED BY	<u>EAGLE</u>

BORING TYPE 6" OD SFA DWG BY CG

SURFACE ELEV. \_\_\_\_\_ CHECKED BY DAV \_\_\_\_\_  
 DATUM \_\_\_\_\_ DRILLED BY EAGLE \_\_\_\_\_

DATE \_\_\_\_\_ DRILLED BY EAGLE

[illegible]

GROUND WATER		
DEPTH	HOUR	DATE

SAMPLE TYPE	
A - Auger Cuttings	
S - 2" O.D. 1.38" I.D. tube sample	
U - 3" O.D. 2.42" I.D. tube sample	
T - 3" O.D. tube sample	



# LOG OF TEST BORING NO. B-2

PROJECT Fort Sam Cemetery Restrooms

JOB NO. 6151120084.001 DATE 3/16/2012



SHEET 1 OF 1

RIG TYPE Mobile B-47 LOGGED PLJ  
 BORING TYPE 6" OD SFA DWG BY CG  
 SURFACE ELEV.  CHECKED BY DAV  
 DATUM  DRILLED BY EAGLE

Depth in feet	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content % of Dry Weight	PID Reading	Unified Soil Classification	Atterberg Limits			REMARKS	VISUAL CLASSIFICATION
									PL	LL	PI		
0			U			22		CH	23	71	48	PP = 2.5	CLAY, with scattered gravel, high plasticity, brown, moist, very stiff to hard
			U									PP = 4.0	
5			U			22						PP = 3.5	
			U					CL				PP = 4.5	SILTY CLAY, with weak calcareous nodules, low to medium plasticity, light orange brown, damp, very stiff to hard
10			U									PP = 4.5	
			U									PP = 3.5	
15													BORING TERMINATED @ 15'
20													
25													
30													
35													
40													

GROUND WATER		
DEPTH	HOUR	DATE

SAMPLE TYPE	
A - Auger Cuttings	
S - 2" O.D. 1.38" I.D. tube sample	
U - 3" O.D. 2.42" I.D. tube sample	
T - 3" O.D. tube sample	

## TABULATION OF TEST RESULTS

## GUIDE SPECIFICATIONS FOR EARTHWORK

### 1. SCOPE

Includes all clearing and grubbing, removal of obstructions, general excavating, filling and any related items necessary to complete the grading for the entire project in accordance with these specifications.

### 2. SUBSURFACE SOIL DATA

Subsurface soil studies have been made and the results are available for examination by the contractor. The contractor is expected to examine the site and determine for himself the character of materials to be encountered.

No additional allowance will be made for rock removal, site clearing and grading, filling, compaction, disposal or removal of any unclassified materials.

### 3. CLEARING AND GRUBBING

- A. **General:** Clearing and grubbing will be required for all areas shown on the plans to be excavated or on which fill is to be constructed.
- B. **Clearing:** Clearing shall consist of removal and disposal of brush, roots and other vegetation within the areas to be cleared. Any existing sidewalks, utilities and related materials shall be removed in their entirety from the building area and other areas as shown on the plans.
- C. **Grubbing:** Stumps, matted roots and roots larger than 2 inches in diameter shall be removed from within 6 inches of the surface of areas on which fills are to be constructed except in roadways. Materials as described above within 18 inches of finished subgrade in either cut or fill sections shall be removed. Areas disturbed by grubbing will be filled as specified hereinafter for STRUCTURAL FILL.

### 4. EARTH EXCAVATION

- A. Earth excavation shall consist of the excavation and removal of suitable soil for use as embankment as well as the satisfactory disposal of all vegetation, debris and deleterious materials encountered within the area to be graded and/or in a borrow area.
- B. Excavated areas shall be continuously maintained such that the surface shall be smooth and have sufficient slope to allow water to drain from the surface.

### 5. SELECT FILL

- A. **General:** Select fill shall consist of a controlled fill constructed in areas indicated on the grading plans.

**B. Materials:**

**(1) Physical Characteristics:** Select fill shall consist of a crushed limestone base material meeting the requirements presented in the Texas Department of Transportation (TxDOT) Standard Specification for Construction of Roadways and Bridges, Item 247, Type A, Grades 1, 2 or 3. In lieu of the above specified materials, other imported materials may be used following approval by the geotechnical engineer. In addition, select fill shall have a plasticity index of 10 to 18, have no particles sizes larger than 3 inches in diameter and be free of vegetation, debris and deleterious materials.

**(2) Site Soil:** Site soil from cuts may be used for select fill, provided they meet the requirements in paragraph 5.B.(1). The results of this soil study indicate the clay soil underlying the site will not meet these requirements.

**(3) Borrow:** When the quantity of suitable material required for embankments is not available within the limits of the jobsite, the contractor shall provide sufficient materials to construct the embankments to the lines, elevations and cross sections as shown on the drawings from borrow areas. The contractor shall obtain from owners of said borrow areas the right to excavate material, shall pay all royalties and other charges involved, and shall pay all expenses in developing the source including the cost of right-of-way required for hauling the material.

**C. Construction:**

**(1) Building Area Treatment – Shallow Foundations:** The building pad shall be inspected by a representative of the geotechnical engineer prior to fill placement to verify clearing and grubbing.

The exposed subgrade materials below all foundations and slabs shall be over excavated 30 inches below existing grades. The over excavations shall then be scarified to a depth of 8 inches, brought to within plus or minus 2 percent of optimum moisture content and compacted. Select fill shall then be placed in compacted lifts as required to final grade.

During construction, the project area shall be shaped to provide drainage of surface water in order to avoid the ponding of water. Surface water shall be pumped immediately from the construction area after each rain and a firm subgrade maintained. In addition, the moisture content and density within the completed subgrade must be maintained until construction is complete. Failure to do so could result in the swelling or desiccation of the subgrade soils and the potential for vertical movements in excess of the design parameters.

**(2) Compaction:** All fill shall be spread in layers not exceeding 8 inches, watered as necessary, and compacted. Moisture content at the time of compaction shall be at plus or minus 2 percent of optimum moisture content. Compaction of the subgrade and select fill shall be accomplished by mechanical means only to obtain a density of not less than 95 percent of maximum dry density for the building pad, paved areas, sidewalks, slabs and other structural areas. Embankments outside the building pad and other structural areas shall be

compacted to 90 percent of maximum dry density. Optimum moisture content and maximum dry density for each type of fill material used and native soils shall be determined in accordance with ASTM D 698. Where vibratory compaction equipment is used, it shall be the contractor's responsibility to insure that the vibrations do not damage nearby buildings or other adjacent property.

**(3) Weather Limitations:** Controlled fill shall not be constructed when the atmospheric temperature is below 35 degrees F. When the temperature falls below 35 degrees, it shall be the responsibility of the contractor to protect all areas of completed surface against any detrimental effects of ground freezing by methods approved by the geotechnical engineer. Any areas that are damaged by freezing shall be reconditioned, reshaped and compacted by the contractor in conformance with the requirements of this specification without additional cost to the owner.

- D. Slope Protection & Drainage:** The edges of the controlled fill embankments shall be graded to the contours shown on the drawings and compacted to the density required in paragraph 5.C.(2). Slopes steeper than 1 vertical to 3 horizontal shall be protected from erosion.

## **6. INSPECTION & TESTS**

- A. Field Inspection & Testing:** The owner shall employ the services of a registered, licensed geotechnical engineer for consultation during all controlled earthwork operations. The geotechnical engineer shall provide continuous on-site observation and testing by experienced personnel during construction of controlled earthwork activities. The contractor shall notify the engineer at least two working days in advance of any field operations of the controlled earthwork, or of any resumption of operations after stoppages. Tests of fill materials and embankments will be made at the following suggested minimum rates:

- (1)** One field density test in the building area for each 500 square feet of original ground surface prior to placing fill or floor slab construction.
- (2)** One field density test in the building areas for each 500 square feet of fill placed or each layer of fill for each work area, whichever is the greater number of tests.
- (3)** One moisture-density curve for each type of material used, as indicated by sieve analysis and plasticity index.

- B. Report of Field Density Tests:** The geotechnical engineer shall submit, daily, the results of field density tests required by these specifications.

- C. Costs of Tests & Inspection:** The costs of tests, inspection and engineering, as specified in this section of the specifications, shall be borne by the owner.

# Important Information About Your Geotechnical Engineering Report

*Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.*

*The following information is provided to help you manage your risks.*

## **Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects**

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. *No one except you* should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one—not even you—*should apply the report for any purpose or project except the one originally contemplated.

## **Read the Full Report**

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

## **A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors**

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, *do not rely on a geotechnical engineering report* that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when

it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,

- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

## **Subsurface Conditions Can Change**

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

## **Most Geotechnical Findings Are Professional Opinions**

Site exploration identifies subsurface conditions *only* at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an *opinion* about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

### **A Report's Recommendations Are *Not* Final**

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

### **A Geotechnical Engineering Report Is Subject To Misinterpretation**

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

### **Do Not Redraw the Engineer's Logs**

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

### **Give Contractors a Complete Report and Guidance**

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the

report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time to perform additional study.* Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

### **Read Responsibility Provisions Closely**

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce such risks, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations", many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

### **Geoenvironmental Concerns Are Not Covered**

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any *geoenvironmental* findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own *geoenvironmental* information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

### **Rely on Your Geotechnical Engineer for Additional Assistance**

Membership in ASFE exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.



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