REPORT
GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL SLAB DESIGN
LAKE CREEK FOREST SECTION 1
5 WIND RIVER COURT (BLOCK 5, LOT 35)
CONROE, TEXAS

PREPARED FOR:

Partners in Building
17361 Village Green Drive
Houston, Texas 77040

PREPARED BY:

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091-3312

HTS Project No.: 14-S-404

November 17, 2014

HTS, INC. Consultants

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Excellence in Engineering, Consulting, Testing and Inspection

November 17, 2014

Partners in Building
17361 Village Green Drive
Houston, Texas 77040

Attn: Mr. Eric Ruiz

Re: Report
Geotechnical Investigation
Proposed Residential Slab Design
Lake Creek Forest Section 1
5 Wind River Court (Block 5, Lot 35)
Conroe, Texas

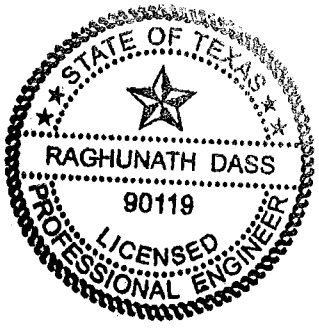
HTS Project No.: 14-S-404

Dear Mr. Ruiz:

HTS, Inc. Consultants is pleased to submit our geotechnical investigation report for the above referenced project. This report includes the results of field and laboratory testing as well as geotechnical recommendations pertaining to the proposed project.

We appreciate the opportunity to perform this geotechnical investigation and look forward to continued participation during the design and construction phases of this project. If you have any questions pertaining to this report, or if we may be of further service, please contact me at your convenience.

Very truly yours,
HTS, Inc. Consultants



11-17-14

Raghunath Dass, P.E.
Senior Engineer

HTS, Inc. Consultants
F-3478

h:word/2014/400-449/14-404

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PROPOSED RESIDENTIAL SLAB DESIGN
LAKE CREEK FOREST SECTION 1
5 WIND RIVER COURT (BLOCK 5, LOT 35)
CONROE, TEXAS

1.0 INTRODUCTION AND SUMMARY

1.1 Introduction

This report presents the results of a geotechnical investigation pertaining to the design of a foundation system for a single-family residential home to be located at 5 Wind River Court (Block 5, Lot 35) within the Lake Creek Forest Section 1 residential subdivision in Conroe, Texas. The site for the proposed residence is shown in Figures 1 and 2.

The purpose of this geotechnical investigation was to provide recommendations concerning the design and construction for the proposed residence.

This geotechnical investigation was performed by HTS, Inc. Consultants (HTS) for Partners in Building.

The scope of work for this geotechnical investigation consisted of:

- drilling 2 geotechnical borings to depths of 20 and 15 (Boring Nos. 1 and 2, respectively) beneath the surface within the plan area of the proposed residence shown in Figure 2,
- performing field tests and recovering both disturbed and relatively undisturbed soil samples,
- measuring the depth to groundwater in the geotechnical borings during drilling and after drilling was completed,
- backfilling the borings with soil cuttings after the completion of the drilling activities,
- visually classifying samples obtained and conducting laboratory tests to determine the physical and mechanical properties of the soils,
- analyzing the field and laboratory test data,
- preparing boring logs based on visual soil classifications and the results of the laboratory tests,
- performing potential vertical rise and bearing capacity for foundations which may be used to support the proposed residence,

- performing engineering analyses as necessary to determine the design parameters for a stiffened concrete slab-on-grade or for a post-tensioned slab-on-grade in accordance with the Federal Housing Administration (FHA) requirements as delineated in the Building Research Advisory Board (BRAB) Report No. 33, entitled "Criteria for Selection and Design of Residential Slabs-on-Ground" and the Post Tensioning Institute (PTI) requirements as contained in PTI's 3rd Edition with 2008 Supplement publications entitled "Design and Construction of Post-Tensioned Slabs-On-Ground",

- performing engineering analyses for the purpose of developing and providing:
  a) site preparation requirements for the proposed residence, and
  b) recommendations pertaining to foundation and floor slab design and construction, and

- submitting 1 bound copy and a pdf file of the geotechnical investigation report.

1.2 Subsurface Soil Strata

The subsurface soil strata at the boring locations are described:

- by the laboratory test results presented in Table 1, and
- on the boring logs for Boring Nos. 1 and 2 as provided in Appendix A.

Data from Boring Nos. 1 and 2 suggest that the upper 20 feet of overburden soils are composed of 3 soil layers. Descriptions of the soil layers are provided below:

LAYER	DEPTH BELOW GROUND SURFACE (FT)	SOIL DESCRIPTION
I	0 - 8	Tan and light gray SANDY SILTY CLAY, SANDY LEAN CLAY, and LEAN CLAY WITH SAND, hard with sand fissures and roots.
II	8 - 15	Tan and light gray CLAYEY SAND, very loose to loose.
III	15 - 20	Tan and light gray FAT CLAY WITH SAND, very stiff with sand seams and sand fissures (encountered in Boring No. 1 only).

Laboratory testing was performed on selected samples of the subsurface materials obtained to classify the soils in accordance with ASTM D 2487 and to define the engineering properties of the soils. Portions of the test results indicating the high and low values of specific testing are provided in the table below:

LAYER	DEPTH (FT)	LIQUID LIMIT (%)		PLASTICITY INDEX (%)		MOISTURE CONTENT (%)		PASSING NO. 200 SIEVE (%)	
		HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW
I	0 - 8	42	18	24	4	14.0	11.1	75.4	60.6
II	8 - 15	34	32	18	16	9.6		30.2	

Groundwater was not encountered during drilling. After drilling was completed, the borings were dry and open to depths of 19.4 and 14.4 feet in Boring Nos. 1 and 2, respectfully. The borings were backfilled with soil cuttings after drilling activities were complete.

1.3 Summary of Recommendations

Recommendations are provided below pertaining to the design and construction of the foundation system for the proposed residence.

1.3.1 Recommended Site Preparation Requirements – Proposed Residential Building

These recommendations pertain to site preparation in the area of the proposed residential building when a stiffened slab-on-grade or a post tensioned slab-on-grade foundation system is used. It is recommended that site preparation be performed by:

- establishing site drainage and installing storm water drainage structures, if required,
- stripping any vegetation and organic topsoil, as applicable, up to a depth of 6 inches,
- proofrolling the exposed subgrade soils with a 15-ton roller or other equivalent suitable equipment as approved by the engineer, observing the soils during proofrolling so as to detect any wet, soft, or unstable soils and treating such soils with suitable drying or stabilizing agents or removing the unsuitable soils and replacing with properly compacted select fill, and
- placing properly compacted select fill as necessary to achieve the desired subgrade elevation.

Select fill should consist of a clayey sand or inactive lean clay with a maximum liquid limit of 35 and a plasticity index range of 8 to 20. The select fill should be placed in 8-inch thick loose lifts and compacted to an in-place dry density equal to at least 95% of the maximum standard dry density (ASTM D 698) at a moisture content within ± 2% of the optimum moisture content. The select fill should be placed/compacted within the proposed

building perimeters and for a distance of at least 5 feet beyond the proposed building perimeters, where applicable.

Depending on weather conditions, difficulty may be encountered in adequately densifying/compacting the surficial soils. If the surficial soils are unsuitably wet, excess pore pressures ("pumping") may develop and excess displacement of the subgrade soils may occur during site preparation. If the site subgrade soils become unsuitably wet, the construction contractor should:

- **dry the soils to within ± 2% of the optimum moisture content by discing these materials,**
- **dry the soils by blending a stabilizing agent (lime or fly-ash) with the unsuitably wet soil, or**
- **remove the unsuitably wet soils and replace with properly compacted select fill having an acceptable moisture content.**

Note: Placing/compacting select fill for a distance at least 5 feet beyond the proposed building perimeters, where sand encountered in order to preclude water seepage below the slab (building),

1.3.2 <u>Stiffened Slab-on-Grade or Post-Tensioned Slab-on-Grade Foundation</u>

After the site has been prepared as previously discussed in Section 1.3.1, a stiffened slab-on-grade or post-tensioned slab may be used to support the loads of the proposed residential building.

The appropriate FHA Report No. 33 (BRAB Report) and Post Tensioning Institute (PTI) 3rd Edition with 2008 Supplement design criteria for slab-on-grade foundation systems are shown in the following table:

BRAB AND PTI DESIGN PARAMETERS	DESIGN VALUES
Net Allowable Bearing Pressures Total Load Dead Load	 3,000 psf 2,000 psf
Design Plasticity Index (PI)	18
Climatic Rating (C_w)	25
Unconfined Compressive Strength (Q_u)	2,000 psf
Soil Support Index (C)	0.98

BRAB AND PTI DESIGN PARAMETERS	DESIGN VALUES
Predominant Clay Mineral	Montmorillonite
Percent Fine Clay	34%
Thornwaite Moisture Index (I_m)	18
Depth of Constant Soil Suction	9 feet
Constant Soil Suction	3.5 pF
Slab-Subgrade Coefficient of Friction (μ)	0.6 to 0.7
Moisture Velocity	0.70 inch/month
Edge Moisture Variation Distance (e_m) Center Lift Edge Lift	 9.0 feet 5.1 feet
Differential Soil Movement (y_m) Center Lift Edge Lift	 0.47 inch 0.34 inch

The FHA Report No. 33 and PTI methods for design of slab-on-grade foundations are essentially empirical design techniques and the parameters provided above are based on our interpretation of the soil borings, laboratory test results, and the criteria published in the FHA Report No. 33 and from PTI's 3rd Edition with 2008 Supplement design manuals.

We recommend that the grade beams extend at least 18 inches below final grade. This recommendation is to reduce surface water migration and develop proper soil bearing and is not based on any structural considerations. The grade beam width and depth should be properly evaluated by the structural engineer. Grade beams may be thickened and widened to serve as spread footings at concentrated load areas.

At the bearing pressures indicated, post construction settlements for the slab foundations described in this subsection should be less than 1 inch, assuming proper construction. Settlement response of slabs may be influenced more by quality of construction than by soil-structure interaction.

2.0 FIELD INVESTIGATION

Two geotechnical borings (Boring Nos. 1 and 2) were drilled and sampled on October 30, 2014 at the locations shown in Figure 2. The boring locations, as shown in Figure 2, were selected and staked in the field by representatives of HTS measuring from existing points of reference. Drilling, sampling, and testing were performed in accordance with applicable ASTM standards by using a truck-mounted drill rig and conventional auger drilling methods.

Soil sampling during the drilling of the geotechnical boring consisted of continuous sampling to a depth of 12 feet and intermittently thereafter, with both relatively undisturbed and disturbed samples being obtained.

Disturbed samples of soil were taken from the auger of the sampler and placed into airtight plastic bags.

Relatively undisturbed samples were obtained by hydraulically forcing sections of 3-inch outside diameter (O.D.) tubing (Shelby tube) into the subsoils. The tube samples were extruded in the field, sealed with foil, and placed into airtight plastic bags. Estimates of the unconfined compressive strengths of the cohesive soils were obtained with pocket penetrometer readings being taken on the tube samples.

The soil samples were visually classified in accordance with ASTM D 2488 standards and methods. All samples were transported to HTS' laboratory for purposes of performing laboratory tests on selected samples.

3.0 LABORATORY TESTING

A laboratory testing program was conducted to obtain engineering properties for use in performing engineering analyses and to adjust field soil classifications. The following laboratory tests were performed:

LABORATORY TEST	TEST STANDARD
Moisture Content of Soils	ASTM D 2216
Percent Soil Particles Passing a No. 200 Sieve	ASTM D 1140
Liquid Limit, Plastic Limit, and Plasticity Index	ASTM D 4318

The number of tests and test results are presented in the attached Table 1. All tests were performed in accordance with applicable ASTM procedures and methods and soil classifications were completed in accordance with the requirements of ASTM D 2487.

4.0 SUBSURFACE CONDITIONS

4.1 Subsoils

The subsurface soil conditions as determined from the drilling of the geotechnical borings are provided in:

- Section 1.2.1 of this report, and
- the boring logs in Appendix A.

The boring logs were prepared by using both field visual classifications and the results of laboratory testing. The stratification lines, shown on the boring logs, represent the approximate boundaries between soil types and the transitions between soil types may be gradual.

4.2 Groundwater

Groundwater conditions are described in Section 1.2.1 of this report and on the boring logs provided in Appendix A of this report. The depth to groundwater was obtained by observing the drilling operations and the free moisture contained in the samples recovered during drilling and after the completion of drilling.

It is possible that seasonal variations will cause fluctuations in the water levels measured at the time of our field investigation. We recommend that the contractor determine the actual groundwater level at the site at the time of construction in order to assess the impact, if any, of the groundwater to the construction activities. It should be noted that recommendations contained in this report are based on groundwater depths at the time of this geotechnical investigation and that an accurate determination of the true groundwater level may require several days or even months of observations.

5.0 ENGINEERING ANALYSES

Engineering analyses were performed in order to determine design parameters that can be used for the design of the proposed single-family residential home foundation. Analyses performed included:

- bearing capacity and settlement analyses for slab-on-grade foundation, and
- analyses to determine the design parameters for stiffened and post-tensioned slab-on-grade foundation system.

Analyses to determine the design parameters for a stiffened slab-on-grade foundation system were performed in accordance with the Federal Housing Administration (FHA) requirements delineated in the Building Research Advisory Board (BRAB) Report No. 33, entitled "Criteria for Selection and Design of Residential Slabs-on-Ground". Analyses to determine design parameters for a post-tensioned slab-on-grade foundation system were performed in accordance with Post Tensioning Institute (PTI) requirements and guidelines as contained in PTI's 3rd Edition with 2008 Supplement publications entitled "Design and Construction of Post-Tensioned Slabs-on Ground".

6.0 CONSTRUCTION CONSIDERATIONS

The following recommendations should be followed with regard to the construction of the proposed residence:

6.1 Foundation Construction

- **Excavations for foundation should be clean and free of all loose materials prior to the placement of concrete. Concrete should be placed at the foundation area immediately upon forming, reinforcing steel placement, cleaning, and inspection.**

- **Fill material and fill compaction should comply with the specifications provided in Section 1.3 of this report.**

- **Construction operations should be monitored by a qualified representative of the soil engineer.**

- **Materials testing should be performed so as to assure that acceptable materials and construction methods are provided by the contractor.**

6.2 Surface Drainage

The following drainage precautions should be observed during construction and maintained at all times after construction has been completed.

- **The ground surface surrounding the exterior of the home should be provided with erosion protection and sloped to drain away from the home in all directions. We recommend a minimum slope of 6 inches in the first 10 feet.**

- **Roof downspouts and drains should discharge well beyond the limits of the edges of the home foundation and be channeled to drain immediately away from the foundation.**

- **Excessive wetting or drying of foundations should be avoided. Trees and other vegetation capable of withdrawing significant amounts of moisture from the subsoils should be located a distance from the nearest foundation equal to at least the expected ultimate height of the vegetation, or appropriate moisture barriers should be provided.**

7.0 CLOSING REMARKS

HTS, Inc. Consultants has performed a geotechnical investigation and provided recommendations pertaining to the design and construction of a slab foundation for the proposed residence to be constructed 5 Wind River Court (Block 5, Lot 35) within the Lake Creek Forest Section 1 residential subdivision in Conroe, Texas. This report has been prepared for the exclusive use of Partners in Building in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

In the event that changes are made in the nature, design, or location of the proposed residential home, the conclusions, design parameters, and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the findings/ recommendations of this report are modified or verified in writing. The analyses and recommendations presented in this report are based upon data obtained from 2 geotechnical borings drilled on October 30, 2014. The nature and extent of variations within the subsurface materials may not become evident until after construction is initiated. If significant variations in the subsurface materials are encountered during construction, it may be necessary to re-evaluate the recommendations provided in this report.

TABLE

TABLE 1

LABORATORY TEST SUMMARY

PROJECT: Proposed Residential Slab Design
Lake Creek Forest Section 1 (Block 5, Lot 35)
LOCATION: Conroe, Texas

HTS PROJECT NO.: 14-S-404

CLIENT: Partners in Building

Boring No.	Sample Depth (feet)	Type of Material	Moisture Content (%)	Atterberg Limits (%)			-200 Sieve (%)	Remarks
				LL	PL	PI		
1	0-2	Sandy Silty Clay (CL-ML)	11.3	18	14	4	60.6	
	4-6	Lean Clay With Sand (CL)	14.0	33	16	17	75.4	
	8-10	Clayey Sand (SC)	9.6	32	16	16	30.2	
2	2-4	Sandy Lean Clay (CL)		41	17	24		
	6-8	Sandy Lean Clay (CL)	11.1	42	18	24	69.2	
	10-12	Clayey Sand (SC)		34	16	18		

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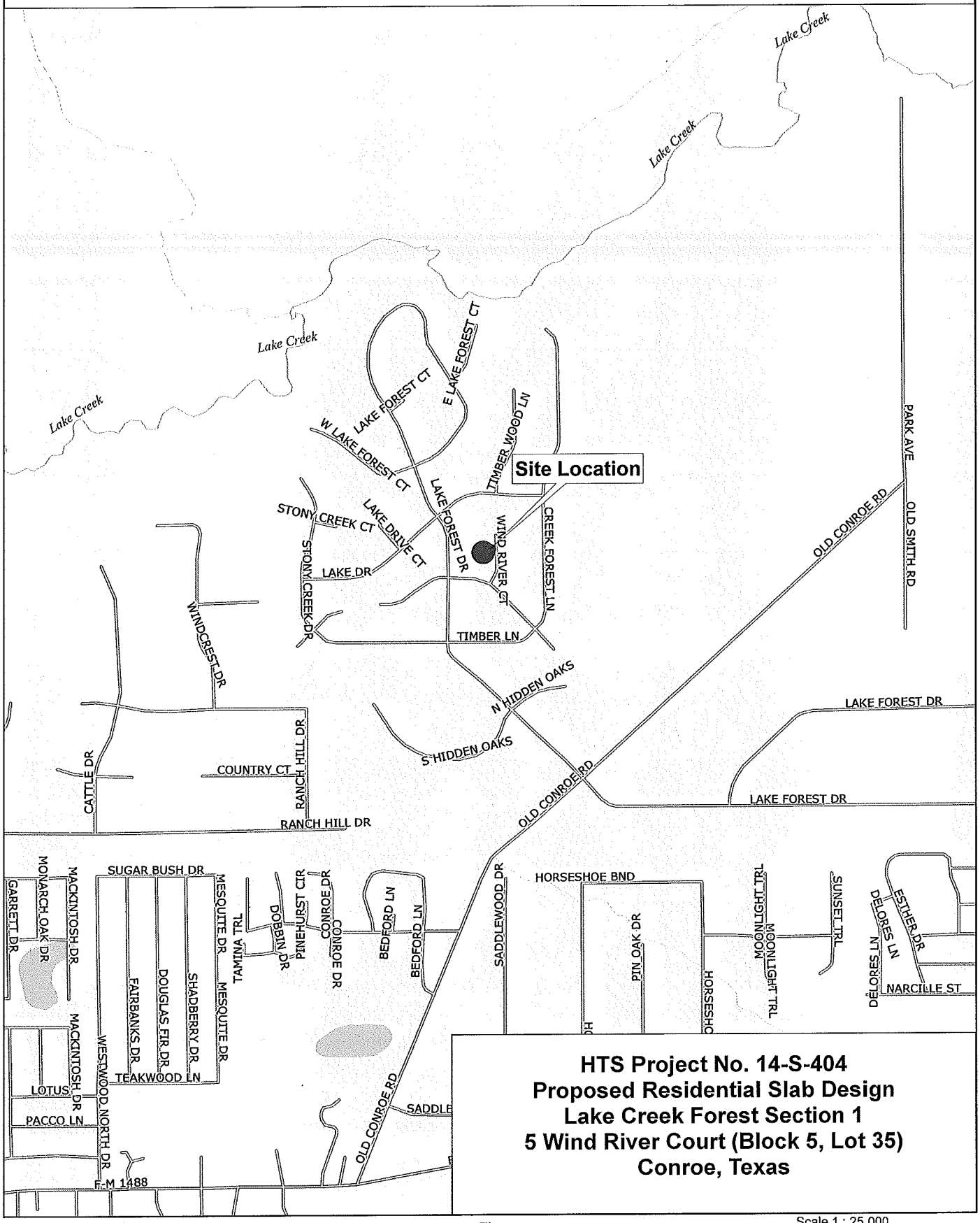
FIGURES

VICINITY MAP

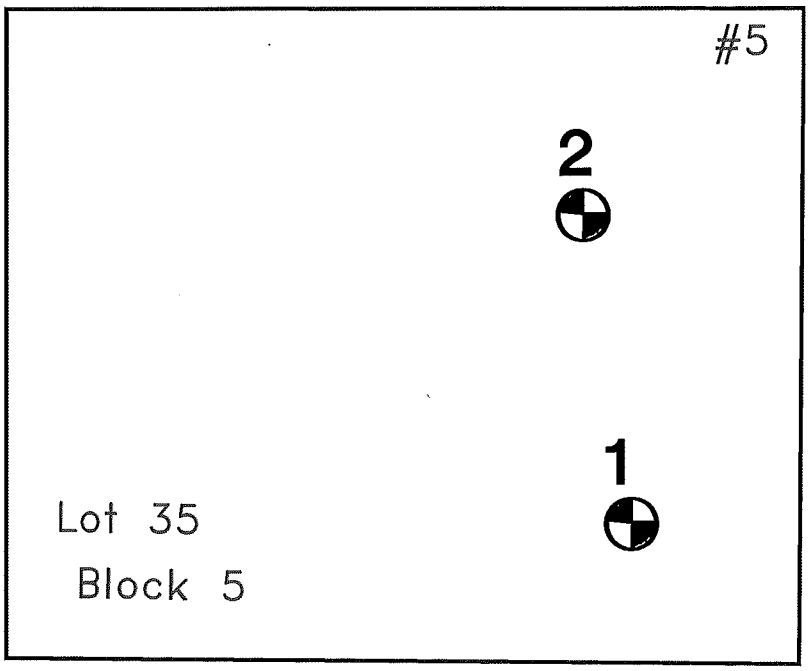
FIGURE 1



HTS Project No. 14-S-404
Proposed Residential Slab Design
Lake Creek Forest Section 1
5 Wind River Court (Block 5, Lot 35)
Conroe, Texas

TN
MN (2.9°E)

Scale 1 : 25,000
1" = 2,083.3 ft
Data Zoom 13-0



Legend

Geotechnical borinss included in the study

HTS, Inc. Consultants			
Proposed Residential Slab Design **Lake Creek Forest Section 1** **5 Wind River Court (Block 5, Lot 35)** **Conroe, Texas**			
DRAWN BY: IAT	DATE: 11-14-14	SCALE: NTS	
CHECKED BY: TJJ	DATE: 11-14-14		
HTS PROJECT NO.: **14-S-404**		FIGURE: **2**	
Boring Locations			

APPENDIX A

Boring Logs

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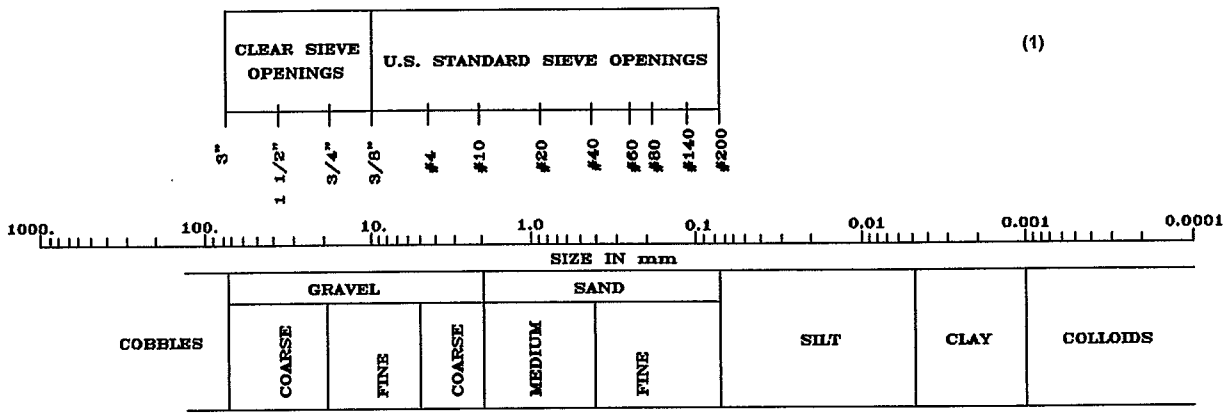
Consultants

DESCRIPTION OF BORING LOG TERMS



(1)

U S C S CLASSIFICATION FOR SOILS

BORING LOG LEGEND

- Core
- Penetration Sample
- No Recovery
- J - Jar
- Groundwater Level Encountered During Drilling
- Static Water Level

SPLIT-SPOON SAMPLER DRIVING RECORD

Blows Per Foot	Description
8-10-12	Number of blows for each six inch increment of split spoon penetration
50/5"	Number of blows of split spoon penetration for the indicated depth of penetration in inches.

STRENGTH OF COHESIVE SOILS (2)

Consistency	Undrained Shear Strength, Tons per Sq. Ft.	Unconfined Compressive Strength, Tons Per Sq. Ft. (Pocket Penetrometer)
Very Soft	0.12	Less than 0.25
Soft	0.12 to 0.25	0.25 to 0.50
Firm	0.25 to 0.50	0.50 to 1.0
Stiff	0.50 to 1.0	1.0 to 2.0
Very Stiff	1.0 to 2.0	2.0 to 4.0
Hard	Greater than 2.0	Greater than 4.0

DENSITY OF GRANULAR SOILS (2)

Blows Per Foot	Descripive Term	Relative Density %
0 - 4	Very Loose	Less than 20
5 - 10	Loose	20 to 40
11 - 30	Medium Dense	40 to 60
31 - 50	Dense	60 to 80
Over 50	Very Dense	Greater than 80

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy. The degree of slickensidedness depends upon the spacing of slickensides and the ease of breaking along these planes.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt: usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of differernt soil types.
Interlayered	Soil sample composed of alternating layers if different soil types.
Intermixed	Soil sample composed of pockets of different soil types and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.

Notes:
The boring logs and related information depict subsurface conditions only at the specific locations and dates indicated. Soil conditions and water levels at other locations may differ from conditions occuring at these boring locations. Also the passage of time may result in a change in the conditions at these boring locations.

References:
(1) ASTM D 422
(2) Soil Mechanics in Engineering Practice, Terzaghi and Peck, 1967.

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LOG OF BORING

PROJECT: Proposed Residential Slab Design
Lake Creek Forest Section 1 (Block 5, Lot 35)

PROJECT LOCATION: Conroe, Texas

CLIENT: Partners in Building

BORING NO.: 1
BORING LOCATION: See Figure 2
BORING TYPE: Auger

HTS PROJECT NO.: 14-S-404
DATE: October 30, 2014

Depth (ft.)	Sample Type	Sample No.	Penetrometer Reading (tsf)	SPT Blows Per Foot	Description of Stratum
1	J	1			Light gray SANDY SILTY CLAY (CL-ML), w/ roots
2					2'
3		2	4.5		Tan and light gray LEAN CLAY WITH SAND (CL), hard w/ sand fissures
4					
5	J	3			
6					6'
7	J	4			Tan and light gray SANDY LEAN CLAY (CL), w/ sand fissures
8					8'
9	J	5			Tan and light gray CLAYEY SAND (SC), loose
10					
11		6	1.0		
12					
13					
14		7	0.75		
15					15'
16		8	3.75		Tan and light gray FAT CLAY WITH SAND (CH), very stiff w/ sand seams
17					
18					- w/ sand fissures at 18'
19		9	4.0		
20					20'
					Boring terminated at 20'

Groundwater was not encountered during drilling. After drilling was completed, the boring was dry and open to a depth of 19.4'.

HTS, INC. Consultants

LOG OF BORING

PROJECT: Proposed Residential Slab Design
Lake Creek Forest Section 1 (Block 5, Lot 35)

PROJECT LOCATION: Conroe, Texas

CLIENT: Partners in Building

BORING NO.: 2
BORING LOCATION: See Figure 2
BORING TYPE: Auger

HTS PROJECT NO.: 14-S-404
DATE: October 30, 2014

Depth (ft.)	Sample Type	Sample No.	Penetrometer Reading (tsf)	SPT Blows Per Foot	Description of Stratum
1	J	1			Light gray SANDY SILTY CLAY (CL-ML), w/ roots
2					2'
3		2	4.5		Tan and light gray SANDY LEAN CLAY (CL), hard w/ sand fissures and ferrous nodules
4					
5		3	4.5		
6					
7		4	4.5		
8					
9		5	4.5		
10					10'
11		6	0.75		Tan and light gray CLAYEY SAND (SC), very loose to loose
12					
13					
14		7	0.25		
15					15'

Boring terminated at 15'

Groundwater was not encountered during drilling. After drilling was completed, the boring was dry and open to a depth of 14.4'.

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