GEOTECHNICAL INVESTIGATION
Proposed Residence
Lot between 502 & 510 Woodbend Lane
Houston, Texas

Reported to:
Opsis, Inc.
Houston, Texas

Prepared by:
Geoscience Engineering
and Testing, Inc.
Houston, Texas

PROJECT NO: 13G21683

August 2013

GEOSCIENCE
ENGINEERING & TESTING, INC.

405 E. 20th Street
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HOUSTON DALLAS SAN ANTONIO NEW ORLEANS

August 02, 2013

Opsis, Inc.
4900 Woodway Drive, Suite 1100
Houston, Texas 77056

Attention: Mr. Marko Dasigenis

Reference: Geotechnical Investigation
Proposed Residence
Lot between 502 & 510 Woodbend Lane
Houston, Texas
GETI NO: 13G21683

Dear Mr. Dasigenis:

GEOSCIENCE ENGINEERING & TESTING, INC. is pleased to submit this report for the above referenced project. This study was authorized by you on July 15, 2013. This report briefly describes the procedures employed in our investigation and presents the conclusions and recommendations of our studies.

We appreciate the opportunity to work with you on this phase of the project. If you have any question concerning this report or require additional information, please contact us.

With Kindest Regards,

Salar Samsami, MSAE
Project Manager

8-6-2013

STATE OF TEXAS
RONALD L. DILLY
111371
LICENSED
PROFESSIONAL ENGINEER

Ronald L. Dilly, Ph.D., P.E.
Principal Engineer

F-4802

Copies Submitted: (1)

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HOUSTON DALLAS SAN ANTONIO NEW ORLEANS

October 4, 2013

Opsis, Inc.
4900 Woodway Drive, Suite 1100
Houston, Texas 77056

Attention: Mr. Marko Dasigenis

Reference: Geotechnical Investigation
Proposed Residence
Lot between 502 & 510 Woodbend Lane
Houston, Texas
GETI NO: 13G21683/A

Dear Mr. Dasigenis:

GEOSCIENCE ENGINEERING & TESTING, INC. (GETI) is pleased to submit this supplemental report for the above referenced project. This supplemental report provides recommendations for using a straight shaft pier footing bearing at a depth of seventeen to eighteen (17-18) feet in-lieu-of the eleven to twelve (11-12) feet that appeared in GETI Project Report NO: 13G21683. With this change, the bearing capacity has been re-evaluated and revised.

The estimated allowable end bearing capacity for the revised depth is defined as 4000 psf using a factor of safety defined as 2.0. This capacity is a function of the estimated standard penetration blow count (in this case defined as 7).

The estimated allowable skin friction to resist load is defined as, $f_{s,\ allowable}$, with the following expression that incorporates a factor of safety defined as 2.0.

$$f_{s,\ allowable} = -0.1214\ z^2 + 14.768\ z + 3.8754,\ \text{psf}$$

where z is the bearing depth below the surface, ft.

The above expression is based on an equation reported by McCarthy[1] where $f_{s,\ allowable}$ is a function of the estimated effective unit weight of overburden material (in this case defined as 100 pcf), the estimated standard penetration blow count (in this case defined as 7), and the bearing depth, z, ft. At 18 feet, $f_{s,\ allowable} = 230$ psf, and the allowable capacity due to skin friction only is 3,251 lbs for a shaft with a 1.00 ft diameter.

We appreciate the opportunity to work with you on this phase of the project. If you have any question concerning this report or require additional information, please contact us.

With Kindest Regards,

Ronald L. Dilly, Ph.D., P.E.
Principal Engineer

I. INTRODUCTION

Geoscience Engineering and Testing, Inc. (GETI) hereby submits this report of geotechnical investigation of subsurface conditions at the site of the proposed Residence located on the lot between 502 & 510 Woodbend Lane in Houston, Texas. GETI's investigation was authorized by Mr. Marko Dasigenis with Opsis, Inc. on July 15, 2013.

The purpose of the geotechnical investigation was to determine the subsurface soil conditions at the site of the proposed Residence with particular reference to the recommendations for the design of the foundation for the structure.

II. SUBSURFACE EXPLORATION

1. General

This report presents the results of our soil exploration and foundation analysis for the proposed Residence located on the lot between 502 & 510 Woodbend Lane in Houston, Texas.

Scope of this investigation included a reconnaissance of the immediate site, the subsurface exploration, field and laboratory testing, an engineering analysis and evaluation of the subsurface materials. The purpose of this subsurface exploration and analysis was to determine soil profile components, the engineering characteristics of the subsurface materials and to provide criteria for use by design engineers and architects in preparing the foundation design.

The exploration and analysis of the subsurface conditions reported herein are considered in sufficient detail and scope to form a reasonable basis for the recommendations. The recommendations submitted are based on the available soil information and the preliminary design details furnished by Mr. Marko Dasigenis with Opsis, Inc. Any revision in plans for the proposed Residence from those enumerated in this report should be brought to the attention of the soil engineer, so that he may determine, if changes in the recommendations are required. If deviations from the noted subsurface conditions are encountered during construction, they should also be brought to the attention of the soil engineer.

2. Description of the Site

The site of the proposed Residence, upon which this subsurface exploration has been made, is located on the lot between 502 & 510 Woodbend Lane in Houston, Texas. The site soil is relatively gently sloping and cleared. The surface soils were possible fill material (sandy clay) and silty clayey sand at the time of drilling operation.

3. Field Investigation

The field investigation, which was completed on July 29, 2013, was to determine the engineering characteristics of the subsurface materials included a reconnaissance of the project site, drilling the exploratory borings and recovering the representative soil samples.

The subsurface soil conditions were explored by advancing and sampling three (3) soil borings. The soil borings B-1 and B-2 were drilled to a depth of forty (40) feet, and B-3 was drilled to a depth of twenty (20) feet below the existing ground surface. The approximate soil boring locations are shown on the attached soil Boring Plan, Plate No. 1.

Sample depth and description of soil classification (based on the Unified Soil Classification System) are presented on the Soil Boring Logs, Plate Nos. 2 through 4. Keys to terms and symbols used on the soil boring logs are shown on Plate No. 5. Photographs appear on Plate No. 6.

The soil borings were of three-inch nominal diameter. Both relatively undisturbed and disturbed soil samples were obtained at two (2) feet intervals continuously to a depth of ten (10) feet and at five (5) feet intervals thereafter. The soil borings were performed with a drilling rig equipped with rotary head conventional solid-stem augers were used to advance the holes. Representative disturbed or undisturbed soil samples were obtained employing thin-walled sampling procedures in accordance with ASTM D-1587. The obtained soil samples were extruded from the tube and visually classified in the field. Soil samples were identified according to the boring number and depth and wrapped in aluminum foil and polyethylene plastic wrapping bags to prevent moisture loss and disturbance. All of the samples were transported to our geotechnical laboratory for examination, testing and analysis. All borings were backfilled after final water readings were obtained with the soil cuttings accumulated during the drilling operation unless noted otherwise on the soil boring logs.

3.1 Field Strength Tests

During the field boring operation, samples of the cohesive soil from the thin-walled tube were frequently tested in compression by use of a calibrated soil penetrometer to aid in determining the strength of the soil.

3.2 Water Level Measurement

The information in this report summarizes condition as found on the date the borings were drilled. Groundwater was encountered at a depth of twenty (20) feet from existing ground surface in soil borings B-1, B-2 and B-3 during the drilling operation. Long-term monitoring of the groundwater level was beyond the scope of this study. It should be noted that the groundwater table may be expected to fluctuate with environmental variations such as frequency and magnitude of rainfall and the time of the year when construction begins.

4. Surface Fault

A surface fault investigation is beyond the scope of this investigation. It should be noted that the coastal plains in this region has a complex geology, which included active surface faulting.

5. Laboratory Testing

In addition to the field investigation, a supplemental laboratory investigation was conducted to ascertain additional pertinent engineering characteristics of the subsurface materials necessary in analyzing their behavior under the proposed loading conditions. During the laboratory investigation all field soil samples from the boring were examined and classified by a soil engineer. Laboratory tests were then performed on selected soil samples in order to evaluate and determine the physical and engineering properties of the soils in accordance with the prescribed ASTM standards and methods. The following laboratory tests were performed:

LABORATORY TEST	TEST STANDARD
Moisture Content of Soils	ASTM D 2216
Moisture Content and In Situ Dry Density of Soils	ASTM D 2937
Unconfined Compressive Strength of Cohesive Soils	ASTM D 2166
Liquid Limit, Plastic Limit, and Plasticity Index of Soils	ASTM D 4318

Strength properties of the soils were determined by means of unconfined compression tests performed on undisturbed samples. The type and number of the laboratory tests performed for this investigation are:

DESCRIPTIONS	No. of Test	DESCRIPTIONS	No. of Test
Hand Penetrometer Test	21	Dry Density Test	2
Moisture Content Test	29	Unconfined Compressive Test	2
Atterberg Limits	12		

The tests noted above were performed to establish the index properties and to aid in the proper classification of the subsurface soils. The test results are shown on the soil boring logs and are presented on Plate Nos. 2 through 4.

III. GENERAL DESCRIPTION OF SUBSURFACE MATERIALS

The specific subsurface stratigraphy as determined by the field exploration is shown in detail on the soil boring logs herein. However, the stratigraphy can be generalized as follow:

STRATUM NUMBER	RANGE OF DEPTH, Ft.	SOIL DESCRIPTION
I	0' – 2'	Possible fill: very stiff to hard, dark gray SANDY CLAY with roots (except in soil boring B-1)
II	0' – 8'	Light brown SILTY CLAYEY SAND (SC-SM)* (encountered only in soil boring B-1)
III	2' – 4'	Dark gray SILTY CLAYEY SAND (SC-SM)* (encountered only in soil boring B-2)
IV	2' – 15'	Very stiff to hard, gray, light gray and light brown CLAYEY SAND and SANDY CLAY (SC*-CL*)
V	8' – 35'	Gray and light brown SILTY CLAYEY SAND and CLAYEY SAND (SC-SM)*(SC)*(encountered only in soil boring B-1)
VI	15' – 35'	Reddish brown and light gray SANDY CLAY (CL)* (except in soil boring B-1)
VII	35' – 40'	Reddish brown CLAY (CH)

*Classification is in accordance with the Unified Soil Classification System

Laboratory tests results for the soils indicate that the Liquid Limits are ranging from 16 to 49, the Plasticity Indices (P.I.) ranging from 4 to 30, and moistures contents from 3 to 32 percent.

Swell Potential
Based on plasticity index results, fill materials (sandy clay), silty clayey sand, clayey sand and sandy clay subsoil are characterized as having a low to high shrink/swell potential.

When the moisture content of these type soils increases, the volume increases; conversely, when the moisture content of these type soils decreases, the soil volume decreases. The volume changes can result in foundation movement and stresses.

IV. FOUNDATION RECOMMENDATION

1. Foundations and Risks

Many lightly loaded foundations are designed and constructed on the basis of economics, risks, soil type, foundation shape and structural loading. Many times, due to economic considerations, higher risks are accepted in foundation design. It should be noted that some levels of risk are associated with all types of foundations. All of these foundations must be stiffened in the areas where expansive soils are present and trees should be removed prior to construction.

2. Foundation Discussion

In general, the foundation for the structures must satisfy two independent criteria. First, the maximum design pressure exerted at foundation levels should not exceed the allowable net bearing pressure based on an adequate factor of safety with respect to soil shear strength. Second, the magnitude of total and differential settlements or heave under sustained foundation loads must be such that the structure movement is within tolerable limits.

Various types of foundation such as Slab-on-Grade, Spread Footings, Underreamed Drilled (Belled) Footings, Straight Shaft Footings etc. have been discussed for the support of the proposed structure. Based on the field investigation and laboratory test results, the soils are silty clayey sand, clayey sand and sandy clay having a low to high shrink/swell potential. Details of soil strata are given in soil boring logs, Plate Nos. 2 through 4. In our opinion, for this type of soil strata both Straight Shaft Footings and Post-tensioned slab are considered suitable foundation systems. Details are given in the following sections.

2.1 Straight Shaft Footings

Based on the soil condition revealed by the field soil borings, laboratory tests and encountered sand materials, it is our understanding that the structure at this site can be supported on a foundation system comprised of Straight Shaft Footings bearing at a depth of eleven to twelve (11-12) feet below existing grade on the layer of very stiff to hard gray, light gray and light brown clayey sand and sandy clay, also gray and light brown silty clayey sand and clayey sand. The footing may be sized for a net allowable bearing pressure of 2,500 psf for dead load plus sustained live load. The bearing pressure contains a factor of safety of 2 and be increased 25 percent for total load conditions, whichever is critical. Spacing between the centers of the two adjacent footings should be at least 3 times of the diameter of the shaft. (The piers should bear on soil at the same elevation.)

Caving of soils around the footings may occur during construction of the drilled piers due to the presence of sands. The bottom of the piers should be dry and clean. If water encounters during installation, it should be pumped out prior to concrete placement. We recommend that the drilling be performed under the supervision of a qualified representative of the Geotechnical Engineer.

If the soil conditions warrant the changing of the shaft diameter, the structural engineer of record should be informed about any changes, because they may require a change in reinforcing steel. The concrete should be placed in a timely manner after drilling to minimize the potential for caving of the foundation soils.

No footing should be poured, without the prior approval of the project engineer, architect or owner's representative. Since the exact locations of the footings are not known at this time, a detailed settlement analysis was not authorized, nor performed. It is anticipated that the footing designed using the recommended allowable bearing capacity will experience small settlement that will be within the tolerable limits for the proposed structure.

The bottom of the shaft should be dry and clean. If water encounters during installation, it should be pumped out prior to concrete placement. We recommend that the drilling be performed under the supervision of a Geotechnical Engineer.

Floor Slab Options
There may be two options for floor slab:

a) Slab supported by piers only: In this option slab is supported by only grade beams, which are supported by piers. In this case loads are applied on only piers. Slab should be raised from the ground surface by at least six (6) inches to avoid the vertical displacement of the slab. The slab should be tied and stiffened with grade beams. The grade beams should have six (6) inches void boxes beneath them. Details for void boxes are given below in the section "Void Boxes".

b) Slab supported by grade beams and sub-grade: Another option is that the slab may be supported by the grade beams and the sub-grade (soil beneath the slab). For this option the surficial soil containing roots, organic and unsuitable materials should be stripped off and replaced by twenty four (24) inches of Structural select fill materials having a liquid limit less than 35 and a plasticity index (P.I.) between 10 and 20 to minimize any possibility of vertical displacement. The structural select fill materials should be filled according to the procedures prescribed in the section "Structural Fill and Subgrade Preparation".

Void Boxes
A void/crawl space of six (6) inches may be provided beneath the grade beams. This void space allows for movement of the expansive soils below the grade beams without distressing the structural system. Structural cardboard void forms are often used to provide this void space.

Void Boxes are typically placed under the grade beams to provide this void space, and act as a barrier separating the grade beams from the expansive soils. The purpose for using the void boxes is when the underlying expansive soils swell, the void boxes will then collapse, thus minimizing the uplift loads caused from the expansive soils on the grade beams.

These voids may act as a channel for water to travel under a foundation system with poor area drainage, however, if this condition occurs, it may result in the subsequent swelling of the soils and an increase in subsoil moisture loads on the floor slabs. It is our opinion that the determination whether or not to provide voids under the grade beams be made by the owner, builder, engineer or architect after both the positive and negative aspects are evaluated. Geoscience Engineering & Testing, Inc. from our experience with these voids, as well as the experiences of other experts, brings us to the conclusion that even though they may be effective in reducing swell pressures on the grade beams, they may provide free water which would be available for absorption by slab support soils.

2.2 Post-Tension Slab Design Parameters

Based on the soil conditions revealed by the field soil test borings and referring the guide from "Design and Construction of Post-Tensioned Slabs on Ground", published by Post-Tensioning Institute (PTI), the structure can be supported on a foundation system comprised of post-tensioned slab. The "VOLFLO" computer program was used to estimate swell/shrinkage. The soil parameters to be utilized for design are as follows with respective PI values input for each defined depth:

POST-TENSION PARAMETERS (Post-Tensioning Institute Third Edition with 2008 Supplement Design)		
Minimum Grade Beam Depth:(Below Final Soil Grade)	24 Inches	Edge Moisture Variation Distance: Center Lift: 8.5 ft. Edge Lift: 4.8 ft.
Minimum Grade Beam Width:	12 Inches	
Plasticity Index (PI):	Depth 0-2', PI=28 Depth 2-10',PI=23	Differential Swell/shrinkage Center Lift: 1.14 inch Edge Lift: 1.23 inch
Depth to Constant Soil Suction:	Approx. 9-ft	
Principal Clay Mineral:	Montmorillonite	Allowable bearing capacity: Dead Load: 900 psf Total Load: 1,350 psf
Constant Suction Value:	pF = 3.6	
Thornthwaite Moisture Index:	18	Slab subgrade coefficient Slab-on-sand bedding: 1.00 Slab-on-polyethylene over sand: 0.75
Estimated Total Settlement:	Less than 1-in.	
Estimated Moisture Velocity:	0.7 in/month	

(Note: If the perimeter grade beams extend into the soil to provide an effective 30-inch vertical barrier to moisture movement, center and edge lift associated with differential shrinkage/swell become 1.07 and 1.15 inches, respectively.)

The PTI and BRAB design parameters, presented above, are based upon our interpretation of the on-site soil conditions found at the time of our field investigation and the empirical data presented in the BRAB and design manual.

Due to the presence of expansive soil at the site, we recommend the floating slabs can be stiffened such that minimum differential movements occur once a portion of the slab is lifted by expansive soils. The PTI differential soil movements estimates do not account for site preparation and vegetative influences, such as prior trees and residential landscaping, which can greatly influence foundation performance. The actual performance of slab-on-grade foundations will largely depend on actual soil moisture conditions, construction techniques, site preparation and landscaping. The construction of post-tensioned slabs requires close attention to detail during construction.

The surficial soil containing roots, organic and unsuitable materials should be removed and replaced with structural select fill and compacted as per recommendations for select fill. A bedding layer of leveling sand, two (2) inches thick should be placed immediately beneath the floor slab. A vapor barrier consisting of six mil plastic sheeting should be placed over the sand cushion to prevent water migration through the concrete slab. The excavations for the grade beams should be clean and free of any loose materials prior to concrete placement.

Information was not available on whether fill will be used to raise site grade prior to foundation construction. In the event fill is placed on the site, specifications should require a uniform thickness throughout the slab area and placement in accordance with our recommendations given in the section "Structural Fill and Subgrade Preparation". Lack of proper consideration of these factors will result in additional stresses and inferior slab performance.

In general, site preparation should consist of removing any existing foundations, paved areas and undesirable materials. The exposed subgrade should be proof-rolled to detect local weak areas which should be excavated, processed, and recompacted in loose lifts of approximately eight-inch thickness.

V. GENERAL CONSTRUCTION CONSIDERATIONS

1. Site Preparation

Our recommendations for site preparations in the floor slab are summarized below:

1.1 In general, remove all vegetation, tree roots, organic topsoil and any undesirable materials from the construction area. Tree trunks and roots under the floor slabs should be removed to a root size of less than 0.5-inch. We recommend that the stripping depth be evaluated at the time of construction by a soil technician.

1.2 Any on-site fill soils, encountered in the structure areas during construction, must have records of successful compaction tests signed by a registered professional engineer that confirms the use of the fill and record of construction and earthwork testing. These tests must have been performed on all the lifts for the entire thickness of the fill. In the event that no compaction test results are available, the fill soil must be removed, processed and re-compacted in accordance with our recommendations of “Structural Fill and Subgrade Preparation”. Excavation should extend at least two feet beyond the structure area. Alternatively, the existing fill soils should be tested comprehensively to evaluate the degree of compaction in the fill soils.

1.3 The subgrade areas should then be proof-rolled with a 15-ton roller, or other equivalent suitable equipment as approved by the engineer. The proof-rolling serves to compact surficial soils and to detect any soft or loose zones. Any soils deflecting excessively under moving loads should be undercut to firm soils and re-compacted. The proof-rolling operations should be observed by an experienced geotechnician.

1.4 In the areas where expansive soils are present, rough grade the site with structural fill soils to insure positive drainage. Due to their high permeability of sands, sands should not be used for site grading where expansive soils are present.

1.5 We recommend that the site and soil conditions used in the structural design of the foundation be verified by the engineer's site visit after all of the earthwork and site preparation has been completed prior to the concrete placement.

2. Structural Fill and Subgrade Preparation

It is recommended that the subgrade and fill be prepared as follow:

2.1 The site should be stripped to suitable depth to remove any top soil and miscellaneous fill material. The exposed subgrade surface then should be proof-rolled. All soft or loose soils should be removed and replaced with select fill materials.

2.2 The natural subgrade should be scarified to a minimum depth of six (6) inches. The scarified soils should then be recompacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor Density Test (ASTM-D 698). The moisture content should range -1% to +3% of optimum moisture.

2.3 Structural Select fill used to elevate the grade should consist of a clean Sandy Clay with Liquid Limit less than 35 and a Plasticity Index (P.I.) between 10 and 20.

2.4 The Structural Select fill material should be placed in maximum of eight (8) inch loose lift and compacted to a minimum of 95 percent of the maximum dry density as per ASTM D-698. The moisture content should be with -1% to +3% of optimum moisture.

2.5 A bedding layer of leveling sand, a maximum of two (2) inches thick may be placed immediately beneath the floor slab. A vapor barrier consisting of six (6) mil plastic sheeting should be placed over the sand cushion to prevent water migration through the concrete slab. The excavations for the grade beams should be clear and free of any loose materials prior to concrete placement.

2.6 In cut areas, the soils should be excavated to grade and the surface soils proofrolled and scarified to a minimum depth of six inches and recompacted to the previously mentioned density tests at the time of construction.

2.7 The select fill soil extending from the building towards the building line should be capped with on-site high plastic clay soils in order to retard any water seepage into subgrade soils.

3. Surface Drainage

It is recommended that the site drainage be well developed. Surface water should be directed away from the foundation soils (use a minimum of 2% with 10 feet away of foundation). No ponding of surface water should be allowed near the structure. The following drainage precaution should be observed during construction and at all times after the structure has been completed.

1) Backfill around the structure should be a cohesive soil material which should be moistened and compacted to at least ninety (90) percent of standard proctor density. Any cohesionless soil material accumulated around the perimeter of the structure during construction should be removed and not allowed to be mixed with or covered by the backfill material.

2) Where landscaping is to be installed next to the perimeter of grade beam, a moisture barrier or other suitable means should be installed to prevent moisture from entering the underlying clay soils.

3) Roof downspouts and drains should discharge well away from the limits of the foundation or grade beams.

4. Vegetation Control

We recommend trees not to be closer than half the canopy diameter of the mature tree from the grade beams, typically a minimum of 20 feet. This will minimize possible foundation settlement caused by the tree root systems.

VI. DISCLAIMER

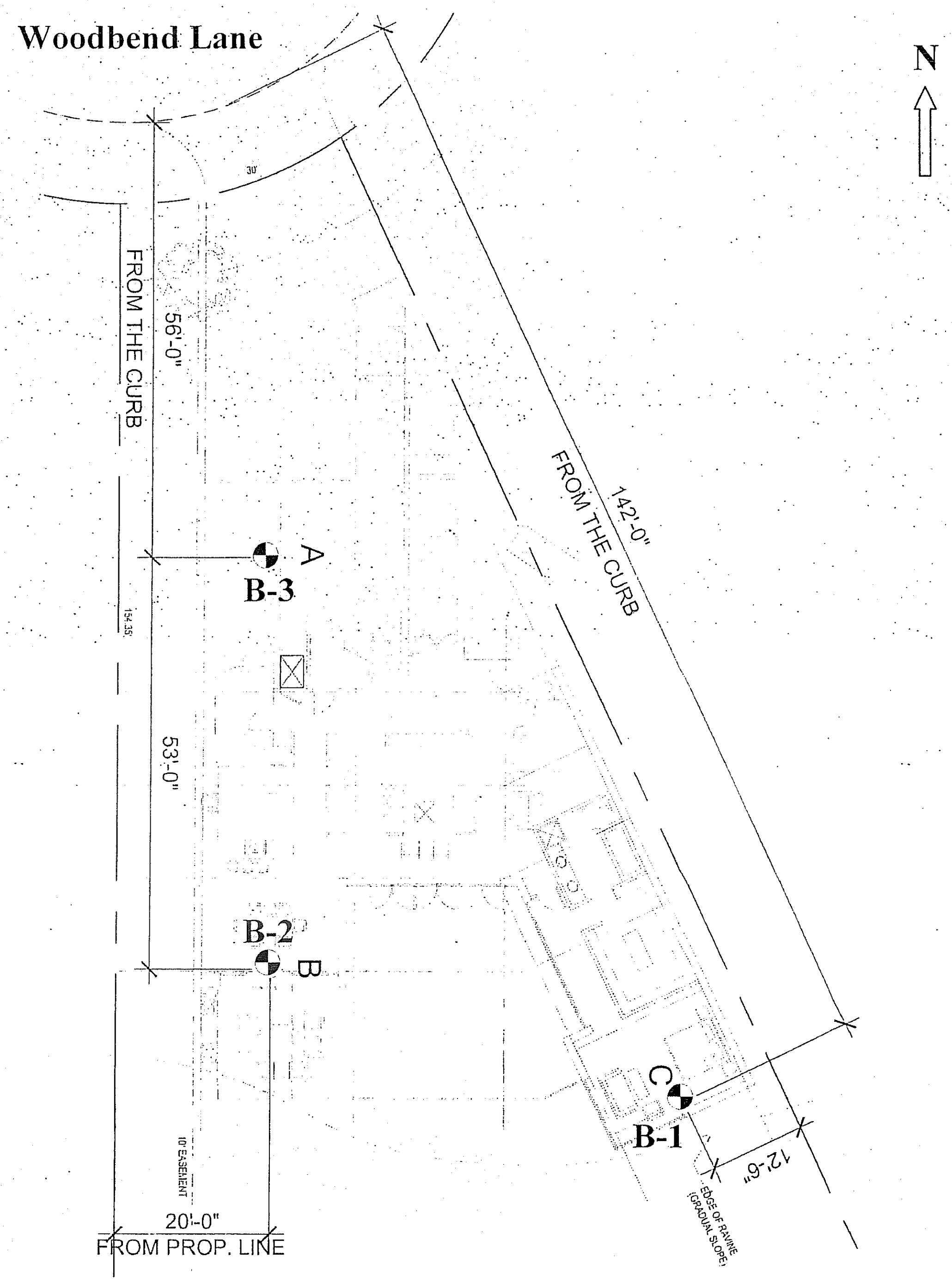
The information and recommendation contained in the report summarized condition found at the site of the proposed Residence located on the lot between 502 & 510 Woodbend Lane in Houston, Texas specified and on the date the field exploration was completed. The attached soil boring logs are a true representation of the soils encountered at the stratigraphy as found during the field exploration and drilling of the subject site.

Reasonable variations from the subsurface information presented in this report are assumed. If condition encountered during construction are significantly different than those presented in this report, GETI should be notified immediately.

The report was prepared for the sole and exclusive use by our client, based on specific and limited objectives. All reports, boring logs, field data, laboratory test results, and other documents prepared by GETI as instruments of service shall remain the property of GETI. Reuse of these documents is not permitted without written approval by GETI. GETI assumes no responsibility or obligation for the unauthorized use of this report by other parties and for purposes beyond the stated project objectives and work limitations.

In addition, the construction process may itself alter site soil conditions. Therefore, experienced geotechnical personnel should observe and document the construction procedures and all conditions encountered. We recommend that the owner retain Geoscience Engineering and Testing, Inc. to provide this service as well as the construction material and testing and inspection required during the construction phase of the project. We would welcome the opportunity to discuss our recommendation with you and hope we may have the opportunity to provide any additional studies or service to complete this project. The following illustrations are attached and complete this report:

ILLUSTRATIONS	PLATE NUMBERS
Boring Location Plan	1
Boring Logs	2-4
Symbols and Terms used on Boring Logs	5
Site Pictures	6



Approximate Boring Locations

LOCATION

Proposed Residence
Lot between 502 & 510
Woodbend ~~Land~~ Lane
Houston, Texas
GETI NO.: 13G21683

NOT TO SCALE

PLATE NO. 1

PROJECT: Proposed Residence Lot between 502 & 510 Woodbend Lane Houston, Texas	BORING NO.: B-1	DEPTH: (0' - 30')/40'
CLIENT: Opsis, Inc. Houston, Texas	PROJECT NO: 13G21683	DATE: July 29, 2013
	Water was encountered **during drilling operation** ▽	

DRILLING METHOD (S)

Continuous Flight Auger & Intermittent Sampling

Legend: Clay, Sandy Clay, Silty Sand, Fill, Clayey Sand, Silty Clayey Sand

DEPTH (FEET)	SOIL SYMBOL	SAMPLES	N: BLOWS/FT, T: INCHES/100 BLOWS, P: TONS/SQ FT, RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	DESCRIPTION OF STRATUM
			B	3		16	12	4			Light brown SILTY CLAYEY SAND (SC-SM)
			B	4							
5			B	5							
			P=3.5	4		19	14	5			-very stiff from 6' to 8'
			B	14							Gray and light brown SILTY CLAYEY SAND and CLAYEY SAND (SC-SM) (SC)
10											
			P=0.25	19		20	14	6			-soft from 13' to 15'
15											
			P=0.25	21						▽	-soft from 18' to 20'
20											-free water at 20'
			B	29		22	14	8			
25											
			B	28							
30											

Continued on Plate No. 2 B

N- STANDARD PENETRATION TEST RESISTANCE
T- TXDOT CONE PENETRATION RESISTANCE
P- POCKET PENETROMETER RESISTANCE
R- PERCENTAGE OF ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

GEOSCIENCE ENGINEERING & TESTING, INC

PROJECT: Proposed Residence Lot between 502 & 510 Woodbend Lane Houston, Texas	BORING NO.: **B-1** DEPTH: **(30' - 40')/40'** (Continued from Plate 2A) PROJECT NO: 13G21683 DATE: July 29, 2013
CLIENT: Opsis, Inc. Houston, Texas	Water was encountered **during drilling operation**

DRILLING METHOD (S): **Continuous Flight Auger & Intermittent Sampling**

Legend

Clay, Sandy Clay, Silty Sand, Fill, Clayey Sand, Silty Clayey Sand

DEPTH (FEET)	SOIL SYMBOL	SAMPLES	N: BLOWS/FT / T: INCHES/100 BLOWS / P: TONS/SQ FT. / RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	DESCRIPTION OF STRATUM
30–35	Silty Clayey Sand	Sample	P=1.25	32							Gray and light brown SILTY CLAYEY SAND and CLAYEY SAND (SC-SM) (SC) -stiff from 33' to 35'
35–40	Clay	Sample	B	29							Reddish brown CLAY (CH)
40–60											

N- STANDARD PENETRATION TEST RESISTANCE
T- TXDOT CONE PENETRATION RESISTANCE
P- POCKET PENETROMETER RESISTANCE
R- PERCENTAGE OF ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

GEOSCIENCE ENGINEERING & TESTING, INC

PROJECT:	**Proposed Residence** Lot between 502 & 510 Woodbend Lane Houston, Texas	BORING NO.: **B-2**	DEPTH: **(0' - 30')/40'**
CLIENT:	**Opsis, Inc.** Houston, Texas	PROJECT NO. 13G21683	DATE: July 29, 2013

Water was encountered **during drilling operation** ▼

DRILLING METHOD (S)

Continuous Flight Auger & Intermittent Sampling

Legend

Clay, Sandy Clay, Silty Sand, Fill, Clayey Sand, Silty Clayey Sand

DEPTH (FEET)	SAMPLES	N: BLOWS/FT / T: INCHES/100 BLOWS / P: TONS/SQ FT / RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	DESCRIPTION OF STRATUM
0-2		P=4.0+	11		44	18	26			Possible fill: very stiff to hard, dark gray SANDY CLAY with roots
2-4		B	5		20	14	6			Dark gray SILTY CLAYEY SAND (SC-SM)
4-6		P=4.0+	10							Very stiff to hard, gray, light gray and light brown CLAYEY SAND and SANDY CLAY (SC-CL)
6-8		P=4.0+	11							
8-10		P=4.0+	11		25	15	10			
13-15		P=4.0+	12		36	17	19			
15										Very stiff, reddish brown and light gray SANDY CLAY (CL)
18-20		P=3.5	17	111	44	17	27	▼	1.50	
20										-free water at 20'
23-25		P=2.5	18	113					1.45	
28-30		P=0.25	22							-soft from 28' to 30'

Continued on Plate No. 3 B

N- STANDARD PENETRATION TEST RESISTANCE T- TXDOT CONE PENETRATION RESISTANCE P- POCKET PENETROMETER RESISTANCE R- PERCENTAGE OF ROCK CORE RECOVERY RQD - ROCK QUALITY DESIGNATION	**GEOSCIENCE ENGINEERING & TESTING, INC**	**PLATE NO. 3 A**

PROJECT:	Proposed Residence Lot between 502 & 510 Woodbend Lane Houston, Texas	BORING NO.: **B-2** (Continued from Plate 3A)	DEPTH: **(30' - 40')/40'**
CLIENT:	**Opsis, Inc.** Houston, Texas	PROJECT NO. 13G21683	DATE: July 29, 2013
		Water was encountered **during drilling operation** ▼	

DRILLING METHOD (S): **Continuous Flight Auger & Intermittent Sampling**

Legend: Clay, Sandy Clay, Silty Sand, Fill, Clayey Sand, Silty Clayey Sand

DEPTH (FEET)	SOIL SYMBOL	SAMPLES	N: BLOWS/FT / T: INCHES/100 BLOWS / P: TONS/SQ FT / RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	DESCRIPTION OF STRATUM
30–35	Sandy Clay		P=0.25	25							Reddish brown and light gray SANDY CLAY (CL) -soft from 33' to 35'
35–40	Clay		P=0.75	30							Reddish brown CLAY (CH) -firm from 38' to 40'
45											
50											
55											
60											

N- STANDARD PENETRATION TEST RESISTANCE
T- TXDOT CONE PENETRATION RESISTANCE
P- POCKET PENETROMETER RESISTANCE
R- PERCENTAGE OF ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

GEOSCIENCE ENGINEERING & TESTING, INC

PROJECT:	**Proposed Residence** Lot between 502 & 510 Woodbend Lane Houston, Texas	BORING NO.: **B-3**	DEPTH: **20'**
		PROJECT NO: 13G21683	DATE: July 29, 2013
CLIENT:	**Opsis, Inc.** Houston, Texas	Water was encountered **during drilling operation** ▼	

DRILLING METHOD (S): **Continuous Flight Auger & Intermittent Sampling**

Legend: Clay, Sandy Clay, Silty Sand, Fill, Clayey Sand, Silty Clayey Sand

FIELD DATA / LABORATORY DATA

DEPTH (FEET)	SOIL SYMBOL	SAMPLES	N: BLOWS/FT, T: INCHES/100 BLOWS, P: TONS/SQ.FT, RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LL (LIQUID LIMIT)	PL (PLASTIC LIMIT)	PI (PLASTICITY INDEX)	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	DESCRIPTION OF STRATUM
0–2	Fill	■	P=4.0+	13		49	19	30			Possible fill: very stiff to hard, dark gray SANDY CLAY with roots
2–15	Sandy Clay	■	P=4.0+	7							Very stiff to hard, gray, light gray and light brown SANDY CLAY (CL)
5		■	P=4.0+	10		40	17	23			
		■	P=4.0+	10							
		■	P=3.5	15							
10											
		■	P=3.75	13		34	16	18			
15–20	Sandy Clay										Reddish brown and light gray SANDY CLAY (CL)
		■	P=4.0	20						▼	-very stiff from 18' to 20' -free water at 20'
20											
25											
30											

N- STANDARD PENETRATION TEST RESISTANCE
T- TXDOT CONE PENETRATION RESISTANCE
P- POCKET PENETROMETER RESISTANCE
R- PERCENTAGE OF ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

GEOSCIENCE ENGINEERING & TESTING, INC

PLATE NO. 4

KEY TO SOIL CLASSIFICATIO AND SYMBOLS

Gravel (GW, GP, GM, GC)	Clayey Sand (SC)	Sandy Silt (ML)
Sand (SW, SP)	Clayey Silt (ML)	Silty or Sandy Clay (CL)
Silty Sand (SM)	Silt (ML)	Clay (CH)

CONSISTENCY OF COHESIVE SOILS

Description	Shear Strength KSF	Penetration Resistance Blows/ Ft
Very Soft	Less than 0.25	0 - 2
Soft	0.25 - 0.5	2 - 4
Firm	0.5 - 1.00	4 - 8
Stiff	1.00 - 2.00	8 - 15
VeryStiff	2.00 - 4.00	15 - 30
Hard	Greater than 4.00	>30

RELATIVE DENSITY OF COHESIONLESS SOILS

Description	Penetration Resistance Blows / Ft	Relative Density %
Very Loose	0 - 4	0 - 15
Loose	4 - 10	15 - 35
Medium dense	10 - 30	35 - 65
Dense	30 - 50	65 - 85
Very Dense	>50	85 - 100

Soil Structure

CALCAREOUS NODULES	-- Nodules of Calcium Carbonate
FERROUS NODULES	-- Nodules of Ferrous Material
SLICKENSIDED	-- Having inclined planes of weakness that are slick and glossy
BLOCKY	-- Having inclined planes of weakness that are frequent and rectangular in pattern
LAMINATED	-- Composed of thin layers of varying soil type and texture
FISSURERD	-- Containing shrinkage cracks frequently filled with fine sand
INTERBEDDED	-- Composed of alternate layers of different soil types

Shelby Tube Sample

Standard Penetration Test

Auger or Wash Sample

No Recovery

GROUNDWATER

(24 hOurs) - Water Level after drilling (time increment after drilling)

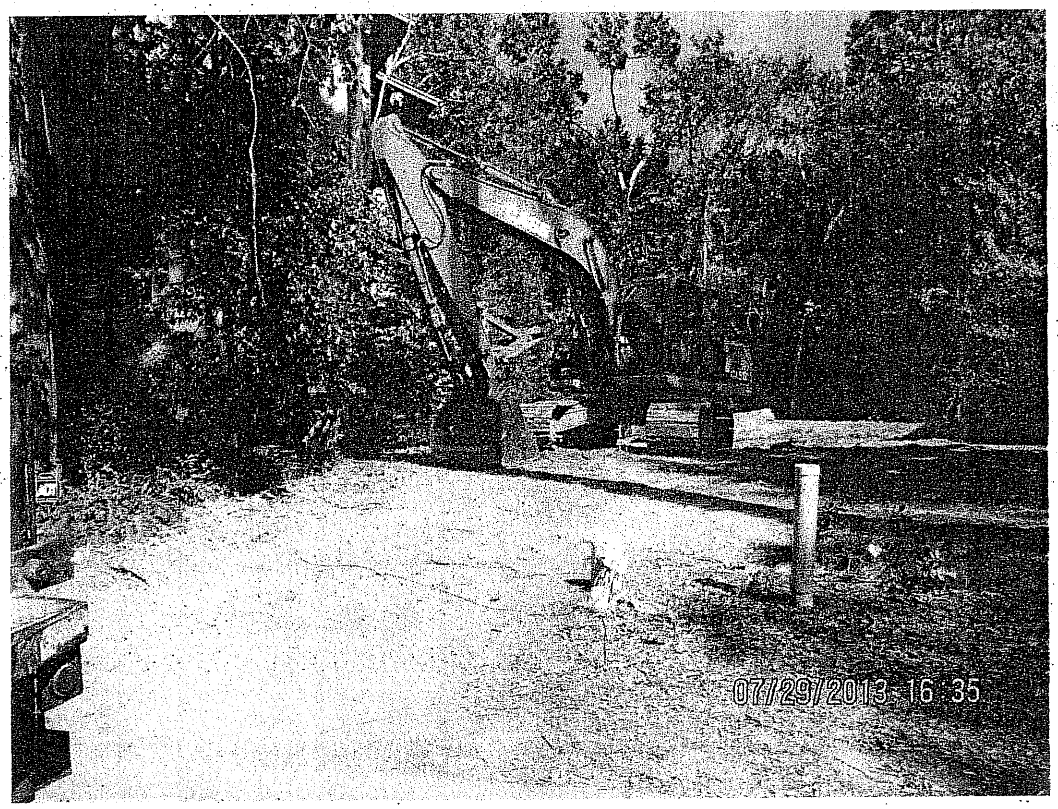
- Free Water observed during drilling

FAILURE DESCRIPTION (COMPRESSION TEST)

B - Bulge
S - Shear
M/S - Multiple Shear

SLS - Failure surface occuring along slickensided plane
SAS - Failure surface occuring along or in sand seam
SS - Failure surface occuring in or along other secondary structure such as calcareous pockets

PLATE NO: 5



Project No.: 13G21683
Plate No.: 6