Subsurface Exploration and Foundation Analysis
Proposed Brown and White Residence at
275 Granite Road
Lot 61, Block 22, Section 12
Texas Grand Ranch
Huntsville, Texas 77340

InTEC Project No: H22G0242
April 19, 2022

Marion Brown
2811 Hadley Springs Lane
Spring, Texas 77386

inTEC

Integrated Testing and Engineering Company of Houston

27523 Morton Road • Katy, Texas 77493 • (281) 371-3330 • fax (281) 371-3334

inTEC Integrated Testing and Engineering Company of Houston
Geotechnical & Environmental Engineering • Construction Services • Geologic Assessment

E.A. "Paul" Palaniappan, Ph.D., P.E.
Chockalingam "Chuck" Palaniappan
Jagtar Singh, M.S., P.E.

April 19, 2022

Marion Brown
2811 Hadley Springs Lane
Spring, Texas 77386

Attention: **Mr. Marion Brown**

RE: Subsurface Exploration and Foundation Analysis
Proposed Residence at
275 Granite Road
Lot 61, Block 22, Section 12
Texas Grand Ranch
Huntsville, Texas 77340

InTEC Project No: H22G0242

Gentlemen:

InTEC of Houston Metro Partnership, L.P. has completed a soil and foundation engineering report at the above referenced project site. The results of the exploration with recommendations are presented in this report.

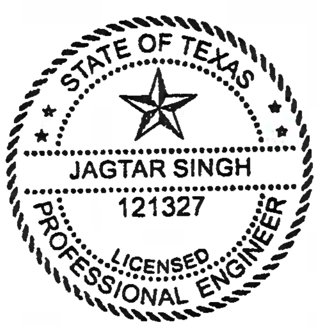
We appreciate and wish to thank you for the opportunity to be of service to you on this project. If we can be of additional assistance during the materials testing-quality control phase of construction, please call us.

Respectfully Submitted,

Very Truly Yours,
InTEC of Houston Metro Partnership, L.P.

Jagtar Singh

Jagtar Singh, M.S., P.E.
ENGINEER
ENGINEERING FIRM # 8726



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EXECUTIVE SUMMARY

The soil conditions at the location of the proposed residence at 275 Granite Road in Huntsville, Texas were explored by drilling 2 borings to depths of 15 and 20 feet. Laboratory tests were performed on selected specimens to evaluate the engineering characteristics of various soil strata encountered in the borings.

The proposed residence may be supported by post-tensioned beam and slab foundation or stiffened grid type beam and slab foundation. Grade beams of the post tensioned beam and slab foundation or stiffened grid type beam and slab foundation supported at a depth of 18 or 24 or 30 or 36 inches below final grade elevation may be sized for an allowable bearing capacity value of 925 or 975 or 1025 or 1075 lbs. per sq. ft., respectively. A design plasticity index value of 35 is recommended. The P.T.I. design criteria soil parameters, 3rd edition, are presented in this report.

Groundwater was not encountered in the borings at the time of drilling.

Detailed descriptions of subsurface conditions, engineering analysis, and design recommendations are included in this report.

INTRODUCTION

General

This report presents the results of our subsurface exploration and foundation analysis for the proposed residence at 275 Granite Road in Huntsville, Texas. This project was authorized by Mr. Marion Brown.

Purpose and Scope of Services

The purpose of our geotechnical investigation was to evaluate the site's subsurface and ground water conditions and provide geotechnical engineering recommendations for the design and construction of the residence. Our scope of services includes the following:

1) drilling and sampling of 2 borings - to depths of 15 and 20 feet;
2) observation of the ground water conditions during drilling operations;
3) performing laboratory tests such as Atterberg Limits, Unconfined Compression and Moisture Content tests;
4) review and evaluation of the field and laboratory test programs during their execution with modifications of these programs, when necessary, to adjust to subsurface conditions revealed by them;
5) compilation, generalization and analysis of the field and laboratory data in relation to the project requirements;
6) estimation of potential vertical movements;
7) development of recommendations for the design, construction, and earthwork phases of project; and
8) preparation of a written geotechnical engineering report for use by the members of the design team in their preparation of design, contract documents, and specifications.

SUBSURFACE EXPLORATION

Scope

The field exploration to determine the engineering characteristics of the subsurface materials included a reconnaissance of the project site, drilling the borings, and collecting Shelby Tube and Split Barrel samples.

Two soil test borings were drilled at the location of the residence. These borings were drilled to depths of 15 and 20 feet below the presently existing ground surface. Boring locations were selected by the project geotechnical engineer.

Drilling and Sampling Procedures

The soil borings were performed with a drilling rig equipped with a rotary head. Relatively Undisturbed Shelby Tube samples and Split Barrel samples were collected.

Field Logs

A field log was prepared for each boring. Each log contains information concerning the boring method, samples attempted and recovered, indications of the presence of various materials such as limestone, clay, gravel or sand and observations of ground water. It also contained an interpretation of subsurface conditions between samples. Therefore, these logs included both factual and interpretive information.

Presentation of the Data

The final logs represent our interpretation of the contents of the field logs for the purpose delineated by our client. The final logs are included on Plates 2 and 3 included in the Illustration Section. A key to classification terms and symbols used on the logs is presented on Plate 4.

LABORATORY TESTING PROGRAM

Purpose

In addition to the field exploration, a supplemental laboratory-testing program was performed to determine additional pertinent engineering characteristics of the subsurface materials necessary in evaluating the design parameters.

Laboratory Tests

All phases of the laboratory-testing program were conducted in general accordance with the indicated applicable ASTM Specifications as presented in Table No. 1.

Table No. 1

Laboratory Test	Applicable Test Standard
Liquid Limit, Plastic Limit, & Plasticity Index of Soil	ASTM D-4318
Moisture Content	ASTM D-2216
Unconfined Compression	ASTM D-2166

In the laboratory, each sample was observed and classified by a geotechnical engineer. As a part of this classification procedure, the natural water contents of selected specimens were determined. Liquid and plastic limit tests were performed on representative specimens to determine the plasticity characteristics of the different soil strata encountered.

Presentation of the Data

In summary, the tests conducted in the laboratory to evaluate the engineering characteristics of the subsurface materials are presented on appropriate boring logs.

GENERAL SUBSURFACE CONDITIONS

Soil Stratigraphy

The soils underlying the site may be grouped into three generalized strata with similar physical and engineering properties. The lines designating the interface between soil strata on the logs represent approximate boundaries. Transition between materials may be gradual. The soil stratigraphy information at the boring locations is presented in Boring Logs, Plates 2 and 3.

Ground Water Observation

Groundwater was not encountered in the borings at the time of our field investigation. Ground water levels may fluctuate with seasonal climatic variations and changes in land use.

It is not unusual to encounter shallow groundwater during or after periods of rainfall. The surface water tends to percolate down through the surface until it encounters a relatively imperious layer.

FOUNDATIONS ON EXPANSIVE SOIL

General

There are many plastic clays that swell considerably when water is added to them and then shrink with the loss of water. Foundations constructed on these clays are subjected to large uplifting forces caused by the swelling.

In the characterization of a building site, two major factors that contribute to potential shrink-swell problems must be considered. Problems can arise if a) the soil has expansive or shrinkage properties and b) the environmental conditions that cause moisture changes to occur in the soil.

Evaluation Of The Shrink-Swell Potential Of The Soils

Subsurface sampling, laboratory testing and data analyses are used in the evaluation of the shrink-swell potential of the soils under the foundations.

The Mechanism Of Swelling

The mechanism of swelling in expansive clays is complex and is influenced by a number of factors. Basically, expansion is a result of changes in the soil-water system that disturbs the internal stress equilibrium. Clay particles in general have negative electrical charges on their surfaces and positively charged ends. The negative charges are balanced by actions in the soil water and give rise to an electrical interparticle force field. In addition, adsorptive forces exist between the clay crystals and water molecules, and Van Der Waals surface forces exist between particles. Thus, there exists an internal electro-chemical force system that must be in equilibrium with the externally applied stresses and capillary tension in the soil water. If the soil water chemistry is changed either by changing the amount of water or the chemical composition, the interparticle force field will change. If the change in internal forces is not balanced by a corresponding change in the state of stress, the particle spacing will change so as to adjust the interparticle forces until equilibrium is reached. This change in particle spacing manifests itself as a shrinkage or swelling.

Antecedent Rainfall Ratio

This is a measure of the local climate and is defined as the total monthly rainfall for the month of and the month prior to laying the slab divided by twice the average monthly rate measured for the period. The intent of this ratio is to give a relative measure of ground moisture conditions at the time the slab is placed. Thus, if a slab is placed at the end of a wet period, the slab should be expected to experience some loss of support around the perimeter as the wet soil begins to dry out and shrink. The opposite effect could be anticipated if the slab is placed at the end of an extended dry period; as the wet season occurs, uplift around the perimeter may occur as the soil at the edge of the slab gains in moisture content.

Age of Slab

The length of time since the slab was cast provides an indication of the type of swelling of the soil profile that can be expected to be found beneath the slab.

Initial Moisture Condition And Moisture Variation

Volume change in an expansive soil mass is the result of increases or decreases in water content. The initial moisture content influences the swell and shrink potential relative to possible limits, or ranges, in moisture content. Moisture content alone is useless as an indicator or predictor of shrink-swell potential. The relationship of moisture content to limiting moisture contents such as the plastic limit and liquid limit must be known.

If the moisture content is below or near plastic limit, the soils have high potential to swell. It has been reported that expansive soils with liquidity index* in the range of 0.20 to 0.40 will tend to experience little additional swell.

The availability of water to an expansive soil profile is influenced by many environmental and man-made factors. Generally, the upper few feet of the profile are subjected to the widest ranges of moisture variation and is least restrained against movement by overburden. This upper stratum of the profile is referred to as the active zone. Moisture variation in the active zone of a natural soil profile is affected by climatic cycles at the surface, and fluctuating groundwater levels at simply by placing a barrier such as a building floor slab or pavement between the soil and atmospheric environment. Other obvious and direct causes of moisture variation result from altered drainage conditions or man-made sources of water, such as irrigation or leaky plumbing. The latter factors are difficult to quantify and incorporate into the analysis but should be controlled to the extent possible for each situation. For example, proper drainage and attention to landscaping are simple means of minimizing moisture fluctuations near structures and should always be taken into consideration.

$$^{*}\ \text{LIQUIDITY INDEX} = \frac{\text{NATURAL WATER CONTENT - PLASTIC LIMIT}}{\text{LIQUID LIMIT - PLASTIC LIMIT}}$$

Man Made Conditions That Can Be Altered

There are a number of factors that can influence whether a soil might shrink or swell and the magnitude of this movement. For the most part, either the owner or the designer has some control over whether the factor will be avoided altogether or if not avoided, the degree to which the factor will be allowed to influence the shrink-swell process.

Lot Drainage

This provides a measure of the slope of the ground surface with respect to available free surface water that may accumulate around the slab. Most builders are aware of the importance of sloping the final grade of the soil away from the structure so that rainwater is not allowed to collect and pond against or adjacent to the foundations. If water were allowed to accumulate next to the foundation, it would provide an available source of free water to the expansive soil underlying the foundation. Similarly, surface water drainage patterns or swales must not be altered so that runoff is allowed to collect next to the foundation.

Topography

This provides a measure of the downhill movement that is associated with light foundations built on slopes in expansive soil areas. The designer should be aware that as the soil swells, it heaves perpendicularly to the ground surface or slope, but when it shrinks, it recedes in the direction of gravity and gradually moves downslope in a saw tooth fashion over a number of shrink-swell cycles. In addition to the shrink-swell influence, the soil will exhibit viscoelastic properties and creep downhill under the steady influence of the weight of the soil. Therefore, if the building constructed on this slope is not to move downhill with the soil, it must be designed to compensate for this lateral soil influence.

Pre-Construction Vegetation

Large amount of vegetation existing on a site before construction may have desiccated the site to some degree, especially where large trees grew before clearing. Constructing over a desiccated soil can produce some dramatic instances of heave and associated structural distress and damage as it wets up.

Post-Construction Vegetation

The type, amount, and location of vegetation that has been allowed to grow since construction can cause localized desiccation. Planting trees or large shrubs near a building can result in loss of foundation support as the tree or shrub removes water from the soil and dries it out. Conversely, the opposite effect can occur if flowerbeds or shrubs are planted next to the foundation and these beds are kept well-watered or flooded. This practice can result in swelling of the soil around the perimeter where the soil is kept wet.

Summation

It is beyond the scope of this investigation to do more than point out that the above factors have a definite influence on the amount and type of swell to which a slab-on-ground is subjected during its useful life. The design engineer must be aware of these factors as he develops his design and make adjustments as necessary according to the results of special measurements or from his engineering experience and judgment.

DESIGN ENGINEERING ANALYSIS

Foundation Design Considerations

Review of the borings and test data indicates that the following factors will affect the foundation design and construction at this site:

1) The underlying sandy clays and clays are moderately plastic to plastic and potential vertical movement (PVR) on the order of 2 to 3 inches may be estimated.
2) If the finish grade elevation is higher than existing grade level, compacted select fill should be used to raise the grade.
3) The select fill should be placed in lifts and compacted as recommended under "Select Fill" in the Construction Considerations section of this report.
4) If the floor slab is underlain by 2 or 3 ½ ft. thick compacted select fill, potential vertical movement on the order of 2 or 1 ¼ inch, respectively, may be estimated.
5) The underlying soils possess moderate shear strengths and will provide adequate bearing capacities for the proposed residence.
6) Groundwater was not encountered in the borings at the time of drilling.
7) The subgrade silty sands should be thoroughly proof rolled before placement and compaction of select fill and foundation system installation. If the surface silty sands are too loose to effectively proof roll, the surface sands should be mixed with some select fill such as sandy clays and then surface soil should be successfully proof rolled.

8) Potential Vertical Movements (PVR) of 2 to 3 inches was estimated by TXDOT Method. This method is based on Empirical Correlations utilizing Plasticity Index Values of the underlying clays and assumed seasonal fluctuations in moisture contents of these clays. Higher or lower PVR Values may be estimated using other methods. However, TXDOT Method is the most widely used method at the project site and in the state of Texas.

Structural Information

Based on the information provided, it is understood that the proposed structure will be a single or two-story residence. This structure is expected to create moderately heavy loads to be carried by the foundation system.

This structure will utilize wood frame or steel construction and brick, rock, metal or stucco exterior walls. It is assumed that the maximum column loads will not exceed 50 kips, while maximum exterior wall loading will be in the range of 1.0 kips per foot.

FOUNDATION RECOMMENDATIONS

General

The following recommendations are based on our field and laboratory test data, our engineering analyses and our experience with soils similar to those at this site.

Post-Tensioned Beam and Slab Foundation

Post-tensioned slab-on-grade foundation may be used to support the proposed structure, provided the anticipated vertical movements presented on page 10 will not impair the performance of the residence. Pertinent design parameters were evaluated and are presented in the following paragraphs.

Differential vertical movements should be expected for shallow type foundations at this site due to expansive soil conditions that were encountered. Differential vertical movements have been estimated for both the center lift and edge lift conditions for post-tensioned slab-on grade construction at this site. These movements were estimated using the procedures and criteria discussed in the Post-Tensioning Institute 3rd Edition Manual. This procedure utilizes the soils data obtained from both the field and laboratory tests performed on the soil samples.

Design and Construction of Post Tensioned Slabs-on-Ground-Third Edition Manual was used to evaluate the Em and Ym values. These values are presented in Table No. 2 on the following page.

Table No. 2

P.T.I. Third Edition

Center Lift (Ym values) – Inches	1.15
Grade Beam supported **18 inch** below final grade elevation on or within natural undisturbed soils or compacted select fill	1.11
Grade Beam supported **24 inch** below final grade elevation on or within natural undisturbed soils or compacted select fill	1.07
Grade Beam supported **30 inch** below final grade elevation on or within natural undisturbed soils or compacted select fill	0.87
Grade Beam supported **36 inch** below final grade elevation on or within natural undisturbed soils or compacted select fill	0.67
Edge Lift (Ym values) - Inches	1.53
Grade Beam supported **18 inch** below final grade elevation on or within natural undisturbed soils or compacted select fill	1.46
Grade Beam supported **24 inch** below final grade elevation on or within natural undisturbed soils or compacted select fill	1.40
Grade Beam supported **30 inch** below final grade elevation on or within natural undisturbed soils or compacted select fill	1.20
Grade Beam supported **36 inch** below final grade elevation on or within natural undisturbed soils or compacted select fill	1.00
Center Lift (Em values, ft)	8.8
Edge Lift (Em values, ft)	4.9

The grade beams may be supported at a depth of 18 or 24 or 30 or 36 inches below the final grade elevation founded on or within the undisturbed soils or compacted select fill. The depth below the final grade elevation and the respective allowable bearing capacity values are presented in Table No. 3.

Table No. 3

Depth Below the Final Grade, Inches	Allowable Bearing Capacity, PSF
18	925
24	975
30	1025
36	1075

The soil and environmental parameters which are used to arrive at the values in Table No. 2 are listed in Table No. 4.

Table No. 4

Thornthwaite Index, IM	+18
Depth to Constant Soil Suction	7 feet
Constant Soil Suction	3.3 PF
Moisture Velocity	0.7 inch/month
Predominant Clay Material	Montmorillonite
Percent Clay	73

Stiffened Grid Type Beam and Slab Foundation

If it is desirable to design the foundation system utilizing the simplifying assumption that the loads are carried by the beams, an allowable bearing capacity as presented in Table No.3 at the respective depth should be used for grade beams, founded within or on the existing soils or compacted structural fill. The beams should be a minimum of 10 inches wide to prevent local shear failure. A design plasticity index value of 35 is recommended.

A climatic rating value of 25 and soil support index value of 0.70 are also recommended.

Moisture Barrier

We recommend placement of a polyethylene moisture barrier under soil supported floor slab to reduce the possibility of moisture migration through the slab.

Utilities

Utilities, which project through slab-on-grade floors, should be designed with either some degree of flexibility or with sleeves in order to prevent damage to these lines should vertical movement occur.

Contraction, Control or Expansion Joints

Contraction, control or expansion joints should be designed and placed in various portions of the structures. Properly planned placement of these joints will assist in controlling the degree and location of material cracking which normally occurs due to soil movements, material shrinkage, thermal affects, and other related structural conditions.

Lateral Earth Pressure

Some of the grade beams may act as a retaining structure in addition to transferring vertical loads. Some cantilever retaining walls may be needed at this site. The equivalent fluid density values were evaluated for various backfill materials. These values are presented in Table No. 5.

Table No. 5

Backfill Material	Equivalent Fluid Density PCF Active Condition	 At Rest Condition
a. Crushed Limestone	40	55
b. Clean Sand	45	60
c. On-site clays	75	95

These equivalent fluid densities do not include the effect of seepage pressures, surcharge loads such as construction equipment, vehicular loads or future storage near the walls.

If the basement wall or cantilever retaining wall can tilt forward to generate "active earth pressure" condition, the values under active condition should be used. For rigid non-yielding walls which are part of the building, the values "at rest condition" should be used.

The compactive effort should be controlled during backfill operations. Over-compaction can produce lateral earth pressures in excess of at-rest magnitudes. Compaction levels adjacent to below-grade walls should be maintained between 95 and 98 percent of standard Proctor (ASTM D 698) maximum dry density.

The backfill behind the wall should be drained properly. The simplest drainage system consists of a drain located near the bottom of the wall. The drain collects the water that enters the backfill and this may be disposed of through outlets in the wall called "weep holes". To ensure that the drains are not clogged by fine particles, they should be surrounded by a granular filter. In spite of a well-constructed toe drain, substantial water pressure may develop behind the wall if the backfill consist of clays or silts. A more satisfactory drainage system, consisting of a back drain of 12 inches to 24 inches width gravel may be provided behind the wall to facilitate drainage.

The maximum toe pressure for footing founded two feet below finish grade elevation should not exceed 1300 pounds per square feet. An adhesion value of 600 pounds per square foot may be used under the wall footings to check against sliding. This adhesion value is applicable for retaining wall bases supported on the existing clay soils.

Some retaining wall bases may be supported on or within compacted select fill material. For these wall bases, a coefficient of sliding friction value of 0.4 is recommended.

If passive pressure is required at any location, we should be informed. We can provide the passive pressure for that particular condition after considering the rigidity and soil-structure interaction characteristics of that structure.

CONSTRUCTION CONSIDERATIONS

Site Drainage

A majority of foundation related problems in the local area are attributable, at least in part, to poor drainage and expansive soils. Poor drainage, and the resulting ponded water, can cause high plasticity clays to swell or even induce settlement in very low plasticity silts or coarser grained materials. We recommend that an effective site drainage plan be devised by others prior to commencement of construction to provide positive drainage away from the foundation perimeter and off the site, both during and after construction.

Site Preparation

In any areas where soil-supported floor slabs or pavement are to be used vegetation and all loose or organic material should be stripped and removed from the site. Subsequent to stripping operations, the subgrade should be proof rolled to 95 percent of the maximum dry density as determined by ASTM D 698, within two percent below or three percent above optimum moisture content. The exposed subgrade should not be allowed to dry out prior to placing structural fill.

Proof rolling can generally be accomplished using a heavy (25 ton or greater total weight) pneumatic tired roller or fully loaded dump truck making several passes over the areas. Where soft or compressible zones are encountered, these areas should be removed to a firm subgrade. Wet or very moist surficial materials may need to be undercut and either dried or replaced with material which can be properly compacted. Any resulting void areas should be backfilled to finish subgrade in 6-inch compacted lifts compacted to 95 percent maximum dry density as determined by ASTM D 698.

Select Fill

Any select fill material used at the site should have a maximum liquid limit of 40 percent and a plasticity index in between 5 and 20. The fill should be compacted to 95 percent of the maximum dry density as determined by ASTM D 698, within two percent below or three percent above optimum moisture content. The fill should be placed in 8-inch loose lifts (app. 6-inch compacted lifts) and compacted. InTEC should perform density tests at each lift and approve before placement of the subsequent lift.

Ground Water

In any areas where significant cuts (2 ft. or more) are made to establish final grades for building pads, attention should be given to possible seasonal water seepage that could occur through natural cracks and fissures in the newly exposed stratigraphy. Subsurface drains may be required to intercept seasonal groundwater seepage. The need for these or other dewatering devices on building pads should be carefully addressed during construction. Our office could be contacted to visually inspect final pads to evaluate the need for such drains. (The seepage may happen several years after construction if the rainfall rate or drainage pattern changes around the residence).

Earthwork and Foundation Acceptance

Exposure to environment may weaken the soils at the foundation bearing level if the excavation remains open for long periods of time. Therefore, it is recommended that all foundation excavations are extended to final grade and the footings constructed as soon as possible to minimize potential damage to bearing soils. The foundation bearing level should be free of loose soil; ponded water or debris sand should be inspected and approved prior to concreting by the geotechnical engineer or his representative.

Foundation concrete should not be placed on soils that have been disturbed by rainfall or seepage. If the bearing soils are softened by surface water intrusion during exposure or by desiccation, the unsuitable soils must be removed from the foundation excavation and replaced prior to placement of concrete.

Subgrade preparation and fill placement operations should be monitored by the soils engineer of InTEC or his representative. As a guideline, at least one in-place density test should be performed for each 2500 square feet of compacted surface per lift. Any areas not meeting the required compaction should be re-compacted and retested until compliance is met.

DRAINAGE AND MAINTENANCE

Final drainage is very important for the performance of the proposed structure and the pavement. Landscaping, plumbing, and downspout drainage is also very important. It is vital that all roof drainage be transported away from the building so that no water ponds around the buildings which can result in soil volume change under the buildings. Plumbing leaks should be repaired as soon as possible in order to minimize the magnitude of moisture change under the slab. Large trees and shrubs should not be planted in the immediate vicinity of the structures, since root systems can cause a substantial reduction in soil volume in the vicinity of the trees during dry periods.

Adequate drainage should be provided to reduce seasonal variations in moisture content of foundation soils. All pavement and sidewalks within 10-ft of the structures should be sloped away from the structures to prevent ponding of water around the foundations. Final grades within 10-ft of the structures should be adjusted to slope away from structures preferably at a minimum slope of 3 percent. Maintaining positive surface drainage throughout the life of the structures is essential.

In areas with pavement or sidewalks adjacent to the new structures, a positive seal must be provided and maintained between the structures and the pavement or sidewalk to minimize seepage of water into the underlying supporting soils. Post-construction movement of pavement and flat-work is not uncommon. Maximum grades practical should be used for paving and flatwork to prevent areas where water can pond. In addition, allowances in final grades should take into consideration post construction movement of flatwork particularly if such movement would be critical. Normal maintenance should include inspection of all joints in paving and sidewalks, etc. as well as re-sealing where necessary.

Several factors relate to civil and architectural design and/or maintenance, which can Significantly affect future movements of the foundation and floor slab systems:

1. Where positive surface drainage cannot be achieved by sloping the ground surface adjacent to the buildings, a complete system of gutters and downspouts should carry runoff water a minimum of 10-ft from the completed structures.

2. Planters located adjacent to the structures should preferably be self-contained. Sprinkler mains should be located a minimum of five feet from the building line.

3. Planter box structures placed adjacent to building should be provided with a means to assure concentrations of water are not available to the subsoil's stratigraphy.

4. Large trees and shrubs should not be allowed closer to the foundations than a horizontal distance equal to roughly their mature height due to their significant moisture demand upon maturing.

5. Moisture conditions should be maintained "constant" around the edge of the slabs. Ponding of water in planters, in unpaved areas, and around joints in paving and sidewalks can cause slab movements beyond those predicted in this report.

6. Roof drains should discharge on pavement or be extended away from the structures. Ideally, roof drains should discharge to storm sewers by closed pipe.

Trench backfill for utilities should be properly placed and compacted as outlined in this report and in accordance with requirements of local City Standards. Since granular bedding backfill is used for most utility lines, the backfilled trench should be prevented from becoming a conduit and allowing an access for surface or subsurface water to travel toward the new structures. Concrete cut-off collars or clay plugs should be provided where utility lines cross building lines to prevent water traveling in the trench backfill and entering beneath the structures.

Final drainage is very important for the performance of the proposed structure and the pavement. Landscaping, plumbing, and downspout drainage is also very important. It is vital that all roof drainage be transported away from the building so that no water ponds around the building which can result in soil volume change under the building. Plumbing leaks should be repaired as soon as possible in order to minimize the magnitude of moisture change under the slab. Large trees and shrubs should not be planted in the immediate vicinity of the structures, since the root systems can cause a substantial reduction in soil volume in the vicinity of the trees during dry periods.

The potential vertical movements estimated and stated under Design Engineering Analysis on page 11 are based on provision and maintenance of positive drainage to divert water away from the structures and the pavement areas. If the drainage is not maintained, the wetted front may move below the assumed twelve feet depth and resulting potential vertical movement will be much greater than 2 or 3 times the stated values under Design Engineering Analysis. Utility line leaks may contribute water and cause similar movements to occur.

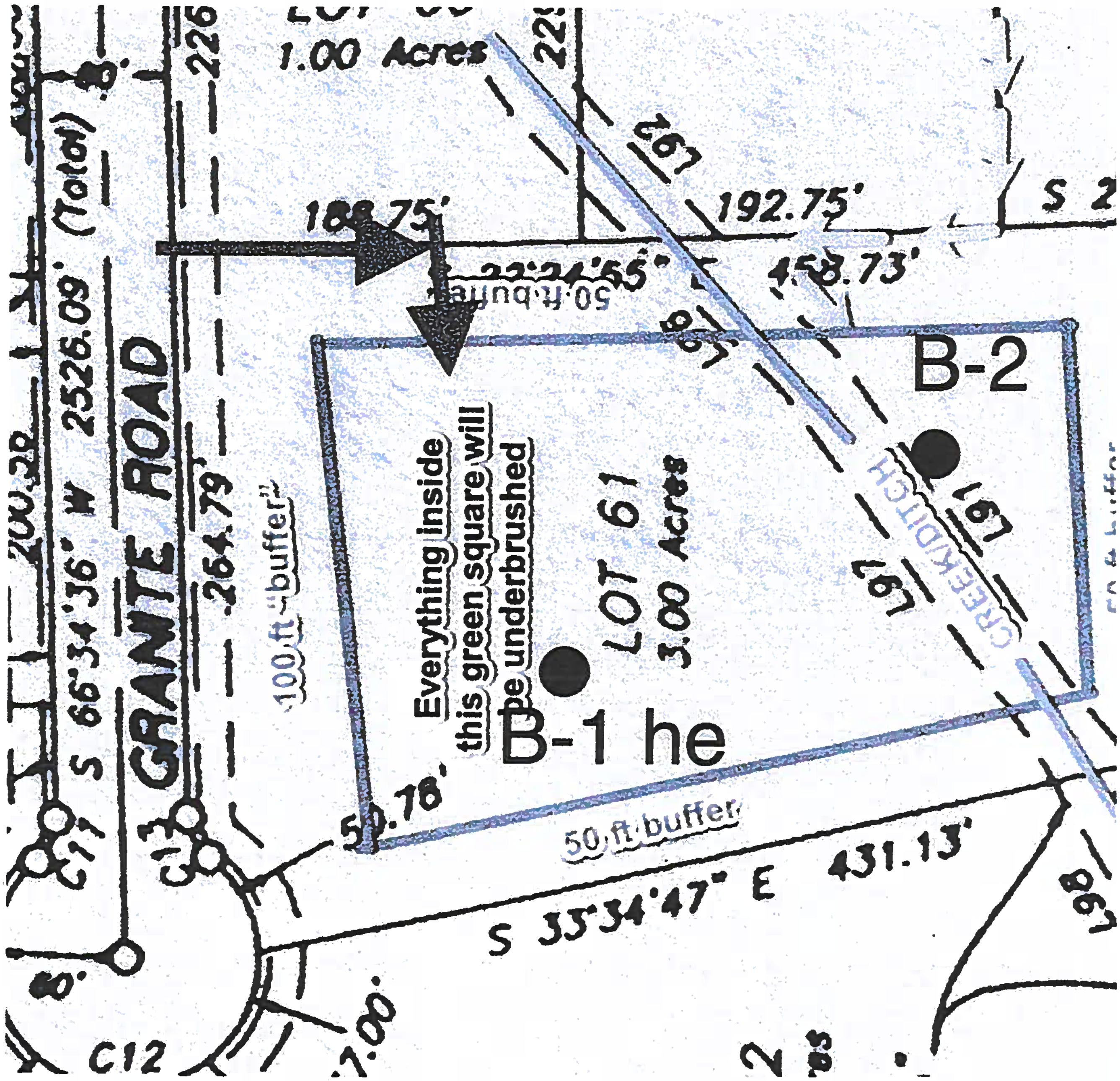
LIMITATIONS

The exploration and analysis of the subsurface conditions reported herein are considered sufficient to form a reasonable basis for the foundation design. The recommendations submitted are based upon the available soil information and design details furnished by Mr. Marion Brown. Final plans for the proposed structure should be reviewed by the geotechnical engineer so that he may determine if changes in the foundation recommendations are required. If deviations from the noted subsurface conditions are encountered during construction, they should be brought to the attention of the geotechnical engineer.

The geotechnical engineer declares that the findings, recommendations, specifications, or professional advice contained herein, have been made after being prepared in accordance with generally accepted professional engineering practice, in the fields of geotechnical engineering, soil mechanics and engineering geology. No other warranties are implied or expressed.

This report has been prepared exclusively for the specific application to the proposed residence at 275 Granite Road in Huntsville, Texas. This report should not be used by others or at any other project location.

ILLUSTRATION SECTION



Subsurface Exploration & Foundation Analysis Brown and White Residence at 275 Granite Road Huntsville, Texas 77340	**Approximate Boring Locations**	
	InTEC Project Number: **H22G0242**	**Plate 1**

LOG OF BORING NO. 1

Project: Brown - White Residence at 275 Granite Road - Lot 61, Block 22, Section 12 of Texas Grand Ranch

Client: Mr. Marion Brown

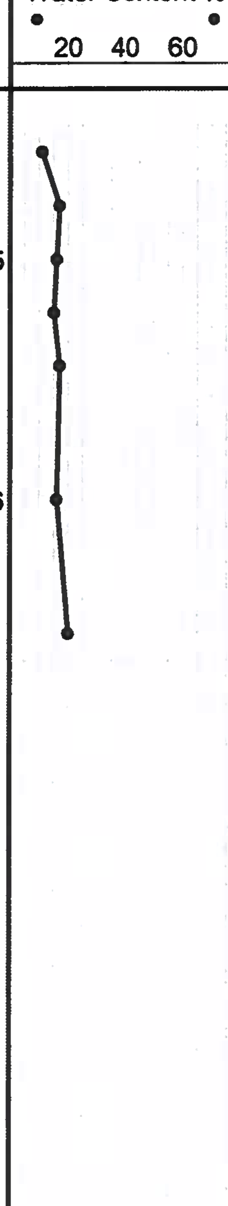
Site Location: Huntsville, Texas 77340

InTEC Project No: H22G0242

SUBSURFACE PROFILE

Depth	Symbol	Samples	SOIL DESCRIPTION Surf. Elev.	Unit Dry Wt. In PCF	S.S. By P.P.	Tor Vane TSF	Blows Per Foot	Shear Strength TSF	Liquid Limit	Plasticity Index
0			Ground Surface							
		SS	Medium Dense Dark Brown Silty Sand				16			
		SS	Medium Dense Brown Sand				22			
5		ST	Very Stiff Reddish Brown To Brown Sandy Clay	97				1.84	31	15
		ST			2.2					
		ST			2.2					
10										
		ST		98				2.12	43	26
15										
		ST			2.2					
20			End of Borehole							
25										
30										
35										
40										

Water Content %



Completion Depth: 20-ft

Ground Water Observed: No

Drill Date: 3/31/2022

S.S. by P.P.- Shear Stength in TSF by Hand Penetrometer

S.S.- Split Spoon Sample
S.T.- Shelby Tube Sample
AU- Auger Sample

L.L.- Liquid Limit
P.L.- Plastic Limit
M.C.- Moisture Content

Plate: 2

LOG OF BORING NO. 2

Project: Brown - White Residence at 275 Granite Road - Lot 61, Block 22, Section 12 of Texas Grand Ranch

Client: Mr. Marion Brown

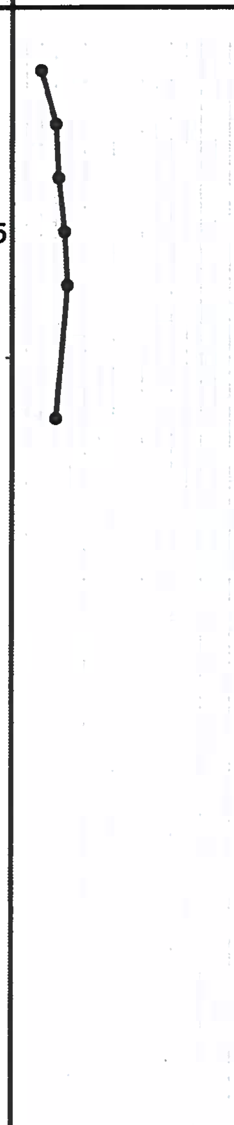
Site Location: Huntsville, Texas 77340

InTEC Project No: H22G0242

SUBSURFACE PROFILE

Depth	Symbol	Samples	SOIL DESCRIPTION Surf. Elev.	Unit Dry Wt. In PCF	S.S. By P.P	Tor Vane TSF	Blows Per Foot	Shear Strength TSF	Liquid Limit	Plasticity Index
0			Ground Surface							
		SS	Medium Dense Dark Brown Silty Sand				14			
		SS	Medium Dense Brown Sand				20			
5		ST	Very Stiff Reddish Brown To Brown Sandy Clay		2.2					
		ST			2.2				51	35
		ST			2.2					
10										
		ST			2.2					
15			End of Borehole							
20										
25										
30										
35										
40										

Water Content %



Completion Depth: 15-ft

Ground Water Observed: No

Drill Date: 3/31/2022

S.S. by P.P.- Shear Stength in TSF by Hand Penetrometer

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Plate: 3

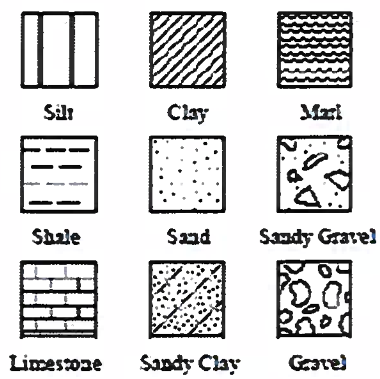
KEY TO CLASSIFICATIONS AND SYMBOLS

Soil Fractions

Component	Size Range
Boulders	Greater than 12"
Cobbles	3" - 12"
Gravel	3" - #4 (4.76mm)
Coarse	3" - ¾"
Fine	¾" - #4
Sand	#4 - #200 (0.074mm)
Coarse	#4 - #10 (2.00mm)
Medium	#10 - #40 (0.42mm)
Fine	#40 - #200 (0.074mm)
Silt and Clay	Less than #200

Soil or Rock Types

(Shown in symbols column)
(Predominate Soil Types Shown Heavy)



TERMS DESCRIBING SOIL CONSISTENCY

Description (Cohesive Soils)	Unconfined Compression TSF	Blows/Ft. Std. Penetration Test	Description (Cohesionless Soils)	Blows/Ft. Std. Penetration Tests
Very Soft	0.25	<2	Very Loose	0 – 4
Soft	0.25 – 0.50	2 – 4	Loose	4 – 10
Firm	0.50 – 1.00	4 – 8	Medium Dense	10 – 30
Stiff	1.00 – 2.00	8 – 15	Dense	30 – 50
Very Stiff	2.00 – 4.00	15 – 30	Very Dense	50
Hard	>4.00	>30		

SOIL STRUCTURE

Calcareous	Containing deposits of calcium carbonate; generally nodular.
Slickenside	Having inclined planes of weakness that are slick and glossy in appearance.
Laminated	Composed of thin layers of varying color and texture.
Fissured	Containing shrinkage cracks frequently filled with fine sand or silt. Usually more or less vertical.
Interbedded	Composed of alternate layers of different soil types.
Jointed	Consisting of hair cracks that fall apart as soon as the confining pressure is removed.
Varved	Consisting of alternate thin layers of sand, silt or clay formed by variations in sedimentations during the various seasons of the year, of often exhibiting contrasting colors when partially dried. Each layer is generally less than ½" in thickness.
Stratified	Composed of, or arranged in layers (usually 1 inch or more)
Well-graded	Having a wide range of grain sizes and substantial amount of all intermediate particle sizes.
Poorly or Gap-graded	Having a range of sizes with some intermediate sizes missing.
Uniformly-graded	Predominantly of one grain size.