REVISED PRELIMINARY FOUNDATION and PAVEMENT REPORT

Sulphur Springs Subdivision

New Sulphur Springs Road and Gardner Road
San Antonio ETJ, Bexar County, Texas

Prepared for:

Lennar
San Antonio, Texas

Prepared by:
TTL, Inc.
San Antonio, Texas

Project No. 00200902069.01
January 24, 2022

TTL
17215 Jones Maltsberger Rd.
Suite 101
San Antonio, TX 78247
210.888.6100
www.TTLUSA.com

January 24, 2022

Mr. Richard Mott, P.E.
Director of Land Development
Lennar
1922 Dry Creek Way, Suite 101
San Antonio, TX 78259

O: 210.403.6282
E: Richard.Mott@Lennar.com

RE: Revised Preliminary Foundation and Pavement Report
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
San Antonio ETJ, Bexar County, Texas
TTL Project No.00200902069.01

Dear Mr. Mott:

TTL, Inc. (*TTL*) is pleased to submit this *preliminary* foundation and final pavement section design report for the above-referenced project. If you have any questions regarding our report, or if additional services are needed, please do not hesitate to contact us.

The enclosed report contains a brief description of the site conditions and our understanding of the project. The preliminary geotechnical recommendations for foundations as well as the final pavement section design recommendations contained within this report are based on our understanding of the proposed development, the results of our field exploration and laboratory tests, and our experience with similar projects.

We appreciate the opportunity to provide these Geotechnical Services for your project and look forward to continuing participation during the design and construction phases of this project.

Respectfully submitted,
TTL, Inc.

Amit Bakane, P.E.
Senior Project Engineer
Geotechnical Services

STATE OF TEXAS
JUNE M. POTTER
106243
LICENSED
PROFESSIONAL ENGINEER
1/24/2022

June M. Potter, P.E.
Project Professional

TABLE OF CONTENTS

GBA Informational Document

APPENDIX A (ILLUSTRATIONS)

APPENDIX B (REFERENCE MATERIALS)

1.0 PROJECT INFORMATION

1.1 Project Description

Item	Description
Project Location	The project site is located in the southeast quadrant of the intersection of New Sulphur Springs Road and Gardner Road in Bexar County, Texas. The Site Location Plan is provided in Appendix A.
Proposed Development	Based on the information provided to us by Lennar, we understand the subdivision will consist of approximately 170 acres of land to be developed as a residential subdivision with approximately 962 lots.
Proposed Construction	The development will consist of one (1) and two (2) story single family residences supported by monolithic slab on grade foundations. The streets comprising the subdivision may consist of Local Type A Streets with or without Bus Traffic, Local Type B Streets, and Collector Streets. The street pavement sections shall be designed as required by Bexar County and the City of San Antonio (COSA) design criteria.
Maximum Loads	Loads were not provided to TTL as a part of this project.

If the above information is not correct, please contact us so that we can make the necessary modifications to this document and our evaluation and recommendations, if needed.

This report was revised to update the plan of borings to the most current lot layout, only. The original report was issued by TTL on October 22, 2020

1.2 Authorization

This Project was authorized by Mr. Richard Mott with Lennar on July 29, 2020 by acceptance of our Agreement for Services, No. P00200902069.00, dated July 23, 2020.

2.0 EXPLORATION FINDINGS

2.1 Site Conditions

Item	Description
Existing Improvements	The site is comprised of residential homesteads, agricultural fields, and relatively undeveloped land.
Existing Site Conditions	The site appears to be used for residential homesteads and agricultural purposes with large sections relatively undeveloped. Based on Google Earth aerial imagery, there appears to be several structures in various locations within the boundaries of the proposed subdivision.
Existing topography	Topographic information was not provided to TTL at the preparation of this report.

2.2 Site Geology

We reviewed the Geologic Atlas of Texas to determine the geologic setting of the project site and surrounding area. Our review indicated the Project Site is located over the Midway Group (Emi) and Wilcox Group (Ewi) of Tertiary geologic age. The Midway Group generally consists of clay and sand that grades upward into the Wilcox Group. This formation ranges from approximately 100 to 400 feet in thickness. The Wilcox Group generally consists of mudstone with some sandstone and lignite. This formation ranges from approximately 440 to 1200 feet in thickness. These formations are known to contain expansive clay soils within the project area.

2.3 Subsurface Stratigraphy

Subsurface conditions within the project's limits were evaluated by drilling exploratory borings at the approximate locations shown on the Boring Location Plan in Appendix A. TTL drilled 18 out of originally planned 28 borings. The locations not drilled were inaccessible to the drill rig due to those areas being heavily vegetated. Site clearing will be required. The remaining borings will be drilled once the site is accessible for drilling operations. **TTL will issue an updated report for this project when drilling, and laboratory testing for those borings is completed.**

Samples obtained during our field exploration were transported to our laboratory where they were reviewed by geotechnical engineering personnel. Representative samples were selected and tested to determine pertinent engineering properties and characteristics for use in our evaluation of the project site. Based on the information developed during our field exploration and laboratory testing, we have determined the stratigraphy of the southern portion of the site is generally as shown on the logs of boring, as shown in Appendix A.

The boring logs presented in Appendix A represent our interpretation of the subsurface conditions at each individual boring location. Our interpretation is based on tests and observations performed during drilling operations, visual examination of the soil samples by a geotechnical engineer, and laboratory tests conducted on the retrieved soil samples. The USCS classifications shown on the boring logs represent classifications based on either visual examination, laboratory testing, or both. The lines designating the interfaces between various strata on the boring logs represent the approximate strata boundary. The transition between strata may be more gradual than shown, especially where indicated by a broken line. All data should only be considered accurate at the exact boring locations.

2.4 Subsurface Water Conditions

Subsurface water was not detected either during or after completion of our exploratory borings. Upon completion of subsurface water observations, the boreholes were backfilled with the spoils generated during drilling operations.

Subsurface water is generally encountered as a ‘true’ or permanent continuous water source that is generally present year-round or as a discontinuous, isolated “‘perched”’ or temporary water source that is temporary. Permanent subsurface water is generally present year-round, which may or may not be influenced by seasonal changes in climate, precipitation, vegetation, surface runoff, water levels in nearby water bodies, and other factors. The subsurface water level below the site may fluctuate up or down in response to such changes and may be at different levels than indicated on the exploration logs at times after the exploration. Temporary subsurface water generally develops as a result of seasonal and climatic conditions.

3.0 GEOTECHNICAL CONSIDERATIONS

The following geotechnical considerations have been prepared based on the information developed during this Project, our experience with similar projects, and our knowledge of sites with similar surface and subsurface conditions.

3.1 Expansive Soils

The expansive potential of a given soil profile may be characterized using the Potential Vertical Rise (PVR) methodology as described in the Texas Department of Transportation (TxDOT) Method TEX-124-E. This methodology is used to estimate how much a given point located on the ground surface may move vertically due to volumetric changes in the soil resulting from fluctuations in soil moisture content. Based on our laboratory test results, the estimated PVR of this site ranges from about 2 inches to about 5 inches (average on the order of 3½ inches) in its present condition. **These estimated PVR values indicate the soils at this site are highly expansive. Care should be taken to carefully evaluate the potential effects of these movements on the structural design of the residential foundations planned for this project.**

3.2 Corrosion Considerations

To evaluate the potential for sulfate exposure to the concrete used to construct foundations for this project, laboratory testing was conducted on soil samples recovered during the field exploration. Selected soil samples were submitted to an analytical laboratory to determine the sulfate content of each sample. The results of that laboratory testing are shown in the following table.

Summary of Laboratory Testing			
Boring No.	**Sample Depth (ft.)**	**Sulfate (ppm)**	**ACI 318-14 Exposure Class**
B-2 (Sample-1)	4½ - 6	2868	S2
B-2 (Sample-2)	4½ - 6	3860	S2
B-7	2½ - 4	242	S1
B-9 (Sample-1)	4½ - 6	116	S0
B-9 (Sample-2)	4½ - 6	92.3	S0
B-13	4½ - 6	278	S1
B-26	2½ - 4	113	S0

According to the 2018 International Residential Code, concrete that will be exposed to sulfate-containing solutions should be designed in accordance with ACI 318. The results of the laboratory testing indicated that dissolved sulfate contents ranged from about 92.3 ppm to 3860 ppm.

The results of this laboratory testing indicated the soils should generally be classified as an exposure class of S1 which would require the use of Type II cement. Please note the sulfate concentrations encountered at boring B-2 were high enough to classify as an exposure class of S2 which would require the use of Type V cement. Selection of an appropriate mix design based on the anticipated sulfate content of the soil at this site is the responsibility of the project structural engineer. The project structural engineer should carefully evaluate the laboratory test result provided above and select the appropriate concrete mix design for the foundations planned for this project.

4.0 EARTHWORK RECOMMENDATIONS

4.1 Subgrade Preparation and Stabilization

The intended performance of earth supported elements such as foundations and utilities are contingent upon following the earthwork recommendations and guidelines outlined in this section. Earthwork activities on the project should be observed and evaluated by TTL personnel. The evaluation of earthwork should include observation and testing of all fill and backfill soils placed at the site, along with subgrade preparation beneath the residential structures, pavements, and other areas to receive fill materials.

Please note that mass grading for the subdivision had not been performed before drilling of TTL exploratory borings at the site. Our <u>preliminary</u> foundation recommendations are based on the existing subsurface conditions we encountered during our drilling operations conducted at accessible locations within the project site. Further geotechnical field exploration consisting of additional test borings will need to be conducted after the mass grading is completed in order to characterize the actual bearing soils and their strength conditions. The final design foundation recommendations will be impacted by the modified site conditions.

If possible, site development should be performed during seasonably dry weather (typically May through October), and excavation and site preparation should not be performed during or immediately following periods of heavy precipitation or freezing temperatures. Positive surface drainage should be maintained during grading operations and construction to prevent water from ponding on the surface. Surface water run-off from off-site areas should be diverted around the site using berms or ditches. The surface can be rolled smooth to enhance drainage if precipitation is expected but should then be scarified prior to resuming fill placement operations. Subgrades damaged by construction equipment should be promptly repaired to avoid further degradation in adjacent areas and water ponding. Our geoprofessional should provide recommendations for treatment if the subgrade materials become wet, dry, or frozen. When work activities are interrupted by heavy rainfall, fill operations should not be resumed until the moisture content and density of the previously placed fill materials are as recommended in this report. The following earthwork recommendations must be performed prior to pavement and utility construction.

4.1.1 <u>Stripping</u>

Subgrade preparation should begin with stripping the existing vegetation and any otherwise unsuitable materials from planned construction areas.

- Stripping should extend at least 3 feet (horizontal) beyond the construction limits or to the property lines, whichever is less. Due to the tree and brush vegetation at the site, the stripping depth may need to be at least 12 to 18 inches to completely grub and remove the roots.

- Organic-laden strippings including root masses and loose topsoil should be removed from the site or disposed of at designated on-site areas located outside the limits of current or future development.

4.1.2 Proof-rolling

After stripping and excavating to the design subgrade elevation, the stability of exposed subgrades in areas to receive fill should be evaluated by proof-rolling. The stability of subgrades exposed by cutting to final grades should also be evaluated by proof-rolling.

- Perform proof-rolling with a rubber-tired vehicle having a gross vehicle weight of at least 20 tons (such as a loaded tandem-axle dump truck, or similar size/weight construction equipment).
- Proof-rolling equipment should make multiple closely-spaced overlapping passes in perpendicular directions over the subgrade at a walking pace.
- The subgrade should be relatively smooth and free of wheel ruts, sheepsfoot roller dimples, loose clods of soil, or loose gravel, and the subgrade should not be desiccated, cracked, wet, or frozen.
- A TTL geotechnical engineer or their representative should observe the proof-rolling to identify, document, and mark areas of unstable subgrade response, such as pumping, rutting, or shoving, if any.

4.1.3 Subgrade Stabilization

Unstable subgrades should be stabilized as recommended below.

- Undercut soft, weak, and unstable soils by excavating below subgrade level to expose stable soils. The excavated soil can be used to restore the excavation subgrade, provided that the soils are relatively free and clean of deleterious material or materials exceeding 3 inches in maximum dimension. The excavated soil, or imported fill soil, shall be placed in maximum 6-inch compacted lifts. Each lift of soil shall be moisture conditioned between optimum and +4 percentage points of the optimum moisture content and compacted to at least 95 percent of the maximum dry density determined in accordance with the Standard compaction effort (ASTM D 698). If undercutting deeper than about 3 feet is needed, contact TTL.
- Soil subgrade areas requiring fill placement should be scarified to a depth of about eight (8) inches and moisture conditioned between optimum and plus four (+4) percentage points of the optimum moisture content. The moisture conditioned subgrade should then be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D 698. The subgrade should be

moisture conditioned just prior to fill placement so the subgrade maintains its compaction moisture levels and does not dry out.

- On-site soils (general fill), Select Fill or Granular Select Fill soil should be placed to achieve the desired elevation as described in Section 4.2 of this report.

4.2 Compacted Fill Materials

Compacted fill materials may consist of general or select fill depending upon its intended use. The general fill material may consist of onsite soils or select fill materials. General fill material should possess good compaction characteristics that will provide uniform support for pavements or other facilities not extremely sensitive to moments. Select fill materials are typically selected for specific engineering characteristics and performance criteria. These characteristics and criteria are typically dependent on the requirements of the structures or other facilities they are intended to support.

General and select fill materials should be clean and free of any vegetation, roots, organic materials, trash or garbage, construction debris, or other deleterious materials. These materials should contain stones no larger than 3 inches in maximum dimension. The following table provides more specific requirements for general and select fill materials.

Material Type	Characteristics	Compaction Procedures	Compaction Control [1, 2]
GENERAL FILL	Shall consist of CH, CL, SC, GC, SW, or GW as defined by ASTM D 2487. Plasticity Index: Not more than 35. Maximum allowable organic content: 3 percent by weight. **This fill material type shall not be used in areas where select fill materials are specified. It is not the intent of this material to control differential soil movements and it shall not be used in areas where control of soil movements is required.**	Maximum loose lift thickness: 8 inches. Compaction requirement: Compaction should be at least 95 percent of the standard Proctor (ASTM D 698) maximum dry density for fill bodies less than 5 feet in thickness. Compaction should be at least 95 percent of the modified Proctor (ASTM D 1557) maximum dry density for fill bodies 5 feet or greater in thickness. Moisture content at time of compaction: within plus to minus 3 percent of the material's optimum moisture content.	General Fill Areas: One field test for every 10,000 square feet per lift, with a minimum of two tests per lift. Utility Trenches (in areas where Select Fill is not required): One field density test per every 100 linear feet, per lift.

Material Type	Characteristics	Compaction Procedures	Compaction Control [1, 2]
SELECT LEAN CLAY FILL (COMPACTED FILL)	Maximum particle size: 3 inches. Maximum gravel and oversize particle content: 15 percent retained on a ¾-inch sieve. At least 70 percent of total material (by weight) passing the No. 200 sieve Maximum allowable organic content: 3 percent by weight, but large roots are not allowed. Liquid Limit: Not more than 40. Plasticity Index: Between 8 and 15. Designation as a CL in accordance with the Unified Soil Classification System (USCS).	Maximum loose lift thickness: 8 inches with compacted thickness of about 6 inches. Compaction requirement: Compaction should be to at least 95 percent of the standard Proctor maximum (ASTM D 698) dry density for non-roadway areas and TEX-114-E for roadway areas. Moisture content at time of compaction: within minus 2 to plus 3 percent of the material's optimum moisture content.	Building Area: One field density test every 5,000 square feet per lift, with a minimum of two tests per lift. Pavement Areas and Slopes: One field density test every 10,000 square feet per lift, with a minimum of two tests per lift. Utility Trenches: One field density test per structure or one test per every 100 linear feet, per lift.
SELECT GRANULAR FILL (COMPACTED FILL)	Crushed stone (limestone) meeting Type A, Grades 1, 2, or 3; Crushed or uncrushed gravel meeting Type B, Grades 1, 2, or 3; Crushed concrete meeting Type D, Grades 1, 2, or 3; of the 2014 TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges. Designation as a GC or GM in accordance with the USCS Clayey gravel (may locally be referred to as "pit-run" material) or caliche having no particle sizes greater than 3 inches in any dimension, at least 50 percent of total material retained on the No. 200 sieve, a Liquid Limit (LL) no greater than 40, and a PI between 7 and 20. Designation as a GC in accordance with the USCS. Commercial Grade Base (may locally be referred to as "three-quarters to dust" material) that is produced by some local/regional quarries having nothing retained on the 2 inch sieve, at least 60 percent retained on the No. 40 sieve, at least 80 percent retained on the No. 200 sieve, an LL no greater than 30, and a PI of 7 or less. Designation as a GM in accordance with the USCS.	Maximum loose lift thickness: 8 inches. Compaction requirement: Compaction should be to at least 98 percent of the TEX-113-E dry density. Moisture content at time of compaction: within minus 2 to plus 3 percent of the material's optimum moisture content.	Building Area: One field density test every 5,000 square feet per lift, with a minimum of two tests per lift. Pavement Areas and Slopes: One field density test every 10,000 square feet per lift, with a minimum of two tests per lift. Utility Trenches: One field density test per structure or one test per every 100 linear feet, per lift.

[1]For preliminary planning only. Our technician/engineer should determine the actual test frequency.
[2] In addition, the fill must be stable under the influence of compaction equipment. Heavy construction traffic should not be allowed to travel on compacted fill areas, except on designated haul roads, to reduce the potential for damaging a previously compacted fill subgrade

If grading occurs during wet, cool weather, when drying soils is more difficult and time-consuming, the grading contractor may have difficulty achieving suitable moisture conditions for proper compaction of soil fill.

The surface of any filled area can experience settlement due to compression of the underlying soils, and sometimes additional settlement results from consolidation of thick soil fills due to their own self-weight. For this project, we expect settlements of fills will occur over the course of several years after completion of fill placement due to the nature of the on-site soils. If thicker fills are constructed, settlements could continue for longer periods of time after completion of fill placement, which could adversely affect utilities, structures, or pavements supported by the fill.

4.3 Excavation Conditions

4.3.1 Temporary Slopes and OSHA Soil Types

The Occupational Safety and Health Administration (OSHA) Safety and Health Standards (29 CFR Part 1926) require that excavations be constructed in accordance with the current OSHA guidelines. The contractor is **solely** responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. To that end, the contractor's 'responsible person' as defined in 29 CFR Part 1926 should evaluate the required excavations and the soils exposed by those excavations and determine appropriate means as part of the contractor's safety procedures.

OSHA requires that excavations in excess of 5 feet be shored or appropriately sloped. Currently available and practiced methods for achieving excavation stability include sloping, benching, shoring, and the use of trench shields. In excavations that are less than 20 feet deep, OSHA addresses maximum allowable slopes on Table as reproduced below.

Soil or Rock Type	Maximum Allowable Slopes (H:V)[1] for Excavations Less Than 20 Feet Deep[2]	
Stable Rock	Vertical	90°
Type A[3]	¾:1	53°
Type B	1:1	45°
Type C	1½:1	34°

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
2. Slopes or benching for excavations that exceed 20 feet shall be designed by a licensed professional engineer.
3. For Type A soils, a short-term maximum allowable slope of ½:1 (63°) is allowed in excavations that are 12 feet deep or less. For excavations deeper than 12 feet, the short-term allowable slope shown above applies. OSHA defines short-term as a period of 24 hours or less.

Based on the results of our field and laboratory testing, it is our opinion that the FAT CLAY (CH) and LEAN CLAY (CL) soils encountered in our soil borings may be considered as Type B soils. If those clay soils become saturated or submerged, they should be downgraded to Type C soils. We have provided this information solely as a service to our client. The actual OSHA regulations should be consulted prior to any excavations that would be subject to OSHA regulations. TTL does not assume responsibility for any construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations.

4.3.2 Anticipated Excavation Conditions

The near-surface soils observed at the boring locations are generally FAT CLAY (CH) soils. These materials have a stiff to hard consistency. The soils encountered at the borings can generally be excavated by conventional earthmoving equipment.

4.3.3 Drainage During Construction

Water should not be allowed to collect in foundation excavations, on foundation surfaces, or on prepared subgrades within the construction area during construction. Excavated areas should be sloped toward designated drainage points to facilitate removal of any collected rainwater, subsurface water, or surface runoff. Positive surface drainage at the site should be provided to reduce infiltration of surface water into subgrades and fill bodies during construction and promote prompt removal of water from the project site.

4.4 Long-Term Drainage Considerations

Long-term drainage conditions can have a significant impact on the performance of structures, pavements, utilities, and other ancillary facilities on a project site. We recommend that site drainage be developed such that long-term ponding does not occur except in areas specifically designed for such purposes. When establishing final grades, the design team should be reminded that in expansive clay environments, it is common for ground surface movements to occur that could potentially cause reversal of site drainage patterns and unwanted ponding of surface water. We recommend the following be considered:

- Elevation of the ground surface adjacent to foundations should be at least 6 inches below the Finished Floor Elevation unless measures are taken to ensure long-term positive drainage away from the structure.
- The slope of the ground surface away from the structure (if not covered with pavement) should be a minimum of 5 percent for a distance of at least 10 feet unless measures are taken to ensure long-term positive drainage away from the structure.
- Gutter downspouts should extend at least 5 feet past the edge of the foundations.
- Sufficient slope of the ground surface should be maintained around pavements and other ancillary facilities to ensure long-term positive drainage.

5.0 INFRASTRUCTURE RECOMMENDATIONS

5.1 Landscape Considerations

We realize landscaping is vital to the aesthetics of any project and is generally typical for residential construction. The owner and design team should be made aware that placing large bushes and trees adjacent to the structures and pavements may contribute to future distress. Vegetation placed in landscape beds adjacent to the structure should be limited to plants and shrubs that will not exceed a mature height of about 3 to 4 feet. Large bushes and trees that will generally exceed these heights should be planted at a reasonable distance away from structures and pavements so their canopy or “drip line” does not extend over the structure when the tree reaches maturity.

Watering of vegetation should be performed in a timely and controlled manner and in sufficient quantity to maintain healthy vegetative cover. Excessive watering should be avoided as excessive irrigation of landscaped areas adjacent to, near or up gradient from foundations and pavements can lead to water migration into building pads and base sections. This migration could cause moisture fluctuations in the underlying clay subgrade which could result in excessive soil movements and loss of subgrade strength.

5.2 Pavement Design Considerations

Based on the COSA design guidelines, the following design parameters were used for design of the pavement sections:

Acceptable Pavement Structural Sections					
	Local Type A without Bus Traffic	Local Type A with Bus Traffic	Local Type B	Collector Street	Secondary Arterial
Reliability, %	70	70	90	90	95
Initial Serviceability Index, po	4.2	4.2	4.2	4.2	4.2
Terminal Serviceability Index, pt	2.0	2.0	2.0	2.5	2.5
Standard Deviation, So	0.45	0.45	0.45	0.45	0.45
Design Life, years	20	20	20	20	20
18-kip ESALs	100,000	1,000,000	2,000,000	2,000,000	3,000,000
Minimum Structural Number	2.02	2.58	2.92	2.92	3.80
Maximum Structural Number	3.18	4.20	5.08	5.08	5.76

Two soil bulk samples were collected to determine the California Bearing Ratio (CBR) value to be used for our pavement design recommendations. The locations at which the CBR bulk samples were taken are indicated on the Boring Location Plan in Appendix A. We performed CBR tests at three compaction levels (i.e. 90%, 95% and 100% for a total of three (3 CBR tests) on each sample location. Based on laboratory test results, CBR values of about 4.5 and 4.1 percent were obtained for the existing untreated subgrade compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D 698. TTL recommends that a CBR value of 4.0 percent be used to represent the pavement subgrade conditions at this site. In accordance with the COSA and Bexar County design guidelines, we used a Resilient Modulus (MR) = 1,500 times the CBR in psi, to convert CBR to MR.

The COSA pavement guidelines require lime treatment of clay subgrades with a PI greater than 20. The subgrade shall be treated with hydrated lime in accordance with TxDOT Item 260. We anticipate that approximately 6 percent of hydrated lime will be required (about 35 pounds per square yard). It is anticipated that even after the mass grading is completed that the soils will require lime treatment. **Furthermore, we understand the lime treated subgrade will not be treated to meet the COSA requirement for lime stabilization.**

Lime Series testing was performed on the bulk samples collected for this project as well. The results of the two (2) sets of Lime Series tests are provided in Appendix A. Based on the results of those tests, we anticipate that six (6) percent lime (by weight) will be required for this project. However, it should be noted that, upon completion of the grading operations at the site, the index properties of the subgrade soils should be checked to determine whether or not the results of the Lime Series tests included in Appendix A are still applicable. This is because mass grading operations may have removed lower PI material to expose higher PI material or higher PI fill may have been placed over lower PI materials.

5.2.1 Pavement Section Recommendations

Following are the recommended pavement sections for Local Type A without Bus Traffic, Local Type A with Bus Traffic, Local Type B, Collector and Secondary Arterial.

Flexible Pavement System	
Component	Local Type A without Bus Traffic
	Pavement Material Thickness, inches
Hot Mixed Asphaltic Concrete	2 inches
Prime Coat	Yes
Granular Base Course (Type A, Grade 1 or 2)	10 inches
Lime Treated Subgrade[1]	6 inches
Required Structural Number	2.24
Provided Structural Number[1]	2.28
Required 18-kip ESALs	100,000
Estimated Provided 18-kip ESALs	113,500

[1]Structural Number for Lime Treated Subgrade was not used in the Pavement Section Calculations.

Flexible Pavement System	
Component	Local Type A with Bus Traffic
	Pavement Material Thickness, inches
Hot Mixed Asphaltic Concrete	3 inches
Prime Coat	Yes
Granular Base Course (Type A, Grade 1 or 2)	14 inches
Lime Treated Subgrade[1]	6 inches
Required Structural Number	3.20
Provided Structural Number[1]	3.28

Flexible Pavement System	
Component	Local Type A with Bus Traffic
	Pavement Material Thickness, inches
Required 18-kip ESALs	1,000,000
Estimated Provided 18-kip ESALs	1,199,000

[1]Structural Number for Lime Treated Subgrade was not used in the Pavement Section Calculations.

Flexible Pavement System	
Component	Local Type B
	Pavement Material Thickness, inches
Hot Mixed Asphaltic Concrete	3 inches
Prime Coat	Yes
Granular Base Course (Type A, Grade 1 or 2)	19 inches
Lime Treated Subgrade[1]	6 inches
Required Structural Number	3.97
Provided Structural Number[1]	3.98
Required 18-kip ESALs	2,000,000
Estimated Provided 18-kip ESALs	2,043,500

[1]Structural Number for Lime Treated Subgrade was not used in the Pavement Section Calculations.

Flexible Pavement System	
Component	Collector
	Pavement Material Thickness, inches
Hot Mixed Asphaltic Concrete	3 inches
Prime Coat	Yes
Granular Base Course (Type A, Grade 1 or 2)	21 inches
Lime Treated Subgrade[1]	6 inches
Required Structural Number	4.22
Provided Structural Number[1]	4.26
Required 18-kip ESALs	2,000,000
Estimated Provided 18-kip ESALs	2,142,700

[1]Structural Number for Lime Treated Subgrade was not used in the Pavement Section Calculations.

Flexible Pavement System		
Component	Secondary Arterials	
	Pavement Material Thickness, inches	
Hot Mixed Asphaltic Concrete – Type D	2 inches	2 inches
Hot Mixed Asphaltic Concrete – Type C	4 inches	2 inches
Dense-Grade Hot-Mix Asphaltic Concrete Base Course (Type B, Item- 341)	----	4 inches
Prime Coat	Yes	Yes
Granular Base Course (Type A, Grade 1 or 2)	15½ inches	10½ inches
Lime Treated Subgrade[1]	6 inches	6 inches
Required Structural Number	4.75	4.75
Provided Structural Number[1]	4.88	4.75
Required 18-kip ESALs	3,000,000	3,000,000
Estimated Provided 18-kip ESALs	3,300,000	3,039,000

[1]Structural Number for Lime Treated Subgrade was not used in the Pavement Section Calculations.

5.2.2 General Guidelines for Pavements

Pavement design methods are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support. **The support characteristics of the subgrade for pavement design do not account for shrink/swell movements of an expansive clayey subgrade. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade. It is, therefore, important to minimize moisture changes in the subgrade to reduce shrink/swell movements.**

On most projects, rough site grading is accomplished relatively early in the construction phase. However, as construction proceeds, excavations are made into these areas; dry weather may desiccate some areas; rainfall and surface water saturates some areas; heavy traffic from concrete and other delivery vehicles disturbs the subgrade; and many surface irregularities are filled in with loose soils to improve trafficability temporarily. As a result, the pavement subgrade should be carefully evaluated as the time for pavement construction approaches. This is particularly important in and around utility trench cuts.

Thorough proof-rolling of pavement areas using appropriate construction equipment weighing at least 20 tons should be performed no more than 24 hours prior to surface paving. Any problematic areas should be reworked and compacted at that time.

Long-term pavement performance will be dependent upon several factors, including maintaining subgrade moisture levels and providing for preventive maintenance. The following recommendations should be considered at a minimum:

- Maintain and promote proper surface drainage away from pavement edges;
- Consider appropriate edge drainage systems;
- Install drainage in areas anticipated for frequent wetting (e.g. landscape beds, discharge area, collection areas, etc.);
- Place joint sealant and seal cracks immediately;
- Seal all landscaped areas in, or adjacent to pavements, to minimize or prevent moisture migration to subgrade soils;
- Placing compacted, low permeability backfill against the exterior side of curb and gutter; and,
- Extending the base of the curb and gutter system through the pavement base material and at least 6 inches into lime treated subgrade soils.

Preventive maintenance should be planned and provided for through an on-going pavement management program. These activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. This consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventive maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements. Prior to implementing any maintenance, additional engineering observation is recommended to determine the type and extent of preventive maintenance.

5.2.3 Drainage Adjacent to Pavements

The performance of the pavement system will not only be dependent upon the quality of construction but also upon the stability of the moisture content of the soils and base underlying the pavement surface. Proper drainage along or adjacent to the pavement edge or curbs is very important and should be provided so infiltration of surface water from unpaved areas surrounding the pavement is minimized. The Project Civil Engineer should design final grades so that there is positive drainage away from the pavement/curb edge. Also, surface slopes for asphaltic concrete pavement areas should be no flatter than two (2) percent to reduce the potential for ponding of water on the asphaltic concrete surface. The importance of proper runoff and drainage cannot be overemphasized and should be thoroughly considered by the Project Civil Engineer. Post construction accumulation or ponding of surface runoff near structures must be avoided.

Since water penetration usually results in degradation of the pavement section with time as vehicular traffic traverses the affected area, we recommend that the curbs extend vertically through the aggregate base course, lime stabilized layer and at least six (6) inches into the pavement subgrade.

5.2.4 Pavement Section Materials

All pavement materials shall conform to the latest edition of City of San Antonio design and construction guidelines. Presented below are selection and preparation guidelines for various materials that may be used to construct the pavement sections. Submittals should be made for each pavement material. The submittals should be reviewed by TTL and any appropriate members of the Project Team. The submittals should provide test information necessary to verify full compliance with the recommended or specified material properties.

Hot Mix Asphaltic Concrete Surface Course - The asphaltic concrete surface course should be plant mixed, hot laid Type D meeting the master specification requirements of 2014 TxDOT Standard Specifications Item 340 and specific criteria for the job mix formula. The mix should be compacted between 91 and 95 percent of the maximum theoretical density as measured by TEX-227-F. The asphalt cement content by percent of total mixture weight should fall within a tolerance of ±0.3 percent asphalt cement from the specific mix. In addition, the mix should be designed so 75 to 85 percent of the voids in the mineral aggregate (VMA) are filled with asphalt cement.

Hot Mix Asphaltic Concrete Binder Course - The asphaltic concrete binder course should be plant mixed, hot laid Type C meeting the master specification requirements of 2014 TxDOT Standard Specifications Item 340 and specific criteria for the job mix formula. The mix should be compacted between 91 and 95 percent of the maximum theoretical density as measured by TEX-227-F. The asphalt cement content by percent of total mixture weight should fall within a tolerance of ±0.3 percent asphalt cement from the specific mix. In addition, the mix should be designed so 75 to 86 percent of the voids in the mineral aggregate (VMA) are filled with asphalt cement.

<table>
<tr><th colspan="4">Asphalt Cement Grades</th></tr>
<tr><th rowspan="2">Street Classifications</th><th colspan="3">Minimum PG Asphalt Cement Grade</th></tr>
<tr><th>Surface Courses</th><th>Binder and Level up courses</th><th>Base Courses</th></tr>
<tr><td>Arterials</td><td>PG 76-22</td><td rowspan="2">PG 70-22</td><td rowspan="4">PG 64-22</td></tr>
<tr><td>Collector and Local Type B Streets</td><td rowspan="2">PG 70-22</td></tr>
<tr><td>Local Type A Street with Bus Traffic</td><td rowspan="2">PG 64-22</td></tr>
<tr><td>Local Type A Street without Bus Traffic</td><td>PG 64-22</td></tr>
</table>

Aggregates known to be prone to stripping should not be used in the hot mix. If such aggregates are used measures should be taken to mitigate this concern. The mix should have at least 70 percent strength retention when tested in accordance with TEX-531-C.

Pavement specimens, which shall be either cores or sections of asphaltic pavement, will be tested according to Test Method TEX-207-F. The nuclear-density gauge or other methods which correlate satisfactorily with results obtained from Project pavement specimens may be used when approved by the Engineer. Unless otherwise shown on the plans, the Contractor shall be responsible for obtaining the required pavement specimens at their expense and in a manner and at locations selected by the Engineer.

<u>Hot Mix Asphaltic Concrete Base Course</u> - The asphaltic concrete base course material should meet the specification requirements of 2014 TxDOT Standard Specification Item 340, Type A or B.

<u>Prime Coat</u> - The prime coat should consist of sealing the base with an oil such as MC-30 or AE-P asphalt cement. The prime coat should be applied at a rate not to exceed 0.35 gallons per square yard with materials which meet TxDOT Item 300. The prime coat will help to minimize penetration of rainfall and other moisture that penetrates the base.

<u>Granular Base Material</u> - Base material may be composed of crushed limestone base meeting all of the requirements of 2014 TxDOT Item 247, Type A, Grade 1 or 2; and should have no more than 15 percent of the material passing the No. 200 sieve. The base should be compacted to at least 95 percent of the maximum dry density determined in accordance with test method TEX-113-E at moisture contents ranging between -2 and +3 percentage points of the optimum moisture content.

<u>Lime Treatment</u> - The subgrade shall be treated with hydrated lime in accordance with TxDOT Item 260. We anticipate that approximately 6 percent hydrated lime will be required (approximately 35 pounds per square yard). The optimum hydrated lime content should result in a soil-lime mixture with a pH of at least 12.4 when tested in accordance with ASTM C 977, Appendix XI.

The hydrated lime should initially be blended with a mixing device such as a pulvermixer. After sufficient moisture conditioning, the treated soil mixture shall be compacted to at least 95 percent of the maximum dry density as determined in accordance with the Standard effort (ASTM D 698) at moisture contents from optimum to +4 percentage points of the optimum moisture content. If the in-place gradation requirements can be achieved during initial mixing, the remixing after the curing period can be eliminated.

Details regarding subgrade preparation are presented in Pavement Earthwork Section below.

5.2.5 <u>Pavement Earthwork</u>

The intended performance of street is contingent upon following the earthwork recommendations and guidelines outlined in this section. Earthwork activities on the Project should be observed and evaluated by *TTL* personnel. The evaluation of earthwork should include observation and testing of all fill and backfill soils placed at the Site, subgrade preparation beneath the streets.

The clay soils across the site have a high potential to undergo expansion and contraction with fluctuations in their moisture content. Expansion and contraction of the clay subgrade can lead to cracking and undulating/corrugation in the pavement and curbs. Remedial methods to address this issue include: removing the expansive soils and replacing them with a non-expansive cohesive soil; chemical injection of the expansive soils; a combination of moisture conditioning, lime or cement treatment and installation of a vertical moisture barrier; other subgrade preparation methods are also available. If additional earthwork preparation methods will be used or evaluated, please contact us. The following earthwork recommendations must be performed prior to pavement construction.

- Subsurface soil conditions exhibit a Plasticity Index (PI) greater than 20; City of San Antonio pavement design guidelines require these soils be lime treated. Expansion and contraction of the clay soils underlying the proposed roadways can reduce the serviceability of the roadway and lead to deterioration in the quality of the pavement system. The following earthwork recommendations must be performed prior to pavement construction.
- Strip vegetation, loose topsoil, existing pavements, vegetation and any otherwise unsuitable materials from the pavement area. The pavement area is defined as the area that extends at least 3 feet (horizontal) beyond the perimeter of the proposed pavement and any adjacent flatwork (sidewalks).
- Perform cut and fill to accommodate the design pavement subgrade elevation (also referenced as the bottom of the base course). On-site soils can be used for grade adjustments in fill areas. Refer to the Section 4.2 of this report for requirements for the placement of on-site soils and select fill materials.
- After achieving the required excavation depth, and before placing any fill, the exposed excavation subgrade should be proof-rolled with at least a 20-ton roller, or equivalent equipment, to evidence any weak yielding zones. A technical representative of our firm should be present to observe the proof-rolling operations. If any weak yielding zones are present, they should be over-excavated, both vertically and horizontally, until competent soils are exposed. The excavated soil can be used to restore the excavation subgrade, provided that the soils are relatively free and clean of deleterious material or materials exceeding 3 inches in maximum dimension. The excavated soil or imported fill soil shall be placed in maximum 6-inch compacted lifts. Each lift of soil shall be moisture conditioned and compacted as described in the Section 4.2.
- After proof-rolling and replacing any weak yielding zones, the clay subgrade should be lime treated in accordance with TxDOT Item 260. The lime shall be in slurry form. It is anticipated that approximately 6 percent hydrated lime will be required (approximately 35 pounds per square yard). The soil-lime mixture shall be placed between optimum and +4 percentage points of the optimum moisture content and shall be compacted to at least 95 percent of the maximum dry density determined in accordance with the Standard compaction effort (ASTM D 698).
- For pavement subgrades consisting of fat clay soils or on-site borrow with a PI greater than 20, the earth work described here should result in approximately 6 inches of lime treated soil below the design pavement subgrade elevation.

6.0 STRUCTURAL RECOMMENDATIONS

6.1 Seismic Design Parameters

Presented below are the seismic design criteria for the project site and immediate area.

Description	Value
2018 International Building Code Site Classification (IBC)[1]	D[2]
Site Latitude	29.35.089°
Site Longitude	-98.32595°
Maximum Considered Earthquake 0.2 second Design Spectral Response Acceleration (S_{DS})	0.055 g
Maximum Considered Earthquake 1.0 second Design Spectral Response Acceleration (S_{D1})	0.037 g

[1] As per the requirements of Section R301.2.2.1.1 in the 2018 IRC and Section 1613.3.2 in the 2015 IBC, the site class definition was determined using SPT N-values in conjunction with Table 20.3-1 of the ASCE 7. The Spectral Acceleration values were determined using publicly available information provided on the United States Geological Survey (USGS) website. The above criteria can be used to determine the Seismic Design Category using Table R301.2.2.1.1 in the 2015 IRC.

[2] Note: Chapter 20 of ASCE 7 requires a site soil profile determination extending to a depth of 100 feet for seismic site classification. The current scope does not include the required 100-foot soil profile determination. The boring extended to a maximum depth of ***15 feet***, and this seismic site class definition considers that similar soils continues below the maximum depth of the subsurface exploration. Additional exploration to deeper depths would be required to confirm the conditions below the current depth of exploration.

6.2 Shallow Foundations

Please note that the foundation design recommendations and construction guidelines provided in this section are ***preliminary*** and shall <u>*only*</u> be used for planning and budgeting purposes. The recommendations and construction guidelines shall not be used for final foundation design.

6.2.1 <u>Preliminary Monolithic Slab and Beam Foundation Recommendations</u>

Slab foundations should be designed such that if the subsoils expand or contract, the entire slab foundation would move as one unit. ***Please note that such a foundation system does not eliminate potential foundation movement due to expansion or contraction of the subsoils. As stated previously, the subsoils may yield a PVR ranging from 2 inches to approximately 5 inches, thus foundation movement of approximately 2 inches to 5 inches should be expected.*** Should this range of potential foundation movement exceed the desired performance, earthwork operations may be required to reduce the PVR of subsoils. TTL can provide these recommendations once a desired PVR is provided to us.

The foundation system would consist of perimeter and interior concrete foundation beams poured monolithic with the slab. Based on subsurface conditions encountered at the site, without accounting for any cuts or fills, ***preliminary*** design parameters for this foundation type are provided below. The ***preliminary*** foundation parameters are provided for the observed soil conditions and are presented in the following table.

EXISTING CONDITIONS – Preliminary Parameters			
PTI Method; 3rd Edition[1,3,4,5]			
Vertical Moisture Barrier Depth (ft)[6,7]:	<2½	2½	3
Edge Moisture Variation Distance (e_m):			
Center Lift (ft):	7.2	6.7	6.5
Edge Lift (ft):	3.8	2.9	2.5
Maximum Unrestrained Differential Soil Movement or Swell (y_m):			
Center Lift (in):	1.7	1.3	1.2
Edge Lift (in):	2.6	1.7	1.5
Coefficient of Slab-Subgrade Friction (μ):	0.75	0.75	0.75
Net Allowable Bearing Pressures[2]:			
Total Load Conditions (psf):	2500	2500	2500
Dead Load Plus Gravity Live Load Conditions (psf):	1700	1700	1700
Maximum Allowable Deflection Ratio of Foundation Beam:	1/360	1/360	1/360

Notes Applicable to the PTI Slab Foundation Design:

1	Design parameters based on preparing the subgrade and constructing a residential pad as recommended in **EARTHWORK RECOMMENDATIONS SECTION 4.0** of this report.
2	Includes a factor of safety (FS) of at least 2 for total load conditions and at least 3 for dead load plus gravity live load conditions.
3	If the floor slab of the foundation is to be covered with wood, vinyl tile, carpet, or other moisture sensitive or impervious coverings, a vapor barrier should be placed beneath concrete slab foundations or concrete floor slabs if they are bearing directly on the ground. The designer should be familiar with the American Concrete Institute (ACI) 302 for procedures and cautions about the use and placement of a vapor barrier.
4	The width of foundation beams should not be less than 10 inches. The minimum bearing depth below the adjacent ground surface (also referred to as "final grade") should not be less than ***24 inches*** for perimeter and interior foundation beams. These foundation dimension recommendations are for the proper development of bearing capacity for the foundations and to reduce the potential for water to migrate beneath the foundation. These recommendations are not based on structural considerations of the applicable design method. Actual foundation depths and widths may need to be greater than the minimum recommended herein for structural considerations, which should be properly evaluated and designed by the Structural or Foundation Engineer.
5	This is essentially an empirical design method and the recommended design parameters are based on our understanding of the proposed project, our interpretation of the information and data collected as a part of this study, our area experience, and the criteria published in the PTI design manual.
6	According to the PTI 3rd Edition, a vertical barrier must extend at least ***24 inches*** below the adjacent ground surface to be considered as having any significant effect. Foundation beams bearing less than 30 inches below the adjacent ground surface ("final grade") are not considered a vertical moisture barrier.

7	According to the PTI 3rd Edition, once the foundation plan has been determined, the Shape Factor (SF) shall be calculated. If the SF exceeds 24, the designer should contact us to discuss additional geotechnical engineering recommendations to reduce the y_m and e_m values to recommended values.

At the time of the field exploration the site had not been cleared of vegetation and mass grading had not been conducted. Therefore, our recommendations for PTI design are based on the subsoil conditions that we encountered during our drilling operations at the Site and at existing grade.

6.2.2 Shallow Foundation Construction Considerations

Excavations for shallow foundations and grade beams shall be neat excavated with a smooth-mouthed bucket. If a toothed bucket is used, excavation with this bucket should be stopped 6 inches above the final foundation bearing surface and the excavation completed with a smooth-mouthed bucket or by hand labor. Debris in the bottom of the excavations should be removed prior to steel placement. If neat excavation is not possible, the foundation should be overexcavated and formed. All loose materials should be removed from the overexcavated areas and filled with lean concrete or flowable fill as described in ACI 229R.

Reinforcing steel should be placed and the foundation constructed as quickly as possible to avoid exposure of the foundation bottoms to wetting and drying. The excavations should be sloped sufficiently to create internal sumps for runoff collection and removal of water. If surface runoff or subsurface water seepage in excess of 1 inch accumulates at the bottom of the excavation, it should be collected and removed so that ponding water does not adversely affect the quality of the bearing surfaces. Special care should be taken to protect exposed bearing surfaces from disturbance or drying out prior to the placement of concrete.

6.3 Settlement of Grade Supported Foundations

Total settlement of grade supported foundations designed and constructed as recommended in this report is expected to be about 1 inch or less. The settlement of the foundations is expected to be elastic in nature with most of the observed settlement occurring during construction. Differential settlement approaching ½ to ¾ of the total foundation settlement should be expected to occur between load bearing foundation elements. The settlement response of grade supported foundations is impacted more by the quality of construction than by soil-structure interaction. The improper installation of foundation elements can result in differential settlements that are greater than we have estimated.

7.0 LIMITATIONS

This geotechnical engineering report has been prepared for the exclusive use of our Client for specific application to this Project. This geotechnical engineering report has been prepared in accordance with generally accepted geotechnical engineering practices using that level of care and skill ordinarily exercised by licensed members of the engineering profession currently practicing under similar conditions in the same locale. No warranties, express or implied, are intended or made.

TTL understands that this geotechnical engineering report will be used by the Client and various individuals and firms' designers and contractors involved with the preliminary design of the Project. TTL should be invited to attend Project meetings (in person or teleconferencing) or be contacted in writing to address applicable issues relating to the geotechnical engineering aspects of the Project. The information provided in this report is intended for planning purposes only and should not be used for final design considerations.

This geotechnical engineering report is based upon the information provided to us by the Client and various other individuals and entities associated with the Project, along with the field exploration, laboratory testing, and engineering analyses and evaluations performed by TTL as described in this report. The Client and readers of this geotechnical engineering report should realize that subsurface variations and anomalies may exist across the site which may not be revealed by our field exploration. Furthermore, the Client and readers should realize that site conditions can change due to the modifying effects of seasonal and climatic conditions and conditions at times after our exploration may be different than reported herein.

The nature and extent of such site or subsurface variations may not become evident until construction commences or is in progress. If site and subsurface anomalies or variations exist or develop, TTL should be contacted immediately so that the situation can be properly evaluated and, if necessary, addressed with provide applicable recommendations.

Unless stated otherwise in this report or in the contract documents between TTL and Client, our scope of services for this Project did not include, either specifically or by implication, any environmental or biological assessment of the site or buildings, or any identification or prevention of pollutants, hazardous materials or conditions at the site or within buildings. If the Client is concerned about the potential for such contamination or pollution, TTL should be contacted to provide a scope of additional services to address the environmental concerns. In addition, TTL is not responsible for permitting, site safety, excavation support, and dewatering requirements.

Should the nature, design, or location of the Project, as outlined in this geotechnical engineering report be modified, the geotechnical engineering recommendations and guidelines provided in this document will not be considered valid unless TTL is authorized to review the changes and either verifies or modifies the applicable Project changes in writing.

Additional information about the use and limitations of a geotechnical report is provided within the Geoprofessional Business Association document included at the end of this report.

Important Information about This

Geotechnical-Engineering Report

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

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:
- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:
- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are <u>not</u> final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are <u>Not</u> Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

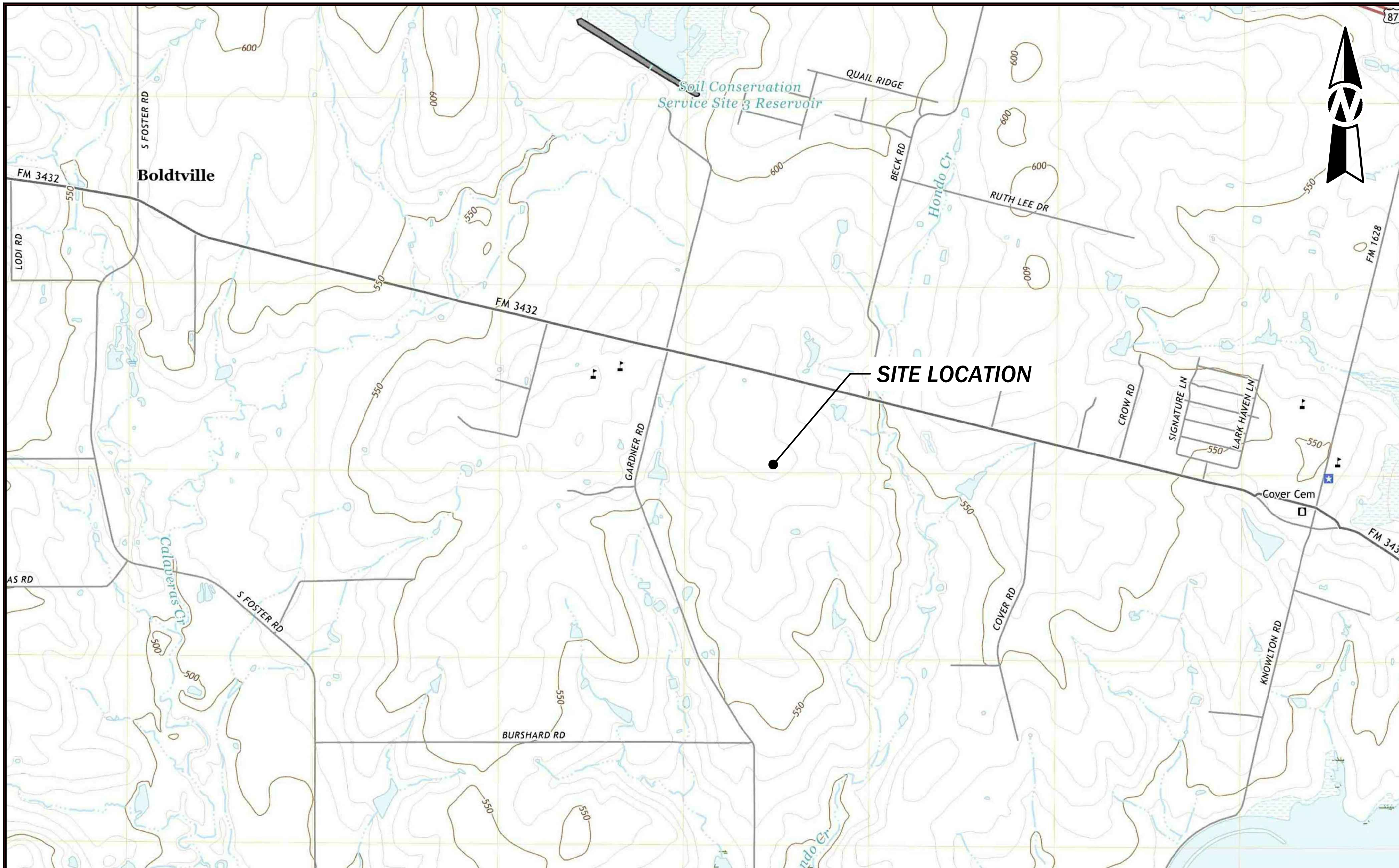
Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will <u>not</u> of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are <u>not</u> building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

APPENDIX A
ILLUSTRATIONS



TTL

17215 Jones Maltsberger, Suite 101 | San Antonio, TX 78232
210.888.6100 | www.ttlusa.com
TBPE Firm Registration No. F-12622 | TBPG Firm Registration No. 50456

SULPHUR SPRINGS SUBDIVISION

NEW SULPHUR SPRINGS ROAD AND GARDNER ROAD
BEXAR COUNTY, TEXAS

Drawn By: EG
Checked By: AB
Date: 08/07/2020
Proj. No.: 00200902069.01
File Name:
Exhibits.dwg

EXHIBIT 1
SITE LOCATION MAP

TTL

17215 Jones Maltsberger, Suite 101 | San Antonio, TX 78232
210.888.6100 | www.ttlusa.com
TBPE Firm Registration No. F-12622 | TBPG Firm Registration No. 50456

SULPHUR SPRINGS SUBDIVISION

NEW SULPHUR SPRINGS ROAD AND GARDNER ROAD
BEXAR COUNTY, TEXAS

Drawn By: NKA
Checked By: JMP
Date: 1/18/2022
Proj. No.: 00200902069.01
File Name: Exhibits.dwg

EXHIBIT 2
BORING LOCATION PLAN

SOIL LEGEND

FINE- AND COARSE-GRAINED SOIL INFORMATION

FINE-GRAINED SOILS (SILTS AND CLAYS)

SPT N-Value	Consistency	Estimated Q_u (TSF)
0 - 1	Very Soft	0 - 0.25
2 - 4	Soft	0.25 - 0.5
5 - 8	Firm	0.5 - 1.0
9 - 15	Stiff	1.0 - 2.0
16 - 30	Very Stiff	2.0 - 4.0
31+	Hard	4.0+

Q_u = Unconfined Compression Strength

COARSE-GRAINED SOILS (SANDS AND GRAVELS)

SPT N-Value	Relative Density
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
51+	Very Dense

PARTICLE SIZE

Name	Size (US Std. Sieve)
Boulders	>300 mm (>12 in.)
Cobbles	75 mm to 300 mm (3 - 12 in.)
Coarse Gravel	19 mm to 75 mm (3/4 - 3 in.)
Fine Gravel	4.75 mm to 19 mm (#4 - 3/4 in.)
Coarse Sand	2 mm to 4.75 mm (#10 - #4)
Medium Sand	0.425 mm to 2 mm (#40 - #10)
Fine Sand	0.075 mm to 0.425 mm (#200 - #40)
Silts and Clays	< 0.075 mm (< #200)

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Terms	Percent of Dry Weight
"Trace"	< 15
"With"	15 - 30
Modifier	> 30

RELATIVE PROPORTIONS OF CLAYS AND SILTS

Descriptive Terms	Percent of Dry Weight
"Trace"	< 5
"With"	5 - 12
Modifier	> 12

CRITERIA FOR DESCRIBING MOISTURE CONDITION

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp, but no visible water
Wet	Visible free water, usually soil is below water table

CRITERIA FOR DESCRIBING CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

CRITERIA FOR DESCRIBING STRUCTURE

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note the thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

SAMPLERS AND DRILLING METHODS

- AUGER CUTTINGS
- BAG/BULK SAMPLE
- GRAB SAMPLE
- CONTINUOUS SAMPLES
- SHELBY TUBE SAMPLE
- PITCHER SAMPLE
- STANDARD PENETRATION SPLIT-SPOON SAMPLE
- SPLIT-SPOON SAMPLE WITH NO RECOVERY
- DYNAMIC CONE PENETROMETER
- ROCK CORE

WATER LEVEL SYMBOLS

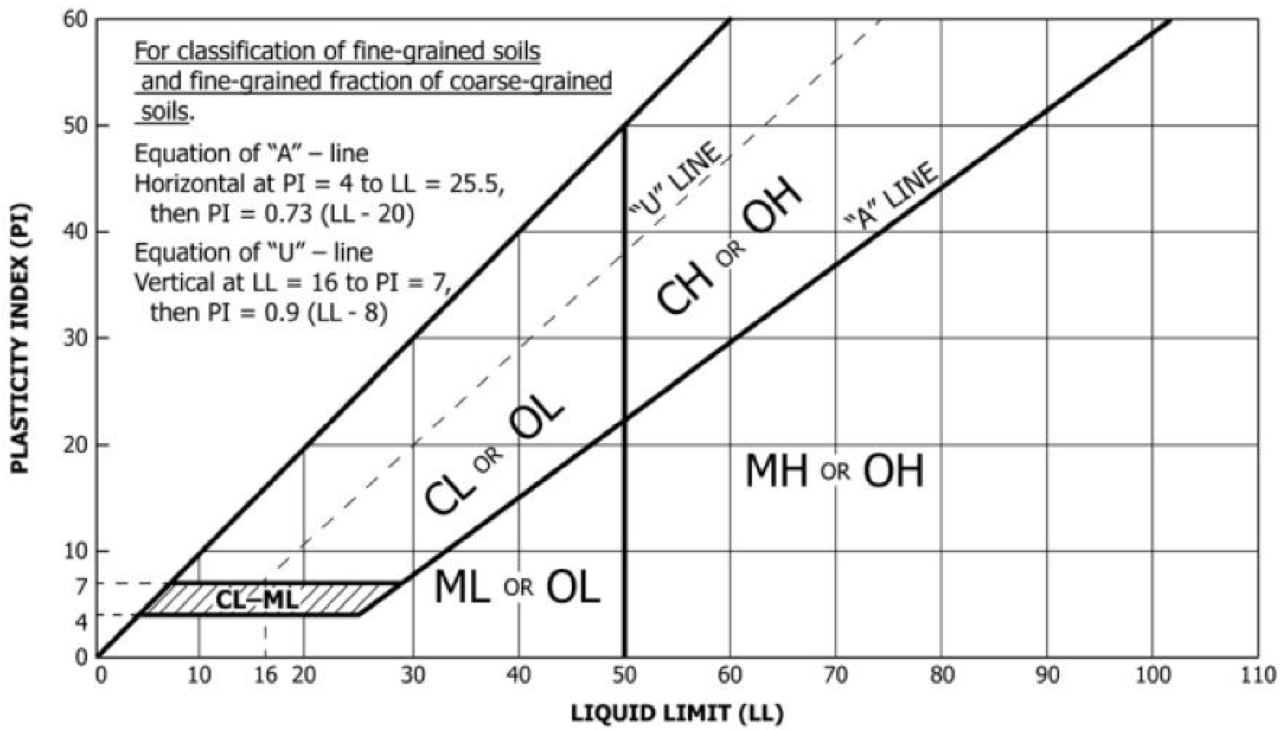
- WATER LEVEL AT TIME OF DRILLING
- PERCHED WATER OBSERVED AT DRILLING
- DELAYED WATER LEVEL OBSERVATION
- CAVE-IN DEPTH
- OBSERVED SEEPAGE

ABBREVIATIONS AND ACRONYMS

WOH	Weight of Hammer
WOR	Weight of Rod
Ref.	Refusal
ATD	At Time of Drilling
DCP	Dynamic Cone Penetrometer
Elev.	Elevation
ft.	feet
HSA	Hollow Stem Auger
ID	Inside Diameter
in.	inches
lbs	pounds
N-Value	Sum of the blows for last two 6-in increments of SPT
NA	Not Applicable or Not Available
OD	Outside Diameter
PPV	Pocket Penetrometer Value
SFA	Solid Flight Auger
SH	Shelby Tube Sampler
SS	Split-Spoon Sampler
SPT	Standard Penetration Test
USCS	Unified Soil Classification System

TTL

PLASTICITY CHART FOR USCS CLASSIFICATION OF FINE-GRAINED SOILS



IMPORTANT NOTES ON TEST BORING RECORDS

1) The report and graphics key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.

2) Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown. Solid lines are used to indicate a change in the material type, particularly a change in the USCS classification. Dashed lines are used to separate two materials that have the same material type, but that differ with respect to two or more other characteristics (e.g. color, consistency).

3) No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.

4) Logs represent general soil and rock conditions observed at the point of exploration on the date indicated.

5) In general, Unified Soil Classification System (USCS) designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.

6) Fine-grained soils that plot within the hatched area on the Plasticity Chart, and coarse-grained soils with between 5% and 12% passing the #200 sieve require dual USCS symbols as presented on the previous page.

7) If the sampler is not able to be driven at least 6 inches, then 50/X" indicates that the sampler advanced X inches when struck 50 times with a 140-pound hammer falling 30 inches.

8) If the sampler is driven at least 6 inches, but cannot be driven either of the subsequent two 6-inch increments, then either 50/X" or the sum of the second 6-inch increment plus 50/X" for the third 6-inch increment will be indicated.
Example 1: Recorded SPT blow counts are 16 - 50/4", the SPT N-value will be shown as N = 50/4"
Example 2: Recorded SPT blow counts are 18 - 25 - 50/2", the SPT N-value will be shown as N = 75/8"

TTL

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Log of B-01

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/22/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.33046 Latitude: 29.34728*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA: 1st 6" - 2nd 6" - 3rd 6" N-VALUE BLOWS/FT; P: TONS/SQFT; RQD / % REC	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0		LEAN CLAY WITH SAND; very stiff, very dark brown (CL)											
				SPT	10 - 8 - 12 N = 20	11	48	14	34					75.3
			FAT CLAY WITH SAND; very stiff to hard, light brown (CH)											
				SPT	9 - 12 - 17 N = 29	15	53	11	42					84.6
	5			SPT	5 - 10 - 16 N = 26	17								
			- with chert rock pieces	SPT	42 - 50/5 N = 50/5"	22								
			- less sand; olive and gray below 8½ feet											
				SPT	8 - 9 - 13 N = 22	21	71	15	56					98.7
	10													
				SPT	8 - 12 - 15 N = 27	24								
	15		Boring terminated at 15 feet.											

R:\GINT\TTL\PROJECTS\2020\00200902069.00 -- SULPHUR SPRINGS SUBDIVSION.GPJ 1/5/22 Report:AEP-GEOTECH LOG - LAT LONG

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/22/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.33219 Latitude: 29.34785*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

Elevation (ft)	Depth (ft)	Materials Description	Bore/Core Data (1st 6" - 2nd 6" - 3rd 6", N-Value Blows/ft)	Moisture Content (%)	LL	PL	PI	Dry Density (psf)	Shear Strength (psf)	Failure Strain (%)	Confining Pressure (psi)	% Passing #200 Sieve
	0	SANDY FAT CLAY; very stiff to hard, very dark brown (CH)										
	1		11 - 10 - 10 N = 20	12	58	15	43					64.3
	2	- with sand between 2½ and 8½ feet										
	3		8 - 7 - 14 N = 21	20								
	4.5	- becomes olive gray below 4½ feet, calcareous										
	5	- with chert rock pieces	6 - 8 - 11 N = 19	21	80	20	60					70.7
	7		19 - 28 - 30 N = 58	24								
	8.5	- less sand below 8½ feet										
	9		4 - 9 - 11 N = 20	25								
	14		8 - 10 - 13 N = 23	27	82	21	61					98.6
	15	Boring terminated at 15 feet.										

R:\GINT\TTL\PROJECTS\2020\00200902069.00 -- SULPHUR SPRINGS SUBDIVSION.GPJ 1/5/22 Report:AEP-GEOTECH LOG - LAT LONG

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Log of B-03

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/22/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.33288 Latitude: 29.3494*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA: 1st 6" - 2nd 6" - 3rd 6" / N-VALUE BLOWS/FT	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0		FAT CLAY WITH SAND; stiff to very stiff, very dark brown (CH)	SPT	7 - 11 - 13 N = 24			11	58	14	44					79.7
			- becomes light brown between 2½ and 4½ feet	SPT	8 - 10 - 13 N = 23			17	67	17	50					80.4
	5		- becomes olive gray below 4½ feet, with chert rock pieces	SPT	7 - 10 - 12 N = 22			23								
				SPT	5 - 7 - 9 N = 16			27								
			- less sand below 8½ feet	SPT	5 - 8 - 10 N = 18			29	89	20	69					87.2
	10															
				SPT	4 - 6 - 8 N = 14			30								
	15		Boring terminated at 15 feet.													

R:\GINT\TTL\PROJECTS\2020\00200902069.00 -- SULPHUR SPRINGS SUBDIVSION.GPJ 1/5/22 Report:AEP-GEOTECH LOG - LAT LONG

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Log of B-04

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/22/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.33119 Latitude: 29.34851*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA: 1st 6" - 2nd 6" - 3rd 6" / N-VALUE BLOWS/FT	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	LL (LIQUID LIMIT)	PL (PLASTIC LIMIT)	PI (PLASTICITY INDEX)	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0		FAT CLAY WITH SAND; stiff to hard, very dark brown (CH)													
				SPT	6 - 6 - 7 N = 13			13	56	16	40					82.4
				SPT	8 - 13 - 15 N = 28			18								
			- becomes olive gray below 4½ feet, with chert rock pieces													
	5			SPT	6 - 12 - 16 N = 28			20	64	27	37					80.1
				SPT	16 - 30 - 45 N = 75			21								
			- less sand below 8½ feet													
				SPT	7 - 13 - 16 N = 29			23								
	10															
				SPT	8 - 14 - 18 N = 32			24	77	20	57					96.6
	15		Boring terminated at 15 feet.													

R:\GINT\TTL\PROJECTS\2020\00200902069.00 -- SULPHUR SPRINGS SUBDIVSION.GPJ 1/5/22 Report:AEP-GEOTECH LOG - LAT LONG

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Log of B-05

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/22/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.32982 Latitude: 29.34795*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks: Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

ELEVATION (ft)	DEPTH (ft)	MATERIALS DESCRIPTION	N-VALUE BLOWS/FT (1st 6" - 2nd 6" - 3rd 6")	MOISTURE CONTENT (%)	LL	PL	PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0	FAT CLAY WITH SAND; firm to very stiff, very dark brown (CH)										
			5 - 5 - 5 N = 10	13								
			4 - 4 - 3 N = 7	11	55	14	41					80.3
		- becomes olive gray below 4½ feet										
	5		5 - 6 - 7 N = 13	15								
		- becomes hard between 6½ and 8 feet	13 - 16 - 20 N = 36	20	72	14	58					79.0
		- less sand below 8½ feet	6 - 11 - 13 N = 24	24								
	10											
			7 - 11 - 14 N = 25	24	70	21	49					
	15	Boring terminated at 15 feet.										

R:\GINT\TTL\PROJECTS\2020\00200902069.00 -- SULPHUR SPRINGS SUBDIVSION.GPJ 1/5/22 Report:AEP-GEOTECH LOG - LAT LONG

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Log of B-06

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/23/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.32858 Latitude: 29.34863*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA: 1st 6" - 2nd 6" - 3rd 6" / N-VALUE BLOWS/FT	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	LL (LIQUID LIMIT)	PL (PLASTIC LIMIT)	PI (PLASTICITY INDEX)	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0		FAT CLAY WITH SAND; stiff to hard, very dark brown (CH)													
				SPT	5 - 7 - 8 N = 15			12								78.7
			- becomes brown between 2½ and 4½ feet													
				SPT	8 - 6 - 8 N = 14			11								
			- less sand and olive gray below 4½ feet, calcareous between 4½ and 6 feet													
	5			SPT	6 - 12 - 12 N = 24			15	58	15	43					86.7
				SPT	8 - 13 - 17 N = 30			18								
				SPT	13 - 11 - 15 N = 26			18	70	18	52					
	10															
				SPT	8 - 15 - 19 N = 34			18								
	15		Boring terminated at 15 feet.													

R:\GINT\TTL\PROJECTS\2020\00200902069.00 -- SULPHUR SPRINGS SUBDIVSION.GPJ 1/5/22 Report:AEP-GEOTECH LOG - LAT LONG

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Log of B-07

Drilling Co.:	*Blue Hole Drilling*	TTL Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/22/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.32713 Latitude: 29.34756*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA (1st 6" - 2nd 6" - 3rd 6", N-VALUE BLOWS/FT)	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	LL (LIQUID LIMIT)	PL (PLASTIC LIMIT)	PI (PLASTICITY INDEX)	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0	SANDY LEAN CLAY; very stiff to hard, brown (CL)													
			SPT	8 - 8 - 10 N = 18			9	41	14	27					61.7
		- with sand between 2½ and 4½ feet													
			SPT	11 - 12 - 17 N = 29			9	49	17	32					79.7
	5		SPT	9 - 13 - 14 N = 27			14								
			SPT	40 - 25 - 22 N = 47			7	49	13	36					58.5
		- less sand below 8½ feet													
			SPT	12 - 23 - 34 N = 57			11	48	24	24					95.8
	10														
			SPT	11 - 16 - 19 N = 35			15								
	15	Boring terminated at 15 feet.													

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Log of B-08

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/23/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.32494 Latitude: 29.3479*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

DEPTH (ft)	MATERIALS DESCRIPTION	BORE/CORE DATA (1st 6" - 2nd 6" - 3rd 6", N-VALUE BLOWS/FT)	MOISTURE CONTENT (%)	LL	PL	PI	% PASSING #200 SIEVE
0	LEAN CLAY WITH SAND; very stiff to hard, very dark brown (CL)						
1.5		7 - 8 - 9, N = 17	11	47	16	31	81.7
2.5		50/2, N = 50/2"					
3.5			9				
4.5	- sandy and light brown below 4½ feet						
5.5		15 - 15 - 14, N = 29	9	45	17	28	66.0
6	FAT CLAY; very stiff to hard, olive gray (CH)						
7.5		8 - 12 - 14, N = 26	17	67	23	44	98.5
9.5		9 - 14 - 17, N = 31	19				
14.5		9 - 19 - 24, N = 43	14				
15	Boring terminated at 15 feet.						

Other columns (ELEVATION (ft), GRAPHIC LOG, TYPE, P: TONS/SQFT, RQD / % REC, DRY DENSITY (psf), SHEAR STRENGTH (psf), FAILURE STRAIN (%), CONFINING PRESSURE (psi)) contain no values.

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/23/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.32295 Latitude: 29.34762*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	MATERIALS DESCRIPTION	TYPE	N-VALUE BLOWS/FT (1st 6" - 2nd 6" - 3rd 6")	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	LL	PL	PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0	LEAN CLAY WITH SAND; stiff to hard, very dark brown (CL)													
	1–2.5		SPT	5 - 6 - 7, N = 13			11								78.1
	3–4.5		SPT	8 - 11 - 14, N = 25			12								
	4.5	- becomes light brown below 4½ feet													
	5	- cemented between 4½ and 6 feet	SPT	10 - 12 - 50/6, N = 62/12"			10								80.9
	6	FAT CLAY; very stiff to hard, olive gray (CH)													
	7–8.5		SPT	6 - 9 - 11, N = 20			18								
	9–10		SPT	11 - 14 - 19, N = 33			14								
	13.5–15		SPT	7 - 13 - 16, N = 29			23	71	21	50					98.2
	15	Boring terminated at 15 feet.													

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/23/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.32215 Latitude: 29.34913*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

DEPTH (ft)	MATERIALS DESCRIPTION	TYPE	N-VALUE (BLOWS/FT) 1st 6" - 2nd 6" - 3rd 6"	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	LL	PL	PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
0	SANDY LEAN CLAY; stiff to very stiff, brown (CL)													
0.5–2		SPT	8 - 6 - 8 N = 14			11								
2.5–4		SPT	10 - 14 - 15 N = 29			10	45	15	30					65.4
4.5	- becomes light brown below 4½ feet													
4.5–6		SPT	13 - 15 - 15 N = 30			12								
6	FAT CLAY; hard, olive gray (CH)													
6.5–8		SPT	9 - 14 - 18 N = 32			19	54	23	31					
8.5–10		SPT	13 - 18 - 21 N = 39			16								
13.5–15		SPT	14 - 20 - 25 N = 45			16								
15	Boring terminated at 15 feet.													

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/23/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.32394 Latitude: 29.35043*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	MATERIALS DESCRIPTION	BORE/CORE DATA (1st 6" - 2nd 6" - 3rd 6", N-VALUE BLOWS/FT)	MOISTURE CONTENT (%)	LL	PL	PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0	LEAN CLAY WITH SAND; stiff to very stiff, very dark brown (CL)										
			4 - 4 - 5 N = 9	10	44	16	28					70.8
			6 - 7 - 10 N = 17	12								
		- becomes light brown below 4½ feet										
	5		11 - 13 - 15 N = 28	9	49	16	33					76.8
	6	FAT CLAY; very stiff to hard, olive gray (CH)										
			9 - 14 - 16 N = 30	16								
			8 - 12 - 16 N = 28	18	68	26	42					
	10											
			9 - 14 - 20 N = 34	20								
	15	Boring terminated at 15 feet.										

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Log of B-14

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/23/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.32595 Latitude: 29.35089*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA: 1st 6" - 2nd 6" - 3rd 6" / N-VALUE BLOWS/FT	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0		LEAN CLAY WITH SAND; stiff to very stiff, very dark brown (CL)													
				SPT	6 - 6 - 7 N = 13			12	38	17	21					
				SPT	10 - 11 - 12 N = 23			15	44	16	28					70.6
			- becomes brown between 4½ and 6½ feet													
	5			SPT	12 - 15 - 15 N = 30			12	46	17	29					
			- becomes tan below 6½ feet													
				SPT	16 - 20 - 24 N = 44			10	45	15	30					84.5
	8		FAT CLAY; hard, olive gray (CH)													
				SPT	13 - 19 - 24 N = 43			15								
	10															
				SPT	8 - 16 - 21 N = 37			18								
	15		Boring terminated at 15 feet.													

R:\GINT\TTL\PROJECTS\2020\00200902069.00 -- SULPHUR SPRINGS SUBDIVSION.GPJ 1/5/22 Report:AEP-GEOTECH LOG - LAT LONG

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/23/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.32779 Latitude: 29.35038*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA: 1st 6" - 2nd 6" - 3rd 6" / N-VALUE BLOWS/FT	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0		LEAN CLAY WITH SAND; stiff to hard, very dark brown (CL)													
				SPT	3 - 4 - 6 N = 10			10	44	16	28					74.1
				SPT	10 - 13 - 15 N = 28			11								
			- becomes tan below 4½ feet													
	5			SPT	11 - 16 - 23 N = 39			11	42	15	27					81.3
	6		FAT CLAY; very stiff, olive gray (CH)													
				SPT	8 - 9 - 12 N = 21			21								
				SPT	5 - 9 - 15 N = 24			22								
	10															
				SPT	6 - 11 - 13 N = 24			22	80	28	52					
	15		Boring terminated at 15 feet.													

TTL	**Lennar** **Sulphur Springs Subdivision** **New Sulphur Springs Road and Gardner Road** Bexar County, Texas	**Log of B-21** Page 1 of 1

Drilling Co.: *Blue Hole Drilling*	**TTL** Project No.: *00200902069.01*	Remarks: Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.
Driller: *B. Perez*	Date Drilled: *8/23/2020*	
Logged by: *E. Garcia*	Boring Depth: *15 feet*	
Equipment: *CME 75*	Boring Elevation: *Ground Surface*	
Hammer Type: *Automatic*	Coordinates: *Longitude: -98.32765 Latitude: 29.35231*	
Drilling Method: *Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling: *Not Encount.* Cave-In at Time of Drilling: *N/A*	Delayed Water Level: *N/A* Delayed Water Observation Date: *N/A*

SAMPLE DATA

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA: N-VALUE BLOWS/FT (1st 6" 2nd 6" 3rd 6")	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0	CL	SANDY LEAN CLAY; stiff to hard, very dark brown (CL)													
				SPT	8 - 6 - 8 N = 14			7	36	13	23					59.9
				SPT	10 - 13 - 15 N = 28			10								
			- becomes dark brown and brown below 4½ feet													
	5			SPT	13 - 24 - 25 N = 49			10								
	6	CH	FAT CLAY; very stiff to hard, olive gray (CH)													
				SPT	8 - 13 - 15 N = 28			17	56	16	40					87.4
				SPT	9 - 11 - 50/4 N = 61/10"			17	60	18	42					
	10															
				SPT	10 - 21 - 27 N = 48			16	53	15	38					
	15		Boring terminated at 15 feet.													

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Log of B-22

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/23/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.32403 Latitude: 29.35149*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

SAMPLE DATA

DEPTH (ft)	MATERIALS DESCRIPTION	BORE/CORE DATA (1st 6" - 2nd 6" - 3rd 6"; N-VALUE BLOWS/FT)	MOISTURE CONTENT (%)	LL	PL	PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
0	SANDY LEAN CLAY; stiff, very dark brown (CL)										
		4 - 5 - 6 N = 11	11	44	12	32					
		4 - 6 - 8 N = 14	14								
4	FAT CLAY WITH SAND; very stiff to hard, olive gray, calcareous (CH)										
5		5 - 8 - 12 N = 20	15	57	13	44					
		9 - 16 - 21 N = 37	14	59	16	43					79.9
		14 - 50/3 N = 50/3"	13								
10											
		13 - 23 - 25 N = 48	17								
15	Boring terminated at 15 feet.										

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road

Bexar County, Texas

Log of B-25

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/23/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.32543 Latitude: 29.35262*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

ELEVATION (ft)	DEPTH (ft)	MATERIALS DESCRIPTION	BORE/CORE DATA: 1st 6" - 2nd 6" - 3rd 6", N-VALUE BLOWS/FT	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	LL	PL	PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0	SANDY LEAN CLAY; stiff to hard, dark brown (CL)												
			8 - 6 - 7, N = 13			8	42	13	29					
		- becomes brown between 2½ and 4½ feet												
			10 - 13 - 13, N = 26			11	45	12	33					
		- becomes tan below 4½ feet												
	5		11 - 13 - 18, N = 31			7								
	6	FAT CLAY WITH SAND; very stiff to hard, olive gray (CH)												
			7 - 10 - 12, N = 22			16								
			7 - 12 - 16, N = 28			21	61	16	45					78.3
	10													
			10 - 14 - 18, N = 32			18								
	15	Boring terminated at 15 feet.												

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Log of B-26

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/23/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.32652 Latitude: 29.35444*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

ELEVATION (ft)	DEPTH (ft)	MATERIALS DESCRIPTION	N-VALUE BLOWS/FT (1st 6" - 2nd 6" - 3rd 6")	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	LL	PL	PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
	0	SANDY LEAN CLAY; very stiff, brown (CL)												
			7 - 9 - 10 N = 19			10	44	11	33					65.8
		- becomes light brown below 2½ feet												
			12 - 17 - 50/4 N = 67/10"			6								51.3
		- weathered mudstone rock layer between 4½ and 6½ feet	50/1 N = 50/1"											
	5					5								
			13 - 13 - 14 N = 27			12	44	12	32					72.6
		FAT CLAY WITH SAND; hard, olive gray (CH)												
			11 - 15 - 17 N = 32			16	58	15	43					
	10													
			11 - 18 - 24 N = 42			16								
	15	Boring terminated at 15 feet.												

R:\GINT\TTL\PROJECTS\2020\00200902069.00 -- SULPHUR SPRINGS SUBDIVSION.GPJ 1/5/22 Report:AEP-GEOTECH LOG - LAT LONG

Lennar
Sulphur Springs Subdivision
New Sulphur Springs Road and Gardner Road
Bexar County, Texas

Log of B-27

Drilling Co.:	*Blue Hole Drilling*	**TTL** Project No.:	*00200902069.01*
Driller:	*B. Perez*	Date Drilled:	*8/23/2020*
Logged by:	*E. Garcia*	Boring Depth:	*15 feet*
Equipment:	*CME 75*	Boring Elevation:	*Ground Surface*
Hammer Type:	*Automatic*	Coordinates:	*Longitude: -98.32401 Latitude: 29.35423*
Drilling Method:	*Solid Flight Auger w/SPT Sampling*	Water Level at Time of Drilling:	*Not Encount.*
		Cave-In at Time of Drilling:	*N/A*

Remarks:
Subsurface water was not encountered during drilling. The borehole was backfilled with soil cuttings after drilling activities were completed.

Delayed Water Level: *N/A*

Delayed Water Observation Date: *N/A*

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIALS DESCRIPTION	TYPE	BORE/CORE DATA: 1st 6" - 2nd 6" - 3rd 6" / N-VALUE BLOWS/FT	P: TONS/SQFT	RQD / % REC	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (psf)	SHEAR STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	% PASSING #200 SIEVE
			SANDY LEAN CLAY; stiff to very stiff, dark brown (CL)													
				X	6 - 7 - 8 N = 15			10	44	12	32					67.7
			- becomes brown and calcareous below 2½ feet													
				X	8 - 11 - 16 N = 27			10								
			CLAYEY SAND; very dense, light brown, trace gravel (SC)													
	5			X	13 - 28 - 24 N = 52			11	48	12	36					49.8
			FAT CLAY WITH SAND; very stiff to hard, olive gray (CH)													
				X	7 - 9 - 12 N = 21			16	76	16	60					
				X	7 - 13 - 15 N = 28			21								
	10															
				X	18 - 23 - 22 N = 45			15	65	15	50					
	15		Boring terminated at 15 feet.													

Boring	Depth	USCS	AASHTO	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Gravel	% Sand	Maximum Size (mm)	% Passing #200 % Silt % Clay (If hydrometer data available)	D50 (mm)
B-01	0.5 - 2	CL	A-7-6 (24)	11	48	14	34	0.0	0.0	0.075	75.3	---
B-01	2.5 - 4	CH	A-7-6 (36)	15	53	11	42	0.0	0.0	0.075	84.6	---
B-01	4.5 - 6	---	---	17	---	---	---	---	---	---	---	---
B-01	6.5 - 8	---	---	22	---	---	---	---	---	---	---	---
B-01	8.5 - 10	CH	A-7-6 (61)	21	71	15	56	0.0	0.0	0.075	98.7	---
B-01	13.5 - 15	---	---	24	---	---	---	---	---	---	---	---
B-02	0.5 - 2	CH	A-7-6 (25)	12	58	15	43	0.0	0.0	0.075	64.3	---
B-02	2.5 - 4	---	---	20	---	---	---	---	---	---	---	---
B-02	4.5 - 6	CH	A-7-6 (42)	21	80	20	60	0.0	0.0	0.075	70.7	---
B-02	6.5 - 8	---	---	24	---	---	---	---	---	---	---	---
B-02	8.5 - 10	---	---	25	---	---	---	---	---	---	---	---
B-02	13.5 - 15	CH	A-7-6 (69)	27	82	21	61	0.0	0.0	0.075	98.6	---
B-03	0.5 - 2	CH	A-7-6 (35)	11	58	14	44	0.0	0.0	0.075	79.7	---
B-03	2.5 - 4	CH	A-7-6 (41)	17	67	17	50	0.0	0.0	0.075	80.4	---
B-03	4.5 - 6	---	---	23	---	---	---	---	---	---	---	---
B-03	6.5 - 8	---	---	27	---	---	---	---	---	---	---	---
B-03	8.5 - 10	CH	A-7-6 (66)	29	89	20	69	0.0	0.0	0.075	87.2	---
B-03	13.5 - 15	---	---	30	---	---	---	---	---	---	---	---
B-04	0.5 - 2	CH	A-7-6 (33)	13	56	16	40	0.0	0.0	0.075	82.4	---
B-04	2.5 - 4	---	---	18	---	---	---	---	---	---	---	---
B-04	4.5 - 6	CH	A-7-6 (32)	20	64	27	37	0.0	0.0	0.075	80.1	---
B-04	6.5 - 8	---	---	21	---	---	---	---	---	---	---	---
B-04	8.5 - 10	---	---	23	---	---	---	---	---	---	---	---
B-04	13.5 - 15	CH	A-7-6 (62)	24	77	20	57	0.0	0.0	0.075	96.6	---
B-05	0.5 - 2	---	---	13	---	---	---	---	---	---	---	---
B-05	2.5 - 4	CH	A-7-6 (33)	11	55	14	41	0.0	0.0	0.075	80.3	---
B-05	4.5 - 6	---	---	15	---	---	---	---	---	---	---	---
B-05	6.5 - 8	CH	A-7-6 (47)	20	72	14	58	0.0	0.0	0.075	79.0	---
B-05	8.5 - 10	---	---	24	---	---	---	---	---	---	---	---
B-05	13.5 - 15	---	---	24	70	21	49	---	---	---	---	---
B-06	0.5 - 2	---	---	12	---	---	---	0.0	0.0	0.075	78.7	---
B-06	2.5 - 4	---	---	11	---	---	---	---	---	---	---	---
B-06	4.5 - 6	CH	A-7-6 (39)	15	58	15	43	0.0	0.0	0.075	86.7	---
B-06	6.5 - 8	---	---	18	---	---	---	---	---	---	---	---
B-06	8.5 - 10	---	---	18	70	18	52	---	---	---	---	---
B-06	13.5 - 15	---	---	18	---	---	---	---	---	---	---	---
B-07	0.5 - 2	CL	A-7-6 (14)	9	41	14	27	0.0	0.0	0.075	61.7	---
B-07	2.5 - 4	CL	A-7-6 (25)	9	49	17	32	0.0	0.0	0.075	79.7	---
B-07	4.5 - 6	---	---	14	---	---	---	---	---	---	---	---
B-07	6.5 - 8	CL	A-7-6 (17)	7	49	13	36	0.0	0.0	0.075	58.5	---
B-07	8.5 - 10	CL	A-7-6 (26)	11	48	24	24	0.0	0.0	0.075	95.8	---
B-07	13.5 - 15	---	---	15	---	---	---	---	---	---	---	---

TTL

Summary of Laboratory Test Results

Client: Lennar
Project: Sulphur Springs Subdivision
Location: Bexar County, Texas
Project Number: 00200902069.01

Boring	Depth	USCS	AASHTO	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Gravel	% Sand	Maximum Size (mm)	% Passing #200 % Silt % Clay (If hydrometer data available)	D50 (mm)
B-08	0.5 - 2	CL	A-7-6 (25)	11	47	16	31	0.0	0.0	0.075	81.7	---
B-08	2.5 - 4	---	---	9	---	---	---	---	---	---	---	---
B-08	4.5 - 6	CL	A-7-6 (16)	9	45	17	28	0.0	0.0	0.075	66.0	---
B-08	6.5 - 8	CH	A-7-6 (49)	17	67	23	44	0.0	0.0	0.075	98.5	---
B-08	8.5 - 10	---	---	19	---	---	---	---	---	---	---	---
B-08	13.5 - 15	---	---	14	---	---	---	---	---	---	---	---
B-09	0.5 - 2	---	---	11	---	---	---	0.0	0.0	0.075	78.1	---
B-09	2.5 - 4	---	---	12	---	---	---	---	---	---	---	---
B-09	4.5 - 6	---	---	10	---	---	---	0.0	0.0	0.075	80.9	---
B-09	6.5 - 8	---	---	18	---	---	---	---	---	---	---	---
B-09	8.5 - 10	---	---	14	---	---	---	---	---	---	---	---
B-09	13.5 - 15	CH	A-7-6 (56)	23	71	21	50	0.0	0.0	0.075	98.2	---
B-12	0.5 - 2	---	---	11	---	---	---	---	---	---	---	---
B-12	2.5 - 4	CL	A-7-6 (17)	10	45	15	30	0.0	0.0	0.075	65.4	---
B-12	4.5 - 6	---	---	12	---	---	---	---	---	---	---	---
B-12	6.5 - 8	---	---	19	54	23	31	---	---	---	---	---
B-12	8.5 - 10	---	---	16	---	---	---	---	---	---	---	---
B-12	13.5 - 15	---	---	16	---	---	---	---	---	---	---	---
B-13	0.5 - 2	CL	A-7-6 (18)	10	44	16	28	0.0	0.0	0.075	70.8	---
B-13	2.5 - 4	---	---	12	---	---	---	---	---	---	---	---
B-13	4.5 - 6	CL	A-7-6 (25)	9	49	16	33	0.0	0.0	0.075	76.8	---
B-13	6.5 - 8	---	---	16	---	---	---	---	---	---	---	---
B-13	8.5 - 10	---	---	18	68	26	42	---	---	---	---	---
B-13	13.5 - 15	---	---	20	---	---	---	---	---	---	---	---
B-14	0.5 - 2	---	---	12	38	17	21	---	---	---	---	---
B-14	2.5 - 4	CL	A-7-6 (18)	15	44	16	28	0.0	0.0	0.075	70.6	---
B-14	4.5 - 6	---	---	12	46	17	29	---	---	---	---	---
B-14	6.5 - 8	CL	A-7-6 (25)	10	45	15	30	0.0	0.0	0.075	84.5	---
B-14	8.5 - 10	---	---	15	---	---	---	---	---	---	---	---
B-14	13.5 - 15	---	---	18	---	---	---	---	---	---	---	---
B-15	0.5 - 2	CL	A-7-6 (19)	10	44	16	28	0.0	0.0	0.075	74.1	---
B-15	2.5 - 4	---	---	11	---	---	---	---	---	---	---	---
B-15	4.5 - 6	CL	A-7-6 (21)	11	42	15	27	0.0	0.0	0.075	81.3	---
B-15	6.5 - 8	---	---	21	---	---	---	---	---	---	---	---
B-15	8.5 - 10	---	---	22	---	---	---	---	---	---	---	---
B-15	13.5 - 15	---	---	22	80	28	52	---	---	---	---	---
B-21	0.5 - 2	CL	A-6 (10)	7	36	13	23	0.0	0.0	0.075	59.9	---
B-21	2.5 - 4	---	---	10	---	---	---	---	---	---	---	---
B-21	4.5 - 6	---	---	10	---	---	---	---	---	---	---	---
B-21	6.5 - 8	CH	A-7-6 (36)	17	56	16	40	0.0	0.0	0.075	87.4	---
B-21	8.5 - 10	---	---	17	60	18	42	---	---	---	---	---
B-21	13.5 - 15	---	---	16	53	15	38	---	---	---	---	---

TTL

Summary of Laboratory Test Results

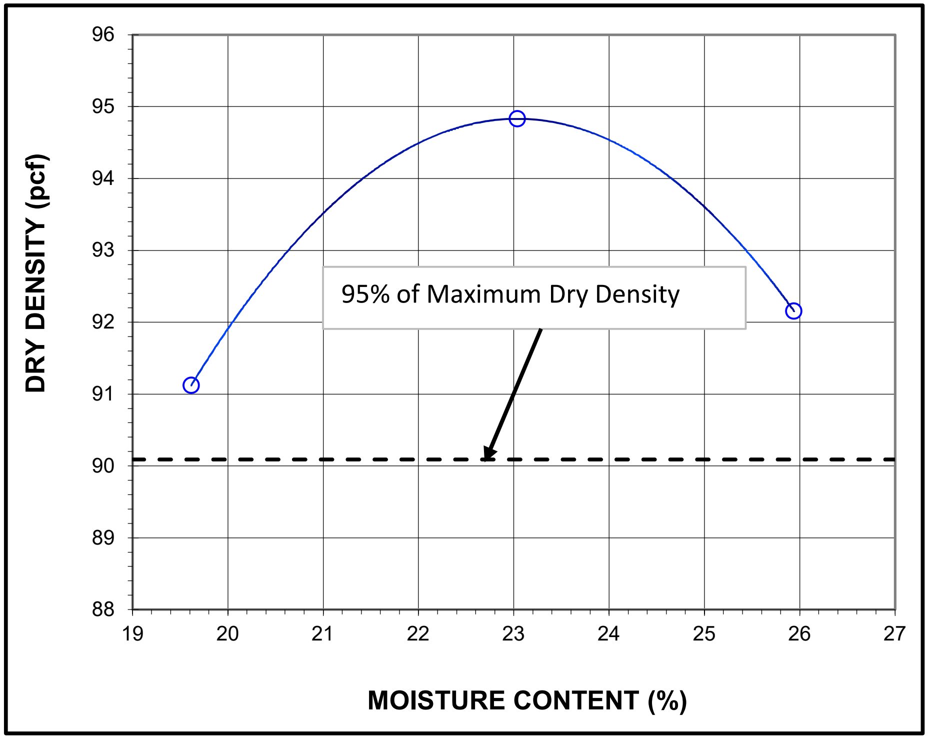
Client: Lennar
Project: Sulphur Springs Subdivision
Location: Bexar County, Texas
Project Number: 00200902069.01

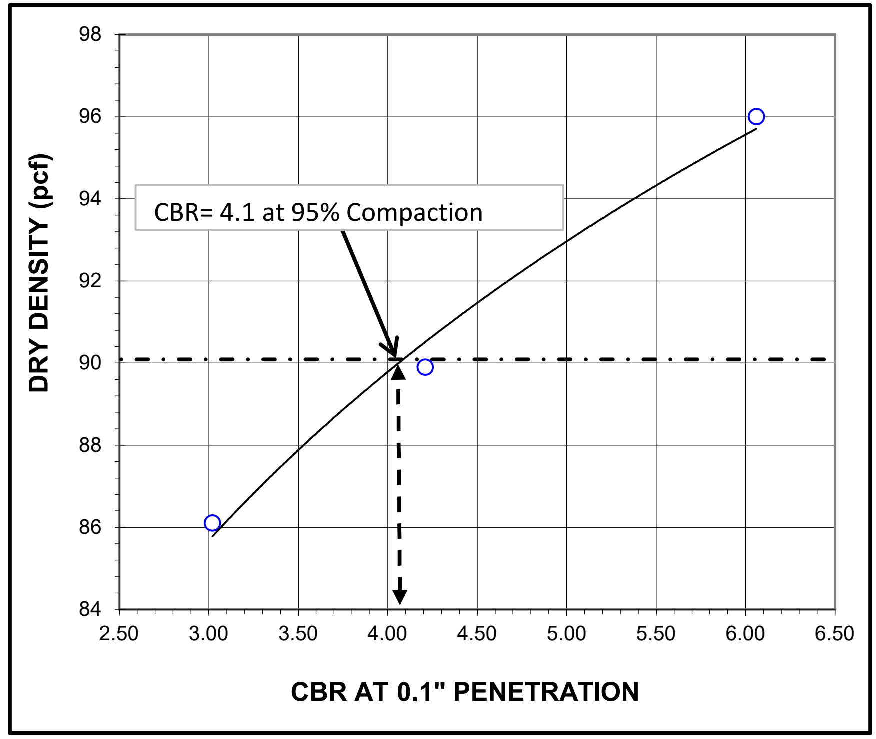
Boring	Depth	USCS	AASHTO	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Gravel	% Sand	Maximum Size (mm)	% Passing #200 % Silt % Clay (If hydrometer data available)	D50 (mm)
B-22	0.5 - 2	---	---	11	44	12	32	---	---	---	---	---
B-22	2.5 - 4	---	---	14	---	---	---	---	---	---	---	---
B-22	4.5 - 6	---	---	15	57	13	44	---	---	---	---	---
B-22	6.5 - 8	CH	A-7-6 (35)	14	59	16	43	0.0	0.0	0.075	79.9	---
B-22	8.5 - 10	---	---	13	---	---	---	---	---	---	---	---
B-22	13.5 - 15	---	---	17	---	---	---	---	---	---	---	---
B-25	0.5 - 2	---	---	8	42	13	29	---	---	---	---	---
B-25	2.5 - 4	---	---	11	45	12	33	---	---	---	---	---
B-25	4.5 - 6	---	---	7	---	---	---	---	---	---	---	---
B-25	6.5 - 8	---	---	16	---	---	---	---	---	---	---	---
B-25	8.5 - 10	CH	A-7-6 (35)	21	61	16	45	0.0	0.0	0.075	78.3	---
B-25	13.5 - 15	---	---	18	---	---	---	---	---	---	---	---
B-26	0.5 - 2	CL	A-7-6 (19)	10	44	11	33	0.0	0.0	0.075	65.8	---
B-26	2.5 - 4	---	---	6	---	---	---	0.0	0.0	0.075	51.3	---
B-26	4.5 - 6	---	---	5	---	---	---	---	---	---	---	---
B-26	6.5 - 8	CL	A-7-6 (21)	12	44	12	32	0.0	0.0	0.075	72.6	---
B-26	8.5 - 10	---	---	16	58	15	43	---	---	---	---	---
B-26	13.5 - 15	---	---	16	---	---	---	---	---	---	---	---
B-27	0.5 - 2	CL	A-7-6 (19)	10	44	12	32	0.0	0.0	0.075	67.7	---
B-27	2.5 - 4	---	---	10	---	---	---	---	---	---	---	---
B-27	4.5 - 6	SC	A-7-6 (13)	11	48	12	36	0.0	0.0	0.075	49.8	---
B-27	6.5 - 8	---	---	16	76	16	60	---	---	---	---	---
B-27	8.5 - 10	---	---	21	---	---	---	---	---	---	---	---
B-27	13.5 - 15	---	---	15	65	15	50	---	---	---	---	---

TTL

Summary of Laboratory Test Results

Client: Lennar
Project: Sulphur Springs Subdivision
Location: Bexar County, Texas
Project Number: 00200902069.01





CBR Sample Location: 29.347391°,-98.328419°

Sample Depth: Between 0 and 5 feet below existing ground surface

Sample: **CBR Sample No. 1**

Proctor Test Method: Standard Proctor (ASTM D-698)

CBR Test Method: California Bearing Ration (ASTM D-1883)

Material: FAT CLAY (CH), Very Dark Brown

Optimum Moisture Content:	23.1	%
Maximum Dry Unit Weight:	94.83	pcf
Atterberg Limit (PI)	24	
% Passing # 200 Sieve	75.6	%

17215 Jones Maltsberger Rd, Suite 101
San Antonio, Texas 78232
T: 210-340-5004 / F: 210-340-5009
WWW.TTLUSA.COM

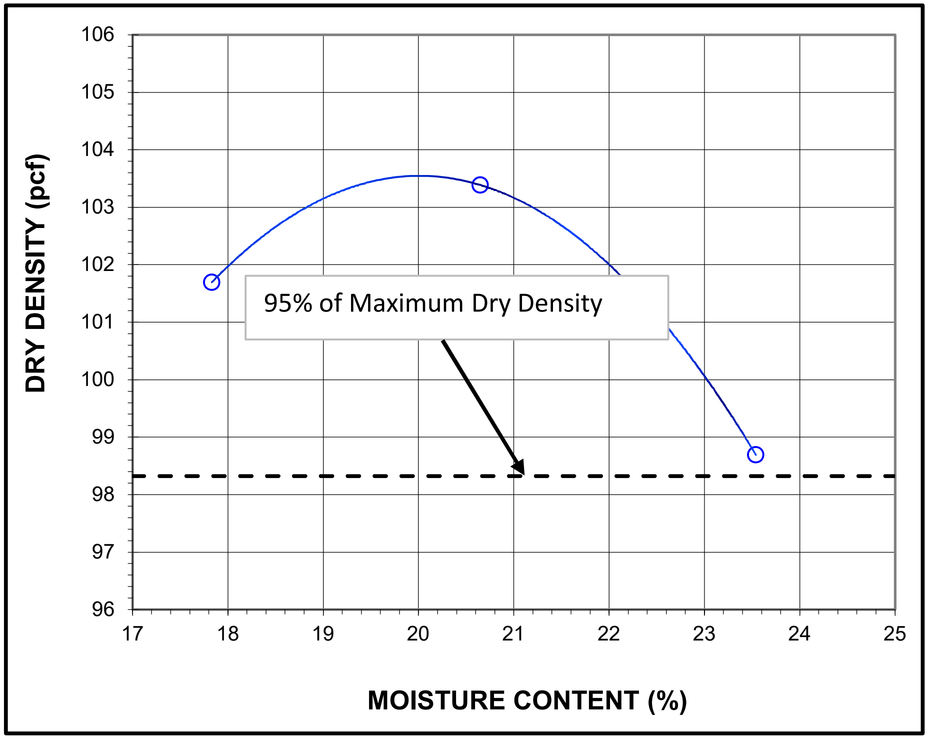
SULPHUR SPRINGS SUBDIVISION

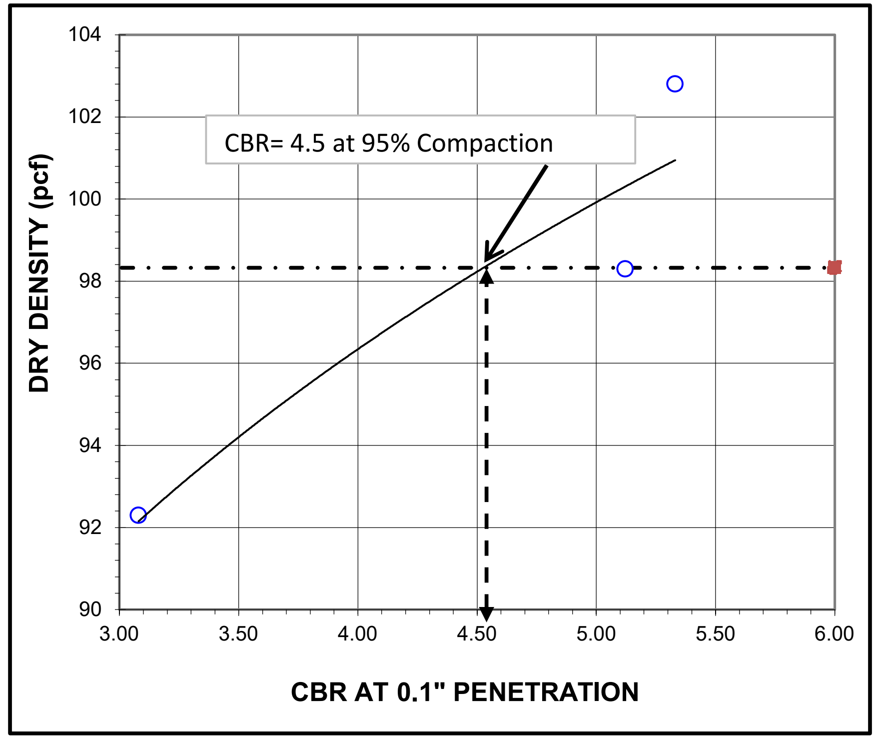
NEW SULPHUR SPRINGS ROAD AND GARDNER ROAD

SAN ANTONIO ETJ, BEXAR COUNTY, TEXAS

Drawn By: EG
Checked By: AB
Proj No:00200902069.01
File Name

CBR PLOT





CBR Sample Location: 29.349657°,-98.323119°
Sample Depth: Between 0 and 5 feet below existing ground surface

Sample:	**CBR Sample No. 2**	Optimum Moisture Content:	20.2 %
Proctor Test Method:	Standard Proctor (ASTM D-698)	Maximum Dry Unit Weight:	103.5 pcf
CBR Test Method:	California Bearing Ration (ASTM D-1883)	Atterberg Limit (PI)	20
Material:	FAT CLAY (CH), Very Dark Brown	% Passing # 200 Sieve	64.5 %

TTL

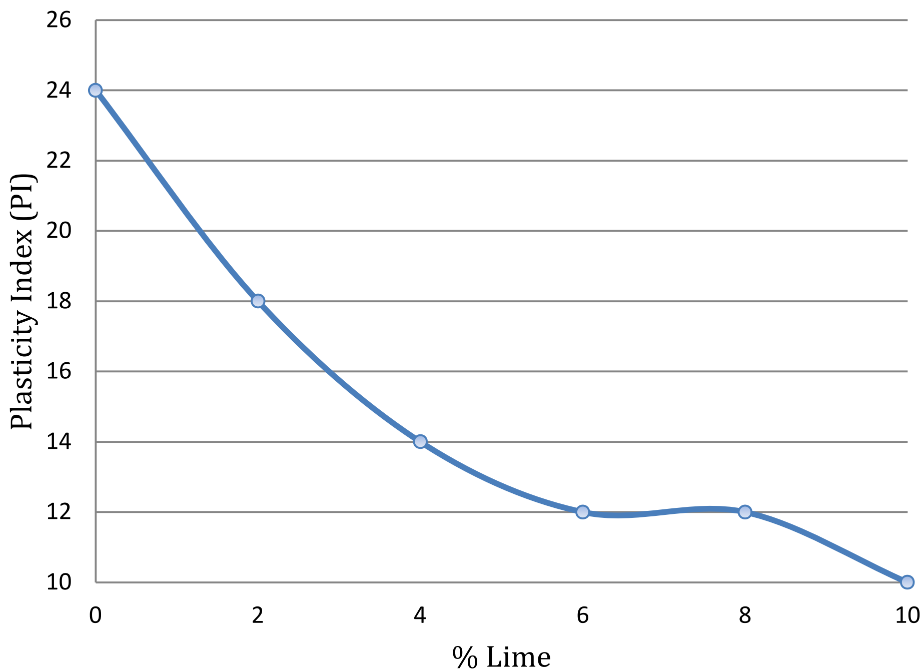
17215 Jones Maltsberger Rd, Suite 101
San Antonio, Texas 78232
T: 210-340-5004 / F: 210-340-5009
WWW.TTLUSA.COM

SULPHUR SPRINGS SUBDIVISION
NEW SULPHUR SPRINGS ROAD AND GARDNER ROAD

SAN ANTONIO ETJ, BEXAR COUNTY, TEXAS

Drawn By: EG
Checked By: AB
Proj No:00200902069.01
File Name

CBR PLOT



% Lime	Plasticity	pH	LL	PL
0	24	7.66	46	22
2	18	11.83	47	29
4	14	12.17	44	30
6	12	12.28	43	31
8	12	12.32	41	29
10	10	12.33	41	31

Test Location:	**CBR Sample No. 1**
Material:	FAT CLAY (CH), Very Dark Brown
Test Method:	TxDOT Item 260, Lime Treatment
Test Method:	ASTM C 977, Appendix XI; pH:Lime Saturation Content
CBR Sample Location:	29.347391°,-98.328419°

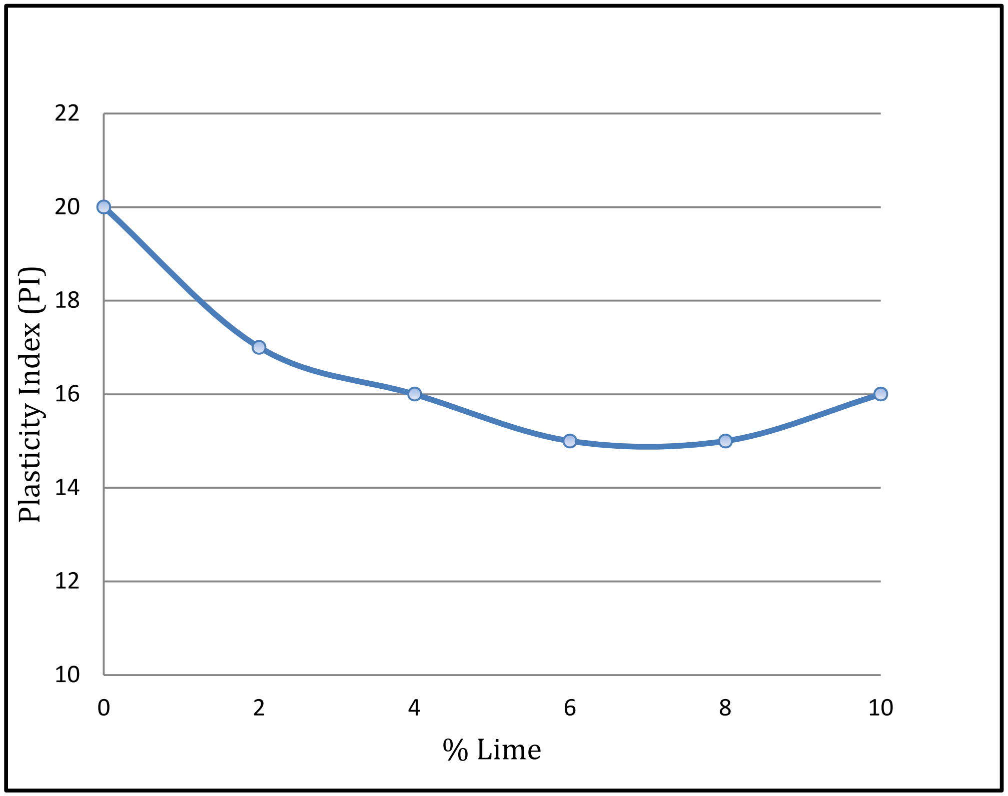
17215 Jones Maltsberger Rd, Suite 101
San Antonio, Texas 78232
T: 210-340-5004 / F: 210-340-5009
WWW.TTLUSA.COM

SULPHUR SPRINGS SUBDIVISION
NEW SULPHUR SPRINGS ROAD AND GARDNER ROAD

SAN ANTONIO ETJ, BEXAR COUNTY, TEXAS

Drawn By: EG
Checked By: AB
Proj No:00200902069.01
File Name

LIME SERIES



% Lime	Plasticity	pH	LL	PL
0	20	8.3	38	18
2	17	11.83	41	24
4	16	12.21	43	27
6	15	12.3	41	26
8	15	12.34	42	27
10	16	12.34	43	27

Test Location: **CBR Sample No. 2**
Material: FAT CLAY (CH), Very Dark Brown
Test Method: TxDOT Item 260, Lime Treatment
Test Method: ASTM C 977, Appendix XI; pH:Lime Saturation Content
CBR Sample Location: 29.349657°,-98.323119°

TTL
17215 Jones Maltsberger Rd, Suite 101
San Antonio, Texas 78232
T: 210-340-5004 / F: 210-340-5009
WWW.TTLUSA.COM

SULPHUR SPRINGS SUBDIVISION
NEW SULPHUR SPRINGS ROAD AND GARDNER ROAD

SAN ANTONIO ETJ, BEXAR COUNTY, TEXAS

Drawn By: EG
Checked By: AB
Proj No:00200902069.01
File Name

LIME SERIES

APPENDIX B
REFERENCE MATERIALS

EXPLORATION PROCEDURES

General

Various drill equipment and procedures are used to obtain soil or rock specimens during geotechnical engineering exploration activities. The drill equipment typically consists of fuel powered machinery that is mounted on a flat-bed truck or an all-terrain vehicle. The ground surface conditions at the site generally determine the type of vehicle to use.

Borings can be drilled either dry or wet. The drilling technique depends on the type of subsurface materials (clays, sands, silts, gravels, rock) encountered and whether or not subsurface water is present during the drilling operations. Sometimes a combination of both techniques is implemented.

The dry method can generally be employed when subsurface water or granular soils are not present. The dry method generally consists of advancing the augers without the use of water or drilling fluids. Air can be employed as necessary to remove cuttings from the borehole or cool the drilling bits during some drilling applications. The wet rotary process is generally used when subsurface water, rock or granular soils are present. The wet rotary process utilizes water or drilling fluids to advance the augers, remove cuttings from the borehole, and cool the drilling bits during drilling.

Sampling

Various sampling devices are available to recover soil or rock specimens during the geotechnical exploration program. The type of sampling apparatus to employ depends on the subsurface materials (clays, sands, silts, gravels, rock) encountered and on their consistency or strength. Most commonly used samplers are Shelby tubes, split-spoons or split-barrels, and NX core barrels. Depending on the subsurface conditions, sampling apparatus such as the Pitcher barrel, Osterberg sampler, Dennison barrel, or California sampler are sometimes used. The procedures for using and sampling subsurface materials with most of these samplers are described in detail by the American Society for Testing and Materials (ASTM). Sampling is generally performed on a two (2) foot continuous interval to a depth of about ten (10) feet, followed by five (5) foot intervals between the depths of about ten (10) to 50 feet, and on ten (10) foot intervals thereafter to the termination depth of the borings. However, sampling intervals may change depending on the project scope and actual subsurface conditions encountered.

If cohesive soils (clays and some silts) are present during drilling, samples are retrieved by using the Shelby tube sampler (ASTM D 1587) or the split-barrel sampler (ASTM D 1586). The Shelby tube is used to recover “virtually” undisturbed soil specimens that can be returned to the laboratory for strength and compressibility testing. The Shelby tube is a three (3) inch nominal diameter, thin-walled tube that is advanced hydraulically into the soil by a single stroke of the drill equipment.

The split-barrel sampler is used when performing the Standard Penetration Test (SPT). The recovered sample is considered to be a "disturbed" specimen due to the SPT procedure. The split-barrel is advanced into the soil by driving the sampler with blows from a 140-pound hammer free falling 30 inches. The SPT procedure is performed to evaluate the strength or competency of the material being sampled. This evaluation is based on the material sampled, depth of the sample, and the number of blows required to obtain full penetration of the split-barrel sampler. This blow count or penetration resistance is referred to as the "N" value.

The split-barrel is typically used when cohesionless soils (sands, silts, gravels) are encountered or when good quality cohesive soils cannot be recovered with the Shelby tube sampler. The SPT procedure can be employed when rock or cemented zones are encountered. However, the split-barrel may not penetrate the rock or cemented zone if the layer is extremely hard, thus resulting in no sample recovery.

When rock or cemented zones are present, and depending on the type of project and engineering testing required, rock coring may be implemented to recover specimens of the particular layer. Typically, an NX double tube core barrel (ASTM D 2113) is used.

Logging

During the drilling activities, one of our geologists or engineering technicians is present to make sure that the appropriate sampling techniques are employed and to extrude or remove all materials from the samplers. The samples are then visually classified by our field representative who records the information on a field boring log. Our field representative may perform pocket penetrometer, hand torvane, or field vane tests on the subsurface materials recovered from the Shelby tube samplers. If the SPT procedure is employed, our field representative will record the N values or blow counts that are germane to that particular field test. If rock coring is utilized, our field representative will calculate the percent recovery and Rock Quality Designation (RQD). The test data for all the field tests will be noted on the appropriate field boring log. Upon completion of the logging activities and field testing of the recovered soil or rock samples, representative portions of the specimens were placed in appropriately wrapped and sealed containers to preserve their natural moisture condition and to minimize disturbance during handling and transporting to our laboratory for additional testing.

When subsurface water is observed during the drilling and sampling operations, drilling will be temporarily delayed so the subsurface water level can be monitored for a period of at least 15 to 30 minutes. Depending on the rise of the subsurface water in the borehole and project requirements, subsurface water measurements may be monitored for periods of 24 hours or more. Generally, observation wells or piezometers are installed in the completed boreholes to monitor subsurface water levels for periods longer than 24 hours.

Following completion of drilling, sampling, and subsurface water monitoring, all boreholes are backfilled with soil cuttings from the completed borings unless the client requests or local ordinance requires special backfilling requirements. If there are not enough soil cuttings available, clean sand will be used to backfill the completed boreholes.

Details concerning the subsurface conditions are provided on each individual boring log presented in this Appendix. The terms and symbols used on each boring log are defined in the Legend Sheet which is also presented in this Appendix.

LABORATORY TESTING PROCEDURES

Classification, and Index Testing

The recovered soil samples were classified in the laboratory by a geoprofessional using the USCS as a guide. Samples were tested for the following properties in general accordance with the applicable ASTM standards:

- Moisture content (ASTM D2216)
- Atterberg Limits (ASTM D4318)
- Percent material passing the No. 200 sieve (ASTM D1140)
- Grain Size Analysis (ASTM D6913 or D1140)
- California Bearing Ratio test (ASTM D1883)

Results of tests for moisture content, Atterberg Limits, and percent material passing the No. 200 sieve are presented on individual boring logs and on the lab summary sheet in Appendix A.