GEOTECHNICAL FEASIBILITY REPORT & PAVEMENT DESIGN

Navarro/ Heinemeyer Subdivision

Guadalupe County, Texas

Prepared for:
Lennar
San Antonio, Texas

Prepared by:
TTL, Inc.
San Antonio, Texas

Project No. 000180903233.01
April 25, 2019

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17215 Jones Maltsberger Rd.
Suite 101
San Antonio, Texas 78247
210-888-6100
www.TTLUSA.com

Richard Mott, P.E.
Lennar
1718 Dry Creek Way, Suite 120
San Antonio, Texas 78259

C: (210) 889-5516
E: richard.mott@lennar.com

RE: Geotechnical Feasibility Report & Pavement Design
Navarro/Heinemeyer Subdivision
South Side of FM 758 and West of FM 123
Guadalupe County, Texas
Agreement No. 000180903233.01

Dear Mr. Mott:

TTL, Inc. (TTL) is pleased to submit this geotechnical engineering 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.

Thank you for selecting TTL to provide the geotechnical engineering services for this phase of the project. We would appreciate the opportunity to continue our involvement in this project by providing the construction materials testing and observation services during the construction phase. One of our client representatives will contact you to discuss these services.

We appreciate the opportunity to work with you, and we look forward to working with you on future projects.

Respectfully submitted,
TTL, Inc.

Amit Bakane, P.E.
Project Engineer

STATE OF TEXAS
THOMAS M. VICK
103964
LICENSED
PROFESSIONAL ENGINEER
4/25/2019

Thomas M. Vick, P.E., PMP
Regional Manager

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EXECUTIVE SUMMARY

This Geotechnical Feasibility Report ("Report") has been prepared for the Navarro Subdivision, hereinafter referred to as either the "Project" or "Site". The Site is located approximately 5000 feet southwest of TX-123 and FM 758 intersection in Guadalupe County, Texas. Navarro Subdivision will involve the development of a single-family residential subdivision. The planned development will accommodate individual lots, multiple interconnecting streets and major utilities. The Project site is currently an undeveloped acreage. According to a lot layout provided to us, prepared by KFW Engineers, Navarro Subdivision will involve 1465 lots in approximately 325.40 acres. Drilling activities at this site were delayed due to cultivated fields and when the crop was harvested, the severe weather conditions and wet surficial soils precluded access for the drilling equipment to the site.

Based on the information provided to us for this study and from data developed as part of our engineering service, the Site is suitable for residential development and construction, provided the site, streets, and utilities are prepared in accordance with the recommendations within this report. We are also providing ***preliminary*** foundation recommendations, which should ***only*** be used for planning and budgeting purposes and ***not*** used for the final foundation design. A general summary of our findings and conclusions are provided below:

- Based on our calculations, the fat clay soils at this site may yield a Potential Vertical Rise (PVR) of about 3½ to 5½ inches.
- Slab-on-grade foundations may be used to support the residences. Key preliminary design parameters are as follows:
  - The foundation beams, may be sized for a net allowable total load-bearing pressure of 1,600 psf (pounds per square foot) or a net allowable dead plus gravity live load-bearing pressure of 1,000 psf.
  - The width of foundation beams should not be less than 10 inches for post-tensioned slab foundations.
- Recommendations for site grading preparation and utility installation are provided in the Report.

This summary is provided for convenience only. For those individuals and entities that may need more details or technical information from this report for their use, it must be read in its entirety to have an understanding of the information and recommendations provided for the Project.

1.0 INTRODUCTION

This Geotechnical Feasibility Report ("Report") has been prepared for the Navarro Subdivision, hereinafter referred to as either the "Project" or "Site". The Site is located approximately 5000 feet southwest of TX-123 and FM 758 intersection in Guadalupe County, Texas. Navarro Subdivision will involve the development of a single-family residential subdivision. The planned development will accommodate individual lots, multiple interconnecting streets and major utilities. The Project site is currently an undeveloped acreage. According to a lot layout provided to us, prepared by KFW Engineers, Navarro Subdivision will involve 1465 lots in approximately 325.40 acres.

The purpose of this Report was to evaluate if the Site, from a geotechnical engineering viewpoint, was suitable for residential development and construction. The planned development will accommodate individual lots, streets and major utilities. The Project site is currently undeveloped acreage.

1.1 Authorization

This Project was authorized by Mr. Richard Mott, Director of Land Management with Lennar, on January 13, 2019, by acceptance of our Agreement for Services, No. P00180903233.01, dated December 31, 2018.

1.2 Purpose and Scope of Services

The purposes of this engineering service were to evaluate the general subsurface conditions (soil, rock, subsurface water) within the Project limits by drilling exploratory borings, conduct tests on samples recovered during drilling of the exploratory borings, analyze and evaluate the test data, perform engineering analyses using the data analyzed and evaluated from the field and laboratory programs to develop geotechnical engineering recommendations and guidelines with respect to:

- Site conditions as applicable
- Subsurface stratigraphy
- Subsurface water conditions
- Potential for soil expansion-contraction
- Site earthwork and grading
- Residential pad preparation
- Utility design and construction

In addition to the above, our scope of services was to provide ***preliminary*** foundation design recommendations for the single-family residential structures. Please note that the ***preliminary*** foundation recommendations should ***ONLY*** be used for planning and budgeting purposes; ***NOT*** for final foundation design.

2.0 PROJECT INFORMATION

The following information was provided to us by the Client, design professionals working on the Project, or was collected by our firm:

Site Location	The boundaries of the Navarro/Heinemeyer Tract Subdivision are FM 758 to the north and Harborth Road to the south in the vicinity of New Braunfels, Texas. FM 123 is east of the site.
Proposed Development	According to a lot layout provided to TTL, prepared by KFW Engineers, the Navarro/Heinemeyer Tract Subdivision consists of approximately 325.40 acres, includes 1465 residential lots.
Proposed Construction	One or two-story residential structures.
Maximum Foundation Loads	Unknown at this time.
Current Site Condition	The Project site currently consists of agricultural land. Based on aerial imagery, a natural drainage pathway/channel generally runs in a north-south direction on the western portion of the property.
Existing Ground Cover	The area is clear of vegetation with the possible exception of active crop land on the north end of the property.
USDA Soil Survey	Branyon clay (BrA & BrB), Houston black clay (HoB) and Barbarossa silty clay (BaA & BaB)
Geology	The northern half of the property lays within the Navarro Group and Marlbrook Marl formation (KnB) and the southern half lays within the Leona formation.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Site Conditions

The Project site, as noted previously, is comprised of undeveloped acreage. Based on visual observations, there were no noticeable or obvious conditions within the site that would affect the geotechnical engineering aspects of this Project.

3.2 Subsurface Conditions

3.2.1 Subsurface Lithology

Subsurface conditions within the Project limits were evaluated by drilling exploratory borings at the locations shown on Exhibit 2, the Bore Location Plan. Information retrieved from the exploratory borings revealed that subsurface conditions consist of high plasticity fat clay soils to 6½ to 8½ feet below ground surface above lean clay soils to the termination depths of the exploratory borings. Borings H-05 to H-12 has gravelly layers below 6½ feet to the termination depths.

The logs of the exploratory borings, presenting more specific information about the subsurface stratigraphy encountered at each exploratory boring location, are provided in the Exhibits section of this Report.

3.2.2 Subsurface Water

Subsurface water was encountered in 4 of the 33 borings. Water levels were recorded when encountered during our drilling activities. The subsurface water readings (rounded to the nearest ½ foot) are summarized in the following table.

Subsurface Water Level Readings

Boring No.	Depth (Feet)
H-5	13
H-7	8½
H-8	8
H-11	12½

After the completion of drilling, each exploratory boring was then backfilled with auger cuttings generated during our drilling activities.

Subsurface water is generally encountered as a *'true'* or permanent water source or as a *'perched'* or temporary water source. Permanent subsurface water is generally present year round, which may or may not be influenced by seasonal climatic changes. Temporary subsurface water generally develops as a result of seasonal climatic conditions.

The contractor should be prepared to check for soft/wet surface conditions and potential groundwater conditions prior to excavating or mass grading at the site.

4.0 GEOTECHNICAL RECOMMENDATIONS AND GUIDELINES

Based on the information provided to us by the Client and Project Team, our exploratory borings drilled at the site, results of laboratory tests performed on samples recovered during the subsurface exploration program, and our engineering analyses, the following evaluation can be made regarding the Project Site:

- The Project site is suitable for the planned use as a residential subdivision, provided the geotechnical recommendations presented in this report are incorporated in the design and construction of the project.
- The subsurface soils exhibit a high potential to undergo expansion and contraction with fluctuations in their moisture contents.
- A slab-on-grade foundation system, designed in accordance with the Post-Tensioning Institute (PTI) design manual, can be used to support the planned residential structures.

The following geotechnical recommendations and guidelines have been prepared based on the data collected or developed during this Project.

4.1 Seismic Design Parameters

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

Description	Value
2015 International Building Code Site Classification (IBC)[1]	D
Site Latitude	29.693836
Site Longitude	-97.971927
Maximum Considered Earthquake 0.2 second Design Spectral Response Acceleration (S_{DS})	0.078
Maximum Considered Earthquake 1.0 second Design Spectral Response Acceleration (S_{D1})	0.050
Notes Applicable to the Seismic Design Parameters:	
[1] As per the requirements of Section R301.2.2.1.1 in the 2015 IRC and Section 1613.3.2 in the 2015 IBC, the site	
[2] Note: Chapter 20 of ASCE 7 requires a site soil profile determination extending to a depth of 100 feet for seismic	

4.2 Expansive Soil Considerations

Subsurface soils at the project site have a high potential for shrinking and swelling. These soils experience volume changes by shrinking with a decrease in moisture content and swelling with an increase in moisture content. Volumetric change in the expansive clay subgrade causes vertical and horizontal movements, which result in undulating surface effects) that eventually lead to curb and pavement cracking (both transverse and longitudinal). Even with the pavements being properly designed and constructed, the pavement section may still not perform as intended due to the expansive clay movement.

Please note that expansive soil subgrades are lime treated. However, the lime treatment is typically treating the upper 6 to 8 inches of the pavement subgrade. The lime treatment depth is not sufficient to reduce expansive soil movements beneath the pavement section. Reason being is that the active zone (i.e., the zone of seasonal moisture variation) is about 15 feet below ground surface. The purpose of lime treating an expansive clay pavement subgrade is to 1) improve the strength of the clay soil, 2) make the soil more resistant to water absorption, which reduces the potential for soil softening, and 3) lower the plasticity index (PI) of the treated zone to reduce volume changes. Therefore, shrink/swell soil movements and related pavement distress will still occur even if the upper 6 to 8 inches of the subgrade is lime treated.

Positive surface drainage along the pavement edge is critical to help reduce the likelihood of water ponding alongside the pavement. We understand that pavement surface and sidewalks will be sloped to divert surface runoff water away from the pavement into the drainage channels located along both sides of the pavement. The distance between the edge of the drainage channels and edge of the sidewalk will be more than 10 feet. If the drainage channels are closer than 10 feet of the pavement edge, we recommend that the drainage channels be lined with cast-in-place concrete rip-rap.

Large bushes and trees adjacent to the pavements will also contribute to future distress to the pavement system. Vegetation placed in landscape beds that are adjacent to the pavements

should be limited to small plants and shrubs that will not exceed a mature height of about 4 feet and that are not '*water demanding*'.

Large bushes and trees that will generally exceed 4-foot heights should be planted at a distance away from the pavement edge so that their canopy or '*drip line*' does not extend to the pavement edge when the tree reaches maturity. Plants and shrubs that are '*water hungry*' should not be planted within 5 feet of the pavement edge.

Utility trenches that traverse beneath the pavements are potential avenues for subsurface water to migrate beneath the pavements. We recommend that, a 'clay soil plug' should be used for the bedding and backfill. The clay soil plug should have a plasticity index (PI) between 18 and 25. The clay soil plug should be at least 5 feet in length, extend equally across the both sides of the pavement, and extend full depth of the trench. Granular materials, unless specifically required by the utility company or local codes, should not be used for bedding or backfill along the clay soil plug. If granular bedding or backfill is to be used, we must be contacted to address this issue. Backfill material placement should follow the recommendations in the Fill Materials and Placement section of this Report.

4.3 Corrosion Considerations

Laboratory tests were conducted on a soil samples recovered from the borings to assess the corrosivity risk of the soils at the boring locations. Soil samples were submitted to an analytical lab to determine the sulfate contents. The results of the laboratory tests are provided below.

Summary of Laboratory Sulfate Tests		
Boring No.	**Sample Depth (ft)**	**Sulfate (ppm)**
B-1	½ - 2	66
B-2	2½ – 4	123
B-4	4½ - 6	74.4
B-5	8½ - 10	184

According to the 2015 IBC, concrete that is exposed to sulfate-containing solutions should be designed in accordance with ACI 318. The sulfate test results indicate that the sulfate exposure level is Class S0. Therefore, Type I or Type II cement should be used.

4.4 Site Preparation

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, subgrade preparation beneath the residential structures, streets, utilities, and any load-bearing requirements within the Project.

The contractor or its applicable subcontractor(s) is responsible for designing and constructing stable, temporary excavations, as required to maintain the stability of both the excavation sides

and bottom. Excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards.

4.4.1 Mass Grading

Mass grading areas should be stripped of the vegetation. The stripping depth may need to be at least 12 to 18 inches to completely grub and remove the roots and organic material. After stripping, cut and fill operations can proceed. Cut areas shall be scarified to a 6-inch depth, moisture conditioned between plus 1 and plus 4 percentage points of the optimum moisture content, and then compacted 95 percent of the maximum dry density as determined according to Tex-114-E, Standard compaction effort.

Imported fill soils, shall be placed in 6-inch compacted lifts, moisture conditioned between minus 2 and plus 3 percentage points of the optimum moisture content, and then compacted according to specifications outlined in the table titled **Placement and Compaction for Fill Materials.** If imported fill soils are needed to complete mass grading, they shall have a PI between 8 and 15 and at least 70 percent of the material passing the No. 200 sieve. On-site soils used as fill shall also be placed in 6-inch compacted lifts and moisture conditioned between plus 1 and plus 4 percentage points of the optimum moisture content, and then compacted according to specifications outlined in the table titled **Placement and Compaction for Fill Materials.**

4.4.2 Residential Pad Preparation

The subsurface soils at this site generally exhibit a very high potential to undergo expansion and contraction during fluctuations in their moisture contents. If the residential pads will be built up to achieve the finished floor elevations, select fill should be used to raise the residential pads. Recommendations for fill selection and placement are included in the following subsection.

4.4.3 Fill Materials and Placement

Unless noted otherwise in another section of this report, select fill and on-site soils should meet the following criteria.

Specification for Fill Materials		
Fill Type [1]	**USCS Classification**	**Acceptable Location for Placement**
Granular [2] Select Fill	Varies	All locations
Select Fill [3]	Varies	All locations
On-Site Soils	CH	The on-site fat clay (CH) material does not meet select fill specifications and can only be used for general, , non-structural and common areas. Otherwise, it should be removed from the site.

[1]	Fill, whether select or non-select, that is being placed in a controlled and compacted manner shall meet one of the above specifications, be free of debris (i.e. trash, rubble, organic materials, vegetation, roots), have no particles exceeding 3 inches in maximum dimension. Prior to any filling operations, samples of the fill materials, whether select or non-select, to be used for construction shall be submitted for approval, which will include performing laboratory tests to verify compliance to the above specifications.

2	Granular Select Fill shall meet one of the following criterion: • Crushed stone (limestone) meeting Type A, 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 Unified Soil Classification System (USCS). • Crushed or uncrushed gravel meeting Type B, 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. • 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 Plasticity Index (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, a LL no greater than 30, and a PI of 7 or less. Designation as a GM in accordance with the USCS. • Clayey sand or silty clayey sand (may locally be referred to as "pit-run" material) 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 LL no greater than 40, and a PI between 7 and 20. Designation as an SC in accordance with the USCS.
3	Select Fill shall meet the following criteria: • Lean clay having no more than 30 percent of total material retained on the No. 200 sieve, a LL no greater than 40, and a PI between 10 and 20 and no more than 15 percent by weight retained on the No. 4 sieve. Designation as a CL in accordance with USCS.

Placement and Compaction Requirements for Fill Materials	
Item	**Description**
Fill Lift Thickness	All fill should be placed in thin, loose lifts not to exceed 8 inches, with compacted thickness of about 6 inches.
Compaction and Moisture Content of Select Fill	Unless stated elsewhere in this report, at least 95 percent of the maximum dry density as determined by the Standard effort (Tex-114-E). The materials should be moisture conditioned between -2 and +3 percentage points of the optimum moisture content.
Compaction and Moisture Content of On-Site Subgrade Soils	Unless stated elsewhere in this report, at least 95 percent of the maximum dry density as determined by the Standard effort (Tex-114-E). The CH materials should be moisture conditioned between +1 and +4 percentage points of the optimum moisture content.

4.4.4 Utility Trenches

Utility trenches that traverse beneath the structure or through the foundation member are potential avenues for subsurface water to migrate beneath the structure. One of the following design recommendations should be considered by the Project Civil or MEP Engineers:

- If the utility trench traverses beneath the structure, a 'clay soil plug' should be used for the bedding and backfill. The clay soil plug should have a plasticity index (PI) between 18 and 25. The clay soil plug should be at least 5 feet in length, extend equally across the structure perimeter, and extend full depth of the trench. Granular materials, unless specifically required by the utility company or local codes, should not be used for bedding or backfill along the clay soil plug. If granular bedding or backfill is to be used, we must be contacted to address this issue. Backfill material placement should follow the recommendations in the Fill Materials and Placement section of this Report.
- If the utility pipes/cables traverse through the foundation member, the hole should be filled with flowable fill or concrete. The pipes/cables traversing through this zone should be designed with some flexibility if they are sensitive to movement. In lieu of this approach, a 'pipe sleeve' can be installed through the foundation member for the utility lines to pass through. The pipe sleeve should have a clearance that is at least 6 inches larger than the outer edges of the utility pipes/cables. The annulus within the pipe sleeve should be filled with a flexible but water-proof material such as sealants or asphaltic mastics.

4.5 Foundations

Please note that the foundation design recommendations and construction guidelines provided in this section are ***preliminary*** and shall ***ONLY*** be used for planning and budgeting purposes; ***NOT*** for final foundation design.

The subsurface soils exhibit a very high potential to undergo expansion and contraction with fluctuations in their moisture contents. Based on our calculations, current conditions at this site may yield a Potential Vertical Rise (PVR) ranging from about 3½ inches to about 5½ inches. The actual movement could be greater if inadequate drainage or other sources of water are allowed to infiltrate beneath the structure after construction. We understand that slab foundation systems are being planned to support the residential structures.

The slab foundation shall be designed as a rigid unit such that if the subsoils expand or contract, the entire slab foundation would move as one unit. ***Please note that a rigid 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 about 3½ inch to about 5½ inches, thus foundation movement ranging from about 3½ inch to about 5½ inches should be expected***. If these potential foundation movement values exceed the desired performance, earthwork operations may be required to reduce the PVR of subsoils. We can provide these recommendations once the 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 foundation parameters are provided for two (2) groups of soil conditions

observed across the site. Group A is associated with an existing PVR of approximately 5½ inches; Group B is associated with an existing PVR of approximately 4 inches. The groups are shown on Exhibit 2 of this report.

EXISTING CONDITION, GROUP A (SEE EXHIBIT 2)					
PTI Method: 3rd Edition [1,3,4,5]					
Vertical Moisture Barrier Depth (ft) [6]:	<2½	2½	3	4	5
Edge Moisture Variation Distance (e_m):					
Center Lift (ft):	5.0	4.3	4.0	2.0	2.0
Edge Lift (ft):	2.8	2.0	2.0	2.0	2.0
Maximum Unrestrained Differential Soil Movement or Swell (y_m):					
Center Lift (in):	2.9	2.0	1.9	1.7	1.5
Edge Lift (in):	5.1*	3.0	2.7	2.2	1.9
Coefficient of Slab-Subgrade Friction (μ):	0.75	0.75	0.75	0.75	0.75
Net Allowable Bearing Pressures [2]:					
Total Load Conditions (psf):	1,600	1,600	1,600	1,600	1,600
Dead Load Plus Gravity Live Load Conditions (psf):	1,000	1,000	1,000	1,000	1,000
Maximum Allowable Deflection Ratio of Foundation Beam:	1/360	1/360	1/360	1/360	1/360

EXISTING CONDITION, GROUP B (SEE EXHIBIT 2)				
PTI Method: 3rd Edition [1,3,4,5]				
Vertical Moisture Barrier Depth (ft) [6,7]:	<2½	2½	3	4
Edge Moisture Variation Distance (e_m):				
Center Lift (ft):	5.5	4.9	4.6	2.0
Edge Lift (ft):	2.9	2.0	2.0	2.0
Maximum Unrestrained Differential Soil Movement or Swell (y_m):				
Center Lift (in):	2.5	1.8	1.7	1.5
Edge Lift (in):	4.1*	2.6	2.3	1.8
Coefficient of Slab-Subgrade Friction (μ):	0.75	0.75	0.75	1.75
Net Allowable Bearing Pressures [2]:				
Total Load Conditions (psf):	1,600	1,600	1,600	1,600
Dead Load Plus Gravity Live Load Conditions (psf):	1,000	1,000	1,000	1,000
Maximum Allowable Deflection Ratio of Foundation Beam:	1/360	1/360	1/360	1/360

Notes Applicable to the PTI Slab Foundation Design:	
*	***Y_m exceeds 4 inches. Please refer to* Design of Post-Tensioned Slabs-on-Ground, Third Edition *publication for slab foundation design recommendations. A vertical moisture barrier shall be considered for this design group; special design considerations may also be required.***
1	Design parameters based on preparing the subgrade and constructing a residential pad as recommended in this report in the section entitled **Earthwork**.
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 grade beams should not be less than 10 inches. The minimum bearing depth below adjacent ground surface (also referred to as "final grade") should not be less than **18 inches** for exterior (i.e., perimeter) foundation grade beams. Interior foundation grade beams should not be less than 12 inches below the bottom of the slab. These foundation dimension recommendations are for 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 30 inches below the adjacent ground surface to be considered as having any significant effect. Foundation beams bearing less than 30 inches below 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 mass grading of the site had not been conducted. Our recommendations for PTI design are based on the subsoil conditions that we encountered during our drilling operations on the existing grading and our assumptions that the FFE will be within 6 inches of the existing grades. If this information changes, please contact us so that we can revise our recommendations.

4.5.1 Foundation Construction Considerations

Excavations for the foundation 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 beam bearing elevation and the foundation beam excavation completed with a smooth-mouthed bucket or by hand labor. Debris in the bottom of the foundation beam excavation should be removed prior to steel placement. Any loose materials should be removed from the over-excavated areas and filled with lean concrete or compacted cement stabilized sand (two sacks cement to one cubic yard of sand).

The foundation beam excavations should be sloped sufficiently to create internal sumps for runoff collection and removal of water. If surface runoff water or subsurface water seepage in excess of 1 inch accumulates at the bottom of the foundation beam excavation, it should be collected and removed so that the **ponding** water does not adversely affect the quality of the foundation beam bearing surface. Special care should also be taken to protect the exposed foundation beam bearing soils from being disturbed or drying out prior to placement of the concrete.

4.6 Lime Series Tests

Since the subsurface fat clay soils exhibit a PI greater than 20, a lime series test was performed on a sample collected during the field exploration. Based on our result, TTL recommends that 6% of lime be added to the dark brown clay subgrade.

4.7 Streets

We understand that a flexible pavement system will be considered for the proposed streets.

4.8 Pavement Design Considerations

Based on our experience and Guadalupe County Subdivision Regulations, the following design parameters were used for design of the pavement section:

	One and Two Family Residential Local Parking Both Sides	Residential Collector Parking Both Sides
Reliability, %	70	90
Initial Serviceability Index, p_o	4.2	4.2
Terminal Serviceability Index, p_t	2.0	2.5
Standard Deviation, S_o	0.45	0.45
Design Life, years	20	20
Minimum HMAC Thickness, inches	2	2
Minimum Base Thickness, inches	10	12

Bulk soil samples were collected from the site to evaluate the California Bearing Ratio (CBR) of the soils to be used for our pavement design recommendations (CBR Sample Location is shown on Exhibit 2). We performed one set of CBR tests each at three compaction levels, i.e. 90%, 95% and 100% (total 3 CBR tests) on the collected bulk samples. Based on the test results, a CBR value of about 3.0% was selected for the fat clay subgrade compacted to at least 95% of maximum dry density determined in accordance with ASTM D698. There are a number of published correlations relating CBR to the Resilient Modulus (M_R). In our report, we used a M_R (psi) = 2555 $(CBR)^{0.64}$, to convert CBR to M_R.

4.9 Pavement Section:

FLEXIBLE PAVEMENT SYSTEM		
Component	**Pavement Material Thickness, inches**	
	One and Two Family Residential Local Parking Both Sides	**Residential Collector Parking Both Sides**
Hot Mixed Asphaltic Concrete	2.0	3.0
Prime Coat	Yes	Yes
Granular Base Course (Flexible Base)	12.0	24.0*
Lime Treated Subgrade	6.0	6.0
Estimated ESALs for this Pavement Section	100,000	2,000,000
Required Structural Number	2.40	4.40
Calculated Structural Number	2.56	4.68
*Geogrid should be placed at the mid-section of the compacted base material layer.		

TTL should be contacted immediately to reevaluate provided pavement sections if expected traffic is more than the estimated ESALs.

4.10 Pavement Earthwork

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 contractor or its applicable subcontractor(s) is responsible for designing and constructing stable, temporary excavations, as required to maintain stability of both the excavation sides and bottom. Excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards.

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 **Fill Materials and Placement** section 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 or constructing the pavement section, the exposed excavation subgrade should be proofrolled 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 proofrolling 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 **Fill Material and Placement** section of this report.

- The final 6 inches below the design pavement section elevation consists of the on-site soils, the ***clay subgrade*** with a PI greater than 20 should be lime treated in accordance with TxDOT Item 260. The lime shall be in slurry form. We anticipate that 6% lime be added to the subgrade, however, the actual percentage required shall be determined by laboratory tests on samples of the subgrade prior to construction. 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 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.

4.11 General Guidelines for Pavements

All pavement design and construction shall conform to the latest edition of Guadalupe County Subdivision Regulations

Proper perimeter drainage is very important and should be provided so infiltration of surface water from unpaved areas surrounding the pavements is minimized. If curbs are needed in certain areas, it is important that proper perimeter drainage be provided so that infiltration of surface water from unpaved areas surrounding the pavement is reduced, or if this is not possible, curbs should extend through the base and into the subgrade for a depth of at least 6 inches. A crack sealant compatible to both asphalt and concrete should be provided at all concrete-asphalt interfaces.

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. Pavement areas should be ***lime treated*** and properly compacted to the recommendations provided in the **Pavement Earthwork** section of this Report.

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 3 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.

4.12 Pavement Section Materials

All pavement materials shall conform to the latest edition of Guadalupe County Subdivision Regulations

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-, The paving mixture and construction methods shall conform to Item 340, "Hot Mix Asphaltic Concrete, Type D" of the Standard Specifications by TxDOT, March 1, 1995. if a full depth asphalt section is selected for construction. 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. The asphalt cement grades should conform to the table shown below or at least conform to Guadalupe County Subdivision Regulations.

<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.

Prime Coat - 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.

Concrete - Concrete should have a minimum 28-day design compressive strength of 4,000 psi and a design flexural strength of 650 psi.

Granular Base Material - 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.

Granular Select Fill and Select Fill- As recommended in the **Fill Materials and Placement** section of this Report.

Lime Treatment – Lime treatment shall be performed only on the dark brown clay subgrade. 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, fill materials, placement and compaction are presented in the **Pavement Earthwork** section of this report.

4.13 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 0.75 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 and at least 6 inches into the pavement subgrade or install a VMB behind the curb.

5.0 INTERPRETATION OF REPORT

TTL understands that its geotechnical engineering report is used by the Client and various individuals and firms involved with the design and construction 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. *TTL* should also be retained to review the final construction plans and specifications to evaluate if the information and recommendations in our geotechnical engineering report has been properly interpreted and implemented in the design and specifications.

6.0 CONSTRUCTION MONITORING AND TESTING

The performance of the foundation system for the proposed structure will be highly dependent upon the quality of construction. As the Geotechnical Engineer of Record for this Project, *TTL* should be retained to provide construction observation and materials testing services during the Project, particularly the construction activities relating to foundations, building pad, pavements, excavation and site grading.

7.0 LIMITATIONS OF REPORT

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. No warranties, express or implied, are intended or made.

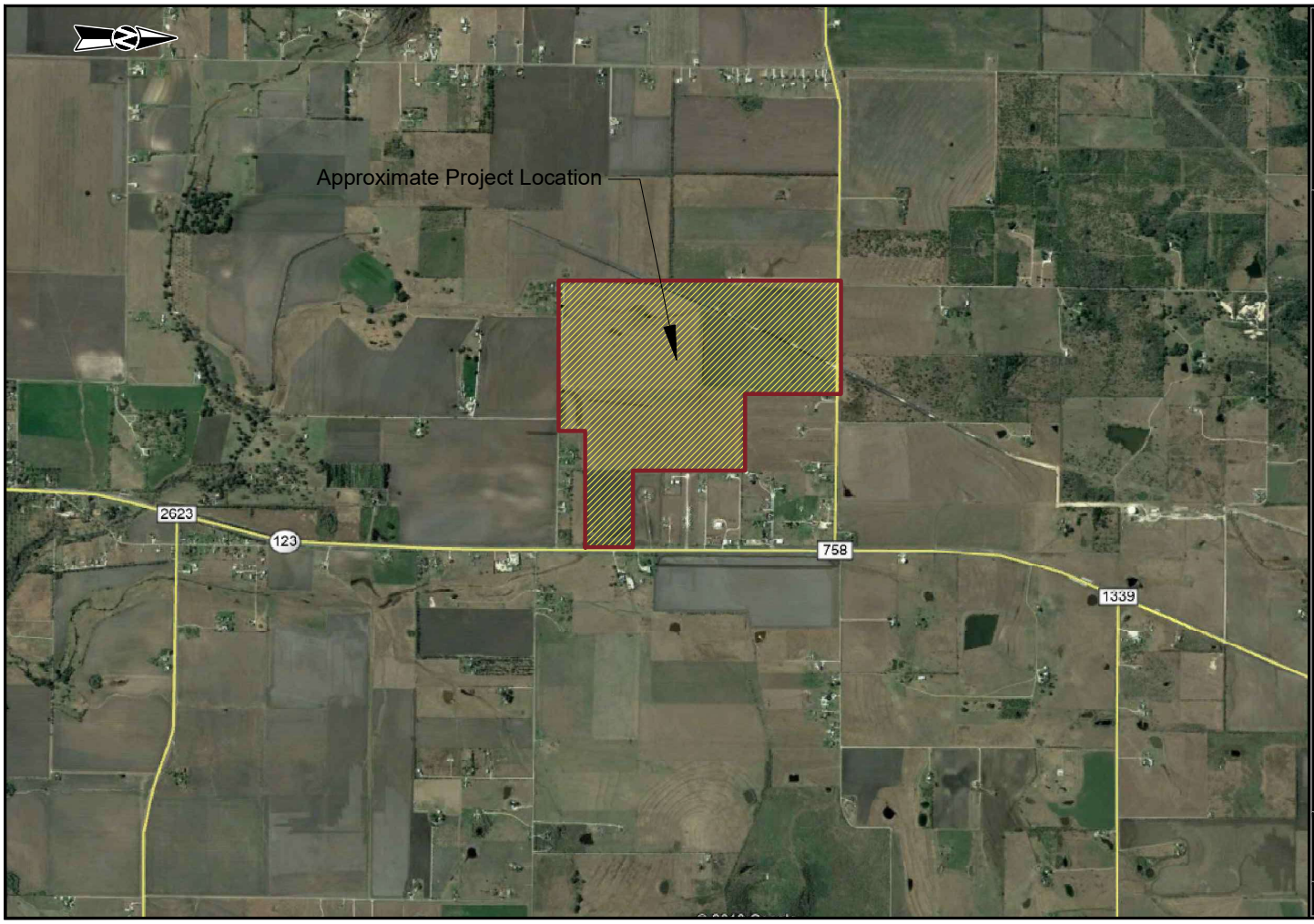
This geotechnical engineering report is based upon the information provided to us by the Client and various other individuals and entities associated with the Project, exploratory borings drilled within the Project limits, laboratory testing of randomly selected soil or rock samples recovered during drilling of the exploratory borings, and our engineering analyses and evaluation. The Client and readers of this geotechnical engineering report, should realize that subsurface variations and anomalies can and will exist across the site and between the exploratory borings. The Client and readers should realize that site conditions will change due to the modifying effects of seasonal and climatic conditions.

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 evaluated and addressed with applicable recommendations. The contractor and applicable subcontractors should familiarize themselves with this report prior to the start of their construction activities, contact *TTL* for any interpretation or clarification of the report, and retain the services of their own consultants to interpret this report, or perform additional geotechnical testing prior to bidding and construction.

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 services to address the environmental concerns. Also, permitting, site safety, excavation support, and dewatering requirements are the responsibility of others.

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

EXHIBITS

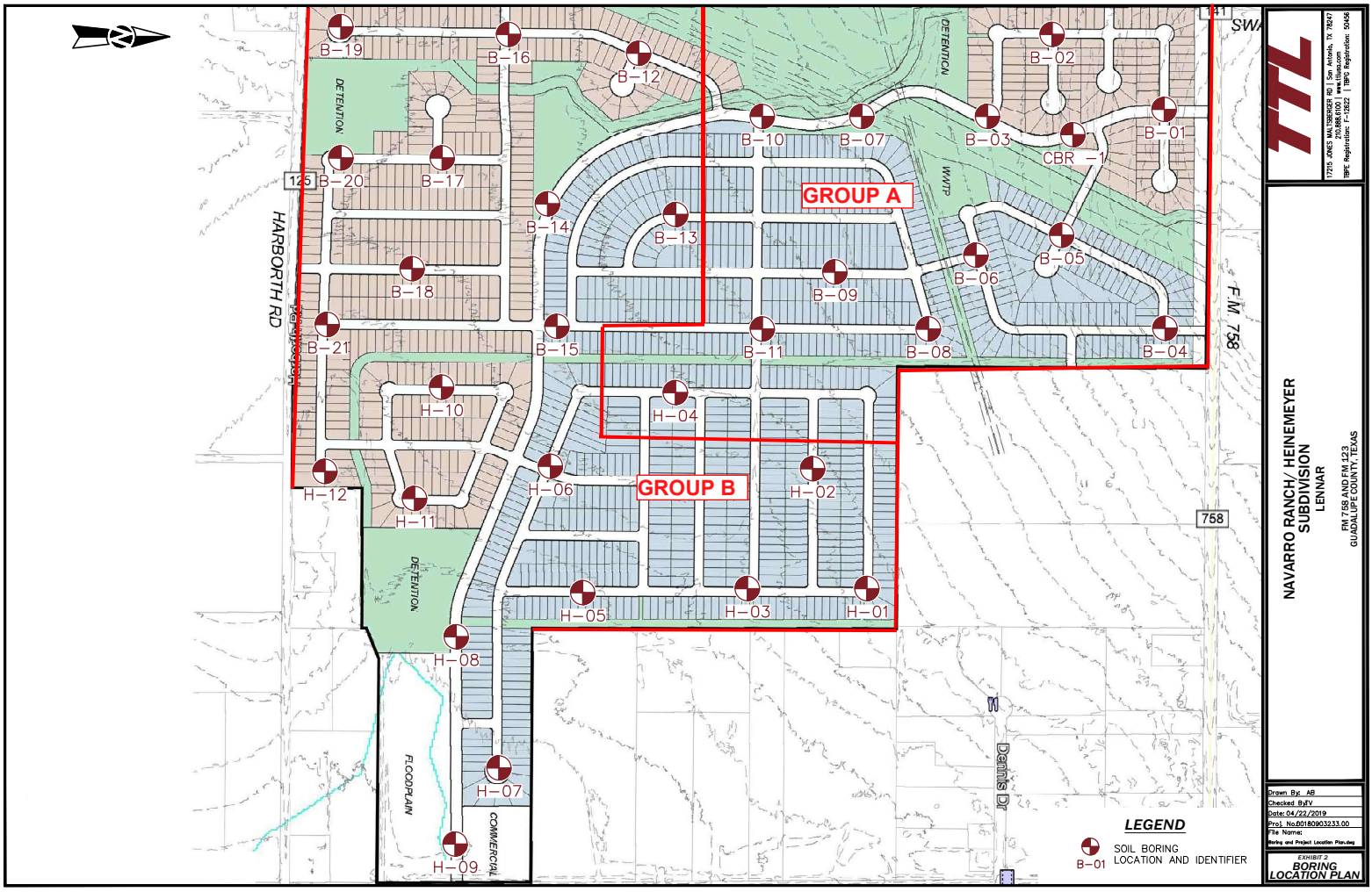


17215 JONES MALTSBERGER RD | San Antonio, TX 78247
210.888.6100 | www.ttiinc.com
TBPE Registration: F-12022 | TBPLS Registration: 10456

NAVARRO RANCH/ HEINEMEYER SUBDIVISION
LENNAR
FM 758 AND FM 123
GUADALUPE COUNTY, TEXAS

Drawn By: AB
Checked By: V
Date: 04/22/2019
Proj. No.: 0018090233.00
File Name:
Navarro and Project Location Plan.dwg

EXHIBIT 1
PROJECT LOCATION PLAN



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17215 JONES MALTSBERGER RD | San Antonio, TX 78247
210.888.6100 | www.ttiaa.com
TBPE Registration: F-12022 | TBPG Registration: 50456

NAVARRO RANCH/ HEINEMEYER SUBDIVISION
LENNAR
FM 758 AND FM 123
GUADALUPE COUNTY, TEXAS

Drawn By: AB
Checked By: TV
Date: 04/22/2019
Proj. No.: 0018090323.00
File Name:
Boring and Project Location Plan.dwg

EXHIBIT 2
BORING LOCATION PLAN

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO. 000180903233.00
BORING NO. B-1
DATE 3/5/2019
SURFACE ELEVATION Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N=6	37									FAT CLAY (CH); dark gray; firm
	2												
			N=37	33									- hard
	4												
			N=8	18									- mottled brown and gray; firm
	6												
			N=14	22	78	24	54						- stiff
	8												
			N=10	34									
	10												
	12												
	14		N=13	30									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
3

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO. 000180903233.00
BORING NO. B-2
DATE 3/5/2019
SURFACE ELEVATION Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; firm to stiff
	2		N=7	34									
	4		N=9	27	81	27	54						
	6		N=8	34									- mottled brown and gray; firm to very stiff
	8		N=13	32									
	10		N=12	30	90	30	60						
	12												
	14		N=21	28									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
4

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO. 000180903233.00
BORING NO. B-3
DATE 3/5/2019
SURFACE ELEVATION Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; firm
	2		N=5	37									
	4		N=7	32									
	6		N=6	32	70	30	40						- mottled brown and gray; firm to stiff
	8		N=10	33									
	10		N=9	33									
	12												
	14		N=16	31									- very stiff
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
5

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	B-4
DATE	3/5/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; firm to stiff
	2		N=7	34									
	4		N=13										
	6		N=15	30									- mottled brown and gray; stiff to very stiff
	8		N=13	31									
	10		N=21	27									
	12												
	14		N=19	24	57	26	31						
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 6

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	B-5
DATE	3/5/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	0												FAT CLAY (CH); dark gray; firm
	2		N=6	28									
	4		N=7	29									
	6		N=62	22									FAT CLAY (CH); mottled brown and gray; very hard to hard; calcareous
	8		N=31	32									
	10		N=26	4	51	22	29					26	CLAYEY SAND (SC); light brown; medium dense
	12												
	14		N=39	16									SANDY LEAN CLAY (CL); light brown; calcareous; very stiff to hard
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 7

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO. 000180903233.00
BORING NO. B-6
DATE 3/5/2019
SURFACE ELEVATION Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	0												FAT CLAY (CH); dark gray; firm to stiff
	2		N=8	35									
	4		N=13										
	6		N=19	22									- mottled brown and gray; very stiff
	8		N=29	16									LEAN CLAY (CL); light brown; calcareous; very stiff to hard
	10		N=43	9									
	12												
	14		N=23	22									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 8

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	B-7
DATE	3/5/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; firm
	2		N=6	37	88	31	57					91	
	4		N=8	39									
	6		N=8	42									- mottled brown and gray; firm
	8		N=19	20									- very stiff
	10		N=18	14	49	18	31					90	LEAN CLAY (CL); light brown; calcareous; very stiff
	12												
	14		N=28	15									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 9

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	B-8
DATE	3/5/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	0												FAT CLAY (CH); dark gray; firm to stiff
	2		N=7	35									
	4		N=9	33									
	6		N=9	31									- mottled brown and gray; stiff to very stiff
	8		N=21	29									
	10		N=15	20									LEAN CLAY (CL); light brown; calcareous; stiff to very stiff
	12												
	14		N=19	20									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 10

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	B-9
DATE	3/5/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; firm
	2		N=5	38									
	4		N=8	37									
	6		N=8	36									- mottled brown and gray; firm to very stiff
	8		N=16	27									
	10		N=14	24	77	29	48						
	12												
	14		N=20	29									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
11

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	B-10
DATE	3/5/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

FIELD DATA				LABORATORY DATA									
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	ATTERBERG LIMITS (%) PLASTIC LIMIT PL	ATTERBERG LIMITS (%) PLASTICITY INDEX PI	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	2		N=6	37									FAT CLAY (CH); dark gray; firm
	4		N=6	39									
	6		N=6	39									- mottled brown and gray; firm to very stiff
	8		N=11	32									
	10		N=12	26									
	12												
	14		N=20	29									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
12

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	B-11
DATE	3/5/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	0												FAT CLAY (CH); dark gray; firm to stiff
	2		N=7	36									
	4		N=11	35									
	6		N=9	36									- mottled brown and gray; stiff
	8		N=15	29									
	10		N=20	31									- very stiff
	12												
	14		N=40	13									LEAN CLAY (CL); light brown; calcareous; very stiff to hard
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 13

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	B-12
DATE	3/6/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	0												FAT CLAY (CH); dark gray; firm to stiff
	2		N=6	34									
	4		N=12	23									
	6		N=15	32									- mottled brown and gray; stiff to very stiff
	8		N=26	24									
	10		N=39	14									SANDY LEAN CLAY (CL); light brown; calcareous; hard
	12												
	14		N=30	14									CLAYEY SAND (SC); light brown; medium dense
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
14

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO. 000180903233.00
BORING NO. B-13
DATE 3/6/2019
SURFACE ELEVATION Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; firm
	2		N=7	37	74	30	44					94	
	4		N=7	38									
	6		N=9	33	103	32	71					93	- mottled brown and gray; stiff to very stiff
	8		N=23	32									
	10		N=30	15	36	16	20					50	CLAYEY SAND (SC); light brown; medium dense
	12												
	14		N=30	10									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 15

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO. 000180903233.00
BORING NO. B-14
DATE 3/6/2019
SURFACE ELEVATION Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; stiff
	2		N=11	34									
	4		N=11	37									
	6		N=11	29									- mottled brown and gray; stiff
	8		N=12	30									
	10		N=46	12									SANDY LEAN CLAY (CL); light brown; calcareous; hard
	12												
	14		N=32	11									CLAYEY SAND (SC); light brown; dense
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 16

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO. 000180903233.00
BORING NO. B-15
DATE 3/6/2019
SURFACE ELEVATION Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N=6	36									FAT CLAY (CH); dark gray; firm to stiff
	2												
			N=10	35									
	4												
			N=15	19									LEAN CLAY (CL); mottled brown and gray; stiff to very stiff
	6												
			N=27	19									
	8												
			N=62	14									SANDY LEAN CLAY WITH GRAVEL (CL); light brown; calcareous; very hard
	10												
	12												
	14		N=70	14									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 17

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	B-16
DATE	3/6/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	2		N=8	34									FAT CLAY (CH); dark gray; firm
	4		N=8	31									
	6		N=15	20									- mottled brown and gray; stiff to hard
	8		N=36	8									
	10		N=49	32	28	16	12					63	SANDY LEAN CLAY WITH GRAVEL (CL); light brown; calcareous; hard
	12												
	14		N=45	13	21	14	7					79	SILTY CLAY WITH SAND (CL-ML); light brown; hard
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
18

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	B-17
DATE	3/6/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; firm to stiff
	2		N=6	12									
	4		N=10	33	78	31	47					92	
	6		N=28	13									- mottled brown and gray; very stiff to hard
	8		N=36	16									
	10		N=27	15									SANDY LEAN CLAY (CL); light brown; calcareous; very stiff
	12												
	14		N=50/2"	10									CLAYEY GRAVEL (GC); light brown; very dense
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
19

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	B-18
DATE	3/6/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	2		N=8	37									FAT CLAY (CH); dark gray; firm
	4		N=8	35									
	6		N=16	23									- mottled brown and gray; very stiff
	8		N=26	12									SANDY LEAN CLAY (CL); light brown; calcareous; very stiff to hard
	10		N=31	14									
	12												
	14		N=29	15									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 20

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	B-19
DATE	3/6/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; stiff to very stiff
	2		N=9	31									
	4		N=18	22									
	6		N=16	17	30	18	12						LEAN CLAY (CL); mottled brown and gray; very stiff to hard
	8		N=47	17									
	10		N=50/3"	13	28	16	12						SANDY LEAN CLAY WITH GRAVEL (CL); light brown; very hard
	12												
	14		N=97/7"	17									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 21

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO. 000180903233.00
BORING NO. B-20
DATE 3/6/2019
SURFACE ELEVATION Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	2		N=8	33									FAT CLAY (CH); dark gray; firm to stiff
	4		N=13	25									
	6		N=27	12									LEAN CLAY (CL); mottled brown and gray; very stiff to hard
	8		N=48	11									
	10		N=50/3"	16									SANDY LEAN CLAY WITH GRAVEL (CL); light brown; calcareous; very hard
	12												
	14		N=50/1"	14									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 22

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	B-21
DATE	3/6/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; stiff
	2		N=9	35									
	4		N=10	32	78	32	46					93	
	6		N=12	22									- mottled brown and gray; stiff to hard
	8		N=36	15									
	10		N=46	12	21	15	6					67	SANDY SILTY CLAY (CL-ML); light brown; hard
	12												
	14		N=83/11"	15									CLAYEY GRAVEL (GC); light brown; very dense
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
23

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	H-01
DATE	3/6/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; firm to stiff
	2		N=6	31	72	31	41						
	4		N=11	20									
	6		N=14	24									- mottled brown and gray; stiff
	8		N=22	22	23	16	7						SANDY LEAN CLAY (CL); light brown; calcareous; very stiff
	10		N=71	12	19	14	5						SANDY LEAN CLAY WITH GRAVEL (CL); light brown; calcareous; very hard
	12												
	14		N=50/3.5"	15									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 24

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO. 000180903233.00
BORING NO. H-02
DATE 3/7/2019
SURFACE ELEVATION Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LL	PL	PI	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; firm to stiff
	2		N=8	31									
	4		N=10	33	79	29	50						- mottled brown and gray; stiff
	6		N=15	27									
	8		N=24	14	36	19	17						SANDY LEAN CLAY (CL); light brown; calcareous; very stiff
	10		N=58	14									SANDY LEAN CLAY WITH GRAVEL (CL); light brown; very hard to hard
	12												
	14		N=46	14									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
25

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	H-03
DATE	3/7/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	2		N=9	34									FAT CLAY (CH); dark gray; stiff to very stiff
	4		N=18	27									
	6		N=13	18									- mottled brown and gray; stiff
	8		N=21	17									SANDY LEAN CLAY (CL); light brown; calcareous; very stiff
	10		N=25	17									
	12												
	14		N=74/11"	10									CLAYEY GRAVEL (GC); light brown; very dense
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 26

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	H-04
DATE	3/7/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	0												FAT CLAY (CH); dark gray; firm
	2		N=6	35									
	4		N=8	35									
	6		N=11	31									- mottled brown and gray; stiff to very stiff
	8		N=19	29									
	10		N=13	29									
	12												
	14		N=32	20									SANDY LEAN CLAY (CL); light brown; calcareous; hard
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 27

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	H-05
DATE	3/7/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was observed at 13 feet during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; firm to stiff
	2		N=5	35	78	31	47					92	
	4		N=11	33									
	6		N=10	30									
	8		N=22	16									LEAN CLAY (CL); mottled brown and gray; very stiff
	10		N=24	15	37	15	22					92	
	12												CLAYEY GRAVEL (GC); light brown; medium dense
	14		N=14	14									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
28

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	H-06
DATE	3/7/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; firm to stiff
	2		N=6	36									
	4		N=9	34									
	6		N=16	24									LEAN CLAY (CL); mottled brown and gray; very stiff
	8		N=21	16									
	10		N=50/5"	13									CLAYEY GRAVEL (GC); light brown; calcareous; very dense
	12												
	14		N=50/4"	10									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 29

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO. 000180903233.00
BORING NO. H-07
DATE 3/7/2019
SURFACE ELEVATION Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was observed at 8.5 feet during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
			N=6	40									FAT CLAY (CH); dark gray; firm
	2												
			N=26	20									- very stiff
	4												
			N=84/8"	8								24	CLAYEY SAND WITH GRAVEL (SC); light brown; very dense
	6												
			N=50/4"	15									CLAYEY GRAVEL (GC); light brown; very dense
	8												
			N=22	18	23	17	6					60	SANDY SILTY CLAY (CL-ML); light brown; very stiff
	10												
	12												
	14		N=22	23									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 30

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	H-08
DATE	3/7/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was observed at 8 feet during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LL	PL	PI	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	2		N=7	33									FAT CLAY (CH); dark gray; firm to very stiff
	4		N=17	20									
	6		N=8	18	25	15	10					60	SANDY LEAN CLAY WITH GRAVEL (CL); mottled brown and gray; firm
	8 ▽		N=17	19	48	18	30					64	CLAYEY GRAVEL (GC); light brown; medium dense
	10		N=69	17									SANDY LEAN CLAY WITH GRAVEL (CL); light brown; calcareous; very hard
	12												
	14		N=50/4"	12									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT 31

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO. 000180903233.00
BORING NO. H-09
DATE 3/7/2019
SURFACE ELEVATION Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; firm to stiff
	2		N=6	39									
	4		N=12	35									
	6		N=33	14									- mottled brown and gray; hard
	8		N=31	35									
	10		N=15	27									SANDY LEAN CLAY (CL); light brown; calcareous; stiff to very stiff
	12												
	14		N=23	24									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
32

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO. 000180903233.00
BORING NO. H-10
DATE 3/7/2019
SURFACE ELEVATION Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LL	PL	PI	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													FAT CLAY (CH); dark gray; firm to stiff
	2		N=7	34									
	4		N=11	33									
	6		N=15	20	41	21	20					90	LEAN CLAY (CL); mottled brown; stif to very stiff
	8		N=27	16	81	19	62					95	
	10		N=65/11"	19									SANDY LEAN CLAY WITH GRAVEL (CL); light brown; very hard
	12												
	14		N=57	17									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
33

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO. 000180903233.00
BORING NO. H-11
DATE 3/7/2019
SURFACE ELEVATION Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was observed at 12.5 feet during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LL	PL	PI	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
					LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX						
	2		N=7	34	81	32	49					93	FAT CLAY (CH); dark gray; firm to very stiff
	4		N=16	24									
	6		N=12	25									
	8		N=18	23	42	19	23					96	LEAN CLAY (CL); light brown; calcareous; very stiff
	10		N=85/11"	13									CLAYEY GRAVEL (GC); light brown; very dense
	12	▽ ▼											
	14		N=13	12									- medium dense
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

TTL

EXHIBIT
34

LOG OF BORING

PROJECT: Navarro Ranch Subdivision
FM 758 and FM 123
Guadalupe County, Texas

CLIENT: LENNAR
San Antonio, Texas

PROJECT NO.	000180903233.00
BORING NO.	H-12
DATE	3/7/2019
SURFACE ELEVATION	Existing Grade

DRILLING METHOD(S):
Solid Stem Auger Drilling to 15 feet

GROUNDWATER INFORMATION:
Groundwater was observed at 13 feet during drilling operations

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	LABORATORY DATA: MOISTURE CONTENT (%)	ATTERBERG LIMITS (%): LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY (POUNDS/CU FT)	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	2		N=8	37	88	30	58					92	FAT CLAY (CH); dark gray; firm to stiff
	4		N=9	39									
	6		N=16	17									SANDY LEAN CLAY (CL); light brown; calcareous; very stiff to hard
	8		N=23	16									
	10		N=37	13									
	12												CLAYEY GRAVEL (GC); light brown; very dense
	14		N=72	11									
													Boring Terminated at 15 feet.

REMARKS
Boring was backfilled after subsurface water observations with soil cuttings and restored to original grade

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EXHIBIT
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APPENDIX

Exploratory Drilling Program

Laboratory Testing Program

Notes Regarding Soil and Rock

EXPLORATORY DRILLING PROGRAM

A truck-mounted, drilling rig was used to drill the exploratory borings and to recover soil/rock samples during the drilling. Soil samples were obtained by a split-barrel ("split-spoon") sampler while performing the Standard Penetration Test ("SPT").

When a soil/rock sample was recovered using a split-barrel sampler, the SPT N-value was recorded on the applicable field log. The SPT procedure consists of driving the split-barrel into the subsurface stratum with a 140-pound hammer falling a distance of 30 inches. The number of blows ("N") required to advance the split-spoon sampler the last 12 inches during a normal 18-inch penetration is the SPT resistance value or N-value. These N-values are indicated on each applicable field log at the depths of occurrence. The samples were sealed and transported to the laboratory for testing and classification.

Our field representative prepared the field logs as part of the drilling operations. The field logs included visual classifications of the materials encountered during drilling, our field representative interpretation of the subsurface conditions between samples, and recording the results of various tests (N-values, PPT, and TV) performed during drilling and sampling. Each field log included with this report represents our technical interpretation of the field log and includes modifications based on visual observations and testing of the samples in the laboratory.

The scope of services for our geotechnical engineering services does not include addressing any environmental issues pertinent to the site.

LABORATORY TESTING PROGRAM

Samples retrieved during the field exploration were taken to the laboratory for further observation by one of our technical representatives, and they were classified in accordance with the Unified Soil Classification System (USCS). At that time, the field descriptions were confirmed or modified as necessary and an applicable laboratory testing program was formulated to determine the physical (index) and engineering properties of the soil/rock.

Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix. The laboratory test results were used for the geotechnical engineering analyses, and the development of foundation and earthwork recommendations. Laboratory tests were performed in general accordance with the applicable ASTM or other accepted standards. The following tests were conducted:

- Moisture Content
- Atterberg Limits
- Amount of Material In-Soil Finer than the № 200 Mesh (75-µm) Sieve

Sample Disposal

All samples were returned to our laboratory. Unless stated otherwise in this report or the Project contract, the samples not tested in the laboratory will be stored for a period of 30 days subsequent to submittal of this report and will be discarded after this period, unless other arrangements are made prior to the disposal period.

NOTES REGARDING SOIL AND ROCK

GEOTECHNICAL SAMPLING SYMBOLS:

SS: Split Barrel (Split Spoon)
ST: Thin-Walled Tube (Shelby tube)
AG: Auger Sample, Grab Sample, or Bulk Sample
RC: Rock Coring Sample

WATER LEVEL MEASUREMENT SYMBOLS:

▽ Water Level Encountered While Drilling and Sampling.
▼ Water Level Measurement After Initial Water Level Encountered During Drilling and Sampling.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Soil Classification System (ASTM D2487). Coarse-Grained Soils have more than 50 percent of their dry weight retained on a No. 200 sieve. The primary descriptors of these soils are: boulders, cobbles, gravel, or sand. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density. Fine-Grained Soils have less than 50 percent of their dry weight retained on a No. 200 sieve. These soils are principally described as clays if they are plastic (have binding/molding characteristics), and silts if they are slightly plastic or non-plastic. Fine-grained soils are defined on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Undrained Shear c_u, psf	Standard Penetration Test (SPT) N-value Blows Per Foot	Consistency
< 250	< 2	Very Soft
250 – 500	2 - 4	Soft
500 – 1,000	5 - 8	Firm
1,000 – 2,000	9 - 15	Stiff
2,000 – 4,000	16 - 30	Very Stiff
4,000+	31 – 50	Hard
4,000+	51+	Very Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration Test (SPT) N-Value Blows Per Foot	Relative Density
0 – 4	Very Loose
5 – 10	Loose
11 – 30	Medium Dense
31 – 50	Dense
51+	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Terms	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

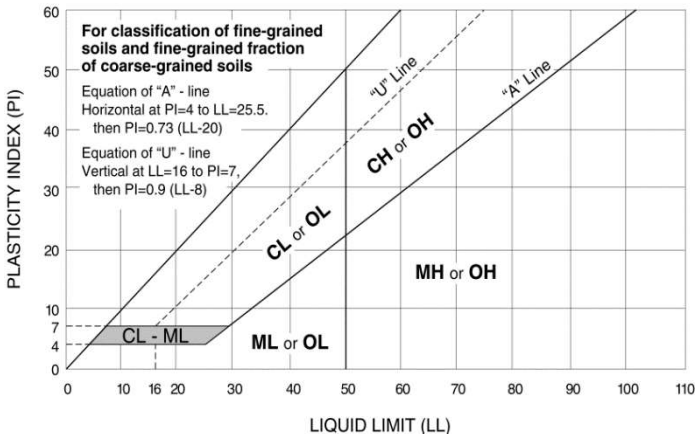
Major Constituent of Soil Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75 mm)
Gravel	3 in. to No. 4 sieve (75mm to 4.75 mm)
Sand	No. 4 to No. 200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing No. 200 Sieve (0.075mm)

RELATIVE PROPORTIONS OF CLAYS AND SILTS

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

PLASTICITY DESCRIPTION

Term	Plasticity Index (PI)
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	30+



CLASSIFICATION OF ROCK WITH RESPECT TO STRENGTH

Very Low Strength	18 – 72 ksf
Low Strength	72 – 288 ksf
Medium Strength	288 – 1,152 ksf
High Strength	1,152 – 4,608 ksf
Very High Strength	4,608 – 18,432 ksf

RQD	DESCRIPTION OF ROCK QUALITY
0 – 25	Very Poor
25 – 50	Poor
50 – 75	Fair
75 – 90	Good
90 - 100	Excellent

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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

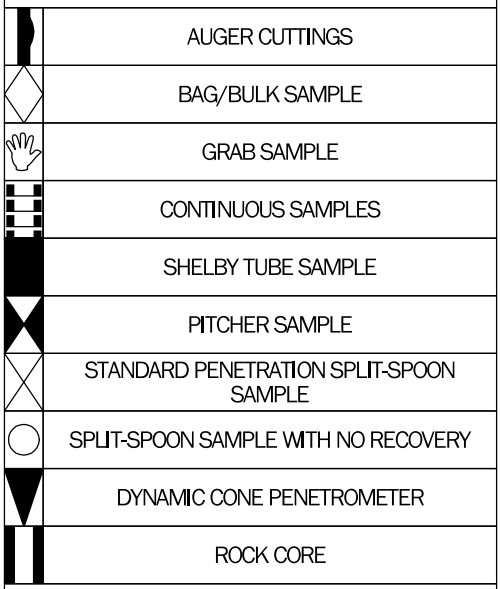
CRITERIA FOR DESCRIBING STRUCTURE

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

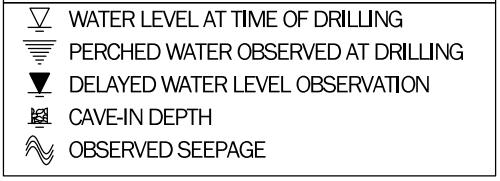
ABBREVIATIONS AND ACRONYMS

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

SAMPLERS AND DRILLING METHODS



WATER LEVEL SYMBOLS



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UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

COARSE GRAINED SOILS (>50% of the material is larger than the #200 sieve)	GRAVELS (>50% of coarse fraction is larger than the #4 sieve)	CLEAN GRAVEL WITH <5% FINES	Cu > 4 Cc = 1-3	GW	Well-graded gravels, gravel-sand mixtures with trace or no fines
			Cu ≤ 4 and/or Cc < 1 Cc > 3	GP	Poorly-graded gravels, gravel-sand mixtures with trace or no fines
		GRAVEL WITH 5% TO 12% FINES	Cu > 4 Cc = 1-3	GW-GM	Well-graded gravels, gravel-sand mixtures with silt fines
				GW-GC	Well-graded gravels, gravel-sand mixtures with clay fines
			Cu ≤ 4 and/or Cc < 1 Cc > 3	GP-GM	Poorly-graded gravels, gravel-sand mixtures with silt fines
				GP-GC	Poorly-graded gravels, gravel-sand mixtures with clay fines
		GRAVEL WITH MORE THAN 12% FINES		GM	Silty gravels, gravel-silt-sand mixtures
				GC	Clayey gravels, gravel-sand-clay mixtures
				GC-GM	Clayey gravels, gravel-sand-clay-silt mixtures
	SANDS (>50% of coarse fraction is smaller than the #4 sieve)	CLEAN SAND WITH <5% FINES	Cu > 6 Cc = 1-3	SW	Well-graded sands, sand-gravel mixtures with trace or no fines
			Cu ≤ 6 and/or Cc < 1 Cc > 3	SP	Poorly-graded sands, sand-gravel mixtures with trace or no fines
		SAND WITH 5% TO 12% FINES	Cu > 6 Cc = 1-3	SW-SM	Well-graded sands, sand-gravel mixtures with silt fines
				SW-SC	Well-graded sands, sand-gravel mixtures with clay fines
			Cu ≤ 6 and/or Cc < 1 Cc > 3	SP-SM	Poorly-graded sands, sand-gravel mixtures with silt fines
				SP-SC	Poorly-graded sands, sand-gravel mixtures with clay fines
		SAND WITH MORE THAN 12% FINES		SM	Silty sands, sand-gravel-silt mixtures
				SC	Clayey sands, sand-gravel-clay mixtures
				SC-SM	Clayey sands, sand-gravel-clay-silt mixtures
FINE GRAINED SOILS (>50% of material is smaller than the #200 sieve)		SILTS & CLAYS (Liquid Limit less than 50)		ML	Inorganic silts with low plasticity
				CL	Inorganic clays of low plasticity, gravelly or sandy clays, silty clays, lean clays
				CL-ML	Inorganic clay-silts of low plasticity, gravelly clays, sandy clays, silty clays, lean clays
				OL	Organic silts and organic silty clays of low plasticity
		SILTS & CLAYS (Liquid Limit more than 50)		MH	Inorgatinc silts of high plasticity, elastic silts
				CH	Inorganic clays of high plasticity, fat clays
				OH	Organic clays and organic silts of high plasticity

USCS - HIGHLY ORGANIC SOILS

Primarily organic matter, dark in color, organic odor

PT	Peat, humus, swamp soils with high organic contents

OTHER MATERIALS

- BITUMINOUS CONCRETE (ASPHALT)
- CONCRETE
- CRUSHED STONE/AGGREGATE BASE
- TOPSOIL
- FILL
- UNDIFFERENTIATED ALLUVIUM
- UNDIFFERENTIATED OVERBURDEN
- BOULDERS AND COBBLES

UNIFORMITY COEFFICIENT

$$C_u = D_{60}/D_{10}$$

COEFFICIENT OF CURVATURE

$$C_C = (D_{30})^2/(D_{60} \times D_{10})$$

Where:

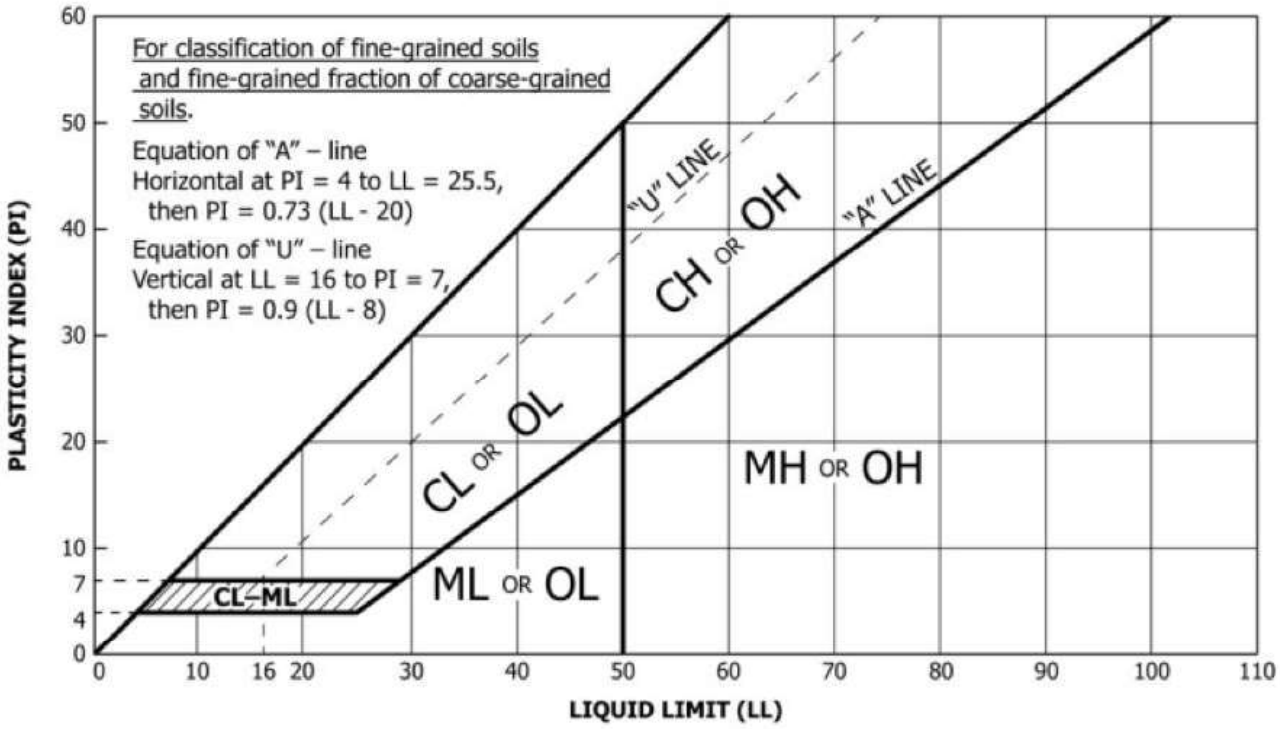
D_{60} = grain diameter at 60% passing

D_{30} = grain diameter at 30% passing

D_{10} = grain diameter at 10% passing

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"