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Subsurface Exploration, Pavement Recommendations And Preliminary Foundation Recommendations Lucero at Luckey Ranch - Unit 1A San Antonio, Texas

Terradyne Project No.: A221080-R6

Mr. Pat Vedra
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January 24, 2025

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2021 ENR Texas & Louisiana TOP DESIGN FIRMS

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January 24, 2025

LGI Homes-Texas, LLC
1450 Lake Robbins Drive, Suite 430
The Woodlands, Texas 77380

Attn: Mr. Pat Vedra

Re: **Subsurface Exploration, Pavement Recommendations, and Preliminary Foundation Recommendations**
Lucero at Luckey Ranch - Unit 1A
San Antonio, Texas
Terradyne Project No.: A221080-R6

Dear Mr. Birt:

Terradyne Engineering, Inc. (Terradyne) has completed a soil and foundation engineering report at the above referenced project site. The results of the exploration are presented in this report.

We appreciate and wish to thank you for the opportunity to service you on this project. Please do not hesitate to contact us if we can be of additional assistance during the Construction Materials Testing and Quality Control phases of construction.

Respectfully Submitted,

Terradyne Engineering, Inc.
Texas Firm Registration No. F-6799

STATE OF TEXAS
JOHN A. GUNTER
47957
REGISTERED PROFESSIONAL ENGINEER

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10/10/2024

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EXECUTIVE SUMMARY

The soil conditions at the site of the proposed residential structures and roadways for Lucero at Luckey Ranch South - Unit 1A in San Antonio, Texas were explored by drilling two (2) borings to a maximum depth of approximately 10 feet below the existing ground surface elevation. Laboratory tests were performed on selected soil samples to evaluate the engineering characteristics of the soil strata encountered in the borings. This investigation is preliminary in nature and based on a very limited number of borings. The foundation design parameters presented in this report are for informational and comparative purposes only and should not be used for actual foundation design.

The results of the exploration, laboratory testing and engineering evaluation indicate the soils underlying this site have moderate to high expansive characteristics. Following is a summary of the results:

1) The boring locations were selected by the geotechnical project manager and are shown on Figure 1. A potential vertical movement on the order of two (2) to four (4) inches was estimated at the existing grade level.
2) The Design Plasticity Index values are 28 to 54.
3) The borings generally encountered Fat Clay (CH) and Clayey Sand with Gravel (SC).
4) Groundwater seepage was not encountered in the borings at the time of the field exploration.

This report presents preliminary stiffened beam and slab foundation design parameters for the site prior to any cut and fill operations or soil modification procedures. Final design values after site work has occurred can be expected to vary.

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

This summary does not contain all the information that is included in the full report. The report should be read in its entirety to obtain a more complete understanding of the information provided.

1.0 INTRODUCTION

This report presents the results of the preliminary subsurface exploration and foundation analysis for the proposed residential structures and roadways for Lucero at Luckey Ranch South - Unit 1A in San Antonio, Texas. The services of Terradyne, were authorized on April 14, 2022 by Mr. Chuck Birt, of LGI Homes-Texas, LLC via email approval of Terradyne proposal No: AP221082 dated March 24, 2022.

2.0 PURPOSE AND SCOPE OF SERVICES

The purpose of the preliminary geotechnical investigation was to evaluate the subsurface materials and groundwater conditions of the site and provide geotechnical-engineering recommendations for the design and construction of new residential structures and roadways. The scope of services includes the following:

1) Drilling and sampling of two (2) borings to a maximum depth of approximately 10 feet below the existing ground surface elevation;
2) Observation of the groundwater conditions during drilling operations;
3) Performing laboratory tests such as Atterberg limits and moisture content tests;
4) Review and evaluation of the field and laboratory test programs during their execution with modifications of these programs, when necessary, to adjust to subsurface conditions revealed by them;
5) Compilation, generalization and analysis of the field and laboratory data in relation to the project requirements;
6) Estimation of potential vertical movement;
7) Development of recommendations for the design, construction, and earthwork phases of project; and
8) Consultations with the Prime Professional and members of the design team on findings and recommendations; and preparation of a written geotechnical engineering report for use by the members of the design team in their preparation of design, contract documents, and specifications.

The Scope of Services did not include any environmental assessment for the presence or absence of wetlands and/or hazardous or toxic materials in the soil, surface water, groundwater, or air, in the proximity of this site. Any statements in this report or on the bore hole logs regarding odors, colors or unusual or suspicious items or conditions are strictly for the information of the client.

2.1 Site Description

The subject property is located on the east side of Montgomery Road and north side of Straus Medina in San Antonio, Texas. The subject site is relatively flat with vegetation and trees in proposed building area. Borings B-1, B-2, B-5 and B-8 were drilled at/near the following GPS location (Lat. 29.346034, Long. -98.736197). An aerial map of the GPS location is included in Figure 9.

3.0 <u>GEOTECHNICAL INVESTIGATION</u>

The field exploration to determine the engineering characteristics of the subsurface materials included a reconnaissance of the project site, drilling the borings, and recovering samples. A total of two(2) borings were drilled to a maximum depth of 10 feet at the project site.

The soil borings were performed with a drilling rig equipped with a rotary head. Conventional solid stem continuous augers were used to advance the hole and samples of the subsurface materials were sampled using a two-inch O.D. split barrel sampler (ASTM D 1586), and Auger. The samples were identified according to depth, encased in polyethylene plastic wrapping to protect against moisture loss, and transported to the laboratory in special containers.

3.1 Field Tests and Measurements

<u>Penetration Tests:</u> During the sampling procedures, standard penetration tests were performed in the borings in conjunction with the split-barrel sampling. The standard penetration value (N) is defined as the number of blows of a 140-pound hammer, falling thirty inches, required to advance the split-spoon sampler one-foot into the soil. The sampler is lowered to the bottom of the drill hole and the number of blows recorded for each of the three successive increments of six inches penetration. The "N" value is obtained by adding the second and third incremental numbers. The results of the standard penetration test indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

<u>Water Level Measurements:</u> Water level observations were made during the excavation operations and the results are noted on the boring logs. In relatively pervious soils, such as sandy soils, the indicated elevations are considered reliable groundwater levels. In relatively impervious soils, an accurate determination of the groundwater elevation may not be possible even after several days of observation. Seasonal variations, temperature and recent rainfall conditions may influence the level of the groundwater table and the volume of water encountered will depend on the permeability of the soils.

3.2 Boring Logs

A field log was prepared for each boring. The logs include information concerning the samples attempted and recovered, indications of the presence of material (such as calcareous clays, sandy clay, etc.) and groundwater observations. It also includes an interpretation of the subsurface conditions between samples. Therefore, these logs include both factual and interpretive information.

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

3.3 Laboratory Testing Program

In addition to field exploration, a supplemental laboratory-testing program was conducted to determine additional pertinent engineering characteristics of the subsurface materials necessary in evaluating the design parameters of the soil. All phases of the laboratory testing program were conducted in general accordance with the indicated applicable ASTM Specifications as presented in Table No. 1.

Table No. 1 – Test Methods Summary

Laboratory Test	Applicable Test Standard
Liquid Limit, Plastic Limit, & Plasticity Index of Soil	ASTM D-4318
Moisture Content	ASTM D-2216
Material Finer than No. 200	ASTM D-1140
California Bearing Ratio (CBR)	ASTM D-1883
Lime Series Testing	TEX-121-E

In the laboratory, each sample was examined and classified by a geotechnical engineer. As a part of this classification procedure, the natural water content of the soil samples was determined. Atterberg limit tests were performed on representative soil samples to determine the plasticity characteristics of the soil strata encountered. The results of these tests are presented on the appropriate boring logs and in the Illustrations.

3.4 General Subsurface Conditions

The site is located within the Navarro Group and Marlbrook Marl (Kknm) overlaid by Fluviatile terrace deposits (Qt). The Fluviatile terrace deposits consist of gravel, sand, silt, and clay. The upper part of the Navarro Group and Marlbrook Marl formation consist of marl, clay, sandstone, and siltstone. The marl and clay contain concretions of limonite and siderite. The sandstone and siltstone are fine grained. The lower part consists of greenish gray to brownish gray clay. The thickness of the Navarro Group and Marlbrook Marl formation is 980 feet.[1]

The soils underlying this site may be grouped into two (2) generalized strata. The soil stratigraphy information and the engineering properties of the underlying soils based Terradyne's professional engineering experience are presented on the Boring Logs, Figures 2 and 3.

[1] Source: United States Geological Survey, Geologic Atlas of Texas [San Antonio Sheet], Bureau of Economic Geology, Texas Natural Resource Information System; http://txpub.usgs.gov/DSS/texasgeology/ (Reprinted 1981).

During the field investigation, subsurface water was not encountered in the borings during drilling. In addition, the soil samples were considered dry. Based upon this information and past projects in the surrounding areas of the site, groundwater is not anticipated to be major concern during construction activities. However, groundwater condition can fluctuate due to seasonal and climatic variations and may be encountered at shallow depths during high precipitation seasons.

4.0 FOUNDATION DESIGN CONSIDERATIONS

Lot Drainage: How a lot is graded affects the accumulation of surface water around the slab. Most builders are aware of the importance of grading the soil away from structures so that rainwater does not collect and pond adjacent to the foundation. If allowed to accumulate next to the foundation, water may infiltrate the expansive soils underlying the foundation, which could cause the foundation to settle. Similarly, runoff from surface water drainage patterns and swales must not collect adjacent to foundation.

Topography: As it swells, soil heaves perpendicularly to the ground surface or slope, but as it shrinks, it recedes in the direction of gravity and gradually moves downslope in a sawtooth fashion over several shrink-swell cycles. In addition to this shrink-swell influence, soil will exhibit viscoelastic properties and creep downhill under the steady influence of the weight of the soil. Therefore, to avoid a structure constructed on a slope from moving downhill with the soil, it must be designed to compensate for this lateral soil influence.

Pre-Construction Vegetation: No vegetation was on a site prior to construction. Constructing over a desiccated soil can produce some dramatic instances of heave and associated structural distress and damage as it becomes wet.

Post-Construction Vegetation: The type, amount, and location of vegetation that has grown since construction can cause localized desiccation. Planting trees or large shrubs near a building can result in the loss of foundation support as the vegetation robs moisture from the foundation soil. Conversely, the opposite effect can occur if flowerbeds or shrubs are planted next to foundations and these beds are kept well-watered or flooded. This practice can result in swelling of the soil around the perimeter where the soil remains wet.

Summation: It is beyond the scope of this investigation to do more than point out the factors that may influence the amount and type of swell a slab-on-grade foundation may be subjected to during its lifetime. The design engineer must be aware of these factors in developing his design, using his engineering experience and judgment as a guide.

5.0 DESIGN ENGINEERING ANALYSIS

Foundation Design Considerations: Review of the borings and test data indicates that the following factors will affect the foundation designs and construction at this site:

1) The site at shallow depths is underlain by subsurface soils of moderate to high expansiveness in character. Structures supported at shallow depths will be subjected to potential vertical movement of two (2) to four (4) inches.
2) The strengths of the underlying soils are adequate to support the proposed structures.
3) Groundwater seepage was not encountered in the borings during drilling.

Vertical Movements: The potential vertical movement (PVR) for slab-on grade construction at this site has been estimated using the general guidelines presented in a) the Texas Department of Transportation Test Method TXDOT-124-E and b) based on Terradyne's experience with the swelling characteristics of the clays that are similar to those at the project site. The Texas Department of Transportation method utilizes the liquid limits and plasticity indices for soils in the seasonally active zone, estimated to be about twelve (12) to fifteen (15) feet in the project area.

The estimated PVR value provided is based on the proposed floor system applying a sustained surcharge load of approximately one pound per square inch on the subgrade materials. Potential vertical movement of two (2) to four (4) inches was estimated for average soil moisture conditions at the finish grade elevation. The PVR value is based on the current site grades. Higher PVR values than the above-mentioned value will occur in areas where water can pond for extended periods.

If the existing grade of the structures must be raised to attain finish grade elevation, select structural fill should be used, placed in lifts, and compacted as recommended under the section titled Select Structural Fill provided in this report.

6.0 FOUNDATION RECOMMENDATIONS

This investigation is a preliminary investigation and is based on a very limited number of borings. The design values provided in the report are for comparative purposes only and should not be used for actual design.

6.1 Stiffened Grid Type Beam and Slab Foundations

A stiffened grid type beam and slab foundation may be considered to support the proposed buildings provided the anticipated vertical movement will not impair the performance of the structures.

It is desirable to design the foundation systems using an assumption that the beams carry the loads. An allowable bearing pressure of 2,000 pounds per square foot should be used for beams founded at a minimum depth of 12 inches below the existing undisturbed soils. If the existing grade of the structure must be raised to achieve design grade, select structural fill should be placed, compacted, and tested. An allowable bearing pressure of 2,500 pounds per square foot should be used for beams bearing on a minimum of 12 inches of compacted select structural fill. Beams should be at least 12 inches deep and 10 inches wide to prevent local shear failure of the bearing soils. Design plasticity index values were evaluated at the boring locations and are presented below in Table No. 2.

Table No. 2

Lucero at Luckey Ranch – Unit 1A	
Boring	**Design Plasticity Index**
1	**33**
2	**54**

6.2 Post-Tensioned Beam and Slab Foundation

A post-tensioned slab-on-grade foundation may also be considered to support the structures provided the anticipated movement will not impair the performance of the structures. Pertinent design parameters were evaluated and are presented in the following paragraphs.

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

Differential vertical movements have been estimated for the center lift and edge lift conditions. The PTI Design Parameters are presented in Table No. 3. Refer to the Stiffened Grid Type Beam and Slab Foundation section for allowable bearing capacities.

Table No. 3
PTI 3rd Edition

Design Plasticity Index/PVR (inches)	Differential Vertical Movement, y_m Inches		Edge Moisture Variation Distance, e_m Feet	
	Center Lift	**Edge Lift**	**Center Lift**	**Edge Lift**
54/4	1.94	2.64	8.0	4.2
33/2	1.22	1.79	9.0	5.2

6.3 Utilities

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

6.4 Contraction, Control or Expansion Joints

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

6.5 Lateral Earth Pressure

Some retaining walls may be needed at the site. The equivalent fluid density values were evaluated for various backfill materials. These values are presented in Table No. 4.

Table No. 4

Backfill Material	Equivalent Fluid Density PCF		
	Active Condition	**At Rest Condition**	**Passive Condition**
a. Crushed Limestone	40	60	530
b. Clean Sand	40	60	360
c. Select Fill (PI ≤ 15)	65	85	265

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

If the basement wall or cantilever retaining wall can tilt forward to generate “active earth pressure” condition, the values under active condition should be used. For rigid non-yielding walls which are part of the buildings, the values “at rest condition” should be used. The compactive effort should be controlled during backfill operations. Over compaction can produce lateral earth pressures more than at rest magnitudes. Compaction levels adjacent to below-grade walls should be maintained between 95 and 98 percent of standard Proctor (ASTM D698) maximum dry density.

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

The maximum toe pressure for wall footings founded a minimum depth of 12 inches into the clay soils should not exceed 1,000 pounds per square foot. An adhesion value of 290 pounds per square foot should be used to check against sliding for wall footings bearing on clay.

7.0 PAVEMENT GUIDELINES

7.1 General

Terradyne understand current plans are that the roadways will likely consist of flexible pavements. Therefore, we have prepared the following recommendations for the design and construction of flexible pavement systems. Terradyne understand the proposed pavements for these subdivision units will be designed and constructed in general accordance with the City of San Antonio design standards. These guidelines require that streets be designed using the American Association of State Highway and Transportation Officials (AASHTO) "Guide for Design of Pavement Structures".

7.2 Subgrade Design Considerations

Based on the subsurface information obtained at the soil borings drilled along the alignment of the proposed streets, the pavement subgrade soil profile generally consists of a stiff to hard FAT CLAY (CH), LEAN CLAY (CL), CLAYEY SAND with GRAVEL (SC), and CLAYEY GRAVEL with SAND (GC). As a part of any pavement design, the strength of the underlying subgrade must be taken into consideration. This is often accomplished by performing a laboratory California Bearing Ratio (CBR) test to approximate a soil resilient modulus which is utilized in the design. Based upon the findings of the exploratory borings and results of laboratory testing, Terradyne's experience with similar soils in nearby subdivision units, Terradyne have used a design CBR of approximately three (3) for the pavements within this development. Local A Streets are designed for a minimum traffic application of 100,000 18-kip ESALs. Local B Streets and Collector Streets are designed for a minimum traffic application of 2,000,000 18-kip ESALs. The following are the pavement design parameters:

Table No. 5

Flexible Pavement Design Parameters	
Reliability, Secondary Arterial, percent	95
Initial Serviceability Index	4.2
Terminal Serviceability Index, Secondary Arterial	2.5
Standard Deviation	0.45

The Plasticity Index (PI) of the soils underlying the proposed street alignment were tested up to a value of 54. The above referenced County document states that roadbed soil having a PI greater than twenty (20) shall be chemically stabilized with lime.

7.3 Pavement Sections

Based on the data provided to Terradyne, the results of the field and laboratory testing, and the Bexar County guidelines, Terradyne have developed the following minimum structural numbers and structural design values for the pavement sections planned for this project.

Required Structural Number (SN) – Secondary Arterial	= 5.22
Design CBR Value	= 3.00
Item 340, Asphaltic Concrete Layer Coefficient	= 0.44
Asphalt Treated Base, Type B	= 0.38
Item 247, Type A, Grade 1 or 2 Base Layer Coefficient	= 0.14
Item 260, Lime Stabilized Subgrade Layer Coefficient	= 0.08

Using the above information, the AASHTO design method, and Terradyne's understanding of the Bexar County Flexible Pavement Design Criteria, the following engineered flexible pavement sections are recommended. Options with and without geogrid subgrade reinforcement are presented.

Table No. 6
Recommended Flexible Pavement Sections- Secondary Arterial Streets
Design ESALs: 3,000,000

Flexible Pavement Section	Thickness in Inches	
	Alt 1	Alt 2
Hot Mix Asphaltic Concrete, Type D	1.5	1.5
Hot Mix Asphaltic Concrete, Type C	2.5	2.5
Aggregate Base	18.0	15.0
Lime Stabilized Subgrade	12.0	8.0
Geogrid*	--	Yes

* A layer of geogrid equivalent to Tensar TX5 or HX5.5 should be placed between the subgrade and base course.

Table No. 7
Recommended Flexible Pavement Sections- Box Culvert-Secondary Streets
Design ESALs: 3,000,000

Flexible Pavement Section	Thickness in Inches
Hot Mix Asphaltic Concrete, Type D	1.5
Hot Mix Asphaltic Concrete, Type C	2.5
Aggregate Base	14.0
Tensar TX-5 or HX5.5*	Yes

**Geogrid shall extend a minimum of four (4) feet on either side of the culvert*

The pavement sections containing geogrid are considered to meet the indicated structural capacity. However, if these options will be considered, the County should first be consulted to determine their acceptance of the structural contribution of the geogrid in the pavement sections.

In any areas where pavements are to be constructed, vegetation and all loose or organic material should be stripped and removed from the site. After stripping operations, the subgrade should be proof-rolled with heavy sheep's-foot roller compactor a minimum of **three (3)-passes** to identify soft zones. Any soft zone detected should be removed to a firm subgrade soils and replaced with compacted suitable soils to reach subgrade level. Upon the acceptance of proof-rolling operations the subgrade should be scarified to a depth of six (6) inches, moisture conditioned and compacted to a 95 percent of maximum dry density as determined by ASTM D 698, between optimum and three (3) percentage points above of optimum moisture content. The exposed subgrade should not be allowed to dry out prior to placing structural fill.

7.4 Base Course

Based on the survey of available materials in the area, a base course of crushed limestone aggregate or gravel appears to be the most practical material for asphalt pavement project. The base course should conform to Texas State Department of Highways and Public Transportation Standard Specification, Item 247, Type A, Grade one (1) – two (2).

The base course should be moisture conditioned within ±2 percentage points of optimum moisture content placed in lifts not exceeding 8-inches loose measure and compacted to at least 95 percent of maximum dry density as determined by test method TXDOT-113-E.

7.5 Asphaltic Concrete

The asphaltic concrete surface course should conform to Texas Department of Transportation (TxDOT) Standard Specifications, Item 340, Type D the secondary asphalt course should consist of

TxDOT Item 340, Type C. The asphaltic concrete should be compacted to between 92 and 97 percent of the theoretical density as determined by ASTM D 2041.

7.6 Lime Stabilized Subgrade

The lime stabilization of the subgrade should meet the performance standards found in TxDOT Item 260. In addition, graduation requirements outlined in Item 260, the lime stabilized clay should also have a minimum of 60 percent, on a weight basis, of the stabilized soil passing the No. 4 sieve at moisture content at or above optimum. The lime stabilized clay soil should have a **plasticity index equal to or less than 20** based on a dry method of sample preparation, ASTM D 421. The lime stabilized subgrade should be compacted to at least 95 percent of the standard Proctor maximum dry density ASTM D 698 between optimum and two (2) percentage points of optimum moisture content. Lime content of **six (6) percent** of the dry unit weight of the clays to be stabilized may be used for planning purposes (it should be verified by performing a lime series test at the time of construction). Using a value of 98 pcf for dry unit weight of clays, **35 lbs per square yard for eight (8) inches** depth stabilization and **53 lbs per square yard for (12) inches** depth stabilization is required. **Prior to the use of lime, the exposed subgrade should be tested for sulfate contents to determine the levels of sulfates are low enough for the use of lime.**

7.7 Perimeter Drainage

<u>It is important that proper perimeter drainage be provided so that infiltration of surface water from compacted areas surrounding the pavement is minimized, or if this is not possible, curbs should extent through the base and into the subgrade</u>. A crack sealant compatible to both asphalt and concrete should be installed at the concrete-asphalt interfaces.

7.8 Pavement Subgrade Fill Materials

It is understood that some general fill materials may be placed within the pavement footprint. These materials shall consist of either onsite or imported soils having a plasticity index (PI) not exceeding 54 and material passing through a No. 200 sieve greater than 35 percent. The CBR of the soil shall not exceed three (3) in order to maintain current pavement designs. All general pavement fills shall be compacted to a minimum of 95 percent of the maximum dry unit weight as determined by ASTM D698 and moisture should be within three (3) percentage points of the optimum moisture content. Each lift of fill shall be tested for these requirements at a frequency of one (1) moisture-density test per 200 linear feet. The final lift shall pass a proof-roll observation as recommended in Section 7.3 of this report.

8.0 <u>CONSTRUCTION CONSIDERATIONS</u>

8.1 Site Drainage

Terradyne recommend that an effective site drainage plan be devised by others prior to commencement of construction to provide positive drainage away from the foundation perimeters and off the site, both during and after construction.

8.2 Site Preparation

In any areas where soil-supported floor slabs are to be constructed, vegetation and all loose or organic material should be stripped and removed from the site. After stripping operations, the subgrade should be proof rolled to identify soft zones. Any soft zone detected should be removed to expose firm soil or rock and replaced with compacted suitable soils to reach subgrade level.

Select fill material used at this site should be clayey sand (SC), lean clay with gravel (CL) or clayey gravel (GC) with maximum liquid limit of 35 percent and plasticity index (PI) between five (5) and 20. The fill should be compacted to at least 95 percent of the maximum dry density as determined by TxDOT-113-E, within ± 2 percentage points of optimum moisture content.

8.3 Groundwater

In any areas where significant cuts (one foot or more) are made to establish final grades for building pads, attention should be given to possible seasonal water seepage that could occur through natural cracks and fissures in the newly exposed stratigraphy. Subsurface drains may be required to intercept seasonal groundwater seepage. The need for these, or other dewatering devices, on building pads should be carefully addressed during construction. Terradyne's office could be contacted to visually inspect final pads to evaluate the need for such drains.

Groundwater seepage may occur several years after construction if the rainfall rate or drainage changes in the vicinity of the project site. If seepage runoff occurs towards the residence, an engineer should be notified to evaluate its' effect and determine whether French Drains are required at the location.

8.4 Earthwork and Foundation Acceptance

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

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

Subgrade preparation and fill placement operations should be monitored by the soils engineer or his representative. As a guideline, at least one in-place density test should be performed for each 2,500 square feet of compacted surface per lift. Any areas not meeting the required compaction should be re-compacted and retested until compliance is met.

9.0 DRAINAGE AND MAINTENANCE

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

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

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

There are several factors, which relate to civil and architectural design and/or maintenance that can significantly affect future movements of the foundation and floor slab systems:

1) Where positive surface drainage cannot be achieved by sloping the ground surface adjacent to the building, a complete system of gutters and downspouts should carry runoff water a minimum of 10-feet from the completed structure;
2) Planters located adjacent to the structure should preferably be self-contained. Sprinkler mains should be located a minimum of five (5) feet from the building line;
3) Planter box structures placed adjacent to buildings should be provided with a means to assure concentrations of water are not available to the subsoil stratigraphy;
4) Large trees and shrubs should not be allowed closer to the foundation than a horizontal distance equal to roughly their mature height due to their significant moisture demand upon maturing;

5) Moisture conditions should be maintained "constant" around the edge of the slabs. Ponding of water in planters, in unpaved areas, and around joints in paving and sidewalks can cause slab movements beyond those predicted in this report; and
6) Roof drains should discharge on pavement or be extended away from the structures. Ideally, roof drains should discharge to storm sewers by closed pipe.

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

The PVR values estimated and stated under "Vertical Movements" are based on the provision that positive drainage shall be maintained to divert water away from the building. If this drainage is not maintained, the wetted front may occur below the assumed fifteen feet depth, and the resulting PVR may be two (2) to three (3) times greater than the stated values shown in this report. Utility leaks may also cause similar high movements to occur.

10.0 SHORING

Shoring of excavations and design of shoring systems are governed by federal, state, and local regulations. The design of shoring systems on this project is beyond the scope of Terradyne's services. The owner or the contractor should retain a shoring design professional to design shoring systems for excavations on this site.

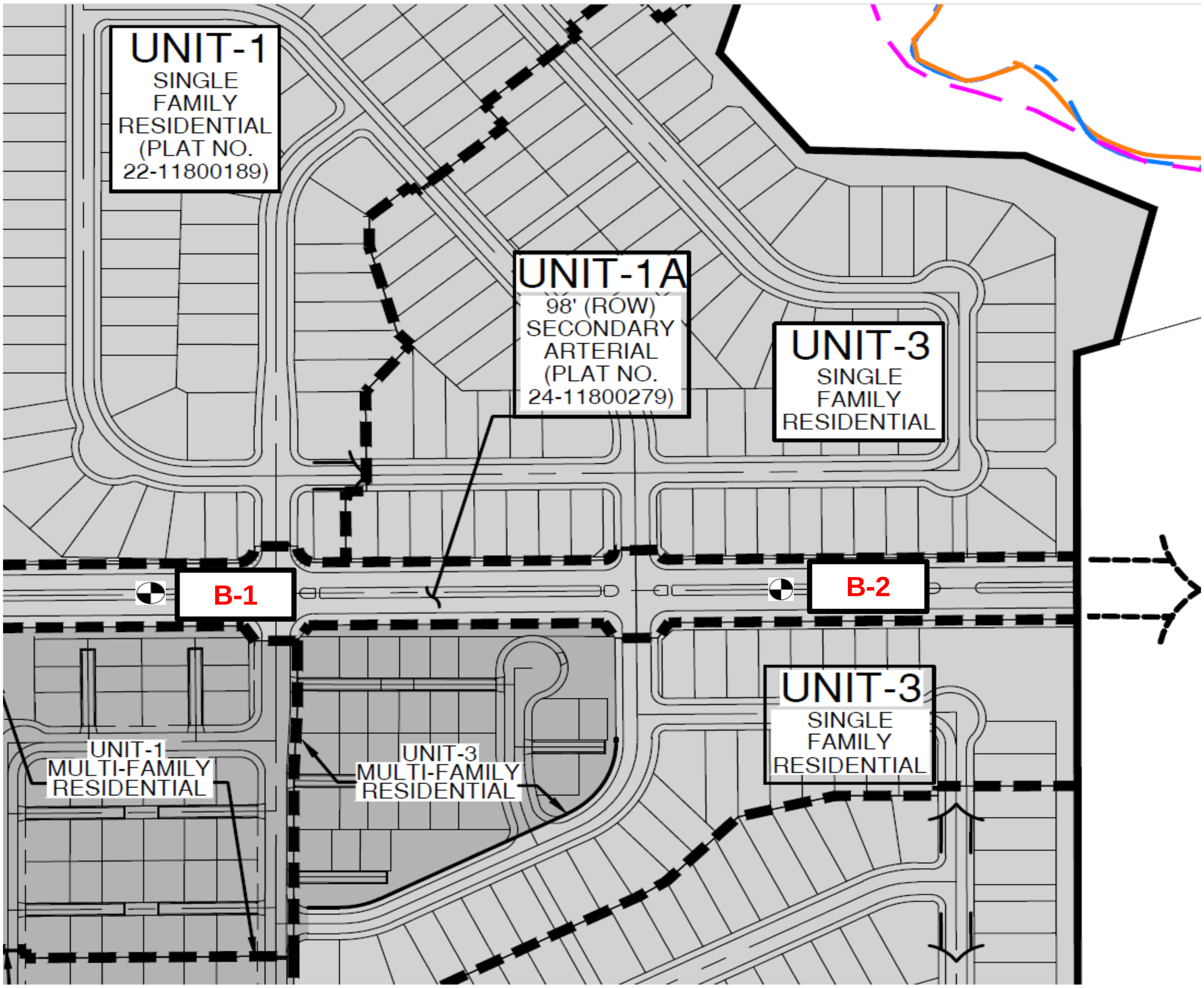
11.0 LIMITATIONS

The analysis and recommendations submitted in this report are based upon the data obtained from the two (2) borings drilled at the site. This report is preliminary, and the values presented are for planning purposes only and should not be used for design. This report may not reflect the exact variations of the soil conditions across the site. The nature and extent of variations across the site may not become evident until construction commences. If variations appear evident, it will be necessary to re-evaluate Terradyne's recommendations after performing on-site observations and tests to establish the engineering significance of any variations. The project geotechnical engineer should review the final plan for the proposed building so that he may determine if changes in the foundation recommendations are required. The project geotechnical engineer declares that the findings, recommendations, or professional advice contained herein have been made and this report prepared in accordance with generally accepted professional engineering practice in the fields of geotechnical engineering and engineering geology. No other warranties are implied or expressed.

This report is valid until site conditions change due to disturbance (cut and fill grading) or changes to nearby drainage conditions or for three (3) years from the date of this report, whichever occurs first. Beyond this expiration date, Terradyne shall not accept any liability associated with the engineering recommendations in the report, particularly if the site conditions have changed. If this report is desired for use for design purposes beyond this expiration date, Terradyne highly recommend drilling additional borings so that Terradyne can verify the subsurface conditions and validate the recommendations in this report.

This report has been prepared for the exclusive use of LGI Homes-Texas, LLC for the specific application of the proposed residential structures and roadways for Lucero at Luckey Ranch - Unit 1A in San Antonio, Texas.

APPENDIX



Approximate Location of Exploratory Borings Proposed Subdivision Lucero at Luckey Ranch - Unit 1A San Antonio, Texas	TERRADYNE Engineers, Geologists & Environmental Scientists		TERRADYNE AUSTIN, TEXAS
	Prepared By: DDS	Scale: Not to Scale	Project # A221080-R4
	Base Plan By: Others	Date: August 1, 2024	Figure # 1

Project: **Proposed Preliminary - Lucero at Luckey Ranch-Unit 1A**
Project Location: **San Antonio, Bexar County, Texas**
Terradyne Project Number: **A221080**

Log of Boring B - 1

TERRADYNE
Engineers, Geologists & Environmental Scientists

Date(s) Drilled	**May 7, 2022**		
Drilling Method	**Solid Flight Auger**	Total Depth of Borehole	**10 Feet**
Drill Rig Type	**CME 45**	Approximate Surface Elevation	**Existing Ground Surface**
Groundwater Level and Date Measured	**Not Encountered**	Sampling Method(s)	**Split Spoon/Auger**
Borehole Backfill	**Natural Soils**	Location	**See Figure 1**

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, tsf	REMARKS AND OTHER TESTS
0					FAT CLAY, very stiff, gray, (CH)								
		16				21							
					CLAYEY SAND with GRAVEL, dense to very dense, dry, with chalk seams, (SC)								
		50				4		36	44	16	28		
5													
						3							
		46				9							
10					End of Borehole								
15													

Project: **Proposed Preliminary - Lucero at Luckey Ranch-Unit 1A**	# Log of Boring B - 2
Project Location: **San Antonio, Bexar County, Texas**	
Terradyne Project Number: **A221080**	

Date(s) Drilled	**May 7, 2022**	TERRADYNE Engineers, Geologists & Environmental Scientists	
Drilling Method	**Solid Flight Auger**	Total Depth of Borehole	**10 Feet**
Drill Rig Type	**CME 45**	Approximate Surface Elevation	**Existing Ground Surface**
Groundwater Level and Date Measured	**Not Encountered**	Sampling Method(s)	**Split Spoon/Auger**
Borehole Backfill	**Natural Soils**	Location	**See Figure 1**

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, tsf	REMARKS AND OTHER TESTS
0	Split Spoon	16		CH	FAT CLAY, very stiff to hard, gray to brown, moist, with chalk and some gravel seams, (CH)	22			71	17	54		
	Split Spoon	41				17							
5	Auger					15							
	Split Spoon	27				18							
10					End of Borehole								
15													

TERRADYNE
Engineers, Geologists & Environmental Scientists

STANDARD REFERENCE NOTES FOR BORING LOGS

I. Sampling & Testing Symbols or Abbreviations:

ST	SS	RC	TC	A	SPT	PT
Shelby Tube	Split-Spoon Sampler	Rock core	Texas Cone	Auger	Standard Penetration Test	Percussion Tube

II. Correlations of Penetration Resistance to Soil Properties:

Relative Density of Sand and Sandy Silt		Consistency of Clay and Clayey Silt		
Relative Density	SPT N-value	Stiffness	SPT N-value (qualitative measure)	Unconfined Compressive Strength (tsf)
Very loose	0 – 4	Very soft	0 – 2	0 – 0.25
Loose	4 – 10	Soft	2 – 4	0.25 – 0.5
Medium dense	10 – 30	Firm	4 – 8	0.5 – 1.0
Dense	30 – 50	Medium stiff	8 – 15	1.0 – 2.0
Very Dense	> 50	Stiff	15 – 30	2.0 – 4.0
		Hard	> 30	> 4.0 OR 4.0+

III. Unified Soil Classification Symbols:

GP - Poorly Graded Gravel
GW - Well Graded Gravel
GM - Silty Gravel
GC - Clayey Gravel
OH - High Plasticity Organics

SP - Poorly Graded Sand
SW - Well Graded Sand
SM - Silty Sand
SC - Clayey Sand
OL - Low Plasticity Organics

ML - Low Plasticity Silt
MH - High Plasticity Silt
CL - Low to Medium Plasticity Clay
CH - High Plasticity Clay

IV. Rock Quality Designation index (RQD):

RQD:	Description of Rock Quality: (if all natural fractures)
0-25 %	Very poor
25-50 %	Poor
50-75 %	Fair
75-90 %	Good
90-100%	Excellent

V. Natural moisture content:

“Dry” No apparent moisture, crumbles easily
“Moist” Damp but no visible water
“Wet” Visible water

VI. Grain size terminology:

Cobble: 3-inches to 12-inches
Gravel: #4 sieve size (4.75 mm) to 3-inches
Coarse sand: #10 to #4 sieve size
Medium sand: #40 to #10 sieve size
Fine sand: #200 to #40 sieve size
Silt or clay: smaller than #200 sieve size

VII. Descriptive terms for soil composition:

“Trace” . . . . 1 to 9%
“Some” . . . . 10 to 29%
(with suffix –y, e.g. sandy, clayey …) . . . . 30 to 49%

VIII. Descriptive terms or symbols:

“Mottled”: occasional/spotted presence of that color
“- […]”: identifies change in soil characteristics
LL: Liquid Limit (moisture content as % of dry weight)
PL: Plastic Limit (moisture content as % of dry weight)
WOH: Weight of hammer
“with […]”: item identified within that sample only
“REC”: Rock core recovery %

IX. Plasticity of cohesive soil:

(function of PI and clay mineral types)

Plasticity Index (PI):	*Plasticity*:
0 to 20	Low
20 to 30	Medium
30 +	High

Approximate Location of Bulk Sample Proposed Subdivision Lucero at Luckey Ranch - Unit 1A San Antonio, Texas	TERRADYNE Engineers, Geologists & Environmental Scientists		TERRADYNE AUSTIN, TEXAS
	Prepared By: DDS	Scale: Not to Scale	Project # A221080-R4
	Base Plan By: Others	Date: June 28, 2023	Figure # 5

Standard Test Method for
CBR (California Bearing Ratio) of Soils - ASTM D 1883

Date:	05/17/2022
Client:	LGI Homes
Project Number:	A221080
Project Name	Lucero at Luckey Ranch South - Unit 1A
Sample ID:	Sample 1
Sample Location:	Bulk Roadway
Sample Description:	Dark Brown

Maximum Dry Density, lbs/ft^3(ASTM D 698): 85.6

Optimum Moisture Content,% (ASTM D 698): 29.8

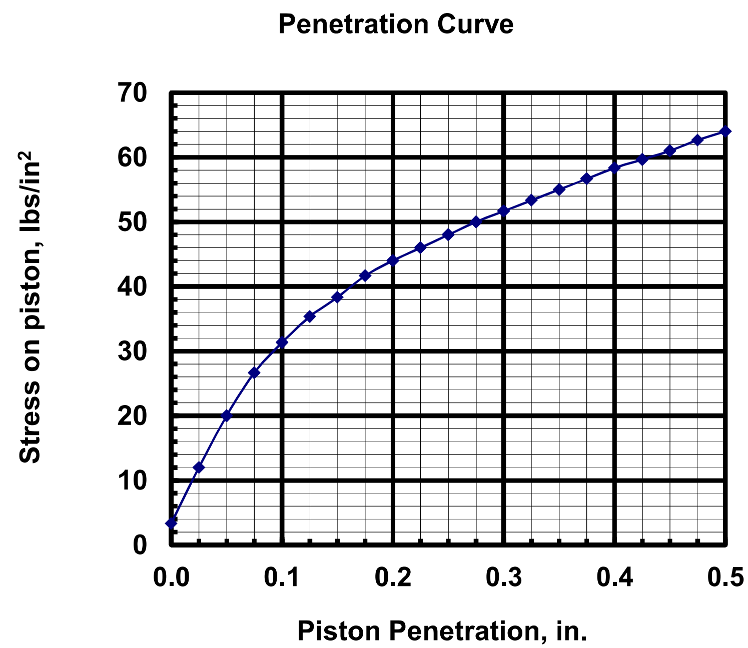
Ht of Sample (in): *4.6840* *% SWELL:* 2.13%

CBR AT 0.10 IN PENETRATION:	*3*
CBR AT 0.20 IN PENETRATION:	*3*

Description	Before	After	Top
Moisture Condition	Soaking	Soaking	1 in.
Tare ID:	351.0	352.0	353.0
Tare Weight, gms:	14.2	14.2	14.2
Wet Wt. of Sample+Tare:	63.3	43.8	44.9
Dry Wt. of Sample +Tare:	52.0	36.5	37.2
Moisture, %:	29.9	32.7	33.5

Density Condition	Before	After	SWELL DIAL	
Weight of Mold, gms:	7245.1	7245.1	Date	Reading
Wt. of Mold & Sample, gms:	10956.5	11009.0	8/19	0.7800
Weight of Sample, lbs:	8.18	8.30	8/21/	0.8800
Volume of Mold, ft3:	0.0750	0.0750		
Wet Density, lbs/ft3:	109.1	110.6		
Dry Density, lbs/ft3:	84.0	83.4		

Record @ Deflection in.	Piston Penetration in.	Actual Load lbs.	Piston Stress lbs/in^2	Corrected Stress lbs/in^2
0.000	0.000	10	3.3	3.3
0.025	0.025	36	12.0	12.0
0.050	0.050	60	20.0	20.0
0.075	0.075	80	26.7	26.7
0.100	0.100	94	31.3	31.3
0.125	0.125	106	35.3	35.3
0.150	0.150	115	38.3	38.3
0.175	0.175	125	41.7	41.7
0.200	0.200	132	44.0	44.0
0.225	0.225	138	46.0	46.0
0.250	0.250	144	48.0	48.0
0.275	0.275	150	50.0	50.0
0.300	0.300	155	51.7	51.7
0.325	0.325	160	53.3	53.3
0.350	0.350	165	55.0	55.0
0.375	0.375	170	56.7	56.7
0.400	0.400	175	58.3	58.3
0.425	0.425	179	59.7	59.7
0.450	0.450	183	61.0	61.0
0.475	0.475	188	62.7	62.7
0.500	0.500	192	64.0	64.0



Piston Area, Sq. In.: 3

Remarks: Soaked 96 hours prior to running test

TERRADYNE Engineers, Geologists & Environmental Scientists
Terradyne Engineering, Inc.
5906 Wall Street, Suite 505
Austin, Texas 78754

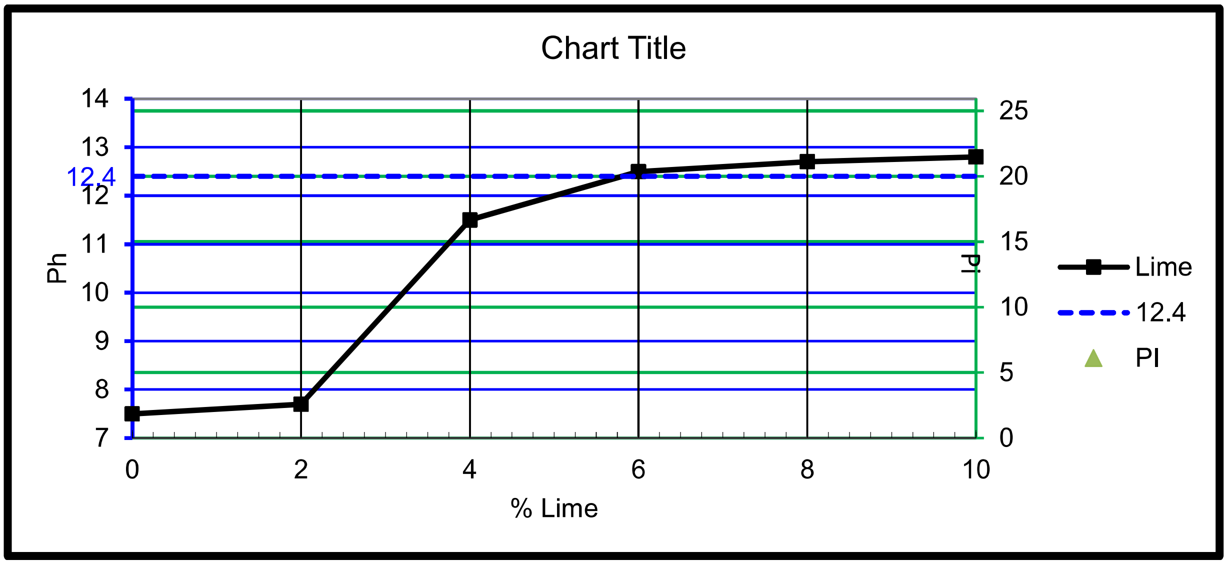
Figure 6

Soil-Lime Testing

ASTM D6276/D4318

Job Name: **Lucero at Luckey Ranch South - Unit 1A** Job #: A221080
Sample ID/Location: Bulk Roadway Date: 5/17/2022
Description : Brown Clay

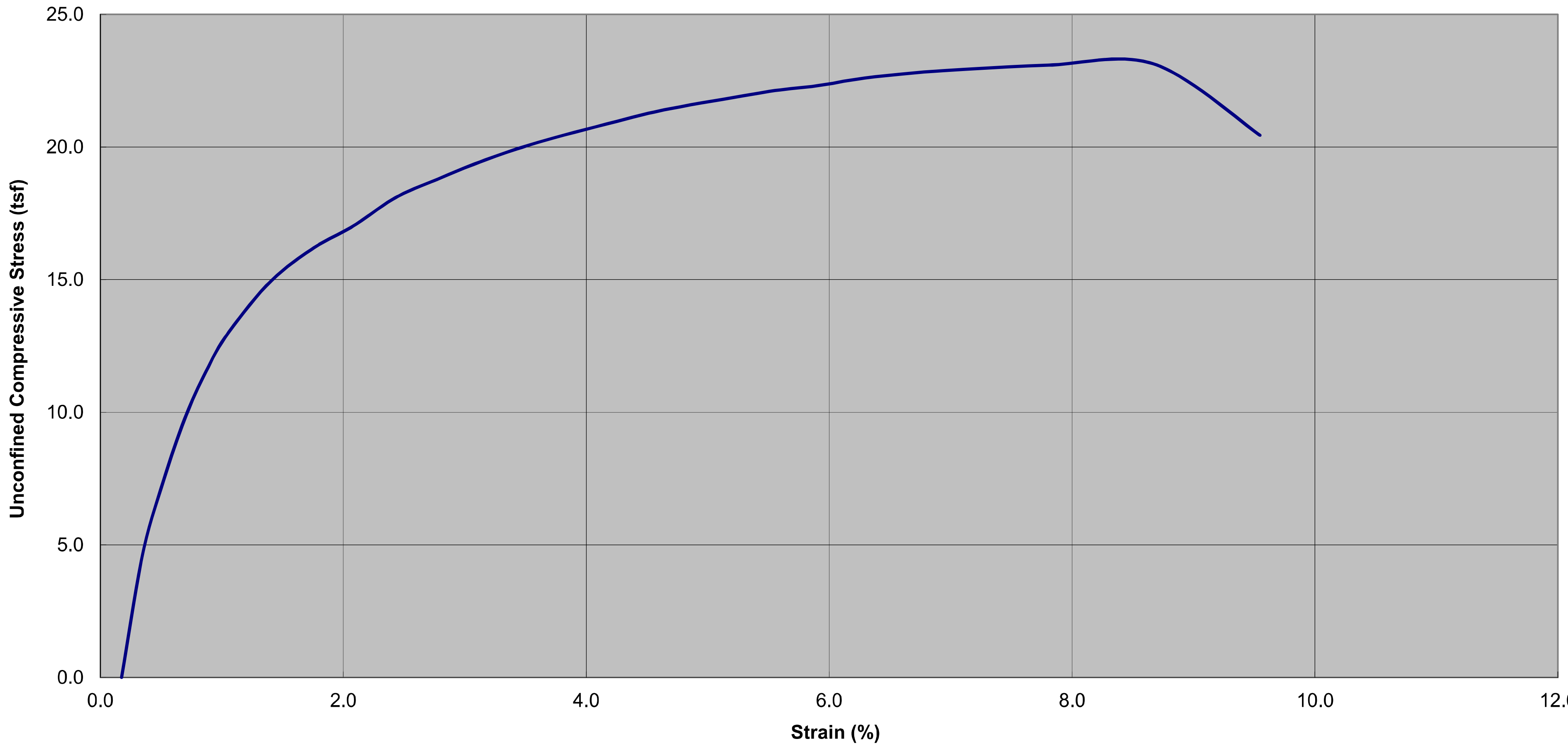
% Lime	0	2	4	6	8	10
pH	7.5	7.7	11.5	12.5	12.7	12.8
Temperature (°F)	85.30	79.50	79.20	79.30	75.40	76.10
PI	47			48	50	46
LL	26			12	15	11



Recommended % Lime:
6.0

Figure 7

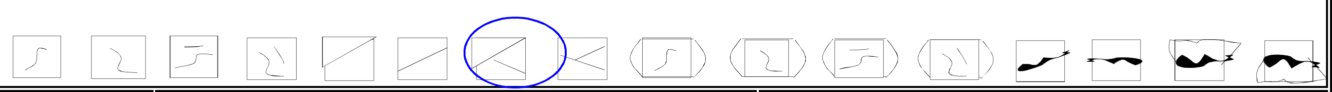
Standard Test Method for Unconfined Compressive Strength of Cohesive Soil (ASTM D2166)



Oven ID: OVEN 1			Scale ID: PS 4500.R1	Calipers: Mitutoyo 500		Load Frame: HM2000		Load Cell: TS 810-10k	
Boring Information		Average Initial Length	Average Initial Diameter	Sample Mass	Water Content	Compressive Strength	Compressive Strength	Dry Unit Weight	Shear Strength
Boring / Sample	Depth (ft)	(in)	(in)	(g)	(%)	(psi)	(tsf)	(pcf)	(tsf)
Bulk Sample	0 - 2	5.652	2.658	913.9	29.80	**321.2**	23.13	85.5	11.56

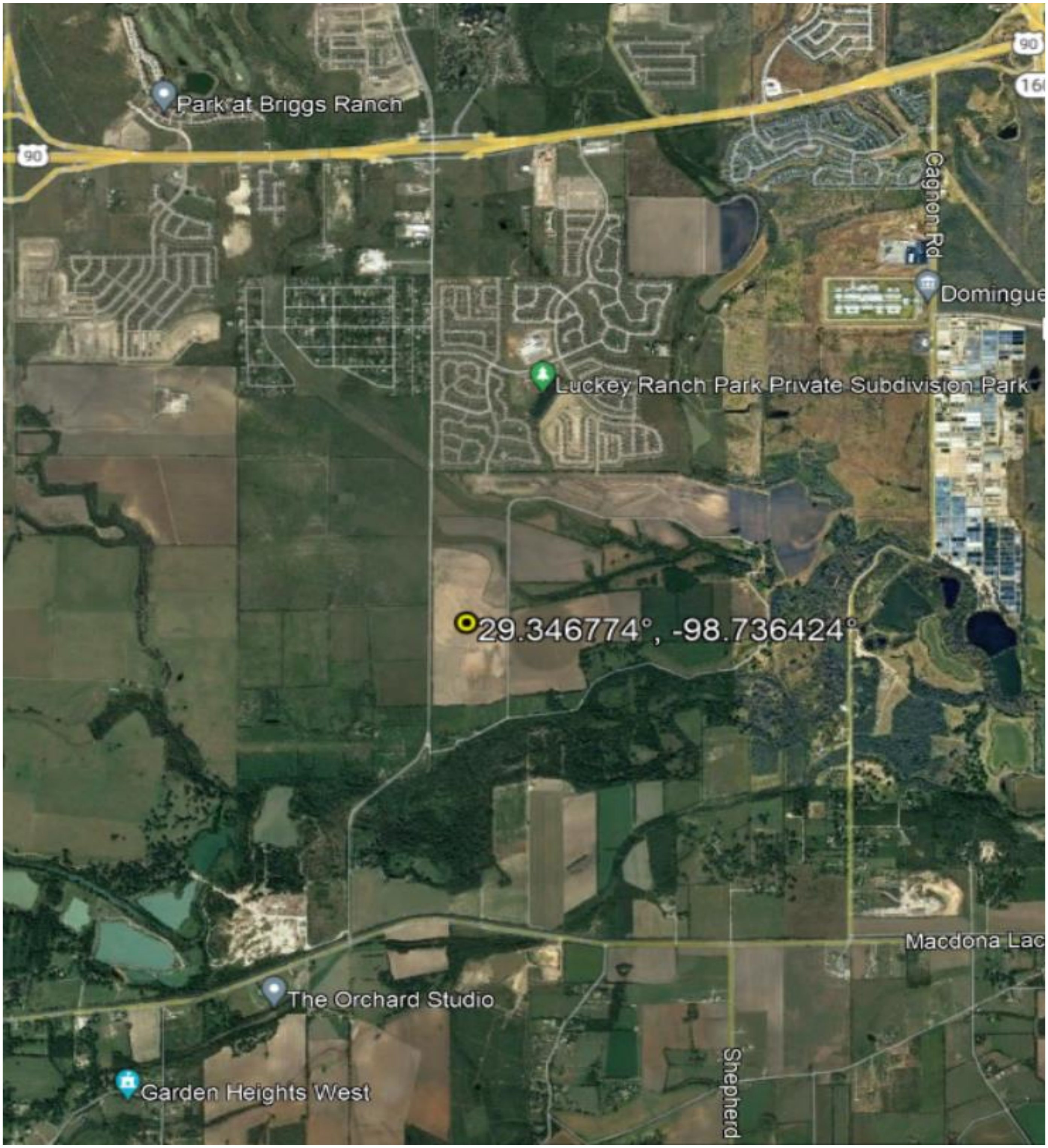
Material Description: Dark Brown Lime Stabilized Clay

Failure Type:



Project Information	Date	Terradyne Project No.
Lucero at Luckey Ranch South - Unit 1A Bulk Sample San Antonio, Texas	May 2022	A221080

Terradyne Engineering, Inc. Figure 12



Site Latitude and Longitude Proposed Subdivision Lucero at Luckey Ranch - Unit 1A San Antonio, Texas	TERRADYNE *Engineers, Geologists & Environmental Scientists*		RRADYNE JSTIN, TEXAS
	Prepared By: LD	Scale: Not to Scale	Project # A221080-R
	Base Plan By: Others	Date: June 28, 2023	Figure # 9