• GEOTECHNICAL ENGINEERING
• CONSTRUCTION MATERIALS
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• SOILS • ASPHALT • CONCRETE

April 14, 2022

Kimley-Horn and Associates, Inc.
601 NW Loop 410, Suite 350
San Antonio, Texas 78216

Attention: Stephen J. Aniol, P.E.

SUBJECT: **SUBSURFACE EXPLORATION, LABORATORY TESTING PROGRAM, AND PAVEMENT DESIGN SERVICES FOR THE PROPOSED THOROUGHFARE KITTY HAWK ROAD UNIVERSAL CITY, TEXAS RETL Project Number: G222085**

Dear Mr. Aniol,

In accordance with our agreement, Rock Engineering and Testing Laboratory, Inc. (RETL) (TXPE Firm #2101) has conducted a subsurface exploration, laboratory testing program and pavement design services for the above referenced project. The results of these geotechnical engineering services, together with our recommendations, are to be found in the accompanying report.

Often, because of design and construction details, that occur on a project, questions arise concerning soil conditions and RETL, would be pleased to continue its role as the Geotechnical Engineer during project implementation.

If there are any questions, please contact our office.

Sincerely,

Kyle D. Hammock, P.E.
Vice President - San Antonio

ROCK ENGINEERING & TESTING LABORATORY, INC.
www.rocktesting.com
6817 LEOPARD STREET • CORPUS CHRISTI, TEXAS 78409-1703
OFFICE: (361) 883-4555 • FAX: (361) 883-4711
10856 VANDALE ST• SAN ANTONIO, TEXAS 78216-3625
OFFICE: (210) 495-8000 • FAX: (210) 495-8015
NO.1 ROUNDVILLE LANE • ROUND ROCK, TEXAS 78664
OFFICE: (512) 284-8022 • FAX: (512) 284-7764

# SUBSURFACE EXPLORATION, LABORATORY TESTING PROGRAM AND PAVEMENT DESIGN SERVICES FOR THE PROPOSED THOROUGHFARE KITTY HAWK ROAD UNIVERSAL CITY, TEXAS

**RETL PROJECT NUMBER: G222085**

**PREPARED FOR:**

**KIMLEY-HORN AND ASSOCIATES, INC.**
**601 NW LOOP 410, SUITE 350**
**SAN ANTONIO, TEXAS 78216**

**APRIL 14, 2022**

**PREPARED BY:**


**ROCK ENGINEERING AND TESTING LABORATORY, INC.**
**10856 VANDALE STREET**
**SAN ANTONIO, TEXAS 78216**
**PHONE: (210) 495-8000; FAX: (210) 495-8015**


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**Kyle D. Hammock, P.E.**
**Vice President - San Antonio**

**J.R. Eichelberger, III, P.E.**
**Senior Project Engineer**

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# INTRODUCTION

This report presents the results of a subsurface exploration, laboratory testing program and geotechnical evaluation for the proposed new Throughfare to be constructed off of Kitty Hawk Road west of its intersection with Universal City Boulevard in Universal City, Texas. This study was conducted for Kimley-Horn and Associates, Inc.

## Authorization

The work for this project was performed in accordance with RETL Proposal No. SGP011222FR1 dated January 27, 2022. Individual Project Order No. 068721201 dated February 17, 2022 was issued in accordance with Master Agreement for Continuing Professional Services between Kimley-Horn and Associates, Inc., and RETL on May 15, 2019.

## Purpose and Scope

The purpose of this exploration was to evaluate the soil and groundwater conditions at the site and to provide pavement and retaining wall recommendations suitable for the proposed project.

The scope of the exploration and analysis included the subsurface exploration, field and laboratory testing, engineering analysis and evaluation of the subsurface soils, developing pavement and retaining wall recommendations and preparation of this report.

The scope of services did not include an environmental assessment. Any statements in this report, or on the drilling logs, regarding odors, colors, unusual or suspicious items or conditions are strictly for the information of the client.

## General

The exploration and analysis of the subsurface conditions reported herein are considered sufficient in detail and scope to provide pavement and retaining wall recommendations for the proposed project. The recommendations submitted for the proposed project are based on the available soil information and the preliminary design details provided by Stephen J. Aniol, P.E of Kimley-Horn and Associates, Inc. If additional design information is needed to complete the design of the pavements, and this information can be obtained from the data obtained within the agreed upon scope of work, then RETL will provide this information in a supplemental report.

The Geotechnical Engineer states that the findings, recommendations, specifications or professional advice contained herein have been presented after being prepared in a manner consistent with that level of care and skill ordinarily exercised by reputable members of the Geotechnical Engineer's profession practicing contemporaneously under similar conditions in the locality of the project. RETL operates in general accordance with "*Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction*", (ASTM D3740). No other representations are expressed or implied, and no warranty or guarantee is included or intended.

This report has been prepared for the exclusive use of Kimley-Horn and Associates, Inc., for the specific purpose of the proposed Thoroughfare project located in Universal City, Texas.

# FIELD EXPLORATION

## Scope

The field exploration was completed to evaluate the engineering characteristics of the existing pavements and subsurface soil materials and included a reconnaissance of the project site, drilling the test borings and recovering disturbed and undisturbed soil samples. Three (3) test borings were advanced to depths of 20 to 30-feet for the purpose of obtaining geotechnical information. Kimley-Horn and Associates, Inc determined the number, depth and location of test borings. RETL located the test borings in the field. A bulk sample of the subgrade soils was also obtained at boring location B-2. In addition, Dynamic Cone Penetrometer (DCP) tests were performed on the subgrade soils at each boring location.

Upon completion of the drilling operations and obtaining the groundwater observations, the test borings were backfilled with soil cuttings, surface patches were installed, and the pavements were cleaned as required. A Boring Location Plan is provided in the Appendix of this report.

## Drilling and Sampling Procedures

The borings were performed using a drilling rig equipped with a rotary head turning solid flight augers to advance the borings to the desired boring termination depths. Disturbed soil samples were obtained employing split-barrel sampling procedures in general accordance with the procedures for "*Penetration Test and Split-Barrel Sampling of Soils*" (ASTM D1586). Relatively undisturbed soil samples were obtained using thin-wall tube sampling procedures in accordance with the procedures for "*Thin Walled Tube Sampling of Soils*" (ASTM D1587).

Samples were classified in the field, placed in plastic bags, marked according to boring number, depth and any other pertinent field data, stored in special containers and delivered to the laboratory for testing.

## Field Tests and Measurements

**Penetration Tests** - During the sampling procedures, standard penetration tests (SPT) were performed to obtain the standard penetration value of the soil. The standard penetration value (N) is defined as the number of blows of a 140-pound hammer falling 30 inches required to advance the split-barrel sampler 1-foot into the soil. The sampler is lowered to the bottom of the previously cleaned drill hole and advanced by blows from the hammer.

The number of blows is recorded for each of three successive 6-inch penetrations. The "N" value is obtained by adding the second and third 6-inch increment number of blows. The results of standard penetration tests indicate the relative density of cohesionless soils and comparative consistency of cohesive soils, thereby providing a basis for estimating the relative strength and compressibility of the soil profile components.

**Water Level Observations** - Water level observations were obtained during the drilling operations. Water level observations are noted on the boring logs provided in the Appendix. In relatively pervious soils, such as sandy soils, the indicated depths are usually reliable groundwater levels. In relatively impervious soils, a suitable estimate of the groundwater depth may not be possible, even after several days of observation. Drilling techniques, seasonal variations, temperature, land-use, proximity to a creek, river or body of water and recent rainfall conditions may influence the depth to groundwater. The amount of water in open test holes largely depends on the permeability of the soils encountered at the test hole locations.

**Surface Elevations** - Surface elevations at the boring locations were not provided. All depths referred to in this report are from the surface elevations at the boring locations during the time of our field investigation.

## LABORATORY TESTING PROGRAM

In addition to the field investigation, a laboratory testing program was conducted to determine additional pertinent engineering characteristics of the subsurface materials necessary in analyzing the behavior of the pavement system for the proposed project.

The laboratory-testing program included supplementary visual classification (ASTM D2487) on all samples. In addition, selected samples were subjected water content tests (ASTM D2216), Atterberg limits tests (ASTM D4318), percent material finer than the #200 sieve tests (ASTM D1140), a moisture density relationship test (ASTM D 698), and a California Bearing Ratio (CBR) test (ASTM D1883). Analytical testing for sulfates was performed in accordance with TxDOT Test Method TEX-620-J. Estimated soil strengths were obtained in the field using a hand penetrometer.

## SUBSURFACE CONDITIONS

### General

The types of subsurface materials encountered in the test borings have been visually classified and are described on the attached logs. The results of the standard penetration tests, strength tests, water level observations, and other laboratory tests are presented on the boring logs. Representative samples of the soil were placed in polyethylene bags and are now stored in the laboratory for further analysis, if desired. All of the samples will be retained in our office for three (3) months unless notified otherwise.

The stratification of the soil, as shown on the boring logs, represents the conditions at the actual test boring locations. Variations may occur between, or beyond, the test boring locations. Lines of demarcation represent the approximate boundary between different soil types, but the transition may be gradual, or not clearly defined.

It should be noted that, whereas the borings were drilled and sampled by experienced drillers, it is sometimes difficult to record changes in stratification within narrow limits. In the absence of foreign substances, it is also difficult to distinguish between discolored soils and clean soil fill.

## Generalized Soil Conditions

The generalized subsurface conditions encountered at the boring locations have been summarized and soil properties including classification, strength, plasticity, and grain size are provided in the following tables:

**BORING B-1**

| D | Description | LL | PI | C | θ | $\gamma_e$ | -#200 | P or N |
|---|---|---|---|---|---|---|---|---|
| 0-1.5 | **HMAC, Base and Concrete** | --- | --- | --- | --- | --- | --- | --- |
| 1.5-4 | Lean **CLAY** | 37 | 16 | 1,000 | 0 | 120 | 81 | N= 7 |
| 4-8 | Fat **CLAY** | 81 | 49 | 3,000 | 0 | 120 | 94 | P= 3.5<br>N= 44 |
| 8-12 | Lean **CLAY** | --- | --- | 1,500 | 0 | 120 | --- | N= 10 |
| 12-20 | Lean **CLAY** | 32 | 16 | 4,000 | 0 | 120 | 98 | P= 4.5+<br>N= 50 |

**BORING B-2**

| D | Description | LL | PI | C | θ | $\gamma_e$ | -#200 | P or N |
|---|---|---|---|---|---|---|---|---|
| 0-4 | Clayey **GRAVEL** | 69 | 42 | 0 | 35 | 125 | 40 | N= 25-29 |
| 4-13 | Lean **CLAY** | 37 | 18 | 3,000 | 0 | 120 | 93 | N= 23-30 |
| 13-20 | Fat **CLAY** | 66 | 44 | 3,500 | 0 | 120 | 98 | P= 4.5<br>N= 34 |

| BORING B-3 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **D** | **Description** | **LL** | **PI** | **C** | **θ** | $\gamma_e$ | **-#200** | **P or N** |
| 0-2 | Clayey **GRAVEL** | --- | --- | 0 | 35 | 125 | --- | N= 23 |
| 2-18 | Lean **CLAY** | 36-43 | 18-25 | 2,500 | 0 | 120 | 95-99 | P= 3.0-4.5+<br>N= 12-28 |
| 18-30 | Lean **CLAY** | 47 | 28 | 4,000 | 0 | 120 | 99 | N= 40-54 |

Where: D = Depth in feet below existing grade
LL = Liquid Limit (%)
PI = Plasticity Index
C = Average Soil Cohesion, psf (undrained)
θ = Angle of Internal Friction, deg. (undrained)
$\gamma_e$ = Effective Soil Unit Weight, pcf
-#200= Percent Material Finer than a #200 Sieve
N = Standard Penetration Value range, blows per foot
P = Pocket Penetrometer Value range, tsf

Detailed descriptions of the soils and shale encountered at the boring locations are provided on the Log of Boring included in the Appendix.

## Seismic Site Class

The field investigation did not include a 100-foot deep soil boring, therefore, the soil properties are not known in sufficient detail to determine the Site Class per IBC. In accordance with IBC Section 1613.3.2-Site Class Definitions and Chapter 20 of ASCE 7, Site Class D materials should have soil undrained shear strengths between 1,000 and 2,000 psf and standard penetration resistances between 15 and 50 blows per foot. The on-site soils extending to the 30-foot depth have strengths similar to Site Class D materials; therefore, RETL recommends that Site Class D, “stiff soil profile” be assumed.

## Existing Pavement Materials Summary

The boring number and the thickness of the existing pavement materials are provided in the following table:

| EXISTING PAVEMENTS | | | |
|---|---|---|---|
| **Boring No.** | **Asphalt (in.)** | **Flexible Base Thickness (in.)** | **Concrete (in.)** |
| B-1 | 3 | 10 | 6 |

## Sulfate Test Results

The sulfate test result on a representative bulk subgrade sample from Boring B-1 is provided in the following table:

| **SULFATE RESULTS** | |
|---|---|
| **Bulk Sample** | **Sulfate (ppm)** |
| B-2 | Below Detection Limits |

The TxDOT Technical Memorandum for stabilization of soils containing sulfates with lime indicates the following risk levels:

| **SULFATE RISK LEVELS** | |
|---|---|
| **Sulfate (ppm)** | **Risk** |
| <3000 | Low |
| 3000-5000 | Moderate |
| 5000-8000 | Moderate to High |
| >8000 | High and Unacceptable |

The sulfate concentrations indicate the subgrade soils at the site are generally low in sulfates with a minimal risk of using lime as a treatment method.

## Lime Series Results

The lime series test results on the bulk subgrade sample from Boring B-2 are provided in the following table:

| **BORING B-2 BULK SUBGRADE SAMPLE LIME SERIES TEST RESULTS** | | |
|---|---|---|
| **% Lime** | **LL / PI** | **pH** |
| 0 | 46/28 | 7.8 |
| 2 | 44/16 | 12.3 |
| 4 | 45/14 | 12.4 |
| 6 | 45/14 | 12.4 |
| 8 | 45/13 | 12.5 |
| 10 | 46/13 | 12.5 |

Where: LL = Liquid Limit (%)
PI = Plasticity Index

The lime series results indicate 4-percent lime would effectively reduce the plasticity index (PI) and increase the pH to acceptable levels.

# PAVEMENT RECOMMENDATIONS

## Project Description

Based on the information provided to RETL, it is understood Universal City is proposing to construct a new thoroughfare off Kitty Hawk Rd west of its intersection with Universal City Blvd. The project will include a new roundabout at the Walmart entrance drive intersection, pedestrian amenities, drainage improvements and a new retraining wall. The thoroughfare will be designed as a Major Collector in accordance with Universal City Department of Public Works guidelines.

## PVR Discussion

The fat clay and clayey gravel soils at this site are very high in plasticity and the lean clay soils at this site are low to moderate in plasticity. **The maximum calculated total potential vertical rise (PVR) for flatwork construction at this site ranges from approximately 1-inch to 2 ½-inches.** The PVR was calculated using the Texas Department of Transportation Method TEX-124E and into account the depth of active zone, and the Atterberg limits test results of the soils encountered within the active zone. Concrete paving, flatwork such as sidewalks and approaches, and curbing will be subject to PVR movements.

The estimated PVR values provided are based on a slab or flatwork system applying a sustained surcharge load of approximately 1.0 pound per square inch on the subgrade soils. It is important to note that the PVR values provided herein were calculated using the Texas Department of Transportation Method TEX-124E and represents the vertical rise that can be experienced by relatively dry subsoils subjected to increases in soil moisture content resulting from capillary effects or rainwater. The TEX-124E method is widely used in Texas for predicting expansive soil movements and has been found to be reasonably accurate for moisture variations resulting from normal seasonal and climatic controlled conditions (environmental conditions). The actual movement of the subsoils is dependent upon their change in moisture content.

Conditions that allow the soils to become saturated or significantly exceed typical moisture variations resulting from environmental conditions or exceed the dry and wet boundary conditions established by the TEX-124E method, such as poor drainage, broken utilities, and variations in subsurface groundwater sources, may result in higher magnitudes of moisture related soil movements than calculated by the PVR method provided herein.

## Pavement Design Discussion

In designing the proposed pavements, the existing subgrade conditions must be considered together with the expected traffic use and loading conditions. The conditions that influence pavement design are the bearing values (CBR and K) of the subgrade, number and frequency of vehicles and their range of axle loads, desired pavement life in years, probable increase in vehicular use over the life of the pavement and the availability of suitable materials to be used in the construction of the pavement and their relative costs and engineering properties.

The conditions at the subgrade level for the new pavements will generally consist of high plasticity clayey gravel soils and moderate plasticity lean clay soils. Specific laboratory testing to define the subgrade strength was performed for the lean clay soil condition. A bulk sample of the lean clay subgrade soil was obtained from boring B-2. The sample was subjected to a standard proctor test and California Bearing Ratio test. The tested laboratory CBR value was 6.5. Based on the results of the Atterberg limits testing, grain size testing and subgrade soil classifications, the selected design CBR for the subgrade soils at this site is 4.

The typical street section for a Universal City Major Collector consists of 3-inches of Type C HMAC, 6-inches of Type B HMAC and 6-inches of flexible base. No other pavement design parameters were found or made available. Therefore, the pavement analyses and section recommendations herein have been prepared in accordance with the City of San Antonio Design Guidance Manual Appendix 10-A and the American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures, 1993. RETL used the following pavement design parameters for the flexible pavement design.

| AASHTO FLEXIBLE PAVEMENT DESIGN PARAMETER | COSA ARTERIAL | COSA COLLECTOR |
|---|---|---|
| 18-kip ESAL | 3,000,000 | 2,000,000 |
| Reliability (R) | 95% | 90% |
| Overall Deviation | 0.45 | 0.45 |
| Initial / Terminal Serviceability | 4.2 / 2.5 | 4.2 / 2.5 |
| Clay Subgrade Design CBR | 4 | 4 |
| Clay Subgrade Resilient Modulus (Mr) | 5,014 | 5,014 |
| Design Life | 20 years | 20 years |

The following lime stabilized subgrade, crushed limestone base and asphaltic concrete layer coefficients were selected for the design.

| PAVEMENT CONSTITUENT | LAYER COEFFICIENT (α) |
|---|---|
| Lime Stabilized Subgrade | 0.08 |
| Crushed Limestone Base | 0.14 |
| Type B HMAC | 0.38 |
| Type C or D HMAC | 0.44 |

## Flexible Pavement Recommendations

The recommended flexible pavement sections were calculated using the previously noted design parameters and the methodology presented in the AASHTO design guide. The results are provided in the following tables:

| **ARTERIAL<br>MINIMUM 18-kip ESAL VALUE = 3,000,000<br>AASHTO STRUCTURAL NUMBER RANGE = 3.80 to 5.76** | | | |
|---|---|---|---|
| Pavement Constituent | Option 1 | Option 2 | Option 3 |
| HMAC Type C or D | 3" | 3" | 3" |
| HMAC Type B | 9" | 4.5" | 3" |
| Crushed Limestone Base | --- | 12" | 12" |
| Lime Stabilized Subgrade | 6" | 6" | --- |
| TENSAR Geogrid | --- | --- | TX-5 or HX-5.5 |
| AASHTO Structural No. | 5.22 | 5.19 | 5.11 |
| Calculated 18-kip ESAL | 3,874,000 | 3,718,000 | 3,339,000 |

| **COLLECTOR<br>MINIMUM 18-kip ESAL VALUE = 2,000,000<br>AASHTO STRUCTURAL NUMBER RANGE = 2.92 to 5.08** | | | |
|---|---|---|---|
| Pavement Constituent | Option 1 | Option 2 | Option 3 |
| HMAC Type C or D | 3" | 3" | 3" |
| HMAC Type B | 7.5" | 3" | 3" |
| Crushed Limestone Base | --- | 12" | 8" |
| Lime Stabilized Subgrade | 6" | 6" | --- |
| TENSAR Geogrid | --- | --- | TX-5 or HX-5.5 |
| AASHTO Structural No. | 4.65 | 4.62 | 4.50 |
| Calculated 18-kip ESAL | 2,527,000 | 2,419,000 | 2,016,000 |

## Pavement Component Specifications

**Subgrade and Embankment** - After the desired subgrade elevation has been achieved, the exposed raw subgrade shall be proof rolled with a heavily loaded dump truck or similar rubber-tired vehicle with a minimum weight of 20-tons. Any soft areas identified should be removed to expose firm soils and the excavation backfilled with crushed limestone base material.

Subgrade and embankment soils should be compacted to a minimum density of 95 - percent of the maximum dry unit weight of the subgrade soils as determined by TEX-114E and at or above the optimum moisture content. Loose lift thicknesses should not exceed 8-inches.

**Lime Stabilized Subgrade** - Lime placement and mixing operations should be performed in accordance with TXDOT ITEM 260 *"LIME TREATMENT FOR SUBGRADE (ROAD MIXED)."* Lime treatment of the subgrade soils is recommended to reduce the effect of soil heave on the pavements. Lime shall be properly mixed at a minimum rate of 4-percent of the maximum dry unit weight of the raw subgrade soils as determined by TEX-114E. This percentage equates to approximately 25 pounds per square yard per 6-inch treatment depth. After proper curing time, usually 48 to 72 hours, the lime stabilized soils should be remixed and compacted to a minimum density of 95-percent of the maximum dry unit weight of the lime stabilized subgrade soils as determined by TEX-114E and at, or above, the optimum moisture content.

**Hot Mix Asphaltic Concrete** - Asphalt concrete should meet the requirements set forth in TXDOT Item 2340 *"HOT MIX ASPHALTIC CONCRETE PAVEMENT"*; Type B, C or D. Asphaltic concrete should be compacted to 91.5 to 96.3-percent of the maximum theoretical specific gravity of the mixture determined according to test method TEX-227F. Pavement cores should be tested for density according to test method TEX-207F.

**Geogrid** - Geogrid should be considered on this project to reduce the potential for cracking in the flexible pavements and significantly improve the long-term performance of the flexible pavements. Geogrid should be placed beneath the flexible base material and on top of the subgrade and should be overlapped in accordance with the manufacturer's recommendations.

## Retaining Wall Design

Retaining walls must be designed to resist the loads imposed by the retained soil without exhibiting rotational and/or sliding movements. In an attempt to reduce the load on the wall, granular backfill materials are typically used to fill the void between the natural soil materials and the wall. The load on the wall is transferred to the footing and resisted by the friction between the footing concrete and underlying soils, the resistance of the soil along the face of the footing and backfill materials placed above the footing.

Equivalent fluid density values for active, passive and at rest conditions were evaluated for various backfill materials. These values and their respective USCS soil classification symbols are presented in the table below:

| Backfill Material | Equivalent Fluid Density (psf per foot of depth) | | |
|---|---|---|---|
| | **Active** | **At Rest** | **Passive** |
| Conventional Select Fill (CL-ML, CL, ML & SC-SM, SC, SM) (PI= 4 to 18) | 70 | 95 | 200 |
| Sand (SP & SW) (PI < 4) | 45 | 65 | 275 |
| Free Draining Gravel (GW, GP or GM) (PI=0) | 40 | 65 | 330 |

Retaining walls, which are allowed to move slightly, will develop an “active” earth pressure condition. If the wall is restrained from lateral movements such as when it is fixed at the top, the “at rest” earth pressure condition will be developed.

The design equivalent fluid density values assume the backfill materials are in a moist condition and have been compacted. It is very important to note that these equivalent fluid densities do not include the effect of seepage or hydrostatic pressures, groundwater, and surcharge loads due to equipment, vehicular loads, paving or future storage near the walls.

It is recommended that the backfill behind the walls placed in the active zone wedge be free draining gravels such as a #57 or #67 grade material, with less than 5-percent passing the #200 sieve. Soils with USCS Classification OL, MH, CH and OH are unsuitable for use as backfill.

A coefficient of sliding friction of **0.50** between concrete footing and supporting soils should be used to design the footing supporting the wall. In addition, the passive soil resistance on the face of the footing may be estimated using an equivalent fluid pressure of **200 psf** provided the surface is armored with hardscape. For an un-armored condition, 2-feet should be neglected. An allowable bearing capacity of **2,000 psf (SF=3)** is available for wall footings founded on competent natural soils or properly compacted fill at a minimum depth of 2-feet below the final grade. The allowable bearing pressure should be confirmed in the field by the RETL Engineer.

For MSE walls, friction angles of 34, 17.5, and 27 may be used for retained select backfill, retained embankment fill, and the natural clay soils respectively.

## CONSTRUCTION CONSIDERATIONS

### Excavations

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations including the current OSHA Excavation and Trench Safety Standards. We are providing this information solely as a service to our client.

Under no circumstances should the information provided herein be interpreted to mean that RETL is assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

In no case should slope height, slope inclination or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. Specifically, the current OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926 should be followed. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor's "competent person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. For excavations, including a trench extending to a depth of more than 20-feet, it will be necessary to have the side slopes designed by a Professional Engineer licensed in the State of Texas. The contractor's "competent person" should establish a minimum lateral distance from the crest of the slope for all vehicles and spoil piles. Likewise, the contractor's "responsible person" should establish protective measures for exposed slope faces.

## Earthwork Acceptance

Exposure to the environment may weaken the soils at the subgrade level if excavations remain open for long periods of time. Therefore, it is recommended that the excavations be extended to final grade and the pavements be constructed as soon as possible to minimize potential damage to the bearing soils.

Concrete for curbs, gutters, and sidewalks should not be placed on soils that have been disturbed by rainfall or seepage. If the bearing soils are softened by surface water intrusion, or by desiccation, the unsuitable soils must be removed from the excavation and be replaced with properly compacted base prior to placement of concrete.

The Geotechnical Engineer, or his designated representative, should approve the condition of the subgrade and monitor the placement of all pavement materials. Compaction testing should be performed in accordance with the COSA Standard Specifications. Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

## Drainage

Proper drainage is very important to achieve the desired performance from flexible asphaltic concrete pavements. RETL has assumed that good drainage will be incorporated into the project and the pavements will be fast draining and puddle free. Low or flat areas in asphalt pavements allow standing water and quick deterioration of the pavement primarily due to saturation of the underlying pavement materials and subgrade soils.

It should be noted that groundwater and/or saturated soils with free water may be encountered during construction. These areas will have to be remediated on a case by case basis with the installation of drain systems and piping to collect and remove the water from the pavement areas.

## GENERAL COMMENTS

If there are any revisions to the plans for the proposed project, or if deviations from the subsurface conditions noted in this report are encountered during construction, RETL should be retained to determine if changes in the recommendations are required. If RETL is not retained to perform these functions, RETL will not be responsible for the impact of those conditions on the performance of the project.

It is recommended that the services of RETL be retained to provide observation and testing during the construction of the project in order to verify that the soils are consistent with those encountered by the borings. RETL cannot accept any responsibility for any conditions that deviate from those described in this report, nor for the performance of the project if not engaged to also provide construction observation and testing. If it is required for RETL to accept any liability, then RETL must agree with the plans and perform such observation during construction as we recommend.

All sheeting, shoring, and bracing of trenches, pits and excavations should be made the responsibility of the contractor and should comply with all current and applicable local, state and federal safety codes, regulations and practices, including the Occupational Safety and Health Administration.

# APPENDIX

# BORING LOCATION PLAN

NO SCALE
BORING LOCATIONS ARE APPROXIMATE


April 14, 2022
Kimley-Horn and Associates, Inc.
RETL Project No.: G222085

**PROPOSED THOROUGHFARE**
Kitty Hawk Road
Universal City, Texas


**ROCK ENGINEERING AND TESTING LABORATORY, INC.**
**10856 VANDALE STREET**
**SAN ANTONIO, TEXAS 78216**
**(210) 495-8000**

# LOG OF BORING B-1



Rock Engineering & Testing Laboratory, Inc.
10856 Vandale Street
San Antonio, Texas 78216
Telephone: 210-495-8000
Fax: 210-495-8015

CLIENT: Kimley-Horn and Associates, Inc.
PROJECT: Thoroughfare
LOCATION: Kitty Hawk Rd; Universal City, TX
NUMBER: G222085

DATE(S) DRILLED: 02/14/2022

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during the drilling operations and the boring was dry upon completion of the drilling operations.

SURFACE ELEVATION: N/A

| Depth (ft) | Sample Number | N: Blows/ft, P: Tons/sq ft, T: Tons/sq ft, Qc: Tons/sq ft | Moisture Content (%) | Liquid Limit LL | Plastic Limit PL | Plasticity Index PI | Dry Density Pounds/cu.ft | Compressive Strength (Tons/sq ft) | Minus No. 200 Sieve (%) | Description of Stratum |
|---|---|---|---|---|---|---|---|---|---|---|
| | CORE S-1 | | | | | | | | | **ASPHALT= 3-INCHES**<br>**LIMESTONE BASE= 10-INCHES**<br>**CONCRETE= 6-INCHES** |
| | SPT S-2 | N= 7 | 25 | 37 | 21 | 16 | | | 81 | **LEAN CLAY WITH SAND**, light brown, moist, firm. (CL) |
| 5 | SH S-3 | P= 3.5 | 26 | | | | | | | **FAT CLAY**, dark brown, moist, very stiff. |
| | SPT S-4 | N= 44 | 33 | 81 | 32 | 49 | | | 94 | Same as above, hard. (CH) |
| | SPT S-4 | N= 10 | 17 | | | | | | | **LEAN CLAY**, with calcareous material, light brown, moist, stiff. |
| 10 | | | | | | | | | | |
| | SH S-5 | P= 4.5+ | 12 | 32 | 16 | 16 | | | 98 | Same as above, very stiff. (CL) |
| 15 | | | | | | | | | | |
| | SPT S-6 | N= 50 | 12 | | | | | | | Same as aboe, sans calcareous, marly, hard. |
| 20 | | | | | | | | | | Boring terminated at a depth of 20-feet. |

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring location determined by RETL. Drilling operations performed by RETL.
GPS Coordinates: N 29.548744°, W -98.310387°

# LOG OF BORING B-2



Rock Engineering & Testing Laboratory, Inc.
10856 Vandale Street
San Antonio, Texas 78216
Telephone: 210-495-8000
Fax: 210-495-8015

CLIENT: Kimley-Horn and Associates, Inc.
PROJECT: Thoroughfare
LOCATION: Kitty Hawk Rd; Universal City, TX
NUMBER: G222085

DATE(S) DRILLED: 02/14/2022

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during the drilling operations and the boring was dry upon completion of the drilling operations.

SURFACE ELEVATION: N/A

| SOIL SYMBOL | DEPTH (FT) | SAMPLE NUMBER | SAMPLES | N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT | MOISTURE CONTENT (%) | LIQUID LIMIT LL | PLASTIC LIMIT PL | PLASTICITY INDEX PI | DRY DENSITY POUNDS/CU.FT | COMPRESSIVE STRENGTH (TONS/SQ FT) | MINUS NO. 200 SIEVE (%) | DESCRIPTION OF STRATUM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SPT S-1 | | N= 25 | 9 | 69 | 27 | 42 | | | 40 | **CLAYEY GRAVEL**, brown, dry, medium dense. (GC) |
| | | SPT S-2 | | N= 29 | 6 | | | | | | | Same as above, light brown. |
| | 5 | SPT S-3 | | N= 30 | 9 | 37 | 19 | 18 | | | 93 | **LEAN CLAY**, with calcareous material, light brown, dry, hard. (CL) |
| | | SPT S-4 | | N= 23 | 8 | | | | | | | Same as above, very stiff. |
| | 10 | SPT S-5 | | N= 23 | 8 | | | | | | | Same as above. |
| | 15 | SPT S-6 | | N= 34 | 15 | 66 | 22 | 44 | | | 98 | **FAT CLAY**, light gray-brown, moist, hard. (CH) |
| | 20 | SH S-7 | | P= 4.5 | 15 | | | | | | | Same as above, light brown, very stiff. |
| | | | | | | | | | | | | Boring terminated at a depth of 20-feet. |

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring location determined by RETL. Drilling operations performed by RETL.
GPS Coordinates: N 29.547721°, W -98.310639°

# LOG OF BORING B-3



Rock Engineering & Testing Laboratory, Inc.
10856 Vandale Street
San Antonio, Texas 78216
Telephone: 210-495-8000
Fax: 210-495-8015

CLIENT: Kimley-Horn and Associates, Inc.
PROJECT: Thoroughfare
LOCATION: Kitty Hawk Rd; Universal City, TX
NUMBER: G222085

DATE(S) DRILLED: 02/14/2022

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during the drilling operations and the boring was dry upon completion of the drilling operations.

SURFACE ELEVATION: N/A

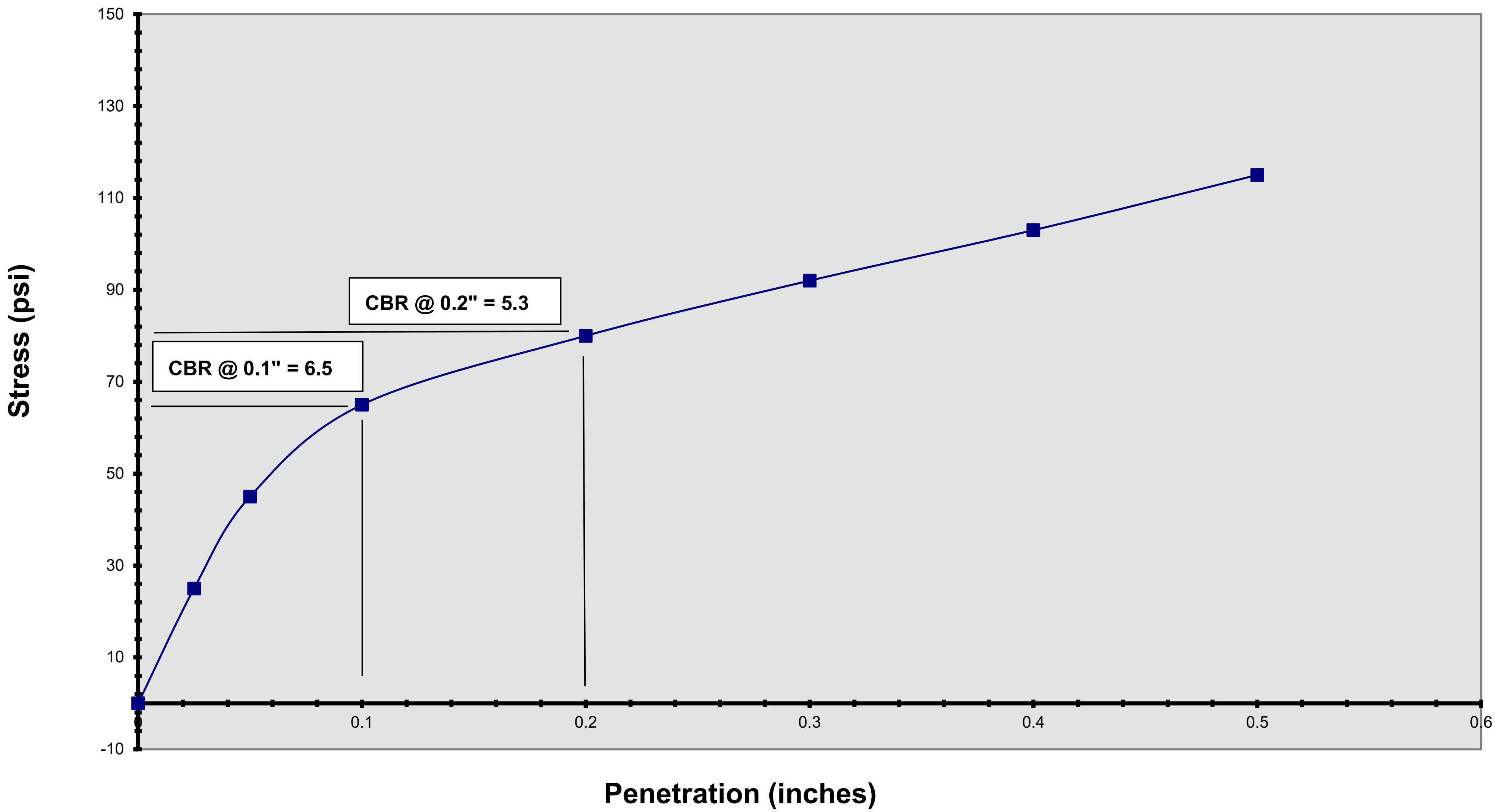
| DEPTH (FT) | SAMPLE NUMBER | N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT | MOISTURE CONTENT (%) | LL | PL | PI | DRY DENSITY POUNDS/CU.FT | COMPRESSIVE STRENGTH (TONS/SQ FT) | MINUS NO. 200 SIEVE (%) | DESCRIPTION OF STRATUM |
|---|---|---|---|---|---|---|---|---|---|---|
| | SPT S-1 | N= 23 | 29 | | | | | | | **CLAYEY GRAVEL**, dark brown, moist, medium dense. |
| | SPT S-2 | N= 12 | 17 | 36 | 18 | 18 | | | 95 | **LEAN CLAY**, with calcareous material, brown, moist, stiff. (CL) |
| 5 | SH S-3 | P= 4.5+ | 16 | | | | | | | Same as above, very stiff. |
| | SH S-4 | P= 3.5 | 16 | | | | 115 | 30 | | Same as above. |
| 10 | SPT S-5 | N= 28 | 14 | 43 | 18 | 25 | | | 99 | **LEAN CLAY**, light brown, moist, very stiff. (CL) |
| 15 | SH S-6 | P= 3.0 | 16 | | | | | | | Same as above, light brown and gray. |
| 20 | SPT S-7 | N= 54 | 13 | | | | | | | Same as above, hard. |
| 25 | SPT S-8 | N= 40 | 10 | | | | | | | **LEAN CLAY**, brown, moist, hard. |
| 30 | SPT S-9 | N= 54 | 15 | 47 | 19 | 28 | | | 99 | Same as above. (CL) |
| | | | | | | | | | | Boring terminated at a depth of 30-feet. |

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring location determined by RETL. Drilling operations performed by RETL.
GPS Coordinates: N 29.548265°, W -98.310360°

# CBR - Stress versus Penetration Curve

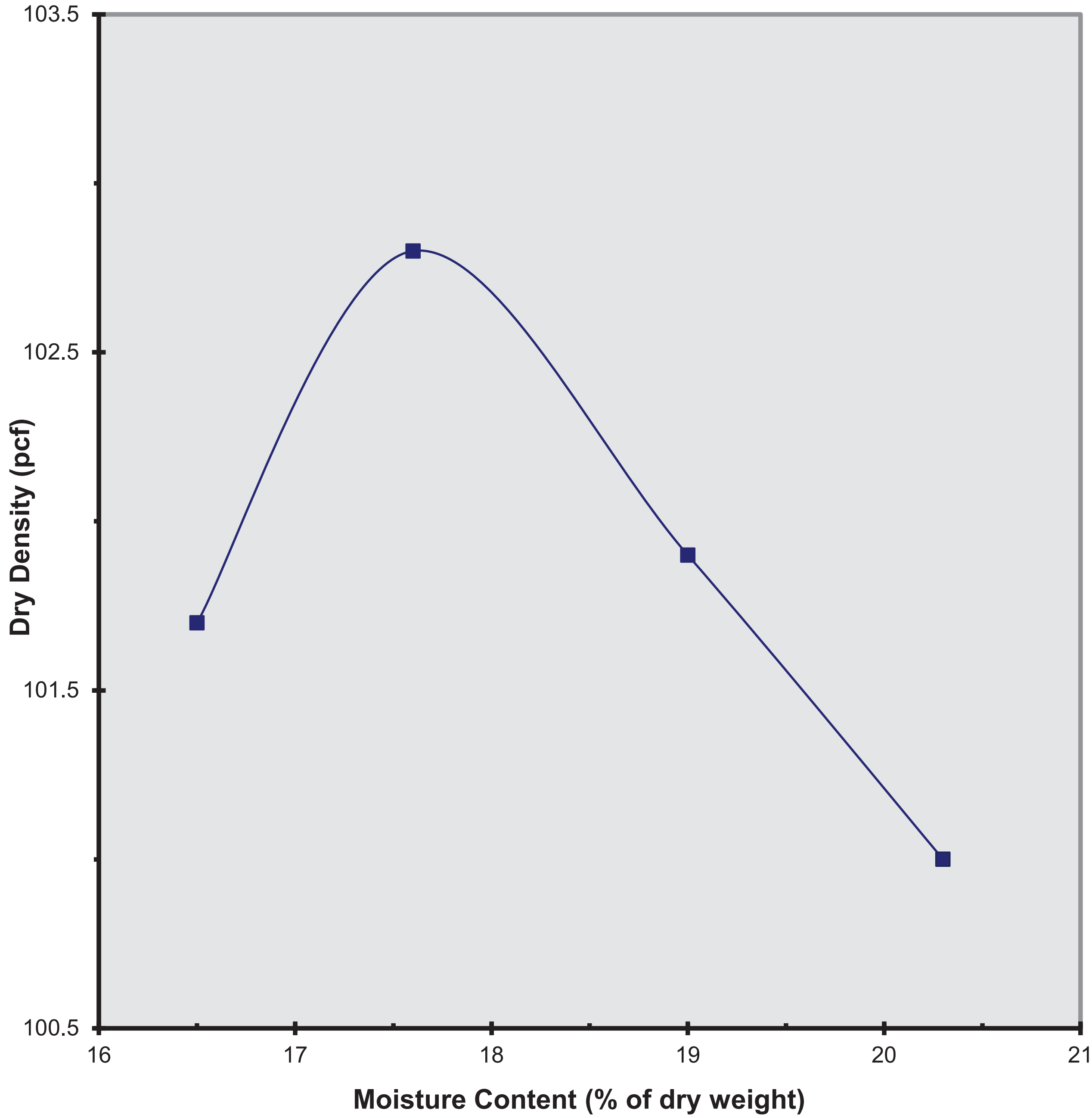
**(ASTM D1883)**




| PROJECT DESCRIPTION | MOLDED DRY DENSITY | CBR @ 0.1 INCH PENETRATION | TEST DATE |
|---|---|---|---|
| Proposed Thoroughfare<br>Universal City, Texas | 100.6 pcf<br>(97.9% of max density) | 6.5 | March 2022 |
| **SAMPLE DESCRIPTION** | **MOLDED MOISTURE CONT.** | **CBR @ 0.2 INCHES PENETRATION** | **RETL PROJ. NO.** |
| Boring B-2 Bulk Sample<br>Brown Gravelly Lean CLAY (CL) | 19.8% | 5.3 | G222085 |

**ROCK ENGINEERING AND TESTING LABORATORY, INC.**

# DENSITY VERSUS MOISTURE CURVE
# (ASTM D698)




| PROJECT | MAXIMUM LAB DENSITY | LAB DATA |
|---|---|---|
| Thoroughfare<br>Universal City, Texas | 102.8 pcf<br><br>ASTM D698 | LL = 46<br>PI = 28<br>Minus #200 = 58% |
| **SAMPLE DESCRIPTION** | **OPTIMUM MOISTURE** | **RETL PROJ. NO.** |
| Boring B-2 Bulk Sample<br>Brown Gravelly Lean CLAY (CL) | 17.6% | G222085 |

**ROCK ENGINEERING AND TESTING LABORATORY, INC.**

Engineering & Testing
Laboratory, Inc.

Rock Engineering & Testing Laboratory
10856 Vandale Street
San Antonio, TX 78216
Telephone: 210-495-8000

## KEY TO SOIL CLASSIFICATION AND SYMBOLS

### UNIFIED SOIL CLASSIFICATION SYSTEM

| MAJOR DIVISIONS | | SYMBOL | NAME |
|---|---|---|---|
| COARSE GRAINED SOILS | GRAVEL AND GRAVELLY SOILS | GW | Well Graded Gravels or Gravel-Sand mixtures, little or no fines |
| | | GP | Poorly Graded Gravels or Gravel-Sand mixtures, little or no fines |
| | | GM | Silty Gravels, Gravel-Sand-Silt mixtures |
| | | GC | Clayey Gravels, Gravel-Sand-Clay Mixtures |
| | SAND AND SANDY SOILS | SW | Well Graded Sands or Gravelly Sands, little or no fines |
| | | SP | Poorly Graded Sands or Gravelly Sands, little or no fines |
| | | SM | Silty Sands, Sand-Silt Mixtures |
| | | SC | Clayey Sands, Sand-Clay mixtures |
| | SILTS AND CLAYS LL < 50 | ML | Inorganic Silts and very fine Sands, Rock Flour, Silty or Clayey fine Sands or Clayey Silts |
| | | CL | Inorganic Clays of low to medium plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays |
| | | OL | Organic Silts and Organic Silt-Clays of low plasticity |
| | SILTS AND CLAYS LL > 50 | MH | Inorganic Silts, Micaceous or Diatomaceous fine Sandy or Silty soils, Elastic Silts |
| | | CH | Inorganic Clays of high plasticity, Fat Clays |
| | | OH | Organic Clays of medium to high plasticity, Organic Silts |
| NON USCS MATERIALS | | | Limestone |
| | | | Marl/Claystone |
| | | | Sandstone |

### TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED - having inclined planes of weakness that are slick and glossy in appearance

FISSURED - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical

LAMINATED (VARVED) - composed of thin layers of varying color and texture, usually grading from sand or silt at the bottom to clay at the top

CRUMBLY - cohesive soils which break into small blocks or crumbs on drying

CALCAREOUS - containing appreciable quantities of calcium carbonate, generally nodular

WELL GRADED - having wide range in grain sizes and substantial amounts of all intermediate particle sizes

POORLY GRADED - predominantly of one grain size uniformly graded) or having a range of sizes with some intermediate size missing (gap or skip graded)

### SYMBOLS FOR TEST DATA

— Groundwater Level (Initial Reading)

— Groundwater Level (Final Reading)

— Shelby Tube Sample

— SPT Samples

— Auger Sample

— Rock Core

— Texas Cone Penetrometer

— Grab Sample

### TERMS DESCRIBING CONSISTENCY OF SOIL

| COARSE GRAINED SOILS | | FINE GRAINED SOILS | | |
|---|---|---|---|---|
| DESCRIPTIVE TERM | NO. BLOWS/FT. STANDARD PEN. TEST | DESCRIPTIVE TERM | NO. BLOWS/FT. STANDARD PEN. TEST | UNCONFINED COMPRESSION TONS PER SQ. FT. |
| Very Loose | 0 - 4 | Very Soft | < 2 | < 0.25 |
| Loose | 4 - 10 | Soft | 2 - 4 | 0.25 - 0.50 |
| Medium | 10 - 30 | Firm | 4 - 8 | 0.50 - 1.00 |
| Dense | 30 - 50 | Stiff | 8 - 15 | 1.00 - 2.00 |
| Very Dense | over 50 | Very Stiff | 15 - 30 | 2.00 - 4.00 |
| | | Hard | over 30 | over 4.00 |

Field Classification for "Consistency" of Fine Grained Soils is determined with a 0.25" diameter penetrometer