• Geotechnical Engineering
• Construction Materials Engineering & Testing
• Soils • Asphalt • Concrete

April 27, 2022

INK Civil
2021 SH 46 W, Ste. 105
New Braunfels, TX 78132

Attention: James Ingalls, P.E

SUBJECT: **SUBSURFACE EXPLORATION, LABORATORY TESTING PROGRAM, AND PAVEMENT EVALUATION**
FOR THE PROPOSED CLEAR CREEK SUBDIVISION ROADWAYS
MISTY ACRES DR
NEW BRAUNFELS, TEXAS
RETL Project No.: G222239

Dear Mr. Ingalls,

In accordance with our agreement, we have conducted a subsurface exploration and pavement evaluation for the above referenced project. The results of this exploration, together with our recommendations, are to be found in the accompanying report, an electronic copy of which is being transmitted herewith. RETL will provide up to two (2) versions of this report in hard copy at the request of the client.

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

RETL also has great interest in providing materials testing and observation services during the construction phase of this project. If you will advise us of the appropriate time to discuss these engineering services, we will be pleased to meet with you at your convenience.

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 EVALUATION FOR THE PROPOSED CLEAR CREEK SUBDIVISION ROADWAYS MISTY ACRES DR NEW BRAUNFELS, TEXAS

RETL PROJECT NUMBER: G222239

PREPARED FOR:

INK CIVIL
2021 SH 46 W, STE. 105
NEW BRAUNFELS, TEXAS 78132

APRIL 27, 2022

PREPARED BY:

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

TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NUMBER 2101

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

TABLE OF CONTENTS

INTRODUCTION

This report presents the results of a subsurface exploration and pavement evaluation for the proposed Clear Creek Subdivision Roadways to be constructed near Misty Acres Drive in New Braunfels, Texas. This study was conducted for INK Civil.

Authorization

The work for this project was performed in accordance with RETL Proposal Number SGP031022B dated March 10, 2022. The proposal contained a scope of work, lump sum fee and limitations. The proposal was approved and signed by Shane Klar on March 10, 2022 and returned to RETL via email.

Purpose and Scope

The purpose of this exploration was to evaluate the soil conditions at the site and to provide pavement recommendations suitable for the proposed subdivision roadways.

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

The scope of services did not include an environmental assessment. Any statements in this report, or on the boring 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 form a reasonable basis for the pavement design. The recommendations submitted for the proposed project are based on the available soil information and the preliminary design details provided by the client. If the civil engineer requires additional soil parameters to complete the pavement designs, RETL will provide the requested information as a supplement to this 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 the 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.

FIELD EXPLORATION

Scope

The field exploration completed in order to evaluate the engineering characteristics of the pavement materials included a reconnaissance of the project site, drilling the test borings, and recovering disturbed split spoon samples and a relatively undisturbed Shelby tube sample.

A total of five (5) borings were performed at the site and were drilled to a depth of 10-feet within the proposed new roadways. RETL determined the number, depth and general location of the borings and staked the borings in the field. RETL performed the boring operations. Upon completion of the drilling operations and obtaining the groundwater observations, the bore holes were backfilled with excavated soil and the site 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 and solid flight auger drilling methods were used to advance the boreholes to their desired depths. Disturbed 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). A relatively undisturbed soil sample was obtained using thin-wall tube sampling procedures in accordance with the procedures for "*Thin Walled Tube Sampling of Soils*" (ASTM D1587).

The samples were classified in the field, placed in plastic bags, marked according to their 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 test boring operations and are noted on the boring logs provided in the Appendix. The amount of water in open boreholes largely depends on the permeability of the soils encountered at the boring locations. 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. Seasonal variations, temperature, land-use, proximity to a body of water, and recent rainfall conditions may influence the depth to the groundwater.

Ground Surface Elevations - Ground surface elevations were not provided at the boring locations. All depths referred to in this report are reported from the actual ground 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 subgrade materials necessary in developing the pavement recommendations for the roadways.

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 D698), a California Bearing Ratio (CBR) test (ASTM D1883), pH tests (ASTM D4972), lime series (TEX Method 121E), and a sulfate content determination (TEX Method 145E). An estimated soil strength was obtained in the field using a hand penetrometer.

All phases of the laboratory-testing program were conducted in general accordance with applicable ASTM or TxDOT Specifications. The results of these tests are to be found in this report or on the accompanying boring logs provided in the Appendix.

SUBSURFACE CONDITIONS

General

The types of subsurface materials encountered in the test borings have been visually classified and are described in detail on the boring logs. The results of the standard penetration tests, strength test, water level observations and laboratory tests are presented on the boring logs in numerical form.

Representative samples of the soils were placed in polyethylene bags and are now stored in the laboratory for further analysis, if desired. Unless notified to the contrary, all samples will be disposed of 3 months after issuance of this report.

The stratification of the soil, as shown on the boring logs, represents the soil conditions at the actual boring locations. Variations may occur between, or beyond, the 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, whereby the test borings were drilled and sampled by experienced technicians, 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 soil conditions at the project site generally consist of fat clays (CH) and lean clay (CL) which extend to the boring termination depths of 10-feet. Intermediate depth clayey sands (SC) were encountered in borings B-4 and B-5. The clay soils are high to very high in plasticity with tested plasticity indices (PI) ranging from 37 to 56. The lean clays are moderate to high in plasticity with tested plasticity indices (PI) of 23 and 32.

Sulfate Test Results

The sulfate test result on a representative subgrade sample is provided in the following table:

UPPER CLAY SUBGRADE SULFATE TEST RESULTS	
Boring No.	**Sulfate (ppm)**
B-3 (Bulk)	960

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

SULFATE RISK LEVELS	
Sulfate (ppm)	**Risk**
<3,000	Low
3,000-5,000	Moderate
5,000-8,000	Moderate to High
>8,000	High and Unacceptable

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

Lime Series and pH Test Results

The lime series and pH test results on the bulk subgrade sample are provided in the following table:

BORING B-3 BULK SUBGRADE SAMPLE LIME SERIES AND pH TEST RESULTS		
% Lime	**LL / PI**	**pH**
0	53 / 30	7.0
2	39 / 13	12.3
4	38 / 12	12.4
6	39 / 12	12.5
8	38 / 11	12.5
10	40 / 13	12.5

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

The results indicate the subgrade soils should be treated with 6-percent lime to reduce the plasticity index (PI) and increase the pH to acceptable levels.

Groundwater Observations

Groundwater was not encountered in the borings during the drilling nor measured in the borings upon completion of the drilling. It should be noted that water levels in open boreholes may require anywhere from several hours to several days to stabilize depending on the permeability of the soils and that groundwater levels at this site may be subject to seasonal conditions, recent rainfall, drought or temperature effects.

PVR Discussion

The laboratory test results indicate that the fat clay soils within the active zone at this site are high to very high in plasticity and the lean clay soils are moderate to high in plasticity. **The maximum calculated total potential vertical rise (PVR) based on the soils encountered in the borings performed at this site and the results of the laboratory tests, is in the range of 1 to 3-inches.** The PVR was calculated using the Texas Department of Transportation Method TEX-124E and took into account the depth of the active zone, estimated to extend to a depth of approximately 15-feet at this site, and the Atterberg limits test results of the soils encountered within the active zone.

The approximate PVR for each boring performed at the site is provided in the following table:

POTENTIAL VERTICAL RISE (PVR) SUMMARY	
Boring Number	**APRROXIMATE PVR (in)**
B-1	1
B-3, B-4	1½ to 2
B-2, B-5	2½ to 3

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, will likely result in higher magnitudes of moisture related soil movements than calculated by the PVR method provided herein.

It is anticipated that when completely inundated with water and allowed to become saturated, which would likely be the case if proper drainage around the structure is not provided or if a broken plumbing line was to occur, the subgrade soils could swell 2 to 3 times or more the magnitude estimated by the TEX-124E PVR represented herein. Differential vertical movements may occur over a distance equal to the depth of the active zone and can potentially be equal to the expected total movements.

PAVEMENT RECOMMENDATIONS

Based on the information provided to RETL, the proposed project will consist of the construction of asphaltic concrete subdivision roadways. 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 can be summarized as follows:

1. Bearing values of the subgrade. These values can be represented by a California Bearing Ratio (CBR) for the design of flexible asphalt pavements.

2. Vehicular traffic, in terms of the number and frequency of vehicles and their range of axle loads.

3. Probable increase in vehicular use over the life of the pavement.

4. The availability of suitable materials to be used in the construction of the pavement and their relative costs.

Specific laboratory testing to define the subgrade strength (i.e. CBR/K values) has been performed for this analysis. **Based upon the CBR test results and the plasticity indices and strengths of the natural clay subgrade soils, a CBR value of 3.0 has been selected for design.**

We have evaluated the proposed new roadways considering the City of New Braunfels Street Design Standards, which are designated as “One and Two Family Residential” and “Residential Collector” streets. **The AASHTO 18-kip ESAL for the City of New Braunfels “One and Two Family Residential” and “Residential Collector” streets are 58,000 and 279,000, respectively.**

RETL used the following pavement design parameters for the flexible pavement design:

AASHTO PAVEMENT DESIGN PARAMETER	DESIGN VALUE
Reliability (R)	70%
Overall Deviation	0.45
Initial/Terminal Serviceability	4.2 / 2.0
Subgrade Design CBR	2.5
Design Life	20 years

The following lime treated subgrade, limestone base, and hot mix asphaltic concrete layer coefficients were selected for the pavement design:

Pavement Constituent	Layer Coefficient (α)
Lime Stabilized Subgrade	0.08
New Crushed Limestone Base (TxDOT Item 247 Type A, Grade 1-2)	0.14
Type D HMAC	0.44

The recommended hot mixed asphaltic concrete (HMAC) pavement sections are provided in the following tables:

"ONE AND TWO FAMILY RESIDENTIAL" (Required AASHTO 18-KIP ESAL = 58,000)		
Hot Mix Asphaltic Concrete	2"	2"
Crushed Limestone Base Material (TxDOT Item 247 Type A; Gr. 1-2)	7"	9"
TENSAR Geogrid	TX-5 or HX5.5	---
Lime Stabilized Subgrade	---	6"
Moisture Conditioned Subgrade	6"	---
Calculated AASHTO 18-kip ESAL	100,000	85,000

"RESIDENTIAL COLLECTOR" (Required AASHTO 18-KIP ESAL = 279,000)		
Hot Mix Asphaltic Concrete	2.5"	2.5"
Crushed Limestone Base Material (TxDOT Item 247 Type A; Gr. 1-2)	9"	12"
TENSAR Geogrid	TX-5 or HX5.5	---
Lime Stabilized Subgrade	---	6"
Moisture Conditioned Subgrade	6"	---
Calculated AASHTO 18-kip ESAL	343,000	356,000

Moisture Conditioned Subgrade

After all surface organics and deleterious materials have been removed and the desired subgrade elevation has been achieved, the upper 6-inches of exposed subgrade 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. Any embankment fill required to achieve the final subgrade elevation shall be placed in maximum 8-inch loose lifts and compacted as specified above.

Lime Stabilized Subgrade

Lime placement and mixing operations should be performed in accordance with TxDOT Item 260, *"LIME TREATMENT FOR MATERIALS USED AS SUBGRADE (ROAD MIXED)."* Lime shall be properly mixed at a rate of 6-percent of the maximum dry unit weight of the raw subgrade soils as determined by TEX 114E. This equates to 30 pounds of lime per square yard per 6-inch stabilized 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.

Triaxial Geogrid

The TX-5 OR HX5.5 geogrid TENSAR shall be placed in accordance with the manufacturer's recommendations. Geogrid is recommended to reduce the magnitude of cracking, reduce maintenance costs and increase the life of the flexible pavements. Alternate geogrid products will not be considered unless the submittal contains a pavement design sealed by a licensed engineer.

Limestone Base

Limestone base materials should meet the requirements set forth in the Texas Department of Transportation (TxDOT) 2014 Standard Specifications for Construction of Highways, Streets and Bridges; Item 247, Type A, Grade 1-2. The base material should be placed in maximum 8-inch thick loose lifts and compacted to a minimum density of 100-percent of the maximum dry density as determined by TEX-113E within -2 to +2 percentage points of the optimum moisture content.

Hot Mix Asphalt

Hot mix asphaltic concrete should meet the requirements set forth in TxDOT Item 340 or Item 340 or 341; Type D surface course. The asphaltic concrete should be compacted to between 91.5 and 96.3-percent of the maximum theoretical density as determined by the Rice specific gravity.

Drainage

Proper drainage is very important for the adequate performance of asphaltic pavements. Ruts and birdbaths in asphalt pavements allow for quick deterioration of the pavement primarily due to saturation of the underlying base materials and subgrade soils.

The pavement design recommendations in this report are based on the assumption that the pavements will have good drainage. A minimum of 1-percent slope in the pavement surface is recommended.

GENERAL COMMENTS

If significant changes are made in the character or location of the proposed project, a consultation should be arranged to review any changes with respect to the prevailing soil conditions. At that time, it may be necessary to submit supplementary recommendations.

It is recommended that the services of RETL be engaged to test and evaluate the subgrade soils in the pavement areas prior to placing pavement constituents in order to verify that the bearing soils are consistent with those encountered in the borings. RETL cannot accept any responsibility for any conditions that deviate from those described in this report, nor for the performance of the pavements if not engaged to also provide construction observation and testing for this project. 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 27, 2022
INK Civil
RETL Project No.: G222239

CLEAR CREEK SUBDIVISION ROADWAYS
Misty Acres Dr
New Braunfels, 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: INK Civil
PROJECT: Clear Creek Subdivision Roadways
LOCATION: Misty Acres Dr; New Braunfels, Texas
NUMBER: G222239
DATE(S) DRILLED: 03/28/2022

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 (%)	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)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1	SPT S-1		N= 2	14	28	17	11			56	**SANDY LEAN CLAY**, dark brown, moist, soft. (CL)
	2											
	3	SPT S-2		N= 3	16							Same as above, brown.
	4											
	5	SPT S-3		N= 9	15	39	16	23			69	Same as above, stiff. (CL)
	6											
	7	SPT S-4		N= 9	12							**SANDY LEAN CLAY**, light brown, moist, stiff.
	8											
	9	SPT S-5		N= 15	9							Same as above, dry.
	10											
	11											
	12											
	13											
	14	SPT S-6		N= 14	7							Same as above.
	15											Boring terminated at a depth of 15-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 XX.XXXXX°, W -XX.XXXXX°

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: INK Civil
PROJECT: Clear Creek Subdivision Roadways
LOCATION: Misty Acres Dr; New Braunfels, Texas
NUMBER: G222239
DATE(S) DRILLED: 03/28/2022

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 (%)	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)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1	SPT S-1		N= 9	18							**SANDY FAT CLAY**, dark brown, moist, stiff.
	2											
	3	SPT S-2		N= 12	17	56	18	38			91	**FAT CLAY**, brown, moist, stiff. (CH)
	4											
	5	SPT S-3		N= 17	18							Same as above, very stiff.
	6											
	7	SPT S-4		N= 48	10	48	17	31			85	**LEAN CLAY**, brown, moist, hard. (CL)
	8											
	9	SPT S-5		N= 13	21							Same as above, stiff.
	10											
	11											
	12											
	13											
	14	SPT S-6		N= 5	12							**SANDY LEAN CLAY**, light brown, moist, firm.
	15											Boring terminated at a depth of 15-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 XX.XXXXX°, W -XX.XXXXX°

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: INK Civil
PROJECT: Clear Creek Subdivision Roadways
LOCATION: Misty Acres Dr; New Braunfels, Texas
NUMBER: G222239
DATE(S) DRILLED: 03/28/2022

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 (%)	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)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1	SPT S-1		N= 8	17							**FAT CLAY WITH SAND**, brown, moist, stiff.
	2											
	3	SPT S-2		N= 10	14	51	20	31			78	Same as above. (CH)
	4											
	5	SPT S-3		N= 14	9							**LEAN CLAY**, light brown, dry, stiff.
	6											
	7	SPT S-4		N= 27	11	36	19	17			93	Same as above, moist, very stiff. (CL)
	8											
	9	SPT S-5		N= 13	14							Same as above.
	10											
	11											
	12											
	13											
	14	SPT S-6		N= 13	16							**LEAN CLAY**, light brown, moist, stiff.
	15											Boring terminated at a depth of 15-feet.

FIELD DATA | LABORATORY DATA | DESCRIPTION OF STRATUM

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 XX.XXXXX°, W -XX.XXXXX°

LOG OF BORING B-4

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

CLIENT: INK Civil
PROJECT: Clear Creek Subdivision Roadways
LOCATION: Misty Acres Dr; New Braunfels, Texas
NUMBER: G222239
DATE(S) DRILLED: 03/28/2022

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 (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1	SPT S-1		N= 8	28	82	29	53			93	**FAT CLAY**, dark brown to brown, moist, stiff. (CH)
	2											
	3	SH S-2		P= 4.5+	7							**GRAVELLY FAT CLAY**, brown, dry, very tiff.
	4											
	5	SPT S-3		N= 25-50/4"	5							**CLAYEY SAND**, with calcareous material, light brown and gravel, dry, very hard.
	6											
	7	SPT S-4		N= 25-50/4"	3							Same as above.
	8											
	9	SPT S-5		N= 30	13	38	17	21			99	**LEAN CLAY**, light brown and gray, moist, hard. (CL)
	10											
	11											
	12											
	13											
	14	SPT S-6		N= 30	15							Same as above.
	15											Boring terminated at a depth of 15-feet.

DESCRIPTION OF STRATUM

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 XX.XXXXX°, W -XX.XXXXX°

LOG OF BORING B-5

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

CLIENT: INK Civil
PROJECT: Clear Creek Subdivision Roadways
LOCATION: Misty Acres Dr; New Braunfels, Texas
NUMBER: G222239
DATE(S) DRILLED: 03/28/2022

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.

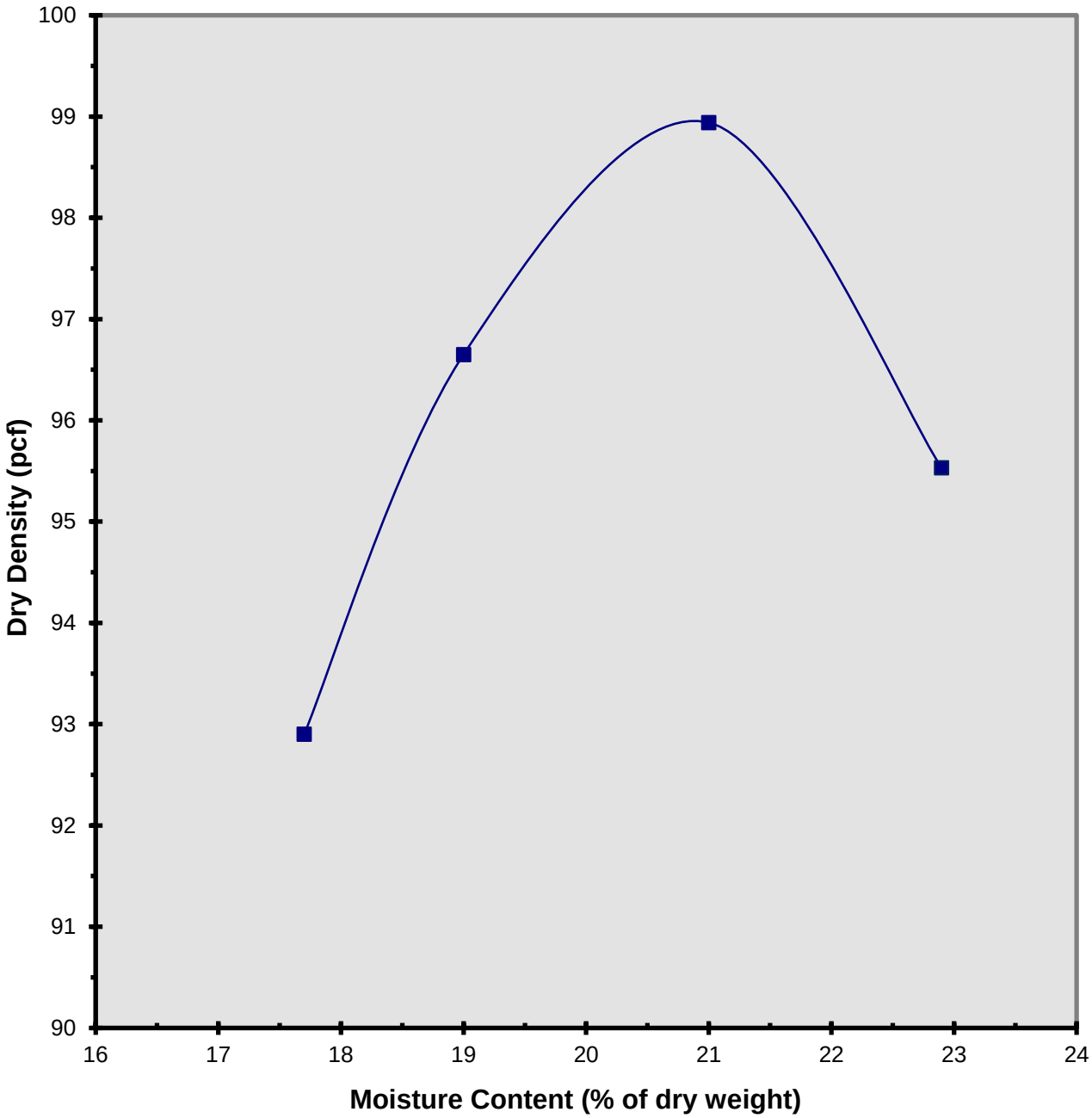
SURFACE ELEVATION: N/A

SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	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)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1	SPT S-1		N= 3	19	74	24	50			93	**FAT CLAY**, dark brown, moist, firm. (CH)
	2											
	3	SPT S-2		N= 5	26							Same as above, dark brown and brown.
	4											
	5	SPT S-3		N= 30	23	71	22	49			83	**FAT CLAY WITH GRAVEL**, dark brown, moist, hard. (CH)
	6											
	7	SPT S-4		N= 52	4							**CLAYEY SAND**, with calcareous material and gravel, light brown, dry, hard.
	8											
	9	SPT S-5		N= 11-50/5"	3							Same as above, very hard.
	10											
	11											
	12											
	13											
	14	SPT S-6		N= 14	17							**LEAN CLAY**, light brown and gray, moist, stiff.
	15											Boring terminated at a depth of 15-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 XX.XXXXX°, W -XX.XXXXX°

DENSITY VERSUS MOISTURE CURVE
(ASTM D698)



PROJECT	MAXIMUM LAB DENSITY	LAB DATA
Clear Creek Subdivision Roadways New Braunfels, Texas	99.0 pcf ASTM D698	LL = 53 PI = 30 Minus #200 = 91%
SAMPLE DESCRIPTION	**OPTIMUM MOISTURE**	**RETL PROJ. NO.**
Boring B-3 Bulk Sample Dark Brown Fat CLAY (CH)	20.8%	G222239

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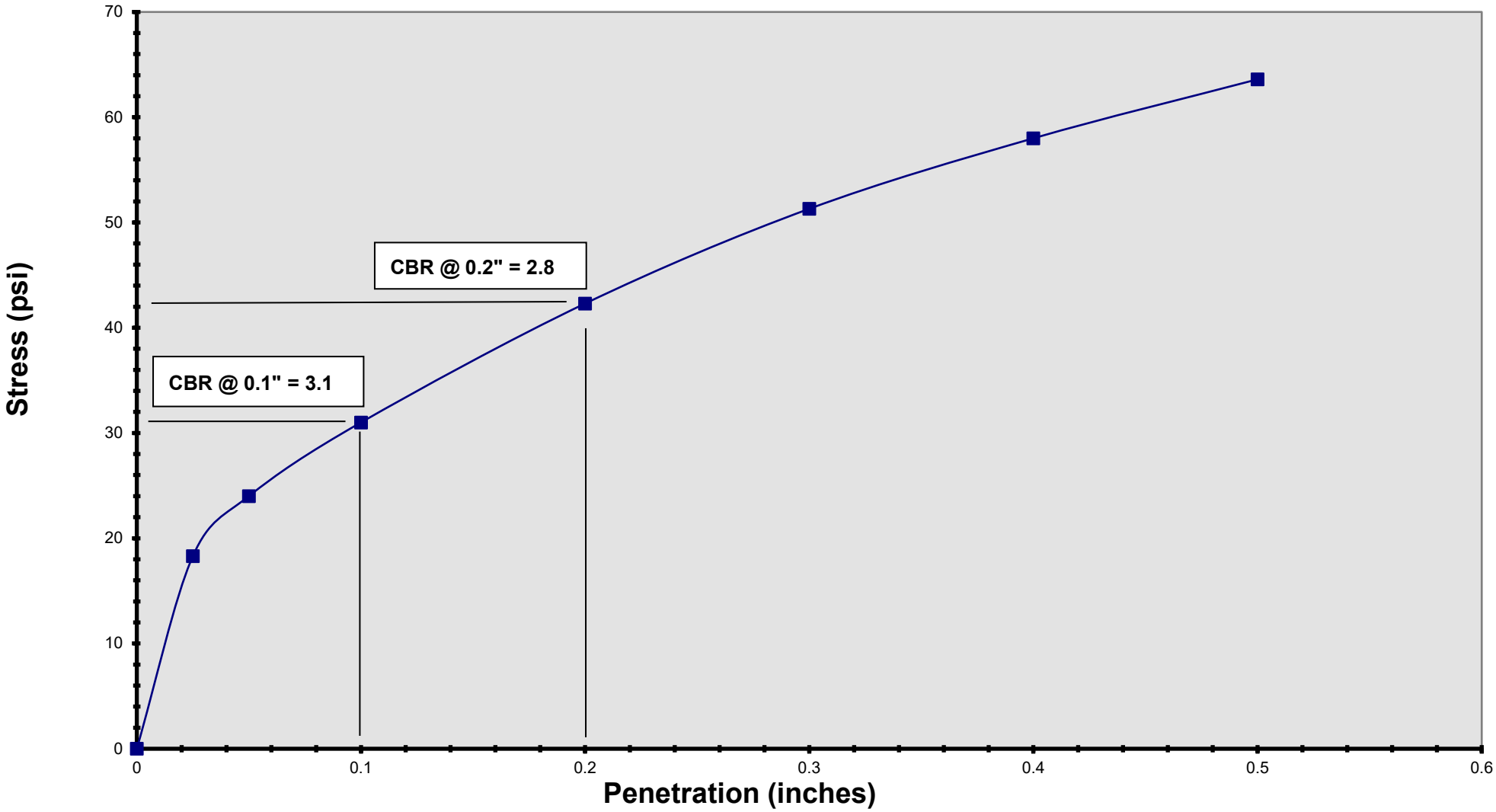
CBR - Stress versus Penetration Curve

(ASTM D1883)



PROJECT DESCRIPTION	MOLDED DRY DENSITY	CBR @ 0.1 INCH PENETRATION	TEST DATE
Clear Creek Subdivision Roadways New Braunfels, Texas	94.3 pcf (95.3% of max density)	3.1	April 2022
SAMPLE DESCRIPTION	**MOLDED MOISTURE CONT.**	**CBR @ 0.2 INCHES PENETRATION**	**RETL PROJ. NO.**
Boring B-3 Bulk Sample Dark Brown Fat CLAY (CH)	20.9%	2.8	G222239

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