CITY OF SAN ANTONIO
TRANSPORTATION & CAPITAL IMPROVEMENTS

ADDENDUM NO. 2

PROJECT NAME: PEGGY DRIVE EXTENSION

DATE: April 22, 2015

ADDENDUM NO. 2

This addendum should be included in and be considered part of the plans and specifications for the name of the project. The contractor shall be required to sign an acknowledgement of the receipt of this addendum and submit with their bid.

TCI PROJECT NO.: 40-00310

Addendum No. 2 is issued to notify, add, change and replace the following:

Formal Invitation for Bid (IFB) and Contract:

- Add Geotechnical Report for Peggy Drive Extension Project, prepared by Rock Engineering and Testing Laboratory, Inc.

Attachments

a) Addendum Acknowledgement Form (1 Page)
b) Geotechnical Report (40 Pages)

STATE OF TEXAS
MASON D. LIEBAU
98293
LICENSED
PROFESSIONAL ENGINEER

4/22/15

END OF ADDENDUM

Cude Engineers
TBPE No. 455

CITY OF SAN ANTONIO
TRANSPORTATION & CAPITAL IMPROVEMENTS

Note: Addenda Acknowledgement Form for Addendum _2_ is attached herein. This form must be signed and submitted with the bid package.

RECEIPT OF ADDENDUM NUMBER(S) 2 IS HEREBY ACKNOWLEDGED FOR PLANS AND SPECIFICATIONS FOR CONSTRUCTION OF **PEGGY DRIVE EXTNSION PROJECT NO. 40-00310**

FOR WHICH BIDS WILL BE OPENED ON **TUESDAY, APRIL 28, 2015 AT 2:00 P.M.**

THIS ACKNOWLEDGEMENT MUST BE SIGNED AND RETURNED WITH THE BID PACKAGE.

Company Name: _____

Address: _____

City/State/Zip Code: _____

Date: _____

_____
Signature

_____
Print Name/Title

SUBSURFACE EXPLORATION, LABORATORY TESTING PROGRAM AND FOUNDATION AND PAVEMENT RECOMMENDATIONS PEGGY DRIVE EXTENSION PROJECT COSA PROPOSED ROUTE SAN ANTONIO, TEXAS

RETL JOB NUMBER: G213223

PREPARED FOR:

CUDE ENGINEERS
1350 N. LOOP 1604 EAST, SUITE 104
SAN ANTONIO, TX 78232

SEPTEMBER 20, 2013

PREPARED BY:

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TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NUMBER 2101

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

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INTRODUCTION

This report presents the results of a subsurface exploration, laboratory testing program and foundation and pavement evaluation for the Peggy Drive Extension Project located in San Antonio, Texas. This study was conducted for Cude Engineers.

Authorization

The work for this project was performed in accordance with RETL Proposal No. P030813A (Revision No. 1) dated March 21, 2013. The proposal contained a proposed scope of work, lump sum fee and limitations. A *"Subconsultant Agreement"* between Cude Engineers and RETL was executed on August 6, 2013.

Purpose and Scope

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

The scope of the exploration and analysis included the subsurface exploration, field and laboratory testing, Dynamic Cone Penetrometer (DCP) testing, performing engineering analysis and evaluation of the subsurface soils, provision of foundation and 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 foundation and pavement designs. The recommendations submitted for the proposed project are based on the available soil information and the preliminary design details provided by Mason Liebau, PE, CFM of Cude Engineers. If the engineers require additional parameters to complete the design of the proposed foundations and pavements, RETL will provide this information as a supplement to this report.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein, have been presented after being prepared in accordance with generally accepted professional engineering practice in the fields of pavement engineering, soil mechanics, and engineering geology. 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) and is AASHTO certified in various soil testing applications. 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 Cude Engineers and the City of San Antonio for the specific application to the Peggy Drive Extension Project located in San Antonio, Texas.

FIELD EXPLORATION

Scope

The field exploration to identify the engineering characteristics of the subsurface soils included a reconnaissance of the project site, performing the test borings and obtaining disturbed split spoon samples and relatively undisturbed Shelby tube samples, obtaining bulk samples of the subgrade materials, and performing DCP tests. During the sample recovery operations the soils encountered were classified and recorded on boring logs in accordance with "*Standard Guide for Field Logging of Subsurface Exploration of Soil and Rock*", (ASTM D5434).

A total of six (6) soil borings were completed at the site to termination depths ranging from 10-feet to 80-feet. The table below provides boring information including boring number, GPS coordinates and boring depth:

TEST BORING INFORMATION		
Boring No.	**GPS Coordinates**	**Boring Depth**
B-1 (Bridge)	N 29° 25.411' W 98° 23.097'	80'
B-2 (Bridge)	N 29° 25.433' W 98° 23.092'	80'
B-3 (Roadway)	N 29° 25.376' W 98° 23.099'	10'
B-4 (Roadway)	N 29° 25.506' W 98° 23.095'	10'
B-5 (Roadway)	N 29° 25.554' W 98° 23.091'	10'
B-6 (Box Culvert)	N 29° 25.605' W 98° 23.088'	25'

RETL determined the location of the soil borings using the site plan provided by Cude Engineers. The drilling operations were performed by a drilling subcontractor to RETL under the supervision of an RETL geo-technician. Upon completion of the drilling operations and obtaining the groundwater observations, the drill holes were backfilled with excavated soil.

During the sample recovery operations, the base materials and subgrade soils encountered were visually classified and recorded on boring logs in accordance with the "*Standard Guide for Filed Logging of Subsurface Exploration Soil and Rock*", (ASTM D5434).

Composite bulk samples of the subgrade soil at boring locations B-3 and B-6 were obtained for moisture/density and California Bearing Ratio (CBR) testing. DCP tests were completed at boring locations B-3, B-4, and B-5 to measure the in-situ CBR of the subgrade soils at those locations.

Drilling and Sampling Procedures

The test borings were performed using a drilling rig equipped with a rotary head turning solid stem flight augers to advance the boreholes to the desired 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). The samples obtained by this procedure were extruded by a hydraulic ram and classified in the field.

All of the soil samples obtained were 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 Test 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.

Dynamic Cone Penetrometer (DCP) Tests - Dynamic Cone Penetrometer (DCP) tests were performed at the project site. The Kessler Dynamic Cone Penetrometer is a device used to estimate the strength characteristics of fine grained soils, granular construction material, and weak stabilized or modified material. The device is driven into the soil by dropping a sliding 17.6-pound or 10.0-pound hammer from a height of 22.6-inches.

The depth of cone penetration is measured at selected penetration or hammer drop intervals and the soil shear strength is reported in terms of DCP index. The DCP index is based on the average penetration depth resulting from one blow of the 17.6-pound or 10.0-pound hammer.

The California Bearing Ratio (CBR) can be estimated using the DCP index. The penetration per blow, or penetration rate (PR), is then used to estimate the in-situ CBR, or shear strength, using the appropriate correlation depending on the soil type. The following correlations were provided by the DCP manufacturer, Kessler Soils Engineering Products, Inc., and have been recommended by the US Army Corps of Engineers:

1. $CBR = 292 / PR^{1.12}$ (All soils except those listed in #2 and #3)
2. $CBR = 1 / (0.017019*PR)^{2}$ (CL soils w/ CBR less than 10)
3. $CBR = 1 / (0.002871*PR)$ (CH Soils)

PR= DCP Penetration Rate, mm per blow

It should be noted that a field DCP measurement results in a field, or in-situ, CBR and will not normally correlate with the laboratory, or soaked, CBR of the same material. The test is thus intended to evaluate the in-situ strength of a material under existing field conditions compared to controlled conditions in a lab.

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 creek, river or lake and recent rainfall conditions may influence the depth to the groundwater.

Ground Surface Elevations - The surface elevations at the boring locations were not provided. Therefore, all depths referred to in this report are from the actual pavement 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 and subsurface soils necessary in developing the pavement and foundation recommendations.

The laboratory-testing program included supplementary visual classification (ASTM D2487) on all samples. In addition, selected samples were subjected to water content tests (ASTM D2216), Atterberg limits tests (ASTM D4318), percent material finer than the #200 sieve tests (ASTM D1140), one-dimensional swell tests (ASTM D4546), moisture density relationship tests (ASTM D698), California Bearing Ratio (CBR) tests (ASTM D1883) and pH tests.

The shear strengths of cohesive soil samples were evaluated from unconfined compressive strength tests (ASTM D2166). Estimated soil strengths were obtained using a hand penetrometer.

Analytical testing for sulfates was performed in accordance with TxDOT Test Method TEX-620-J.

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 subgrade soils encountered in the test borings have been visually classified and are described in detail on the boring logs. The results of the SPT tests, strength tests and laboratory tests are presented on the boring logs in numerical form. Representative samples of the soil 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 three months after issuance of this report.

The stratification of the subgrade soils, as shown on the boring logs, represents the conditions at the actual boring locations. Variations may occur between, or beyond, the boring locations. Lines of demarcation on the boring logs 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 test 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.

Soil Conditions

The subsurface conditions encountered at the bridge abutment and box culvert areas have been summarized and soil properties including classification, strength, plasticity and grain size are provided in the following tables:

BORINGS B-1 AND B-2 (BRIDGE ABUTMENTS)								
D	**Description**	**LL**	**PI**	**C**	**Ø**	**γ_e**	**-#200**	**N or P**
0-4	Fat **CLAY**	56-59	33-35	2,000	0	120	60-75	N= 24-45
4-9	Silty **CLAY**	19	6	3,000	0	120	74-81	N= 50/5”-50/3”
9-63	Lean / Fat **CLAY**	58-73	34-45	4,000	0	120	87-98	N= 57-50/3” P= 4.0-4.5+
63-80	Fat Clay **SHALE**	73-81	46-49	4,500	0	60	96-98	N= 56-50/4” P= 4.5+

BORING B-6 (BOX CULVERT AREA)								
D	**Description**	**LL**	**PI**	**C**	**Ø**	**γ_e**	**-#200**	**N or P**
0-13	Lean / Fat **CLAY**	36-56	21-33	2,500	0	120	56-86	N= 26-58 P= 2.0-4.5+
13-20	Clayey **SAND**	---	---	3,500	0	120	42	N= 34-57
20-25	Fat **CLAY**	65	43	4,000	0	120	94	N=49

Where: D = Depth below existing grade, ft.
LL = Liquid Limit (%)
PI = Plasticity Index
C = Average Soil Cohesion, psf (undrained)
Ø = Angle of Internal Friction, deg. (undrained)
γ_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

The subsurface conditions encountered within the borings located at the pavement areas (B-3, B-4 and B-5) generally consist of interbedded lean and fat clays that extend from the surface to a depth of approximately 10-feet. A 2-foot stratum of silty gravel was encountered at approximately the 6-foot depth in boring B-4. Atterberg limits test results indicate that the lean and fat clay soils are generally moderate to high in plasticity with tested liquid limits ranging from 43 to 70-percent and plasticity indices (PI) ranging from 26 to 43.

Sulfate Test Results

The sulfate test results on representative subgrade samples are provided in the following table:

SULFATE TEST RESULTS		
Boring No.	**Depth (ft)**	**Sulfate (ppm)**
B-3	0-2	121
B-6	0-2	96

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 **low risk** of using lime as a stabilization method.

Swell Test Results

The swell test results on representative samples from the borings are provided in the following table:

SWELL TEST RESULTS		
Boring No.	**Depth (ft)**	**Swell (%)**
B-3	2-4	6.3
B-6	2-4	8.2

The results indicate the clay soils at the site have a **high to very high potential** for swell.

Lime Series and pH Test Results

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

BORING B-3 BULK SUBGRADE SAMPLE LIME SERIES AND pH TEST RESULTS		
% Lime	**LL / PI**	**pH**
0	48 / 26	---
2	33 / 5	11.3
4	32 / 4	11.9
6	32 / 4	12.1

BORING B-6 BULK SUBGRADE SAMPLE LIME SERIES AND pH TEST RESULTS		
% Lime	**LL / PI**	**pH**
0	61 / 42	---
2	40 / 10	11.4
4	40 / 7	11.6
6	39 / 5	11.9

Where: LL = Liquid Limit (%)
PI = Plasticity Index
NP = Non-Plastic

The results indicate that a minimum of 6-percent lime should be used for subgrade treatment.

Groundwater Observations

Groundwater (GW) was encountered in borings B-1, B-2, and B-6 during drilling operations at depths of 70-feet, 38-feet, and 19-feet respectively. Upon completion of the drilling operations, groundwater was measured at depths of 67-feet, 71-feet, and 19-feet in borings B-1, B-2, and B-6, respectively. It should be noted that water levels in open boreholes may require several hours to several days to stabilize depending on the permeability of the soils and that groundwater levels or zones of seepage may be subject to seasonal conditions, recent rainfall, drought or temperature effects.

PAVEMENT RECOMMENDATIONS

Project Description

Based on the information provided to RETL, it is understood that the Peggy Dr. Extension Project route proposed by the City of San Antonio (COSA) will include an extension of a Local Type A (without bus traffic) street that is approximately 1,500 LF in length and will also include box culverts for a crossing over a drainage channel, as well as a bridge structure for a crossing over Rosillo Creek. It is anticipated that the bridge piers at the bent could have loads of up to 200 tons each.

The pavement is to be designed in accordance with the COSA Design Guidance Manual Appendix 10A. The minimum 18-kip Equivalent Single Axle Load (ESAL) value selected for the Local Type A (without bus traffic) pavement design is 100,000.

PVR Discussion

The lean and fat clays soils encountered in the borings at this site are moderate to high in plasticity. **The maximum calculated total potential vertical rise (PVR) for slab on grade and flatwork type construction at this site is in the range of 2 to 3-inches.** The PVR was calculated using the Texas Department of Transportation Method TEX-124E and into account the depth of active zone, estimated to extend to a depth of approximately 15-feet, and the Atterberg limits test results of the soils encountered within the active zone.

The estimated PVR value provided is based on a slab or flatwork system applying a sustained surcharge load of approximately 1.0 pound per square inch on the subgrade soils. The value represents the vertical rise that can be experienced by dry subsoils if they are subjected to conditions that allow them to become saturated, such as poor drainage. Using dry soil conditions to calculate the PVR is generally considered the worst-case scenario. The actual movement of the subsoils is dependent upon their change in moisture content. Differential vertical movements can potentially be equal to the expected total movements. Differential vertical movements associated with the soils at this site may occur over a distance of 15-feet, or approximately the depth of the active zone.

Pavement Design Discussion

In designing the proposed flexible pavement, 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) 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.

Specific laboratory testing to define the subgrade strength was performed for this analysis. Bulk samples of the subgrade soil were obtained from borings B-3 and B-6. The samples were subjected to standard proctor tests and California Bearing Ratio (CBR) tests. The maximum dry density values were 101 and 92 pcf and the optimum moisture contents were 17 and 23-percent, respectively. The tested laboratory CBR values were 9.3 and 4.3. In addition, Dynamic Cone Penetrometer (DCP) tests were performed to measure the in-place CBR values of the subgrade soils. The average CBR values based on the DCP value was 14.

Based on the results of the lab and field CBR testing, Atterberg limits testing, grain size testing, and subgrade soil classifications, the selected design CBR for the natural fat and lean clay subgrade soil at this site is 3. RETL used the following pavement design parameters for the flexible pavement design.

AASHTO FLEXIBLE PAVEMENT DESIGN PARAMETER (LOCAL TYPE A WITHOUT BUS)	COSA VALUE
Reliability (R)	70%
Overall Deviation	0.45
Initial / Terminal Serviceability	4.2 / 2.0
Subgrade Design CBR	3
Subgrade Resilient Modulus (Mr)	4,500
Design Life	20 years

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

PAVEMENT CONSTITUENT	COSA 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 American Association of State Highway and Transportation Officials, *"GUIDE FOR DESIGN OF PAVEMENT STRUCTURES"* and Tensar International Corporation program SpectrPave4 Pro. The results are provided in the following table:

LOCAL TYPE A STREET WITHOUT BUS TRAFFIC COSA MINIMUM 18-kip ESAL = 100,000 AASHTO STRUCTURAL NUMBER RANGE = 2.02 TO 3.18			
Pavement Constituent	Option No. 1	Option No. 2	Option No. 3
HMAC Type C or D	2"	2"	1.5"
HMAC Type B	---	---	4"
Crushed Limestone Base Material	9"	7"	---
Lime Treated Subgrade	6"	---	6"
TENSAR Geogrid	---	TX-5	---
AASHTO Structural Number (SN)	2.620	2.686	2.660
Calculated 18-kip ESAL	141,000	165,000	155,000

All TxDOT specifications are reference from the Texas Department of Transportation, *"STANDARD SPECIFICATIONS FOR CONSTRUCTION OF HIGHWAYS, STREETS AND BRIDGES".*

Subgrade – 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 new crushed limestone base material.

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 a standard Proctor test (ASTM D698) and at or above the optimum moisture content prior to lime treatment or placing the geogrid materials.

Lime Treatment - 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 the standard Proctor (ASTM D698). 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 a standard Proctor test (ASTM D698) and at, or above, the optimum moisture content.

Geogrid – Tensar TX-5 Geogrid should be used on top of the compacted subgrade and below the base section. The geogrid should be installed and overlapped a minimum of 12-inches in accordance with the manufacturer's recommendations. In addition, the geogrid should extend a minimum distance of 12-inches beyond the back of the curb. Alternate geogrid materials will not be considered unless a complete pavement design analysis is submitted which is sealed by a professional engineer.

Flexible Base Material – New flexible base materials should meet the minimum physical requirements set forth in the Texas Department of Transportation (TxDOT) 2004 Standard Specifications for Construction of Highways, Streets and Bridges; Item 247, Type A, Grade 2. The base material should be placed in maximum 8-inch thick loose lifts and compacted to a minimum density of 95-percent of the maximum dry density as determined by the modified Proctor test (ASTM D1557) and within 2-percent of the optimum moisture content. The base should extend a minimum distance of 12-inches beyond the back of the curb.

Hot Mix Asphaltic Concrete – Surface course asphalt concrete should meet the requirements set forth in TxDOT Item 340 or 341; Type C or D. Base course mix asphaltic concrete should meet the requirements set forth in TxDOT Item 340; Type B. The asphaltic concrete should be compacted to 92 to 96-percent of the maximum theoretical specific gravity of the mixture determined according to test method TEX 227-F. Pavement cores should be tested for density according to test method TEX 207-F.

Bridge Foundation Recommendations

The structural designer can utilize the deep foundation design values and L-Pile design parameters included in the following table to resist the axial and lateral loads given the average strengths of the subsurface soils encountered:

BORINGS B-1 AND B-2 (BRIDGE ABUTMENTS)							
D	**Description**	**C**	**Ø**	**γ_e**	**K**	**E_{50}**	**Fa**
0-4	Fat **CLAY**	2,000	0	120	500	0.007	---
4-9	Silty **CLAY**	3,000	0	120	500	0.007	825
9-63	Lean / Fat **CLAY**	4,000	0	120	1,000	0.005	1,100
63-80	Fat Clay **SHALE**	4,500	0	120	2,000	0.004	1,250

Where: D = Depth below existing grade, ft.
C = Soil Cohesion, psf (undrained)
Ø = Angle of Internal Friction, deg. (undrained)
γ_e = Effective Soil Unit Weight, pcf
K = Modulus of Subgrade Reaction (pci) (static)
E_{50} = 50% Strain Value
Fa = Allowable Skin Friction (psf)

E_{50} values were estimated from known correlations.

The allowable unit skin friction values provided above are based on the average strengths of the in-situ soils and utilize a safety factor of 2 to prevent shear failure. The upper five feet of soil and all fill soils should be neglected when calculating allowable capacities. An allowable end bearing value to 12 ksf (SF=3.0) may be used for piers founded deeper than 20-feet. Resistance to uplift can be calculated by taking 60-percent of the axial capacity of a deep foundation. Deep foundations should be spaced no closer than three diameters apart measured center to center.

Straight shaft drilled piers at this site should be adequately reinforced with a minimum of 1-percent of the cross-sectional area of the pier shaft throughout the depth of the pier to withstand uplift forces.

Straight shaft drilled piers excavated in the natural soils and designed using the design parameters provided, should experience settlements of less than 1-inch. Down-drag or negative skin friction is not a design consideration at the bridge site.

Based on observations made in the field, temporary steel casing or slurry may be required to successfully install straight shaft drilled piers at this site. A unit price for temporary steel casing on a cost per linear foot should be included in the bid documents. Pier excavations should not be allowed to stay open overnight.

CONSTRUCTION CONSIDERATIONS

Concrete Flatwork

Concrete flatwork at the site such as sidewalks and approaches will be subject to PVR movements when constructed over highly plastic fat clay soils. The PVR estimate for this site is in the range of 2 to 3-inches. Changes in the moisture content of the supporting highly plastic soils causes volumetric changes, resulting in differential movements of the flatwork. PVR movements were discussed in the “PVR Discussion” section of this report.

Traditional methods to minimize movements include undercutting the highly plastic clay soils and replacing them with properly compacted non-expansive select fill soils to achieve tolerable movements. The cost/benefit ratio of this method to minimize PVR and differential movements are generally not considered cost effective for use on concrete flatwork, but some reduction in PVR may be warranted if the budget will allow.

If it is desired to increase the performance level and reduce the PVR for concrete flatwork, the fat clay soils should not be used to backfill behind the curb and below the flatwork. RETL recommends placing select fill soils to backfill the void behind the curb and extending the select fill to the outside edge of the flatwork. An additional measure to reduce moisture migration in a vertical direction could include extending the geogrid/ lime treatment and base section to the outside edge of the flatwork and to apply an asphalt seal coat to the surface of the base as a moisture barrier.

Select Fill

Imported select fill material used at this site should have a maximum liquid limit of 40-percent and a plasticity index (PI) between 5 and 20. The select fill should be placed in no greater than 8-inch thick loose lifts and shall be compacted to a minimum density of 95-percent of the maximum dry density as determined by the standard Proctor (ASTM D698) and within 3-percent of the optimum moisture content.

Excavations and Slopes

The soil parameters provided in the tables below may be used for the design of braced excavations or below grade walls. The trench protection should be designed to provide the most conservative design.

EXCAVATION DESIGN PARAMETERS BORINGS B-1 AND B-2 (BRIDGE ABUTMENTS)							
D	**Description**	**C**	**Ø**	**C'**	**Ø'**	**Ka**	**Kp**
0-4	Fat **CLAY**	2,000	0	520	25	0.41	2.46
4-9	Silty **CLAY**	3,000	0	520	27	0.38	2.66
9-25	Lean / Fat **CLAY**	4,000	0	520	30	0.33	3.0

EXCAVATION DESIGN PARAMETERS BORING B-6 (BOX CULVERT AREA)							
D	**Description**	**C**	**Ø**	**C'**	**Ø'**	**Ka**	**Kp**
0-13	Lean / Fat **CLAY**	2,500	0	520	27	0.38	2.66
13-20	Clayey **SAND**	3,500	0	520	27	0.38	2.66
20-25	Fat **CLAY**	4,000	0	520	30	0.33	3.0

Where: D = Depth below existing grade (ft)
C= Undrained Shear Strength (psf)
Ø = Undrained Angle of Internal Friction (degrees)
C'= Drained Shear Strength (psf)
θ'= Drained Angle of Internal Friction (degrees)
K_a= Active Earth Pressure Coefficient
K_p= Passive Earth Pressure Coefficient

It should be noted that the values provided in the table above are based on the average soil strengths and soil densities encountered in the field. Empirical formulas were used to correlate undrained shear strengths to drained shear strengths and the corresponding angle of internal friction for clay soils.

The active and passive earth pressure coefficients for the clay soils encountered were calculated using the drained angle of internal friction as recommended in "*FOUNDATION ANALYSIS AND DESIGN*", written by Mr. Joseph Bowles where he states, "Drained soil parameters for stiff clays and Ø-C soils in general may be appropriate for lateral pressures behind braced walls where the excavation is open for a considerable length of time".

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.

Long term side slopes for the drainage channel should be constructed at a 3H:1V slope or flatter. Slopes should be protected from erosion with soil retention blankets until vegetation can be established.

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 and structures 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 base materials and select fill. Compaction testing should be performed in accordance with the City of San Antonio 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 design of 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 base 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 excavated 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 pavements and foundations 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

September 20, 2013
Cude Engineers
RETL Project No.: G213223

PEGGY DRIVE EXTENSION PROJECT
COSA Proposed Route
San Antonio, Texas

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

LOG OF BORING 01

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

CLIENT: Cude Engineers
PROJECT: Peggy Dr. Extension Project
LOCATION: COSA Proposed Route - San Antonio, TX.
NUMBER: G213223
DATE(S) DRILLED: 08/20/2013 - 08/20/2013

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater was encountered at 70-feet during drilling. GW measured 67-feet upon the completion of the drilling.

SURFACE ELEVATION: N/A

FIELD DATA					LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		SPT S-1	X	N= 29	8						60	**GRAVELLY FAT CLAY**, dark gray, dry, very stiff.
		SPT S-2	X	N= 38	13	59	24	35			75	**FAT CLAY**, with gravel, dark gray, slightly moist, hard. (CH)
	5	SPT S-3	X	N= 30-50/4"	7							**SILTY CLAY**, with sand and abundant calcareous material, white, dry, very hard.
		SPT S-4	X	N= 50/4"	9							Same as above.
		SPT S-5	X	N= 33-50/5"	10	40	16	24			87	**LEAN CLAY**, black, slightly moist, very hard. (CL)
	10											
	15	SPT S-6	X	N= 50/5"	10							**SANDY LEAN CLAY**, with gravel and calcareous material, grayish-tan, slightly moist, very hard.
	20	SPT S-7	X	N= 57	9							**FAT CLAY**, with calcareous material, grayish-brown, dry, hard.
	25	SPT S-8	X	N= 29-50/5"	16	58	24	34			87	Same as above, slightly moist, very hard. (CH)
	30	SPT S-9	X	N= 29-50/5"	19							Same as above, sans calcareous, light brown.
	35	SPT S-10	X	N= 54	21						98	**FAT CLAY**, light brown, with gray seams, moist, hard.
	40	SPT S-11	X	P= 4.5+	23				101	3.0		Same as above, slightly slickensided, very stiff.
	45	SPT S-12	X	N= 33-50/3"	20	67	28	39			90	Same as above, brown, slightly moist, very hard. (CH)
	50	SPT S-13	X	N= 67	23							**FAT CLAY SHALE** grayish-brown, moist, hard.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by a drilling subcontractor to RETL.
GPS Coordinates: N 29° 25.411', W 98° 23.097'

LOG OF BORING 01

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

CLIENT: Cude Engineers
PROJECT: Peggy Dr. Extension Project
LOCATION: COSA Proposed Route - San Antonio, TX.
NUMBER: G213223
DATE(S) DRILLED: 08/20/2013 - 08/20/2013

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater was encountered at 70-feet during drilling. GW measured 67-feet upon the completion of the drilling.

FIELD DATA					LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT T: TONS/SQ.FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ.FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	55	SPT S-14	X	N= 54	19							Same as above, slightly moist.
	60	SPT S-15	X	N= 56	24	69	28	41			98	Same as above, moist. (CH)
	65	SPT S-16	X	N= 40-50/5"	21							**FAT CLAY SHALE** dark gray, slightly moist, very hard.
	70	SPT S-17	X	N= 34-50/4"	21							Same as above.
	75	SPT S-18	X	N= 23-50/4"	24	81	32	49			96	Same as above. (CH)
	80	SPT S-19	X	N= 50/4"	23							**FAT CLAY SHALE** dark gray, slightly moist, very hard.
												Boring terminated at a depth of 80-feet.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by a drilling subcontractor to RETL.
GPS Coordinates: N 29° 25.411', W 98° 23.097'

LOG OF BORING 02

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

CLIENT: Cude Engineers
PROJECT: Peggy Dr. Extension Project
LOCATION: COSA Proposed Route - San Antonio, TX.
NUMBER: G213223
DATE(S) DRILLED: 08/21/2013 - 08/21/2013

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater was encountered at 38-feet during drilling. GW measured 71-feet upon the completion of the drilling.

SURFACE ELEVATION: N/A

FIELD DATA					LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		SPT S-1	X	N= 24	12	56	23	33			73	**FAT CLAY**, with sand, dark brown, slightly moist, very stiff. (CH)
		SPT S-2	X	N= 45	14							Same as above, hard.
	5	SPT S-3	X	N= 30-50/5"	5						81	**SILTY CLAY**, with sand and abundant calcareous material, white, dry, very hard.
		SPT S-4	X	N= 50/3"	9	19	13	6			74	Same as above, slightly moist. (CL-ML)
		SPT S-5	X	N= 50/3"	10							Same as above.
	10											
	15	SPT S-6	X	N= 35-50/4"	11							**SANDY LEAN CLAY**, with calcareous material, light brown, slightly moist, very hard.
	20	SPT S-7	X	P= 4.0	22	73	28	45	105	3.6	87	**FAT CLAY**, brown with gray seams, slightly moist, very stiff. (CH)
	25	SPT S-8	X	P= 4.5+	22							Same as above, very hard.
	30	SPT S-9	X	P= 4.5+	22							Same as above.
	35	SPT S-10	X	P= 4.5+	24	70	28	42	102	1.4	96	**FAT CLAY**, slickensided, brown, with gray seams, moist, hard. (CH)
	40	SPT S-11	X	P= 4.5+	23							Same as above.
	45	SPT S-12	X	P= 4.5+	21				104	2.1	95	Same as above, slightly slickensided, slightly moist.
	50	SPT S-13	X	P= 4.5+	22	59	22	37			91	**FAT CLAY**, brownish-gray, moist, hard. (CH)

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by a drilling subcontractor to RETL.
GPS Coordinates: N 29° 25.433', W 98° 23.092'

LOG OF BORING 02

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

CLIENT: Cude Engineers
PROJECT: Peggy Dr. Extension Project
LOCATION: COSA Proposed Route - San Antonio, TX.
NUMBER: G213223
DATE(S) DRILLED: 08/21/2013 - 08/21/2013

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater was encountered at 38-feet during drilling. GW measured 71-feet upon the completion of the drilling.

FIELD DATA					LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	55	SPT S-14		P= 4.5+	22							Same as above.
	60	SPT S-15		P= 4.5+	23				102	5.6		Same as above.
	65	SPT S-16		P= 4.5+	21	73	27	46			98	**FAT CLAY SHALE** dark gray, slightly moist, hard. (CH)
	70	SPT S-17		N= 48-50/5"	23							Same as above, moist, very hard.
	75	SPT S-18		N= 37-50/5"	24							Same as above.
	80	SPT S-19		N= 56	27	80	31	49			96	**FAT CLAY SHALE** dark gray, moist, hard. (CH)

Boring terminated at a depth of 80-feet.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by a drilling subcontractor to RETL.
GPS Coordinates: N 29° 25.433', W 98° 23.092'

LOG OF BORING 03

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

CLIENT: Cude Engineers
PROJECT: Peggy Dr. Extension Project
LOCATION: COSA Proposed Route - San Antonio, TX.
NUMBER: G213223
DATE(S) DRILLED: 08/20/2013 - 08/20/2013

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling, nor measured upon the completion of the drilling.

SURFACE ELEVATION: N/A

FIELD DATA					LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ.FT T: TONS/SQ.FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ.FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1	SPT S-1		N= 20	19	48	19	29			75	**LEAN CLAY FILL**, with sand, dark brown, moist, very stiff. (CL)
	2											
	3	SPT S-2		P= 4.5+	18	57	26	31	107	8.7	82	**FAT CLAY**, black, slightly moist, very stiff. (CH) (swell= 6.3%, final moisture= 20%)
	4											
	5	SPT S-3		P= 4.5+	13						60	**GRAVELLY FAT CLAY**, with calcareous material, brown, slightly moist, very stiff.
	6											
	7	SPT S-4		N= 45	11	49	18	31			57	**SANDY LEAN CLAY**, with calcareous material, reddish-brown, slightly moist, hard. (CL)
	8											
	9	SPT S-5		N= 33-50/5"	10							Same as above, grayish-tan, very hard.
	10											Boring terminated at a depth of 10-feet.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by a drilling subcontractor to RETL.
GPS Coordinates: N 29° 25.376', W 98° 23.099'

LOG OF BORING 04

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

CLIENT: Cude Engineers
PROJECT: Peggy Dr. Extension Project
LOCATION: COSA Proposed Route - San Antonio, TX.
NUMBER: G213223
DATE(S) DRILLED: 08/20/2013 - 08/20/2013

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling, nor measured upon the completion of the drilling.

SURFACE ELEVATION: N/A

FIELD DATA					LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1	SPT S-1		N= 22	10	43	17	26			76	**LEAN CLAY**, with sand, dark brown, slightly moist, very stiff. (CL)
	2											
	3	SPT S-2		N= 40	13	46	18	28			75	Same as above, hard. (CL)
	4											
	5	SPT S-3		N= 18	12							Same as above, with gravel and calcareous material, very stiff.
	6											
	7	SPT S-4		N= 50/5"	6						26	**SILTY GRAVEL**, light tan, dry, very dense.
	8											
	9	SPT S-5		N= 50/4"	7						66	**SANDY LEAN CLAY**, tan, dry, very hard.
	10											Boring terminated at a depth of 10-feet.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by a drilling subcontractor to RETL.
GPS Coordinates: N 29° 25.506', W 98° 23.095'

LOG OF BORING 05

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

CLIENT: Cude Engineers
PROJECT: Peggy Dr. Extension Project
LOCATION: COSA Proposed Route - San Antonio, TX.
NUMBER: G213223
DATE(S) DRILLED: 08/20/2013 - 08/20/2013

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling, nor measured upon the completion of the drilling.

SURFACE ELEVATION: N/A

FIELD DATA					LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS 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
	1	SPT S-1		N= 17	15	64	23	41			82	**FAT CLAY**, with sand, dark brown, slightly moist, very stiff. (CH)
	2											
	3	SPT S-2		N= 22	19	70	27	43			88	**FAT CLAY**, dark brown, slightly moist, very stiff. (CH)
	4											
	5	SPT S-3		N= 27	15						85	Same as above, with calcareous material, brown.
	6											
	7	SPT S-4		N= 27	14	43	16	27			78	**LEAN CLAY**, with sand and calcareous material, light brown, moist, very stiff. (CL)
	8											
	9	SPT S-5		N= 60	10							Same as above, slightly moist, hard.
	10											Boring terminated at a depth of 10-feet.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by a drilling subcontractor to RETL.
GPS Coordinates: N 29° 25.554', W 98° 23.091'

LOG OF BORING 06

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

CLIENT: Cude Engineers
PROJECT: Peggy Dr. Extension Project
LOCATION: COSA Proposed Route - San Antonio, TX.
NUMBER: G213223
DATE(S) DRILLED: 08/21/2013 - 08/21/2013

DRILLING METHOD(S):
Solid Stem Auger

GROUNDWATER INFORMATION:
Groundwater was encountered at 19-feet during drilling. GW measured 18-feet upon the completion of the drilling.

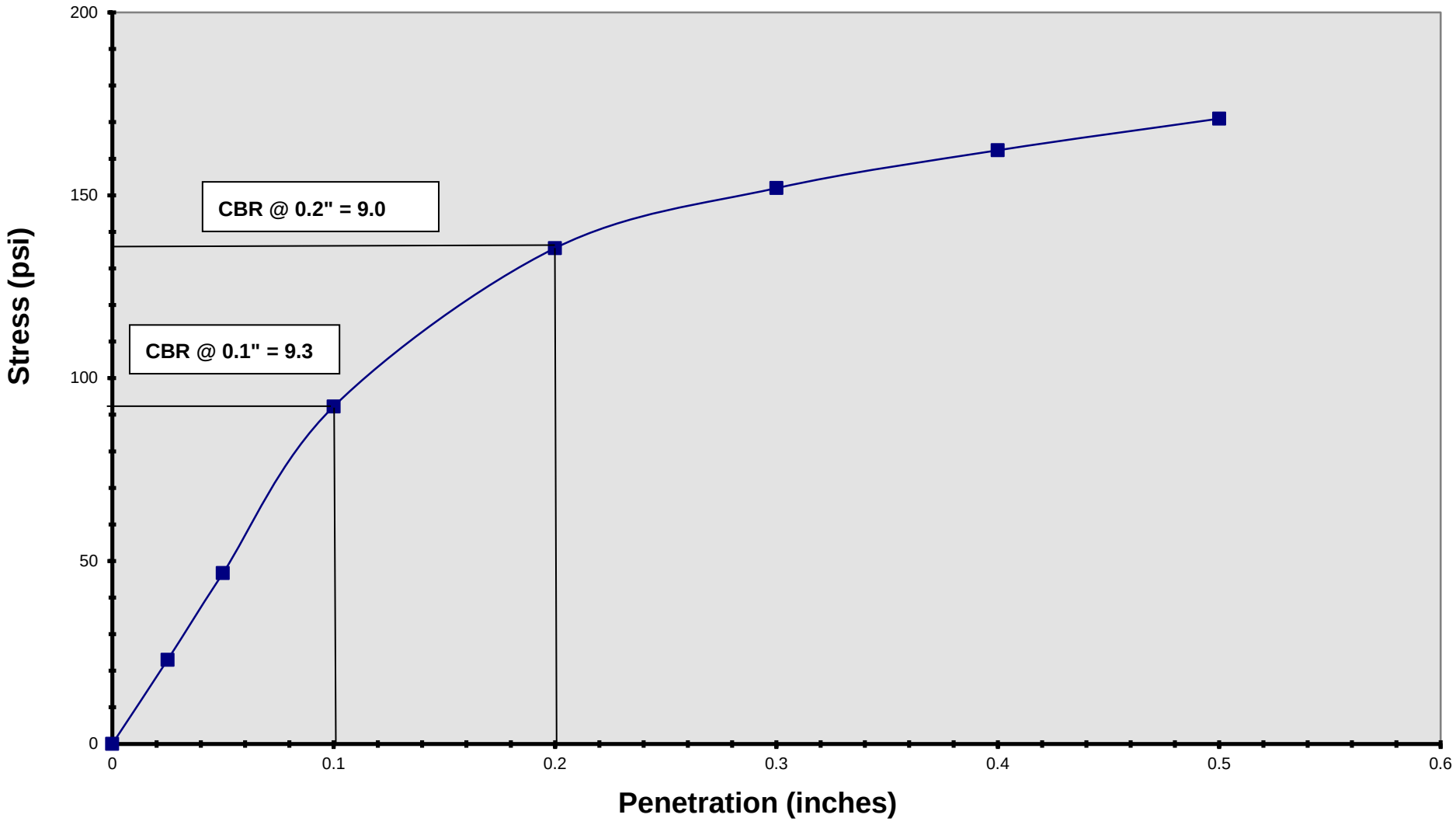
SURFACE ELEVATION: N/A

FIELD DATA					LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	ATTERBERG LIMITS: PLASTIC LIMIT PL	ATTERBERG LIMITS: PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		SPT S-1		N= 28	12	56	23	33			79	**FAT CLAY**, with sand, black, slightly moist, very stiff. (CH)
		SPT S-2		P= 4.5+	17				103	3.9	84	Same as above. (swell= 8.2%, final moisture= 31%)
	5	SPT S-3		P= 2.0	9						56	**SANDY LEAN CLAY**, light tan, dry, stiff.
		SPT S-4		N= 58	12	36	15	21			86	**LEAN CLAY**, light tan, moist, hard. (CL)
	10	SPT S-5		N= 26	15	50	22	28			57	**SANDY FAT CLAY**, light tan, slightly moist, very stiff. (CH)
	15	SPT S-6		N= 34	12							**CLAYEY SAND**, tan, slightly moist, hard.
	20	SPT S-7		N= 57	17						42	Same as above, moist.
	25	SPT S-8		N= 49	18	65	22	43			94	**FAT CLAY**, brown, moist, hard. (CH)
												Boring terminated at a depth of 25-feet.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by a drilling subcontractor to RETL.
GPS Coordinates: N 29° 25.605', W 98° 23.088'

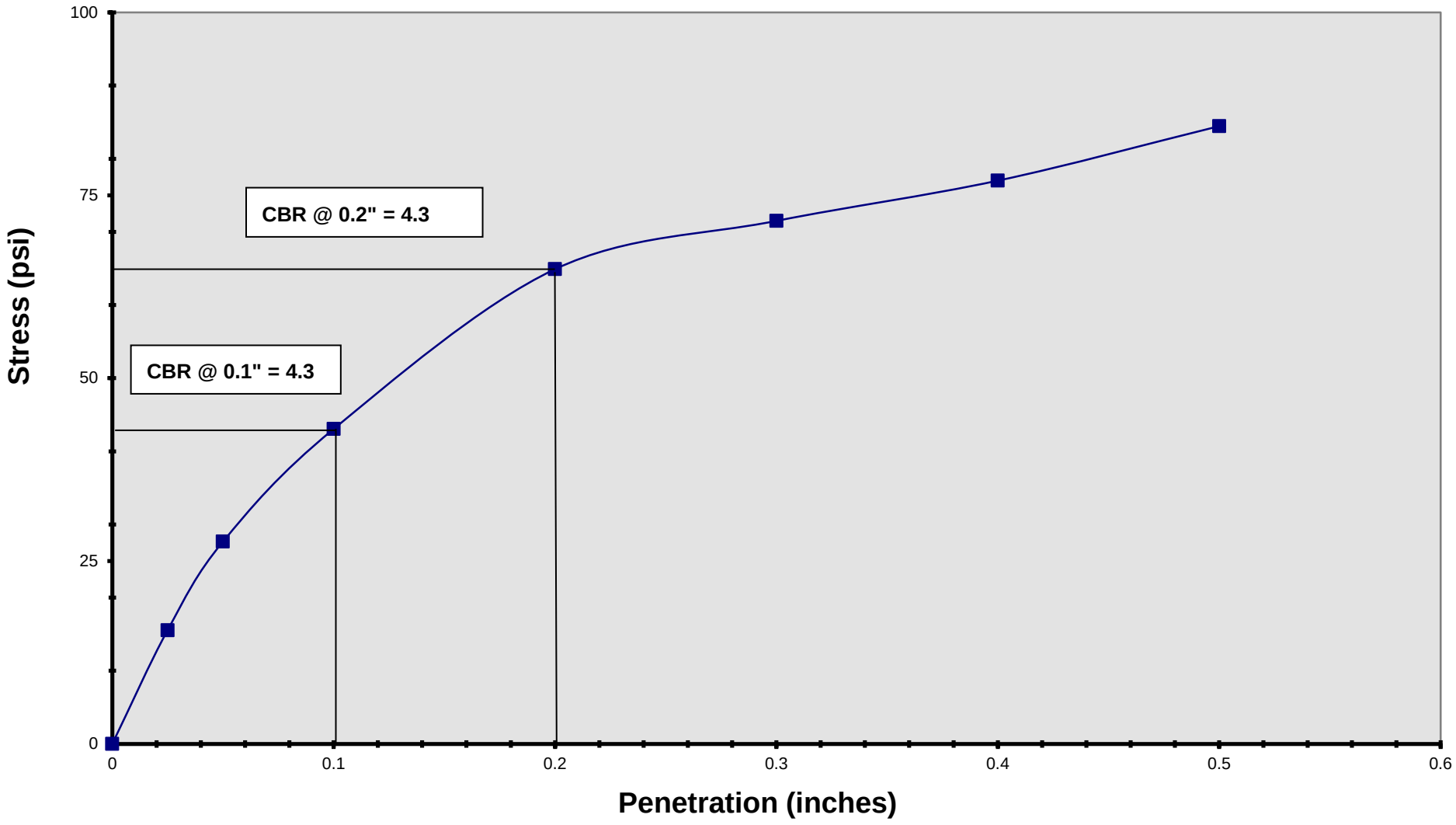
CBR - Stress versus Penetration Curve



PROJECT DESCRIPTION	MOLDED DRY DENSITY	CBR @ 0.1 INCH PENETRATION	TEST DATE
Peggy Dr. Extension San Antonio, Bexar County, Texas	101.4 pcf (100.4 % of max density)	9.30	September 2013
SAMPLE DESCRIPTION	MOLDED MOISTURE CONTENT	CBR @ 0.2 INCHES PENETRATION	RETL PROJ. NO.
Subgrade Bulk Sample B-3 Sandy Lean Clay (CL)	14.2%	9.00	G213223

ROCK ENGINEERING AND TESTING LABORATORY, INC.

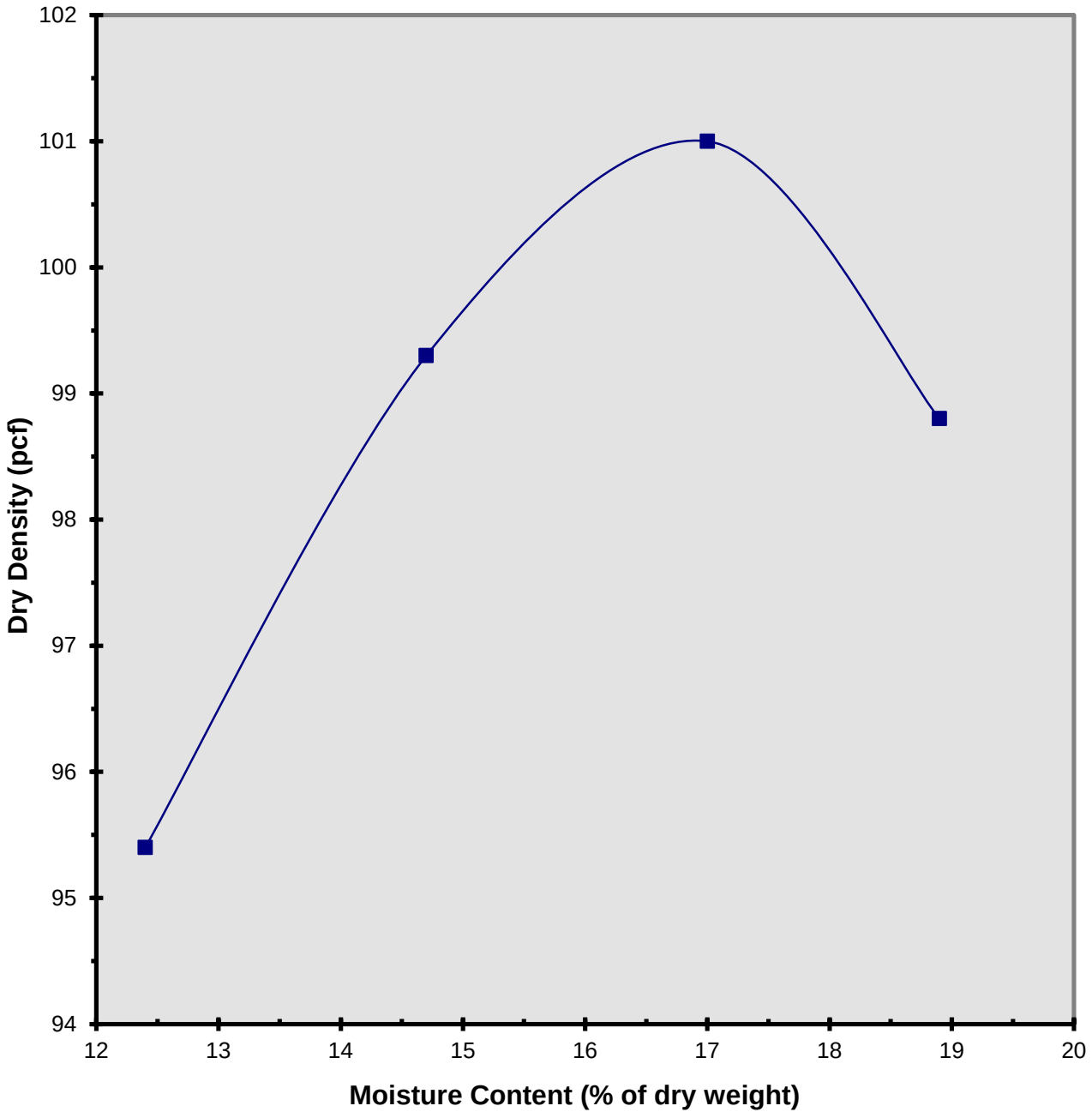
CBR - Stress versus Penetration Curve



PROJECT DESCRIPTION	MOLDED DRY DENSITY	CBR @ 0.1 INCH PENETRATION	TEST DATE
Peggy Dr. Extension San Antonio, Bexar County, Texas	90.1 pcf (97.9 % of max density)	4.30	September 2013
SAMPLE DESCRIPTION	MOLDED MOISTURE CONTENT	CBR @ 0.2 INCHES PENETRATION	RETL PROJ. NO.
Subgrade Bulk Sample B-6 Fat Clay, with sand (CH)	18.4%	4.30	G213223

ROCK ENGINEERING AND TESTING LABORATORY, INC.

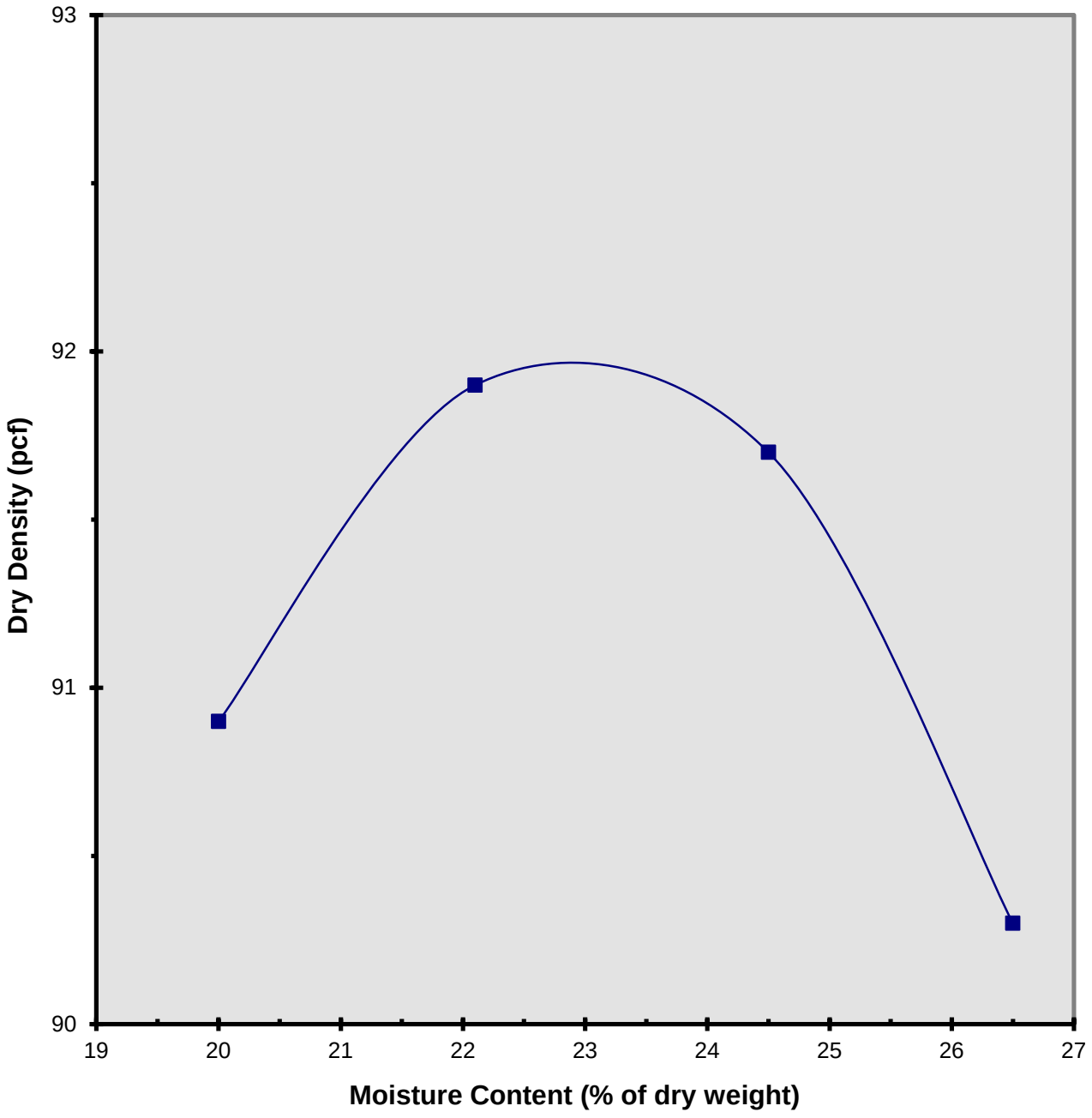
DENSITY VERSUS MOISTURE CURVE



PROJECT DESCRIPTION	MAXIMUM LAB DENSITY	TEST DATE
Peggy Dr. Extension Project San Antonio, Texas	101.0 pcf ASTM D698A	August 2013
SAMPLE DESCRIPTION	**OPTIMUM MOISTURE**	**RETL PROJ. NO.**
Subgrade Bulk Sample Boring B-3 Sandy Lean Clay (CL)	17.0%	G213223

ROCK ENGINEERING AND TESTING LABORATORY, INC.

DENSITY VERSUS MOISTURE CURVE



PROJECT DESCRIPTION	MAXIMUM LAB DENSITY	TEST DATE
Peggy Dr. Extension Project San Antonio, Texas	92.0 pcf ASTM D698A	August 2013
SAMPLE DESCRIPTION	**OPTIMUM MOISTURE**	**RETL PROJ. NO.**
Subgrade Bulk Sample Boring B-6 Fat Clay, with sand (CH)	23.0%	G213223

ROCK ENGINEERING AND TESTING LABORATORY, INC.

Project: Peggy Dr. Extension Project (RETL Project No. G213223)
Location: B-3

Date: 8/22/2013
Personnel: LV/GW
Hammer Wt.: 17.6 lbs.
Weather: Clear
Water Table: Approximately the 38-foot depth or deeper

Depth of Zero Point Below Surface: 6-inches
Material Classification: Lean clay, with sand (CL)
Starting Heighth (mm): 346
Starting Heighth (in): 13.6
Number of Blows: 16

Blow # (N)	Gauge Reading (mm)	Penetration (mm)	Cummulative Penetration (mm)	Penetration (in)	Cummulative Penetration (in)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Ultimate Bearing Capacity (psf)
0	346	0	0	0	0				
1	393	47	47	1.85	1.85	1	47	3.91	1351.97
2	435	42	89	1.65	3.50	1	42	4.44	1469.93
3	475	40	129	1.57	5.08	1	40	4.69	1524.24
4	513	38	167	1.50	6.57	1	38	4.97	1583.51
5	547	34	201	1.34	7.91	1	34	5.63	1720.06
6	580	33	234	1.30	9.21	1	33	5.82	1758.67
7	620	40	274	1.57	10.79	1	40	4.69	1524.24
8	657	37	311	1.46	12.24	1	37	5.12	1615.23
9	703	46	357	1.81	14.06	1	46	4.01	1373.77
10	748	45	402	1.77	15.83	1	45	4.11	1396.41
11	794	46	448	1.81	17.64	1	46	4.01	1373.77
12	839	45	493	1.77	19.41	1	45	4.11	1396.41
13	881	42	535	1.65	21.06	1	42	4.44	1469.93
14	926	45	580	1.77	22.83	1	45	4.11	1396.41
15	955	29	609	1.14	23.98	1	29	6.72	1936.06

Average CBR (%)	Average Bearing Capacity (psf)
4.42	1430.66

Project: Peggy Dr. Extension Project (RETL Project No. G213223)
Location: B-4

Date: 8/22/2013
Personnel: LV/GW
Hammer Wt.: 10.0 lbs.
Weather: Clear
Water Table: Approximately the 38-foot depth or deeper

Depth of Zero Point Below Surface: 10-inches
Material Classification: Lean clay, with sand (CL)
Starting Heighth (mm): 295
Starting Heighth (in): 11.6
Number of Blows: 20

Blow # (N)	Gauge Reading (mm)	Penetration (mm)	Cummulative Penetration (mm)	Penetration (in)	Cummulative Penetration (in)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Ultimate Bearing Capacity (psf)
0	295	0	0	0	0				
1	303	8	8	0.32	0.32	2	16	12.80	2969.35
2	305	3	11	0.10	0.42	2	5	47.20	7062.56
3	310	5	16	0.20	0.62	2	10	21.72	4217.86
4	313	3	18	0.10	0.72	2	5	47.20	7062.56
5	318	5	23	0.20	0.92	2	10	21.72	4217.86
6	323	5	29	0.20	1.12	2	10	21.72	4217.86
7	331	8	36	0.30	1.42	2	15	13.79	3119.87
8	336	5	41	0.20	1.62	2	10	21.72	4217.86
9	341	5	46	0.20	1.82	2	10	21.72	4217.86
10	344	3	49	0.10	1.92	2	5	47.20	7062.56
11	349	5	54	0.20	2.12	2	10	21.72	4217.86
12	354	5	59	0.20	2.32	2	10	21.72	4217.86
13	359	5	64	0.20	2.53	2	10	21.72	4217.86
14	364	5	69	0.20	2.73	2	10	21.72	4217.86
15	369	5	74	0.20	2.93	2	10	21.72	4217.86
16	374	5	79	0.20	3.13	2	10	21.72	4217.86
17	379	5	84	0.20	3.33	2	10	21.72	4217.86
18	384	5	90	0.20	3.53	2	10	21.72	4217.86
19	389	5	95	0.20	3.73	2	10	21.72	4217.86
20	394	5	100	0.20	3.93	2	10	21.72	4217.86

Average CBR (%)	Average Bearing Capacity (psf)
24.70	4527.24

Project: Peggy Dr. Extension Project (RETL Project No. G213223)
Location: B-5

Date: 8/22/2013
Personnel: LV/GW
Hammer Wt.: 10.0 lbs.
Weather: Clear
Water Table: Approximately the 38-foot depth or deeper

Depth of Zero Point Below Surface: 10-inches
Material Classification: Fat clay, with sand (CH)
Starting Heighth (mm): 312
Starting Heighth (in): 12.3
Number of Blows: 20

Blow # (N)	Gauge Reading (mm)	Penetration (mm)	Cummulative Penetration (mm)	Penetration (in)	Cummulative Penetration (in)	Hammer Factor	DCP Index (mm/blow)	CBR (%)	Ultimate Bearing Capacity (psf)
0	312	0	0	0	0				
1	326	13	13	0.52	0.52	2	27	7.42	2066.93
2	336	10	23	0.40	0.92	2	20	9.99	2518.96
3	344	8	31	0.30	1.22	2	15	13.79	3119.87
4	351	8	39	0.30	1.52	2	15	13.79	3119.87
5	359	8	46	0.30	1.83	2	15	13.79	3119.87
6	366	8	54	0.30	2.13	2	15	13.79	3119.87
7	377	10	64	0.40	2.53	2	20	9.99	2518.96
8	384	8	72	0.30	2.83	2	15	13.79	3119.87
9	397	13	85	0.50	3.33	2	25	7.78	2133.79
10	412	15	100	0.60	3.93	2	31	6.34	1863.23
11	425	13	113	0.50	4.43	2	25	7.78	2133.79
12	435	10	123	0.40	4.83	2	20	9.99	2518.96
13	448	13	135	0.50	5.33	2	25	7.78	2133.79
14	453	5	141	0.20	5.53	2	10	21.72	4217.86
15	463	10	151	0.40	5.93	2	20	9.99	2518.96
16	468	5	156	0.20	6.13	2	10	21.72	4217.86
17	476	8	163	0.30	6.43	2	15	13.79	3119.87
18	481	5	168	0.20	6.63	2	10	21.72	4217.86
19	489	8	176	0.30	6.93	2	15	13.79	3119.87
20	494	5	181	0.20	7.13	2	10	21.72	4217.86

Average CBR (%)	Average Bearing Capacity (psf)
13.02	2955.89

CLIENT: Rock Engineering & Testing Laboratory, I
Lab Order: 1308184
Project: G213223 Peggy Dr

Alamo Lab ID	Client ID	Collection Date	Analyses	Matrix	Result	Rpt Limit	Units	DF
TestName: TEX-620-J		**TestNo:** TX620J	**Date Analyzed** 9/5/2013 11:00:00 AM			Initials: SS		
1308184-01A	B3 0-2'	8/20/2013 12:00:00 PM	Sulfate	Solid	121	50	mg/Kg	10
1308184-02A	B6 0-2'	8/20/2013 12:00:00 PM	Sulfate	Solid	96.3	50	mg/Kg	10

Approved by: bsreddy

Report of Laboratory Analysis

Note: The analysis contained in this report applies only to the samples tested and for the exclusive use of the addressed client. Reproduction of this report wholly or in part requires written permission of the client.

CLIENT: Rock Engineering & Testing Laboratory, I **Project:** G213223 Peggy Drive
Lab Order: 1309091

Alamo Lab ID	Client ID	Collection Date	Analyses	Matrix	Result	Rpt Limit	Units	DF
TestName: CORROSIVITY by pH		**TestNo:** SW9045B	**Date Analyzed** 9/19/2013 10:00:00 AM			Initials: SS		
1309091-01A	B-3 2%	8/21/2013 12:00:00 PM	pH at 25 o C	Solid	11.30	1	pH Units	1
1309091-02A	B-3 4%	8/21/2013 12:00:00 PM	pH at 25 o C	Solid	11.90	1	pH Units	1
1309091-03A	B-3 6%	8/21/2013 12:00:00 PM	pH at 25 o C	Solid	12.10	1	pH Units	1
1309091-04A	B-6 2%	8/21/2013 12:00:00 PM	pH at 25 o C	Solid	11.40	1	pH Units	1
1309091-05A	B-6 4%	8/21/2013 12:00:00 PM	pH at 25 o C	Solid	11.60	1	pH Units	1
1309091-06A	B-6 6%	8/21/2013 12:00:00 PM	pH at 25 o C	Solid	11.90	1	pH Units	1

Approved by: bsoedly

Report of Laboratory Analysis

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Engineering & Testing
Laboratory, Inc.

6817 Leopard Street
Corpus Christi, Texas 78409
Office: (361) 883-4555 Fax: (361) 883-4711

KEY TO SOIL CLASSIFICATIONS AND SYMBOLS

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions		Letter	Symbol: Hatching	Symbol: Color	NAME
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW		RED	Well – graded gravels or gravel – sand mixtures, little or no fines
		GP			Poorly-graded gravels or gravel – sand mixtures, little or no fines
		GM		YELLOW	Silty gravels, gravel – sand – silt mixtures
		GC			Clayey gravels, gravel - sand – clay mixtures
	SAND AND SANDY SOILS	SW		RED	Well - graded sands or gravelly sands, little or no fines
		SP			Poorly – graded sands or gravelly sands, little or no fines
		SM		YELLOW	Silty sands, sand – silt mixtures
		SC			Clayey sands, sand – clay mixtures
FINE GRAINED SOILS	SILTS AND CLAYS LL < 50	ML		GREEN	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with
		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		BLUE	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
HIGHLY ORGANIC SOILS		Pt		ORANGE	Peat and other highly organic soils

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

M/C = 15 – Natural moisture content in percent.

γ = 95 – Dry unit weight in lbs/cu ft.

Qu = 1.23 – Unconfined compression strength in tons/ sq ft.

51 – 21 – 30 – Liquid limit, Plastic limit, and Plasticity index.

30% FINER – Percent finer than No. 200 mesh sieve

30 B/F – Blows per foot, standard penetration test.

▼ – Ground water table.

TERMS DESCRIBING CONSISTENCY OF SOIL (2)

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
Firm (medium)	10 – 30	Plastic (med. Stiff)	4 – 8	0.50- 1.00
Dense	30 – 50	Stiff	8 – 15	1.0 – 2.00
Very Dense	over 50	Very Stiff	15 – 30	2.00 – 4.00
		Hard	over 30	over 4.00

Field classification for "Consistency" is determined with a 0.25" diameter penetrometer.