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Project No. ASA13-073-00 (Revised)
October 11, 2013

Mr. Daniel Thoma, P.E.
Pape-Dawson Engineers, Inc.
555 East Ramsey
San Antonio, Texas 78216

RE: Geotechnical Engineering Study
Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

Dear Mr. Thoma:

RABA KISTNER Consultants Inc. (RKCI) is pleased to submit the revised report of our Geotechnical Engineering Study for the above-referenced project. This study was performed in accordance with a subcontract agreement between RKCI and Pape-Dawson Engineers, Inc. for the City of San Antonio – Project Number 40-00312, date July 2, 2013. The purpose of this study was to drill borings within the proposed roadway alignment, to perform laboratory testing to classify and characterize subsurface conditions, and to prepare an engineering report presenting pavement design recommendations and construction guidelines as well as foundation design recommendations and construction considerations for three culvert structures.

The following report contains our design recommendations and considerations based on our current understanding of the project information provided to our office. There may be alternatives for value engineering of the pavement systems, and RKCI recommends that a meeting be held with the Owner and design team to evaluate these alternatives.

We appreciate the opportunity to be of service to you on this project. Should you have any questions about the information presented in this report, or if we may be of additional assistance with value engineering or on the materials testing-quality control program during construction, please call.

Very truly yours,

RABA KISTNER CONSULTANTS, INC.

Matthew J. Robbins, E.I.T.
Graduate Engineer

T. Ian Perez, P.E.
Area Project Manager

STATE OF TEXAS
TERRANCE IAN PEREZ
101225
LICENSED
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MJR/TIP/dlc
Attachments
Copies Submitted: Above (4 and email)

GEOTECHNICAL ENGINEERING STUDY

For

RAY ELLISON BOULEVARD (CIMS)
LOOP 410 TO OLD PEARSALL ROAD
SAN ANTONIO, TEXAS

Prepared for

PAPE-DAWSON ENGINEERS, INC.
San Antonio, Texas

Prepared by

RABA KISTNER CONSULTANTS, INC.
San Antonio, Texas

PROJECT NO. ASA13-073-00 (Revised)

October 11, 2013

RABA KISTNER

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INTRODUCTION

RABA KISTNER Consultants Inc. (RKCI) has completed the authorized subsurface exploration and engineering analysis for the proposed improvements to Ray Ellison Boulevard from Loop 410 to Old Pearsall Road in San Antonio, Texas. This report briefly describes the procedures utilized during this study and presents our findings along with our recommendations for pavement design and construction guidelines as well as foundation design and construction recommendations for three culvert structures.

PROJECT DESCRIPTION

The roadway to be considered in this study includes the existing alignment of Ray Ellison Boulevard located in San Antonio, Texas. The roadway under consideration is approximately 1.8 miles long and extends from Loop 410 to Old Pearsall Road. The proposed roadway improvements are to be evaluated in accordance with the *City of San Antonio's Design Guidance Manual* regarding arterial streets. Also included in this report are foundation design recommendations and construction considerations for three culvert structures along Ray Ellison Boulevard. Plan sheets for the culverts were not available at the time of our study.

LIMITATIONS

This engineering report has been prepared in accordance with accepted Geotechnical Engineering practices in the region of south/central Texas and for the use of Pape-Dawson Engineers, Inc. (CLIENT) and its representatives for pavement design purposes. This report may not contain sufficient information for purposes of other parties or other uses. This report is not intended for use in determining construction means and methods.

The recommendations submitted in this report are based on the data obtained from the 17 borings and 1 bulk sample collected at this site and the information provided to us. This report may not reflect the actual variations of the subsurface conditions across the site. The nature and extent of variations across the site may not become evident until construction commences. The construction process itself may also alter subsurface conditions. If variations appear evident at the time of construction, it may be necessary to reevaluate our recommendations after performing on-site observations and tests to establish the engineering impact of the variations.

The scope of our Geotechnical Engineering Study does not include an environmental assessment of the air, soil, rock, or water conditions either on or adjacent to the site. No environmental opinions are presented in this report.

BORINGS AND LABORATORY TESTS

Subsurface conditions at the site were evaluated by 17 borings drilled at the locations shown on the Boring Location Map, Figure 1. These locations are approximate and distances were measured using a recreational grade, hand-held, GPS Locator; tape; angles; pacing; etc. The borings were drilled using a truck-mounted drilling rig to depths below the existing ground surface of approximately 10 ft for the

"P-series" borings and 45 ft for the "B-series" borings. During drilling operations, the following samples were collected:

Type of Sample	Number Collected
Split-Spoon (with Standard Penetration Test)	112
Undisturbed Shelby Tube	12

In addition to the above samples, a bulk sample of the predominant subgrade soil was also collected for use in California Bearing Ratio (CBR) testing; Lime Series testing for both Plasticity Indices and pH considerations; and unconfined compression testing of lime treated samples. The bulk sample was collected in the vicinity of Boring P-4. Each sample was visually classified in the laboratory by a member of our Geotechnical Engineering staff. The geotechnical engineering properties of the strata were evaluated by the following tests:

Type of Test	Number Conducted
Natural Moisture Content	127
Atterberg Limits	23
Percent Passing a No. 200 Sieve	4
Unconfined Compression	12

The results of all laboratory tests are presented in graphical or numerical form on the boring logs illustrated on Figures 2 through 18. A key to classification terms and symbols used on the logs is presented on Figure 19. The results of the laboratory and field testing are also tabulated on Figure 20 for ease of reference. The results of the CBR testing can be found on the Moisture Density Relationship Curve, Figure 21. The pH-Lime Series Curve can be found on Figure 22.

Standard penetration test results are noted as "blows per ft" on the boring logs and Figure 20, where "blows per ft" refers to the number of blows by a falling hammer required for 1 ft of penetration into the soil/weak rock. Where hard or dense materials were encountered, the tests were terminated at 50 blows even if one foot of penetration had not been achieved. When all 50 blows fall within the first 6 in. (seating blows), refusal "ref" for 6 in. or less will be noted on the boring logs and on Figure 20.

Samples will be retained in our laboratory for 30 days after submittal of this report. Other arrangements may be provided at the request of the Client.

FINDINGS AND TEST RESULTS

SUBSURFACE

The subsurface stratigraphy at this site can be described as firm to hard, dark brown clay which ranges in thickness from 3 to 11 ft overlying stiff to hard, tan clay which extends to at least the termination depth in all of our borings. Fill material consisting of clays and gravel, approximately 2 ft thick was encountered at the surface of Boring B-5. Each stratum has been designated by grouping soils that possess similar physical and engineering characteristics. The boring logs should be consulted for more specific stratigraphic information. The lines designating the interfaces between strata on the boring logs represent approximate boundaries. Transitions between strata may be gradual.

All of our borings with the exception of Boring B-5 were drilled through the existing pavements and the field measured pavement thicknesses are presented in the table below.

Boring	Asphalt Thickness, (in.)	Base Material Thickness, (in.)
B-1	1	4
B-2	5	10
B-3	5	5
B-4	4	6
B-5	NA	NA
B-6	6	4
P-1	4	12
P-2	12	3
P-3	5	7
P-4	5	11
P-5	9	6
P-6	4-1/2	3
P-7	1	12
P-8	6	6
P-9	6	4
P-10	6	5
P-11	6	24

Subgrade Strength Characterization

We have assumed the pavement subgrade will consist of recompacted on-site clays. The CBR was measured using *ASTM D 1883 Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils* and was determined to be 4.9 using the soaked sample methodology. Swell was also measured as part of the CBR procedure and was determined to be 2.3 percent. Based on these results and our experience with the soils in this area, we have assumed a design CBR value of 4.5 for use in our pavement section analysis. The average unconfined compression strength of a remolded sample with 4 percent lime content was determined to be 153 psi. Therefore, per the City of San Antonio, structural credit may be given to the lime treated subgrade layers for the pavements at this site.

If clay soils are imported for the purpose of constructing the roadbed then imported materials must be selected that have a CBR value of at least 4.5. If lower quality clay fill materials are utilized, the pavement sections will have to be increased based on the quality (tested CBR value) of the clays imported.

Swell/Heave Potential

Assuming that the clays extend to depths of 15 ft below the existing ground surface for the pavement borings, the estimated Potential Vertical Rise (PVR) for this site ranges from 4-1/2 to 6 in. These values were determined using the empirical procedure, Texas Department of Transportation (TxDOT) Tex-124-E, Method for Determining the Potential Vertical Rise (PVR). A surcharge load of 1 psi, an active zone of 15 ft, and dry moisture conditions were assumed in estimating the above PVR values.

Subgrade soils that are highly expansive when water is introduced (i.e. highly plastic soils) will heave, causing the pavement to become rough or uneven over time. Pavement roughness is generally defined as an expression of irregularities in the pavement surface that adversely affect the ride quality of a vehicle (and thus the user). Roughness is an important pavement characteristic because it affects not only ride quality but also vehicle costs, fuel consumption, and maintenance costs. Pavement heave can be reduced through various measures but cannot be totally eliminated without full removal of the problematic soil. Measures available for reducing heave include:

- Soil Treatment with Lime or Other Chemicals
- Removal and Replacement of High PI Soils
- Drains or Barriers to Collect or Inhibit Moisture Infiltration

Soil treatment with lime (or other chemicals) is typically used to reduce the swelling potential of the upper portion of the pavement subgrade containing moderately plastic soils. Lime and water are mixed with the top 6 to 12 inches (or possibly more) of the subgrade and allowed to mellow or cure for a period of time. After mellowing the soil-lime mixture is compacted to form a strong soil matrix that can improve pavement performance and potentially reduce soil heave. However, in highly plastic soils, lime treatment of only the top portion of the expansive subgrade may not provide an acceptable reduction in PVR. For a more substantial reduction in PVR, removal and replacement of the high PI soil may be the only method available to reduce the potential vertical rise of the pavement to an acceptable level. As stated previously though, it must be recognized that partial removal of expansive clay soil only reduces the potential (or risk) of the damage swell can cause to a pavement and does not completely eliminate this risk.

In addition, capturing water infiltration via French drains, pavement edge drains, or inhibiting water through the use of vertical moisture barriers would reduce the potential for heave since one important component of the heaving mechanism, water, would be reduced. Geocomposite membranes, like geogrids, are also another tool available that may help reduce the damage that heaving subgrades cause to flexible pavements and may be considered in addition to or as an alternative to other mitigation techniques.

It should be noted that the pavement sections derived in the following sections are structurally adequate for the given traffic levels and existing clay subgrade strength, but do not consider the long-term effects of pavement roughness due to heave, which can only be addressed by the measures discussed in this section.

FOUNDATION RECOMMENDATIONS - CULVERTS

It is our understanding that box culvert systems crossing Ray Ellison Boulevard are planned as an option at the Apple Valley Drive, 5 Palms Drive, and the South San Antonio Independent School District crossings. The Apple Valley Drive culvert system is approximately 280 ft east of the intersection of Apple Valley Drive and Ray Ellison Boulevard. The 5 Palm Drive culvert system is approximately 360 ft west of the intersection of 5 Palms Drive and Ray Ellison Boulevard. The South San Antonio Independent School District culvert system is approximately 1,140 ft west of the intersection of Vista Point and Ray Ellison Boulevard.

Based on the conditions encountered in our borings, the culvert systems planned at all three crossings may be designed using an allowable bearing pressure of 2,500 psf from 0 to 5 ft below the existing ground surface and 4,000 psf from 5 to 10 ft below the existing ground surface.

The above presented maximum allowable bearing pressures will provide factors of safety in excess of 3 with respect to the measured shear strength of the in-situ soils and provided that the subgrade is prepared in accordance with the recommendations outlined in the *Site Preparation* section under the *Foundation Construction Considerations* section of this report.

FOUNDATION CONSTRUCTION CONSIDERATIONS

SITE PREPARATION

The existing culverts and any existing foundation elements should be removed prior to beginning construction of the new culverts. Water flow should be rerouted or otherwise diverted from the culvert construction area. The exposed subgrades should be thoroughly proofrolled in order to locate and densify any weak, compressible zones. A minimum of 5 passes of a fully-loaded dump truck or a similar heavily-loaded piece of construction equipment should be used for planning purposes. Proofrolling operations should be observed by the Geotechnical Engineer or his representative to document subgrade condition and preparation.

Weak or soft areas identified during proofrolling should be removed and replaced with suitable, compacted on-site clays, free of organics, oversized materials, and degradable or deleterious materials. If the exposed subgrade material is too wet for proofrolling and exhibits significant pumping during the proofrolling operations and the site conditions are such that these materials will not dry out with scarification and exposure, then considerations could be given to placing 3 by 5 in. rock (bull rock) on top of the subgrade and rolling it into the soft subgrade soils until it “bridges” the soft material and will allow for the placement and compaction of select fill material or a mud slab for the culvert construction.

SELECT FILL

If utilized beneath proposed culverts, select fill preferably should be crushed stone or gravel aggregate. We recommend that materials specified for use as select fill meet the 2008 City of San Antonio Standard Specifications Item 200, *Flexible Base*, Types A or C, Grades 1 through 3.

Soils classified as CH, CL, MH, ML, SM, GM, OH, OL and Pt under the USCS are **not** considered suitable for use as select fill materials at this site. The native soils at this site are **not** considered suitable for use as select fill materials.

Select fill should be placed in loose lifts not exceeding 8 in. in thickness and compacted to at least 100 percent of maximum density as determined by TxDOT, Tex-113-E, Compaction Test. The moisture content of the fill should be maintained within the range of 2 percentage points below to 2 percentage points above the optimum moisture content until final compaction.

If select fill is placed over moisture conditioned clays, the first lift of select fill may be placed at 95 percent of the maximum density as determined by TxDOT, Tex 113-E, Compaction Test.

SHALLOW FOUNDATION EXCAVATIONS

Shallow foundation excavations should be observed by the Geotechnical Engineer or his representative prior to placement of reinforcing steel and concrete. This is necessary to verify that the bearing soils at the bottom of the excavations are similar to those encountered in our borings and that excessive loose materials and water are not present in the excavations. If soft pockets of soil are encountered in the foundation excavations, the recommendations presented in the *Site Preparation* section should be utilized.

EXCAVATION SLOPING AND BENCHING

If utility trenches or other excavations extend to or below a depth of 5 ft below construction grade, the contractor or others shall be required to develop a trench safety plan to protect personnel entering the trench or trench vicinity. The collection of specific geotechnical data and the development of such a plan, which could include designs for sloping and benching or various types of temporary shoring, are beyond the scope of the current study. Any such designs and safety plans shall be developed in accordance with current OSHA guidelines and other applicable industry standards.

EXCAVATION EQUIPMENT

Our boring logs are not intended for use in determining construction means and methods and may therefore be misleading if used for that purpose. We recommend that earth-work and utility contractors interested in bidding on the work perform their own tests in the form of test pits to determine the quantities of the different materials to be excavated, as well as the preferred excavation methods and equipment for this site.

PAVEMENT RECOMMENDATIONS

CITY OF SAN ANTONIO DESIGN PARAMETERS – HOT MIX ASPHALT PAVEMENTS

The roadway to be considered in this study is the existing alignment of Ray Ellison Boulevard from Loop 410 to Old Pearsall Road. The roadway improvements are to be evaluated in accordance with the *City of San Antonio's Design Guidance Manual* regarding arterials. Based on information provided by the City of San Antonio, we understand that the following design parameters are required for use in the design of flexible pavements for these types of streets.

Street Classification	Equivalent 18-kip Single Axle Load Applications (ESALs)	Reliability	Serviceability Initial/Terminal	Standard Deviation	Structural Number Minimum/Maximum
Arterial	3,000,000	95	4.2/2.5	0.45	3.80/5.76

The required structural number is related to the CBR value of the pavement subgrade and the amount of traffic that the pavement will carry over its service life. The CBR provides an estimate of the relative strength of the subgrade and consequently indicates the ability of the pavement section to carry load. This site specific CBR value is utilized in conjunction with the above specified parameters to determine the required Structural Number (SN) for use in the design of the pavement section.

To determine the required design SN value, we utilized a software program entitled "AASHTOWare DARWin 3.1.017, Pavement Design and Analysis System," which is published by the American Association of State Highway and Transportation Officials (AASHTO) and is based on the 1993 edition of the AASHTO "Guide for the Design of Pavement Structures."

The "required by design" SN values presented below are calculated using the DARWin software. Also shown are the values subsequently chosen for use in design of the pavement sections for this site.

Structural Number Recommendations

Description	Structural Number			
	Required by Design	*Minimum Value Provided by Design*		
		Flex Base Option	*Full Depth Asphalt Option*	*Mechanically Stabilized Layer Option*
Clay Subgrade	4.57	4.64	4.74	4.60

Appendix 10-A of the *City of San Antonio's Design Guidance Manual* states that subgrade soils with a plasticity index (PI) greater than 20 must be treated with lime or other proven methods of treatment to reduce the PI of the soil to less than 20. Based on the results of our Atterberg Limits testing performed on the bulk sample and in the upper 5 ft of our borings, the PI of the surficial subgrade clays ranges from 36 to 58. Thus, per the City of San Antonio, pavements designed using the clay subgrade recommendations at this site will need to include a minimum of 6 in. of lime-treated subgrade. The lime treated unconfined compression test performed with 4 percent lime resulted in 153 psi. Therefore, per the City of San Antonio, the lime treated subgrade layer may be included as a structural component in our pavement sections.

PAVEMENT DESIGN PARAMETERS – HOT MIX ASPHALT PAVEMENTS

The following input variables are utilized to design flexible base pavements (commonly referred to as Asphaltic Cement Concrete or Asphalt pavements) when using the procedures detailed in the *1993 AASHTO Guide for Design of Pavement Structures*:

- Performance Period
- Roadbed Soil Resilient Modulus psi
- Serviceability Indices
- Overall Standard Deviation
- Reliability, %
- Design Traffic, 18-kip ESALs

Performance Period

The pavement structure was designed for a 20-year performance period which is typical for most flexible pavements.

Roadbed Soil Resilient Modulus

The Resilient Modulus (M_R) is the material property used to characterize the support characteristics of the roadbed soils in flexible pavement design. It is a measure of the soil's deformation response to cyclic applications of loads much smaller than a failure load. Using conventional correlations, local experience and design CBR values of 4.5, as discussed above, Resilient Moduli of 6,750 psi have been used for this project, respectively.

To determine the resilient modulus (M_r) of the subgrade, we utilized the correlation equation proposed for the latest version of the AASHTO Mechanistic-Empirical Pavement Design Guide (ME-PDG). The equation is shown below:

$M_r = 1500 \times CBR$

Serviceability Indices

Initial serviceability is a measure of the pavement's smoothness or rideability immediately after construction. Terminal serviceability is the minimum tolerable serviceability of a pavement. When the serviceability of a pavement reaches its terminal value, rehabilitation is required. See the recommended Initial and Terminal Serviceability Indices on the table presented in the *City of San Antonio Design Parameters – Hot Mix Asphalt Pavements* section of this report.

Overall Standard Deviation

Overall standard deviation accounts for both chance variation in the traffic prediction and normal variation in pavement performance prediction for a given traffic. Higher values represent more variability; thus, the pavement thickness increases with higher overall standard deviations. A value of 0.45 was utilized for the flexible pavement designs presented herein.

Reliability, %

The reliability value represents a "safety factor," with higher reliabilities representing pavement structures with less chance of failure. The AASHTO Guide recommends values ranging from 50 to 99.9%, depending on the functional classification and the location (urban vs. rural) of the roadway. See the recommended Reliability values on the table presented in the *City of San Antonio Design Parameters – Hot Mix Asphalt Pavements* section of this report.

Design Traffic 18-kip ESAL

The 18-kip ESALs were determined from the traffic data specified in the Unified Development Code for the City of San Antonio. See the recommended values on the table presented in the *City of San Antonio Design Parameters – Hot Mix Asphalt Pavements* section of this report.

RECOMMENDED PAVEMENT SECTIONS – HOT MIX ASPHALT PAVEMENTS

Utilizing the design SN values discussed above and minimum layer thicknesses, the optional pavement sections presented in the tables below are recommended.

If clay fill is utilized for fill grading, it should be placed and compacted as discussed in the *On-Site Clay Fill* section of this report. For areas that require fill and where pavement sections will utilize the clay subgrade recommendations, the final 6 in. of fill should be lime treated (see *Lime Treated Subgrade*). If fill grading is not planned and clays remain in place, then lime treatment of the exposed clay subgrade should be performed in conjunction with the scarifying, moisture conditioning, and recompaction described in the *Site Preparation* section of this report.

For this site, the following options for pavement sections are available.

Arterial; CBR=4.5	**Layer Description**	**Layer Thickness**	**Recommended SN Coeff.**	**S.N. Extension**
Flexible Base Option	Type D Surface Course	2.0 in.	0.44	0.88
	Type C/D Surface Course	3.0 in.	0.44	1.32
	Flexible (Granular) Base	14.0 in.	0.14	1.96
	Lime Treated Subgrade*	6.0 in.	0.08	0.48
	Combined Total	**25.0 in.**		**4.64**
Full Depth Asphalt Option	Type D Surface Course	1.5 in.	0.44	0.66
	Type C/D Surface Course	2.0 in.	0.44	0.88
	Type B Base	8.0 in.	0.34	2.72
	Lime Treated Subgrade	6.0 in.	0.08	0.48
	Combined Total	**17.5 in.**		**4.74**
Mechanically Stabilized Layer Option	Type D Surface Course	2.0 in.	0.44	0.88
	Type C/D Surface Course	3.0 in.	0.44	1.32
	Mechanically Stabilized Layer	8.0 in.	0.24	1.92
	Lime Treated Subgrade	6.0 in.	0.08	0.48
	Combined Total	**19.0 in.**		**4.60**

*If lime treatment is increased from 6 to 8 in. in the Flexible Base Option or Full Depth Asphalt Option, the flexible base layer/Type B Base layer may be reduced by 1 in.

It is our understanding that consideration is being given to increasing the lime treated subgrade layer to 8 or 10 in. (possible more). Any additional lime treatment of the subgrade will be beneficial to the overall performance of the pavements, but as previously discussed; will not completely eliminate the risk of shrink/swell during the assumed performance period. We do not recommend that any lime treated subgrade layer thicknesses exceeding 8 in. contribute to the pavement section as a structural component (towards the calculated structural number).

A Mechanically Stabilized Layer (MSL) is a composite layer consisting of flexible (granular) base and a Tensar TriAx product. TriAx geogrid provides lateral restraint to the flexible base by confining aggregate particles within the plane of the geogrid, thereby creating a reinforced, or mechanically stabilized layer. The unique design of the TriAx geogrid allows the thickness of the reinforced layer to be optimized which reduces the thickness of the required flexible base and provides a stronger, more resilient structure. For this particular application, we recommend Tensar TriAx TX-5 geogrid. We do not recommend that an alternative geogrid be utilized in this section as the performance of the final pavement structure may be inferior which will result in premature pavement distresses. If an alternate geogrid is to be utilized in these pavement sections, we should be retained to review and revise our recommendations.

CITY OF SAN ANTONIO DESIGN PARAMETERS – PORTLAND CEMENT CONCRETE PAVEMENTS

The roadway to be considered in this study is Ray Ellison Boulevard. The proposed roadway is to be evaluated in accordance with the *City of San Antonio's Design Guidance Manual* regarding arterials. Based on information provided by the City of San Antonio, we understand that the following design parameters are required for use in the design of rigid pavements for these types of streets.

Street Classification	Equivalent 18-kip Single Axle Load Applications (ESALs)	Reliability	Serviceability Initial/Terminal	Standard Deviation	Rigid Pavement Slab Thickness Minimum/Maximum
Arterial	4,500,000	95	4.5/2.5	0.35	9.0/13.0

To determine the required design rigid pavement thickness, we utilized a software program entitled "AASHTOWare DARWin 3.1.01, Pavement Design and Analysis System," which is published by the American Association of State Highway and Transportation Officials (AASHTO) and is based on the 1993 edition of the AASHTO "Guide for the Design of Pavement Structures."

PAVEMENT DESIGN PARAMETERS – PORTLAND CEMENT CONCRETE PAVEMENTS

The following input variables are utilized to design rigid pavements (commonly referred to as Portland Cement Concrete or PCC pavements) when using the procedures detailed in the *1993 AASHTO Guide for Design of Pavement Structures*:

- Performance Period
- 28-day Concrete Modulus of Rupture, psi
- 28-day Concrete Elastic Modulus, psi
- Effective Modulus of Subbase/Subgrade Reaction, pci
- Serviceability Indices
- Load Transfer Coefficient
- Drainage Coefficient
- Overall Standard Deviation
- Reliability, %
- Design Traffic, 18-kip ESALs

Performance Period

The pavement structure was designed for a 30-year performance period which is typical for most rigid pavements.

28-day Concrete Modulus of Rupture, M_r

The M_r of concrete is a measure of the flexural strength of the concrete as determined by breaking concrete beam test specimens. An M_r of approximately 600 psi at 28 days was used in the analysis and is typical of local concrete production.

28-day Concrete Elastic Modulus

Elastic modulus of concrete is an indication of concrete stiffness and varies depending on the coarse aggregate type used in the concrete. A modulus of 4,000,000 psi is used for this pavement design.

Effective Modulus of Subbase/Subgrade Reaction: k-value

Concrete slab support is characterized by the modulus of subgrade/subbase reaction, otherwise known as the k-value with units typically shown as psi/in. A k-value of 140 psi/in. was used in the rigid pavement design procedure and is based upon a CBR value of 4.5, as discussed above.

Serviceability Indices

Initial serviceability is a measure of the pavement's smoothness or rideability immediately after construction. Terminal serviceability is the minimum tolerable serviceability of a pavement. When the serviceability of a pavement reaches its terminal value, rehabilitation is required. See the recommended Initial and Terminal Serviceability Indices on the table presented in the *City of San Antonio Design Parameters – Portland Cement Concrete Pavements* section of this report.

Load Transfer Coefficient

The load transfer coefficient is used to incorporate the effect of dowels, reinforcing steel, tied shoulders, and tied curb and gutter on reducing the stress in the concrete slab due to traffic loading and therefore causing a reduction in the required concrete slab thickness. The coefficients recommended in the AASHTO Guide are based on findings from the AASHO Road Test presented below.

CRCP or Load Transfer Devices at Transverse Joints	Tied PCC shoulders, curb and gutter, or greater than two lanes in one direction	
	Yes	No
Yes	2.9	3.2
No	3.7	4.2

The load transfer coefficient used in this pavement design is 3.4.

Drainage Coefficient

The drainage coefficient characterizes the quality of drainage of the subbase layers under the concrete slab. Good draining pavement structures do not give water the chance to saturate the subbase and subgrade; thus, pumping is not as likely to occur.

There is no subbase recommended for this pavement structure. Therefore, the drainage coefficient used in this pavement design is 0.90 and is based upon local design experience for slabs without subbases on expansive clay subgrade.

Overall Standard Deviation

Overall standard deviation accounts for both chance variation in the traffic prediction and normal variation in pavement performance prediction for a given traffic. Higher values represent more variability; thus, the pavement thickness increases with higher overall standard deviations. See the recommended Overall

Standard Deviation on the table presented in the *City of San Antonio Design Parameters – Portland Cement Concrete Pavements* section of this report.

Reliability, %

The reliability value represents a "safety factor," with higher reliabilities representing pavement structures with less chance of failure. The AASHTO Guide recommends values ranging from 50 to 99.9%, depending on the functional classification and the location (urban vs. rural) of the roadway. See the recommended Reliability on the table presented in the *City of San Antonio Design Parameters – Portland Cement Concrete Pavements* section of this report.

Design Traffic 18-kip ESAL

The 18-kip ESALs were determined from the street classifications as discussed previously in the *City of San Antonio Design Parameters – Portland Cement Concrete Pavements* section of this report.

RECOMMENDED PAVEMENT SECTIONS – PORTLAND CEMENT CONCRETE PAVEMENTS

The recommended concrete slab thicknesses determined with the inputs discussed above are presented in the table below. An optional lime treated subgrade is recommended to facilitate construction over the clay subgrade but is not required.

Portland Cement Concrete Design - Cross Sections	Layer Description	TxDOT Spec. Item	Layer Thickness
Arterial	PCC Surface	360	11.0 in.
	Subbase	----	0.0 in.
	Lime Treated Subgrade[(1)]	260	6.0 in.
	Combined Total		17.0 in.

1) Used as a working or construction platform only.

PAVEMENT CONSTRUCTION CONSIDERATIONS

SITE PREPARATION

Preparation for the right-of-way (for streets, sidewalks, utilities, etc.) should be performed in accordance with the 2008 City of San Antonio Standard Specification Item 101 – *Preparing of Right-of-Way*. Exposed subgrades should be thoroughly proofrolled in order to locate and densify any weak, compressible zones. A minimum of 5 passes of a fully-loaded dump truck or a similar heavily-loaded piece of construction equipment should be used for planning purposes. Proofrolling operations should be observed by the Geotechnical Engineer or his representative to document subgrade condition and preparation. Weak or soft areas identified during proofrolling should be removed and replaced with a suitable, compacted backfill.

After completion of the proofrolling operations and just prior to flexible base placement, the exposed subgrade should be moisture conditioned by scarifying to a minimum depth of 6 in. and recompacting to a minimum of 95 percent of the maximum density determined from the Texas Department of Transportation Compaction Test (TxDOT, Tex-114-E). The moisture content of the subgrade should be maintained within the range of optimum moisture content to 3 percentage points above optimum until permanently covered.

Upon completion of fill grading using the on-site clays, the final 6 in. of fill should be lime treated (see *Lime Treatment of Subgrade*). If fill grading is not planned, then lime treatment of the stripped clay subgrade should be performed in conjunction with the scarifying, moisture conditioning, and recompaction described previously.

ON-SITE CLAY FILL

We recommend that the on-site soils be placed to conform to the 2008 City of San Antonio Standard Specifications Item 107 – *Embankment* Type B and should be placed in lifts not exceeding 6 in. (compacted) in thickness and compacted to the requirements of Table 2 in Item 107 based on the maximum density and optimum moisture content as determined by TxDOT, Tex-114-E. The moisture content of the fill should be maintained to be at least equal to the optimum water content, but not exceed 3 percentage points above the optimum water content until permanently covered. Fill materials shall be free of roots and other organic or degradable material. We recommend that the maximum particle size not exceed 3 in. or one half the completed lift thickness, whichever is smaller. If other import fill materials are utilized, RKCI should be notified, as additional CBR testing and thicker pavement sections may be required.

It is imperative that the subgrade modulus utilized in the pavement design process be met or exceeded by the fill material. In the event that the clay fill used is different than the existing subgrade, the recommendations in this report could be invalidated and the design engineer must be consulted to determine if additional CBR testing and thicker pavement sections are required.

LIME TREATMENT OF SUBGRADE

Lime treatment of the subgrade soils with PIs greater than 20 should be in accordance with the 2008 City of San Antonio Standard Specification, Item 108 – Lime Treated Subgrade. Lime-treated subgrade soils should be compacted to a minimum of 95 percent of the maximum density at a moisture content within the range of optimum moisture content to 3 percentage points above the optimum moisture content as determined by Tex-113-E. Based on the results of the Lime Series Curve, we recommend that at least 4 percent hydrated lime by weight be used to reduce the PI of the subgrade clays or the minimum required by the City of San Antonio which is 15 pounds/S.Y. for 6 in. of lime treated subgrade. If dry placement of lime is used during construction, an additional 1 percent of lime should be added to account for expected loss.

It is also recommended to perform additional laboratory testing to determine the concentration of soluble sulfates in the subgrade soils, in order to investigate the potential for adverse reaction to lime in certain sulfate-containing soils. The adverse reaction, referred to as sulfate-induced heave, has been known to cause cohesive subgrade soils to swell in short periods of time, resulting in pavement heaving and possible failure.

GEOGRID REINFORCEMENT

The geogrid reinforcement should be Tensar TX-5. An approved source of geogrid is The Tensar Corporation, Morrow, GA or their designated representative. The geogrid component shall be integrally formed and produced from a punched sheet of polypropylene which is then oriented in three substantially equilateral directions so that the resulting ribs shall have a high degree of molecular orientation, which continues at least in part through the mass of the integral node. The resulting geogrid structure shall have apertures that are triangular in shape, and shall have ribs with a depth-to-width ratio greater than 1.0.

The geogrid shall have the nominal characteristics shown in the table below, and shall be certified in writing by the manufacturer to be TX-5:

Properties	Longitudinal	Diagonal	Transverse	General
Rib pitch, mm (in.)	40 (1.60)	40 (1.60)		
Mid-rib depth, mm (in.)		1.3 (0.05)	1.2 (0.05)	
Mid-rib width, mm (in.)		0.9 (0.04)	1.2 (0.05)	
Rib shape				Rectangular
Aperture shape				Triangular

The geogrid should be placed at the bottom of the flexible (granular) base section in all cases. An alternative to the above geogrid should not be considered without approval from RKCI.

GRANULAR BASE COURSE

The flexible base course should be crushed limestone conforming to the 2008 City of San Antonio Standard Specification, Item 200 – *Flexible Base*, Type A Grade 1. The base course should be placed in lifts with a maximum compacted thickness of 8 in. (10 inches loose) and compacted to a minimum of 95 percent of the maximum density determined by Tex-113-E at a moisture content within the range of 2 percentage points below to 2 percentage points above the optimum moisture content as determined by Tex-113-E.

PRIME COAT

A prime coat should be placed on top of a flexible base course (if used) and should be a MC-30 or AE-P conforming to the 2008 City of San Antonio Standard Specification for Construction Item 202 – *Prime Coat* as well as TxDOT Standard Specifications 2004, Item 300 – *Asphalts, Oils or Emulsions*. Prime coat application rates are typically between 0.1 to 0.3 gal/yd^2 and are generally dependent upon the absorption rate of the granular base and other environmental conditions at the time of placement. City of San

Antonio Standard Specification Item 202 – *Prime Coat* states that the application rate shall not exceed 0.2 gal/yd^2.

TACK COAT

A tack coat should be placed between asphaltic concrete base and/or surface lifts and should be a PG binder with a minimum high-temperature grade of PG 58, SS-1H, CSS-1H, or EAP&T conforming to TxDOT Standard Specifications 2004, Item 300 – *Asphalts, Oils or Emulsions*. For construction, City of San Antonio Standard Specification Item 203 – *Tack Coat* shall be specified and the application rate shall not exceed 0.1 gal/yd^2. See additional requirements for tack coats in the appropriate City of San Antonio Standard Specification for Asphaltic Concrete Materials.

ASPHALTIC CONCRETE SURFACE AND/OR BINDER[1] COURSES

The asphaltic concrete surface and/or binder courses should conform to the 2008 City of San Antonio Standard Specification Item 205 – *Hot Mix Asphaltic Concrete Pavement* Types C or D for the surface and binder, and Type B for the base, if the full depth asphalt section is selected for construction. Recycled asphalt pavement (RAP) should be limited to 20 percent of the total weight of the mix for Types C and D mixes and 30 percent for Type B mixes. Higher percentages of RAP may be permissible depending on the material source. If higher percentages of RAP are desired, contact RKCI for consideration. Asphalt cement grades should conform to the table shown below, which conforms to the requirements of Item 205.

Street Classifications	Minimum PG Asphalt Cement Grade		
	Surface Courses	Binder & Level Up Courses	Base Courses
Primary and Secondary Arterials	PG 76-22	PG 70-22	PG 64-22

The asphaltic concrete should be compacted on the roadway to contain from 5 to 9 percent air voids computed using the maximum theoretical specific gravity (Rice) of the mixture determined according to Test Method Tex-227-F. Pavement specimens, which shall be either cores or sections of asphaltic pavement, will be tested according to Test Method Tex-207-F. The nuclear-density gauge or other methods which correlate satisfactorily with results obtained from project roadway specimens may be used when approved by the Engineer. Unless otherwise shown on the plans, the Contractor shall be responsible for obtaining the required roadway specimens at their expense and in a manner and at locations selected by the Engineer.

It is recommended that the hot mix asphalt concrete pavement be placed with a paving machine only and not with a motor grader unless prior approval is granted by the Engineer for special circumstances.

[1] A binder course is defined as the hot mixed asphalt concrete (HMAC) layer placed directly beneath the HMAC surface or wearing course but is not an asphalt treated base layer.

PORTLAND CEMENT CONCRETE

The Portland cement concrete should conform to the requirements of 2008 City of San Antonio Standard Specification Item 209 – *Concrete Pavement* section 209.2.A Hydraulic Cement Concrete Class P. Liquid membrane-forming curing compound should be applied as soon as practical after broom finishing the concrete surface and conform to section 209.2.D Curing Compound. The curing compound will help reduce the loss of water from the concrete. The reduction in the rapid loss in water will help reduce shrinkage cracking of the concrete.

CONCRETE PAVEMENT CONSTRUCTION CONTROL

Construction of Portland Cement Concrete Pavements should be controlled by the 2008 City of San Antonio Standard Specification Item 209 – *Concrete Pavement*. The surface of all concrete pavements should be textured or tined. Texturing using carpet dragging or tining should be in accordance with Item 209 Section 3, paragraph D, sub-paragraphs 1 and 2. Other texturing techniques may be utilized as described in ACI 330.1-03 Section 3 Subparagraph 9.

CONCRETE PAVEMENT TYPE

Jointed Plain Concrete Pavement (which is referred to by TxDOT as Concrete Pavement Contraction Design or CPCD) is suggested for roadways with crosswalks, adjacent parking, or sidewalks and is recommended as the pavement type for this city street.

JOINT SPACING AND DETAILS

Construction joint spacing should not exceed 15 ft in either the longitudinal or transverse direction. The depth of sawcut should be a minimum of 1/4 of the slab depth if utilizing a conventional saw or 1 in. when using an early entry saw (early entry sawing is recommended). The width of the joint will be a function of the sealant chosen to seal the joint. It is recommended that a joint seal be utilized to minimize the introduction of incompressible material into the joint.

It is recommended that dowel bars be used to provide load transfer and reduce differential movement (or faulting) across transverse joints. Dowels should be smooth #9 bars (Grade 60 steel) spaced 12 in. on center with an embedment length of at least 8 in.

Tie bars should be used to tie longitudinal joints within the pavement lanes and at the shoulder. Tie bars should be deformed #4 bars at a minimum (Grade 60 steel) spaced 36 in. on center with a minimum length of 30 in.

Isolation joints must be used around fixed structures including light standard foundations and drainage inlets to offset the effects of differential horizontal and vertical movements. Premolded joint fillers should be used around the fixed structures prior to placing the concrete pavement to prevent bonding of the slab to the structure and should extend through the depth of the slab but slightly recessed from the pavement surface to provide room for the joint sealant.

SUGGESTED PAVEMENT DETAILS

Suggested details that can be utilized for construction are:

- TxDOT JS-94, Concrete Paving Details, Joint Seals
- TxDOT CPCD-94, Concrete Pavement Details, Contraction Design, T-8 through 15 inches

See Figure 23 of the Attachments for the above joint details

MISCELLANEOUS PAVEMENT RELATED CONSIDERATIONS

Drainage Considerations

As with any soil-supported structure, the satisfactory performance of a pavement system is contingent on the provision of adequate surface and subsurface drainage. Insufficient drainage which allows saturation of the pavement subgrade and/or the supporting granular pavement materials will greatly reduce the performance and service life of the pavement systems.

Surface and subsurface drainage considerations crucial to the performance of pavements at this site include (but are not limited to) the following:

- Any known natural or man-made subsurface seepage at the site which may occur at sufficiently shallow depths as to influence moisture contents within the subgrade should be intercepted by drainage ditches or below grade French drains.
- Final site grading should eliminate isolated depressions adjacent to curbs, which may allow surface water to pond and infiltrate into the underlying soils. Curbs should be installed to a sufficient depth to reduce infiltration of water beneath the curbs and into the pavement base materials.
- Pavement surfaces should be maintained to help minimize surface ponding and to provide rapid sealing of any developing cracks. These measures will help reduce infiltration of surface water downward through the pavement section.

Utilities

Our experience indicates that significant settlement of backfill can occur in utility trenches, particularly when trenches are deep, when backfill materials are placed in thick lifts with insufficient compaction, and when water can access and infiltrate the trench backfill materials. The potential for water to access the backfill is increased where water can infiltrate flexible base materials due to insufficient penetration of curbs, and at sites where geological features can influence water migration into utility trenches (such as fractures within a rock mass or at contacts between rock and clay formations). It is our belief that another factor which can significantly impact settlement is the migration of fines within the backfill into the open voids in the underlying free-draining bedding material.

To reduce the potential for settlement in utility trenches, we recommend that consideration be given to the following:

- All backfill materials should be placed and compacted in controlled lifts appropriate for the type of backfill and the type of compaction equipment being utilized and all backfilling procedures should be tested and documented.
- Consideration should be given to wrapping free-draining bedding gravels with a geotextile fabric (similar to Mirafi 140N) to reduce the infiltration and loss of fines from backfill material into the interstitial voids in bedding materials.

Curb and Gutter

It is good practice to construct curbs such that the depth of the curb extends through the entire depth of the granular base material and into the underlying (lime treated) subgrade to act as a protective barrier against the infiltration of water into the granular base. Pavements that do not have this protective barrier to moisture tend to develop longitudinal cracks 1 to 2 ft from the edge of the pavement. Once these cracks develop, further degradation and weakening of the underlying granular base may occur due to water seepage through the cracks.

Pavement Maintenance

Regular pavement maintenance is critical in maintaining pavement performance over a period of several years. All cracks that develop in asphalt pavements should be regularly sealed. Areas of moderate to severe fatigue cracking (also known as alligator cracking) should be sawcut and removed. The underlying base should be checked for contamination or loss of support and any insufficiencies fixed or removed and the entire area patched. All cracks that develop in concrete pavements should be routed and sealed regularly. Joints in concrete pavements should be maintained to reduce the influx of incompressible materials that restrain joint movement and cause spalling and/or cracking. Other typical TxDOT or City of San Antonio maintenance techniques should be followed as required.

Construction Traffic

Construction traffic on prepared subgrade, granular base or asphalt treated base (black base) should be restricted as much as possible until the protective asphalt surface pavement is applied. Significant damage to the underlying layers resulting in weakening may occur if heavily loaded vehicles are allowed to use these areas.

* * * * * * * * * * * * * * * * * *

The following figures are attached and complete this report:

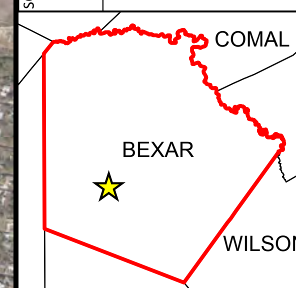
Figure 1	Boring Location Map
Figures 2 through 18	Logs of Borings
Figure 19	Key to Terms and Symbols
Figure 20	Results of Soil Analyses
Figure 21	Moisture Density Relationship Curve
Figure 22	pH-Lime Series Curve
Figure 23	Joint Details

ATTACHMENTS

RABA KISTNER CONSULTANTS
12821 West Golden Lane
San Antonio, Texas 78249
(210)699-9090 TEL
(210)699-6426 FAX
www.rkci.com
TBPE Firm Number 3257

SOURCE: 2012 Aerial Photograph Provided by The City of San Antonio (COSA)

BORING LOCATION MAP
RAY ELLISON BOULEVARD (CIMS)
LOOP 410 TO OLD PEARSALL ROAD
SAN ANTONIO, TEXAS



PROJECT No.: ASA13-073-00	
ISSUE DATE:	09/17/2013
DRAWN BY:	CCL
CHECKED BY:	TIP
REVIEWED BY:	TIP

FIGURE

1

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

LOG OF BORING NO. B-1

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

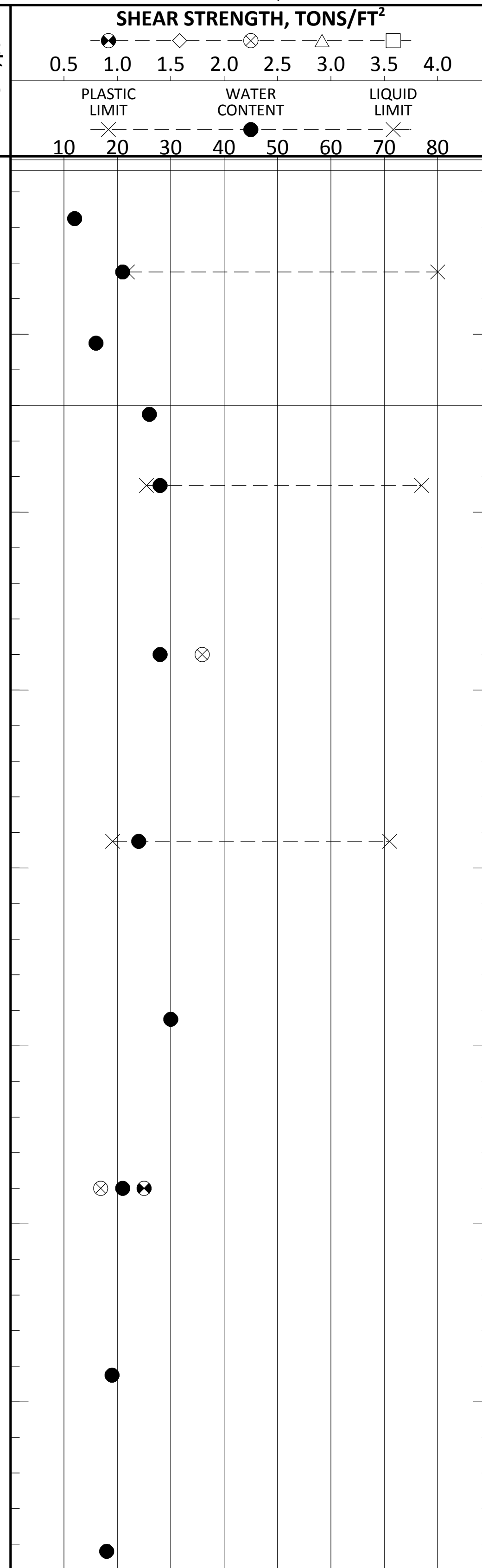
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35710; W 98.62120

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
ASPHALT (1 in.)				
BASE MATERIAL (4 in.)				
CLAY, Very Stiff to Hard, Dark Brown, with a trace of gravel	33			
	19		58	
	44			
CLAY, Very Stiff to Hard, Tan	16			
	17		52	
		96		
- with calcareous deposits and glauconite above 18 ft	35		52	
	19			
		105		
	36			
	50/11"			

Depth, ft: 5, 10, 15, 20, 25, 30, 35



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	45.0 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/30/2013	**DATE MEASURED:**	8/30/2013	**FIGURE:**	2a

LOG OF BORING NO. B-1

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35710; W 98.62120

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
			CLAY, Very Stiff to Hard, Tan *(continued)*				
				50/9"			
45			Boring Terminated				
50							
55							
60							
65							
70							
75							

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 45.0 ft
DATE DRILLED: 8/30/2013
DEPTH TO WATER: DRY
DATE MEASURED: 8/30/2013
PROJ. No.: ASA13-073-00
FIGURE: 2b

LOG OF BORING NO. B-2

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35719; W 98.62141

SHEAR STRENGTH, TONS/FT²: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (5 in.)				
	BASE MATERIAL (10 in.)				
	CLAY, Firm to Stiff, Dark Brown, with a trace of gravel	13			
		7		42	
5		10			
	CLAY, Stiff to Hard, Tan	13			
10		15		49	
15			93		
20	- with calcareous deposits and glauconite above 19 ft	20		60	
25		27			
30		49			
35			112		
		50			

DEPTH DRILLED: 45.0 ft
DATE DRILLED: 8/30/2013
DEPTH TO WATER: DRY
DATE MEASURED: 8/30/2013
PROJ. No.: ASA13-073-00
FIGURE: 3a

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-2

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35719; W 98.62141

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5–4.0) / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT (10–80)	PLASTICITY INDEX	% -200
			CLAY, Stiff to Hard, Tan *(continued)*					
				50/10"		Water content ≈ 18		
45			Boring Terminated					
50								
55								
60								
65								
70								
75								

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	45.0 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/30/2013	**DATE MEASURED:**	8/30/2013	**FIGURE:**	3b

LOG OF BORING NO. B-3

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35639; W 98.61761

SHEAR STRENGTH, TONS/FT²: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0
PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70, 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (5 in.)				
	BASE MATERIAL (5 in.)				
	CLAY, Very Stiff to Hard, Dark Brown, with a trace of gravel	21		53	
		24			
5		50/11"			
	CLAY, Stiff to Hard, Tan	12			
10		17			
15			102		
20		50/8"			
25		47			
30		50/9"			
35			104		
		40			

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 45.0 ft
DATE DRILLED: 8/29/2013
DEPTH TO WATER: DRY
DATE MEASURED: 8/29/2013
PROJ. No.: ASA13-073-00
FIGURE: 4a

LOG OF BORING NO. B-3

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35639; W 98.61761

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT	PLASTICITY INDEX	% -200
			CLAY, Stiff to Hard, Tan *(continued)*					
				50		Water content ≈ 18		
45			Boring Terminated					

Shear strength scale: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0
Water content scale: 10, 20, 30, 40, 50, 60, 70, 80

Depth scale: 45, 50, 55, 60, 65, 70, 75

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	45.0 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/29/2013	**DATE MEASURED:**	8/29/2013	**FIGURE:**	4b

LOG OF BORING NO. B-4

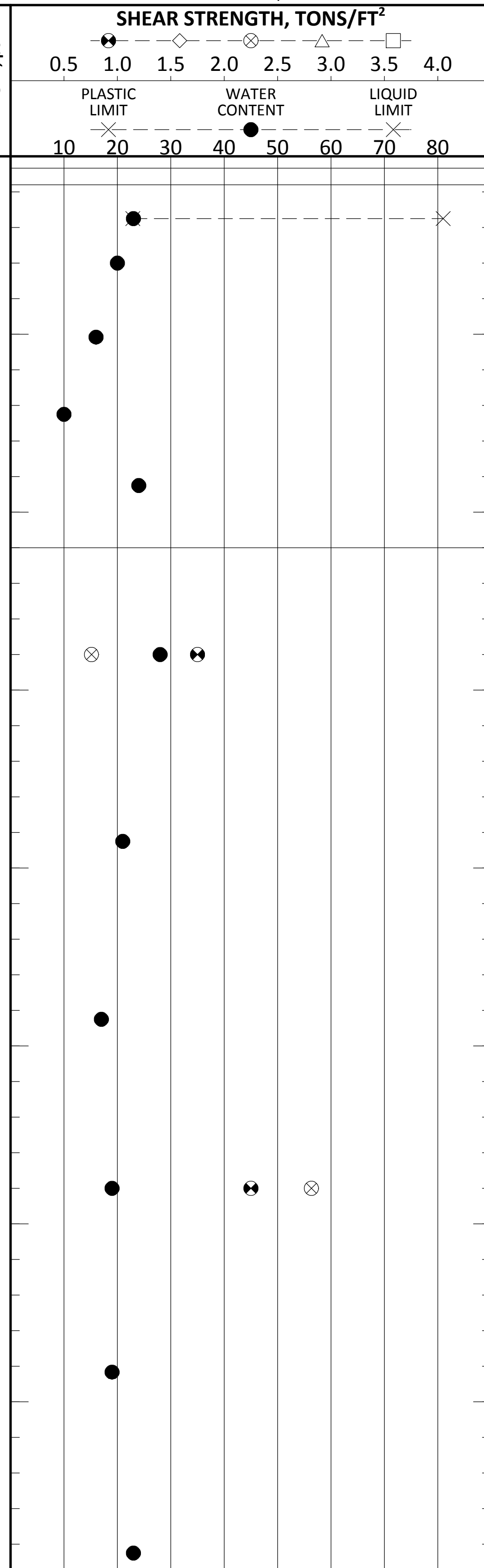
Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35644; W 98.61657

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
			ASPHALT (4 in.)				
			BASE MATERIAL (6 in.)				
			CLAY, Stiff to Hard, Dark Brown, with a trace of gravel	13		58	
				50/6"			
5				50/8"			
				45			
10				40			
			CLAY, Hard, Tan				
15					99		
20				38			
25				49			
30					112		
35				50/10"			
				44			



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	44.7 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/29/2013	**DATE MEASURED:**	8/29/2013	**FIGURE:**	5a

LOG OF BORING NO. B-4

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35644; W 98.61657

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0) / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT (10 20 30 40 50 60 70 80)	PLASTICITY INDEX	% -200
			CLAY, Hard, Tan *(continued)*					
				50/10"		● (water content ≈ 19)		
45			Boring Terminated					
50								
55								
60								
65								
70								
75								

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	44.7 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/29/2013	**DATE MEASURED:**	8/29/2013	**FIGURE:**	5b

LOG OF BORING NO. B-5

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35599; W 98.61249

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0–2	FILL MATERIAL (2 ft)	50/7"		26	
2–4	CLAY, Very Stiff, Dark Brown, with a trace of gravel	16			
4–	CLAY, Very Stiff to Hard, Tan	15			
		34			
		41			
		34			
			108		
		36			
		50/10"			
			105		
		50/9"			

Depth scale: 5, 10, 15, 20, 25, 30, 35

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	44.2 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/28/2013	**DATE MEASURED:**	8/28/2013	**FIGURE:**	6a

LOG OF BORING NO. B-5

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35599; W 98.61249

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5–4.0) / PLASTIC LIMIT – WATER CONTENT – LIQUID LIMIT (10–80)	PLASTICITY INDEX	% -200
			CLAY, Very Stiff to Hard, Tan *(continued)*					
				50/3"		Water content ≈ 18		
45			Boring Terminated					
50								
55								
60								
65								
70								
75								

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	44.2 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/28/2013	**DATE MEASURED:**	8/28/2013	**FIGURE:**	6b

LOG OF BORING NO. B-6

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35564; W 98.61185

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0) / PLASTIC LIMIT, WATER CONTENT, LIQUID LIMIT (10 20 30 40 50 60 70 80)	PLASTICITY INDEX	% -200
			ASPHALT (6 in.)					
			BASE MATERIAL (4 in.)					
			CLAY, Very Stiff, Dark Brown, with a trace of gravel	18				
				15			52	
5				18				
			CLAY, Very Stiff to Hard, Tan	21				
					116			
10								
15				40				
20				44				
					111			
25								
30				43				
35				44				
				49				

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	44.7 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/28/2013	**DATE MEASURED:**	8/28/2013	**FIGURE:**	7a

LOG OF BORING NO. B-6

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger **LOCATION:** N 29.35564; W 98.61185

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0) / PLASTIC LIMIT, WATER CONTENT, LIQUID LIMIT (10 20 30 40 50 60 70 80)	PLASTICITY INDEX	% -200
			CLAY, Very Stiff to Hard, Tan *(continued)*					
				50/10"		● (water content ≈ 22)		
45			Boring Terminated					
50								
55								
60								
65								
70								
75								

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	44.7 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/28/2013	**DATE MEASURED:**	8/28/2013	**FIGURE:**	7b

LOG OF BORING NO. P-1

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.36079; W 98.63145

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (4 in.)				
	BASE MATERIAL (12 in.)				
	CLAY, Very stiff to Hard, Brown	23		10	
		44			28
5		14			
	CLAY, Very Stiff, Tan, with calcareous deposits.	16			
		20			
10	Boring Terminated				

Depth scale: 5, 10, 15, 20, 25, 30, 35

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/27/2013	**DATE MEASURED:**	8/27/2013	**FIGURE:**	8

LOG OF BORING NO. P-2

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35927; W 98.62914

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (12 in.)				
	BASE MATERIAL (3 in.)				
	CLAY, Very Stiff to Hard, Brown	22		51	
		35			
	CLAY, Stiff,Tan, with chert, and calcareous deposits				
5		24			
		12			
		13			
10	Boring Terminated				

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

Depth scale: 5, 10, 15, 20, 25, 30, 35

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/27/2013	**DATE MEASURED:**	8/27/2013	**FIGURE:**	9

LOG OF BORING NO. P-3

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35789; W 98.62662

Shear strength legend: SHEAR STRENGTH, TONS/FT² (0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0); PLASTIC LIMIT, WATER CONTENT, LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70, 80)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	ASPHALT (5 in.)				
	BASE MATERIAL (7 in.)				
	CLAY, Very Stiff to Hard, Brown, with trace gravel	34		58	
		14			
5		26		55	
6	CLAY, Very Stiff to Hard, Tan	21			
		30			
10	Boring Terminated				

Depth scale: 5, 10, 15, 20, 25, 30, 35

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/27/2013	**DATE MEASURED:**	8/27/2013	**FIGURE:**	10

LOG OF BORING NO. P-4

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35745; W 98.62363

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5 – 4.0); PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 – 80)	PLASTICITY INDEX	% -200
0			ASPHALT (5 in.)					
			BASE MATERIAL (11 in.)					
		X	CLAY, Very Stiff, Brown, with trace gravel	25		PL ≈ 20, WC ≈ 23, LL ≈ 62	41	
		X		24		WC ≈ 26		
5		X		15		WC ≈ 27		
		X	CLAY, Very Stiff, Tan, with calcareous deposits	14		WC ≈ 27		
		X		16		WC ≈ 30		
10			Boring Terminated					

Depth scale: 5, 10, 15, 20, 25, 30, 35

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 8/27/2013
DEPTH TO WATER: DRY
DATE MEASURED: 8/27/2013
PROJ. No.: ASA13-073-00
FIGURE: 11

LOG OF BORING NO. P-5

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35696; W 98.61995

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT²: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 / PLASTIC LIMIT, WATER CONTENT, LIQUID LIMIT: 10 20 30 40 50 60 70 80	PLASTICITY INDEX	% -200
			ASPHALT (9 in.)					
			BASE MATERIAL (6 in.)					
			CLAY, Very Stiff to Hard, Brown, with trace gravel	32				
				23			43	
5				40			52	
			CLAY, Very Stiff, Tan	25				90
				27				
10			Boring Terminated					
15								
20								
25								
30								
35								

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 8/27/2013
DEPTH TO WATER: DRY
DATE MEASURED: 8/27/2013
PROJ. No.: ASA13-073-00
FIGURE: 12

LOG OF BORING NO. P-6

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35670; W 98.61856

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² / PLASTIC LIMIT, WATER CONTENT, LIQUID LIMIT	PLASTICITY INDEX	% -200
			ASPHALt (4-1/2 in.)					
			BASE MATERIAL (3 in.)					
			CLAY, Very Stiff to Hard, Dark Brown, with trace gravel	30			52	
				21				
5			CLAY, Very Stiff, Tan, with chert, and Calcareous deposits	50				
				18				22
				25				
10			Boring Terminated					

Shear strength scale: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0
Water content scale: 10, 20, 30, 40, 50, 60, 70, 80

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/27/2013	**DATE MEASURED:**	8/27/2013	**FIGURE:**	13

LOG OF BORING NO. P-7

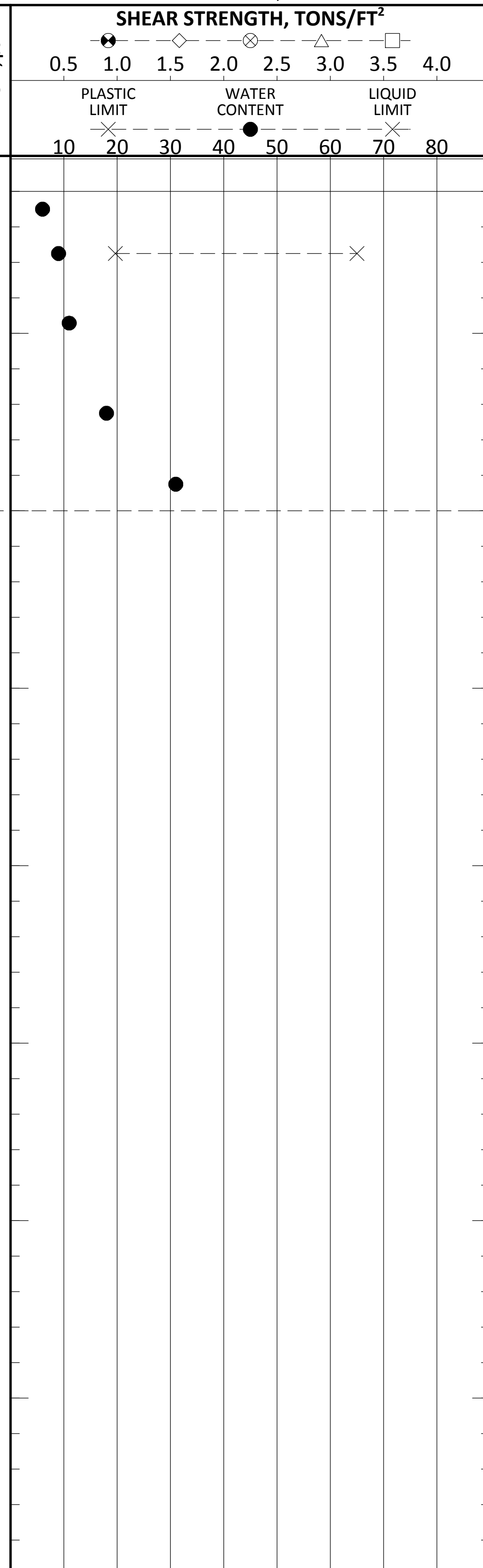
Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35609; W 98.61455

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (1 in.)				
	BASE MATERIAL (12 in.)	50			
	CLAY, Very Stiff to Hard, Tan, with chert, and calcareous deposits	ref/6"		45	
5		ref/5"			
		21			
		22			
10	Boring Terminated				



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 8/27/2013
DEPTH TO WATER: DRY
DATE MEASURED: 8/27/2013
PROJ. No.: ASA13-073-00
FIGURE: 14

LOG OF BORING NO. P-8

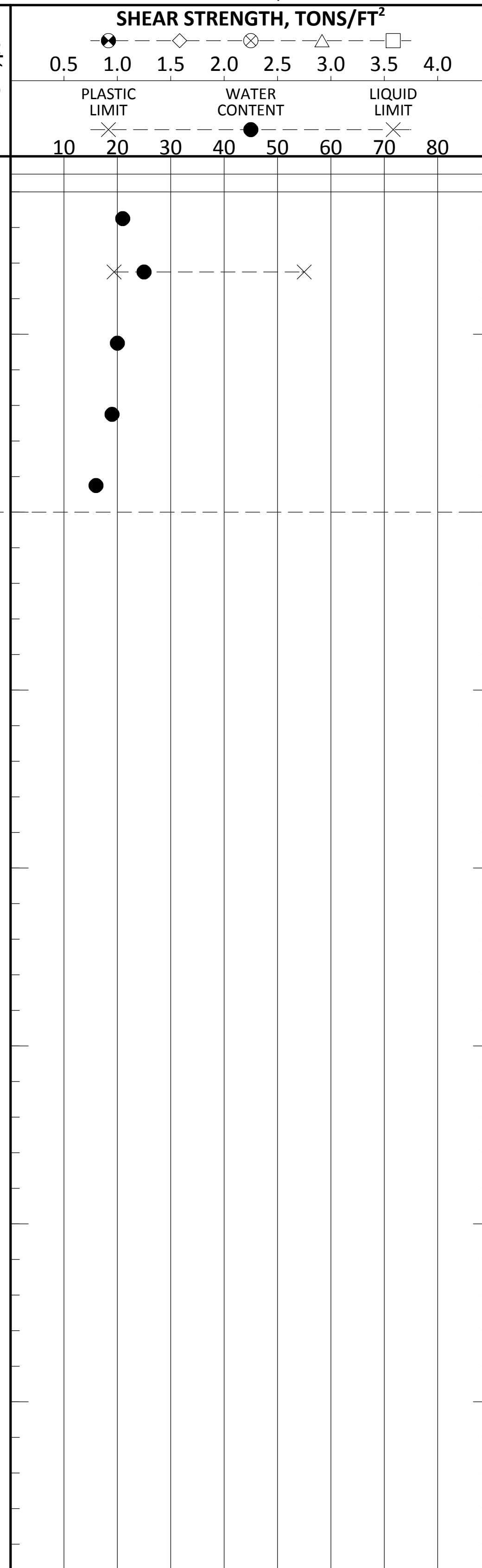
Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35538; W 98.60986

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (6 in.)				
	BASE MATERIAL (6 in.)				
	CLAY, Very Stiff to Hard, Tan, with chert, and calcareous deposits	22			
		15		36	
5		23			
		40			
		38			
10	Boring Terminated				



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/27/2013	**DATE MEASURED:**	8/27/2013	**FIGURE:**	15

LOG OF BORING NO. P-9

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35515; W 98.60772

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	ASPHALT (6 in.)				
	BASE MATERIAL (4 in.)				
	CLAY, Stiff, Brown, with trace gravel	22		36	
3	CLAY, Very Stiff, Tan, with chert, and calcareous deposits	11			
5		22			
		23			
		18			
10	Boring Terminated				

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

Depth scale: 5, 10, 15, 20, 25, 30, 35

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 8/27/2013
DEPTH TO WATER: DRY
DATE MEASURED: 8/27/2013
PROJ. No.: ASA13-073-00
FIGURE: 16

LOG OF BORING NO. P-10

Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35479; W 98.60574

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (6 in.)				
	BASE MATERIAL (5 in.)				
	CLAY, Very Stiff to Hard, Brown, with trace gravel	23		37	
		31			
	CLAY, Very Stiff to Hard, Tan, with chert, and calcareous deposits				
5		17			
		24			
		41			
10	Boring Terminated				
15					
20					
25					
30					
35					

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 8/27/2013
DEPTH TO WATER: DRY
DATE MEASURED: 8/27/2013
PROJ. No.: ASA13-073-00
FIGURE: 17

LOG OF BORING NO. P-11

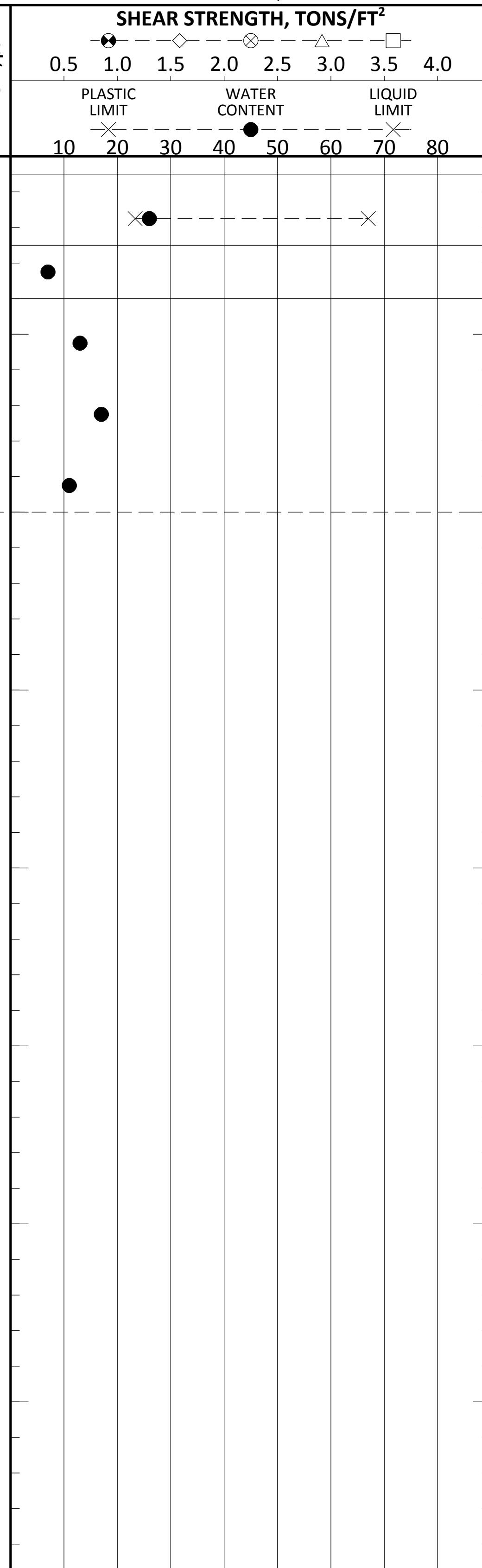
Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.35448; W 98.60408

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0 – 0.5	ASPHALT (6 in.)				
0.5 – 2.5	BASE MATERIAL (24 in.)	27		44	
2.5 – 4	CLAY, Very Stiff to Hard, Brown, with trace gravel	48			20
4 – 10	CLAY, Very Stiff to Hard, Tan, with chert, and calcareous deposits	21			
		20			
		50			
10	Boring Terminated				



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	DRY	**PROJ. No.:**	ASA13-073-00
DATE DRILLED:	8/27/2013	**DATE MEASURED:**	8/27/2013	**FIGURE:**	18

KEY TO TERMS AND SYMBOLS

MATERIAL TYPES

SOIL TERMS

CALCAREOUS
PEAT
CALICHE
SAND
CLAY
SANDY
CLAYEY
SILT
GRAVEL
SILTY
GRAVELLY
FILL

ROCK TERMS

CHALK
LIMESTONE
CLAYSTONE
MARL
CLAY-SHALE
METAMORPHIC
CONGLOMERATE
SANDSTONE
DOLOMITE
SHALE
IGNEOUS
SILTSTONE

OTHER

ASPHALT
BASE
CONCRETE/CEMENT
BRICKS / PAVERS
WASTE
NO INFORMATION

WELL CONSTRUCTION AND PLUGGING MATERIALS

BLANK PIPE
BENTONITE
BENTONITE & CUTTINGS
CUTTINGS
SAND
SCREEN
CEMENT GROUT
CONCRETE/CEMENT
GRAVEL
VOLCLAY

SAMPLE TYPES

AIR ROTARY
MUD ROTARY
SHELBY TUBE
GRAB SAMPLE
NO RECOVERY
SPLIT BARREL
CORE
NX CORE
SPLIT SPOON
GEOPROBE SAMPLER
PITCHER
TEXAS CONE PENETROMETER
ROTOSONIC -DAMAGED
ROTOSONIC -INTACT
DISTURBED

STRENGTH TEST TYPES

POCKET PENETROMETER
TORVANE
UNCONFINED COMPRESSION
TRIAXIAL COMPRESSION UNCONSOLIDATED-UNDRAINED
TRIAXIAL COMPRESSION CONSOLIDATED-UNDRAINED

NOTE: VALUES SYMBOLIZED ON BORING LOGS REPRESENT SHEAR STRENGTHS UNLESS OTHERWISE NOTED

PROJECT NO. ASA13-073-00

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

Terms used in this report to describe soils with regard to their consistency or conditions are in general accordance with the discussion presented in Article 45 of SOILS MECHANICS IN ENGINEERING PRACTICE, Terzaghi and Peck, John Wiley & Sons, Inc., 1967, using the most reliable information available from the field and laboratory investigations. Terms used for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in American Society for Testing and Materials D2487-06 and D2488-00, Volume 04.08, Soil and Rock; Dimension Stone; Geosynthetics; 2005.

The depths shown on the boring logs are not exact, and have been estimated to the nearest half-foot. Depth measurements may be presented in a manner that implies greater precision in depth measurement, i.e 6.71 meters. The reader should understand and interpret this information only within the stated half-foot tolerance on depth measurements.

RELATIVE DENSITY

Penetration Resistance Blows per ft	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
> 50	Very Dense

COHESIVE STRENGTH

Resistance Blows per ft	Consistency	Cohesion TSF
0 - 2	Very Soft	0 - 0.125
2 - 4	Soft	0.125 - 0.25
4 - 8	Firm	0.25 - 0.5
8 - 15	Stiff	0.5 - 1.0
15 - 30	Very Stiff	1.0 - 2.0
> 30	Hard	> 2.0

PLASTICITY

Plasticity Index	Degree of Plasticity
0 - 5	None
5 - 10	Low
10 - 20	Moderate
20 - 40	Plastic
> 40	Highly Plastic

ABBREVIATIONS

B = Benzene
T = Toluene
E = Ethylbenzene
X = Total Xylenes
BTEX = Total BTEX
TPH = Total Petroleum Hydrocarbons
ND = Not Detected
NA = Not Analyzed
NR = Not Recorded/No Recovery
OVA = Organic Vapor Analyzer
ppm = Parts Per Million

Qam, Qas, Qal = Quaternary Alluvium
Qat = Low Terrace Deposits
Qbc = Beaumont Formation
Qt = Fluviatile Terrace Deposits
Qao = Seymour Formation
Qle = Leona Formation
Q-Tu = Uvalde Gravel
Ewi = Wilcox Formation
Emi = Midway Group
Mc = Catahoula Formation
EI = Laredo Formation
Kknm = Navarro Group and Marlbrook Marl
Kpg = Pecan Gap Chalk
Kau = Austin Chalk

Kef = Eagle Ford Shale
Kbu = Buda Limestone
Kdr = Del Rio Clay
Kft = Fort Terrett Member
Kgt = Georgetown Formation
Kep = Person Formation
Kek = Kainer Formation
Kes = Escondido Formation
Kew = Walnut Formation
Kgr = Glen Rose Formation
Kgru = Upper Glen Rose Formation
Kgrl = Lower Glen Rose Formation
Kh = Hensell Sand

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.
Carbonate	Having more than 50% carbonate content.

SAMPLING METHODS

RELATIVELY UNDISTURBED SAMPLING

Cohesive soil samples are to be collected using three-inch thin-walled tubes in general accordance with the Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587) and granular soil samples are to be collected using two-inch split-barrel samplers in general accordance with the Standard Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). Cohesive soil samples may be extruded on-site when appropriate handling and storage techniques maintain sample integrity and moisture content.

STANDARD PENETRATION TEST (SPT)

A 2-in.-OD, 1-3/8-in.-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

NOTE: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

FILE NAME: GINT STD US LAB.GPJ 9/17/2013

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-1	1.0 to 2.5	33	12								
	2.5 to 4.0	19	21	80	22	58	CH				
	4.5 to 6.0	44	16								
	6.5 to 8.0	16	26								
	8.5 to 10.0	17	28	77	25	52	CH				
	13.0 to 15.0		28					96		1.79	UC
	18.5 to 20.0	35	24	71	19	52	CH				
	23.5 to 25.0	19	30								
	28.0 to 30.0		21					105		0.84	UC
	33.5 to 35.0	36	19								
	38.5 to 39.9	50/11"	18								
	43.5 to 44.8	50/9"	18								
B-2	1.0 to 2.5	13	25								
	2.5 to 4.0	7	26	63	21	42	CH				
	4.5 to 6.0	10	29								
	6.5 to 8.0	13	29								
	8.5 to 10.0	15	30	71	22	49	CH				
	13.0 to 15.0		31					93		1.32	UC
	18.5 to 20.0	20	24	80	20	60	CH				
	23.5 to 25.0	27	25								
	28.5 to 30.0	49	19								
	33.0 to 35.0		19					112		2.75	UC
	38.5 to 40.0	50	18								
	43.5 to 44.8	50/10"	18								
B-3	1.0 to 2.5	21	28	76	23	53	CH				
	2.5 to 4.0	24	26								
	4.5 to 5.9	50/11"	14								
	6.5 to 8.0	12	21								
	8.5 to 10.0	17	17								
	13.0 to 15.0		23					102		0.89	UC
	18.5 to 19.7	50/8"	19								
	23.5 to 25.0	47	17								
	28.5 to 29.7	50/9"	22								
	33.5 to 35.0		23					104		2.19	UC
	38.5 to 40.0	40	20								
	43.5 to 45.0	50	18								
B-4	1.0 to 2.5	13	23	81	23	58	CH				
	2.5 to 3.5	50/6"	20								
	4.5 to 5.7	50/8"	16								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ASA13-073-00

RABA KISTNER

FIGURE 20a

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

FILE NAME: GINT STD US LAB.GPJ 9/17/2013

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-4	6.5 to 8.0	45	10								
	8.5 to 10.0	40	24								
	13.0 to 15.0		28					99		0.76	UC
	18.5 to 20.0	38	21								
	23.5 to 25.0	49	17								
	28.0 to 30.0		19					112		2.82	UC
	33.5 to 34.8	50/10"	19								
	38.5 to 40.0	44	23								
	43.5 to 44.8	50/10"	19								
B-5	0.0 to 1.1	50/7"	6	40	14	26	CL				
	2.5 to 4.0	16	10								
	4.5 to 6.0	15	17								
	6.5 to 8.0	34	16								
	8.5 to 10.0	41	15								
	13.5 to 15.0	34	18								
	18.0 to 20.0		20					108		2.08	UC
	23.5 to 25.0	36	24								
	28.5 to 29.7	50/10"	18								
	33.0 to 35.0		19					105		1.16	UC
	38.5 to 39.7	50/9"	20								
	43.5 to 44.3	50/3"	18								
B-6	1.0 to 2.5	18	8								
	2.5 to 4.0	15	28	72	20	52	CH				
	4.5 to 6.0	18	21								
	6.5 to 8.0	21	19								
	8.0 to 10.0		17					116		1.27	UC
	13.5 to 15.0	40	20								
	18.5 to 20.0	44	19								
	23.0 to 25.0		18					111		2.10	UC
	28.5 to 30.0	43	15								
	33.5 to 35.0	44	19								
	38.5 to 40.0	49	23								
	43.5 to 44.8	50/10"	22								
P-1	1.0 to 2.5	23	9	24	14	10	CL				
	2.5 to 4.0	44	9						28		
	4.5 to 6.0	14	16								
	6.5 to 8.0	16	19								
	8.5 to 10.0	20	23								
P-2	1.0 to 2.5	22	34	79	28	51	CH				

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ASA13-073-00

RABAKISTNER

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

FILE NAME: GINT STD US LAB.GPJ 9/17/2013

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
P-2	2.5 to 4.0	35	7								
	4.5 to 6.0	24	8								
	6.5 to 8.0	12	23								
	8.5 to 10.0	13	26								
P-3	1.0 to 2.5	34	16	81	23	58	CH				
	2.5 to 4.0	14	20								
	4.5 to 6.0	26	22	76	21	55	CH				
	6.5 to 8.0	21	20								
	8.5 to 10.0	30	20								
P-4	1.0 to 2.5	25	23	62	21	41	CH				
	2.5 to 4.0	24	26								
	4.5 to 6.0	15	27								
	6.5 to 8.0	14	27								
	8.5 to 10.0	16	30								
P-5	1.0 to 2.5	32	12								
	2.5 to 4.0	23	22	61	18	43	CH				
	4.5 to 6.0	40	19	73	21	52	CH				
	6.5 to 8.0	25	24						90		
	8.5 to 10.0	27	21								
P-6	1.0 to 2.5	30	26	74	22	52	CH				
	2.5 to 4.0	21	27								
	4.5 to 6.0	50	9								
	6.5 to 8.0	18	18						22		
	8.5 to 10.0	25	18								
P-7	1.0 to 2.0	50	6								
	2.5 to 3.0	ref/6"	9	65	20	45	CH				
	4.5 to 4.9	ref/5"	11								
	6.5 to 8.0	21	18								
	8.5 to 10.0	22	31								
P-8	1.0 to 2.5	22	21								
	2.5 to 4.0	15	25	55	19	36	CH				
	4.5 to 6.0	23	20								
	6.5 to 8.0	40	19								
	8.5 to 10.0	38	16								
P-9	1.0 to 2.5	22	17	56	20	36	CH				
	2.5 to 4.0	11	15								
	4.5 to 6.0	22	18								
	6.5 to 8.0	23	19								
	8.5 to 10.0	18	19								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ASA13-073-00

RABA KISTNER

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Ray Ellison Boulevard (CIMS)
Loop 410 to Old Pearsall Road
San Antonio, Texas

FILE NAME: GINT STD US LAB.GPJ 9/17/2013

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
P-10	1.0 to 2.5	23	24	57	20	37	CH				
	2.5 to 4.0	31	18								
	4.5 to 6.0	17	12								
	6.5 to 8.0	24	10								
	8.5 to 10.0	41	13								
P-11	1.0 to 2.5	27	26	67	23	44	CH				
	2.5 to 4.0	48	7						20		
	4.5 to 6.0	21	13								
	6.5 to 8.0	20	17								
	8.5 to 10.0	50	11								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

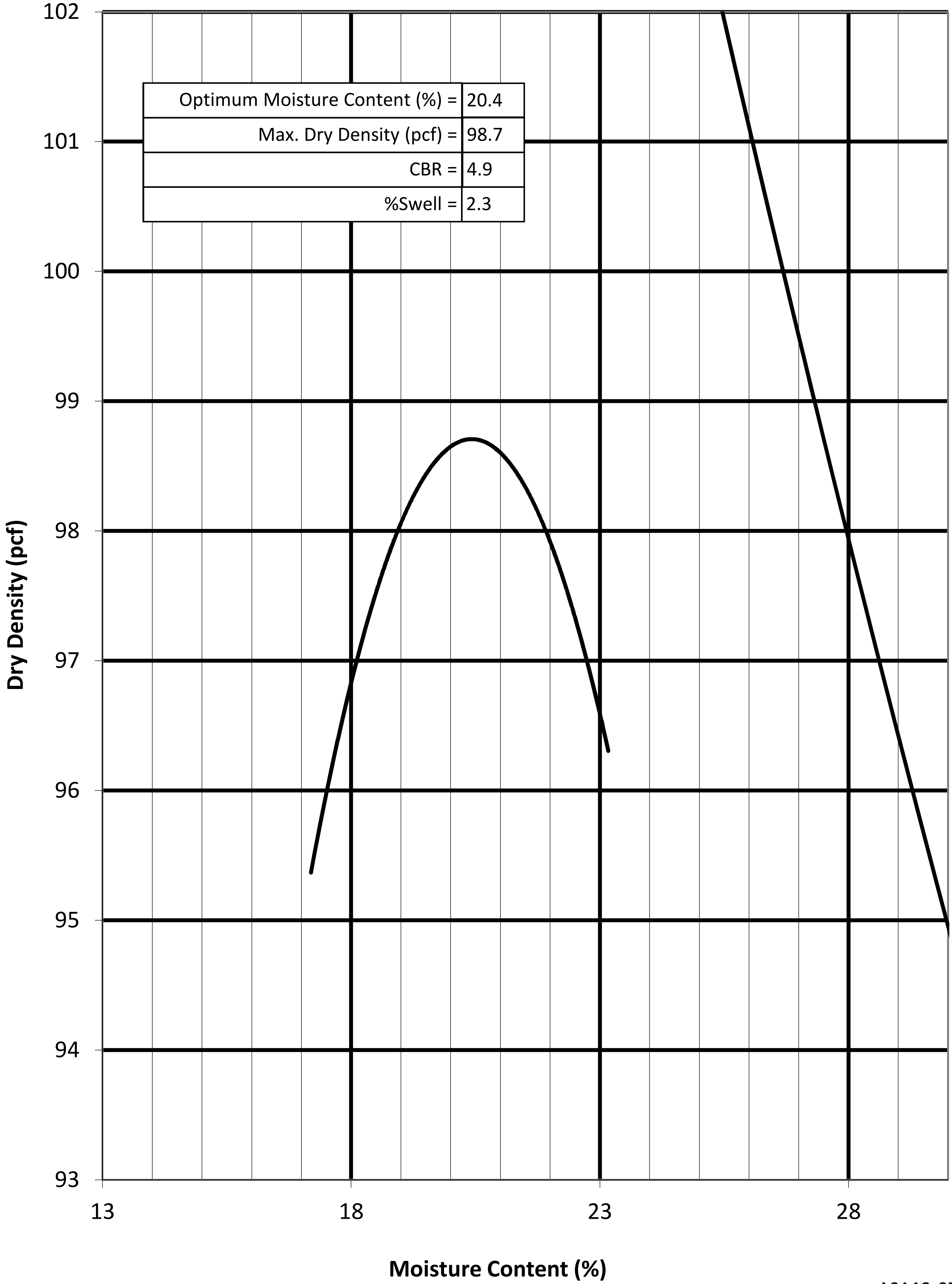
CU = Consolidated Undrained Triaxial

PROJECT NO. ASA13-073-00

RABA KISTNER

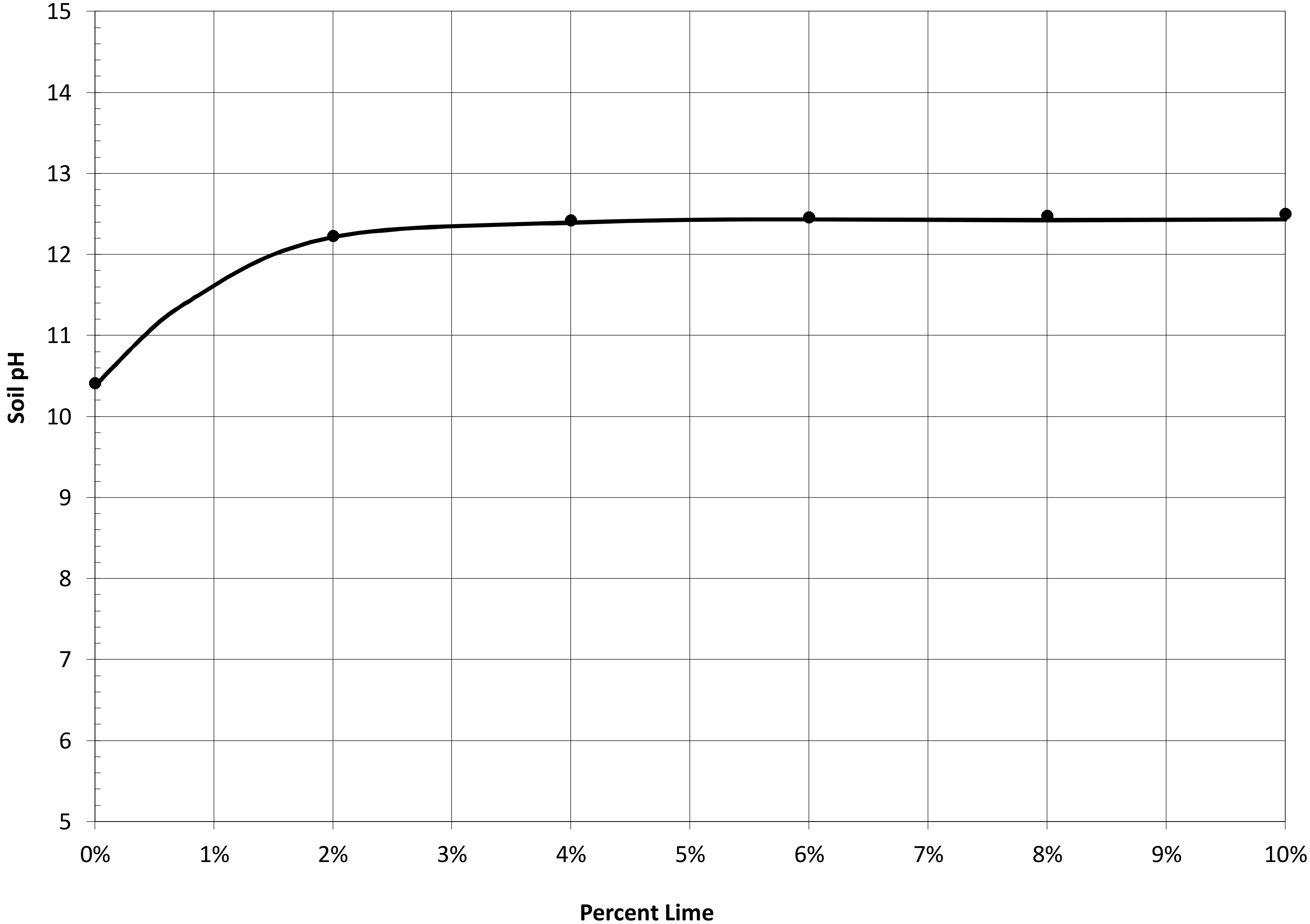
MOISTURE DENSITY RELATIONSHIP CURVE

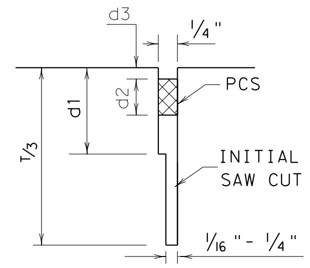
Ray Ellison Boulevard (CIMS)



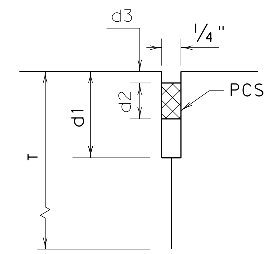
pH-LIME SERIES CURVE

Ray Ellison Boulevard (CIMS)



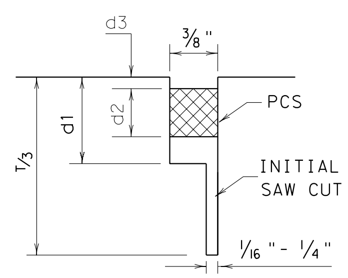


SAWED
LONGITUDINAL JOINT

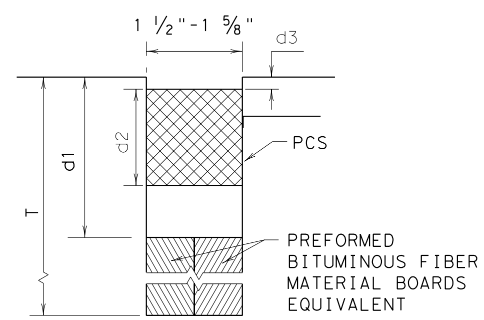


LONGITUDINAL
CONSTRUCTION JOINT

LONGITUDINAL JOINT SEALS



SAWED
CONTRACTION JOINT



FORMED
FORMED EXPANSION JOINT

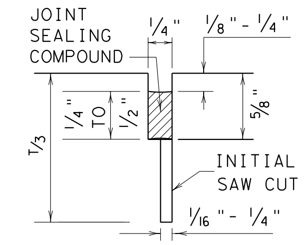
TRANSVERSE JOINT SEALS

METHOD A: PREFORMED COMPRESSION SEALS (PCS)

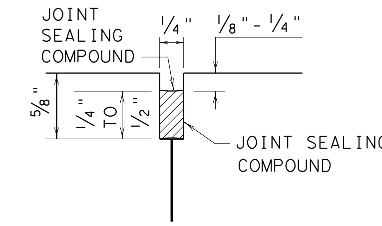
(CLASS 6 PREFORMED JOINT SEALANT)

GENERAL NOTES FOR METHOD "A"

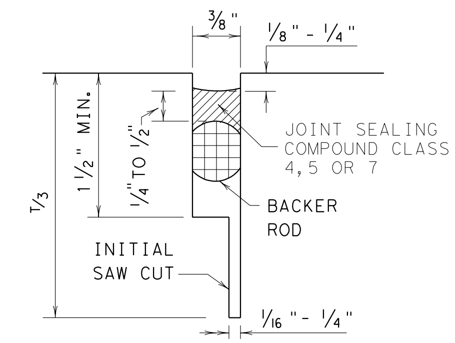
1. UNLESS OTHERWISE SHOWN IN THE PLANS, EITHER METHOD "A" OR METHOD "B" MAY BE USED.
2. THE LOCATION OF JOINTS SHALL BE AS SHOWN ELSEWHERE IN THE PLANS.
3. DIMENSIONS d1, d2, AND d3 SHALL BE IN ACCORDANCE WITH THE PREFORMED COMPRESSION SEAL MANUFACTURES RECOMMENDATION.
4. THE JOINT RESERVOIR FOR SEALANT SHALL BE SAWED UNLESS OTHERWISE SHOWN ON THE PLANS FOR THE LONGITUDINAL AND TRANSVERSE CONSTRUCTION AND THE TWO SAWED JOINTS.
5. THE JOINTS SHALL BE CLEANED IN ACCORDANCE WITH THE ITEM 438 AND PRIOR TO BEGINNING OPERATIONS, THE CONTRACTOR SHALL SUBMIT A STATEMENT FROM THE SEALANT MANUFACTURER SHOWING THE RECOMMENDED EQUIPMENT AND INSTALLATION PROCEDURES TO BE USED.
6. THE SAW CUT FOR THE LONGITUDINAL JOINT SHALL BE ONE FOURTH THE SLAB THICKNESS WHEN CRUSHED LIMESTONE IS USED AS THE COARSE AGGREGATE.



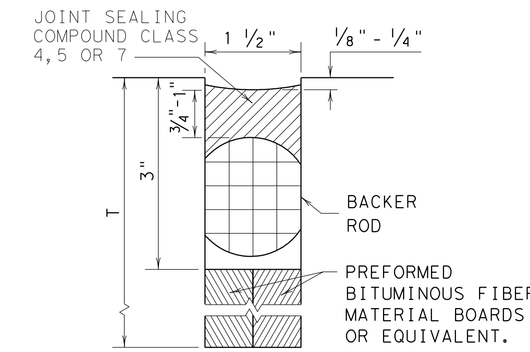
SAWED
LONGITUDINAL JOINT



LONGITUDINAL OR TRANSVERSE
CONSTRUCTION JOINT



TRANSVERSE SAWED
CONTRACTION JOINT



TRANSVERSE FORMED
EXPANSION JOINT

METHOD B: JOINT SEALING COMPOUND

GENERAL NOTES FOR METHOD "B"

1. UNLESS OTHERWISE SHOWN IN THE PLANS, EITHER METHOD "A" OR METHOD "B" MAY BE USED.
2. THE LOCATION OF JOINTS SHALL BE AS SHOWN ELSEWHERE IN THE PLANS.
3. THE ENGINEER SHALL SELECT A TARGET PLACEMENT THICKNESS FOR THE SEALANT DETAILS WHICH SHOW RANGES IN THICKNESS. THE TARGET THICKNESS WILL NORMALLY BE THE MIDPOINT OF THE RANGE.
4. THE JOINT RESERVOIR FOR SEALANT SHALL BE SAWED UNLESS OTHERWISE SHOWN ON THE PLANS FOR THE LONGITUDINAL AND TRANSVERSE CONSTRUCTION AND THE TWO SAWED JOINTS.
5. THE JOINTS SHALL BE CLEANED IN ACCORDANCE WITH THE ITEM 438 AND PRIOR TO BEGINNING OPERATIONS, THE CONTRACTOR SHALL SUBMIT A STATEMENT FROM THE SEALANT MANUFACTURER SHOWING THE RECOMMENDED EQUIPMENT AND INSTALLATION PROCEDURES TO BE USED.
6. THE SAW CUT FOR THE LONGITUDINAL JOINT SHALL BE ONE FOURTH THE SLAB THICKNESS WHEN CRUSHED LIMESTONE IS USED AS THE COARSE AGGREGATE.

PROJECT No. ASA13-073-00
Figure 23A

Texas Department of Transportation
Construction Division (Pavement)

CONCRETE PAVING DETAILS
JOINT SEALS

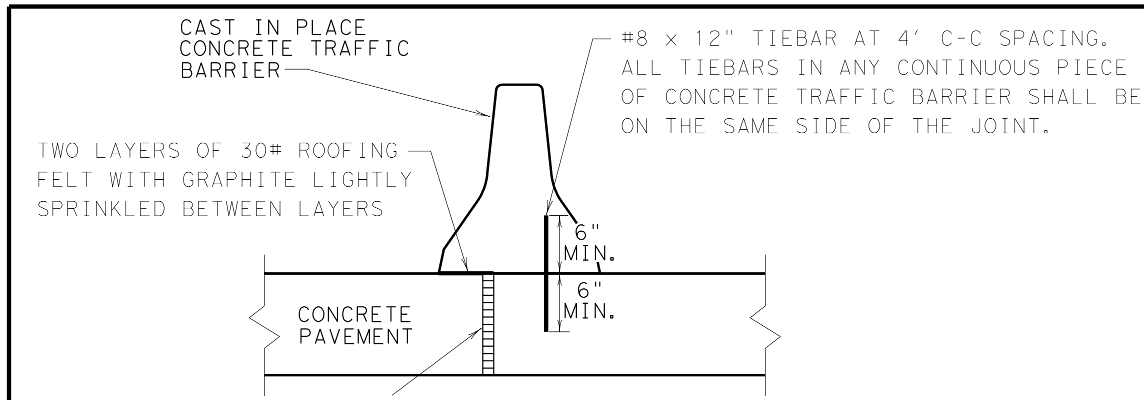
JS-94

DN: LJB	CK: LJB	DW: BGD	CK: GLG

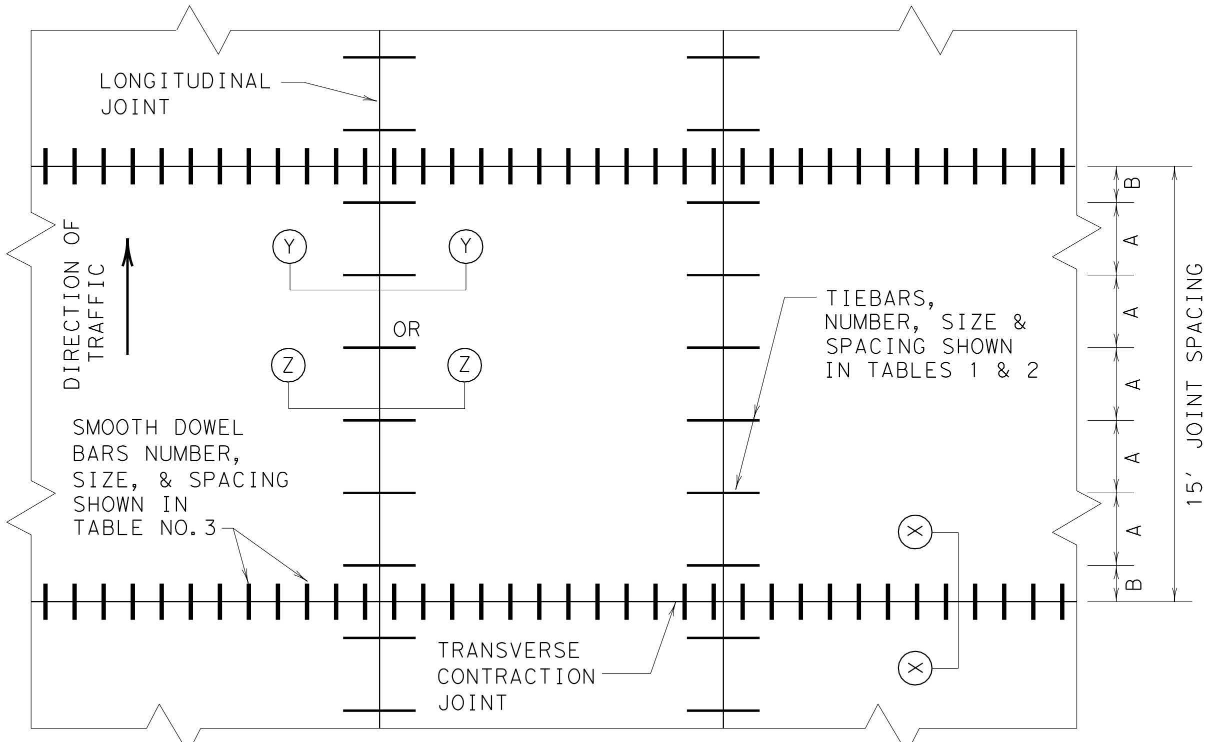
MODIFICATIONS

DISTRICT	FEDERAL AID PROJECT			SHEET
COUNTY	CONTROL	SECTION	JOB	HIGHWAY

LEVELS DISPLAYED
1



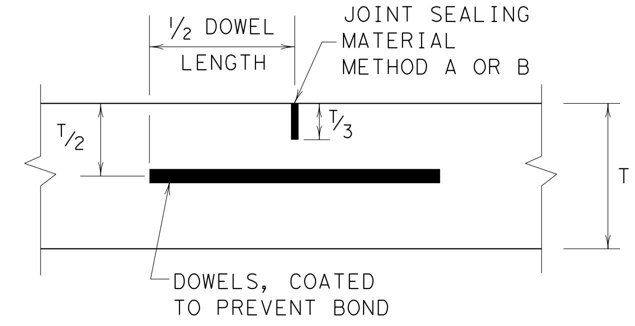
FREE LONGITUDINAL JOINT DETAIL



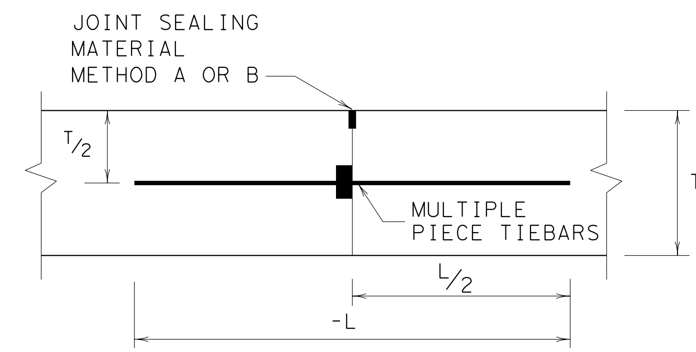
PAVEMENT DETAIL LAYOUT

TABLE NO. 1 TIEBARS REQUIRED FOR LONGITUDINAL JOINT JOINTS FOR EACH 15' SLAB						
ASTM A-616 OR A-615 (GRADE 60) STRAIGHT OR MULIPLE PIECE REINFORCING TIEBARS		CONCRETE SLAB THICKNESS	DISTANCE FROM THE LONGITUDINAL JOINT TO THE NEAREST LONGITUDINAL FREE EDGE			
			< OR =16'	< OR =24'	< OR =34'	< OR =50'
BAR LENGTH, "L" INCHES	BAR SIZE	"T" INCHES	REQUIRED NO. OF BARS	REQUIRED NO. OF BARS	REQUIRED NO. OF BARS	REQUIRED NO. OF BARS
42	#5 (5/8")	8	5	5	6	9
		9	5	5	7	10
		10	5	5	7	11
		11	5	6	8	12
		12	5	6	9	13
		13	5	7	9	13
		14	6	7	10	NA
		15	6	8	11	NA
50	#6 (3/4")	8	5	5	5	6
		9	5	5	5	7
		10	5	5	5	8
		11	5	5	6	8
		12	5	5	6	9
		13	5	5	7	10
		14	5	5	7	10
		15	5	6	8	11

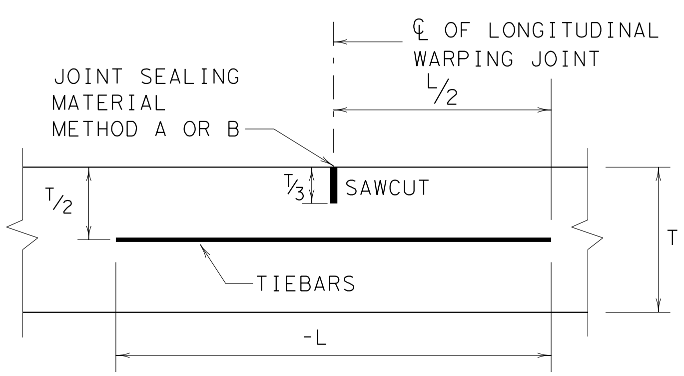
THE DISTANCE TO THE FREE EDGE WILL BE DETERMINED BY THE ENGINEER AND THE DISTANCE WILL BE BASED ON THE NOMINAL WIDTHS OF THE LANES AND SHOULDERS PLUS ANY TIED RAMPS OR CONNECTING ROADWAYS.



TRANSVERSE CONTRACTION JOINT
SECTION X-X



LONGITUDINAL CONSTRUCTION JOINT
SECTION Y-Y



LONGITUDINAL WARPING JOINT
SECTION Z-Z

TABLE NO. 2 TIEBAR SPACINGS		
SPACING REQUIREMENT FOR 15' SLAB FOR REQUIRED NUMBER OF BARS		
REQUIRED NO. OF BARS	REGUALR SPACING "A" INCHES	FIRST AT JOINT "B" INCHES
5	36	18
6	30	15
7	25	15
8	21	16.5
9	18	18
10	16	18
11	15	15
12	13	18.5
13	12	18

TABLE NO. 3 DOWELS REQUIEMENTS		
T, IN.	DOWELS (SMOOTH BARS)	
	SIZE AND LENGTH	AVERAGE SPACING (INCHES)
8	1" X 18"	12
9	1 1/8" X 18"	12
10	1 1/4" X 18"	12
11	1 3/8" X 18"	12
12	1 1/2" X 18"	12
13	1 5/8" X 18"	12
14	1 3/4" X 18"	12
15	1 7/8" X 18"	12

GENERAL NOTES

1. CONCRETE SLABS WIDER THAN 100' WITHOUT A FREE JOINT, ARE NOT COVERED BY THIS STANDARD.
2. FOR FURTHER INFORMATION REGARDING THE PLACEMENT OF CONCRETE AND LOAD TRANSFER DEVICES REFER TO THE GOVERNING SPECIFICATIONS FOR "CONCRETE PAVEMENT" AND "REINFORCING STEEL."
3. DETAILS FOR PAVEMENT WIDTH, PAVEMENT THICKNESS, AND CROWN CROSS SLOPE SHALL BE AS SHOWN ELSEWHERE IN THE PLANS.
4. THE DETAIL FOR THE JOINT SEALANT AND RESERVOIR WILL BE SHOWN IN CONCRETE PAVEMENT DETAIL, JOINT SEALANT STANDARD (JS-94).
5. PAVEMENT WIDTHS IN EXCESS OF 16' SHALL BE PROVIDED WITH A LONGITUDINAL JOINT (SECTION Z-Z OR Y-Y). THESE JOINTS SHALL BE LOCATED WITHIN 6" OF THE LANE LINES UNLESS SHOWN ELSEWHERE ON THE PLANS.
6. THE JOINT BETWEEN OUTSIDE LANE AND SHOULDER SHALL BE A LONGITUDINAL WARPING JOINT (SECTION Z-Z) UNLESS OTHERWISE SHOWN IN THE PLANS.
7. THE SPACING BETWEEN TRANSVERSE JOINTS SHALL BE 15 FEET UNLESS OTHERWISE SHOWN IN THE PLANS.
8. WHERE A MONOLITHIC CURB IS SPECIFIED, THE JOINT IN THE CURB SHALL COINCIDE WITH PAVEMENT JOINTS AND MAY BE FORMED BY ANY MEANS APPROVED BY THE ENGINEER.
9. TRANSVERSE CONSTRUCTION JOINTS MAY BE FORMED BY USE OF METAL OR WOOD FORMS EQUAL IN DEPTH TO THE NOMINAL DEPTH OF THE PAVEMENT, OR BY METHODS APPROVED BY THE ENGINEER.
10. THE ENGINEER WILL ADJUST THE REQUIRED NUMBER OF TIEBARS FOR SLABS SHORTER OR LONGER THAN 15'. SPACING "B" WILL BE ADJUSTED TO MAINTAIN A MINIMUM CLEARANCE OF 2" BETWEEN THE TIEBAR AND THE DOWEL BARS AT THE TRANSVERSE JOINT AND THE "A" SPACING WILL REMAIN AS REQUIRED FOR THE PAVEMENT SLAB WIDTH.
11. MULTIPLE PIECE TIEBARS SHALL BE USED AT LONGITUDINAL CONSTRUCTION JOINTS UNLESS OTHERWISE SPECIFIED IN THE PLANS.
12. THE SAW CUT FOR LONGITUDINAL WARPING AND THE TRANSVERSE CONSTRUCTION JOINTS MAY BE ONE FOURTH THE SLAB THICKNESS WHEN CRUSHED LIMESTONE IS USED AS THE COARSE AGGREGATE.

PROJECT No. ASA13-073-00
Figure 23B

Texas Department of Transportation
Construction Division (Pavements)

CONCRETE PAVEMENT DETAILS
CONTRACTION DESIGN
T-8 THROUGH 15 INCHES
CPCD-94

DN: LJB CK: LJB DW: BGD CK: GLG
MODIFICATIONS | DISTRICT | FEDERAL AID PROJECT | SHEET
COUNTY | CONTROL | SECTION | JOB | HIGHWAY

LEVELS DISPLAYED

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

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