0016-08-034
Pavement Design Report

Bexar County

SAN ANTONIO DISTRICT
PAVEMENT DESIGN REPORT
FOR
BEXAR COUNTY
LP 368 (Broadway Corridor)
FROM: Hildebrand Avenue
TO: Roy Smith Street
CSJ 0016-08-034

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This document is released for the purpose of interim review and is not intended for bidding, construction, or permitting purposes.

Draft
Pavement Design Report

LP 368 (Broadway Corridor)
From Hildebrand Avenue
To Roy Smith Street
San Antonio, Bexar County, Texas
CSJ: 0016-08-034

Prepared For:

Texas Department of Transportation

San Antonio District

PREPARED BY:

ARIAS GEOPROFESSIONALS

Firm No: F-32

UNDER THE DIRECTION OF:

IDCUS PLANNERS + ENGINEERS + MANAGERS

Firm No: F-6825

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THIS DOCUMENT IS RELEASED FOR
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DRAFT
PAVEMENT DESIGN REPORT

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INTRODUCTION

The results of our pavement analyses and designs are included in this draft Pavement Design Report (PDR) for the Loop 368 (Broadway Corridor) Project (Project) in San Antonio, Bexar County, Texas.

In the absence of a TxDOT Planning and Programming Division (TPP) Traffic Analysis for Highway Design Report (TPP TAHD Report), the pavement designs included herein are based on traffic data provided by the Project team and the traffic data assumptions noted herein. We can update the pavement designs, as necessary, once a TPP TAHD Report becomes available. Alternatively, the designs can be considered as final with TxDOT's approval of the traffic data/parameters used for design.

SCOPE OF SERVICES

The purpose of this PDR was to prepare pavement section design options based on:

1. Existing pavement and subgrade conditions encountered along the Project alignment;
2. Falling Weight Deflectometer (FWD) data provided by the Texas Department of Transportation (TxDOT); and,
3. Traffic data made available for this Project including the traffic assumptions noted herein. To date, a TPP TAHD Report has not been provided for this Project. If necessary, the pavement designs and recommendations included herein will be updated once a TPP TAHD Report becomes available.

PROJECT INFORMATION

The Project will consist of the reconstruction of LP 368 (Broadway Street) from Hildebrand Avenue to Roy Smith Street in San Antonio, Bexar County, Texas. We understand that LP 368 will be completely reconstructed, which will include the removal of the existing asphalt, concrete and base materials followed by the preparation of the subgrade and construction of the new pavement section.

The site is located within the TxDOT San Antonio District. The approximate limits of the Project are depicted on the Vicinity Map, which is included as Figure 1 in Appendix A. The Project will begin at Hildebrand Avenue and end at Roy Smith Street.

PAVEMENT DESIGN DATA, ANALYSES, AND RECOMMENDATIONS

We understand that both rigid and flexible pavement systems are being considered for this Project. If any of the information presented herein is known to be inaccurate, we should be notified in writing to determine if modifications to our pavement analyses, designs, and recommendations are needed.

Subsurface Soil and Groundwater Conditions, and Existing Pavement Structure

The geotechnical boring and laboratory findings along the Project alignment are presented subsequently. The pavement design parameters, analyses and recommendations provided in this report are based in part on the findings from the pavement cores, geotechnical boring data and the results of our laboratory testing. A more comprehensive presentation of our findings is included in the boring logs provided in Appendix C.

<u>Field Exploration</u>

Eight (8) pavement cores/bores were performed within the Project alignment. Coring was performed to determine the thickness of the existing pavement section. Geotechnical borings were then performed to depths of about 10 feet below the pavement surface to sample the existing subgrade soils for laboratory testing.

The approximate exploration locations are shown on the Overall Boring Location Plan included as Figure 2 in Appendix A. The locations were identified in the field by Arias personnel using a hand-held Global Positioning System (GPS) unit so that underground utility locations could be identified and marked prior to the start of coring/drilling. The GPS coordinates obtained at the completed core/bore locations are presented in Table 1 below.

Table 1: Approximate Core/Bore Locations

Bore/Core No.	Geographic Coordinates	
	Latitude	Longitude
B-1	29°27'54.24"N	98°27'50.97"W
B-2	29°27'41.21"N	98°27'59.67"W
B-3	29°27'28.85"N	98°28'7.97"W
B-4	29°27'16.41"N	98°28'16.98"W
B-5	29°27'2.82"N	98°28'26.48"W
B-6	29°26'48.06"N	98°28'31.75"W
B-7	29°26'32.46"N	98°28'36.98"W
B-8	29°26'20.59"N	98°28'41.88"W

Select photographs of our field exploration operations are provided in Appendix A. Soil classifications and borehole logging were conducted by our Senior Engineering Technician working under the direct supervision of the Project Pavement Engineer. A core barrel was used to core through the existing HMA and concrete (where encountered). A truck-mounted drill rig equipped with continuous flight augers (ASTM D1452), coupled with the sampling procedures noted herein, was then used to secure subsurface soil samples beneath the existing pavement structure. Samples were obtained by pushing thin-walled tube samplers, driving split-barrel samplers, and/or by obtaining grab samples from the auger cuttings.

Arias' field representative visually logged each recovered sample and placed a portion of the recovered sample into a sealed container for transport to our laboratory. After completion of drilling, the boreholes were backfilled with dry concrete mix to the bottom of the pavement, and the remainder was filled with tamped cold patch asphalt.

Soil classifications and borehole logging were conducted during the exploration as previously noted. The final soil classifications presented on the WinCore boring logs provided in Appendix C, were determined by the Project Pavement Engineer based on laboratory and field test results and applicable TxDOT and ASTM procedures. The material descriptions provided on the boring logs generally conform to the Unified Soils Classification System (USCS). A Key to the terms and symbols used on the boring logs is provided after the boring logs in Appendix C.

Remaining samples recovered from this exploration will be discarded following submittal of this report in final form.

<u>Laboratory Testing</u>

As a supplement to the field exploration, laboratory testing was conducted to determine index properties including: soil water content, Atterberg Limits, percent finer than the No. 200 sieve, and soluble sulfate content. The moisture content, Atterberg Limits and sieve tests were generally performed on the soil subgrade samples. The laboratory test results are reported on the boring logs provided in Appendix C, and are graphically presented in Appendix D.

The soil laboratory testing for this Project was done in accordance with applicable TxDOT procedures with the specifications and definitions for these tests listed subsequently in Table 2.

Table 2: Laboratory Testing Program Summary

Test Name	Test Method	Number of Tests
Determining Moisture Content in Soil Materials	TEX-103-E	30
Determination of Soil Constants including: Liquid Limit, Plastic Limit and Plasticity Index of Soils	TEX-104-E, TEX-105-E, TEX-106-E	17
Determination of Percent Passing #200 Sieve	TEX-111-E	14
Determination of Sulfate Content in Soils	TEX-145-E	8

Laboratory testing was conducted on select sample specimens to evaluate for potential adverse reactions to calcium-based treatment agents (i.e. modifiers) such as lime and cement. A high sulfate content subgrade material can chemically react with calcium-based modifiers resulting in excessive heaving of the treated layer through the growth of ettringite crystals. It should be noted that the use of lime or cement treatment is not recommended where sulfate contents are greater than 3,000 parts per million (ppm). Accordingly, testing was performed in accordance with TxDOT test method Tex-145-E "Determining Sulfate Content in Soils" to evaluate whether it is appropriate to lime or cement treat the subgrade. The results are presented subsequently in Table 3.

The soluble sulfate test results are indicative of low soil sulfate contents. Based on the results of the sulfate testing, lime or cement treatment of the soil subgrade are viable options at this Project site.

<u>Existing Pavement Structure</u>
To estimate the pavement structure along the Project alignment, Arias cored the pavement at each of the pavement locations listed subsequently in Table 3. The observed pavement thickness of each portion of the pavement section and the results of our laboratory tests on the subgrade are summarized in Table 3. Photographs of the recovered asphalt cores are presented in Appendix A.

Table 3: Existing Pavement Structure

Bore/Core No.	Pavement Section, inches				Subgrade Material	Subgrade PI	Subgrade -200 (%)	Subgrade Sulfate Content (ppm)[2]
	HMA	Concrete	Cement-Treated Base	Total				
B-1	14	0	0	14	SANDY FAT CLAY (CH) to FAT CLAY (CH)	49 to 68	70 to 97	160
B-2	9-1/2	10	0	19-1/2	LEAN CLAY (CL) to FAT CLAY (CH)	32 to 44	96	360 to 1,220
B-3	10-1/4	7	0	17-1/4	FAT CLAY (CH)	50 to 101	90 to 95	--
B-4	7-3/4	10-1/2	0	18-1/4	FAT CLAY (CH)	46	91	160
B-5	7-3/4	7-1/4	0	15	FAT CLAY (CH)	56 to 60	90 to 91	900
B-6	8-1/4	10	0	18-1/4	FAT CLAY (CH)	32 to 49	81	160
B-7	5-1/2	0	9	14-1/2	FAT CLAY (CH)	51 to 55	91 to 96	220
B-8	5	0	18-1/2	23-1/2	FAT CLAY (CH)	39 to 59	90 to 97	160

Notes:
1. "--"indicates that sulfate testing was not performed at that boring location.
2. The results of the phenolphthalein testing indicated the presence of lime or cement modifiers in the pavement subgrade at B-3, and in the pavement base material at B-7 and B-8.
3. At Borings B-7 and B-8, cement-treated base material was encountered below the upper HMA layers.

Geology

The earth materials underlying the project site have been regionally mapped as Pliocene-age Uvalde Gravel (Q-Tu) of the Tertiary Period and Pleistocene-age Fluviatile terrace (Qt) deposits of the Quaternary Period. The Fluviatile terrace (Qt) deposits are comprised of a mixture of gravel, sand, silt, clay, and organic matter. The Uvalde Gravel (Q-Tu) consists of caliche-cemented gravel. A Geologic Map is included as Figure 4 in Appendix A.

The Qt and Q-Tu deposits are believed to underlain by the Navarro Group and Marlbrook Marl (Kknm) of the Cretaceous Period. The Navarro Group and Marlbrook Marl (Kknm) formation consists mainly of clay, marly clay, marl and shale. Very hard layers of marl, shale, sandstone and/or siltstone can be encountered in this formation. Within the Project limits, the formation has very high liquid limit and plasticity index values which most likely are due to the presence of significant amounts of the clay mineral montmorillonite. The clay is very highly expansive.

The strata encountered in the soil borings drilled along the Project alignment generally consisted of alluvial (clayey) soils of high to very high plasticity.

Generalized Subsurface Stratigraphic Conditions

Based on the subgrade conditions encountered beneath the pavement sections, the subgrade soils were fairly consistent. That is, high to very high plasticity soils were encountered in the borings drilled within the Project alignment. The high to very high plasticity soils[1] encountered have a high to very high potential to shrink and swell due to fluctuations in moisture content.

Groundwater Conditions

A dry soil sampling method was used to obtain the soil samples. Groundwater was not observed in the pavement borings to the depths drilled as part of this Project. Groundwater levels will often change significantly over time. Water levels in open boreholes may require several hours to several days to stabilize depending on the permeability of the soils.

The quantity of transient or perched groundwater seepage is dependent on antecedent rainfall conditions and can usually be accommodated with “sump and pump” techniques if encountered during construction. However, the long-term performance of the pavement section will be adversely affected if groundwater seepage is present. If groundwater seepage becomes problematic, interceptor drains will likely be required to intercept and redirect the seepage away from the pavement structure.

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[1] Peck, R., Hanson, W., Thornburn, T., *Foundation Engineering*, 2nd Edition, Wiley & Sons, New York, 1974, pg 337.

It should be noted that groundwater levels at the time of construction may differ from the observations obtained during the field exploration because perched groundwater is subject to seasonal conditions, recent rainfall, flooding, drought or temperature affects. Granular soils such as gravelly and sandy soils can readily transmit subsurface water. Groundwater levels should be verified immediately prior to construction. *Should dewatering become necessary, it is considered "means and methods" and is solely the responsibility of the Contractor.*

Subgrade Properties - Texas Triaxial Class and Subgrade Modulus

A Texas Triaxial Class (TTC) is assigned to the subgrade using one of the following methods: (1) determined from the Soil Conservation Services Series, Research Report 3-05-71-035, (2) determined by site specific triaxial testing of subgrade samples, (3) determined by correlation with the subgrade's Plasticity Index (PI), or (4) estimated based on soil type from the County database in the FPS-21 software.

FWD data was provided by TxDOT for the Project limits. The FWD data was analyzed using the MODULUS 6.1 software developed by the Texas Transportation Institute (TTI). The existing pavement structures, i.e. pavement layers and thicknesses, were estimated based on the pavement core data presented previously in Table 3.

The estimated pavement structures were entered in the MODULUS 6.1 program along with the FWD data. Back-calculation of the pavement layer and subgrade moduli values were then performed. The back-calculated in-situ subgrade modulus, i.e. subgrade support, as outlined subsequently was used in our pavement designs.

The following subgrade material properties were utilized in the analysis of the pavement designs:

1. *Texas Triaxial Class (TTC)* - Recommended TTC values range from 3.0 for sandy/gravelly soils to 6.5 for extremely weak plastic soils.

   Based on our geotechnical boring and laboratory findings for this Project, high plasticity clay subgrade soils were encountered within the Project Limits. PVR is discussed further in the Potential Vertical Rise (PVR) section of this report. The pavement subgrade conditions are presented further on Figure 3 in Appendix A.

   For our pavement designs, we used a TTC value of 5.6 for "CH" soils (based on the Bexar County database) to perform the Modified Triaxial Check.

2. *Subgrade Modulus (ksi)* - To evaluate the subgrade conditions beneath the existing pavement, FWD data was provided to us by TxDOT.

The FWD data included test locations along the existing Northbound and Southbound Travel Lanes. Back-calculation analyses were conducted for the existing pavements. The depth-to-bedrock (DTB) and back-calculated subgrade modulus value used in design are summarized subsequently in Table 4.

Table 4: Back-calculated Subgrade Moduli Values

Pavement Location	Existing Total Pavement Thickness [Range] / Average (inches)	Subgrade Design Modulus (ksi)	Depth-To-Bedrock (DTB) (inches)	TTC
Northbound and Southbound Travel Lanes	[14 to 23½] / 17½	6.0	163.9	5.6

Notes:
1. Pavement thickness based on 8 pavement cores.
2. The MODULUS 6.1 program output files are included in Appendix E.

Based on the FWD testing, a design subgrade modulus value of 6.0 ksi was used in our pavement designs for the proposed reconstruction. The 6.0 ksi subgrade design modulus value was selected due to: (1) numerous back-calculated locations near 6.0 ksi, (2) the high plasticity clay "CH" soils encountered in the borings, and (3) the high FWD deflections (d7).

The high FWD deflections (d7) indicate very poor to poor subgrade conditions. The high plasticity clay "CH" subgrade is a contributor. However, the presence of multiple buried utilities is also believed to be a contributor. It is our opinion that poorly-compacted, utility backfill coupled with moist/weak CH soils has resulted in non-uniform subgrade support issues at this site. The presence of concrete and cement-treated base below the existing HMA is likely the result of attempting to "bridge" over non-uniform weak subgrade conditions.

Due to potential non-uniform subgrade conditions, it will be prudent to proof roll the existing subgrade prior to new pavement construction. Weak/soft areas evidenced during proof rolling should be corrected prior to pavement construction.

Traffic Data

A summary of the traffic data used in our pavement designs is shown subsequently in Tables 5 and 6.

The methodology used to determine the design traffic data is outlined below:

- The ADT's presented are based on the Broadway 2014 and 2040 Corridor Volumes provided in Appendix F.

  A back-analysis of the traffic volume data was performed to determine an approximate growth rate of 2.66%.

- The initial ADT was assumed at Year 2020 and projected to be 40,628 vehicles per day (vpd) based on the reported 2014 ADT=34,700 vpd and a growth rate of 2.66%

- The Percent Trucks in ADT of 5.0% was based on the 2017 traffic counts data provided in Appendix F.

- A Truck Factor of 0.80 was assumed and used for our 20-Year Flexible ESAL calculation. A Truck Factor of 1.0 was assumed and used for our 30 Year Rigid ESAL calculation.

- The ATHWLD, Percent Tandem Axles in ATHWLD, and Percent Trucks in ADT were assumed at 12,200 lbs, 30%, and 5%, respectively.

Table 5: LP 368: 30-year Traffic Data for Rigid Pavement Design

Section	ADT		Percent Trucks in ADT	ATHWLD	Percent Tandem Axles in ATHWLD	Equivalent 18k Single Axle Load Applications (ESALs)
	2020	2050				
LP 368 From: Hildebrand Avenue To: Roy Smith Street	40,628	89,396	5.0	12,200	30	16,720,000

Note:

1. The traffic data provided above will be revised, as necessary, once a TPP-generated report becomes available. *Alternatively, the designs included herein can be considered as final with TxDOT's approval of the traffic data/parameters used for design.*

Table 6: LP 368: 20-year Traffic Data for Flexible Pavement Design

Section	ADT		Percent Trucks in ADT	ATHWLD	Percent Tandem Axles in ATHWLD	Equivalent 18k Single Axle Load Applications (ESALs)
	2020	2040				
LP 368 From: Hildebrand Avenue To: Roy Smith Street	40,628	68,731	5.0	12,200	30	7,710,000

Note:

1. The traffic data provided above will be revised, as necessary, once a TPP-generated report becomes available. *Alternatively, the designs included herein can be considered as final with TxDOT's approval of the traffic data/parameters used for design.*

Rigid Pavement Design: AASHTO (1993) and TxCRCP-ME Methods

Rigid pavement recommendations were prepared in accordance with the *1993 AASHTO Guide for Design of Pavement Structures and the TxCRCP-ME design program*. The rigid pavement designs were based on an analysis period of ***30 years.*** Program design inputs were based on the preferences of the TxDOT San Antonio District and guidelines provided in the 2018 TxDOT Pavement Manual. Pavement design recommendations are provided subsequently for both continuously reinforced concrete pavement (CRCP) and concrete pavement contraction design (CPCD).

CPCD is feasible regarding the traffic loading ESALs, and in consideration of the high quantity of existing utilities within the right-of way (ROW) with the possibility for future utility repair. However, the TxDOT 2018 Pavement Manual recommends the use of CRCP where there is a higher risk of expansive soil heave. Highly expansive clay soils are present at this site, and Arias recommends the use of CRCP, accordingly, if feasible. The use of flexible pavement may be more practical due to the presence of utilities. In this scenario, the use of CRCP or CPCD could be limited to VIA bus pads.

The AASHTO Pavement Design Calculations are included in Appendix G.

<u>Rigid Pavement Design Parameters</u>

Rigid pavement design parameters were selected in accordance with the 1993 AASHTO Guide for Design of Pavement Structure, and the 2018 TxDOT Pavement Manual. The rigid concrete pavement designs presented in Table 8 were based on the design parameters outlined subsequently in Table 7:

Table 7: Parameters for Rigid Concrete Pavement Design

Design Parameters	Travel Lanes
Reliability Factor, %	95
Overall Standard Deviation	0.39
Initial Serviceability Index	4.5
Terminal Serviceability Index	2.5
Drainage Coefficient (DC)	1.02
Load Transfer Coefficient (J)	2.9 for CPCD
28-day Concrete Elastic Modulus, psi	5,000,000
28-day Concrete Modulus of Rupture, psi	570 to 620
Effective Modulus of Subgrade Reaction (k), pci	300 to 457
Design ESALs	16,720,000
Service Life (years)	30

Proposed Rigid Pavement Sections

The pavement recommendations included in this section are based on TxDOT design procedures for rigid pavements. ***Importantly, removal of the existing HMA and underlying concrete pavement will require a new pavement section designed thick enough to restore grade following the lime-treatment of the soil subgrade. Based on our pavement core data - following lime-treatment of the soil subgrade - we recommend the use of a 20-inch thick pavement section. Lime-treatment is included for each pavement option due to the soil's high plasticity.***

Table 8: Rigid Designs for Reconstruction of LP 368

Pavement Design Criteria					
Pavement Location		LP 368 from Hildebrand Avenue to Roy Smith Street			
Service Life (years)		30			
Design ESALs		16,720,000			
Material		**Material Thickness, Inches**			
Type	**TxDOT Item**	**Option 1**	**Option 2**	**Option 3**	**Option 4**
CRCP		10.0	10.0	--	--
CPCD	--	--	--	10.5	10.5
DG HMA Ty B (PG 64-22)	341	10.0[2]	--	9.5[2]	--
Bond Breaker: DG HMA Ty D (PG 64-22)	341	--	2.0[2]	--	1.5[2]
Cement-Treated Base, Item 247 Type A or D, Grade 5	276, Class L	--	8.0[2]	--	8.0[2]
Lime-Treated Subgrade	260	12.0	12.0	12.0	12.0
Proof Roll Exposed Subgrade	216	Yes	Yes	Yes	Yes
Total Pavement Section (Not Including the Lime-Treated Subgrade)	--	20.0	20.0	20.0	20.0

Notes:
1. Pavement details are included in Appendix B.
2. The thickness of the pavement material types noted were increased to result in a minimum 20-inch total pavement section. A minimum 20-inch thick pavement section was selected (based on the project core data) to allow removal of the existing pavement structure and to restore grade.

CRCP. The longitudinal and transverse steel should be sized by the designers to meet the minimum requirements presented on the TxDOT design standards presented on CRCP (1)-17. For CRCP from 7 to 13 inches thick, TxDOT detail: CRCP (1)-17, Continuously Reinforced Concrete Pavement, One-Layer Steel Bar Placement, should be used.

CPCD. The longitudinal construction or contraction joints, dowel spacing, dowel bars, tie bars, and other design details should meet the requirements presented on the TxDOT design standards presented on CPCD-14. For CPCD from 6 to 12 inches thick, TxDOT detail: CPCD-14, Concrete Pavement Details Contraction Design, should be used.

Flexible to Rigid Transitions. Where flexible pavement will transition to concrete pavement, the TXDOT detail, *Junction Terminals Flexible Pavement with Concrete Pavement* JTFPCP- 04 (MOD), should be considered.

The referenced details are provided in Appendix I.

Flexible Pavement Design: FPS-21 Method

Flexible pavement recommendations were prepared in accordance with the *TTI Flexible Pavement Design System, FPS-21*. Program design inputs were based on the preferences of the TxDOT San Antonio District and guidelines provided in the 2018 TxDOT Pavement Manual.

Proposed Flexible Pavement Sections

Provided subsequently are flexible pavement options for the reconstruction of LP 368. ***Importantly, removal of the existing HMA and underlying concrete pavement will require a new pavement section designed thick enough to restore grade following the lime-treatment of the soil subgrade. Based on our pavement core data - following lime-treatment of the soil subgrade - we recommend the use of a 20-inch thick pavement section. Lime-treatment is included for each pavement option due to the soil's high plasticity.***

- Pavement Options No. 1 and 2 include using hot mix asphalt (HMA) over flexible base material over a lime-treated subgrade. A lime-treated subgrade will aid in mitigating the high plasticity clay subgrade soils while also providing a more "all-weather" working platform. A layer of Type 2 geogrid is recommended on top of the lime-treated subgrade at the bottom of the flexible base layer to aid in "bridging" over the non-uniform pavement subgrade conditions as previously discussed.

- Pavement Option No. 3 includes using full-depth HMA over a lime-treated subgrade. A lime-treated subgrade will aid in mitigating the high plasticity clay subgrade soils while also providing a more "all-weather" working platform.

- Pavement Option No. 4 includes using HMA over cement-treated base (CTB) over a lime-treated subgrade. A lime-treated subgrade will aid in mitigating the high plasticity clay subgrade soils while also providing a more "all-weather" working platform.

- *<u>Pavement Option No. 5</u> includes the rehabilitation option of milling (removing) a portion of the existing pavement structure and constructing a new HMA inlay on top of the underlying existing pavement structure. Importantly, this rehabilitation option is based on the pavement core data collected for this Project. The cores were generally performed near the center of the roadway due to existing utility conflicts. Thus, we recommend that Ground Penetrating Radar (GPR) testing be performed to determine if the existing pavement structure (i.e. HMA, concrete, and/or CTB) meets the minimum estimated thickness presented herein.*

  The existing pavement has experienced a significant amount of pavement cracking along the Project corridor. The pavement cracking is believed to be related to one or a combination of the following:

  - *Cracks and/or joints in the underlying concrete layer or cracks in the underlying cement-treated base layer reflecting up through the HMA;*
  - *Settlement of utility backfill; and/or*
  - *Expansive soil (i.e. PVR) movement.*

  Noteworthy, numerous HMA (mill and inlay) patches were observed within the Project corridor. Based on our site reconnaissance, the patched areas appear to be performing well to date. Before selecting this option, maintenance records for the patches should be reviewed to determine the approximate depth of mill and inlay and the Year(s) the patches were constructed. The history and details of the patches will be considered before approving this rehabilitation option.

  For this mill and inlay rehabilitation option, the Owner should be cognizant that reflective cracking from underlying cracked pavement layers will eventually propagate up through the new pavement surface. To help delay reflective cracking, a geosynthetic pavement interlayer is recommended for this rehabilitation option. Furthermore, mitigation of PVR movements is not considered with this option. Thus, the Owner should plan for more routine preventative maintenance (i.e. crack sealing and mill and inlays) due to reflective cracking and PVR issues when compared to the reconstruction Options 1 to 4 presented herein.

The recommended pavement thickness options presented subsequently in Table 9 may be considered to meet the design requirements. Other choices/alternatives are possible. The FPS-21 input and output files for the pavement design options included in Table 9 are included in Appendix H.

Table 9: FPS Designs for Reconstruction of LP 368

Pavement Design Criteria						
Pavement Location		LP 368 from Hildebrand Avenue to Roy Smith Street				
Service Life (years)		*20*				
ESALs (20 years)		7,710,000				
Material		**Material Thickness, Inches**				
Type (Oil)	**TxDOT Item**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Option 5**
SP-D SAC-B (PG 70-22)	344	2.0	2.0	2.0	2.0	2.0
Underseal[1]	316	Yes	Yes	Yes	Yes	Yes
DG HMA - Type B (PG 64-22)	341	12.0[3]	8.0[3]	18.0[3]	8.0[3]	3.75 to 5.0[5]
Prime Coat (MC-30 or AE-P)	300	Yes	Yes	Yes	Yes	No
Type II Reinforcement Grid for Asphalt (TxDOT Item 3057)	--	--	--	--	--	Yes
DG HMA - Type D (PG 64-22)	341	--	--	--	--	2.0
Cement-Treated Base (Onsite or Import Flexible Base, Item 247, Type D, Grade 5)	275	--	--	--	10.0	--
Existing Pavement	--	--	--	--	--	5.0 to 14.5[4]
Flexible Base, Type A or D, Grade 1-2	247	6.0	10.0	--	--	--
Type 2 Geogrid (Punched and Drawn)	DMS-6240	Yes	Yes	--	--	--
Lime-Treated Subgrade	260	12.0	12.0	12.0	12.0	--
Proof Roll Exposed Base/Subgrade	216	Yes	Yes	Yes	Yes	--
FPS-21 Estimated Performance Life (years)		*40*	*34*	*40*	*40*	
Total Pavement Section (Not including the Lime-Treated Subgrade)		20.0	20.0	20.0	20.0	14.0 to 23.5[4]

Notes:

1. Pavement details are included in Appendix B for the above options.
2. The underseal should consist of a Membrane Underseal – or as an alternate – a One Course Surface Treatment (OCST).
3. The thickness of the pavement material types noted were increased to result in a minimum 20-inch total pavement section. A minimum 20-inch thick pavement section was selected (based on the project core data) to allow removal of the existing pavement structure and to restore grade.
4. Rehabilitation Option 5 is based on the thickness of the existing pavement structure determined from core data. GPR testing should be performed to determine that the existing pavement structure (i.e. HMA, concrete, and/or CTB) meets the minimum estimated thickness presented herein.
5. Where the existing HMA is underlain by concrete pavement (e.g. B-4, B-5 and B-6), the mill depth can be stopped to the top of concrete resulting in an inlay less than 9" thick. Otherwise, the mill depth should be to a 9-inch depth.
6. The completed surface aggregate selection form is included in Appendix K.

Mechanistic and Modified Triaxial Design Checks

The pavement section options were further evaluated by the FPS-21 Mechanistic Check, and with the Modified Triaxial Check (MTC) Design Procedure. The Mechanistic Check determines the fatigue life of the hot mix asphalt (HMA) layers and full depth rutting life of the pavement section.

The MTC was performed utilizing the ATHWLD, Percentage of Tandem Axles, Subgrade TTC, Modified Cohesionmeter Value (C_m) and Design Wheel Load. The required Modified Triaxial design thicknesses are shown subsequently in Table 10 for the proposed Main Lane pavement sections. ***Except for the rehabilitation Option 5, the FPS-21 designs provided in Table 10 meet the thickness requirements of the Mechanistic and the MTC checks.***

Table 10: MTC Design Thickness

Pavement Option No.	C_m Value, Pavement Type and Subgrade Profile	Triaxial Thickness Required	Allowable Thickness Reduction	Modified Triaxial Thickness
Reconstruction of LP 368				
Options 1 & 2	C_m=800, HMA + Flexible Base + Geogrid + Lime-Treated Subgrade + Proof Rolled Subgrade	23.5"	7.7"	**15.8"**
Option 3	C_m=800, HMA + Lime-Treated Subgrade + Proof Rolled Subgrade			
Option 4	C_m=800, HMA + Cement-Treated Base + Lime-Treated Subgrade + Proof Rolled Subgrade			
Option 5	C_m=800, HMA (Mill and Inlay) + Existing Pavement			

Note:

1. The Modified Cohesionmeter Value, C_m=800 is utilized for Hot-Mixed Bituminous Materials equal to or greater than 6 inches thick.
2. Based on our pavement core data, Pavement Option No. 5 does not meet the MTC.

Potential Vertical Rise (PVR)

High plasticity soils were encountered in the pavement borings along the Project alignment. The soils have the potential to shrink/swell with changes in soil moisture content. The 2018 TxDOT Pavement Manual recommends the use of maximum PVR values of 1.5 inches for the design of Main Lanes, and 2.0 inches for Frontage Roads. In accordance with the referenced manual, PVR values were determined within the Project limits using the Tex-124-

E method for a maximum 7-foot depth. The calculated PVR values are provided in Appendix J and summarized subsequently in Table 11.

Table 11: Range of Calculated PVR values

LP 368 PVR [Range] / (Average) (inches)
[2.3 to 5.4] (3.3)

Note:
1. The above values are based on 8 borings drilled within the Project Limits.

The average PVR value was calculated to be about 3.3 inches.

<u>PVR Mitigation</u>
Based on our PVR calculations, we recommend that PVR mitigation be employed at this Project site.

Importantly, it is common for moisture content values to remain fairly constant in the middle of the roadway. The moisture levels in the subgrade soils located near the edge of roadway are more susceptible to changes in moisture that occur due to natural seasonal moisture fluctuations. The edges will dry and shrink during drought conditions, relative to the center of the roadway. During extremely wet climate periods, the edges will swell relative to the center of the roadway. The shrinking and swelling of subgrade soils near the edge of pavements will result in longitudinal, surface cracking that occurs parallel to the roadway. Based on our experience, the cracking typically occurs at a distance of 3 to 9 feet from the edge of the roadway. Edge cracking associated with soil shrinkage movements may occur at greater distances during extreme environmental conditions. Soil shrink-swell movements can also result in undulating pavements resulting in a reduced ride quality. Our pavement recommendations have been developed to provide an adequate structural thickness to support the anticipated traffic volumes and provide lime-treatment of the subgrade soils to help reduce/mitigate potential PVR issues.

Geogrid is also recommended for pavement Options 1 and 2 in Table 9 due to both the expansive soil subgrade and non-uniform subgrade support conditions that may be related to poorly-compacted utility backfill. Importantly, even with the recommendations included herein the resulting PVR ranges from about 1.4 inches to 3.4 inches with an average of 2.2 inches. Further PVR reduction could be accomplished by over-excavating the expansive clay soil and replacing this soil with an inert select fill. Due to the existing urban development and underground utilities within the roadway alignment, over-excavation and select fill replacement may not be a viable option for this Project. The PVR mitigation techniques can be adjusted to result in a lower PVR if desired by TxDOT.

TxDOT should recognize that over time, pavements may develop undulations and/or cracking, and undergo some deterioration and loss of serviceability. Deterioration can occur more rapidly due to climatic extremes such as drought conditions, or periods that are wetter than normal. We recommend that project budgets include an allowance for maintenance such as routine crack sealing and patching/repair of cracks, as well as for providing periodic mill and overlays over the life of the pavement.

The effect of existing and proposed (if applicable) trees/vegetation should be considered for this Project due to the expansive soil subgrade. Soil moisture can be affected by the roots of vegetation that extend beneath pavements. Trees remove large quantities of water from the soil through their root systems, particularly during the growing season, and cause localized drier areas in the vicinity of the roots. The limits of affected areas are typically related to the lateral extent of a root system, which are a function of the tree height and the spread of its branches. It is generally accepted that a root system will influence the soil moisture levels to a distance roughly equivalent to the drip line (extent of branches). Pavements constructed over a tree root system may shrink due to changes in moisture content and result in cracking. These types of movements result in concentric and/or longitudinal crack patterns in pavements located near trees. If trees will be located next to the roadway, localized root barriers should be considered as part of the pavement construction.

If pervious storm water planters are being considered in proposed landscape areas along the roadway, significant movement could occur in overlying and nearby grade-supported structures (e.g., flatwork, curbs, and pavement) if water from the planters is allowed to infiltrate to the expansive clays. Accordingly, these planter types should be designed as water-tight with infiltrating subsurface water conveyed in non-perforated piping to storm sewers or other outlets such that the collected water is not allowed to infiltrate into the expansive clays.

PAVEMENT CONSTRUCTION

Site Preparation

Where applicable, existing pavements should be removed. Topsoil stripping should be performed, as needed, to remove organic materials, soft/very soft “mucky” soils, and vegetation. Furthermore, removal should include any debris, trash, undocumented fill, and landfill materials, and be properly disposed of offsite.

A loaded dump truck weighing at least 20 tons should make at least 15 passes to proof roll over the resulting subgrade and flexible base areas planned to receive the proposed construction. A representative of the Geotechnical Engineer should be present to observe proof rolling operations. As per the representative of the Geotechnical Engineer, areas of deflection should be removed, re-compacted and/or replaced with Embankment Select Fill, as applicable, meeting the material and compaction requirements given subsequently.

The resulting subgrade following proof rolling should then be scarified to a depth of at least 6 inches, moisture conditioned to between optimum and plus four (+4) percentage points of optimum moisture content, and compacted to at least 95 percent of the maximum density determined using TEX-114-E. Existing flexible base should be compacted to at least 100% TEX-113-E.

We recommend that one of our representatives be scheduled to observe that the site preparation operations are performed in accordance with our recommendations.

Embankment Select Fill

Roadway Embankment Select Fill should consist of inert (non-swelling) Type C embankment fill (TxDOT Item 132) that meets the following requirements:

- maximum liquid limit (LL) of 45;
- maximum plasticity index (PI) of 25;
- maximum particle size of 3 inches;
- sulfate contents ≤ 500 ppm;
- placed in maximum 8-inch loose lifts;
- moisture conditioned to between optimum moisture and +4 percentage points of optimum moisture; and
- compacted to between 98% and 102% of the maximum dry density (TEX-114-E).

Recycled pavement can be considered for reuse as select fill provided it meets the criteria presented herein.

Embankment Select Fill should not contain organics, deleterious debris, trash or landfill materials. Conformance testing should be performed during construction to assure that the materials used for construction meet (and are placed in accordance with) the project plans and specifications. The suitability of all fill materials should be approved by the Geotechnical Engineer.

We recommend that one of our representatives be scheduled to observe that the site preparation and fill placement and compaction operations are performed in accordance with our recommendations.

Lime-Treated Subgrade

Lime treatment, in accordance with TxDOT Item 260, of the final subgrade is recommended for the proposed pavements. Material and compaction requirements are given subsequently in Table 12:

Table 12: Lime Treatment of Pavement Subgrade

Treatment depth	8 inches
Additive type	Hydrated Lime
Hydrated Lime application rate (estimated)	8% by dry weight.
Soil dry unit weight (estimated)	100 pcf but may be variable
Determination of Lime application rate	The actual stabilizer application rate should be determined by laboratory testing of soil samples taken after the pavement subgrade elevation has been achieved. The quantity of lime should be determined as outlined in Tex-121-E.
Treatment procedure	Meet requirements given in TxDOT Item 260 Lime Treatment (Road-Mixed)
Treatment layer compaction and moisture criteria	Tex-117-E ≥ 98 % compaction at -2 to +3 from optimum

Geogrid

For flexible pavement, we recommend the use of a punched and drawn, Type 2 Geogrid (DMS-6240) to help reduce the severity of potential pavement cracking due to expansive soil-related movements, as well as to aid in “bridging” over non-uniform subgrade support conditions.

Geogrid should be installed on top of a subgrade that has passed a proof roll. The geogrid should be installed as per the manufacturer guidelines. A representative of the geogrid supplier should be present at the start of geogrid placement to instruct the workforce on proper installation techniques.

Reinforcement Grid for Asphalt

A geosynthetic pavement interlayer should be installed with Pavement Option 5 in Table 9. For the pavement interlayer, we recommend the use of a Type II Reinforcement Grid for Asphalt (Item 3057).

The grid should be installed on top of the 2-inch HMA TY D (level-up) layer. A hot applied tack coat (Item Description 300-006) is recommended between the HMA TY D and TY B layers. The grid should be installed as per the manufacturer guidelines. A representative of the grid supplier should be present during construction to instruct the workforce on proper installation techniques.

Flexible Base

New flexible base material should comply with TxDOT Item 247, Type A or D, Grade 1-2. The flexible base should be compacted in maximum 8-inch loose lifts to at least 100 percent of the maximum dry density as evaluated by TEX-113-E within ±2 percentage points of optimum moisture content.

In areas where unbound flexible base material will be utilized as fill or as part of the pavement base course over box culverts, a non-woven 4oz/yd2 minimum fabric, such as "Mirafi 140N", should be placed on top of the box culvert and underneath the initial lift of unbound base fill for the entire width of the roadway. This will help to reduce the potential for fines from the base material dispersing into any clean gravel backfill placed around, between and below the concrete box culverts. The fabric should not be used directly beneath black base or hot mix asphalt due to detrimental effects caused by higher installation temperatures of these materials.

Cement-Treated Base

For CRCP or CPCD, cement treated base should be in accordance with TxDOT Item 276, Class L. For bidding purposes, we estimate using 5% cement, by weight, to treat flexible base (Item 247, Type A or D, Grade 5). Using an estimated 140 pcf dry unit weight, the application rate would be approximately 31.5 lbs/SY for a 6-inch thick section. However, the actual application rate should be determined during construction through a mix design using TEX-120-E.

For the cement-treated flexible pavement Option 4 in Table 9, cement treatment should be in accordance with TxDOT Item 275, including but not limited to, the requirements and specifications for pulverization, application, mixing, compaction, finishing, microcracking, and curing. Import flexible base materials proposed for cement treatment should comply with TxDOT Item 247, Type D, Grade 5. For bidding purposes, we estimate using 5% cement, by weight, for CTB. Using an estimated 140 pcf dry unit weight, the application rate would be approximately 52.5 lbs/SY for a 10-inch thick section. However, the actual cement application rate should be determined by laboratory testing of soil samples taken after the pavement subgrade elevation has been achieved. The quantity of cement should be the minimum amount to result in an unconfined compressive strength (UCS) at 7 days of at least 200 psi.

For CRCP or flexible pavement, CTB layers should be compacted to at least 95 percent of the maximum dry density as evaluated by TEX-120-E within ±2 percentage points of optimum moisture content.

Concrete Pavement

Concrete pavement should comply with TxDOT Item 360 Concrete Pavement provided in the 2014 TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.

Hot Mix Asphalt (HMA) Layers

Hot mix asphalt (HMA) should comply with 2014 TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges referring to the respective Items listed previously in Tables 8 and 9 of this report.

Compaction tests, as necessary, should be performed during construction in accordance with the project documents. The HMA materials should be tested to verify compliance with the TxDOT Item, sampling frequency, approved design and current job mix formula. The job mix formula should be submitted to the State by the supplier/manufacturer for approval.

Underseal

The underseal should consist of a spray-applied polymer emulsion membrane (Item 3002).

As an alternate, a OCST with Asphalt (AC-15P, AC-20-5TR, AC-20XP, or AC-10-2TR) at 0.30 GAL/SY can be considered. The OCST aggregate would consist of Type PB Grade 4 at 115 SY/CY. The OCST Item descriptions are 0316-6410 and 0316-6431.

Site Drainage

We recommend that areas along the roadway be properly maintained to allow for positive drainage and keep water from ponding adjacent to the pavements as the construction proceeds. This consideration should be included in the project specifications.

Positive drainage should also be maintained after construction so that ponded water does not occur near the roadway. Poor drainage can result in pavement subgrade failures, as well as in pavement distress associated with expansive soil heave.

CONCLUSIONS

The recommended pavement designs for this Project are presented subsequently herein.

Due to the presence of highly expansive clay, we recommend lime-treatment of the pavement subgrade.

Due to anticipated non-uniform subgrade support conditions, and if feasible, we recommend that the CRCP Pavement Option 1 in Table 8 be selected. If the quantity of existing utilities within the right-of way (ROW) and the possibility for future utility repair preclude the use of a rigid pavement section, we recommend the lime-treated subgrade with geogrid, flexible Pavement Option 1 in Table 9 be selected.

If the Project construction schedule does not allow for the placement and cure times associated with the use of flexible base or stabilized base layers, we recommend that Pavement Option 3 in Table 9 be selected.

If costs and constructability dictate pavement rehabilitation, then the rehabilitation Pavement Option 5 in Table 9 can be selected provided that: (1) a GPR survey is performed to confirm that the required minimum existing pavement thickness exists within the Project alignment, (2) the history and details of the existing patches infer that this rehabilitation option will have acceptable performance, and (3) the Owner is cognizant that reflective cracking from underlying cracked pavement layers will eventually propagate up through the new pavement surface.

GENERAL COMMENTS

This report was prepared as an instrument of service for this project exclusively for the use of IDCUS, TxDOT, TCI and the project design team. If the development plans change relative to layout and cross sections of the pavements, anticipated traffic loads, or if different subsurface conditions are encountered during construction, we should be informed and retained to ascertain the impact of these changes on our recommendations. We cannot be responsible for the potential impact of these changes if we are not informed. Important information about this geotechnical report is provided in the ASFE publication included in Appendix L.

Geotechnical Design Review

Arias should be given the opportunity to review the design and construction documents. The purpose of this review is to check to see if our geotechnical recommendations are properly interpreted into the project plans and specifications. Please note that design review was not included in the authorized scope and additional fees may apply.

Quality Assurance Testing

As a guideline, at least one in-place density test should be performed for every 100 linear feet of the roadway subgrade and each lift of fill material (minimum of 3 tests per lift). Any areas not meeting the required compaction should be re-compacted and retested until compliance is met.

The long-term success of the project will be affected by the quality of materials used for construction and the adherence of the construction to the project plans and specifications. As Geotechnical Engineer of Record (GER), we should be engaged by the Owner to provide Quality Assurance (QA) testing. Our services will be to evaluate the degree to which constructors are achieving the specified conditions they are contractually obligated to achieve and observe that the encountered materials during earthwork and foundation installation are consistent with those encountered during this study. If Arias is not retained to provide QA testing, we should be immediately contacted if differing subsurface conditions are encountered during construction. Differing materials may require modification to the recommendations that we provided herein. A message to the Owner with regard to the project QA is provided in the ASFE publication included in Appendix M.

Arias has an established in-house laboratory that meets the standards of the American Standard Testing Materials (ASTM) specifications of ASTM E-329 defining requirements for Inspection and Testing Agencies for soil, concrete, steel and bituminous materials as used in construction. We maintain soils, concrete, asphalt, and aggregate testing equipment to provide the testing needs required by the project specifications. Our equipment is calibrated by an independent testing agency in accordance with the National Bureau of Standards. In addition, Arias is accredited by the American Association of State Highway & Transportation Officials (AASHTO), the United States Army Corps of Engineers (USACE) and the Texas Department of Transportation (TxDOT) and maintains AASHTO Materials Reference Laboratory (AMRL) and Cement and Concrete Reference Laboratory (CCRL) proficiency sampling, assessments and inspections.

Furthermore, Arias employs a technical staff certified through the following agencies: the National Institute for Certification in Engineering Technologies (NICET), the American Concrete Institute (ACI), the American Welding Society (AWS), the Precast/Prestressed Concrete Institute (PCI), the Mine & Safety Health Administration (MSHA), the Texas Asphalt Pavement Association (TXAPA) and the Texas Board of Professional Engineers (TBPE). Our services are conducted under the guidance and direction of a Professional Engineer (P.E.) licensed to work in the State of Texas, as required by law.

Subsurface Variations

Soil and groundwater conditions may vary away from the sample boring locations. Transition boundaries or contacts, noted on the boring logs to separate soil types, are approximate. Actual contacts may be gradual and vary at different locations. The Contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions or highly variable subsurface conditions are encountered during construction, we should be contacted to evaluate the significance of the changed conditions relative to our recommendations.

Standard of Care

Subject to the limitations inherent in the agreed scope of services as to the degree of care and amount of time and expenses to be incurred, and subject to any other limitations contained in the agreement for this work, Arias has performed its services consistent with that level of care and skill ordinarily exercised by other professional engineers practicing in the same locale and under similar circumstances at the time the services were performed.

APPENDIX A: FIGURES, SITE PHOTOS, ASPHALT CORE PHOTOS

ARIAS GEOPROFESSIONALS

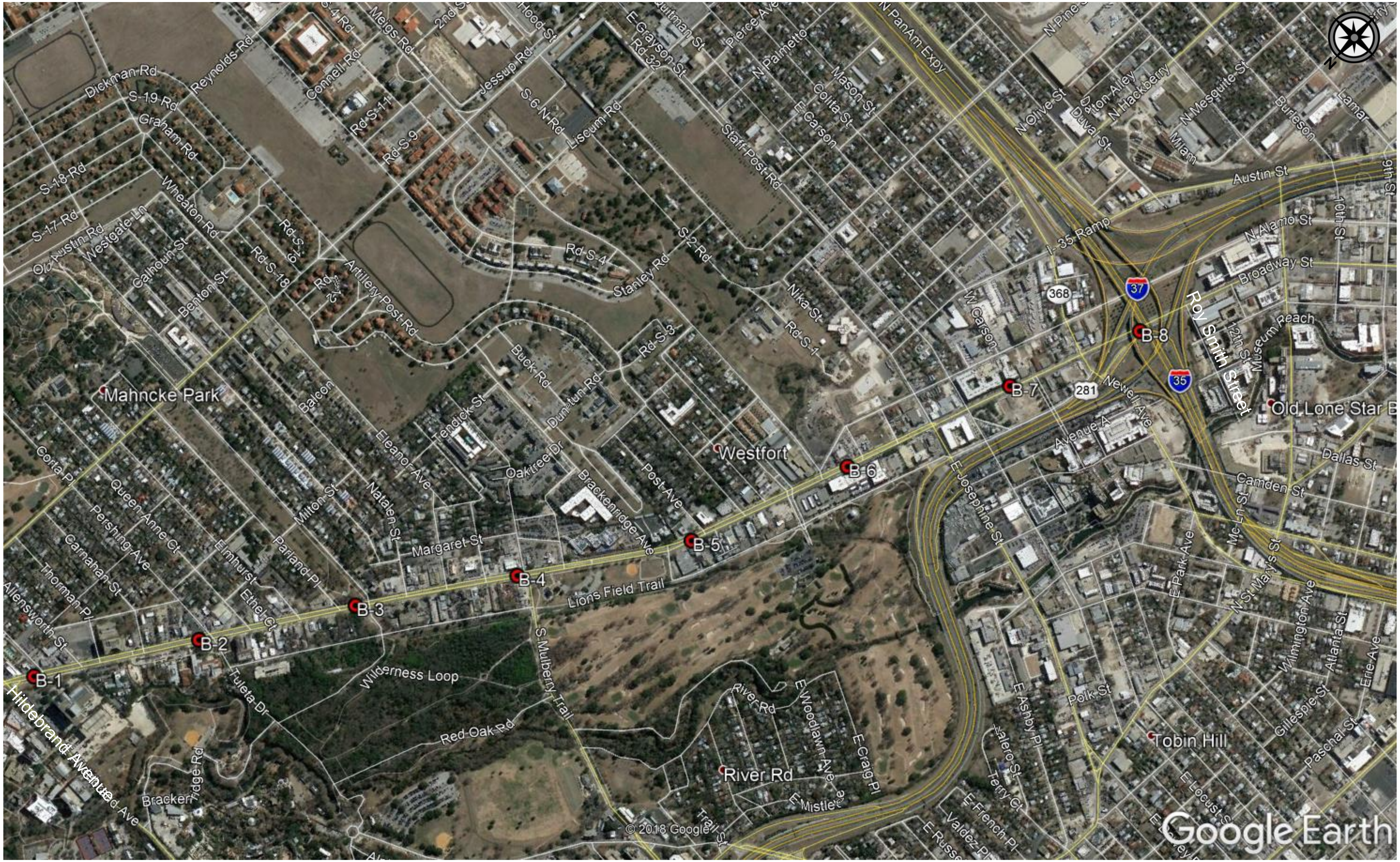
142 Chula Vista, San Antonio, Texas 78232
Phone: (210) 308-5884 • Fax: (210) 308-5886

VICINITY MAP

LP 368 (Broadway Corridor)
From Hildebrand Avenue to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ: 0016-08-034

Date: August 10, 2018	Job No.: 2018-363
Drawn By: RWL	Checked By: GK
Approved By: SAH	Scale: N.T.S.

Figure 1



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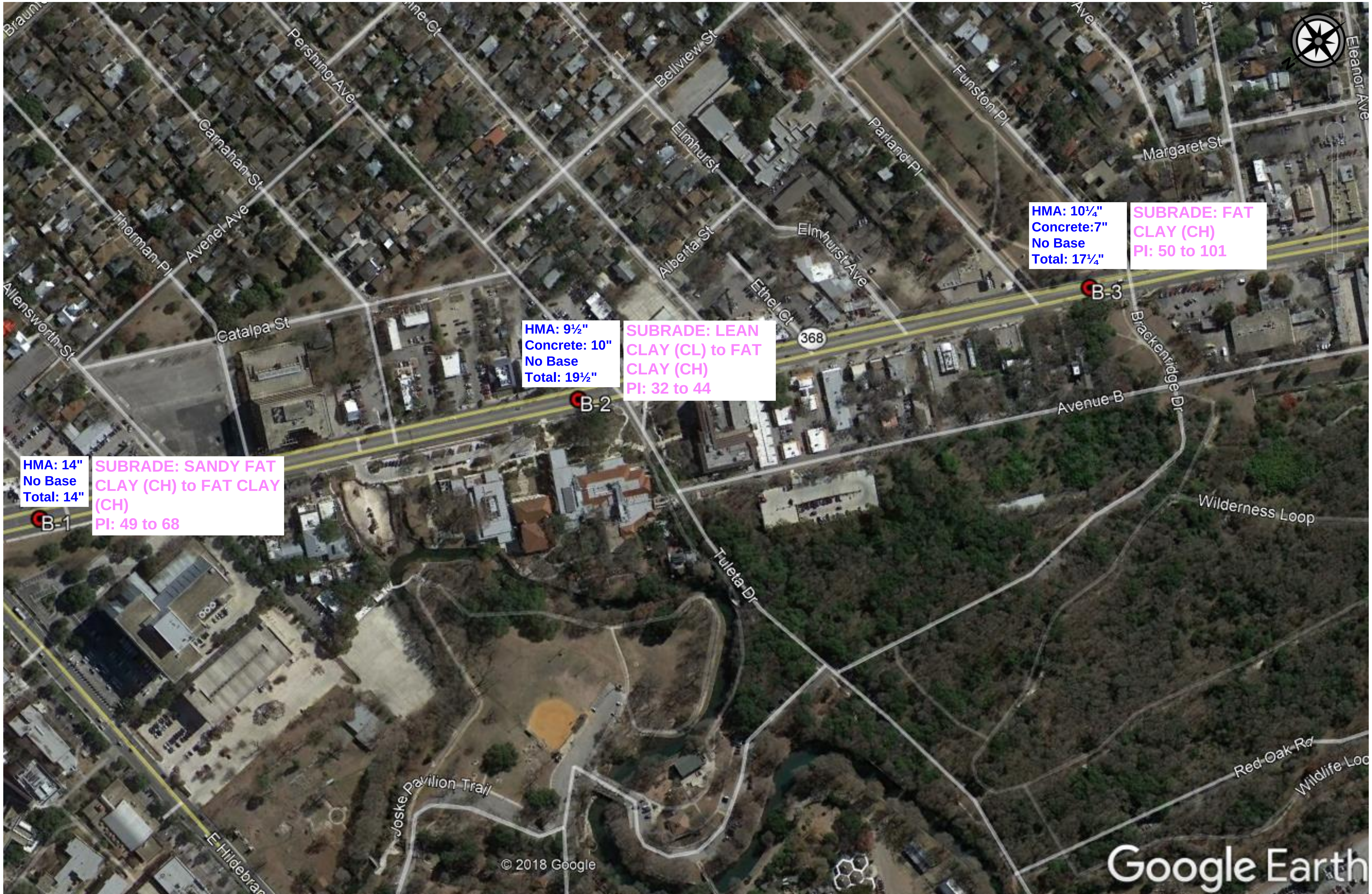
Overall Boring Location Plan

Loop 368 (Broadway Corridor)
From Hildebrand to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ No: 0016-08-034

Job No.:	2018-363
Scale:	N.T.S.
Date:	August 3, 2018
Drawn By:	GK
Checked By:	SAH
Approved By:	SAH

Figure 2



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Summary of Pavement Sections and Subgrade Conditions

Loop 368 (Broadway Corridor)
From Hildebrand to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ No: 0016-08-034

Job No.:	2018-363
Scale:	N.T.S.
Date:	August 3, 2018
Drawn By:	GK
Checked By:	SAH
Approved By:	SAH

Figure 3

ARIAS GEOPROFESSIONALS
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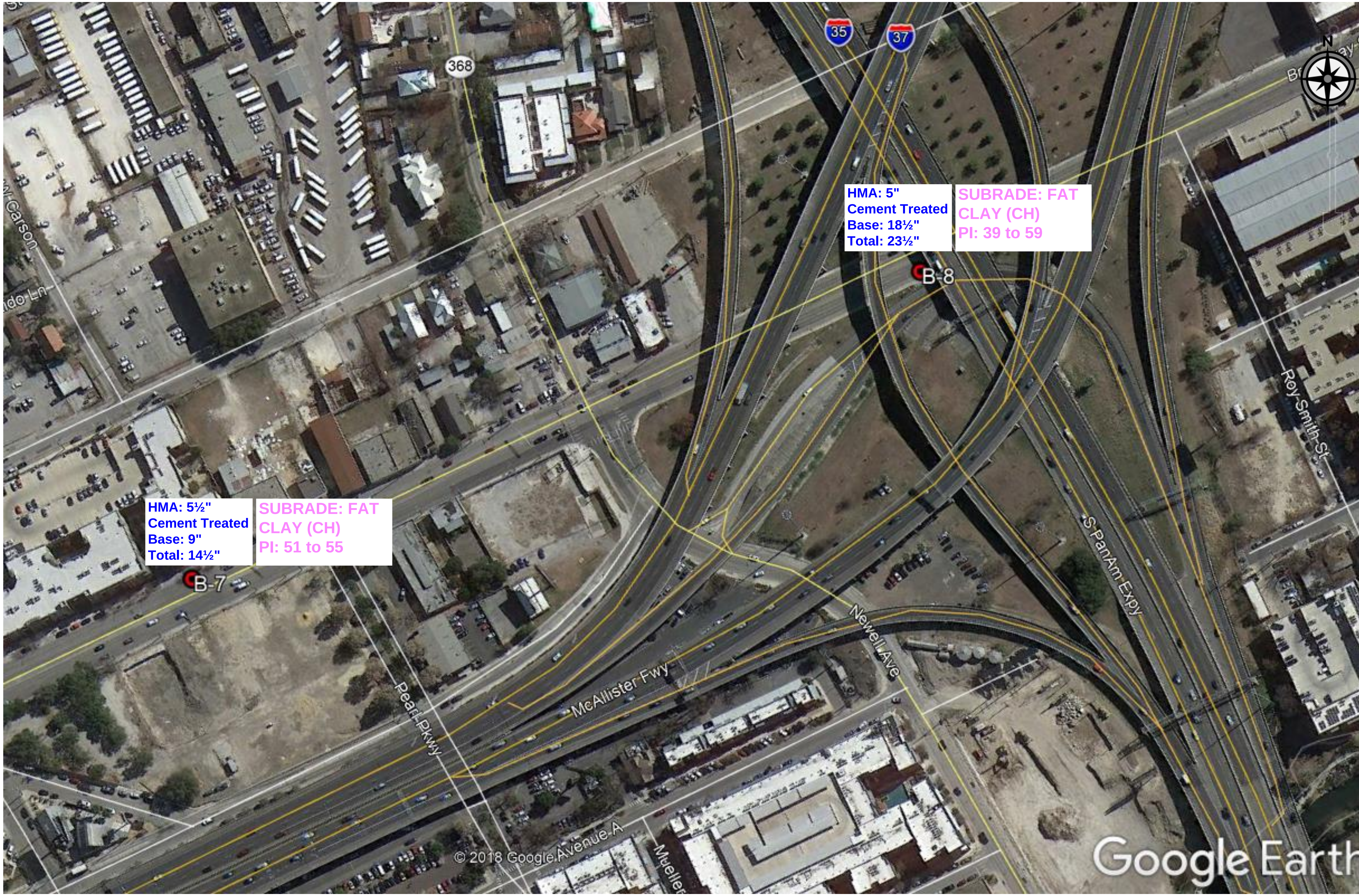
Summary of Pavement Sections and Subgrade Conditions

Loop 368 (Broadway Corridor)
From Hildebrand to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ No: 0016-08-034

Job No.:	2018-363
Scale:	N.T.S.
Date:	August 3, 2018
Drawn By:	GK
Checked By:	SAH
Approved By:	SAH

Figure 3



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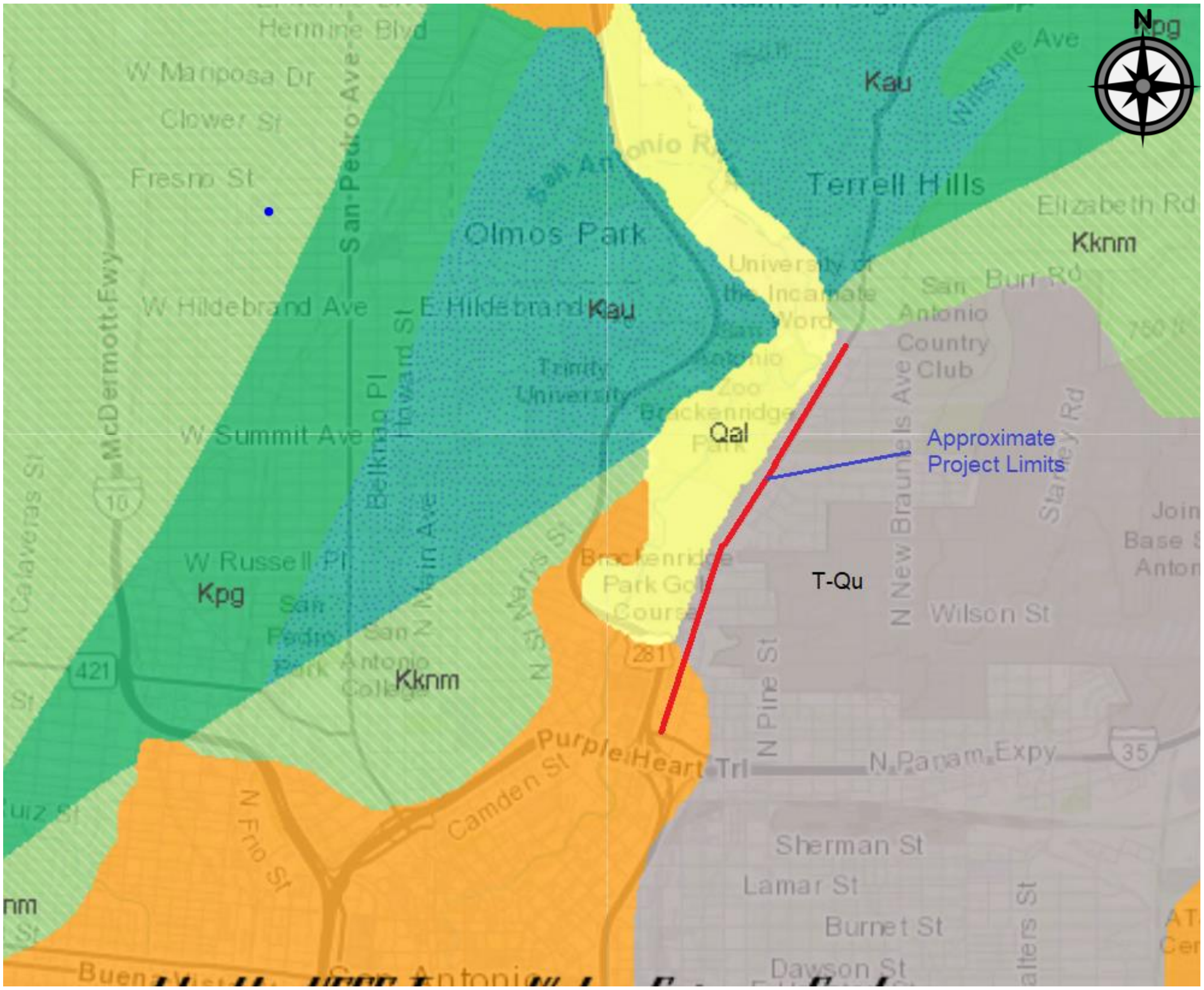
Summary of Pavement Sections and Subgrade Conditions

Loop 368 (Broadway Corridor)
From Hildebrand to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ No: 0016-08-034

Job No.: 2018-363
Scale: N.T.S.
Date: August 3, 2018
Drawn By: GK
Checked By: SAH
Approved By: SAH

Figure 3



PORTION OF GEOLOGIC ATLAS OF TEXAS
(Developed and Powered by USGS Texas Water Science Center)

LEGEND

Symbol	Name	Age
Qt	Fluviatile Terrace Deposits	Quaternary Period / Holocene
Kknm	Navarro-Midway Group	Upper Cretaceous Period
Kpg	Pecan Gap Chalk	Upper Cretaceous Period
Kau	Austin Chalk	Upper Cretaceous Period
T-Qu	Uvalde Gravel	Quaternary Period / Pleistocene

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GEOLOGIC MAP

Loop 368 (Broadway Corridor)
From Hildebrand Avenue to Roy Smith Street
San Antonio, Bexar County, Texas.
CSJ: 0016-08-034

Date: July 6, 2018	Job No.: 2018-123
Drawn By: RWL	Checked By: GK
Approved By: CMS	Scale: N.T.S.

Figure 4

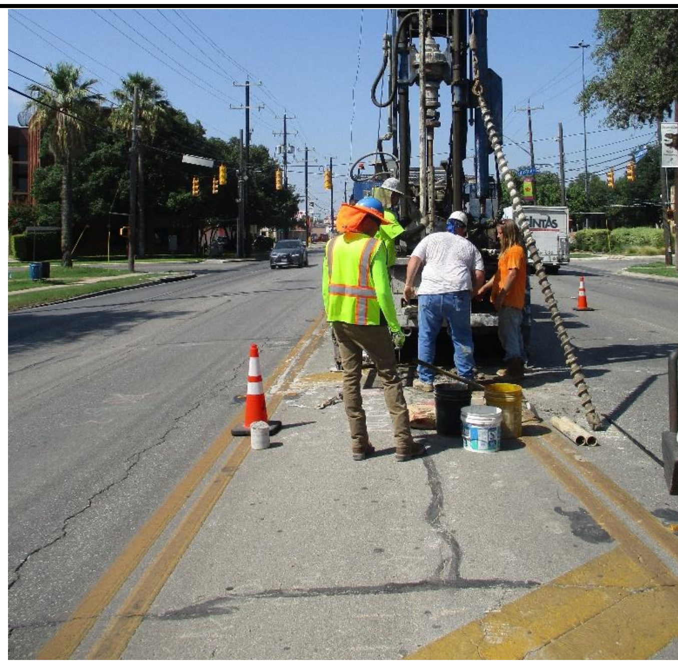

Photo 1 – View looking towards coring/boring operations of B-3 performed at North of Broadway St and Funston Pl. Intersection.

Photo 2 – View looking towards coring/boring operations of B-4 performed at North of Broadway St and E. Mulberry Ave. Intersection

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SITE PHOTOS

LP 368 (Broadway Corridor)
From Hildebrand Avenue to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ 0016-08-034

Date: August 6, 2018	Job No.: 2018-363
Drawn By: GK	Checked By: SAH
Approved By: SAH	Scale: N.T.S.

Appendix A

Asphalt Core from Boring B-1
North of Broadway St and Groveland Pl Intersection
At Median between Northbound and Southbound Broadway St

Asphalt and Concrete Core from Boring B-2
North of Broadway St and Pershing Ave. Intersection
At Southbound Left Turn Lane to Pershing Lane

Asphalt and Concrete Core from Boring B-3
North of Broadway St and Funston Pl. Intersection
At Southbound Left Turn Lane to Funston Pl.

Asphalt and Concrete Core from Boring B-4
North of Broadway St and E. Mulberry Ave. Intersection
At Southbound Left Turn Lane to E. Mulberry Ave.

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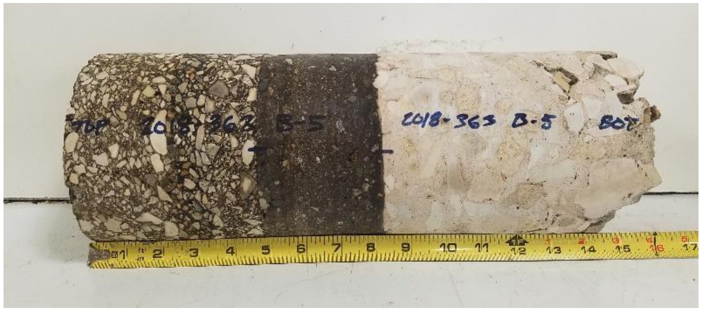
PAVEMENT CORE PHOTOS

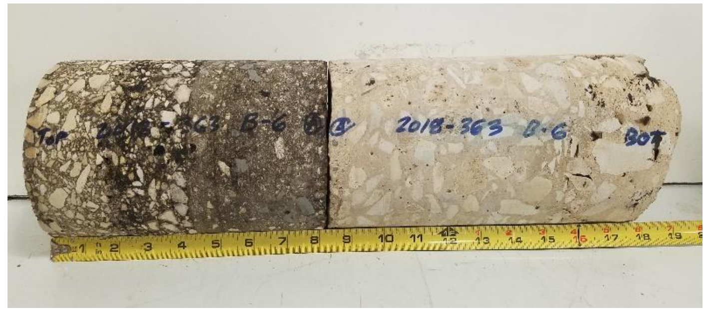
LP 368 (Broadway Corridor)
From Hildebrand Avenue to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ 0016-08-034

Date: July 27, 2018	Job No.: 2018-363
Drawn By: GK	Checked By: SAH
Approved By: SAH	Scale: N.T.S.

Appendix A



Asphalt and Concrete Core from Boring B-5
North of Broadway St and Post Ave. Intersection
At Southbound Left Lane



Asphalt and Concrete Core from Boring B-6
North of Broadway St and Appler St Intersection
At Southbound Left Lane

Asphalt Core from Boring B-7
North of Broadway St and Pearl Pkwy Intersection
At Northbound Left Lane

Asphalt Core from Boring B-8
North of S. PanAm Expy Over Broadway St
At Southbound Right Lane

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PAVEMENT CORE PHOTOS

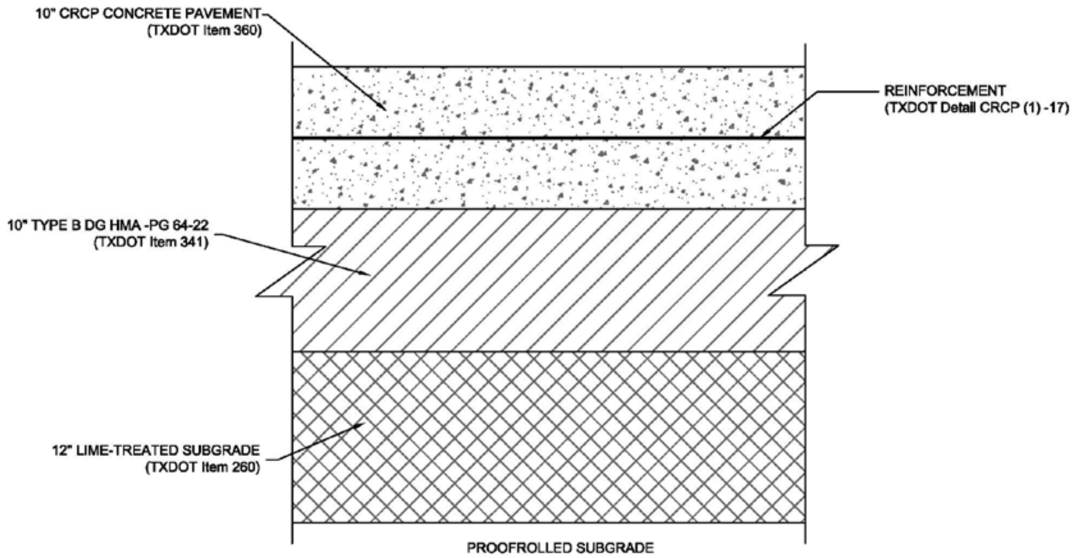
LP 368 (Broadway Corridor)
From Hildebrand Avenue to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ 0016-08-034

Date: July 27, 2018	Job No.: 2018-363
Drawn By: GK	Checked By: SAH
Approved By: SAH	Scale: N.T.S.

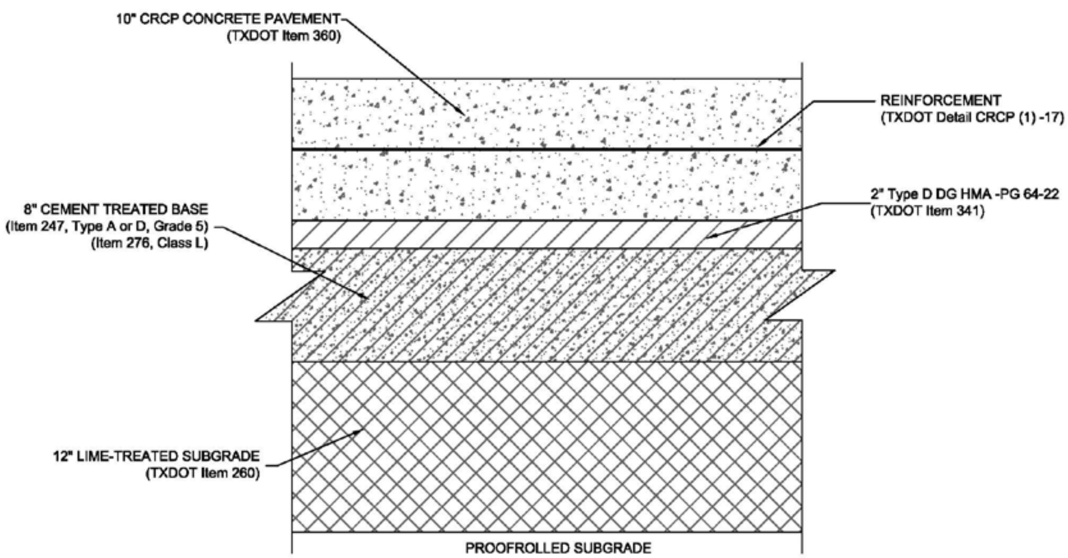
Appendix A

APPENDIX B: PAVEMENT DETAILS

CONCRETE PAVEMENT DETAIL
Option No. 1
NOT TO SCALE



CONCRETE PAVEMENT DETAIL
Option No. 2
NOT TO SCALE



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PAVEMENT DETAILS

LP 368 (Broadway Corridor)
From Hildebrand Avenue to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ: 0016-08-034

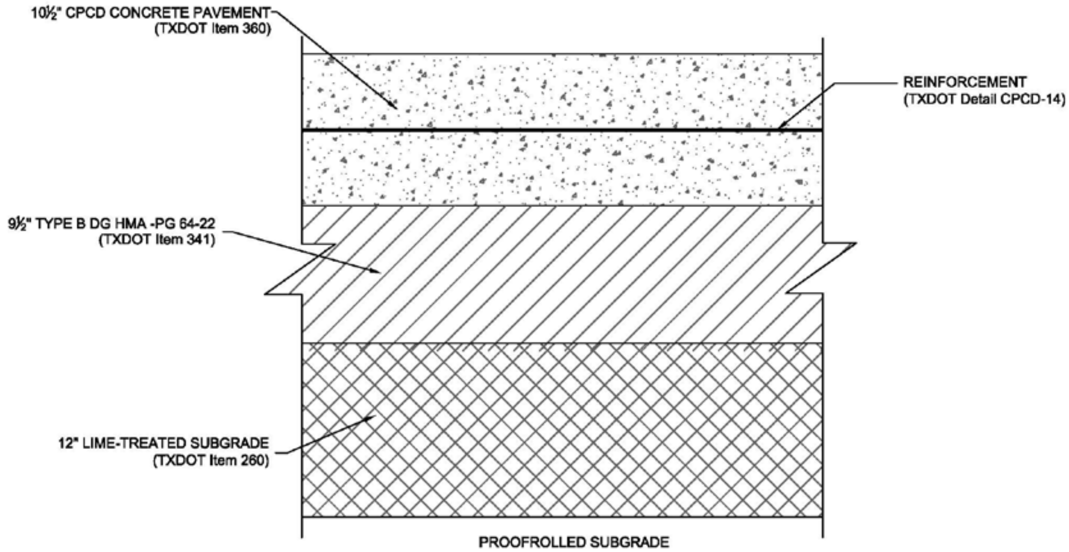
Date: February 27, 2019	Job No.: 2018-363
Drawn By: TAS	Checked By: CMS
Approved By: SAH	Scale: N.T.S.

REVISIONS:

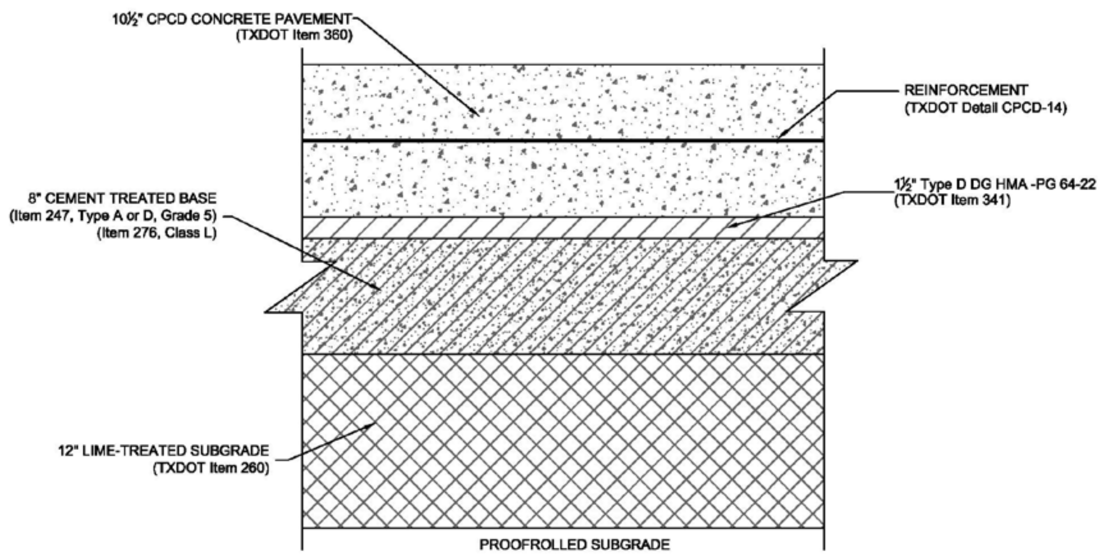
No.:	Date:	Description:

Appendix B

CONCRETE PAVEMENT DETAIL
Option No. 3
NOT TO SCALE



CONCRETE PAVEMENT DETAIL
Option No. 4
NOT TO SCALE



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PAVEMENT DETAILS

LP 368 (Broadway Corridor)
From Hildebrand Avenue to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ: 0016-08-034

Date: February 27, 2019	Job No.: 2018-363
Drawn By: TAS	Checked By: CMS
Approved By: SAH	Scale: N.T.S.

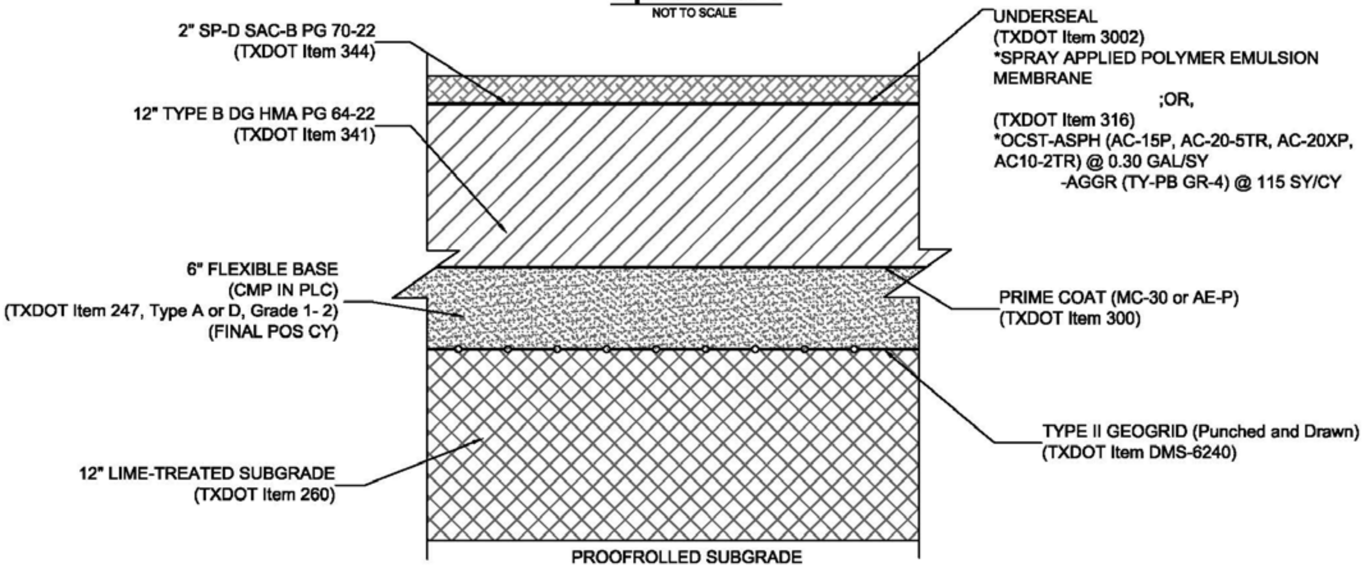
REVISIONS:

No.:	Date:	Description:

Appendix B

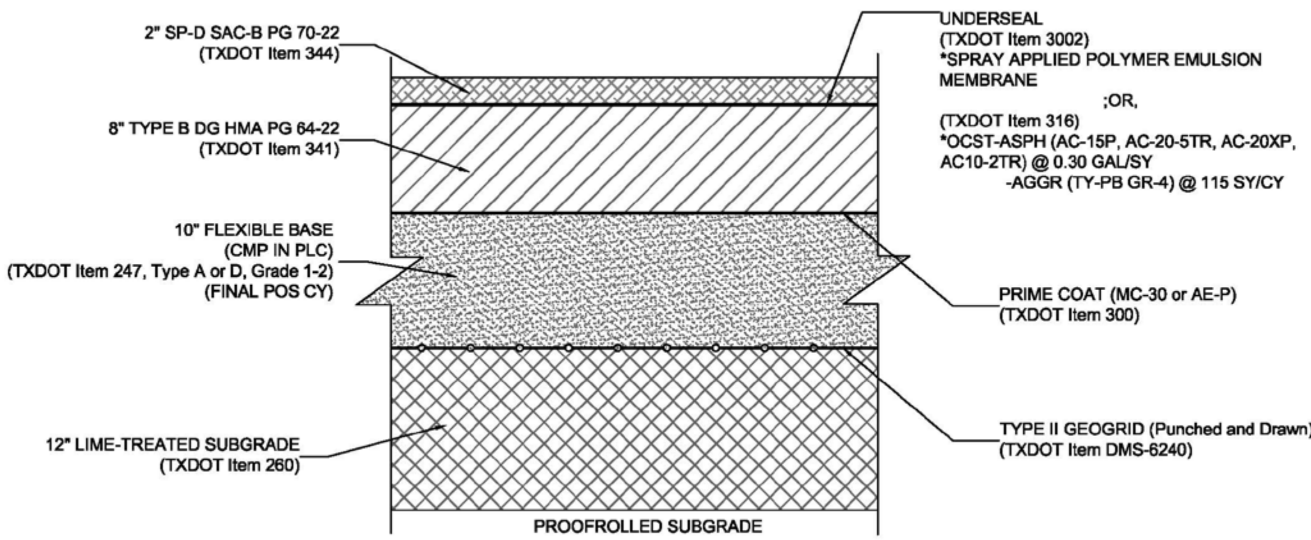
FLEXIBLE PAVEMENT DETAIL - Option No. 1

NOT TO SCALE



FLEXIBLE PAVEMENT DETAIL - Option No. 2

NOT TO SCALE



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Phone: (210) 308-5884 • Fax: (210) 308-5886

PAVEMENT DETAILS

LP 368 (Broadway Corridor)
From Hildebrand Avenue to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ: 0016-08-034

Date: March 1, 2019	Job No.: 2018-363
Drawn By: TAS	Checked By: CMS
Approved By: SAH	Scale: N.T.S.

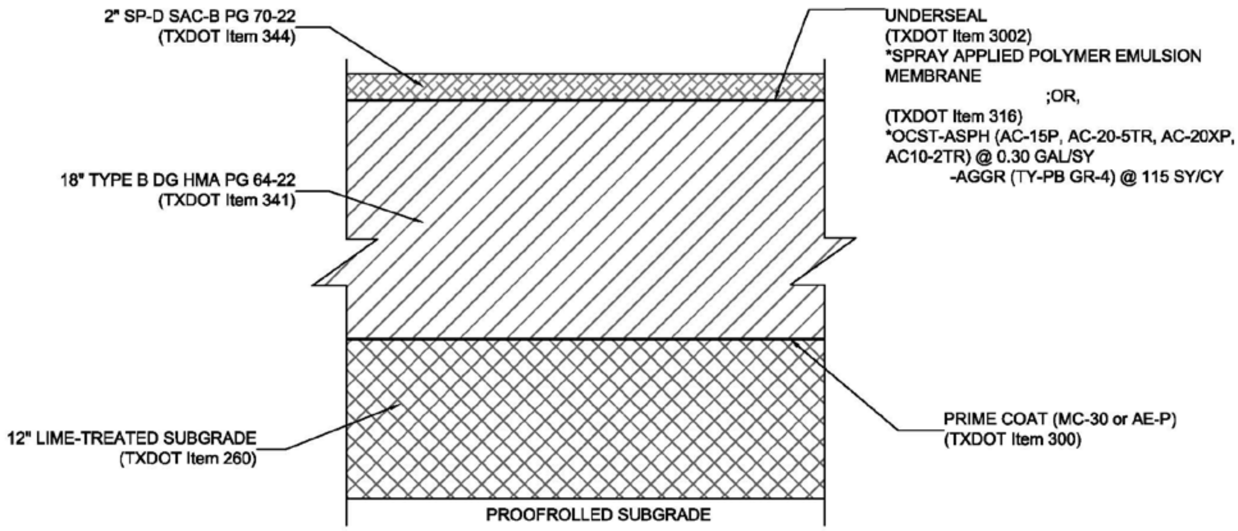
REVISIONS:

No.:	Date:	Description:

Appendix B

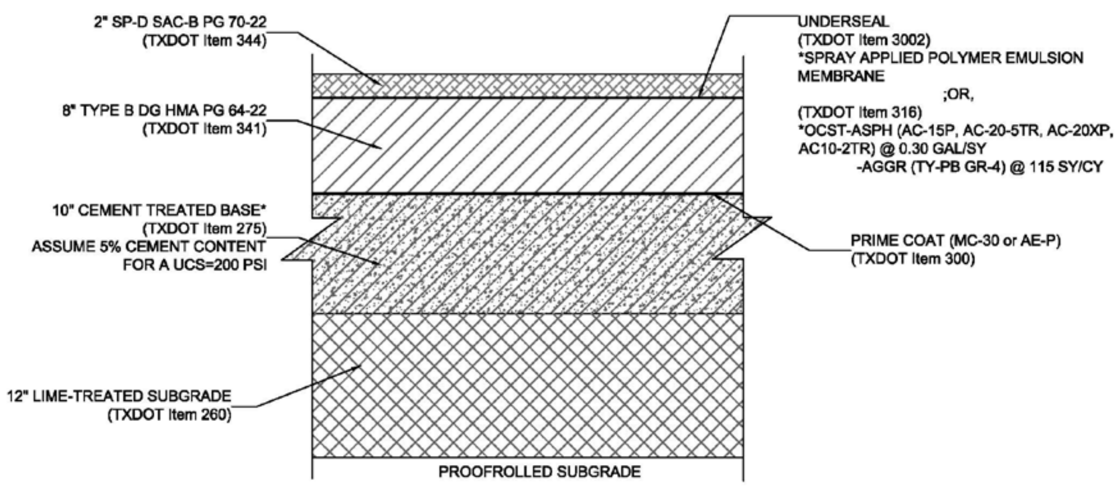
FLEXIBLE PAVEMENT DETAIL - Option No. 3

NOT TO SCALE



FLEXIBLE PAVEMENT DETAIL - Option No. 4

NOT TO SCALE



*USE IMPORT FLEXIBLE BASE, TYPE D, GRADE 5

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PAVEMENT DETAILS

LP 368 (Broadway Corridor)
From Hildebrand Avenue to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ: 0016-08-034

Date: February 27, 2019	Job No.: 2018-363
Drawn By: TAS	Checked By: CMS
Approved By: SAH	Scale: N.T.S.

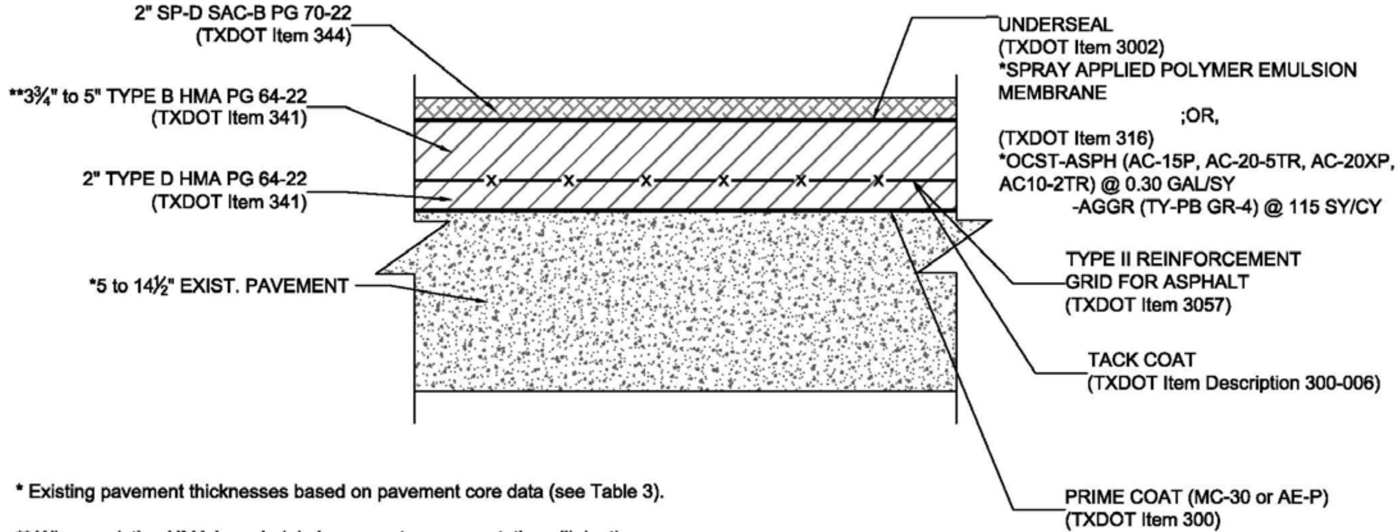
REVISIONS:

No.:	Date:	Description:

Appendix B

FLEXIBLE PAVEMENT DETAIL - Option No. 5

NOT TO SCALE



* Existing pavement thicknesses based on pavement core data (see Table 3).

** Where existing HMA is underlain by concrete pavement, the mill depth can be stopped to the top of concrete resulting in an inlay less than 9" thick with Type B HMA layer less than 5" thick.

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PAVEMENT DETAILS

LP 368 (Broadway Corridor)
From Hildebrand Avenue to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ: 0016-08-034

Date: March 1, 2019	Job No.: 2018-363
Drawn By: TAS	Checked By: CMS
Approved By: SAH	Scale: N.T.S.

REVISIONS:

No.:	Date:	Description:

Appendix B

APPENDIX C: BORING LOGS AND KEY TO TERMS AND SYMBOLS

DRILLING LOG

WinCore
Version 3.1

County	Bexar	Hole	B-1	District	SAT
Highway	LP 368 (Broadway Corr)	Structure	Pavement	Date	7/3/2018
CSJ	0016-08-034	Station		Grnd. Elev.	100.00 ft
		Offset		GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	Properties: MC	Properties: LL	Properties: PI	Properties: Wet Den. (pcf)	Additional Remarks
			ASPHALT, 14 inches, No base			21				
98.8			CLAY, fat, soft, dark brown, sandy (CH)							Sulfate Content = 160 ppm
						28	92	68		No. -200 = 70%
						30				PP = 4.0 tsf
5		5 (6) 5 (6)								
						21	69	49		No. -200 = 97%; PP = 3.5 tsf
92.			CLAY, fat, soft, tan (CH)							
10		9 (6) 11 (6)								
85. 15										

Remarks: PP=Pocket Pen, SS= Split Spoon Sample with 170-lb hammer. Boring performed in the Median between Northbound and Southbound Lane GPS Coor: N29.465065, W98.464159

The ground water elevation was not determined during the course of this boring.

Driller: Eagle Drilling **Logger: R. Arizola** **Organization: Arias Geoprofessionals**

DRILLING LOG

WinCore
Version 3.1

County	Bexar	Hole	B-2	District	SAT
Highway	LP 368 (Broadway Corr)	Structure	Pavement	Date	7/19/2018
CSJ	0016-08-034	Station		Grnd. Elev.	100.00 ft
		Offset		GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	Properties: MC	Properties: LL	Properties: PI	Properties: Wet Den. (pcf)	Additional Remarks
			ASPHALT, 9.5 inches							
99.2			CONCRETE, 10 inches							
98.4			CLAY, lean, soft, tan, with calcareous deposits (CL)			16	48	32		No. -200 = 96%; PP = 2.75 tsf Sulfates = 360ppm
95. 5		8 (6) 14 (6)	CLAY, fat, stiff, tan (CH)			20	64	44		PP = 4.2.5 tsf; Sulfates = 1,220ppm
										PP = 3.25 tsf
10		4 (6) 5 (6)								
85. 15										

Remarks: PP=Pocket Pen, SS= Split Spoon Sample with 170-lb hammer. Boring performed in the Southbound Left turn Lane
GPS Coor: N29.461448, W98.466574

The ground water elevation was not determined during the course of this boring.

Driler: Eagle Drilling | Logger: J. Kniffen | Organization: Arias Geoprofessionals

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DRILLING LOG

WinCore
Version 3.1

County	Bexar	Hole	B-3	District	SAT
Highway	LP 368 (Broadway Corr)	Structure	Pavement	Date	7/19/2018
CSJ	0016-08-034	Station		Grnd. Elev.	100.00 ft
		Offset		GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	Properties: MC	Properties: LL	Properties: PI	Properties: Wet Den. (pcf)	Additional Remarks
			ASPHALT, 10.25 inches							
99.1			CONCRETE, 7 inches							
98.5			CLAY, fat, soft, dark brown to brown, with bentonite (CH)			25				SS = 3-4-7
						22	129	101		No. -200 = 95%; SS = 4-6-6
5		6 (6) 6 (6)								
						28	77	50		No. -200 = 90%; SS = 3-5-8
						30	77	52		SS = 2-4-8; tan below 8.5'
10		8 (6) 9 (6)								
85. 15										

Remarks: PP=Pocket Pen, SS= Split Spoon Sample with 170-lb hammer. Boring performed in the Southbound Left turn Lane
GPS Coor: N29.458014, W98.46880

The ground water elevation was not determined during the course of this boring.

Driler: Eagle Drilling | Logger: J. Kniffen | Organization: Arias Geoprofessionals

DRILLING LOG

WinCore
Version 3.1

County	Bexar	Hole	B-4	District	SAT
Highway	LP 368 (Broadway Corr)	Structure	Pavement	Date	7/19/2018
CSJ	0016-08-034	Station		Grnd. Elev.	100.00 ft
		Offset		GW Elev.	N/A

Elev. (ft)	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	MC	LL	PI	Wet Den. (pcf)	Additional Remarks
		ASPHALT, 7.75 inches							
99.3		CONCRETE, 10.5 inches			28	71	46	114	No. -200 = 91%; PP = 1.5 tsf DD = 89 pcf; Uc = 1.98 tsf
98.5		CLAY, fat, stiff to soft, dark brown (CH)			26				PP = 2.25 tsf
5	6 (6) 10 (6)								Sulfates = 160 ppm
					5				No. -200 = 14%; SS = 19-38-41
91.5		GRAVEL, tan, clayey, with sand (GC)							
10	50 (3) 50 (3)								
85. 15									

Remarks: PP=Pocket Pen, SS= Split Spoon Sample with 170-lb hammer. Boring performed in the Southbound Left turn Lane
GPS Coor: N29.454558, W98.471383

The ground water elevation was not determined during the course of this boring.

Driler: Eagle Drilling Logger: J. Kniffen Organization: Arias Geoprofessionals

DRILLING LOG

WinCore
Version 3.1

County	Bexar	Hole	B-5	District	SAT
Highway	LP 368 (Broadway Corr)	Structure	Pavement	Date	7/19/2018
CSJ	0016-08-034	Station		Grnd. Elev.	100.00 ft
		Offset		GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	MC	LL	PI	Wet Den. (pcf)	Additional Remarks
99.4			ASPHALT, 7.75 inches							
98.5			CONCRETE, 7.25 inches			31				SS = 3-3-3
			CLAY, fat, very soft to soft, dark brown (CH)			26	83	60		No. -200 = 90%; SS = 2-2-3
5		2 (6) 3 (6)								
						28				Sulfates = 900 ppm; SS = 2-2-5
						24	78	56		No. -200 = 91%; SS = 3-4-6
10		7 (6) 11 (6)								
85. 15										

Remarks: PP=Pocket Pen, SS= Split Spoon Sample with 170-lb hammer. Boring performed in the Southbound Left Lane
GPS Coor: N29,450783 W98.474023

The ground water elevation was not determined during the course of this boring.

Driller: Eagle Drilling | Logger: J. Kniffen | Organization: Arias Geoprofessionals

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DRILLING LOG

WinCore
Version 3.1

County	Bexar	Hole	B-6	District	SAT
Highway	LP 368 (Broadway Corr)	Structure	Pavement	Date	7/19/2018
CSJ	0016-08-034	Station		Grnd. Elev.	100.00 ft
		Offset		GW Elev.	N/A

Elev. (ft)	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	MC	LL	PI	Wet Den. (pcf)	Additional Remarks
		ASPHALT, 8.25 inches							
99.3		CONCRETE, 10 inches							
98.4		CLAY, fat, soft, dark brown (CH)			28	71	49	117	DD = 92 pcf; Uc = 1.34 tsf PP = 1.5 tsf
					27				Sulfates = 160 ppm; PP = 2 tsf
5	6 (6) 7 (6)								
					23				PP = 2.5 tsf
					17	47	32		No. -200 = 81%; PP = 3 tsf
92.		CLAY, lean, soft, tan, with sand (CL)							
10	6 (6) 11 (6)								
85. 15									

Remarks: PP=Pocket Pen, SS= Split Spoon Sample with 170-lb hammer. Boring performed in the Southbound Left Lane
GPS Coor: N29.446722, W98.475472

The ground water elevation was not determined during the course of this boring.

Driller: Eagle Drilling **Logger: W. Persyn** **Organization: Arias Geoprofessionals**

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DRILLING LOG

WinCore
Version 3.1

County	Bexar	Hole	B-7	District	SAT
Highway	LP 368 (Broadway Corr)	Structure	Pavement	Date	7/20/2018
CSJ	0016-08-034	Station		Grnd. Elev.	100.00 ft
		Offset		GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	Properties: MC	Properties: LL	Properties: PI	Properties: Wet Den. (pcf)	Additional Remarks
99.5			ASPHALT, 5.5 inches							
98.5			CEMENT TREATED BASE, 9 inches			4				
						29	72	51		No. -200 = 91%; PP = 1.5 tsf
			CLAY, fat, soft, brown to tan (CH)							
						23				PP = 2.25 tsf;Sulfate Content= 220 ppm
5		6 (6) 8 (6)								
						21	74	55		No. -200 = 96%; PP = 2.75 tsf
						20				PP = 3.5 tsf
10		4 (6) 7 (6)								
85. 15										

Remarks: PP=Pocket Pen, SS= Split Spoon Sample with 170-lb hammer. Boring performed in the Northbound Left Lane
GPS Coor: N29.442333, W98.47700

The ground water elevation was not determined during the course of this boring.

Driler: Eagle Drilling | Logger: R. Arizola | Organization: Arias Geoprofessionals

DRILLING LOG

WinCore
Version 3.1

County	Bexar	Hole	B-8	District	SAT
Highway	LP 368 (Broadway Corr)	Structure	Pavement	Date	7/20/2018
CSJ	0016-08-034	Station		Grnd. Elev.	100.00 ft
		Offset		GW Elev.	N/A

Elev. (ft)	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	MC	LL	PI	Wet Den. (pcf)	Additional Remarks
		ASPHALT, 5 inches							
99.5		CEMENT TREATED BASE, 18.5 inches							
98.1					6	81	59		No. -200 = 90%; SS = 19-5-2
		CLAY, fat, soft, brown and tan (CH)							Sulfate Content = 160 ppm
					28				PP = 1.75 tsf
5	7 (6) 7 (6)								
					21	62	44		No. -200 = 97%; SS = 5-6-8
					16	55	39		PP = 4.5 tsf; with calcareous deposits
10	50 (5) 50 (3.5)								
85. 15									

Remarks: PP=Pocket Pen, SS= Split Spoon Sample with 170-lb hammer. Boring performed in the Southbound Right Lane
GPS Coor: N29.439028, W98.47833

The ground water elevation was not determined during the course of this boring.

Driller: Eagle Drilling   Logger: R. Arizola   Organization: Arias Geoprofessionals

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KEY TO TERMS AND SYMBOLS USED ON BORING LOGS

TABLE 1 Soil Classification Chart (ASTM D 2487-11)

Criteria of Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Soil Classification: Group Name[B]
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve	Gravels (More than 50% of coarse fraction retained on No. 4 sieve)	Clean Gravels (Less than 5% fines[C])	Cu ≥ 4 and 1 ≤ Cc ≤ 3[D]	GW	Well-Graded Gravel[E]
			Cu < 4 and/or [Cc < 1 or Cc > 3][D]	GP	Poorly-Graded Gravel[E]
		Gravels with Fines (More than 12% fines[C])	Fines classify as ML or MH	GM	Silty Gravel[E,F,G]
			Fines classify as CL or CH	GC	Clayey Gravel[E,F,G]
	Sands (50% or more of coarse fraction passes No. 4 sieve)	Clean Sands (Less than 5% fines[H])	Cu ≥ 6 and 1 ≤ Cc ≤ 3[D]	SW	Well-Graded Sand[I]
			Cu < 6 and/or [Cc < 1 or Cc > 3][D]	SP	Poorly-Graded Sand[I]
		Sands with Fines (More than 12% fines[H])	Fines classify as ML or MH	SM	Silty Sand[F,G,I]
			Fines classify as CL or CH	SC	Clayey Sand[F,G,I]
FINE-GRAINED SOILS 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean Clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried <0.75	OL	Organic Clay[K,L,M,N]
					Organi Silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat Clay[K,L,M]
			PI plots on or below "A" line	MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried <0.75	OH	Organic Clay[K,L,M,P]
					Organic Silt[K,L,M,Q]
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75mm) sieve
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name
[C] Gravels with 5% to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly-graded gravel with silt
- GP-GC poorly-graded gravel with clay

[D] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[E] If soil contains ≥ 15% sand, add "with sand" to group name
[F] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM
[G] If fines are organic, add "with organic fines" to group name
[H] Sand with 5% to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly-graded sand with silt
- SP-SC poorly-graded sand with clay

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay
[K] If soil contains 15% to < 30% plus No. 200, add "with sand" or "with gravel," whichever is predominant
[L] If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name
[N] PI ≥ 4 and plots on or above "A" line
[O] PI < 4 or plots below "A" line
[P] PI plots on or above "A" line
[Q] PI plots below "A" line

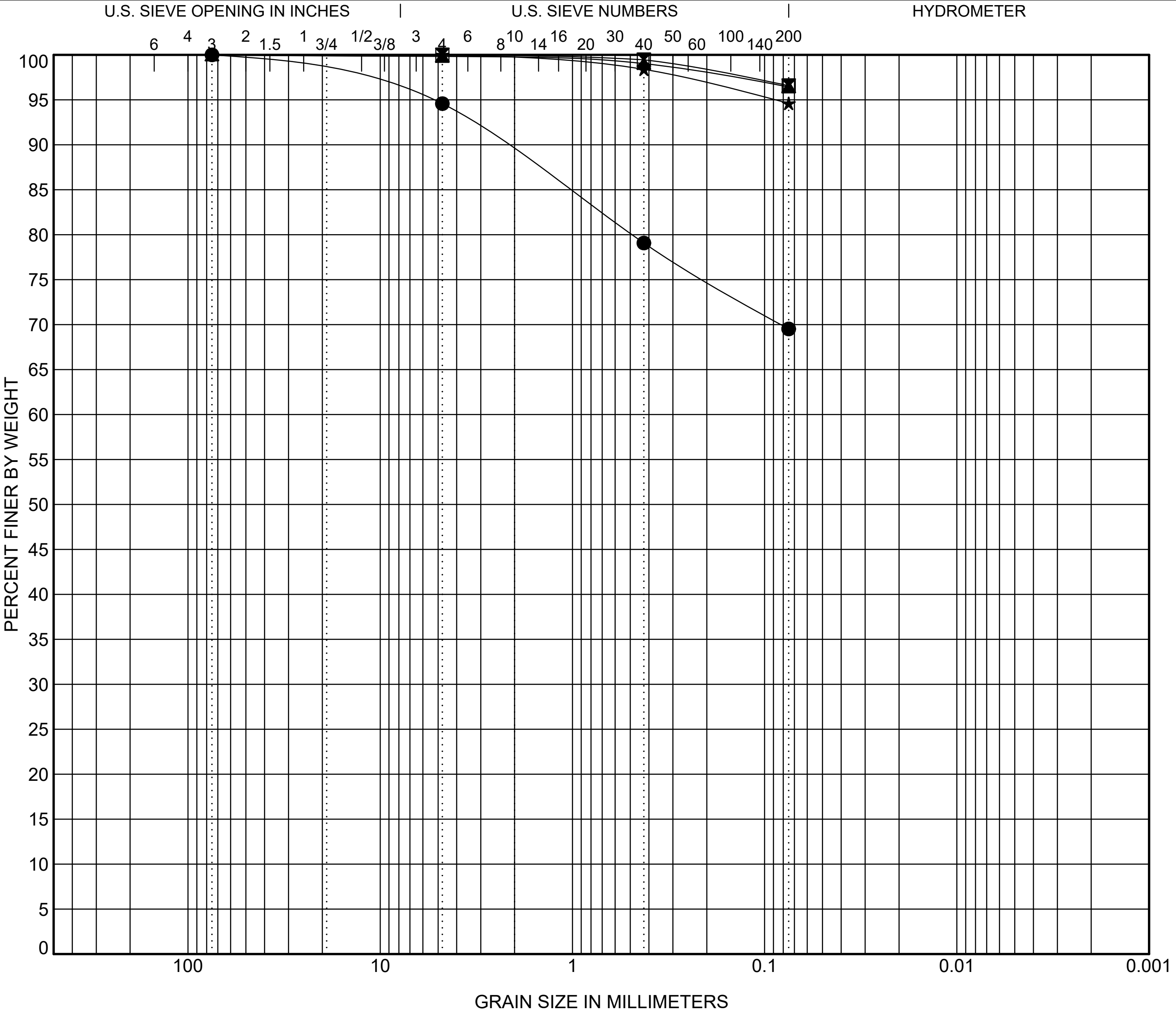
TERMINOLOGY

Boulders Over 12-inches (300mm)
Cobbles 12-inches to 3-inches (300mm to 75mm)
Gravel 3-inches to No. 4 sieve (75mm to 4.75mm)
Sand No. 4 sieve to No. 200 sieve (4.75mm to 0.075mm)
Silt or Clay Passing No. 200 sieve (0.075mm)
Calcareous Containing appreciable quantities of calcium carbonate, generally nodular

Parting Inclusion < 1/8-inch thick extending through samples
Seam Inclusion 1/8-inch to 3-inches thick extending through sample
Layer Inclusion > 3-inches thick extending through sample

Stratified Alternating layers of varying material or color with layers at least 6mm thick
Laminated Alternating layers of varying material or color with the layers less than 6mm thick
Fissured Breaks along definite planes of fracture with little resistance to fracturing
Slickensided Fracture planes appear polished or glossy sometimes striated
Blocky Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Homogeneous Same color and appearance throughout

APPENDIX D: LABORATORY TEST RESULTS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	1		2.0	**SANDY FAT CLAY (CH)**	**92**	**24**	**68**		
⧗	1		8.0	**FAT CLAY (CH)**	**69**	**20**	**49**		
▲	2		2.0	**LEAN CLAY (CL)**	**48**	**16**	**32**		
★	3		3.5	**FAT CLAY (CH)**	**129**	**28**	**101**		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	1	2.0	75				5.4	25.1	69.5	
⧗	1	8.0	4.75				0.0	3.4	96.6	
▲	2	2.0	75				0.2	3.4	96.4	
★	3	3.5	4.75				0.0	5.4	94.6	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

142 Chula Vista
San Antonio, Texas 782323
Phone: (210) 308-5884
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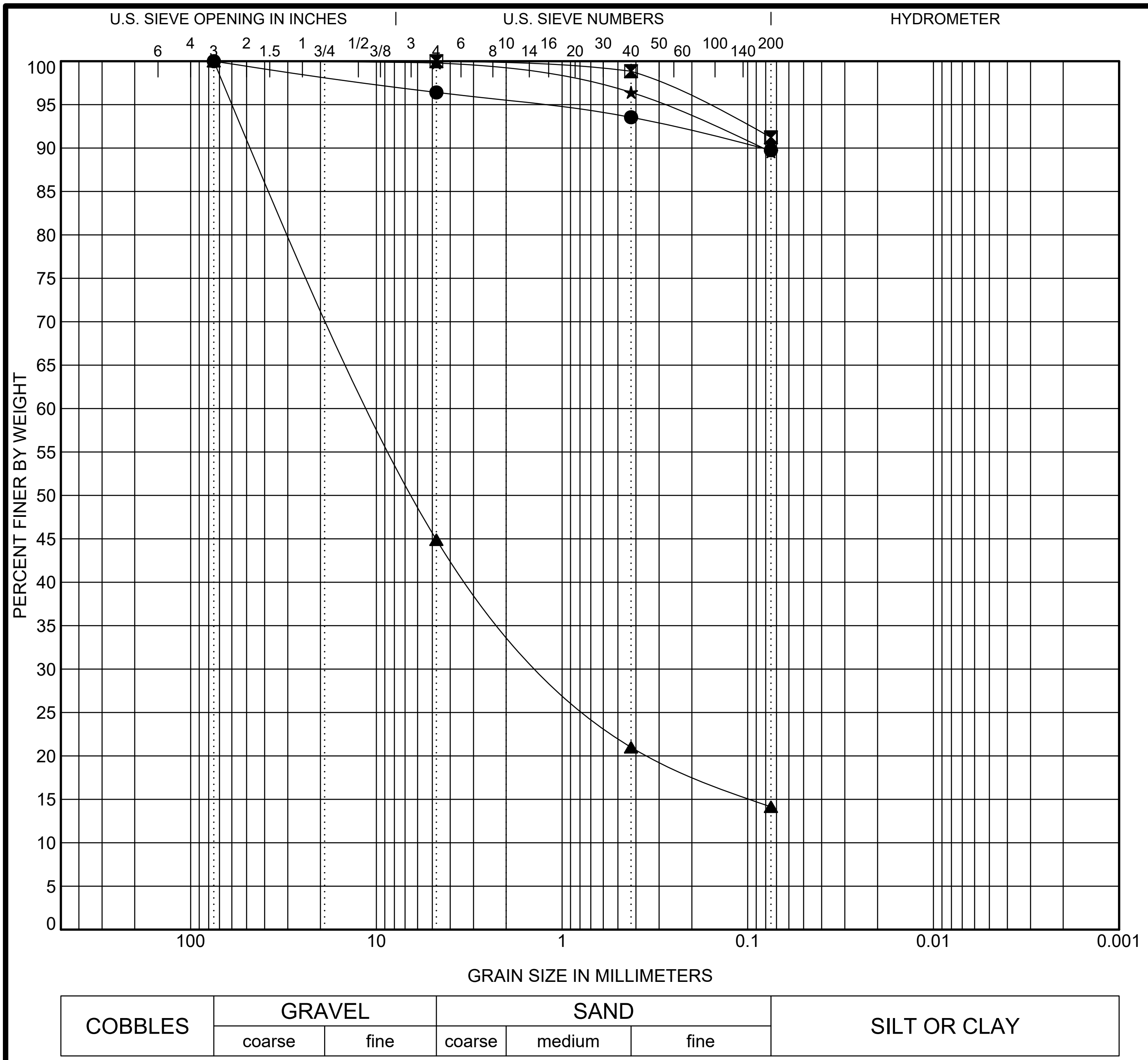
GRAIN SIZE DISTRIBUTION

Project: Broadway Corridor

Location: See Boring Location Plan

Job No.: 2018-363



	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	3		6.5	**FAT CLAY (CH)**	77	27	50		
⧗	4		1.5	**FAT CLAY (CH)**	71	25	46		
▲	4		8.5						
★	5		3.0	**FAT CLAY (CH)**	83	23	60		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	3	6.5	75				3.6	6.7	89.7	
⧗	4	1.5	4.75				0.0	8.8	91.2	
▲	4	8.5	75	10.12	1.055		55.1	30.8	14.1	
★	5	3.0	75				0.2	10.2	89.6	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

2018-363.GPJ 11/21/18 (GRAIN SIZE ARIAS.US LAB.GDT,LIBRARY2013-01.GLB)

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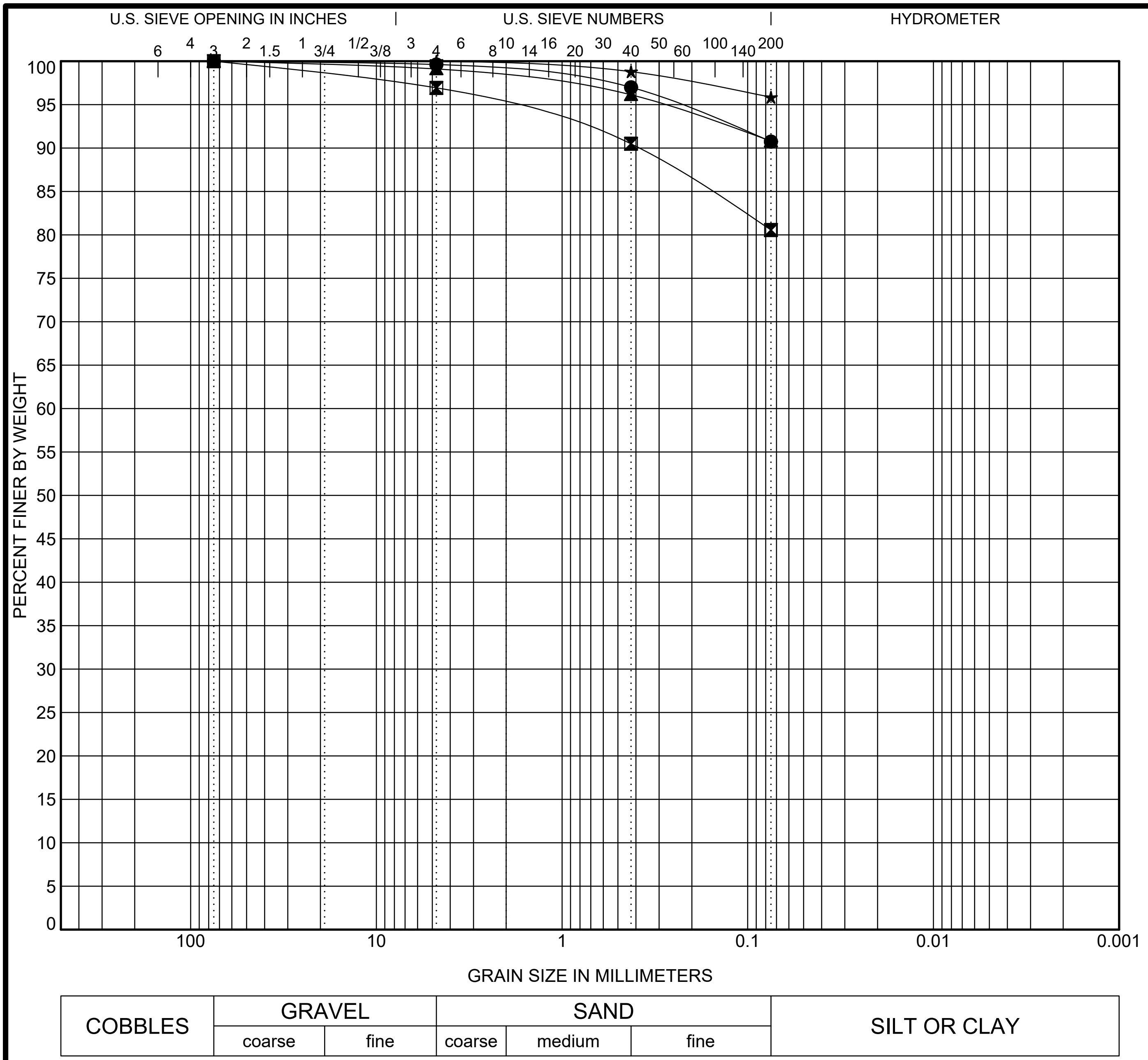
GRAIN SIZE DISTRIBUTION

Project: Broadway Corridor

Location: See Boring Location Plan

Job No.: 2018-363



	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	**5**		**8.5**	**FAT CLAY (CH)**	**78**	**22**	**56**		
⧗	**6**		**8.0**	**LEAN CLAY with SAND (CL)**	**47**	**15**	**32**		
▲	**7**		**1.5**	**FAT CLAY (CH)**	**72**	**21**	**51**		
★	**7**		**6.5**	**FAT CLAY (CH)**	**74**	**19**	**55**		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**5**	**8.5**	**75**				**0.4**	**8.9**	**90.7**	
⧗	**6**	**8.0**	**75**				**3.1**	**16.4**	**80.6**	
▲	**7**	**1.5**	**75**				**0.9**	**8.3**	**90.8**	
★	**7**	**6.5**	**4.75**				**0.0**	**4.2**	**95.8**	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

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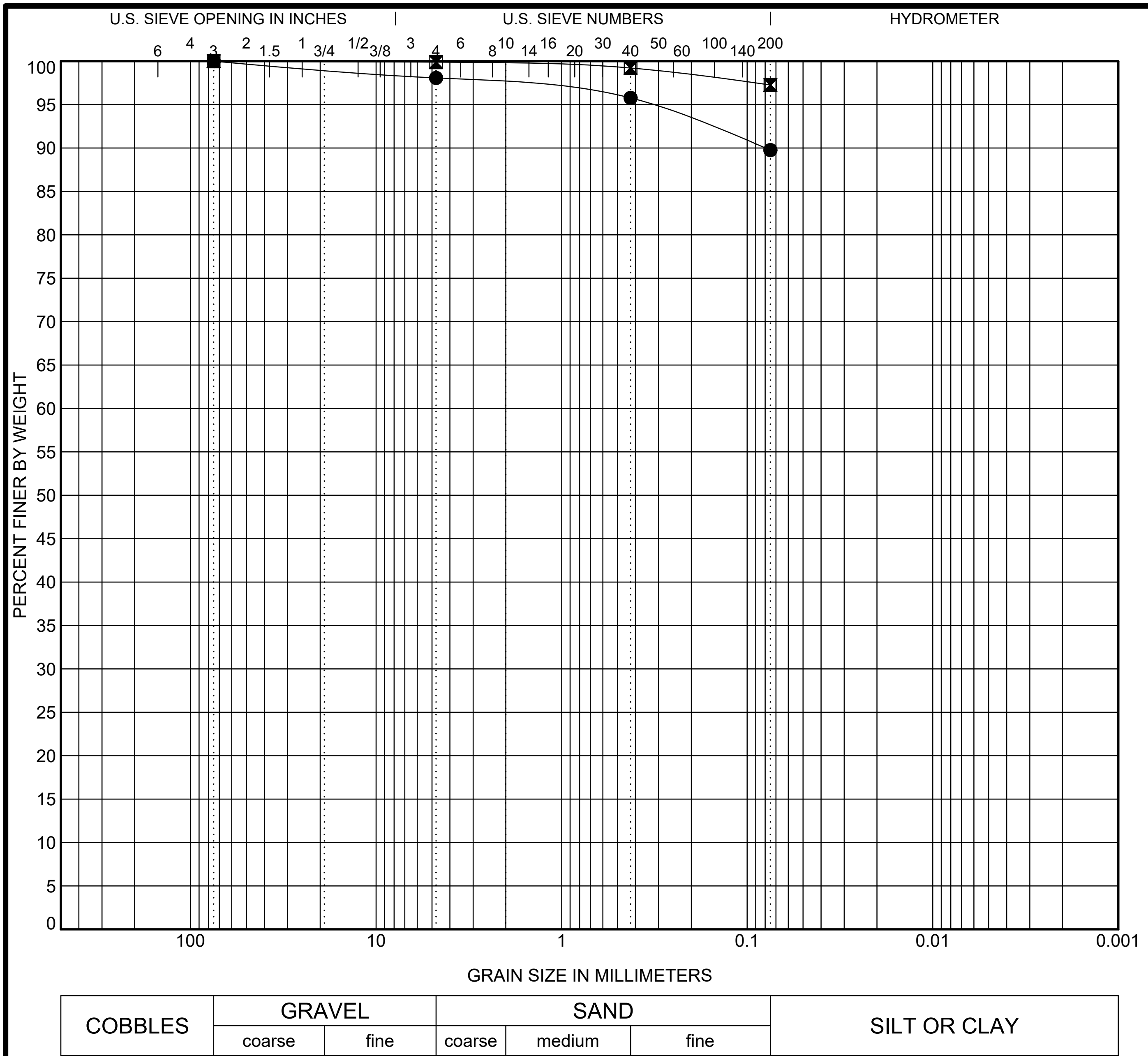
GRAIN SIZE DISTRIBUTION

Project: Broadway Corridor

Location: See Boring Location Plan

Job No.: 2018-363



	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	**8**		**1.0**	**FAT CLAY (CH)**	**81**	**22**	**59**		
⧗	**8**		**7.0**	**FAT CLAY (CH)**	**62**	**18**	**44**		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**8**	**1.0**	**75**				**1.9**	**8.3**	**89.8**	
⧗	**8**	**7.0**	**75**				**0.1**	**2.6**	**97.3**	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

142 Chula Vista
San Antonio, Texas 782323
Phone: (210) 308-5884
Fax: (210) 308-5886

GRAIN SIZE DISTRIBUTION

Project: Broadway Corridor

Location: See Boring Location Plan

Job No.: 2018-363

2018-363.GPJ 11/21/18 (GRAIN SIZE ARIAS,US_LAB.GDT,LIBRARY2013-01.GLB)

APPENDIX E: FWD DATA AND MODULUS BACK-CALCULATION

LP 368 Northbound near B-1 to B-8

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 7.0)

		Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
District:					
County :					
Highway/Road:	Pavement:	8.00	60,000	2,000,000	H1: v = 0.35
	Base:	8.00	10,000	2,000,000	H2: v = 0.25
	Subbase:	0.00			H3: v = 0.00
	Subgrade:	96.55(by DB)	5,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): W1	W2	W3	W4	W5	W6	W7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Dpth to Bedrock
0.000	9,399	11.94	9.11	7.76	6.06	4.43	3.27	2.16	315.5	373.9	0.0	5.8	1.61	100.0
560.000	9,541	6.63	5.80	5.02	4.25	3.39	2.78	2.04	1531.2	638.6	0.0	6.2	0.65	107.4
1074.000	9,059	24.77	17.43	9.81	6.40	4.50	3.54	2.75	122.2	38.9	0.0	6.0	8.73	175.3
1633.000	9,169	19.79	13.38	7.88	4.73	3.04	2.22	1.91	171.6	32.1	0.0	8.6	5.68	106.4
2179.000	9,256	17.96	12.46	7.75	5.08	3.40	2.58	1.94	174.8	62.9	0.0	7.9	5.71	127.3
2735.000	9,454	10.61	7.57	5.79	4.64	3.44	2.54	1.65	208.2	710.3	0.0	7.8	1.57	88.0
3263.000	9,311	18.30	15.33	12.16	9.23	6.31	4.52	3.11	659.1	38.6	0.0	4.2	1.21	120.3
3870.000	9,267	23.38	17.84	12.20	8.18	5.22	3.54	2.40	246.7	28.2	0.0	5.2	2.10	109.3
4315.000	9,585	7.89	6.65	6.40	6.02	5.14	3.76	2.74	809.6	2000.0	0.0	3.3	4.77	90.2 *
4830.000	9,541	10.67	9.02	7.05	5.57	4.00	3.10	2.15	830.9	166.3	0.0	6.4	1.73	190.7
5362.000	9,596	10.27	8.25	6.76	5.58	4.25	3.39	2.40	417.2	552.7	0.0	5.7	1.33	105.8
5860.000	9,169	21.12	14.89	9.41	6.11	3.77	2.33	1.50	205.7	26.7	0.0	7.1	1.07	89.1
6425.000	9,432	14.35	10.70	9.02	7.00	5.11	3.93	2.72	209.7	415.2	0.0	4.9	1.42	114.8
6928.000	9,388	13.90	10.04	7.36	5.50	3.72	2.74	1.85	220.8	182.3	0.0	7.2	2.05	129.2
7462.000	9,497	10.55	7.62	5.25	3.90	2.78	2.14	1.47	267.4	266.7	0.0	10.0	4.40	168.7
8099.000	9,651	4.77	2.74	2.38	1.92	1.38	1.03	0.69	388.1	2000.0	0.0	21.2	4.80	78.9 *
8744.000	9,574	8.18	6.46	5.88	5.19	4.22	3.52	2.63	496.1	2000.0	0.0	4.6	1.59	111.3 *
9291.000	9,585	8.13	6.61	5.56	4.47	3.33	2.58	1.86	2000.0	37.2	0.0	9.4	7.08	110.5 *
9616.000	9,322	18.13	12.00	9.30	7.11	5.12	4.06	3.09	97.0	512.3	0.0	5.1	3.04	232.0
10161.0	9,519	10.93	8.06	5.94	4.57	3.15	2.33	1.68	294.0	272.0	0.0	8.6	2.11	133.9
10639.0	9,508	11.36	8.76	7.62	6.38	5.03	4.11	3.10	249.5	1370.6	0.0	4.4	0.76	135.3
11250.0	9,695	4.22	3.20	2.70	2.32	1.90	1.63	1.31	1118.5	2000.0	0.0	12.0	3.99	130.0 *
11720.0	9,662	8.04	5.82	3.95	2.61	1.63	1.17	0.90	543.8	116.5	0.0	16.8	2.90	85.3
Mean:		12.86	9.55	7.08	5.34	3.84	2.90	2.09	503.4	601.8	0.0	7.8	3.06	112.6
Std. Dev:		5.86	4.14	2.54	1.74	1.23	0.93	0.68	479.5	725.2	0.0	4.1	2.20	27.2
Var Coeff(%):		45.55	43.35	35.79	32.64	32.04	32.01	32.36	95.3	120.5	0.0	53.4	71.83	24.2

LP 368 Northbound near B-1 to B-8

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 7.0)

District:
County :

	Thickness (in)	MODULI RANGE (psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	8.00	60,000	2,000,000	H1: v = 0.35
Base:	8.00	10,000	2,000,000	H2: v = 0.25
Subbase:	0.00			H3: v = 0.00
Subgrade:	96.55 (by DB)		5,000	H4: v = 0.40

Highway/Road:

Station	Load	Measured Deflection (mils): W1	W2	W3	W4	W5	W6	W7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	ERR/Sens	Bedrock	
0.000	9,399	11.94	9.11	7.76	6.06	4.43	3.27	2.16	315.5	373.9	0.0	5.8	1.61	100.0	
560.000	9,541	6.63	5.80	5.02	4.25	3.39	2.78	2.04	1531.2	638.6	0.0	6.2	0.65	107.4	
1074.000	9,059	24.77	17.43	9.81	6.40	4.50	3.54	2.75	122.2	38.9	0.0	6.0	8.73	175.3	
1633.000	9,169	19.79	13.38	7.88	4.73	3.04	2.22	1.91	171.6	32.1	0.0	8.6	5.68	106.4	
2179.000	9,256	17.96	12.46	7.75	5.08	3.40	2.58	1.94	174.8	62.9	0.0	7.9	5.71	127.3	
2735.000	9,454	10.61	7.57	5.79	4.64	3.44	2.54	1.65	208.2	710.3	0.0	7.8	1.57	88.0	
3263.000	9,311	18.30	15.33	12.16	9.23	6.31	4.52	3.11	659.1	38.6	0.0	4.2	1.21	120.3	
3870.000	9,267	23.38	17.84	12.20	8.18	5.22	3.54	2.40	246.7	28.2	0.0	5.2	2.10	109.3	
4315.000	9,585	7.89	6.65	6.40	6.02	5.14	3.76	2.74	809.6	2000.0	0.0	3.3	4.77	90.2	*
4830.000	9,541	10.67	9.02	7.05	5.57	4.00	3.10	2.15	830.9	166.3	0.0	6.4	1.73	190.7	
5362.000	9,596	10.27	8.25	6.76	5.58	4.25	3.39	2.40	417.2	552.7	0.0	5.7	1.33	105.8	
5860.000	9,169	21.12	14.89	9.41	6.11	3.77	2.33	1.50	205.7	26.7	0.0	7.1	1.07	89.1	
6425.000	9,432	14.35	10.70	9.02	7.00	5.11	3.93	2.72	209.7	415.2	0.0	4.9	1.42	114.8	
6928.000	9,388	13.90	10.04	7.36	5.50	3.72	2.74	1.85	220.8	182.3	0.0	7.2	2.05	129.2	
7462.000	9,497	10.55	7.62	5.25	3.90	2.78	2.14	1.47	267.4	266.7	0.0	10.0	4.40	168.7	
8099.000	9,651	4.77	2.74	2.38	1.92	1.38	1.03	0.69	388.1	2000.0	0.0	21.2	4.80	78.9	*
8744.000	9,574	8.18	6.46	5.88	5.19	4.22	3.52	2.63	496.1	2000.0	0.0	4.6	1.59	111.3	*
9291.000	9,585	8.13	6.61	5.56	4.47	3.33	2.58	1.86	2000.0	37.2	0.0	9.4	7.08	110.5	*
9616.000	9,322	18.13	12.00	9.30	7.11	5.12	4.06	3.09	97.0	512.3	0.0	5.1	3.04	232.0	
10161.0	9,519	10.93	8.06	5.94	4.57	3.15	2.33	1.68	294.0	272.0	0.0	8.6	2.11	133.9	
10639.0	9,508	11.36	8.76	7.62	6.38	5.03	4.11	3.10	249.5	1370.6	0.0	4.4	0.76	135.3	
11250.0	9,695	4.22	3.20	2.70	2.32	1.90	1.63	1.31	1118.5	2000.0	0.0	12.0	3.99	130.0	*
11720.0	9,662	8.04	5.82	3.95	2.61	1.63	1.17	0.90	543.8	116.5	0.0	16.8	2.90	85.3	
Mean:		12.86	9.55	7.08	5.34	3.84	2.9	2.09	503.4	601.8	0.0	7.8	3.06	112.6	
Std. Dev:		5.86	4.14	2.54	1.74	1.23	0.93	0.68	479.5	725.2	0.0	4.1	2.2	27.2	
Var Coeff(%):		45.55	43.35	#	32.64	32.04	32.01	32.36	95.3	120.5	0.0	53.4	71.83	24.2	

THRESHOLD VALUES				
LAYER:	SURF (E1)	BASE (E2)	SUBB (E3)	SUBG (E4)
MAX:	982.9	1327.0	0.0	11.9
MIN:	23.9	0.0	0.0	N/A

OUTLIERS

NEW AVERAGE		
SURF (E1)	BASE (E2)	SUBG (E4)
346.4	248.4	6.2

HMA Temp 90 F

Base Thick. 8 inches

FOR DESIGN CONSIDERATION		
SURF (E1)	BASE (E2)	SUBG (E4)
537.0	265.8	6.2

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 7.0)

District:
County :
Highway/Road:

	Thickness(in)	MODULI RANGE(psi) Minimum	Maximum	Poisson Ratio Values
Pavement:	8.00	60,000	2,000,000	H1: v = 0.35
Base:	10.00	10,000	5,000,000	H2: v = 0.25
Subbase:	0.00			H3: v = 0.00
Subgrade:	145.93(by DB)	5,000		H4: v = 0.40

Station	Load (lbs)	Measured Deflection (mils): W1	W2	W3	W4	W5	W6	W7	Calculated Moduli values (ksi): SURF(E1)	BASE(E2)	SUBB(E3)	SUBG(E4)	Absolute ERR/Sens	Dpth to Bedrock	
29148.0	9,749	4.60	3.31	2.61	2.08	1.57	1.24	0.95	614.4	666.1	0.0	22.2	1.16	113.1	
29770.0	9,760	6.24	4.89	4.19	3.53	2.83	2.30	1.79	580.8	843.1	0.0	11.1	0.40	129.2	
30787.0	9,322	22.28	14.41	10.73	8.83	6.94	5.62	4.12	71.7	288.0	0.0	5.0	3.37	127.0	
31332.0	9,465	12.57	8.76	7.62	6.51	5.11	4.20	3.17	155.5	855.7	0.0	6.0	0.86	131.1	
31861.0	9,246	18.65	8.72	7.12	5.77	4.24	3.34	2.50	60.0	522.5	0.0	8.5	2.97	240.2	*
32455.0	9,738	3.28	2.65	2.57	2.30	1.88	1.45	1.00	1378.8	2649.7	0.0	14.2	3.95	300.0	
33413.0	9,497	13.89	5.89	4.56	3.95	3.26	2.80	2.16	61.6	2465.0	0.0	10.3	4.05	119.6	
33983.0	9,717	4.66	3.64	3.65	3.56	3.39	3.20	2.61	2000.0	1850.1	0.0	6.7	8.16	300.0	*
34484.0	9,717	6.06	5.37	4.67	4.00	2.96	2.38	1.96	2000.0	95.3	0.0	13.0	8.71	186.0	*
35036.0	9,673	5.24	4.24	3.86	3.56	3.14	2.86	2.41	633.5	5000.0	0.0	6.6	1.35	300.0	*
36073.0	9,717	3.73	2.71	2.46	2.31	2.09	1.96	1.74	977.1	5000.0	0.0	11.5	5.48	300.0	*
36605.0	9,760	3.99	3.32	3.17	3.06	2.86	2.72	2.47	2000.0	3428.5	0.0	6.7	4.80	300.0	*
37131.0	9,717	6.31	5.32	4.86	4.41	3.87	3.48	2.97	598.7	3579.1	0.0	5.3	0.78	300.0	
37683.0	9,421	12.83	9.72	5.43	2.94	1.54	0.93	0.54	406.6	10.0	0.0	23.0	4.06	61.7	*
38223.0	9,574	9.12	6.11	4.02	3.03	2.25	1.74	1.19	275.9	172.7	0.0	16.4	3.99	92.4	
38740.0	9,311	14.65	9.63	5.46	3.85	2.74	2.16	1.62	183.2	52.4	0.0	13.0	6.12	166.1	
39393.0	9,333	20.04	13.12	9.83	7.36	5.31	4.00	2.86	111.7	106.5	0.0	6.6	1.01	127.7	
39911.0	9,443	8.96	7.70	6.32	5.03	3.52	2.65	1.82	2000.0	23.8	0.0	10.0	1.70	149.7	*
40383.0	9,607	6.20	5.07	4.41	3.69	2.89	2.35	1.78	927.0	510.0	0.0	10.5	1.16	118.2	
Mean:		9.65	6.56	5.13	4.20	3.28	2.70	2.09	791.4	1479.9	0.0	10.9	3.37	163.9	
Std. Dev:		5.94	3.40	2.31	1.79	1.37	1.12	0.87	730.8	1700.1	0.0	5.2	2.49	80.0	
Var Coeff(%):		61.61	51.91	45.02	42.62	41.57	41.57	41.74	92.3	114.9	0.0	48.3	73.81	48.8	

TTI MODULUS ANALYSIS SYSTEM (SUMMARY REPORT) (Version 7.0)

District:

County :

	Thickness (in)	MODULI RANGE (psi) Minimum	Maximum	Poisson Ratio Values Highway/Road:
Pavement:	8.00	60,000	2,000,000	H1: v = 0.35
Base:	10.00	10,000	5,000,000	H2: v = 0.25
Subbase:	0.00			H3: v = 0.00
Subgrade:	145.93 (by DB)		5,000	H4: v = 0.40

Station	Load	W1	W2	W3	W4	W5	W6	W7	SURF (E1)	BASE (E2)	SUBB (E3)	SUBG (E4)	ERR/Sens	Bedrock	
		Measured Deflection (mils):							Calculated Moduli values (ksi):						
29148.0	9,749	4.60	3.31	2.61	2.08	1.57	1.24	0.95	614.4	666.1	0.0	22.2	1.16	113.1	
29770.0	9,760	6.24	4.89	4.19	3.53	2.83	2.30	1.79	580.8	843.1	0.0	11.1	0.40	129.2	
30787.0	9,322	22.28	14.41	10.73	8.83	6.94	5.62	4.12	71.7	288.0	0.0	5.0	3.37	127.0	
31332.0	9,465	12.57	8.76	7.62	6.51	5.11	4.20	3.17	155.5	855.7	0.0	6.0	0.86	131.1	
31861.0	9,246	18.65	8.72	7.12	5.77	4.24	3.34	2.50	60.0	522.5	0.0	8.5	2.97	240.2	*
32455.0	9,738	3.28	2.65	2.57	2.30	1.88	1.45	1.00	1378.8	2649.7	0.0	14.2	3.95	300.0	
33413.0	9,497	13.89	5.89	4.56	3.95	3.26	2.80	2.16	61.6	2465.0	0.0	10.3	4.05	119.6	
33983.0	9,717	4.66	3.64	3.65	3.56	3.39	3.20	2.61	2000.0	1850.1	0.0	6.7	8.16	300.0	*
34484.0	9,717	6.06	5.37	4.67	4.00	2.96	2.38	1.96	2000.0	95.3	0.0	13.0	8.71	186.0	*
35036.0	9,673	5.24	4.24	3.86	3.56	3.14	2.86	2.41	633.5	5000.0	0.0	6.6	1.35	300.0	*
36073.0	9,717	3.73	2.71	2.46	2.31	2.09	1.96	1.74	977.1	5000.0	0.0	11.5	5.48	300.0	*
36605.0	9,760	3.99	3.32	3.17	3.06	2.86	2.72	2.47	2000.0	3428.5	0.0	6.7	4.80	300.0	*
37131.0	9,717	6.31	5.32	4.86	4.41	3.87	3.48	2.97	598.7	3579.1	0.0	5.3	0.78	300.0	
37683.0	9,421	12.83	9.72	5.43	2.94	1.54	0.93	0.54	406.6	10.0	0.0	23.0	4.06	61.7	*
38223.0	9,574	9.12	6.11	4.02	3.03	2.25	1.74	1.19	275.9	172.7	0.0	16.4	3.99	92.4	
38740.0	9,311	14.65	9.63	5.46	3.85	2.74	2.16	1.62	183.2	52.4	0.0	13.0	6.12	166.1	
39393.0	9,333	20.04	13.12	9.83	7.36	5.31	4.00	2.86	111.7	106.5	0.0	6.6	1.01	127.7	
39911.0	9,443	8.96	7.70	6.32	5.03	3.52	2.65	1.82	2000.0	23.8	0.0	10.0	1.70	149.7	*
40383.0	9,607	6.20	5.07	4.41	3.69	2.89	2.35	1.78	927.0	510.0	0.0	10.5	1.16	118.2	
Mean:		9.65	6.56	5.13	4.2	3.28	2.7	2.09	791.4	1479.9	0	10.9	3.37	163.9	
Std. Dev:		5.94	3.40	2.31	1.79	1.37	1.12	0.87	730.8	1700.1	0.0	5.2	2.49	80.0	
Var Coeff(%):		61.61	51.91	45.02	42.62	41.57	41.57	41.74	92.3	114.9	0.0	48.3	73.81	48.8	

THRESHOLD VALUES				
LAYER:	SURF (E1)	BASE (E2)	SUBB (E3)	SUBG (E4)
MAX:	1522.2	3180.0	0.0	16.1
MIN:	60.6	0.0	0.0	N/A

OUTLIERS

NEW AVERAGE		
SURF (E1)	BASE (E2)	SUBG (E4)
498.3	740.7	9.1

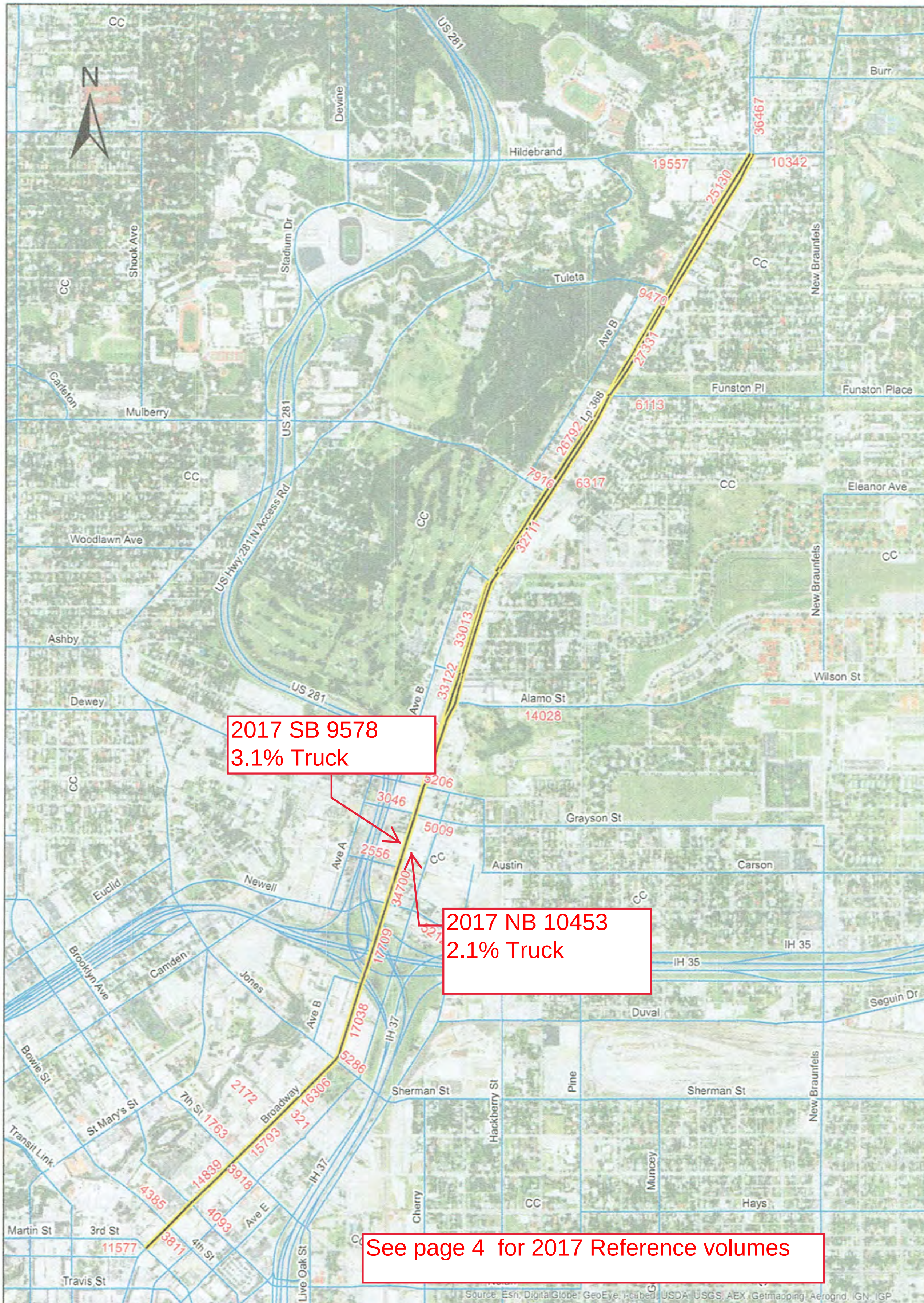
HMA Temp 90 F

Base Thick. 10 inches

FOR DESIGN CONSIDERATION		
SURF (E1)	BASE (E2)	SUBG (E4)
772.5	740.7	9.1

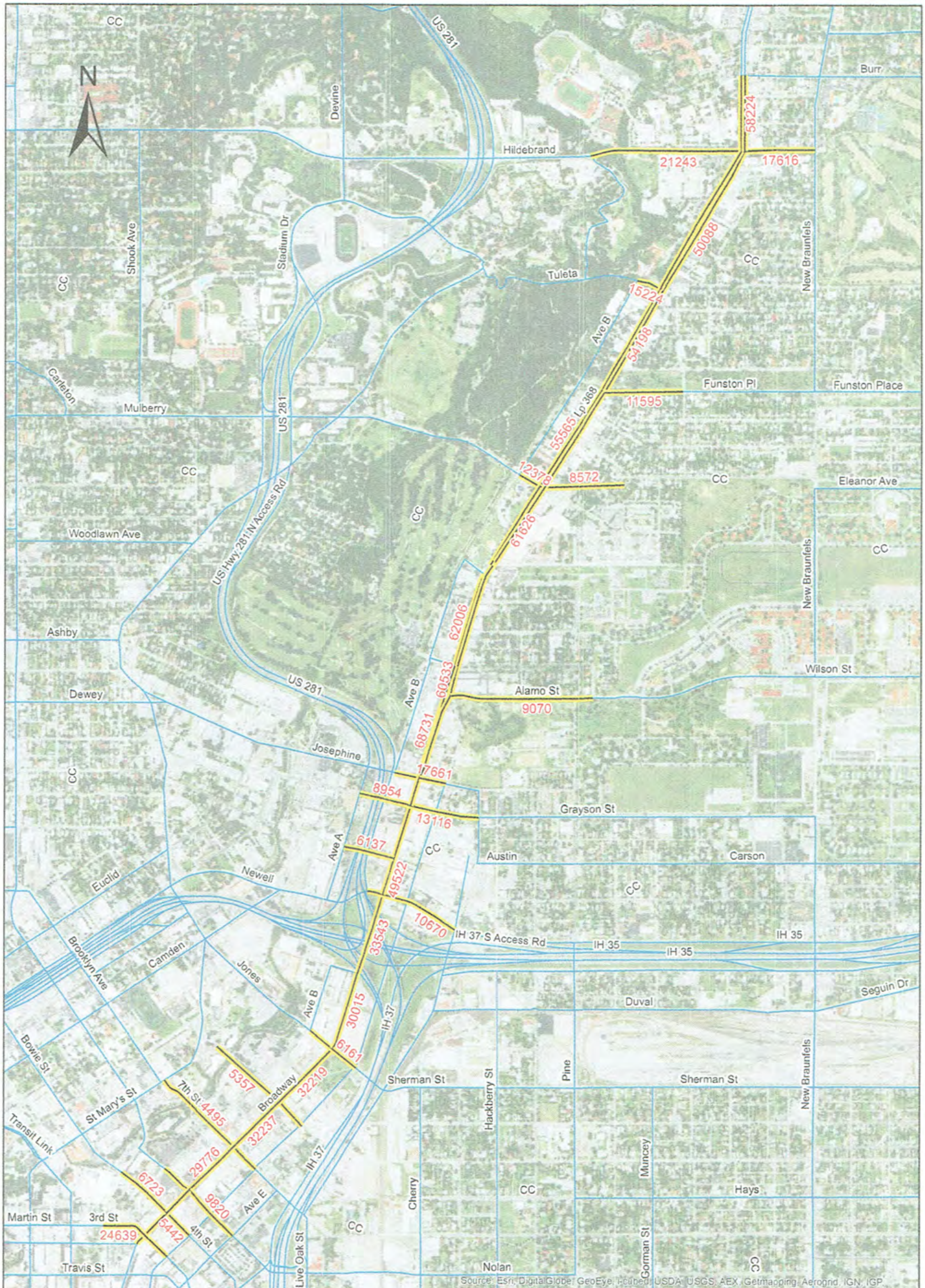
APPENDIX F: TRAFFIC DATA

Broadway 2014 Corridor Volumes



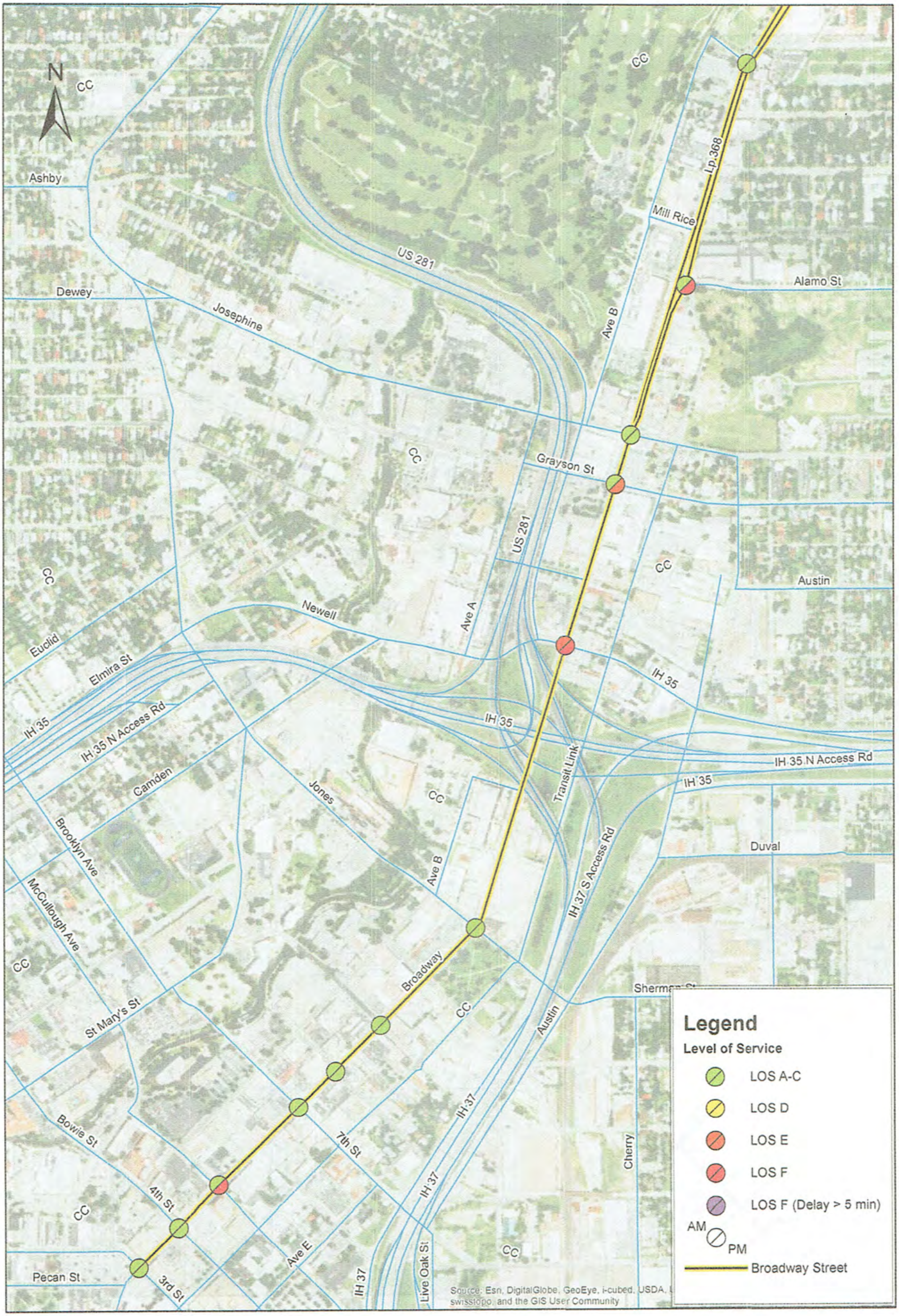
WSP | PARSONS BRINCKERHOFF

Broadway 2040 Corridor Volumes



WSP | PARSONS BRINCKERHOFF

Broadway No Build Level of Service - 2040 (Lower)



WSP | PARSONS BRINCKERHOFF

Major Street	Location	Cross Street	Direction	Date Counted	Volume	85% Speed	Trucks	Street Width	Speed	Lanes
Broadway	S of	Loop 410	SB	8/24/2015	11535			42	35	Four Lane Undivided
Broadway	N of	Loop 410	NB	11/15/2016	15917			62	35	Five Lane
Broadway	N of	Loop 410	SB	11/15/2016	12727			62	35	Five Lane
Broadway	S of	Jones Ave	SB	2/20/2017	7051	36.5	173	66	30	Five Lane
Broadway	S of	Carnahan	SB	2/20/2017	9253	40.3	410	66	35	Six Lane Undivided
Broadway	S of	Carnahan	NB	2/20/2017	10478	38.7	357	66	35	Six Lane Undivided
Broadway	S of	Humphrey	SB	2/20/2017	8253	40.3	410	66	35	Six Lane Undivided
Broadway	S of	Humphrey	NB	2/20/2017	10785	36.8	414	66	35	Six Lane Undivided
Broadway	N of	Pearl Pkwy	SB	2/20/2017	9578	38.2	297	66	35	Six Lane Undivided
Broadway	N of	Pearl Pkwy	NB	2/20/2017	10453	36.8	228	66	35	Five Lane
Broadway	S of	Jones Ave	NB	2/20/2017	5390	33.9	86	66	30	Five Lane
Broadway	M	Roy Smith	SB	3/23/2017	10220			66	35	Four Lane Undivided
Broadway	S of	Roy Smith	NB	3/23/2017	9159			66	35	Four Lane Undivided
Broken Oak	W of	Heimer	EB	2/23/2016	775	31.6	8	30	30	Two Lane
Broken Oak	W of	Heimer	WB	2/23/2016	663	31	3	30	30	Two Lane
Brooklyn	E of	Broadway	EB	9/11/2014	925			42	30	Two Lane
Brooklyn	E of	Broadway	WB	9/11/2014	1897			42	30	Two Lane
Brooklyn	E of	Broadway	EB	7/22/2015	798			42	30	Two Lane
Brooklyn	E of	Broadway	WB	7/22/2015	2006			42	30	Two Lane
Brooklyn	N of	Quincy	NB	6/6/2016	5795			40	30	Four Lane Undivided
Brooklyn	N of	Quincy	SB	6/6/2016	3303			40	30	Four Lane Undivided
Brooklyn	E of	Broadway	WB	7/28/2016	2791			42	30	Two Lane
Brooklyn	E of	Broadway	EB	8/17/2016	1064			42	30	Two Lane
Brooklyn	E of	Broadway	EB	8/17/2016	1064					
Brooklyn	W of	Ave B	EB	8/10/2017	1122	2836	9	40	30	Two Lane
Brooklyn	W of	Ave B	WB	8/10/2017	1368	28.6	13	40	30	Two Lane
Brookport	E of	Hidden Creek	EB	2/20/2014	779	35.8	4	30	30	Two Lane
Brookport	E of	Hidden Creek	WB	2/20/2014	767	35.1	7	30	30	Two Lane
Brownleaf	W of	Westleaf	WB	11/7/2015	390	1	1	30	30	Two Lane
Brownleaf	W of	Westleaf	EB	12/7/2015	369	33.2	1	36	30	Two Lane
Bryn Mawr	W of	N Vandiver	EB	4/30/2013	180	25.9	5	28	30	Two Lane

Growth Rate, g (%), Back-Analysis

Tf	T (%)	G	D (%)	L (%)	Y	g (%)	ADT_o	ADT_f
0.90	5.9	36.82	50	100	26	2.66	34,700	68,731

12,389,973 ESALs

Growth Rate, g (%), Back-Analysis

Year	ADT	Percent Trucks	Truck Factor	Lane Distribution Factor	Directional Distribution Factor	ESALs	Cummulative ESALs	Year
2014	34700							
2015	35624	5.9%	0.90	100%	50%	336,499	336,499	1
2016	36573	5.9%	0.90	100%	50%	345,462	681,962	2
2017	37547	5.9%	0.90	100%	50%	354,664	1,036,626	3
2018	38547	5.9%	0.90	100%	50%	364,111	1,400,736	4
2019	39574	5.9%	0.90	100%	50%	373,809	1,774,545	5
2020	40628	5.9%	0.90	100%	50%	383,766	2,158,311	6
2021	41710	5.9%	0.90	100%	50%	393,988	2,552,299	7
2022	42821	5.9%	0.90	100%	50%	404,482	2,956,781	8
2023	43962	5.9%	0.90	100%	50%	415,256	3,372,036	9
2024	45133	5.9%	0.90	100%	50%	426,316	3,798,352	10
2025	46335	5.9%	0.90	100%	50%	437,671	4,236,024	11
2026	47569	5.9%	0.90	100%	50%	449,329	4,685,353	12
2027	48836	5.9%	0.90	100%	50%	461,297	5,146,650	13
2028	50137	5.9%	0.90	100%	50%	473,584	5,620,235	14
2029	51473	5.9%	0.90	100%	50%	486,199	6,106,433	15
2030	52844	5.9%	0.90	100%	50%	499,149	6,605,582	16
2031	54251	5.9%	0.90	100%	50%	512,444	7,118,026	17
2032	55696	5.9%	0.90	100%	50%	526,094	7,644,120	18
2033	57180	5.9%	0.90	100%	50%	540,106	8,184,227	19
2034	58703	5.9%	0.90	100%	50%	554,493	8,738,719	20
2035	60266	5.9%	0.90	100%	50%	569,262	9,307,981	21
2036	61871	5.9%	0.90	100%	50%	584,425	9,892,406	22
2037	63519	5.9%	0.90	100%	50%	599,991	10,492,397	23
2038	65211	5.9%	0.90	100%	50%	615,973	11,108,370	24
2039	66948	5.9%	0.90	100%	50%	632,379	11,740,749	25
2040	68731	5.9%	0.90	100%	50%	649,223	12,389,973	26
					Cumulative 20 year ESALs		12,389,973	

Growth **2.66** **%**

LP 368 ESAL Approximation (Rigid Pavement)

Tf	T (%)	G	D (%)	L (%)	Y	g (%)	ADT_o	ADT_f
1.00	5	45.07	50	100	30	2.66	40,628	89,396

16,718,542 ESALs

LP 368 ESAL Approximation (Rigid Pavement)

Year	ADT	Percent Trucks	Truck Factor	Lane Distribution Factor	Directional Distribution Factor	ESALs	Cummulative ESALs	Year
2020	40628							
2021	**41710**	**5.0%**	**1.00**	**100%**	**50%**	370,984	370,984	1
2022	42821	5.0%	1.00	100%	50%	380,866	751,850	2
2023	43962	5.0%	1.00	100%	50%	391,011	1,142,861	3
2024	45133	5.0%	1.00	100%	50%	401,425	1,544,286	4
2025	46335	5.0%	1.00	100%	50%	412,118	1,956,404	5
2026	47569	5.0%	1.00	100%	50%	423,095	2,379,499	6
2027	48836	5.0%	1.00	100%	50%	434,364	2,813,863	7
2028	50137	5.0%	1.00	100%	50%	445,934	3,259,797	8
2029	51472	5.0%	1.00	100%	50%	457,812	3,717,609	9
2030	52843	5.0%	1.00	100%	50%	470,006	4,187,614	10
2031	54251	5.0%	1.00	100%	50%	482,525	4,670,139	11
2032	55696	5.0%	1.00	100%	50%	495,377	5,165,516	12
2033	57179	5.0%	1.00	100%	50%	508,572	5,674,088	13
2034	58702	5.0%	1.00	100%	50%	522,118	6,196,207	14
2035	60266	5.0%	1.00	100%	50%	536,025	6,732,232	15
2036	61871	5.0%	1.00	100%	50%	550,303	7,282,535	16
2037	63519	5.0%	1.00	100%	50%	564,960	7,847,495	17
2038	65211	5.0%	1.00	100%	50%	580,009	8,427,504	18
2039	66948	5.0%	1.00	100%	50%	595,458	9,022,961	19
2040	68731	5.0%	1.00	100%	50%	611,318	9,634,279	20
2041	70562	5.0%	1.00	100%	50%	627,601	10,261,880	21
2042	72441	5.0%	1.00	100%	50%	644,318	10,906,198	22
2043	74371	5.0%	1.00	100%	50%	661,480	11,567,678	23
2044	76352	5.0%	1.00	100%	50%	679,099	12,246,776	24
2045	78385	5.0%	1.00	100%	50%	697,187	12,943,963	25
2046	80473	5.0%	1.00	100%	50%	715,757	13,659,720	26
2047	82617	5.0%	1.00	100%	50%	734,822	14,394,542	27
2048	84817	5.0%	1.00	100%	50%	754,394	15,148,936	28
2049	87077	5.0%	1.00	100%	50%	774,488	15,923,425	29
2050	89396	5.0%	1.00	100%	50%	795,117	16,718,542	30
					Cumulative 30 year ESALs		16,718,542	

Growth **2.66** **%**

LP 368 ESAL Approximation (Flexible Pavement)

Tf	T (%)	G	D (%)	L (%)	Y	g (%)	ADT_o	ADT_f
0.80	5	25.97	50	100	20	2.66	40,628	68,731

7,707,423 ESALs

LP 368 ESAL Approximation (Flexible Pavement)

Year	ADT	Percent Trucks	Truck Factor	Lane Distribution Factor	Directional Distribution Factor	ESALs	Cummulative ESALs	Year
2020	40628							
2021	**41710**	**5.0%**	**0.80**	**100%**	**50%**	296,788	296,788	1
2022	42821	5.0%	0.80	100%	50%	304,693	601,480	2
2023	43962	5.0%	0.80	100%	50%	312,808	914,289	3
2024	45133	5.0%	0.80	100%	50%	321,140	1,235,429	4
2025	46335	5.0%	0.80	100%	50%	329,694	1,565,123	5
2026	47569	5.0%	0.80	100%	50%	338,476	1,903,599	6
2027	48836	5.0%	0.80	100%	50%	347,491	2,251,090	7
2028	50137	5.0%	0.80	100%	50%	356,747	2,607,837	8
2029	51472	5.0%	0.80	100%	50%	366,249	2,974,087	9
2030	52843	5.0%	0.80	100%	50%	376,005	3,350,092	10
2031	54251	5.0%	0.80	100%	50%	386,020	3,736,111	11
2032	55696	5.0%	0.80	100%	50%	396,302	4,132,413	12
2033	57179	5.0%	0.80	100%	50%	406,858	4,539,271	13
2034	58702	5.0%	0.80	100%	50%	417,695	4,956,965	14
2035	60266	5.0%	0.80	100%	50%	428,820	5,385,786	15
2036	61871	5.0%	0.80	100%	50%	440,242	5,826,028	16
2037	63519	5.0%	0.80	100%	50%	451,968	6,277,996	17
2038	65211	5.0%	0.80	100%	50%	464,007	6,742,003	18
2039	66948	5.0%	0.80	100%	50%	476,366	7,218,369	19
2040	68731	5.0%	0.80	100%	50%	489,054	7,707,423	20
					Cumulative 20 year ESALs		7,707,423	

Growth **2.66** **%**

APPENDIX G: 1993 AASHTO DESIGN – RIGID PAVEMENT

AASHTO Pavement Design Calculations

Spencer A. Higgs, P.E.

Rigid Structural Design

LP 368 (Broadway Corridor)
Travel Lanes
from Hildebrand Avenue to Roy Smith Street
San Antonio, Bexar County, Texas
CSJ: 0016-08-034

Rigid Structural Design Data

Pavement type:	CPCD
Slab Thickness for Performance Period Traffic (in.):	10.5
Initial Serviceability:	4.5
Terminal Serviceability:	2.5
28-day mean PCC Modulus of Rupture (psi):	620
28-day mean Elastic Modulus of Slab (psi):	5.00E+06
Mean Effective k-value (psi/in):	300
Reliability level (%):	95
Overall Standard Deviation:	0.39
Load Transfer Coefficient, J:	2.6
Overall Drainage Coefficient, Cd:	1.02
Stage Construction:	1

Calculated ESALs:	18,347,325
Required ESALs:	16,720,000

INPUT DATA

A. Project Identification

District	SAT
County	Bexar
Highway	LP 368
CSJ	0016-08-034
Direction	
Station (Begin)	Hildebrand Ave
Station (End)	Roy Smith

B. Design Parameters

Design Life (year)	30
Number of Punchouts per Mile	10

C. Design Traffic

Total Number of Lanes in One Direction	2
Total Design Traffic in One Direction (million ESALs)	17

D. Concrete Layer Information

Thickness of Concrete Layer (in.)	10
28-Day Modulus of Rupture (psi)	570

E. Support Layers Information

Soil Classification System	USCS
Soil Classification of Subgrade	SC
Base Type	CTB
Base Thickness (in.)	6
Modulus of Base Layer (ksi)	500

Composite K (psi/in.)	554

CRCP PERFORMANCE

Number of Punchouts per Mile	9.1

INPUT DATA

A. Project Identification

District	SAT
County	Bexar
Highway	LP 368
CSJ	0016-08-034
Direction	
Station (Begin)	Hildebrand Ave
Station (End)	Roy Smith

B. Design Parameters

Design Life (year)	30
Number of Punchouts per Mile	10

C. Design Traffic

Total Number of Lanes in One Direction	2
Total Design Traffic in One Direction (million ESALs)	17

D. Concrete Layer Information

Thickness of Concrete Layer (in.)	10
28-Day Modulus of Rupture (psi)	570

E. Support Layers Information

Soil Classification System	USCS
Soil Classification of Subgrade	SC
Base Type	HMA
Base Thickness (in.)	6
Modulus of Base Layer (ksi)	400

Composite K (psi/in.)	489

CRCP PERFORMANCE

Number of Punchouts per Mile	9.5

APPENDIX H: FPS DESIGNS – FLEXIBLE PAVEMENT

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 *FLEXIBLE PAVEMENT SYSTEM* *Release:1-18-2018*

PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/26/2019**	**1**

COMMENTS ABOUT THIS PROBLEM

LP 368 (Broadway Corridor), from Hildebrand Avenue to Roy Smith Street

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	8.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	8.0
DESIGN CONFIDENCE LEVEL (95.0%)	C
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.8
FINAL SERVICEABILITY INDEX P2	2.5
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.2
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	6.00
INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)	7.0

PROGRAM CONTROLS AND CONSTRAINTS

NUMBER OF SUMMARY OUTPUT PAGES DESIRED (8 DESIGNS/PAGE)	3
MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)	99.00
MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)	69.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	6.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	40628.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	68731.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	7.710
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	60.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	45.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	5.0
PERCENT TRUCKS IN ADT	5.0

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 *FLEXIBLE PAVEMENT SYSTEM* *Release:1-18-2018*

PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/26/2019**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	1.5
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	12.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.98
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	200.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	200.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	50.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	3
TOTAL NUMBER OF LANES OF THE FACILITY	4
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	1
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	2
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	0.60
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.60
DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)	0.00

PAVING MATERIALS INFORMATION

LAYER	CODE	MATERIALS NAME	COST PER CY	E MODULUS	POISSON RATIO	MIN. DEPTH	MAX. DEPTH	SALVAGE PCT.
1	E	SP-D	125.00	850000.	0.35	2.00	2.00	90.00
2	C	DG HMA TY B	115.00	650000.	0.35	12.00	12.00	90.00
3	M	FLEXIBLE BASE	37.00	50000.	0.35	6.00	6.00	75.00
4	R	LIME-TREATED SUBGR	15.00	35000.	0.30	12.00	12.00	70.00
5	T	SUBGRADE	2.00	6000.	0.40	163.90	163.90	90.00

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 *FLEXIBLE PAVEMENT SYSTEM* *Release:1-18-2018*

PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

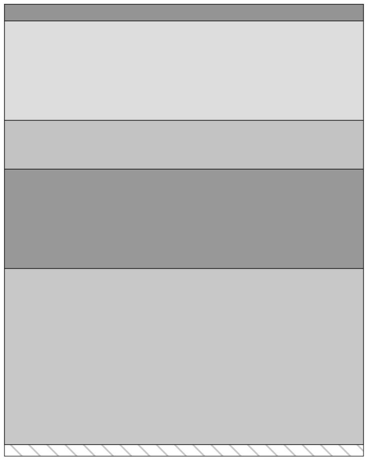
PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/26/2019**	**3**

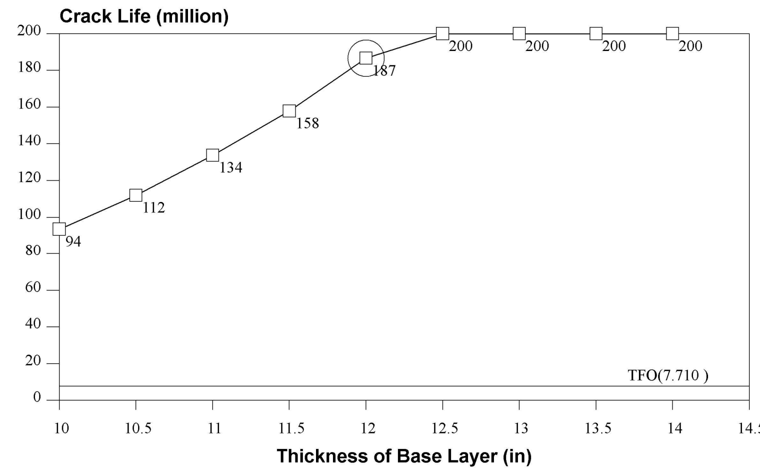
C. LEVEL C SUMMARY OF THE BEST DESIGN STRATEGIES
IN ORDER OF INCREASING TOTAL COST

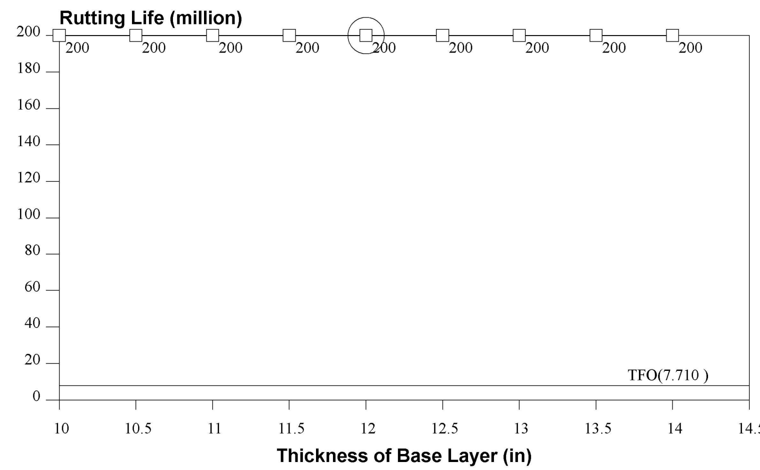
	1
MATERIAL ARRANGEMENT	ECMR
INIT. CONST. COST	56.44
OVERLAY CONST. COST	0.00
USER COST	0.00
ROUTINE MAINT. COST	0.91
SALVAGE VALUE	-12.63
TOTAL COST	44.73
NUMBER OF LAYERS	4
LAYER DEPTH (INCHES)	
D(1)	2.00
D(2)	12.00
D(3)	6.00
D(4)	12.00
NO.OF PERF.PERIODS	1
PERF. TIME (YEARS)	
T(1)	40.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)	

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 1

Thickness (inches)	*Modulus (ksi)*	*Poisson's Ratio*	*Material Name*
2.00	850.00	0.35	SP-D
12.00	650.00	0.35	DG HMA TY B
6.00	50.00	0.35	FLEXIBLE BASE
12.00	35.00	0.30	LIME-TREATED SUBGRADE
163.90	6.00	0.40	SUBGRADE







Fatigue Crack Model:

$$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$$

f_1 =7.96E-02

f_2 = 3.291

f_3 = .854

Rutting Model:

$$N_d = f_4 (\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09

f_5 = 4.477

TFO(Traffic to 1st Overlay): 7.71 (million)

Crack Life: 186.57 (million) ε_τ = 44.10 (με)

Rut Life: 200.00 (million) ε_v = -116.00 (με)

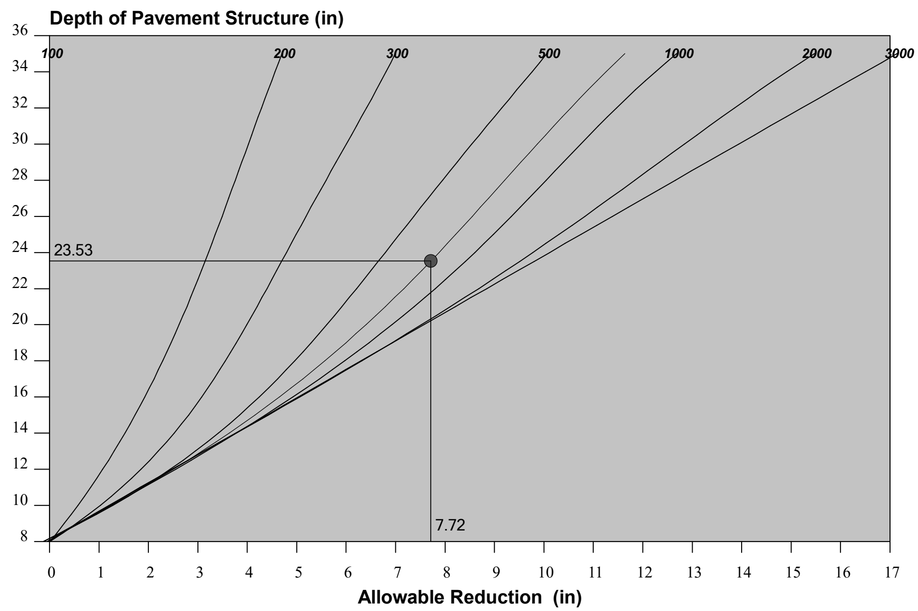
Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:7.71millions.
Also the start ADT:40628.0 and ending ADT:68731.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.4Release:1-18-2018)			
Highway	LP 368	Problem	001
C-S-J	0016 - 08 - 034	Date	2/26/2019
District	San Antonio	County	BEXAR
Design Type:User Defined Pavement Design			

Layer	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
SP-D	2.00	850.00	0.35	SP-D
DG HMA TY B	12.00	650.00	0.35	DG HMA TY B
FLEXIBLE BASE	6.00	50.00	0.35	FLEXIBLE BASE
LIME-TREATED SUBGRADE	12.00	35.00	0.30	LIME-TREATED SUBGRADE
SUBGRADE	163.90	6.00	0.40	SUBGRADE
Bed Rock		600.00	0.15	Bed Rock



Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	12200.0 (lb)
Percentage of TandemAxles	30.0 (%)
Modified Cohesionmeter Value	800.0
Design Wheel Load	12200.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	5.60
User Input TTC based on historical TEX-117-E	

RESULT:

Triaxial Thickness Required	23.5 (in)
The FPS Design Thickness	32.0 (in)
Allowable Thickness Reduction	7.7 (in)
Modified Triaxial Thickness	15.8 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output	**(FPS21-1.4Release:1-18-2018)**		
Highway	LP 368	Problem	001
C-S-J	0016 - 08 - 034	Date	2/26/2019
District	San Antonio	County	BEXAR
Design Type:User Defined Pavement Design			

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 *FLEXIBLE PAVEMENT SYSTEM* *Release:1-18-2018*

PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
002	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/26/2019**	**1**

COMMENTS ABOUT THIS PROBLEM

LP 368 (Broadway Corridor), from Hildebrand Avenue to Roy Smith Street

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BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	8.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	8.0
DESIGN CONFIDENCE LEVEL (95.0%)	C
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.8
FINAL SERVICEABILITY INDEX P2	2.5
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.2
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	6.00
INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)	7.0

PROGRAM CONTROLS AND CONSTRAINTS

NUMBER OF SUMMARY OUTPUT PAGES DESIRED (8 DESIGNS/PAGE)	3
MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)	99.00
MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)	69.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	6.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	40628.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	68731.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	7.710
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	60.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	45.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	5.0
PERCENT TRUCKS IN ADT	5.0

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 *FLEXIBLE PAVEMENT SYSTEM* *Release:1-18-2018*

PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
002	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/26/2019**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	1.5
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	12.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.98
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	200.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	200.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	50.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	3
TOTAL NUMBER OF LANES OF THE FACILITY	4
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	1
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	2
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	0.60
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.60
DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)	0.00

PAVING MATERIALS INFORMATION

LAYER	CODE	MATERIALS NAME	COST PER CY	E MODULUS	POISSON RATIO	MIN. DEPTH	MAX. DEPTH	SALVAGE PCT.
1	E	SP-D	125.00	850000.	0.35	2.00	2.00	90.00
2	B	DG HMA TY B	115.00	650000.	0.35	8.00	8.00	30.00
3	M	FLEXIBLE BASE	37.00	50000.	0.35	10.00	10.00	75.00
4	S	LIME-TREATED SUBGR	15.00	35000.	0.35	12.00	12.00	70.00
5	T	SUBGRADE	2.00	6000.	0.40	163.90	163.90	90.00

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 *FLEXIBLE PAVEMENT SYSTEM* *Release:1-18-2018*

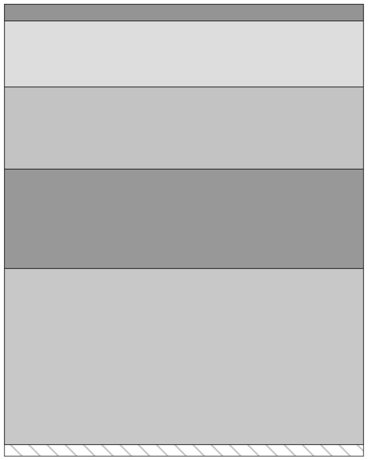
PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
002	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/26/2019**	**3**

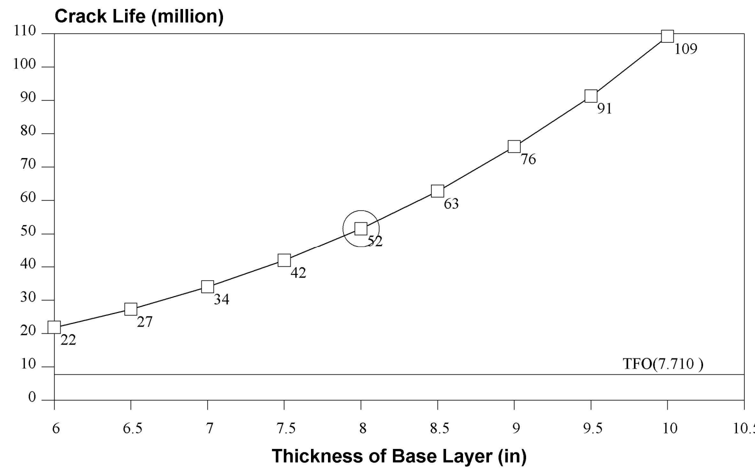
C. LEVEL C SUMMARY OF THE BEST DESIGN STRATEGIES
IN ORDER OF INCREASING TOTAL COST

	1
MATERIAL ARRANGEMENT	EBMS
INIT. CONST. COST	47.78
OVERLAY CONST. COST	0.00
USER COST	0.00
ROUTINE MAINT. COST	0.91
SALVAGE VALUE	-6.49
TOTAL COST	42.20
NUMBER OF LAYERS	4
LAYER DEPTH (INCHES)	
D(1)	2.00
D(2)	8.00
D(3)	10.00
D(4)	12.00
NO.OF PERF.PERIODS	1
PERF. TIME (YEARS)	
T(1)	34.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)	

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 1



Thickness (inches)	*Modulus (ksi)*	*Poisson's Ratio*	*Material Name*
2.00	850.00	0.35	SP-D
8.00	650.00	0.35	DG HMA TY B
10.00	50.00	0.35	FLEXIBLE BASE
12.00	35.00	0.35	LIME-TREATED SUBGRADE
163.90	6.00	0.40	SUBGRADE



Fatigue Crack Model:

$$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$$

f_1 =7.96E-02

f_2 = 3.291

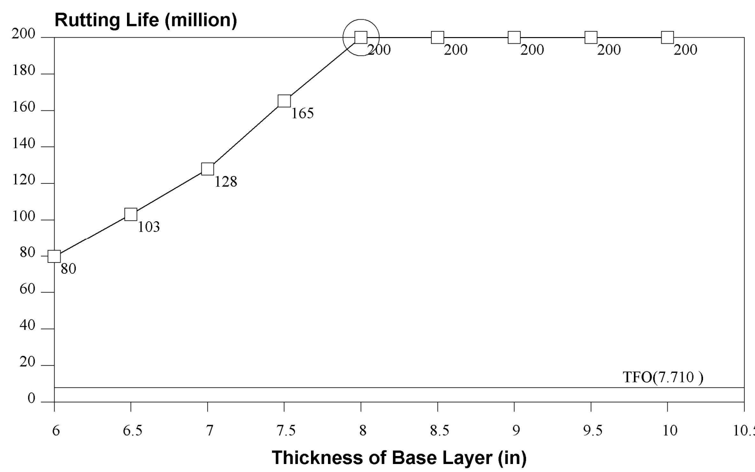
f_3 = .854

Rutting Model:

$$N_d = f_4 (\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09

f_5 = 4.477



TFO(Traffic to 1st Overlay): 7.71 (million)

Crack Life: 51.52 (million) ε_τ = 65.20 ($\mu\varepsilon$)

Rut Life: 200.00 (million) ε_v = -146.00 ($\mu\varepsilon$)

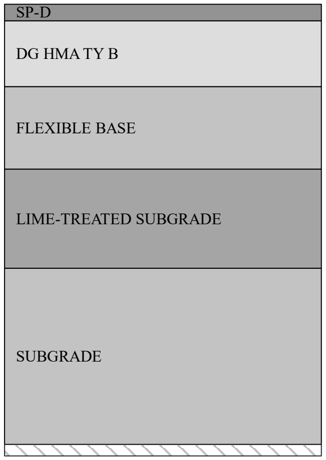
Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:7.71millions.
Also the start ADT:40628.0 and ending ADT:68731.0

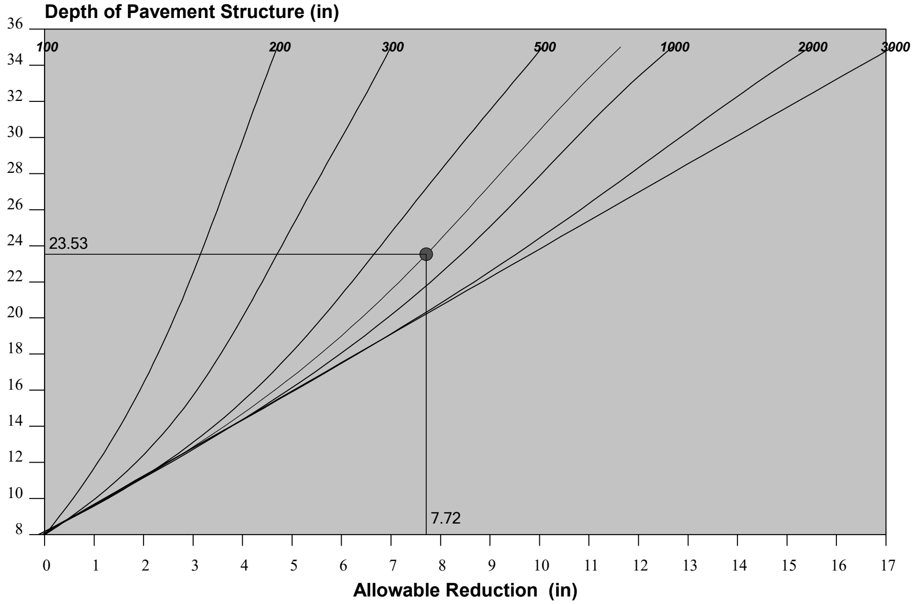
Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output	**(FPS21-1.4Release:1-18-2018)**		
Highway	LP 368	Problem	002
C-S-J	0016 - 08 - 034	Date	2/26/2019
District	San Antonio	County	BEXAR
Design Type:User Defined Pavement Design			

Layer	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
SP-D	2.00	850.00	0.35	SP-D
DG HMA TY B	8.00	650.00	0.35	DG HMA TY B
FLEXIBLE BASE	10.00	50.00	0.35	FLEXIBLE BASE
LIME-TREATED SUBGRADE	12.00	35.00	0.35	LIME-TREATED SUBGRADE
SUBGRADE	163.90	6.00	0.40	SUBGRADE
Bed Rock		600.00	0.15	Bed Rock





Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	12200.0 (lb)
Percentage of TandemAxles	30.0 (%)
Modified Cohesionmeter Value	800.0
Design Wheel Load	12200.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	5.60
User Input TTC based on historical TEX-117-E	

RESULT:

Triaxial Thickness Required	23.5 (in)
The FPS Design Thickness	32.0 (in)
Allowable Thickness Reduction	7.7 (in)
Modified Triaxial Thickness	15.8 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output	**(FPS21-1.4Release:1-18-2018)**		
Highway	LP 368	Problem	002
C-S-J	0016 - 08 - 034	Date	2/26/2019
District	San Antonio	County	BEXAR
Design Type:User Defined Pavement Design			

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 *FLEXIBLE PAVEMENT SYSTEM* *Release:1-18-2018*

PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
003	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/26/2019**	**1**

COMMENTS ABOUT THIS PROBLEM

LP 368 (Broadway Corridor), from Hildebrand Avenue to Roy Smith Street

---

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	8.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	8.0
DESIGN CONFIDENCE LEVEL (95.0%)	C
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.8
FINAL SERVICEABILITY INDEX P2	2.5
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.2
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	6.00
INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)	7.0

PROGRAM CONTROLS AND CONSTRAINTS

NUMBER OF SUMMARY OUTPUT PAGES DESIRED (8 DESIGNS/PAGE)	3
MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)	99.00
MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)	69.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	6.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	40628.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	68731.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	7.710
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	60.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	45.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	5.0
PERCENT TRUCKS IN ADT	5.0

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 *FLEXIBLE PAVEMENT SYSTEM* *Release:1-18-2018*

PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
003	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/26/2019**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	1.5
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	12.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.98
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	200.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	200.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	50.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	3
TOTAL NUMBER OF LANES OF THE FACILITY	4
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	1
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	2
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	0.60
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.60
DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)	0.00

PAVING MATERIALS INFORMATION

LAYER	CODE	MATERIALS NAME	COST PER CY	E MODULUS	POISSON RATIO	MIN. DEPTH	MAX. DEPTH	SALVAGE PCT.
1	E	SP-D	125.00	850000.	0.35	2.00	2.00	90.00
2	C	DG HMA TY B	115.00	650000.	0.35	18.00	18.00	90.00
3	R	LIME-TREATED SUBGR	15.00	35000.	0.30	12.00	12.00	70.00
4	T	SUBGRADE	2.00	6000.	0.40	163.90	163.90	90.00

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 — *FLEXIBLE PAVEMENT SYSTEM* — *Release:1-18-2018*

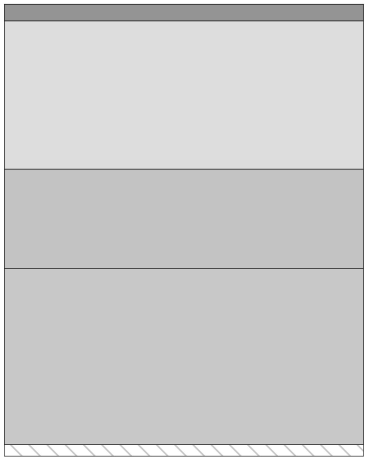
PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
003	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/26/2019**	**3**

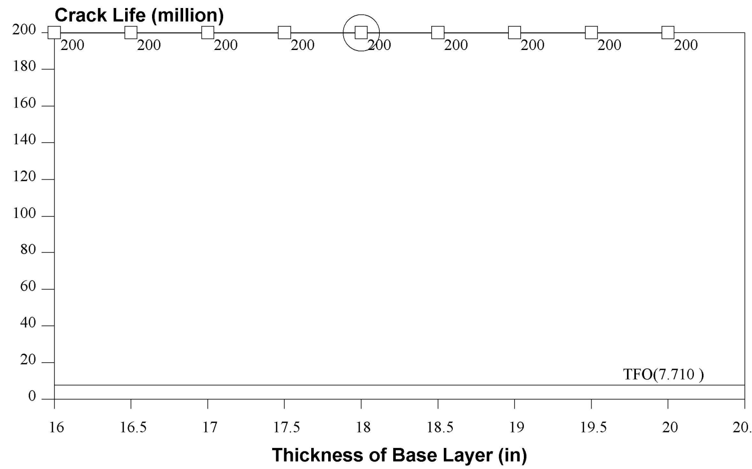
C. LEVEL C SUMMARY OF THE BEST DESIGN STRATEGIES
IN ORDER OF INCREASING TOTAL COST

	1
MATERIAL ARRANGEMENT	ECR
INIT. CONST. COST	69.44
OVERLAY CONST. COST	0.00
USER COST	0.00
ROUTINE MAINT. COST	0.91
SALVAGE VALUE	-15.89
TOTAL COST	54.46
NUMBER OF LAYERS	3
LAYER DEPTH (INCHES)	
D(1)	2.00
D(2)	18.00
D(3)	12.00
NO.OF PERF.PERIODS	1
PERF. TIME (YEARS)	
T(1)	40.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)	

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 1



Thickness (inches)	*Modulus (ksi)*	*Poisson's Ratio*	*Material Name*
2.00	850.00	0.35	SP-D
18.00	650.00	0.35	DG HMA TY B
12.00	35.00	0.30	LIME-TREATED SUBGRADE
163.90	6.00	0.40	SUBGRADE



Fatigue Crack Model:

$$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$$

f_1 =7.96E-02

f_2 = 3.291

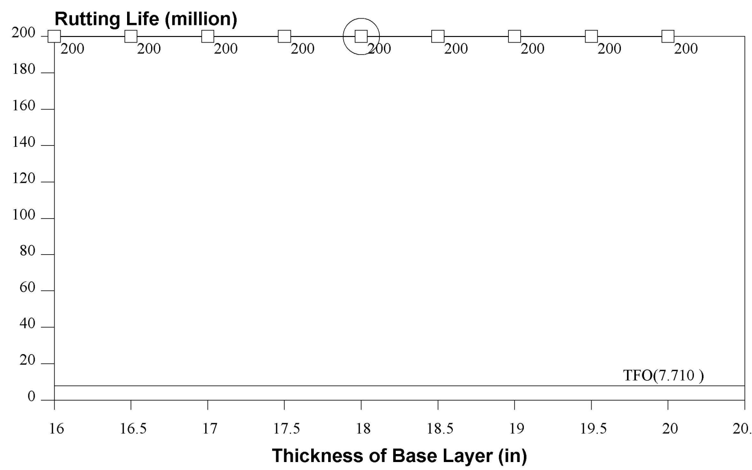
f_3 = .854

Rutting Model:

$$N_d = f_4 (\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09

f_5 = 4.477



TFO(Traffic to 1st Overlay): 7.71 (million)

Crack Life: 200.00 (million) ε_τ = 27.80 ($\mu\varepsilon$)

Rut Life: 200.00 (million) ε_v = -81.30 ($\mu\varepsilon$)

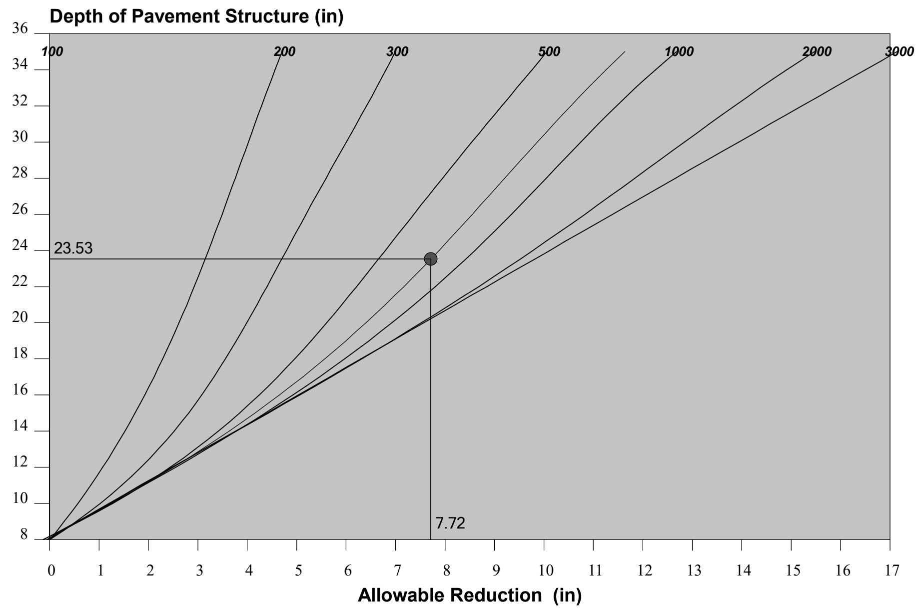
Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:7.71millions.
Also the start ADT:40628.0 and ending ADT:68731.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.4Release:1-18-2018)			
Highway	LP 368	Problem	003
C-S-J	0016 - 08 - 034	Date	2/26/2019
District	San Antonio	County	BEXAR
Design Type:User Defined Pavement Design			

Layer	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
SP-D	2.00	850.00	0.35	SP-D
DG HMA TY B	18.00	650.00	0.35	DG HMA TY B
LIME-TREATED SUBGRADE	12.00	35.00	0.30	LIME-TREATED SUBGRADE
SUBGRADE	163.90	6.00	0.40	SUBGRADE
Bed Rock		600.00	0.15	Bed Rock



Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	12200.0 (lb)
Percentage of TandemAxles	30.0 (%)
Modified Cohesionmeter Value	800.0
Design Wheel Load	12200.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	5.60

User Input TTC based on historical TEX-117-E

RESULT:

Triaxial Thickness Required	23.5 (in)
The FPS Design Thickness	32.0 (in)
Allowable Thickness Reduction	7.7 (in)
Modified Triaxial Thickness	15.8 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output (FPS21-1.4Release:1-18-2018)

Highway	LP 368	Problem	003
C-S-J	0016 - 08 - 034	Date	2/26/2019
District	San Antonio	County	BEXAR

Design Type:User Defined Pavement Design

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 *FLEXIBLE PAVEMENT SYSTEM* *Release:1-18-2018*

PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
004	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/26/2019**	**1**

COMMENTS ABOUT THIS PROBLEM

LP 368 (Broadway Corridor), from Hildebrand Avenue to Roy Smith Street

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	8.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	8.0
DESIGN CONFIDENCE LEVEL (95.0%)	C
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.8
FINAL SERVICEABILITY INDEX P2	2.5
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.2
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	6.00
INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)	7.0

PROGRAM CONTROLS AND CONSTRAINTS

NUMBER OF SUMMARY OUTPUT PAGES DESIRED (8 DESIGNS/PAGE)	3
MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)	99.00
MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)	69.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	6.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	40628.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	68731.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	7.710
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	60.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	45.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	5.0
PERCENT TRUCKS IN ADT	5.0

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 — *FLEXIBLE PAVEMENT SYSTEM* — *Release:1-18-2018*

PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
004	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/26/2019**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	1.5
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	12.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.98
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	200.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	200.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	50.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	3
TOTAL NUMBER OF LANES OF THE FACILITY	4
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	1
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	2
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	0.60
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.60
DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)	0.00

PAVING MATERIALS INFORMATION

LAYER	CODE	MATERIALS NAME	COST PER CY	E MODULUS	POISSON RATIO	MIN. DEPTH	MAX. DEPTH	SALVAGE PCT.
1	E	SP-D	125.00	850000.	0.35	2.00	2.00	90.00
2	C	DG HMA TY B	115.00	650000.	0.35	8.00	10.00	90.00
3	P	CEMENT STABILIZED	45.00	130000.	0.25	10.00	12.00	70.00
4	S	LIME-TREATED SUBGR	15.00	35000.	0.35	12.00	12.00	70.00
5	T	SUBGRADE	2.00	6000.	0.40	163.90	163.90	90.00

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 *FLEXIBLE PAVEMENT SYSTEM* *Release:1-18-2018*

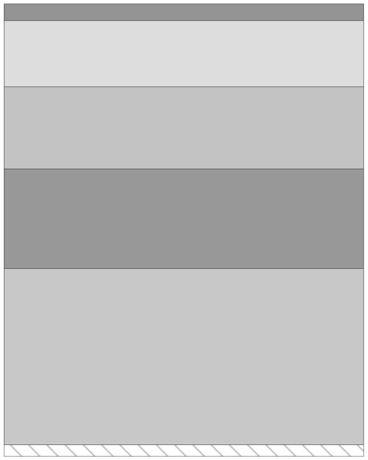
PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
004	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/26/2019**	**3**

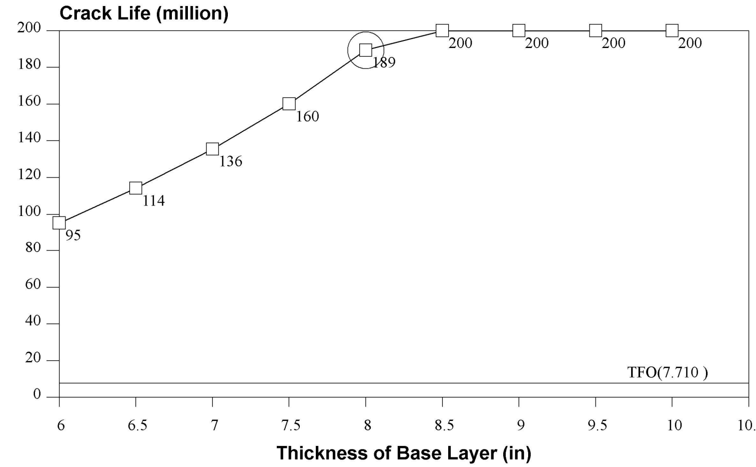
C. LEVEL C SUMMARY OF THE BEST DESIGN STRATEGIES
IN ORDER OF INCREASING TOTAL COST

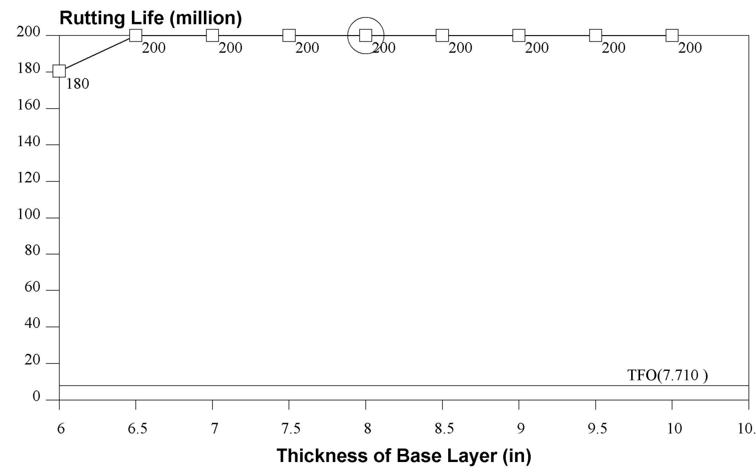
	1
MATERIAL ARRANGEMENT	ECPS
INIT. CONST. COST	50.00
OVERLAY CONST. COST	0.00
USER COST	0.00
ROUTINE MAINT. COST	0.91
SALVAGE VALUE	-10.72
TOTAL COST	40.19
NUMBER OF LAYERS	4
LAYER DEPTH (INCHES)	
D(1)	2.00
D(2)	8.00
D(3)	10.00
D(4)	12.00
NO.OF PERF.PERIODS	1
PERF. TIME (YEARS)	
T(1)	40.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)	

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 30



Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
2.00	850.00	0.35	SP-D
8.00	650.00	0.35	DG HMA TY B
10.00	130.00	0.25	CEMENT STABILIZED BASE
12.00	35.00	0.35	LIME-TREATED SUBGRADE
163.90	6.00	0.40	SUBGRADE





Fatigue Crack Model:

$$N_f = f_1(\varepsilon_t)^{-f_2}(E_1)^{-f_3}$$

f_1 =7.96E-02
f_2 = 3.291
f_3 = .854

Rutting Model:

$$N_d = f_4(\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09
f_5 = 4.477

TFO(Traffic to 1st Overlay): 7.71 (million)

Crack Life: 189.38 (million) ε_τ = 43.90 ($\mu\varepsilon$)

Rut Life: 200.00 (million) ε_v = -125.00 ($\mu\varepsilon$)

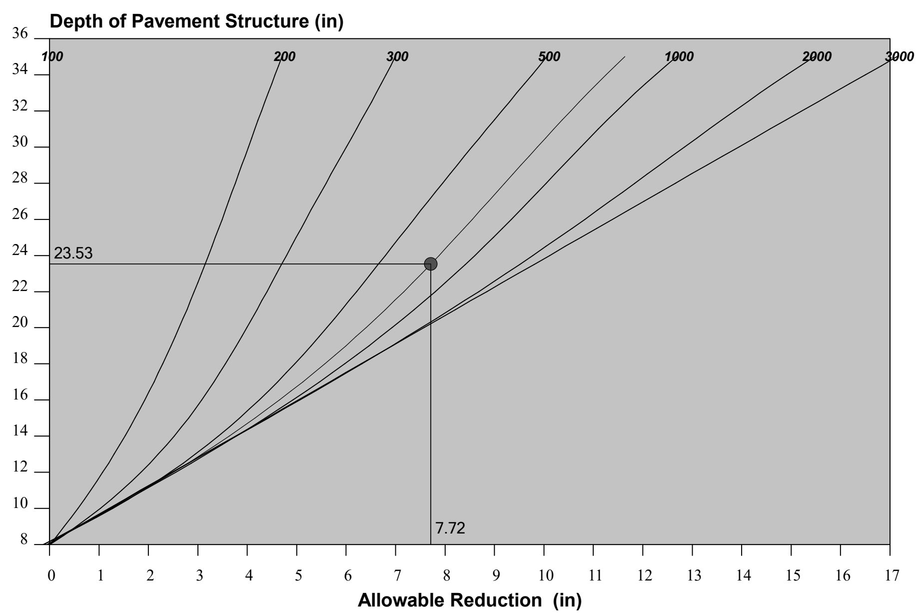
Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:7.71millions.
Also the start ADT:40628.0 and ending ADT:68731.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output	(FPS21-1.4Release:1-18-2018)		
Highway	LP 368	Problem	004
C-S-J	0016 - 08 - 034	Date	2/26/2019
District	San Antonio	County	BEXAR
Design Type:User Defined Pavement Design			

Layer	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
SP-D	2.00	850.00	0.35	SP-D
DG HMA TY B	8.00	650.00	0.35	DG HMA TY B
CEMENT STABILIZED BASE	10.00	130.00	0.25	CEMENT STABILIZED BASE
LIME-TREATED SUBGRADE	12.00	35.00	0.35	LIME-TREATED SUBGRADE
SUBGRADE	163.90	6.00	0.40	SUBGRADE
Bed Rock		600.00	0.15	Bed Rock



Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	12200.0 (lb)
Percentage of TandemAxles	30.0 (%)
Modified Cohesionmeter Value	800.0
Design Wheel Load	12200.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	5.60
User Input TTC based on historical TEX-117-E	

RESULT:

Triaxial Thickness Required	23.5 (in)
The FPS Design Thickness	32.0 (in)
Allowable Thickness Reduction	7.7 (in)
Modified Triaxial Thickness	15.8 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output	(FPS21-1.4Release:1-18-2018)		
Highway	LP 368	Problem	004
C-S-J	0016 - 08 - 034	Date	2/26/2019
District	San Antonio	County	BEXAR

Design Type:User Defined Pavement Design

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 — *FLEXIBLE PAVEMENT SYSTEM* — *Release:1-18-2018*

PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
005	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/25/2019**	**1**

COMMENTS ABOUT THIS PROBLEM

LP 368 (Broadway Corridor), from Hildebrand Avenue to Roy Smith Street

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	8.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	8.0
DESIGN CONFIDENCE LEVEL (95.0%)	C
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.8
FINAL SERVICEABILITY INDEX P2	2.5
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.2
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	6.00
INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)	7.0

PROGRAM CONTROLS AND CONSTRAINTS

NUMBER OF SUMMARY OUTPUT PAGES DESIRED (8 DESIGNS/PAGE)	3
MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)	99.00
MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)	69.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	6.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	40628.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	68731.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	7.710
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	60.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	45.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	5.0
PERCENT TRUCKS IN ADT	5.0

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 *FLEXIBLE PAVEMENT SYSTEM* *Release:1-18-2018*

PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
005	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/25/2019**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	1.5
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	12.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.98
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	200.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	200.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	50.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	3
TOTAL NUMBER OF LANES OF THE FACILITY	4
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	1
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	2
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	0.60
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.60
DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)	0.00

PAVING MATERIALS INFORMATION

LAYER	CODE	MATERIALS NAME	COST PER CY	E MODULUS	POISSON RATIO	MIN. DEPTH	MAX. DEPTH	SALVAGE PCT.
1	E	SP-D	125.00	850000.	0.35	2.00	2.00	90.00
2	C	DG HMA TY B OVER 2	115.00	650000.	0.35	6.00	12.00	90.00
3	M	EXISTING PAVEMENT	37.00	100000.	0.35	5.00	5.00	75.00
4	T	SUBGRADE	2.00	6000.	0.40	163.90	163.90	90.00

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.4 *FLEXIBLE PAVEMENT SYSTEM* *Release:1-18-2018*

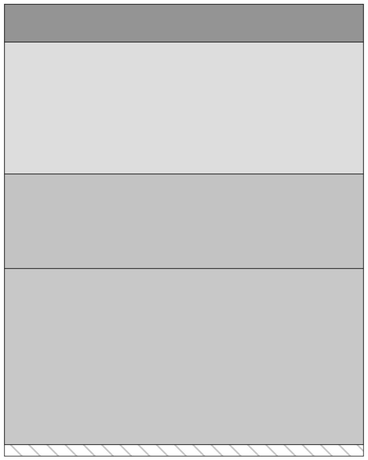
PAVEMENT DESIGN TYPE # 7 -- USER DEFINED PAVEMENT

PROB	DIST.-15	COUNTY- 15	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
005	**San Antonio**	**BEXAR**	**0016**	**08**	**034**	**LP 368**	**2/25/2019**	**3**

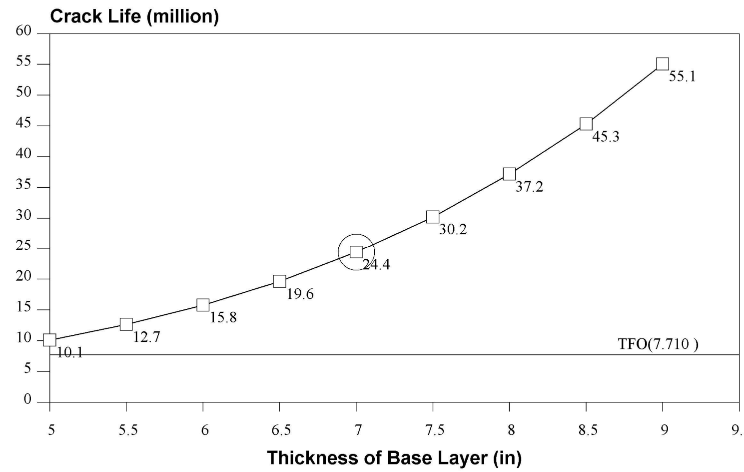
C. LEVEL C SUMMARY OF THE BEST DESIGN STRATEGIES IN ORDER OF INCREASING TOTAL COST

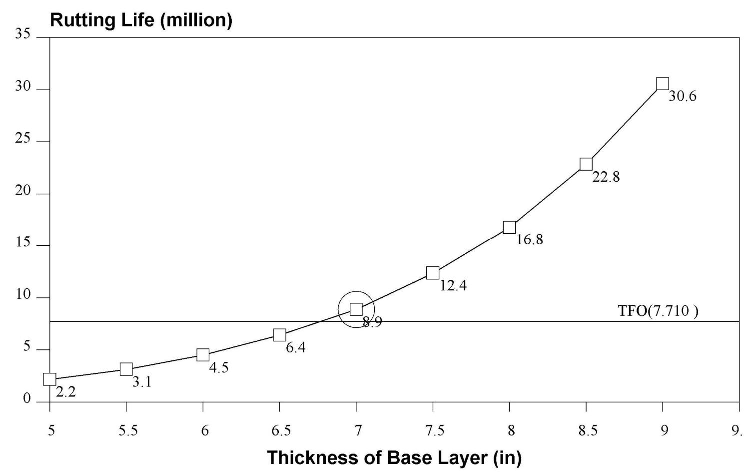
	1	2
MATERIAL ARRANGEMENT	ECM	ECM
INIT. CONST. COST	31.25	34.44
OVERLAY CONST. COST	2.20	0.00
USER COST	1.16	0.00
ROUTINE MAINT. COST	0.80	0.91
SALVAGE VALUE	-8.28	-7.81
TOTAL COST	27.14	27.54
NUMBER OF LAYERS	3	3
LAYER DEPTH (INCHES)		
D(1)	2.00	2.00
D(2)	6.00	7.00
D(3)	5.00	5.00
NO.OF PERF.PERIODS	2	1
PERF. TIME (YEARS)		
T(1)	17.	22.
T(2)	30.	
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)		
O(1)	2.0	

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 13



Thickness (inches)	*Modulus (ksi)*	*Poisson's Ratio*	*Material Name*
2.00	850.00	0.35	SP-D
7.00	650.00	0.35	DG HMA TY B OVER 2" TY D
5.00	100.00	0.35	EXISTING PAVEMENT
163.90	6.00	0.40	SUBGRADE





Fatigue Crack Model:

$$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$$

f_1 =7.96E-02

f_2 = 3.291

f_3 = .854

Rutting Model:

$$N_d = f_4 (\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09

f_5 = 4.477

TFO(Traffic to 1st Overlay): 7.71 (million)

Crack Life: 24.42 (million) ε_τ = 81.80 ($\mu\varepsilon$)

Rut Life: 8.87 (million) ε_v = -294.00 ($\mu\varepsilon$)

Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:7.71millions.
Also the start ADT:40628.0 and ending ADT:68731.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output	**(FPS21-1.4Release:1-18-2018)**		
Highway	LP 368	Problem	005
C-S-J	0016 - 08 - 034	Date	2/25/2019
District	San Antonio	County	BEXAR
Design Type:User Defined Pavement Design			

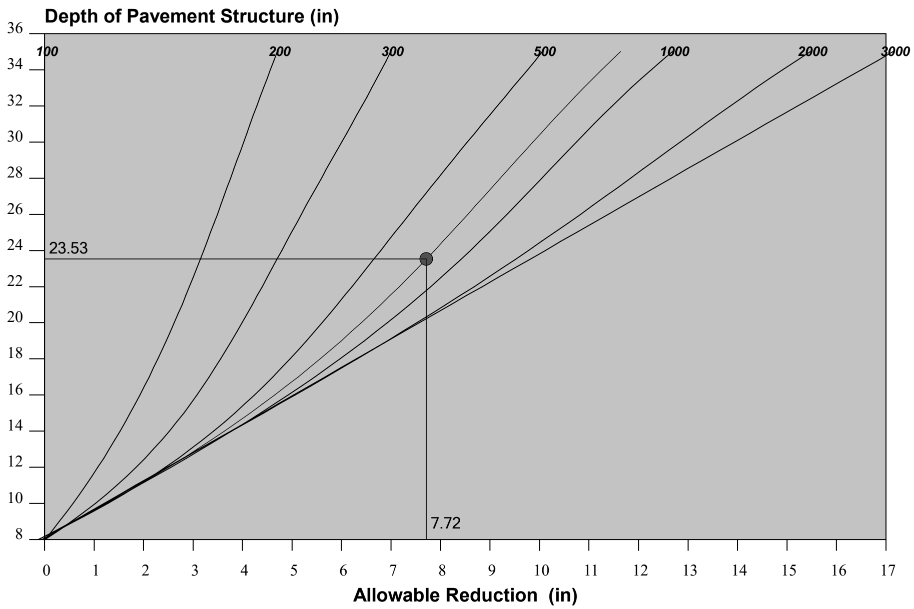
Layer	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
SP-D	2.00	850.00	0.35	SP-D
DG HMA TY B OVER 2" TY D	7.00	650.00	0.35	DG HMA TY B OVER 2" TY D
EXISTING PAVEMENT	5.00	100.00	0.35	EXISTING PAVEMENT
SUBGRADE	163.90	6.00	0.40	SUBGRADE
Bed Rock		600.00	0.15	Bed Rock

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	12200.0 (lb)
Percentage of TandemAxles	30.0 (%)
Modified Cohesionmeter Value	800.0
Design Wheel Load	12200.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	5.60
User Input TTC based on historical TEX-117-E	

RESULT:

Triaxial Thickness Required	23.5 (in)
The FPS Design Thickness	14.0 (in)
Allowable Thickness Reduction	7.7 (in)
Modified Triaxial Thickness	15.8 (in)



Thickness Reduction Chart for Stabilized Layers

TRIAXIAL CHECK CONCLUSION:

The Design Fails !

FPS 21 Triaxial Design Check Output	(FPS21-1.4Release:1-18-2018)		
Highway	LP 368	Problem	005
C-S-J	0016 - 08 - 034	Date	2/25/2019
District	San Antonio	County	BEXAR
Design Type:User Defined Pavement Design			

APPENDIX I: CRCP, CPCD, AND FLEXIBLE-TO-RIGID TRANSITION DETAILS

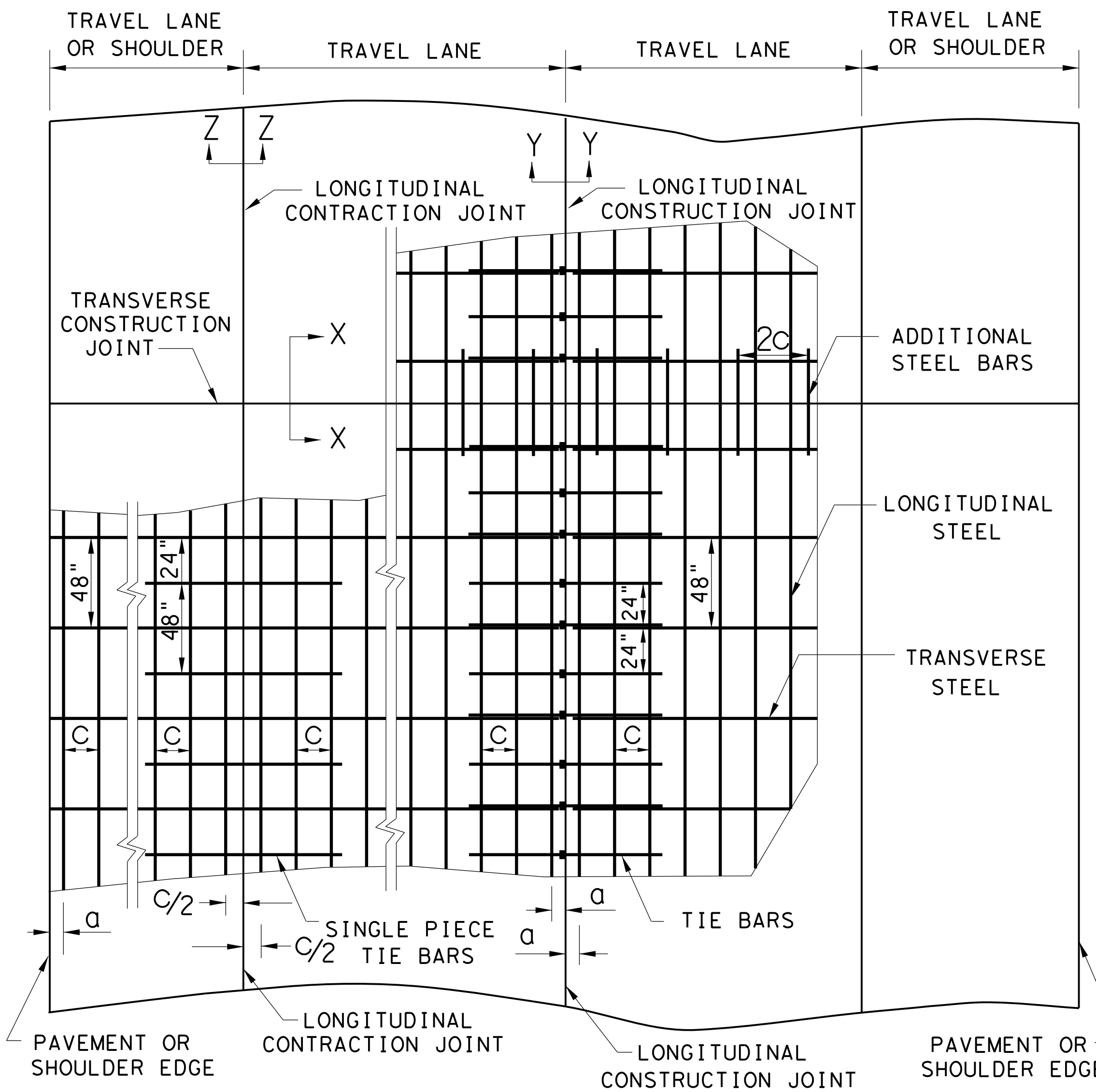
DATE:
FILE:

TABLE NO. 1 LONGITUDINAL STEEL

SLAB THICKNESS AND BAR SIZE		REGULAR STEEL BARS	FIRST SPACING AT EDGE OR JOINT	ADDITIONAL STEEL BARS AT TRANSVERSE CONSTRUCTION JOINT (SECTION X-X)	
T (IN.)	BAR SIZE	SPACING c (IN.)	SPACING a (IN.)	SPACING 2 x c (IN.)	LENGTH L (IN.)
7.0	#5	6.5	3 TO 4	13	50
7.5	#5	6.0	3 TO 4	12	50
8.0	#6	9.0	3 TO 4	18	50
8.5	#6	8.5	3 TO 4	17	50
9.0	#6	8.0	3 TO 4	16	50
9.5	#6	7.5	3 TO 4	15	50
10.0	#6	7.0	3 TO 4	14	50
10.5	#6	6.75	3 TO 4	13.5	50
11.0	#6	6.5	3 TO 4	13	50
11.5	#6	6.25	3 TO 4	12.5	50
12.0	#6	6.0	3 TO 4	12	50
12.5	#6	5.75	3 TO 4	11.5	50
13.0	#6	5.5	3 TO 4	11	50

TABLE NO. 2 TRANSVERSE STEEL AND TIE BARS

SLAB THICKNESS (IN.)	TRANSVERSE STEEL		TIE BARS AT LONGITUDINAL CONTRACTION JOINT (SECTION Z-Z)		TIE BARS AT LONGITUDINAL CONSTRUCTION JOINT (SECTION Y-Y)	
	BAR SIZE	SPACING (IN.)	BAR SIZE	SPACING (IN.)	BAR SIZE	SPACING (IN.)
7.0 - 7.5	#5	48	#5	48	#5	24
8.0 - 13.0	#5	48	#6	48	#6	24

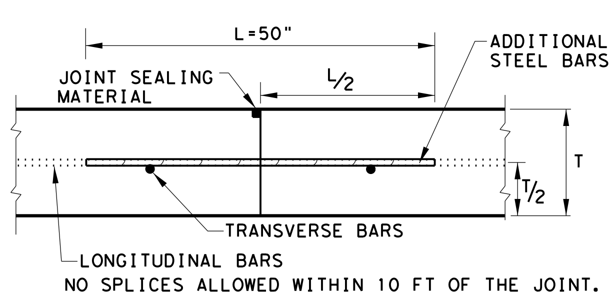


TYPICAL PAVEMENT LAYOUT

PLAN VIEW (NOT TO SCALE)

GENERAL NOTES

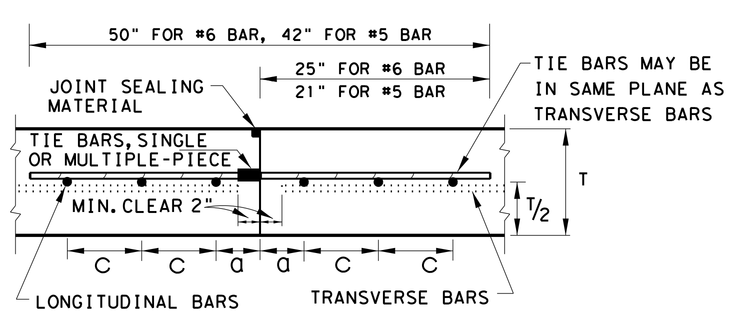
1. DETAILS FOR PAVEMENT WIDTH, PAVEMENT THICKNESS AND THE CROWN CROSS-SLOPE SHALL BE SHOWN ELSEWHERE IN THE PLANS. PAVEMENTS WIDER THAN 100 FT. WITHOUT A FREE LONGITUDINAL JOINT ARE NOT COVERED BY THIS STANDARD.
2. USE COARSE AGGREGATES WITH A RATED COEFFICIENT OF THERMAL EXPANSION (CoTE) OF NOT MORE THAN 5.5 X 10^{-6} IN/IN/ °F AS LISTED IN THE CONCRETE RATED SOURCE QUALITY CATALOG (CRSQC).
3. ALL THE REINFORCING STEEL AND TIE BARS SHALL BE DEFORMED STEEL BARS CONFORMING TO ASTM A 615 (GRADE 60) OR ASTM A 996 (GRADE 60) OR ABOVE. STEEL BAR SIZES AND SPACINGS SHALL CONFORM TO TABLE NO. 1 AND TABLE NO. 2.
4. WHEN COARSE AGGREGATE WITH A RATED CoTE OF NOT MORE THAN 4.3 X 10^{-6} IN/IN/ °F IS USED, TABLE NO. 1A MAY BE USED FOR LONGITUDINAL STEEL AS APPROVED BY THE ENGINEER.
5. STEEL BAR PLACEMENT TOLERANCE SHALL BE +/- 1 IN. HORIZONTALLY AND +/- 0.5 IN. VERTICALLY. CALCULATED AVERAGE BAR SPACING (CONCRETE PLACEMENT WIDTH / NUMBER OF LONGITUDINAL BARS) SHALL CONFORM TO TABLE NO. 1 OR TABLE NO. 1A.
6. PAVEMENT WIDTHS OF MORE THAN 15 FT. SHALL HAVE A LONGITUDINAL JOINT (SECTION Z-Z OR SECTION Y-Y). THESE JOINTS SHALL BE LOCATED WITHIN 6 IN. OF THE LANE LINE UNLESS THE JOINT LOCATION IS SHOWN ELSEWHERE ON THE PLANS.
7. THE SAW CUT DEPTH FOR THE LONGITUDINAL CONTRACTION JOINT (SECTION Z-Z) SHALL BE ONE THIRD OF THE SLAB THICKNESS (T/3).
8. WHEN TYING CONCRETE GUTTER AT A LONGITUDINAL JOINT, THE TIE BAR LENGTH OR POSITION MAY BE ADJUSTED. PROVIDE 3 IN. OF CONCRETE COVER FROM THE BACK OF GUTTER TO THE END OF TIE BAR.
9. REPLACE MISSING OR DAMAGED TIE BARS WITHOUT ADDITIONAL COMPENSATION BY DRILLING MIN. 10 IN. DEEP AND GROUTING TIE BARS WITH TYPE III, CLASS C EPOXY. MEET THE PULL-OUT TEST REQUIREMENTS IN ITEM 361.
10. OMIT TIE BARS LOCATED WITHIN 18-IN. OF THE TRANSVERSE CONSTRUCTION JOINTS (SECTION X-X). USE HAND-OPERATED IMMERSION VIBRATORS TO CONSOLIDATE THE CONCRETE ADJACENT TO ALL FORMED JOINTS.
11. LONGITUDINAL REINFORCING STEEL SPLICES SHALL BE A MINIMUM OF 25 IN. STAGGER THE LAP LOCATIONS SO THAT NO MORE THAN 1/3 OF THE LONGITUDINAL STEEL IS SPLICED IN ANY GIVEN 12-FT. WIDTH AND 2-FT. LENGTH OF THE PAVEMENT.
12. THE DETAIL FOR THE JOINT SEALANT AND RESERVOIR IS SHOWN ON STANDARD SHEET "CONCRETE PAVING DETAILS, JOINT SEALS."



NO SPLICES ALLOWED WITHIN 10 FT OF THE JOINT.

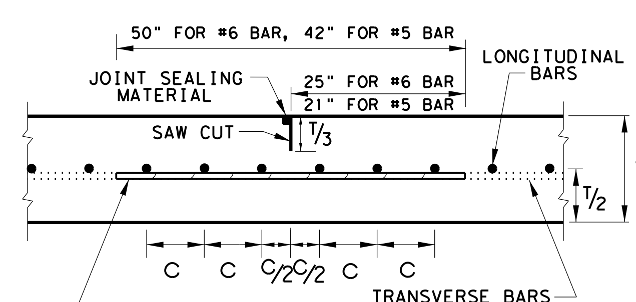
TRANSVERSE CONSTRUCTION JOINT

SECTION X - X



LONGITUDINAL CONSTRUCTION JOINT

SECTION Y - Y



SINGLE PIECE TIE BARS SHOULD BE IN SAME PLANE AS TRANSVERSE BARS FOR 7.0 IN. TO 9.5 IN. SLABS. MAY BE PLACED ABOVE LONGITUDINAL BARS FOR 10.0 IN. TO 13.0 IN. SLABS.

LONGITUDINAL CONTRACTION JOINT

SECTION Z - Z

SHEET 1 OF 2

Texas Department of Transportation — Design Division Standard

CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

ONE LAYER STEEL BAR PLACEMENT
T - 7 to 13 INCHES

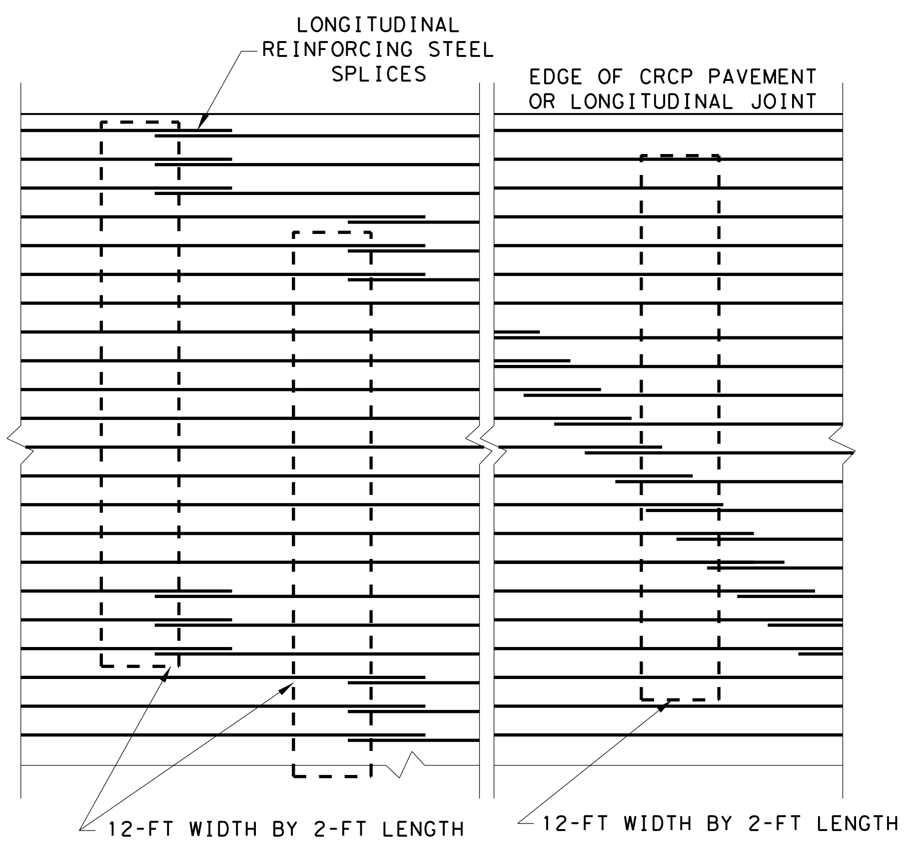
CRCP(1)-17

FILE: crcp117.dgn	DN: TxDOT	CK: AN	DW: HC	CK: VP/KM
© TxDOT: May 2017	CONT	SECT	JOB	HIGHWAY
REVISIONS 10/10/2011 ADD GN #12 04/09/2013 REMOVE 6" AND 6.5" ADD CTE REQUIREMENTS 05/05/2017 CoTE AS RATED 4.3	DIST	COUNTY		SHEET NO.

DATE:
FILE:

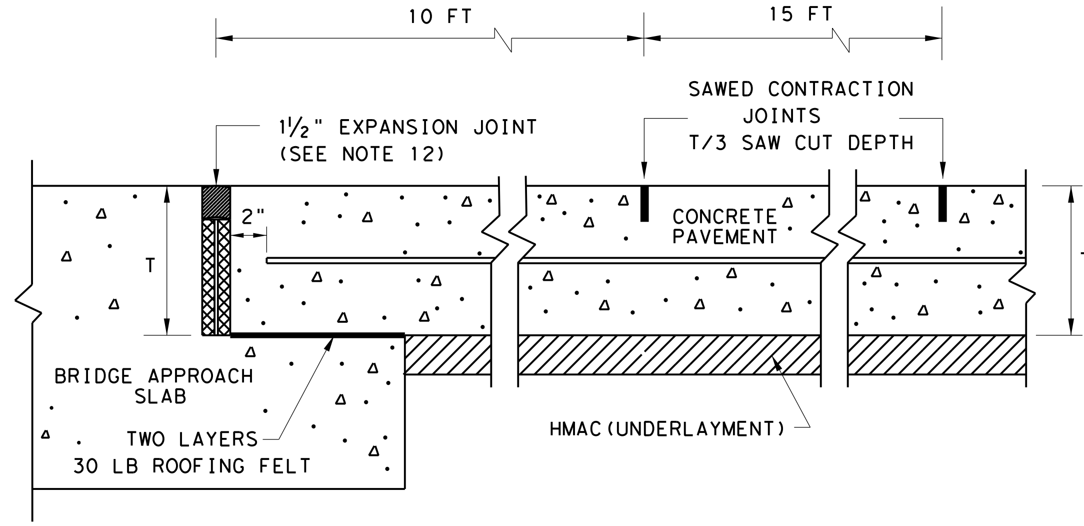
TABLE NO.1A LONGITUDINAL STEEL FOR LOW CoTE CONCRETE AS APPROVED BY THE ENGINEER

SLAB THICKNESS AND BAR SIZE		REGULAR STEEL BARS	FIRST SPACING AT EDGE OR JOINT	ADDITIONAL STEEL BARS AT TRANSVERSE CONSTRUCTION JOINT (SECTION X-X)	
T (IN.)	BAR SIZE	SPACING c (IN.)	SPACING a (IN.)	SPACING 2 x c (IN.)	LENGTH L (IN.)
7.0	#5	7.5	3 TO 4	15	50
7.5	#5	7.0	3 TO 4	14	50
8.0	#6	10.0	3 TO 4	20	50
8.5	#6	9.5	3 TO 4	19	50
9.0	#6	9.0	3 TO 4	18	50
9.5	#6	8.5	3 TO 4	17	50
10.0	#6	8.0	3 TO 4	16	50
10.5	#6	7.5	3 TO 4	15	50
11.0	#6	7.0	3 TO 4	14	50
11.5	#6	6.75	3 TO 4	13.5	50
12.0	#6	6.50	3 TO 4	13	50
12.5	#6	6.25	3 TO 4	12.5	50
13.0	#6	6.0	3 TO 4	12	50

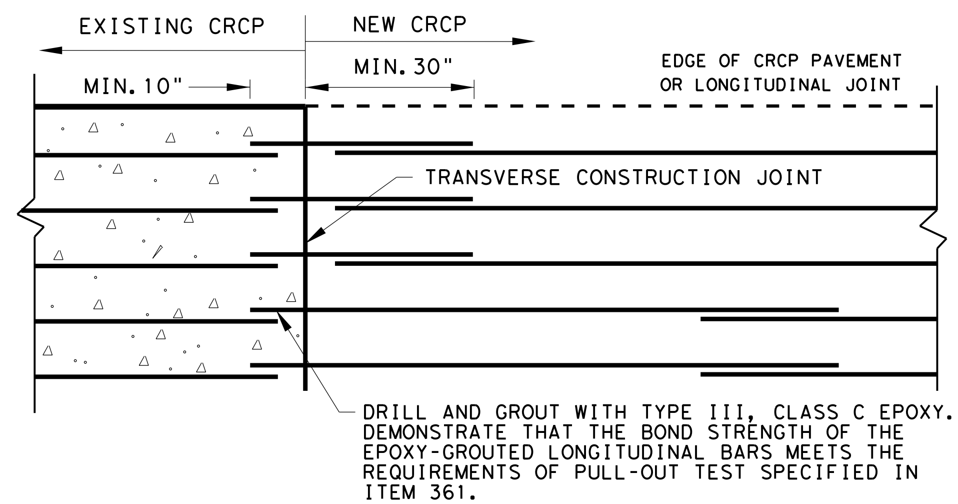


STAGGER THE LAP LOCATIONS SO THAT NO MORE THAN 1/3 OF THE LONGITUDINAL STEEL IS SPLICED IN ANY GIVEN 12-FT. WIDTH AND 2-FT. LENGTH OF THE PAVEMENT. ANY OTHER LAP CONFIGURATION MEETING THIS REQUIREMENT WILL BE ALLOWED.

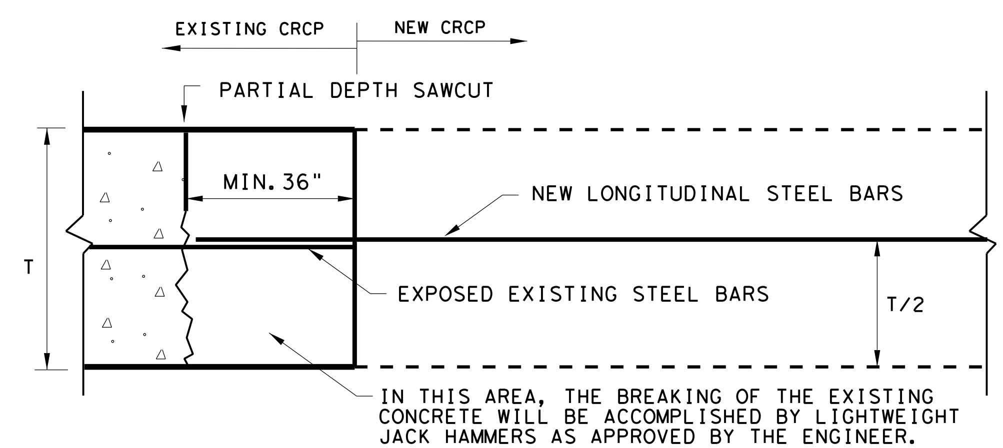
EXAMPLES OF LAP CONFIGURATION
PLAN VIEW (NOT TO SCALE)



TRANSVERSE EXPANSION JOINT DETAIL
AT BRIDGE APPROACH

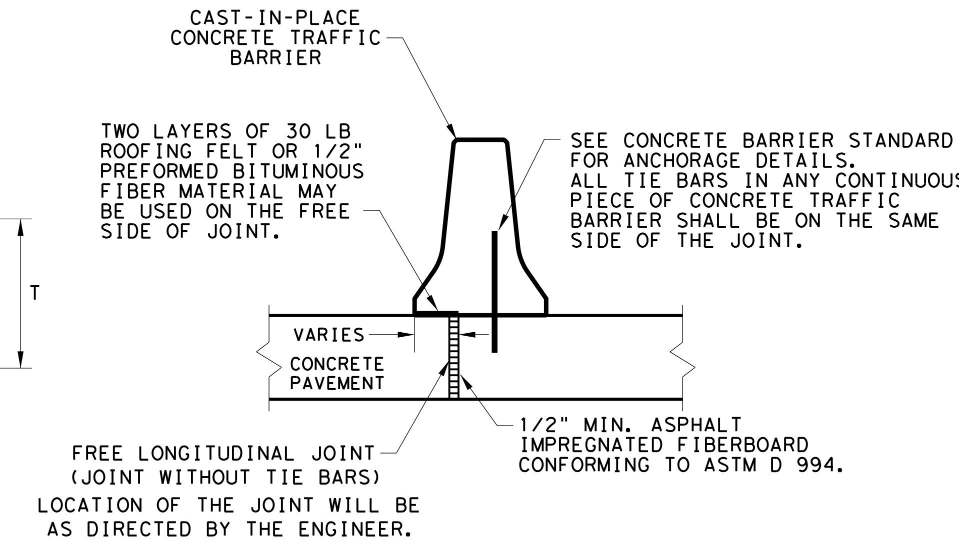


OPTION A: DRILL AND EPOXY
PLAN VIEW (NOT TO SCALE)

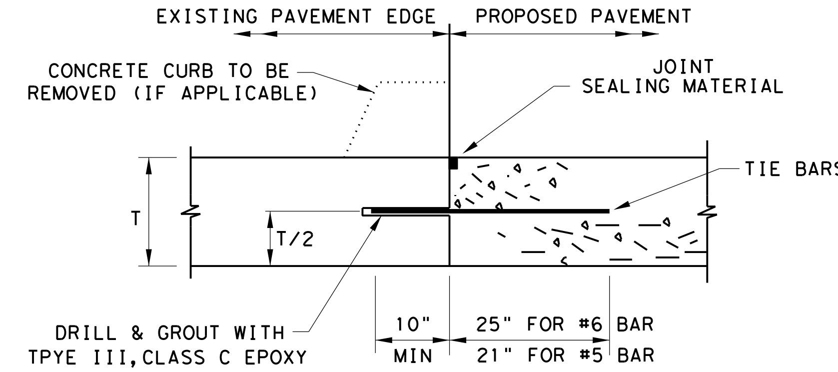


OPTION B: BREAKBACK AND LAP

TRANSVERSE TIE JOINT DETAIL
EXISTING CRCP TO NEW CRCP



FREE LONGITUDINAL JOINT DETAIL



1. BEFORE WIDENING WORK, DEMONSTRATE THAT THE BOND STRENGTH OF THE EPOXY-GROUTED TIE BARS MEETS THE REQURIMENTS OF PULL-OUT TEST SPECIFIED IN ITEM 361.
2. SPACE TIE BARS AT 24" SPACING. USE #6 TIE BARS FOR 8" AND THICKER SLABS, USE #5 TIE BARS FOR LESS THAN 8" THICK SLABS.

LONGITUDINAL WIDENING JOINT DETAIL

SHEET 2 OF 2

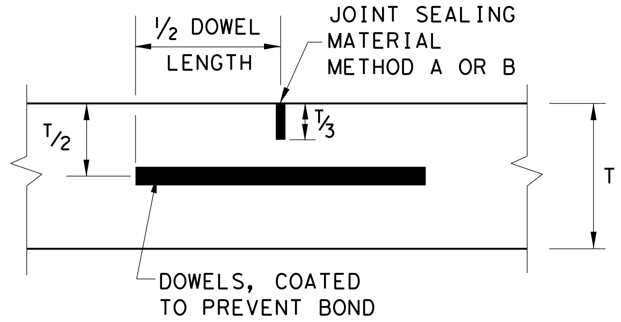
Texas Department of Transportation | Design Division Standard

CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

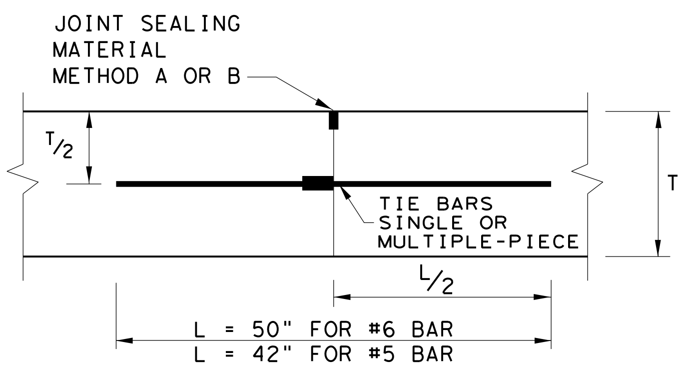
ONE LAYER STEEL BAR PLACEMENT
T - 7 to 13 INCHES

CRCP(1)-17

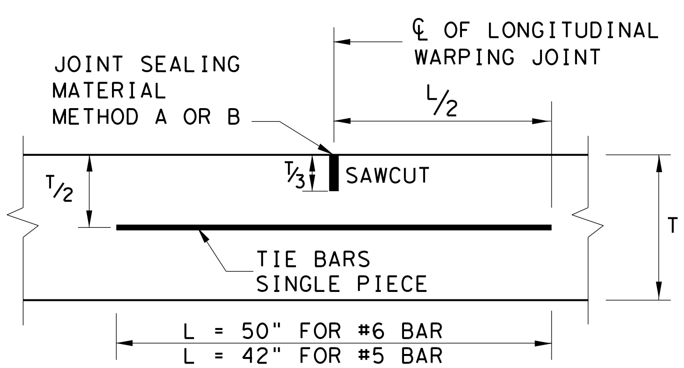
FILE: crcp117.dgn	DN: TxDOT	CK: AN	DW: HC	CK: VP/KM
© TxDOT: May 2017	CONT	SECT	JOB	HIGHWAY
REVISIONS	DIST		COUNTY	SHEET NO.



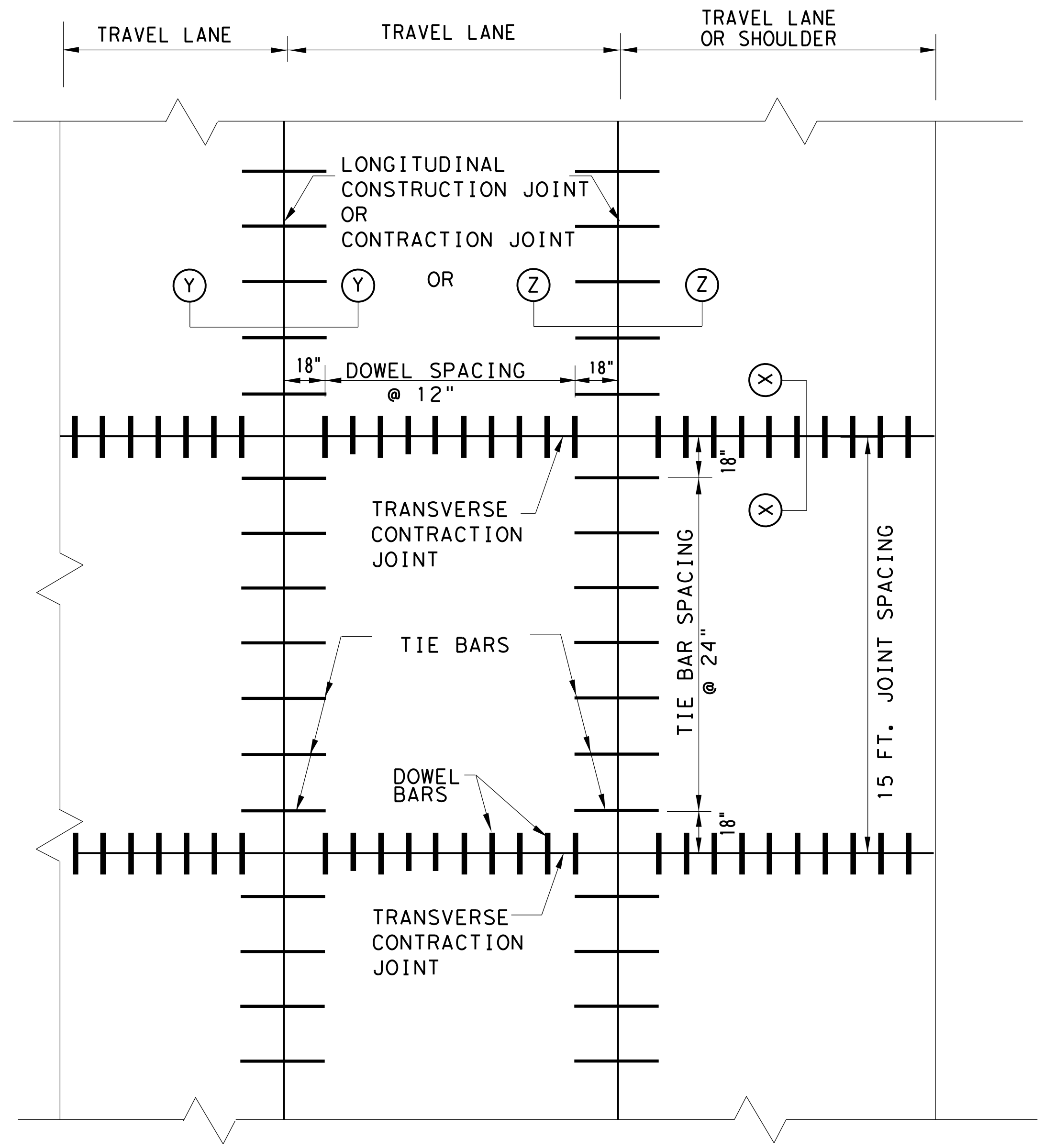
TRANSVERSE CONTRACTION JOINT
SECTION X-X



LONGITUDINAL CONSTRUCTION JOINT
SECTION Y-Y



LONGITUDINAL CONTRACTION JOINT
SECTION Z-Z



TYPICAL PAVEMENT LAYOUT
PLAN VIEW (NOT TO SCALE)

GENERAL NOTES

1. DETAILS FOR PAVEMENT WIDTH, PAVEMENT THICKNESS AND THE CROWN CROSS-SLOPE SHALL BE SHOWN ELSEWHERE IN THE PLANS. PAVEMENTS WIDER THAN 100 FT. WITHOUT A FREE LONGITUDINAL JOINT ARE NOT COVERED BY THIS STANDARD.
2. FOR FURTHER INFORMATION REGARDING THE PLACEMENT OF CONCRETE AND LOAD TRANSFER DEVICES REFER TO THE GOVERNING SPECIFICATION FOR "CONCRETE PAVEMENT".
3. THE SPACING BETWEEN TRANSVERSE CONTRACTION JOINTS SHALL BE 15 FT. UNLESS OTHERWISE SHOWN IN THE PLANS.
4. TRANSVERSE CONSTRUCTION JOINTS MAY BE FORMED BY USE OF METAL OR WOOD FORMS EQUAL IN DEPTH TO THE DEPTH OF PAVEMENT, OR BY METHODS APPROVED BY THE ENGINEER.
5. USE HAND-OPERATED IMMERSION VIBRATORS TO CONSOLIDATE THE CONCRETE ADJACENT TO ALL THE FORMED JOINTS.
6. PAVEMENT WIDTHS OF MORE THAN 15 FT. SHALL HAVE A LONGITUDINAL JOINT (SECTION Z-Z OR SECTION Y-Y). THESE JOINTS SHALL BE LOCATED WITHIN 6 IN. OF THE LANE LINE UNLESS THE JOINT LOCATION IS SHOWN ELSEWHERE ON THE PLANS.
7. THE JOINT BETWEEN OUTSIDE LANE AND SHOULDER SHALL BE A LONGITUDINAL CONTRACTION JOINT (SECTION Z-Z) UNLESS OTHERWISE SHOWN IN THE PLANS. THE SAW CUT DEPTH FOR THE LONGITUDIANL CONTRACTION JOINT (SECTION Z-Z) SHALL BE ONE THIRD OF THE SLABTHICKNESS (T/3).
8. WHEN TYING CONCRETE GUTTER AT A LONGITUDINAL JOINT, THE TIE BAR LENGTH OR POSITION MAY BE ADJUSTED. PROVIDE 3 IN. OF CONCRETE COVER FROM THE BACK OF GUTTER TO THE END OF TIE BAR.
9. REPLACE MISSING OR DAMAGED TIE BARS WITHOUT ADDITIONAL COMPENSATION BY DRILLING MIN. 10 IN. DEEP AND GROUTING TIE BARS WITH TYPE III, CLASS C EPOXY. MEET THE PULL-OUT TEST REQUIREMENTS IN ITEM 361.
10. WHEN AN MONOLITHIIC CURB IS SPECIFIED, THE JOINT IN THE CURB SHALL COINCIDE WITH PAVEMENT JOINTS AND MAY BE FORMED BY ANY MEANS APPROVED BY THE ENGINEER.
11. DOWEL BAR PLACEMENT TOLERANCE SHALL BE +/- 1/4 IN. HORIZONTALLY AND VERTICALLY UNLESS OTHERWISE SPECIFIED.WHERE DOWEL BAR BASKETS ARE USED, REMOVE THE SHIPPING WIRES.
12. THE DETAIL FOR JOINT SEALANT AND RESERVOIR IS SHOWN ON STANDARD SHEET "CONCRETE PAVING DETAILS, JOINT SEALS."

TABLE NO.1 DOWELS (SMOOTH BARS)

SLAB THICKNESS T (IN.)	BAR DIA. AND LENGTH	AVERAGE SPACING (IN.)
6 to 7.5	1" X 18"	12
8 to 10	1 1/4" X 18"	12
>= 10.5	1 1/2" X 18"	12

TABLE NO.2 TIE BARS (DEFORMED BARS)

SLAB THICKNESS T (IN.)	BAR SIZE	AVERAGE SPACING (IN.)
6 to 7.5	#5	24
>= 8	#6	24

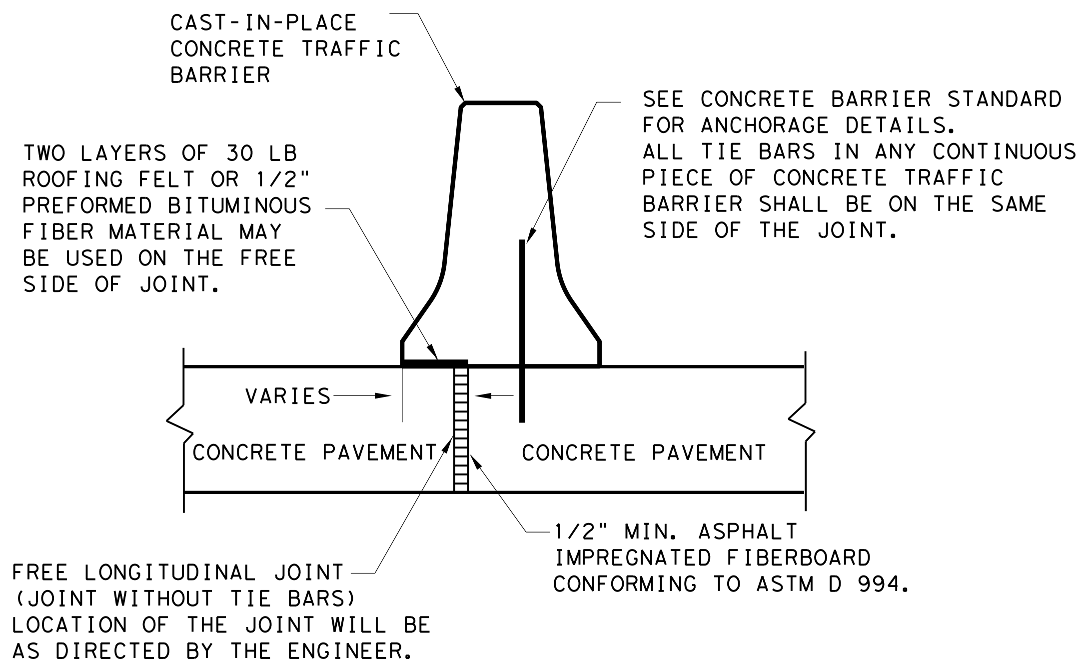
Texas Department of Transportation
Design Division Standard

CONCRETE PAVEMENT DETAILS CONTRACTION DESIGN
T-6 to 12 INCHES

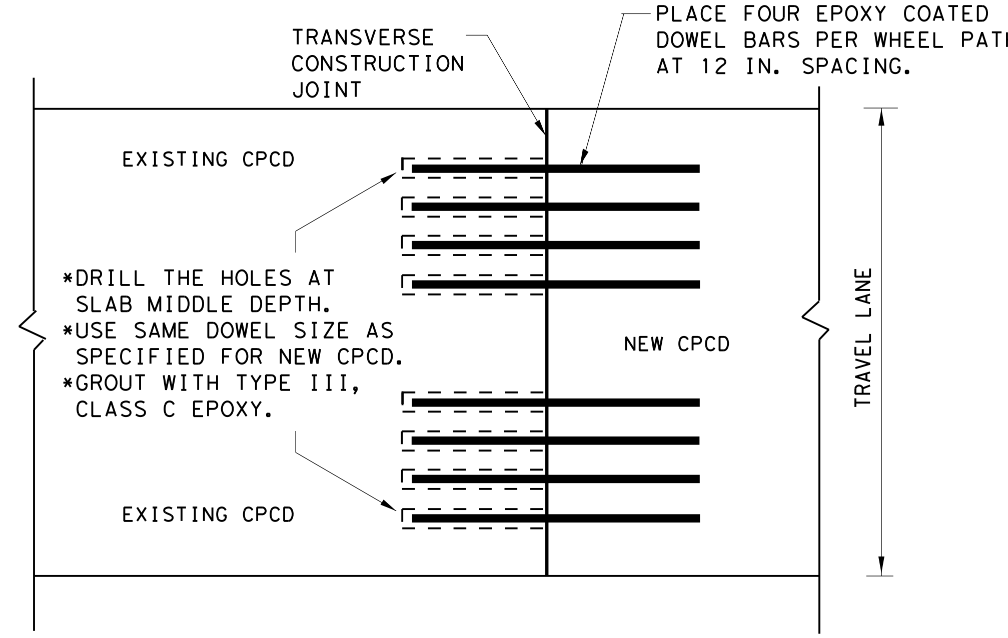
CPCD-14

FILE: cpcd14.dgn | DN: TxDOT | CK: HC | DW: HC | CK: AN
 | CONT | SECT | JOB | HIGHWAY
REVISIONS | DIST | COUNTY | SHEET NO.

DATE:
FILE:



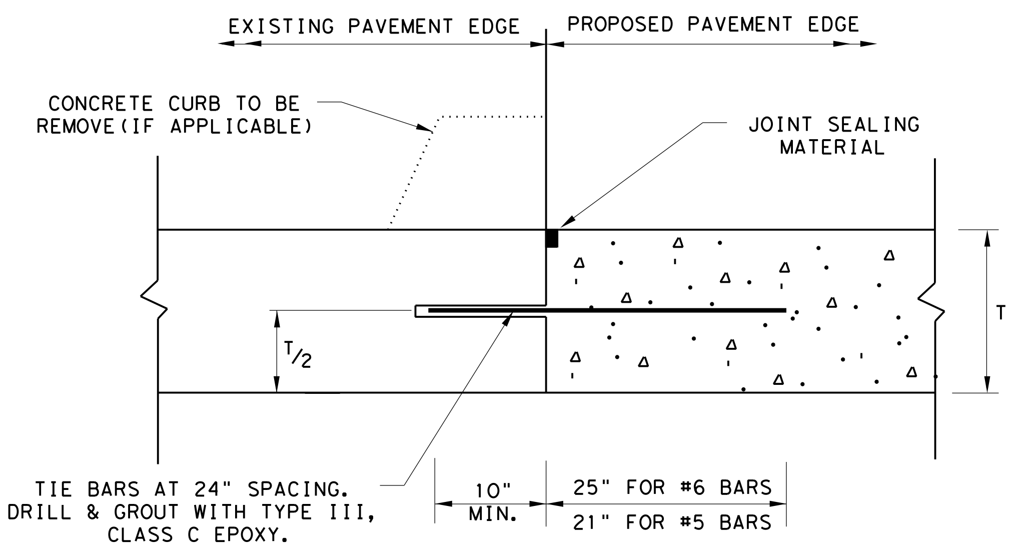
FREE LONGITUDINAL JOINT DETAIL



TRANSVERSE JOINT DETAIL

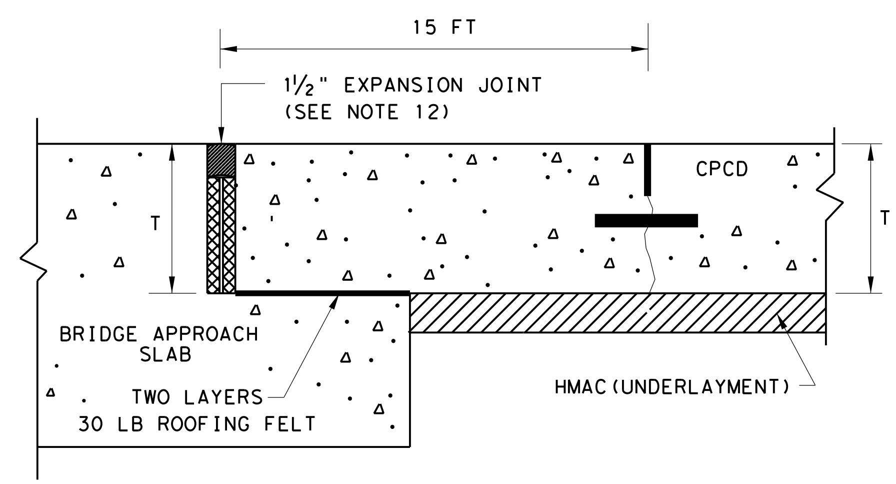
EXISTING CPCD TO NEW CPCD

PLAN VIEW (NOT TO SCALE)



1. BEFORE WIDENING WORK, DEMONSTRATE THAT THE BOND STRENGTH OF THE EPOXY-GROUTED TIE BARS MEETS THE REQUIREMENTS OF PULL-OUT TEST SPECIFIED IN ITEM 361.
2. SPACE TIE BARS AT 24" SPACING. USE #6 BARS FOR 8" AND THICKER SLABS, USE #5 BARS FOR LESS THAN 8" THICK SLABS.
3. THE TRANSVERSE JOINTS OF PROPOSED PAVEMENT SHALL COINCIDE WITH EXISTING PAVEMENT JOINTS UNLESS OTHERWISE SHOWN ON THE PLANS.

LONGITUDINAL WIDENING JOINT DETAIL



TRANSVERSE EXPANSION JOINT DETAIL

AT BRIDGE APPROACH

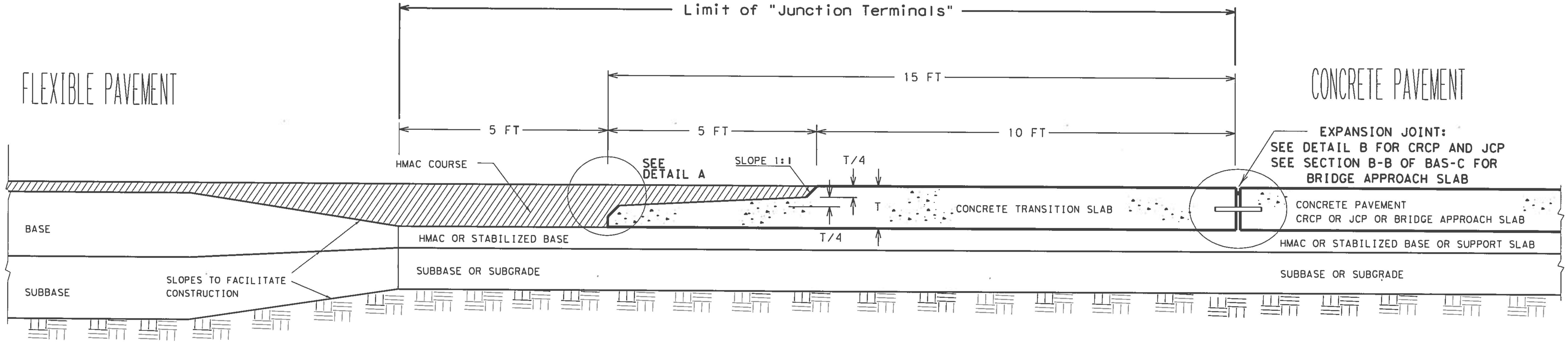
Texas Department of Transportation — Design Division Standard

CONCRETE PAVEMENT DETAILS
CONTRACTION DESIGN
T-6 to 12 INCHES

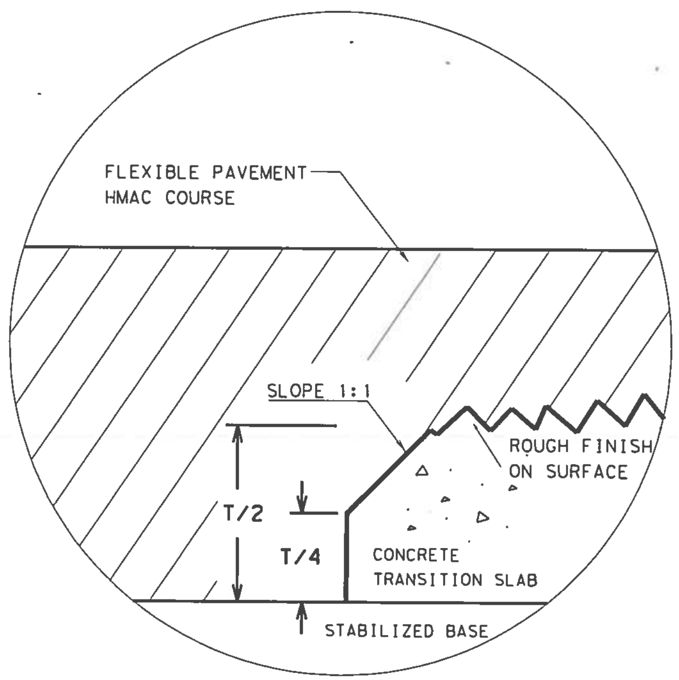
CPCD-14

FILE: cpcd14.dgn	DN: TxDOT	DN: HC	DW: HC	CK: AN
© TxDOT: DECEMBER 2014	CONT	SECT	JOB	HIGHWAY
REVISIONS				
	DIST		COUNTY	SHEET NO.

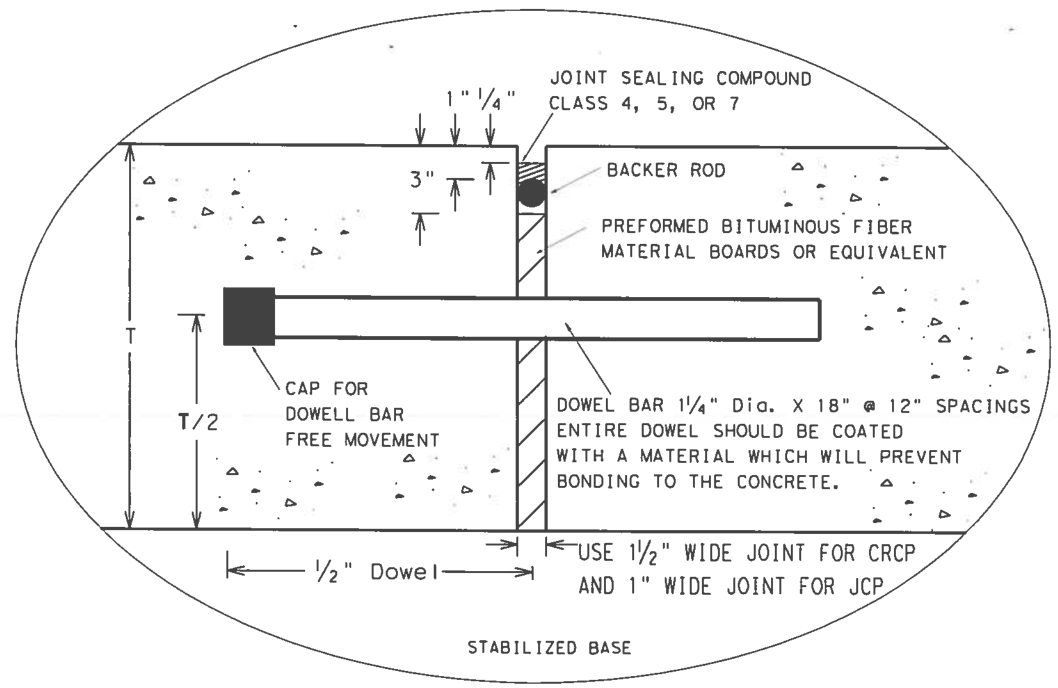
DATE:
FILE:



JUNCTION TERMINALS - FLEXIBLE PAVEMENT WITH CONCRETE PAVEMENT

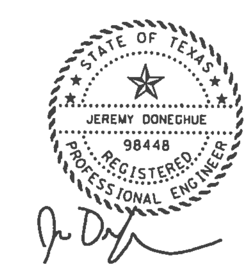


DETAIL A



DETAIL B

06/30/2015



GENERAL NOTES

	STA	OFFSET	OFFSET	QUANTITY•
IH 10	907+80	10.84' RT	38.84' RT	20
	907+80	13.58' LT	38.84' LT	20
	931+20	0.00' RT	39.00' RT	20
	931+20	0.00' LT	39.00' LT	20
			TOTAL	80

• FOR CONTRACTOR'S INFORMATION ONLY

1. FOR FURTHER INFORMATION REGARDING THE PLACEMENT OF CONCRETE AND LOAD TRANSFER DEVICES REFER TO THE GOVERNING SPECIFICATIONS FOR "CONCRETE PAVEMENT" AND "REINFORCING STEEL."
2. DETAILS FOR PAVEMENT WIDTH AND THE CROWN CROSS-SLOPE SHALL BE SHOWN ELSEWHERE IN THE PLANS.
3. FOR THE CONCRETE TRANSITION SLAB, THE CONTRACTOR SHALL PROVIDE THE SAME AMOUNT OF THE REINFORCING STEELS AS THE ADJOINING CONCRETE PAVEMENT UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
4. WHEN USING TRANSITION SLAB FOR BRIDGE APPROACH SLAB, USE SECTION B-B OF BAS-C STANDARD FOR THE DETAILS OF EXPANSION JOINT.
5. MATCH THE LONGITUDINAL JOINTS OF THE CONCRETE TRANSITION SLAB WITH ADJOINING CONCRETE PAVEMENT. PROVIDE EQUIVALENT TIEBARS OR TRANSVERSE BARS AT THESE LONGITUDINAL JOINTS.
6. PAYMENT FOR "JUNCTION TERMINALS" IS SUBSIDIARY TO ITEM 0360, CONCRETE PAVEMENT.
7. SEE TABLE FOR APPROX. LOCATIONS.

Texas Department of Transportation
Design Division (Pavements)

JUNCTION TERMINALS FLEXIBLE PAVEMENT WITH CONCRETE PAVEMENT

JTFPCP - 04 (MOD)

©TxDOT APRIL 2003	DN: HC	CK: MCW	DW: HC	CK: RR	MOD NO.: R0000
MODIFICATIONS	STATE DISTRICT	FEDERAL REGION	FEDERAL AID PROJECT		HIGHWAY
09/23/2004 1:1 SLOPES AT END OF SLAB; 1" WIDE JOINT FOR JCP	SAT	6	STP 1502 (610) MM		IH10
10/27/04 USE FOR BRIDGE APPROACH SLAB	COUNTY		CONTROL	SECTION	JOB / SHEET
	KENDALL		0072	06	072 / 255

DATE: 6/30/2015 TIME: 12:17:14 PM
FILE: TxDOT_South_Regional_Support_Center\IH-10_Scenic_Loop_WA_3\6.0_CAD_BIM\6.2_Work_In_Progress\6.2.2_Contract_Files\Steel_Files\Standards\Roadway\JTFPCPoct04.dgn
ACC: /usc/d481303
FILE: JCPFPSEPT04.DGN
LEVELS DISPLAYED

APPENDIX J: POTENTIAL VERTICAL RISE

POTENTIAL VERTICAL RISE (PVR)
TEX-124-E

Refresh Workbook

File Version: 03/09/15 10:25:48

SAMPLE ID:	B-1	SAMPLED DATE:	
TEST NUMBER:		LETTING DATE:	
SAMPLE STATUS:		CONTROLLING CSJ:	0016-08-034
COUNTY:	Bexar	SPEC YEAR:	
SAMPLED BY:		SPEC ITEM:	
SAMPLE LOCATION:		SPECIAL PROVISION:	
MATERIAL CODE:		GRADE:	
MATERIAL NAME:			
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	

COURSE\LIFT:		STATION:		DIST. FROM CL:	

Boring Number:	B-1	Ground Elevation (z):		Longitude (x):		Latitude (y):	

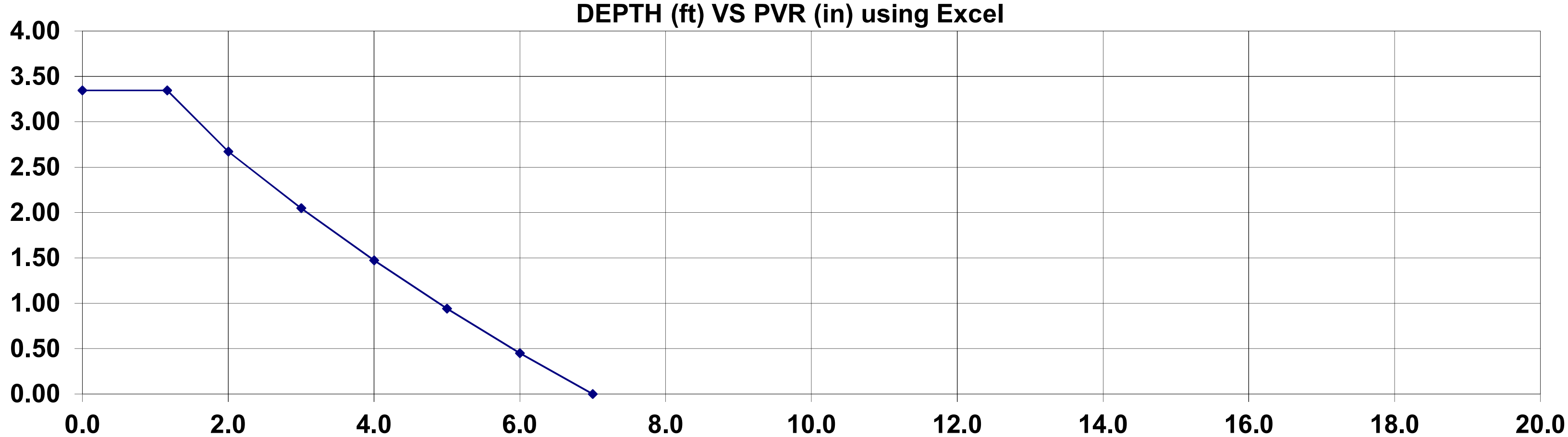
PVR Data BH

Depth to Bottom of Layer [ft]	Average Load [psi]	Liquid Limit (LL)	Dry 0.2LL+9	Wet 0.47LL+2	Percent Moisture	Dry Avg Wet	Percent -No.40	Plasticity Index (PI)	Percent Volume Swell	Percent Free Swell	PVR [in] Top of Layer	PVR [in] Bottom of Layer	Differential Swell [in]	Modified -No.40 Factor	Modified Density Factor	PVR in Layers [in]	Total PVR [in]
0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**3.35**
1.2	0.6	25	14.0	13.8	4.0	Dry	40.0	8	0.9	3.5	**0.00**	**0.00**	0.00	0.40	1.00	0.00	**3.35**
2.0	1.6	92	27.4	45.2	28.0	Dry	80.0	68	18.2	22.0	**0.00**	**0.84**	0.84	0.80	1.00	0.67	**2.67**
3.0	2.5	92	27.4	45.2	28.0	Dry	80.0	68	18.2	22.0	**0.84**	**1.62**	0.78	0.80	1.00	0.62	**2.05**
4.0	3.5	92	27.4	45.2	30.0	Dry	80.0	68	18.2	22.0	**1.62**	**2.34**	0.72	0.80	1.00	0.58	**1.47**
5.0	4.5	92	27.4	45.2	30.0	Dry	80.0	68	18.2	22.0	**2.34**	**3.01**	0.66	0.80	1.00	0.53	**0.94**
6.0	5.5	92	27.4	45.2	30.0	Dry	80.0	68	18.2	22.0	**3.01**	**3.62**	0.61	0.80	1.00	0.49	**0.45**
7.0	6.5	92	27.4	45.2	30.0	Dry	80.0	68	18.2	22.0	**3.62**	**4.18**	0.56	0.80	1.00	0.45	**0.00**
	3.5		9.0	2.0		Dry			0.0	0.0	**4.18**	**4.18**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**4.18**	**4.18**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**4.18**	**4.18**	0.00	0.00	1.00	0.00	**0.00**

Fields are chart inputs | Fields are final answers per layer | Final Total PVR for the borehole

Note: PVR calculations are based on future pavement grade being the same as present grade. Bold numbers are interpolated and extrapolated values.

DEPTH (ft) VS PVR (in) using Excel



Remarks:

Test Method:	Tested By:	Tested Date:
TX124		

Test Stamp Code:	Omit Test:	Completed Date:	Reviewed By:

Locked By:	TxDOT:	District:	Area:

Authorized By:	Authorized Date:

POTENTIAL VERTICAL RISE (PVR)
TEX-124-E

Refresh Workbook

File Version: 03/09/15 10:25:48

SAMPLE ID:	B-2	SAMPLED DATE:	
TEST NUMBER:		LETTING DATE:	
SAMPLE STATUS:		CONTROLLING CSJ:	0016-08-034
COUNTY:	Bexar	SPEC YEAR:	
SAMPLED BY:		SPEC ITEM:	
SAMPLE LOCATION:		SPECIAL PROVISION:	
MATERIAL CODE:		GRADE:	
MATERIAL NAME:			
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	

COURSE\LIFT:		STATION:		DIST. FROM CL:	

Boring Number:	B-2	Ground Elevation (z):		Longitude (x):		Latitude (y):	

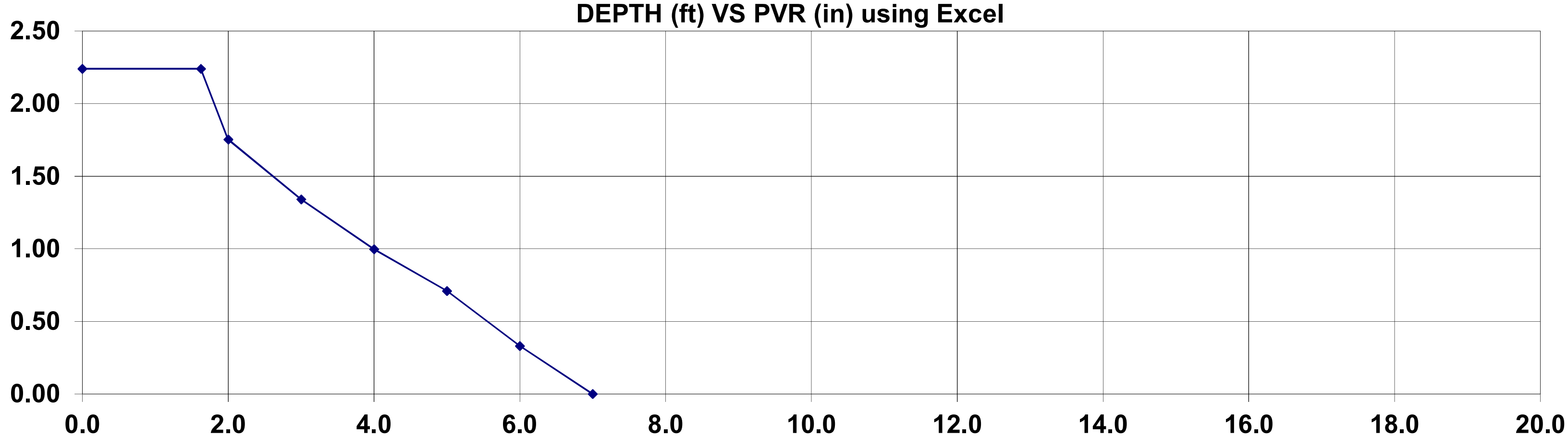
PVR Data BH

Depth to Bottom of Layer [ft]	Average Load [psi]	Liquid Limit (LL)	Dry 0.2LL+9	Wet 0.47LL+2	Percent Moisture	Dry Avg Wet	Percent -No.40	Plasticity Index (PI)	Percent Volume Swell	Percent Free Swell	PVR [in] Top of Layer	PVR [in] Bottom of Layer	Differential Swell [in]	Modified -No.40 Factor	Modified Density Factor	PVR in Layers [in]	Total PVR [in]
0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2.24**
1.6	0.8	25	14.0	13.8	4.0	Dry	40.0	8	0.9	3.5	**0.00**	**0.00**	0.00	0.40	1.00	0.00	**2.24**
2.0	1.8	48	18.6	24.6	16.0	Dry	99.0	32	8.7	11.9	**0.00**	**0.49**	0.49	0.99	1.00	0.49	**1.75**
3.0	2.5	48	18.6	24.6	16.0	Dry	99.0	32	8.7	11.9	**0.49**	**0.91**	0.42	0.99	1.00	0.41	**1.34**
4.0	3.5	48	18.6	24.6	16.0	Dry	99.0	32	8.7	11.9	**0.91**	**1.26**	0.35	0.99	1.00	0.34	**1.00**
5.0	4.5	48	18.6	24.6	16.0	Dry	99.0	32	8.7	11.9	**1.26**	**1.55**	0.29	0.99	1.00	0.29	**0.71**
6.0	5.5	64	21.8	32.1	20.0	Dry	99.0	44	12.6	16.0	**2.11**	**2.50**	0.38	0.99	1.00	0.38	**0.33**
7.0	6.5	64	21.8	32.1	20.0	Dry	99.0	44	12.6	16.0	**2.50**	**2.83**	0.33	0.99	1.00	0.33	**0.00**
	3.5		9.0	2.0		Dry			0.0	0.0	**2.83**	**2.83**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**2.83**	**2.83**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**2.83**	**2.83**	0.00	0.00	1.00	0.00	**0.00**

Fields are chart inputs | Fields are final answers per layer | Final Total PVR for the borehole

Note: PVR calculations are based on future pavement grade being the same as present grade. Bold numbers are interpolated and extrapolated values.

DEPTH (ft) VS PVR (in) using Excel



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Test Method:	Tested By:	Tested Date:
TX124		

Test Stamp Code:	Omit Test:	Completed Date:	Reviewed By:

Locked By:	TxDOT:	District:	Area:

Authorized By:	Authorized Date:

POTENTIAL VERTICAL RISE (PVR)
TEX-124-E

Refresh Workbook

File Version: 03/09/15 10:25:48

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TEST NUMBER:		LETTING DATE:	
SAMPLE STATUS:		CONTROLLING CSJ:	0016-08-034
COUNTY:	Bexar	SPEC YEAR:	
SAMPLED BY:		SPEC ITEM:	
SAMPLE LOCATION:		SPECIAL PROVISION:	
MATERIAL CODE:		GRADE:	
MATERIAL NAME:			
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	

COURSE\LIFT:		STATION:		DIST. FROM CL:	

Boring Number:	B-3	Ground Elevation (z):		Longitude (x):		Latitude (y):	

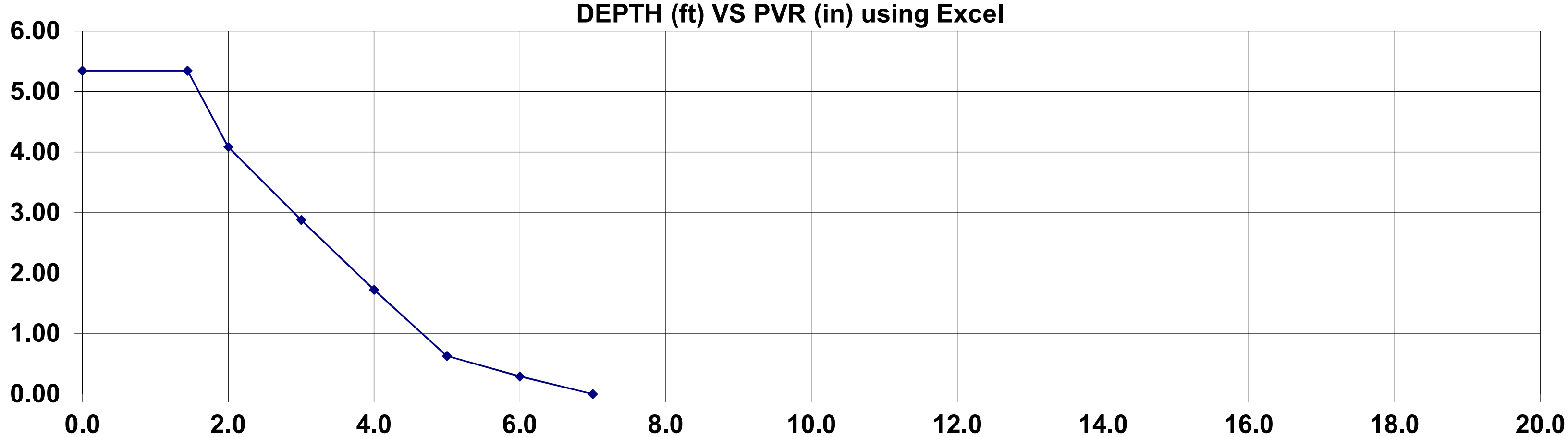
PVR Data BH

Depth to Bottom of Layer [ft]	Average Load [psi]	Liquid Limit (LL)	Dry 0.2LL+9	Wet 0.47LL+2	Percent Moisture	Dry Avg Wet	Percent -No.40	Plasticity Index (PI)	Percent Volume Swell	Percent Free Swell	PVR [in] Top of Layer	PVR [in] Bottom of Layer	Differential Swell [in]	Modified -No.40 Factor	Modified Density Factor	PVR in Layers [in]	Total PVR [in]
0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.35
1.4	0.7	25	14.0	13.8	4.0	Dry	40.0	8	0.9	3.5	**0.00**	**0.00**	0.00	0.40	1.00	0.00	5.35
2.0	1.7	129	34.8	62.6	25.0	Dry	99.0	97	30.6	35.4	**0.00**	**1.28**	1.28	0.99	1.00	1.26	4.08
3.0	2.5	129	34.8	62.6	25.0	Dry	99.0	97	30.6	35.4	**1.28**	**2.50**	1.22	0.99	1.00	1.21	2.88
4.0	3.5	129	34.8	62.6	22.0	Dry	99.0	97	30.6	35.4	**2.50**	**3.66**	1.16	0.99	1.00	1.15	1.72
5.0	4.5	129	34.8	62.6	28.0	Dry	99.0	97	30.6	35.4	**3.66**	**4.77**	1.11	0.99	1.00	1.10	0.63
6.0	5.5	77	24.4	38.2	28.0	Avg	99.0	50	11.8	15.2	**1.95**	**2.29**	0.34	0.99	1.00	0.34	0.29
7.0	6.5	77	24.4	38.2	30.0	Avg	99.0	50	11.8	15.2	**2.29**	**2.59**	0.29	0.99	1.00	0.29	0.00
	3.5		9.0	2.0		Dry			0.0	0.0	**2.59**	**2.59**	0.00	0.00	1.00	0.00	0.00
	0.0		9.0	2.0		Dry			0.0	0.0	**2.59**	**2.59**	0.00	0.00	1.00	0.00	0.00
	0.0		9.0	2.0		Dry			0.0	0.0	**2.59**	**2.59**	0.00	0.00	1.00	0.00	0.00

Fields are chart inputs | Fields are final answers per layer | Final Total PVR for the borehole

Note: PVR calculations are based on future pavement grade being the same as present grade. Bold numbers are interpolated and extrapolated values.

DEPTH (ft) VS PVR (in) using Excel



Remarks:

Test Method:	Tested By:	Tested Date:
TX124		

Test Stamp Code:	Omit Test:	Completed Date:	Reviewed By:

Locked By:	TxDOT:	District:	Area:

Authorized By:	Authorized Date:

POTENTIAL VERTICAL RISE (PVR)
TEX-124-E

Refresh Workbook

File Version: 03/09/15 10:25:48

SAMPLE ID:	B-4	SAMPLED DATE:	
TEST NUMBER:		LETTING DATE:	
SAMPLE STATUS:		CONTROLLING CSJ:	0016-08-034
COUNTY:	Bexar	SPEC YEAR:	
SAMPLED BY:		SPEC ITEM:	
SAMPLE LOCATION:		SPECIAL PROVISION:	
MATERIAL CODE:		GRADE:	
MATERIAL NAME:			
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	

COURSE\LIFT:		STATION:		DIST. FROM CL:	

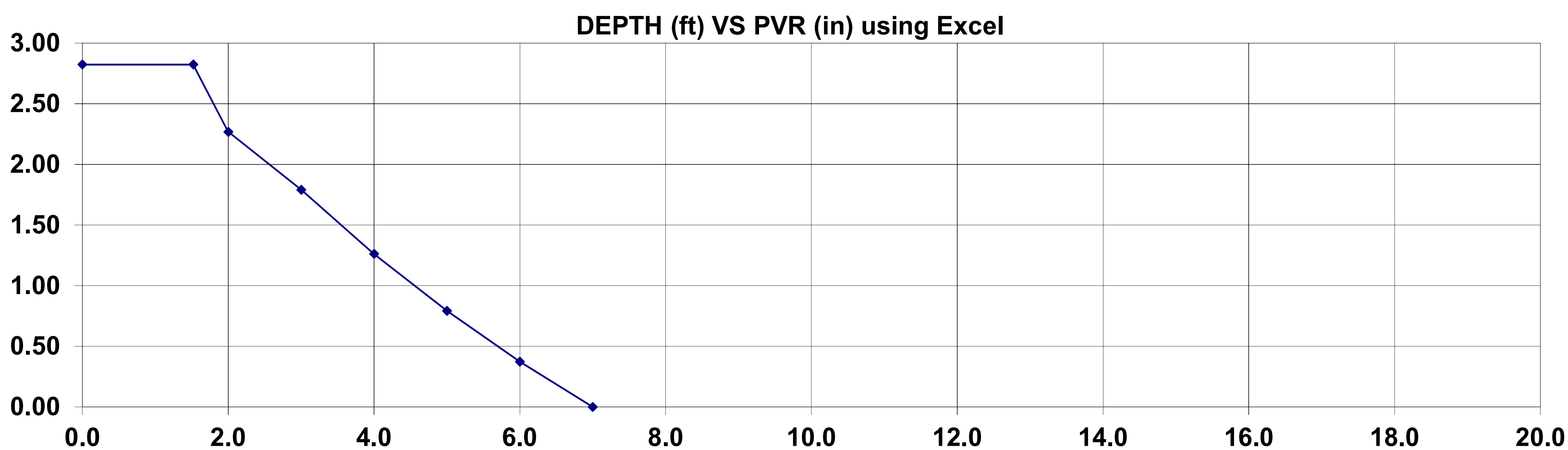
Boring Number:	B-4	Ground Elevation (z):		Longitude (x):		Latitude (y):	

PVR Data BH

Depth to Bottom of Layer [ft]	Average Load [psi]	Liquid Limit (LL)	Dry 0.2LL+9	Wet 0.47LL+2	Percent Moisture	Dry Avg Wet	Percent -No.40	Plasticity Index (PI)	Percent Volume Swell	Percent Free Swell	PVR [in] Top of Layer	PVR [in] Bottom of Layer	Differential Swell [in]	Modified -No.40 Factor	Modified Density Factor	PVR in Layers [in]	Total PVR [in]
0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2.82**
1.5	0.8	25	14.0	13.8	4.0	Dry	40.0	8	0.9	3.5	**0.00**	**0.00**	0.00	0.40	1.00	0.00	**2.82**
2.0	1.8	71	23.2	35.4	28.0	Avg	99.0	46	10.6	14.0	**0.00**	**0.56**	0.56	0.99	1.00	0.55	**2.27**
3.0	2.5	71	23.2	35.4	28.0	Avg	99.0	46	10.6	14.0	**0.56**	**1.04**	0.48	0.99	1.00	0.48	**1.79**
4.0	3.5	71	23.2	35.4	26.0	Dry	99.0	46	13.2	16.7	**1.27**	**1.80**	0.53	0.99	1.00	0.53	**1.26**
5.0	4.5	71	23.2	35.4	26.0	Dry	99.0	46	13.2	16.7	**1.80**	**2.28**	0.48	0.99	1.00	0.47	**0.79**
6.0	5.5	71	23.2	35.4	26.0	Dry	99.0	46	13.2	16.7	**2.28**	**2.70**	0.42	0.99	1.00	0.42	**0.37**
7.0	6.5	71	23.2	35.4	26.0	Dry	99.0	46	13.2	16.7	**2.70**	**3.07**	0.38	0.99	1.00	0.37	**0.00**
	3.5		9.0	2.0		Dry			0.0	0.0	**3.07**	**3.07**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**3.07**	**3.07**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**3.07**	**3.07**	0.00	0.00	1.00	0.00	**0.00**

Fields are chart inputs | Fields are final answers per layer | Final Total PVR for the borehole

Note: PVR calculations are based on future pavement grade being the same as present grade. Bold numbers are interpolated and extrapolated values.



Remarks:

Test Method:	Tested By:	Tested Date:
TX124		

Test Stamp Code:	Omit Test:	Completed Date:	Reviewed By:

Locked By:	TxDOT:	District:	Area:

Authorized By:	Authorized Date:

POTENTIAL VERTICAL RISE (PVR)
TEX-124-E

Refresh Workbook | File Version: 03/09/15 10:25:48

SAMPLE ID:	B-5	SAMPLED DATE:	
TEST NUMBER:		LETTING DATE:	
SAMPLE STATUS:		CONTROLLING CSJ:	0016-08-034
COUNTY:	Bexar	SPEC YEAR:	
SAMPLED BY:		SPEC ITEM:	
SAMPLE LOCATION:		SPECIAL PROVISION:	
MATERIAL CODE:		GRADE:	
MATERIAL NAME:			
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	

COURSE\LIFT:		STATION:		DIST. FROM CL:	

Boring Number:	B-5	Ground Elevation (z):		Longitude (x):		Latitude (y):	

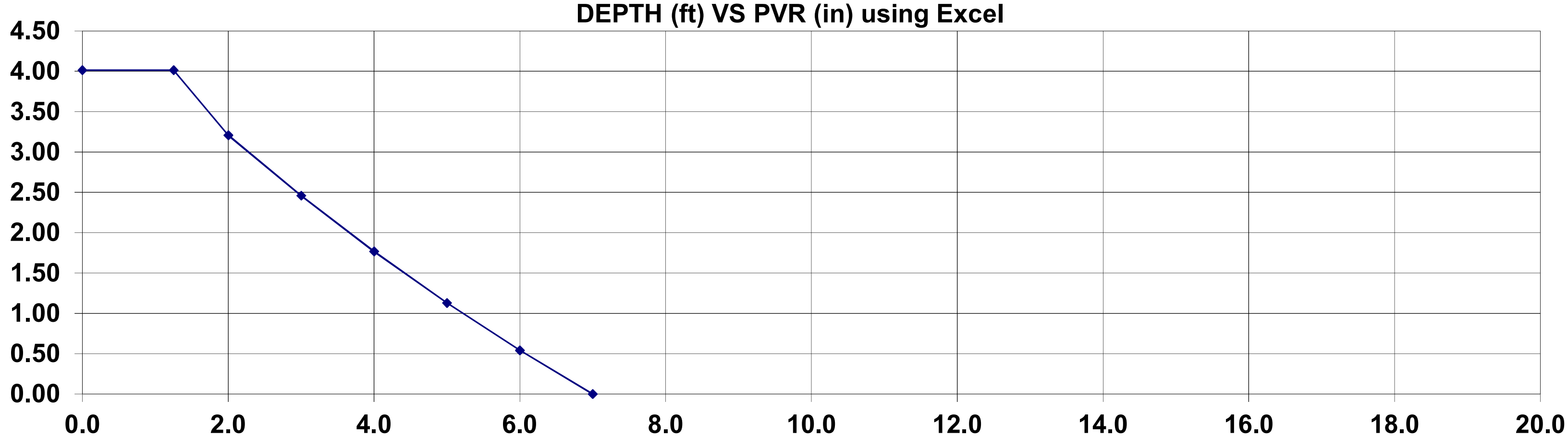
PVR Data BH

Depth to Bottom of Layer [ft]	Average Load [psi]	Liquid Limit (LL)	Dry 0.2LL+9	Wet 0.47LL+2	Percent Moisture	Dry Avg Wet	Percent -No.40	Plasticity Index (PI)	Percent Volume Swell	Percent Free Swell	PVR [in] Top of Layer	PVR [in] Bottom of Layer	Differential Swell [in]	Modified -No.40 Factor	Modified Density Factor	PVR in Layers [in]	Total PVR [in]
0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**4.01**
1.3	0.6	25	14.0	13.8	4.0	Dry	40.0	8	0.9	3.5	**0.00**	**0.00**	0.00	0.40	1.00	0.00	**4.01**
2.0	1.6	83	25.6	41.0	26.0	Dry	96.0	60	17.8	21.6	**0.00**	**0.84**	0.84	0.96	1.00	0.81	**3.21**
3.0	2.5	83	25.6	41.0	26.0	Dry	96.0	60	17.8	21.6	**0.84**	**1.62**	0.78	0.96	1.00	0.75	**2.46**
4.0	3.5	83	25.6	41.0	26.0	Dry	96.0	60	17.8	21.6	**1.62**	**2.34**	0.72	0.96	1.00	0.69	**1.77**
5.0	4.5	83	25.6	41.0	28.0	Dry	96.0	60	17.8	21.6	**2.34**	**3.01**	0.66	0.96	1.00	0.64	**1.13**
6.0	5.5	83	25.6	41.0	28.0	Dry	96.0	60	17.8	21.6	**3.01**	**3.62**	0.61	0.96	1.00	0.59	**0.54**
7.0	6.5	83	25.6	41.0	28.0	Dry	96.0	60	17.8	21.6	**3.62**	**4.18**	0.56	0.96	1.00	0.54	**0.00**
	3.5		9.0	2.0		Dry			0.0	0.0	**4.18**	**4.18**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**4.18**	**4.18**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**4.18**	**4.18**	0.00	0.00	1.00	0.00	**0.00**

Fields are chart inputs | Fields are final answers per layer | Final Total PVR for the borehole

Note: PVR calculations are based on future pavement grade being the same as present grade. Bold numbers are interpolated and extrapolated values.

DEPTH (ft) VS PVR (in) using Excel



Remarks:

Test Method:	Tested By:	Tested Date:
TX124		

Test Stamp Code:	Omit Test:	Completed Date:	Reviewed By:

Locked By:	TxDOT:	District:	Area:

Authorized By:	Authorized Date:

POTENTIAL VERTICAL RISE (PVR)
TEX-124-E

Refresh Workbook

File Version: 03/09/15 10:25:48

SAMPLE ID:	B-6	SAMPLED DATE:	
TEST NUMBER:		LETTING DATE:	
SAMPLE STATUS:		CONTROLLING CSJ:	0016-08-034
COUNTY:	Bexar	SPEC YEAR:	
SAMPLED BY:		SPEC ITEM:	
SAMPLE LOCATION:		SPECIAL PROVISION:	
MATERIAL CODE:		GRADE:	
MATERIAL NAME:			
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	

COURSE\LIFT:		STATION:		DIST. FROM CL:	

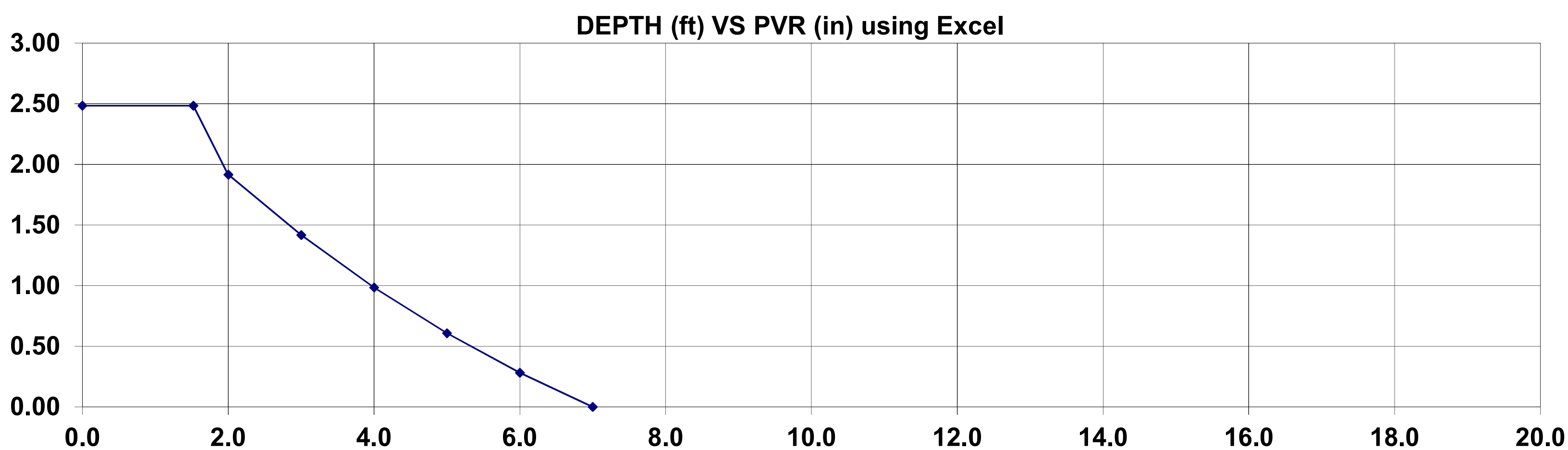
Boring Number:	B-6	Ground Elevation (z):		Longitude (x):		Latitude (y):	

PVR Data BH

Depth to Bottom of Layer [ft]	Average Load [psi]	Liquid Limit (LL)	Dry 0.2LL+9	Wet 0.47LL+2	Percent Moisture	Dry Avg Wet	Percent -No.40	Plasticity Index (PI)	Percent Volume Swell	Percent Free Swell	PVR [in] Top of Layer	PVR [in] Bottom of Layer	Differential Swell [in]	Modified -No.40 Factor	Modified Density Factor	PVR in Layers [in]	Total PVR [in]
0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2.48**
1.5	0.8	25	14.0	13.8	4.0	Dry	40.0	8	0.9	3.5	**0.00**	**0.00**	0.00	0.40	1.00	0.00	**2.48**
2.0	1.8	71	23.2	35.4	28.0	Avg	96.0	49	11.5	14.9	**0.00**	**0.59**	0.59	0.96	1.00	0.57	**1.91**
3.0	2.5	71	23.2	35.4	28.0	Avg	96.0	49	11.5	14.9	**0.59**	**1.11**	0.52	0.96	1.00	0.50	**1.42**
4.0	3.5	71	23.2	35.4	27.0	Avg	96.0	49	11.5	14.9	**1.11**	**1.56**	0.45	0.96	1.00	0.43	**0.98**
5.0	4.5	71	23.2	35.4	27.0	Avg	96.0	49	11.5	14.9	**1.56**	**1.95**	0.39	0.96	1.00	0.38	**0.61**
6.0	5.5	71	23.2	35.4	27.0	Avg	96.0	49	11.5	14.9	**1.95**	**2.29**	0.34	0.96	1.00	0.33	**0.28**
7.0	6.5	71	23.2	35.4	27.0	Avg	96.0	49	11.5	14.9	**2.29**	**2.59**	0.29	0.96	1.00	0.28	**0.00**
	3.5		9.0	2.0		Dry			0.0	0.0	**2.59**	**2.59**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**2.59**	**2.59**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**2.59**	**2.59**	0.00	0.00	1.00	0.00	**0.00**

Fields are chart inputs | Fields are final answers per layer | Final Total PVR for the borehole

Note: PVR calculations are based on future pavement grade being the same as present grade. Bold numbers are interpolated and extrapolated values.



Remarks:

Test Method: TX124
Tested By:
Tested Date:

Test Stamp Code:
Omit Test:
Completed Date:
Reviewed By:

Locked By:
TxDOT:
District:
Area:

Authorized By:
Authorized Date:

POTENTIAL VERTICAL RISE (PVR)
TEX-124-E

Refresh Workbook

File Version: 03/09/15 10:25:48

SAMPLE ID:	B-7	SAMPLED DATE:	
TEST NUMBER:		LETTING DATE:	
SAMPLE STATUS:		CONTROLLING CSJ:	0016-08-034
COUNTY:	Bexar	SPEC YEAR:	
SAMPLED BY:		SPEC ITEM:	
SAMPLE LOCATION:		SPECIAL PROVISION:	
MATERIAL CODE:		GRADE:	
MATERIAL NAME:			
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	

COURSE\LIFT:		STATION:		DIST. FROM CL:	

Boring Number:	B-7	Ground Elevation (z):		Longitude (x):		Latitude (y):	

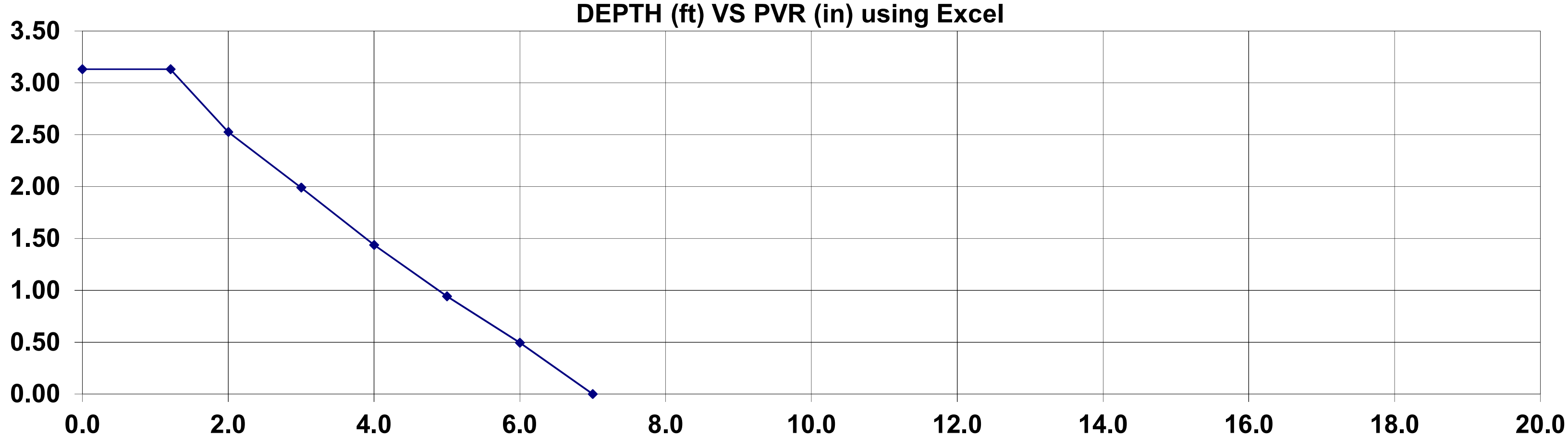
PVR Data BH

Depth to Bottom of Layer [ft]	Average Load [psi]	Liquid Limit (LL)	Dry 0.2LL+9	Wet 0.47LL+2	Percent Moisture	Dry Avg Wet	Percent -No.40	Plasticity Index (PI)	Percent Volume Swell	Percent Free Swell	PVR [in] Top of Layer	PVR [in] Bottom of Layer	Differential Swell [in]	Modified -No.40 Factor	Modified Density Factor	PVR in Layers [in]	Total PVR [in]
0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**3.13**
1.2	0.6	25	14.0	13.8	4.0	Dry	40.0	8	0.9	3.5	**0.00**	**0.00**	0.00	0.40	1.00	0.00	**3.13**
2.0	1.6	72	23.4	35.8	29.0	Avg	96.0	51	12.1	15.5	**0.00**	**0.63**	0.63	0.96	1.00	0.60	**2.53**
3.0	2.5	72	23.4	35.8	29.0	Avg	96.0	51	12.1	15.5	**0.63**	**1.19**	0.56	0.96	1.00	0.54	**1.99**
4.0	3.5	72	23.4	35.8	23.0	Dry	96.0	51	14.8	18.5	**1.34**	**1.92**	0.57	0.96	1.00	0.55	**1.44**
5.0	4.5	72	23.4	35.8	23.0	Dry	96.0	51	14.8	18.5	**1.92**	**2.44**	0.52	0.96	1.00	0.50	**0.94**
6.0	5.5	72	23.4	35.8	23.0	Dry	96.0	51	14.8	18.5	**2.44**	**2.90**	0.47	0.96	1.00	0.45	**0.50**
7.0	6.5	72	23.4	35.8	21.0	Dry	99.0	55	16.1	19.9	**3.31**	**3.81**	0.50	0.99	1.00	0.50	**0.00**
	3.5		9.0	2.0		Dry			0.0	0.0	**3.81**	**3.81**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**3.81**	**3.81**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**3.81**	**3.81**	0.00	0.00	1.00	0.00	**0.00**

Fields are chart inputs | Fields are final answers per layer | Final Total PVR for the borehole

Note: PVR calculations are based on future pavement grade being the same as present grade. Bold numbers are interpolated and extrapolated values.

DEPTH (ft) VS PVR (in) using Excel



Remarks:

Test Method:	Tested By:	Tested Date:
TX124		

Test Stamp Code:	Omit Test:	Completed Date:	Reviewed By:

Locked By:	TxDOT:	District:	Area:

Authorized By:	Authorized Date:

POTENTIAL VERTICAL RISE (PVR)
TEX-124-E

Refresh Workbook

File Version: 03/09/15 10:25:48

SAMPLE ID:	B-8	SAMPLED DATE:	
TEST NUMBER:		LETTING DATE:	
SAMPLE STATUS:		CONTROLLING CSJ:	0016-08-034
COUNTY:	Bexar	SPEC YEAR:	
SAMPLED BY:		SPEC ITEM:	
SAMPLE LOCATION:		SPECIAL PROVISION:	
MATERIAL CODE:		GRADE:	
MATERIAL NAME:			
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	

COURSE\LIFT:		STATION:		DIST. FROM CL:	

Boring Number:	B-8	Ground Elevation (z):		Longitude (x):		Latitude (y):	

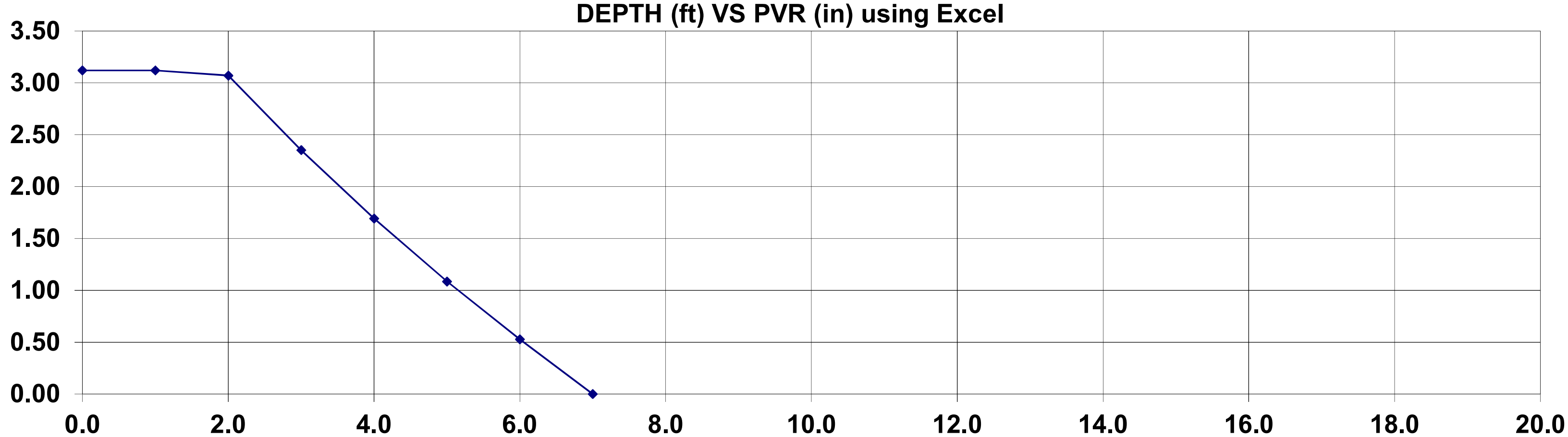
PVR Data BH

Depth to Bottom of Layer [ft]	Average Load [psi]	Liquid Limit (LL)	Dry 0.2LL+9	Wet 0.47LL+2	Percent Moisture	Dry Avg Wet	Percent -No.40	Plasticity Index (PI)	Percent Volume Swell	Percent Free Swell	PVR [in] Top of Layer	PVR [in] Bottom of Layer	Differential Swell [in]	Modified -No.40 Factor	Modified Density Factor	PVR in Layers [in]	Total PVR [in]
0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**3.12**
1.0	0.5	25	14.0	13.8	4.0	Dry	40.0	8	0.9	3.5	**0.00**	**0.00**	0.00	0.40	1.00	0.00	**3.12**
2.0	1.5	25	14.0	13.8	4.0	Dry	40.0	8	0.9	3.5	**0.00**	**0.12**	0.12	0.40	1.00	0.05	**3.07**
3.0	2.5	81	25.2	40.1	28.0	Dry	96.0	59	17.4	21.2	**0.81**	**1.56**	0.75	0.96	1.00	0.72	**2.35**
4.0	3.5	81	25.2	40.1	28.0	Dry	96.0	59	17.4	21.2	**1.56**	**2.25**	0.69	0.96	1.00	0.66	**1.69**
5.0	4.5	81	25.2	40.1	28.0	Dry	96.0	59	17.4	21.2	**2.25**	**2.88**	0.63	0.96	1.00	0.61	**1.08**
6.0	5.5	81	25.2	40.1	28.0	Dry	96.0	59	17.4	21.2	**2.88**	**3.46**	0.58	0.96	1.00	0.56	**0.53**
7.0	6.5	81	25.2	40.1	28.0	Dry	99.0	59	17.4	21.2	**3.46**	**3.99**	0.53	0.99	1.00	0.53	**0.00**
	3.5		9.0	2.0		Dry			0.0	0.0	**3.99**	**3.99**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**3.99**	**3.99**	0.00	0.00	1.00	0.00	**0.00**
	0.0		9.0	2.0		Dry			0.0	0.0	**3.99**	**3.99**	0.00	0.00	1.00	0.00	**0.00**

Fields are chart inputs | Fields are final answers per layer | Final Total PVR for the borehole

Note: PVR calculations are based on future pavement grade being the same as present grade. Bold numbers are interpolated and extrapolated values.

DEPTH (ft) VS PVR (in) using Excel



Remarks:

Test Method:	Tested By:	Tested Date:
TX124		

Test Stamp Code:	Omit Test:	Completed Date:	Reviewed By:

Locked By:	TxDOT:	District:	Area:

Authorized By:	Authorized Date:

APPENDIX K: SURFACE AGGREGATE SELECTION FORM

Surface Aggregate Selection Form

Form 2088
(Rev. 05/12)

CSJ: 0016 - 08 - 034 **Date:** 11/20/18

Highway: LP 368 (Broadway Corridor)

Limits: from Hildebrand Ave to Roy Smith Street

County: Bexar

District: SAT

Designer's Name: Spencer A. Higgs, P.E.

Selection Guidelines for Bituminous Surface Aggregate Classification (SAC)

DESIGNER'S RATING

Demand for Friction	Low (1)	Moderate (2)	High (3)	1	2	3
Rain Fall (inches/year)	≤20	>20 ≤40	>40	☐	☒	☐
Traffic (ADT)	≤5000	>5000 ≤15,000	>15,000	☐	☐	☒
Speed (mph)	≤35	>35 ≤60	>60	☐	☒	☐
Trucks (%)	≤8	>8 ≤15	>15	☒	☐	☐
Vertical Grade (%)	≤2	>2 ≤5	>5	☒	☐	☐
Horizontal Curve (º)	≤3	>3 ≤7	>7	☐	☒	☐
Driveways (per mile)	≤5	>5 ≤10	>10	☐	☐	☒
Intersecting Roadways (ADT)	≤500	>500 ≤750	>750	☐	☐	☒
Wet Surface Crashes (%)	≤5	>5 <15	≥15	☐	☒	☐
Summary of Total Frictional Demand					19	
***Available Friction**	**Low (2)**	**Moderate (5)**	**High (8)**	**2**	**5**	**8**
Cross Slope (%)	<2	2 - 3	3 - 4	☐	☒	☐
Surface Design Life (years)	>10	>5 ≤10	≤5	☐	☒	☐
Macro Texture of proposed surface	Fine (Such as: HMAC Type 'D' and 'F')	Medium (Such as: HMAC Type 'C', CMHB, SuperPave, Microsurface)	Coarse (Such as: PFC, SMA, Seal Coat, NovaChip)	☐	☒	☐
Aggregate MicroTexture	SAC C	SAC B	SAC A	☐	☒	☐
Summary of Total Friction Available					20	
Does total available friction equal or exceed total frictional demand?				☒ Yes	☐ No	

*Parameters set by the designer that affect pavement friction.
Total friction available should always exceed total frictional demand.

Comments:
Parameters Need to be Approved by TxDOT

APPENDIX L: ASFE INFORMATION – GEOTECHNICAL REPORT

Important Information about Your

Geotechnical Engineering Report

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

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

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 your ASFE-member geotechnical engineer for more information.

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APPENDIX M: PROJECT QUALITY ASSURANCE

A Message to Owners

Construction materials engineering and testing (CoMET) consultants perform quality-assurance (QA) services to evaluate the degree to which constructors are achieving the specified conditions they're contractually obligated to achieve. Done right, QA can save you time and money; prevent unanticipated-conditions claims, change orders, and disputes; and reduce short-term and long-term risks, especially by detecting molehills before they grow into mountains.

Done right, QA can save you time and money; prevent claims and disputes; and reduce risks. Many owners don't do QA right because they follow bad advice.

Many owners don't do QA right because they follow bad advice; e.g., "CoMET consultants are all the same. They all have accredited facilities and certified personnel. Go with the low bidder." But there's no such thing as a standard QA scope of service, meaning that – to bid low – each interested firms *must* propose the cheapest QA service it can live with, jeopardizing service quality and aggravating risk for the entire project team. Besides, the advice is based on misinformation.

Fact: ***Most CoMET firms are not accredited***, and the quality of those that are varies significantly. Accreditation – which is important – nonetheless means that a facility met an accrediting body's minimum criteria. Some firms practice at a much higher level; others just barely scrape by. And what an accrediting body typically evaluates – management, staff, facilities, and equipment – can change substantially before the next review, two, three, or more years from now.

Most CoMET firms are not accredited. It's dangerous to assume CoMET personnel are certified.

Fact: ***It's dangerous to assume CoMET personnel are certified.*** Many have no credentials at all; some are certified by organizations of questionable merit, while others have a valid certification, but *not* for the services they're assigned.

Some CoMET firms – the "low-cost providers" – *want* you to believe that price is the only difference between QA providers. It's not, of course. Firms that sell low price typically lack the facilities, equipment, personnel, and insurance quality-oriented firms invest in to achieve the reliability concerned owners need to achieve quality in quality assurance.

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Firms that sell low price typically lack the facilities, equipment, personnel, and insurance quality-oriented firms invest in to achieve the reliability concerned owners need to achieve quality in quality assurance.

To derive maximum value from your investment in QA, require the CoMET firm's project manager to serve actively on the project team from beginning to end, a level of service that's relatively inexpensive and can pay huge dividends. During the project's planning and design stages, experienced CoMET professionals can help the design team develop uniform technical specifications and establish appropriate observation, testing, and instrumentation procedures and protocols. They can also analyze plans and specs much as constructors do, looking for the little errors, omissions, conflicts, and ambiguities that often become the basis for big extras and big claims. They can provide guidance about operations that need closer review than others, because of their criticality or potential for error or abuse. They can also relate their experience with the various constructors that have expressed interest in your project.

To derive maximum value, require the project manager to serve actively on the project team from beginning to end.

CoMET consultants' construction-phase QA services focus on two distinct issues: those that relate to geotechnical engineering and those that relate to the other elements of construction.

The geotechnical issues are critically important because they are essential to the "observational method" geotechnical engineers use to significantly reduce the amount of sampling they'd otherwise require. They apply the observational method by developing a sampling plan for a project, and then assigning field representatives to ensure samples are properly obtained, packaged, and transported. The engineers review the samples and, typically, have them tested in their own laboratories. They use the information they derive to characterize the site's subsurface and develop *preliminary* recommendations for the structure's foundations and for the specifications of various "geo" elements, like excavations, site grading, foundation-bearing grades, and roadway and parking-lot preparation and surfacing.

Geotechnical engineers cannot finalize their recommendations until they or their field representatives are on site to observe what's excavated to verify that the subsurface conditions the engineers predicted are those that actually exist.

When unanticipated conditions are observed, recommendations and/or specifications should be modified.

Responding to client requests, many geotechnical-engineering firms have expanded their field-services mix, so they're able to perform overall construction QA, encompassing – in addition to geotechnical issues – reinforced concrete, structural steel, welds, fireproofing, and so on. Unfortunately, that's caused some confusion. Believing that all CoMET consultants are alike, some owners take bids for the overall CoMET package, including the geotechnical field observation. *Entrusting geotechnical field observation to someone other than the geotechnical engineer of record (GER) creates a significant risk.*

Geotechnical engineers cannot finalize their recommendations until they are on site to verify that the subsurface conditions they predicted are those that actually exist. Entrusting geotechnical field observation to someone other than the geotechnical engineer of record (GER) creates a significant risk.

GERs have developed a variety of protocols to optimize the quality of their field-observation procedures. Quality-focused GERs meet with their field representatives before they leave for a project site, to brief them on what to look for and where, when, and how to look. (***No one can duplicate this briefing***, because no one else knows as much about a project's geotechnical issues.) And once they arrive at a project site, the field representatives know to maintain timely, effective communication with the GER, because that's what the GER has trained them to do. By contrast, it's extremely rare for a different firm's field personnel to contact the GER, even when they're concerned or confused about what they observe, because they regard the GER's firm as "the competition."

Divorcing the GER from geotechnical field operations is almost always penny-wise and pound-foolish. Still, because owners are given bad advice, it's commonly done, helping to explain why ***"geo" issues are the number-one source of construction-industry claims and disputes.***

Divorcing the GER from geotechnical field operations is almost always penny-wise and pound-foolish, helping to explain why "geo" issues are the number-one source of construction-industry claims and disputes.

To derive the biggest bang for the QA buck, identify three or even four quality-focused CoMET consultants. (If you don't know any, use the "Find a Geoprofessional" service available free at www.asfe.org.) Ask about the firms' ongoing and recent projects and the clients and client representatives involved; *insist upon receiving verification of all claimed accreditations, certifications, licenses, and insurance coverages.*

Insist upon receiving verification of all claimed accreditations, certifications, licenses, and insurance coverages.

Once you identify the two or three most qualified firms, meet with their representatives, preferably at their own facility, so you can inspect their laboratory, speak with management and technical staff, and form an opinion about the firm's capabilities and attitude.

Insist that each firm's designated project manager participate in the meeting. You will benefit when that individual is a seasoned QA professional familiar with construction's rough-and-tumble. Ask about others the firm will assign, too. There's no substitute for experienced personnel who are familiar with the codes and standards involved and know how to:

- read and interpret plans and specifications;
- perform the necessary observation, inspection, and testing;
- document their observations and findings;
- interact with constructors' personnel; and
- respond to the unexpected.

Important: Many of the services CoMET QA field representatives perform – like observing operations and outcomes – require the good judgment afforded by extensive training and experience, especially in situations where standard operating procedures do not apply. You need to know who will be exercising that judgment: a 15-year "veteran" or a rookie?

Many of the services CoMET QA field representatives perform require good judgment.

Also consider the tools CoMET personnel use. Some firms are passionate about proper calibration; others, less so. Passion is a good thing! Ask to see the firm's calibration records. If the firm doesn't have any, or if they are not current, be cautious. *You cannot trust test results derived using equipment that may be out of calibration.* Also ask a firm's representatives about their reporting practices, including report distribution, how they handle notifications of nonconformance, and how they resolve complaints.

Scope flexibility is needed to deal promptly with the unanticipated.

For financing purposes, some owners require the constructor to pay for CoMET services. ***Consider an alternative approach*** so you don't convert the constructor into the CoMET consultant's client. If it's essential for you to fund QA via the constructor, have the CoMET fee included as an allowance in the bid documents. This arrangement ensures that you remain the CoMET consultant's client, and it prevents the CoMET fee from becoming part of the constructor's bid-price competition. (Note that the International Building Code (IBC) *requires the owner to pay* for Special Inspection (SI) services commonly performed by the CoMET consultant as a service separate from QA, to help ensure the SI services' integrity. Because failure to comply could result in denial of an occupancy or use permit, having a contractual agreement that conforms to the IBC mandate is essential.)

If it's essential for you to fund QA via the constructor, have the CoMET fee included as an allowance in the bid documents. Note, too, that the International Building Code (IBC) requires the owner to pay for Special Inspection (SI) services.

CoMET consultants can usually quote their fees as unit fees, unit fees with estimated total (invoiced on a unit-fee basis), or lump-sum (invoiced on a percent-completion basis referenced to a schedule of values). No matter which method is used, estimated quantities need to be realistic. Some CoMET firms lower their total-fee estimates by using quantities they know are too low and then request change orders long before QA is complete.

Once you and the CoMET consultant settle on the scope of service and fee, enter into a written contract. Established CoMET firms have their own contracts; most owners sign them. Some owners prefer to use different contracts, but that can be a mistake when the contract was prepared for construction services. *Professional services are different.* Wholly avoidable problems occur when a contract includes provisions that don't apply to the services involved and fail to include those that do.

Some owners create wholly avoidable problems by using a contract prepared for construction services.

This final note: CoMET consultants perform QA for owners, not constructors. While constructors are commonly allowed to review QA reports as a *courtesy*, you need to make it clear that constructors do *not* have a legal right to rely on those reports; i.e., if constructors want to forgo their own observation and testing and rely on results derived from a scope created to meet *only* the needs of the owner, they *must do so at their own risk*. In all too many cases where owners have not made that clear, some constructors have alleged that they did have a legal right to rely on QA reports and, as a result, the CoMET consultant – not they – are responsible for their failure to deliver what they contractually promised to provide. The outcome can be delays and disputes that entangle you and all other principal project participants. Avoid that. Rely on a CoMET firm that possesses the resources and attitude needed to manage this and other risks as an element of a quality-focused service. Involve the firm early. Keep it engaged. And listen to what the CoMET consultant says. A good CoMET consultant can provide great value.

For more information, speak with your ASFE-Member CoMET consultant or contact ASFE directly.

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