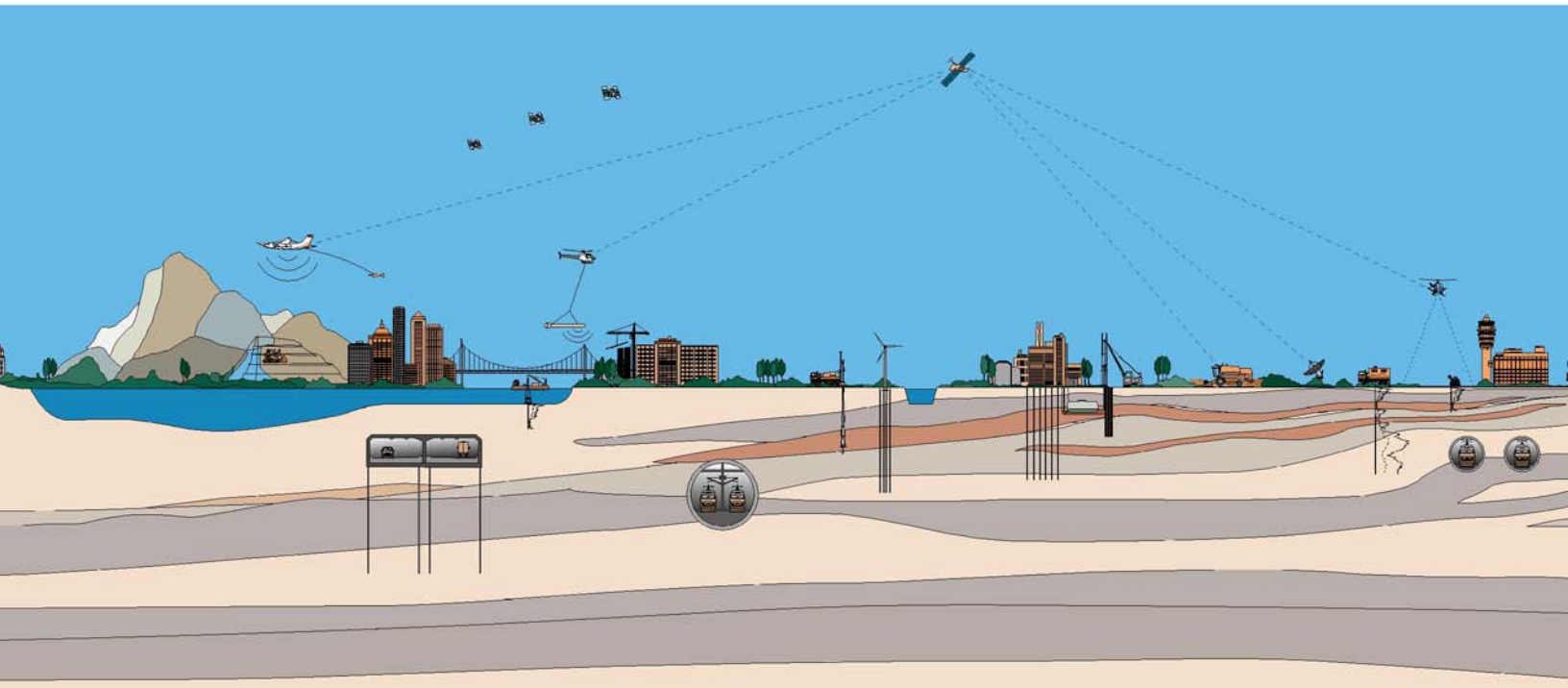
FUGRO CONSULTANTS, INC.

PAVEMENT THICKNESS DESIGN
GOFORTH ROAD REALIGNMENT
HAYS COUNTY, TEXAS

HAYS COUNTY

AUSTIN, TEXAS



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Report No. 04.30141063
October 14, 2014

Attention: C/o Ms. Jessica Rodriguez, P.E.

Geotechnical Investigation and Pavement Thickness Design
Goforth Road Realignment
Hays County, Texas

Submitted herewith is the report of the geotechnical investigation and pavement thickness design for the above referenced project. In brief, the report includes a plan of borings, boring logs with results of laboratory tests, and descriptions of subsurface conditions. Based on the findings, recommendations are set forth for the design and construction of pavements, and earthwork.

Fugro appreciates the opportunity to provide these geotechnical engineering services to Freese and Nichols, Inc. We look forward to our continued association.

Sincerely,

FUGRO CONSULTANTS, INC.
TBPE FIRM REGISTRATION NO. 299

Deepa Modi, E.I.T.
Project Engineer

Johnny F. Flores, P.E.
Branch Manager

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GEOTECHNICAL INVESTIGATION AND PAVEMENT THICKNESS DESIGN
GOFORTH ROAD REALIGNMENT
HAYS COUNTY, TEXAS

Report to:

HAYS COUNTY
San Marcos, Texas

Submitted by:

FUGRO CONSULTANTS, INC.
October 2014

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INTRODUCTION

On September 22, 2014, Fugro Consultants, Inc. (Fugro) initiated a geotechnical investigation for the proposed realignment of the existing Goforth Road, generally located on the downstream side of the Soil Conservation Service Site 6 Reservoir of the Plum Creek Watershed in Kyle, Texas. The approximate site location is shown on the Vicinity Map, Plate 1.

The proposed project will consist of approximately 800 linear feet realignment of the existing Goforth Road. Our understanding of the project is based on the information provided by Ms. Jessica Rodriguez of Freese and Nichols, Inc. We have received the partial site plan prepared by Freese and Nichols, Inc. for the Natural Resources Conservation Service (NRCS) showing the proposed Gorforth Road alignment, and have discussed the project with Ms. Rodriguez. It is understood that the project will consist of new pavement construction, and that an evaluation of the existing pavement condition is not included in this scope. A culvert and spillway will cross the new road section, however, recommendations for these structures are beyond the scope of this report.

AUTHORIZATION

The investigation was authorized with Purchase Order No. 2014-00001490 dated September 9, 2014. The Purchase Order referenced Fugro proposal dated August 29, 2014 which outlines the authorized scope of services for this project.

PURPOSE AND SCOPE

The purpose of the investigation was to determine subsurface conditions at the project site as a basis for 1) the formulation of pavement thickness design criteria with respect to cost and performance, 2) the selection of materials and compaction requirements for earth construction.

The scope of the investigation included 1) a field investigation for determining subsurface conditions and obtaining representative samples for classification and testing, 2) a laboratory testing program to aid in the classification of the substrata and to provide parameters for the selection of pavement thickness design criteria, and 3) engineering analyses and evaluations of the results of the field and laboratory data to aid in assessing the geology, geotechnical design recommendations, and construction issues.

Field sampling methods, laboratory testing procedures, soil classifications and strata descriptions were in general accordance with methods, procedures, and practices set forth by the American Society for Testing and Materials, latest edition, where applicable.

FIELD INVESTIGATION

The field investigation consisted of one (1) pavement borings (designated B-701) drilled to the 20-ft depth, and two (2) pavement borings (designated B-702 and B-703) drilled to a depth of 15-feet. The boring locations are shown on the Plan of Borings, Plate 2.

Detailed descriptions of the subsurface materials encountered at the boring locations are presented on the boring logs, Plates 3 through 5. Keys to Terms and Symbols used on the boring logs are set forth on Plates 6 and 7. Pocket penetration values in tons per square foot are shown on the boring logs at the corresponding sample depth. No groundwater was encountered during drilling work. Boring elevations shown on the boring logs were obtained from Google Earth Professional, 2014 and should be considered approximate. Latitude and longitude coordinates were obtained at the boring locations using a handheld GPS device accurate to about 3 horizontal meters. The latitude and longitude coordinates are shown on the bottom of the boring logs in notes.

The borings were drilled with a truck-mounted drill rig equipped with 1) continuous flight augers for advancing the holes dry and recovering disturbed samples (ASTM D 1452), 2) seamless push tubes for obtaining relatively undisturbed soil samples of cohesive strata (ASTM D 1587), 3) split-barrel samplers and drive weight assembly for obtaining representative samples and measuring the penetration resistance (N values) of non-cohesive soil strata (ASTM D 1586), and 4) double-tube wireline core barrels equipped with diamond bits for obtaining 2-inch diameter rock cores (ASTM D 2113)

LABORATORY TESTING

The laboratory testing program included identification and classification testing of all strata encountered in the subsurface. Soil classifications tests, including Atterberg limit determinations (ASTM D 4318) and partial grain size analyses (ASTM D 422) were conducted on representative soil samples. Unconfined compression strength tests (ASTM D 2850) were conducted on representative soil samples. The classification and unconfined compression tests included natural water content determinations (ASTM D 2216). The unconfined compression tests also included unit dry weight determinations. Laboratory testing also included free swell tests, pH lime

series, and soluble sulfate analytical testing. Brief descriptions of the physical and analytical laboratory tests are presented in the following sections.

Natural Water Content (ASTM D 2216)

Natural water content tests were performed on samples in which classification and/or strength tests were performed. Each sample was visually classified in the laboratory. Natural water contents are tabulated at the sample depth on the boring logs.

Atterberg Limits (ASTM D 4318)

Atterberg limit tests are classification tests that determine the liquid limit and plastic limit of the soil fraction finer than the No. 40 sieve. The Atterberg limits are approximate water contents at which the soil tested behaves in a specified manner. The liquid limit is determined by measuring, in a standard device, the water content and number of blows required to close a specific width groove cut in a remolded soil sample a specified length. The plastic limit is determined by measuring the water content when threads of soil 1/8-inch in diameter begin to crumble. The plasticity index, defined as the difference between the liquid and plastic limits, indicates the degree of plasticity or the magnitude of the water content over which the soil remains plastic. Liquid limit and plasticity index values are tabulated at sample depths on the boring logs.

Sieve Analysis (ASTM D 422)

Grain-size characteristics of the natural soils were investigated by the determination of the percent of soil passing the No. 4, 40 and 200 sieves. These tests were performed by washing or sieving material through the respective sieves. The results are tabulated at sample depth on the boring logs for the percent passing the Nos. 4 and 200 sieves.

Unconsolidated-Undrained Triaxial Compression Test (ASTM D 2850)

In the unconsolidated-undrained compression test of intact soil samples, a laterally supported cylindrical soil sample is loaded axially in compression to failure. First, a confining pressure of one (1) psi per foot of depth was applied to a sample of 2¾ inches diameter by 5½ inches in length. Next, an axial load was applied at a constant rate of deformation to produce failure in a test time between 2 and 15 minutes. The measured applied load at failure is recorded. The results of these unconsolidated-undrained compressive strength tests are tabulated on boring logs at sample depths.

Free Swell Tests

One-dimensional free swell tests (ASTM D 4546) were conducted on relatively undisturbed soil samples. The samples tested were approximately 2 inches in diameter and about 1.25 inches in height. In this test method, a soil sample is restrained laterally and axially drained while subjected to an applied vertical loading equal to the natural overburden pressure. Initially, the sample is inundated and load is applied to maintain zero change in height, referred to as the swell pressure. Once the swell pressure is determined, the load is removed, the sample is allowed to free swell, and the change in height is measured. The table below presents the results of the four free swell tests conducted on relatively undisturbed samples obtained from all the three borings.

Pressure Swell Test Results Summary				
Boring	**Depth (feet)**	**Soil Type**	**Overburden Pressure (psf)**	**% Swell**
B-701	3.0	Fat Clay	375.0	2.15
B-701	7.0	Fat Clay	875.0	2.38
B-702	5.0	Fat Clay	625.0	4.87
B-703	9.0	Fat Clay	621.1	0.01

Typical Classification of Soil Expansiveness based on Loaded Swell Test Results at In-Situ Overburden Stress[1]	
Swell Potential (%)	**Swell Classification**
<0.5	Low
0.5 – 1.5	Marginal
>1.5	High

[1] D. P. Coduto, "Foundation Design - Principles and Practices" Prentice Hall, 2nd Edition, 2001

Relation between Swelling Potential of Soils and Plasticity Index[2]	
Plasticity Index	**Swell Potential**
0-15	Low
10-35	Marginal
20-55	High
35 and above	Very High

Measured free swell ranged from 0.01 to 4.87 percent and plasticity index ranged from 21 and 50. The two tables presented above indicates the soil at the site has low to high swell potential based on the swell tests, and high to very high swelling potential based on the Plasticity Indices. Swell potential is a function of in-situ moisture content, plasticity indices, and clay mineralogy. Swell potential is further discussed in the "Potential Vertical Soil Movements" section of this report.

Eades and Grim pH (ASTM D 6276)

The Eades and Grim pH test (ASTM D 6276) is used to determine soil lime demand. This test identifies the lime content required to satisfy immediate lime-soil reactions and still provide significant residual calcium and a high system pH (about 12.4 at 25°C). This is necessary to provide proper conditions for the long-term pozzolanic reaction that is responsible for strength and stiffness development. All soil passing a No. 40 sieve is tested with 0, 2, 3, 4, 5, 6 and 7% of hydrated lime. Special attention is given to maintain the room temperature at 25°C, as pH of lime-soil mixture is temperature dependent. Laboratory test results are presented in Plate 9.

Soluble Sulfate Content Tests

Six soluble sulfate content tests were conducted on representative soil samples obtained from the borings. The tests were performed in accordance with TxDOT Test Methods TEX-145-E Part II to evaluate soils with regard to the phenomenon known as "sulfate induced heave." The results of the soluble sulfate content tests are presented in the following table.

[2] R.B. Peck, W.E. Hanson, T.H. Thornburn, "Foundation Engineering" John Wiley & Sons, Inc., 2nd Edition, June 1973

Soluble Sulfate Content Test Results		
Boring	**Sample Depth (ft.)**	**Soluble Sulfate Content**
B-701	0 - 2	<100
B-701	4 - 6	<100
B-702	0 - 2	<100
B-702	6 - 8	348
B-703	2 - 4	194
B-703	8 - 10	3052
<100 mg/kg – Below detectible limit		

The following table presents some general guidelines concerning the soluble sulfate content in soils and the associated level of risk with regard to causing sulfate induced heave when lime stabilizing subgrade soils. These general guidelines were presented in a Technical Memorandum titled “Guidelines for Stabilization of Soils Containing Sulfates” presented at a Soil Stabilization Seminar that was sponsored by the Lime Association of Texas.

Soluble Sulfate Content (mg/kg or ppm)	Level of Risk*
< 3,000	Low
3,000 to 5,000	Moderate
5,000 to 8,000	Moderate to High
> 8,000	High to Unacceptable
* Level of risk associated with routine lime stabilization procedures.	

The measured sulfate contents were 3052 mg/kg maximum at depth 8.0 to 10.0 feet and 348 mg/kg (ppm) or less above 8.0 feet which is in the low to moderate level of risk category associated with lime stabilization procedures.

Strata Descriptions

Descriptions of strata made in the field at the time of boring were drilled were modified in accordance with results of laboratory tests and visual examination in the laboratory. All recovered soil samples were examined and classified in general accordance with ASTM D 2487 and described as recommended in ASTM D 2488. Classifications of the soils and finalized descriptions of soil strata are shown on the boring logs.

SITE AND SUBSURFACE CONDITIONS

Site Physiography

The project site extends along the existing Goforth Road, on the downstream end of the Soil Conservation Service Site 6 Reservoir Bebee Road is towards northwest and High Road is towards southeast of the site location. Estimated ground surface elevations range from El. 627 ft. at Boring B-701 to El. 612 ft. at Boring B-703. Borings B-701 and B-702 are surrounded by woods.

Mapped Geology

According to the Geologic Atlas of Texas, Seguin Sheets[3], the site is underlain by clay and shale of the Pecan Gap formation of the Taylor Group. The Pecan Gap generally consists of highly plastic, calcareous clay and shale with some limestone. The Pecan Gap was deposited in the Upper Cretaceous age as calcareous clay. After emergence, weathering and drying changed the calcareous clay to an overconsolidated clayey limestone or clayshale. With further weathering, near-surface Pecan Gap most often becomes fat clay with high shrink/swell potential when subjected to moisture changes.

Stratigraphy and Engineering Properties

Subsurface conditions can best be understood by a thorough review of the Logs of Borings presented on Plates 3 through 5. In general, the borings encountered fat clay and elastic silt of the Pecan Gap formation. A brief description of the subsurface conditions in the three “Pavement Borings” is provided in the following sections.

Borings B-701 through B-703 were drilled within the proposed roadway realignment to depths of 20 ft for B-701 and 15-ft each for B-702 and B-703. The borings encountered alluvium and fat clay of Pecan Gap Formation of the Taylor Group.

Tan and gray fat clay encountered in the boring had measured liquid limits ranging from 55 to 72 (average 62), plasticity indices ranging from 21 to 50 (average 38), and percent fines (material passing the No. 200 sieve) ranging from 52 to 95 (average 76). Measured compressive strengths of clay samples ranged from 4.5 to 14.0 (average 9.8) tsf. As confirmed by aforementioned swell tests, these soils have the potential to shrink and swell with changes in moisture content.

[3] "Geologic Atlas of Texas, Seguin Sheet", Donald Clinton Barton Memorial Edition, Reprinted 1979.

Groundwater

Groundwater was not encountered in any of the borings at the time of drilling. Perched or transient groundwater could be encountered in excavations during and shortly after periods of rainfall. Groundwater seepage usually occurs within the joints, fissures, and discontinuities of the Pecan Gap clay stratum, and sometimes along the interface of the alluvium and Pecan Gap, and also at the lower interface with the clayshale strata. Ferrous staining and calcite layers within the Pecan Gap indicates the passage of groundwater.

Potential Vertical Soil Movements

Estimates of vertical soil movements at the site were evaluated using the Texas Department of Transportation (TxDOT) Potential Vertical Rise (PVR) test method, TEX-124-E[4]. Past experience in Central Texas indicates actual heave may be more than calculated by this method. The PVR procedure derives potential swell from a historic PI versus swell curve. Therefore, the estimated vertical movement values calculated using the PVR method might be different from actual measured movements that occur at the project site. The estimated potential vertical movement for dry soil conditions varied from 2.0 to 3.0 inches.

PAVEMENT RECOMMENDATIONS

Traffic Estimate

Traffic measurements were provided by Hays County and are included in the Appendix-A. For this section of road, we reviewed the traffic spectrum analysis from Goforth Road East of Bebee Road dated August 13 through 20, 2014 and August 20 through September 2, 2014, representing the periods of time before and after the start of the public school academic year. The 18-Kip Equivalent Single Axle Load (ESAL) was estimated from the results of this study. Assuming 4 % growth, the one directional ESALs ranged from 1.7 million and 2.1 million ESALs. These values were compared with published values for similar traffic loads.

The City of Austin (COA) Transportation Criteria Manual was reviewed and does not have an exact corresponding functional street classification with the similar road width and traffic load. The Primary Undivided 6-lane Collector and the Minor Undivided Arterial-5 were considered nominally similar and were selected for design.

[4] The State of Texas, Texas Department of Transportation, Materials and Test Division, Manual of Testing Procedures, Volume 1, Test Method TEX-124-E, Rev. January 1, 1978.

The design ESAL calculation is based on a 20-year analysis period. The following equation and traffic input parameters presented in the table below were used to calculate the design ESAL loading. An appropriate ESAL value should be selected for the final roadway classification and design. Fugro should be consulted if the final design ESAL value differs from that presented herein.

$$ESAL = (ADT_i)(T)(T_f)(365)(L)(D)(((1+G)^Y - 1)/G)$$

Where:

- ADT_i = Initial Average Daily Traffic (2008)
- T = Percent Trucks
- T_f = Truck Equiv. Factor
- L = Lane Distribution Factor
- D = Directional Distribution Factor
- G = Percent Growth
- 365 = Number of days in a year
- Y = Design period ($Y_{Flexible}$)

ESAL factors	COA - Primary Undivided 6-lane Collector	Hays County Traffic Data	COA - Minor Arterial Undivided, 5
$ADT_{i\ (2014)}$	8000	8637	8000
T	7.45%	*	9.9%
Tf	0.62	*	0.62
L**	100 %	100 %	100 %
D	50 %	50 %	50 %
G	4 %	4 %	4 %
$Y_{Flexible}$	20	20	20
$ESAL_{F\ (2034)}$	**2,010,000**	**2,067,778**	**2,680,000**

*Not used, but individual ESAL factors applied to each category of vehicle reported on traffic study data– see AASHTO Appendix D.

** Two lane road was assumed for this section.

Flexible Pavement Thickness Design

The subgrade resilient modulus (M_R) values, used in the pavement design were estimated using published empirical correlations[5,6] with measured plasticity indices and liquid limits and engineering judgment. As noted in the boring logs, the subgrade mostly consists of tan and gray fat clay. Based on the observed subgrade characteristics and traffic levels, the plasticity index (PI) of 38 percent was selected for analysis. For a PI of 38 percent, the correlated subgrade resilient modulus is 3000 psi. The "back calculated modulus" used in the *FPS-21 V1.3* mechanistic check is typically accepted as 3 times the laboratory resilient modulus and therefore, a value of 9000 psi was used.

Using the above estimated design ESAL loading; a pavement thickness design analysis was performed using the TxDOT *FPS-21 V1.3* with mechanistic check and the AASHTO 1993 pavement thickness design. The results were comparable. The mechanistic check was performed to verify that the pavement did not fail during the design period using 20% fatigue cracking or 0.5 inch rutting failure criteria. These checks involve structural computations of the tensile strains at the bottom of the asphalt concrete layer that governs the number of load repetitions to failure in terms of fatigue, and vertical compressive strains at the top of the subgrade layer that govern the number of load repetitions to failure in terms of rutting. *The FPS 21 V1.3* software from TxDOT was used to perform the mechanistic design checks. The pavement design options are based on a reliability level of 95 percent, terminal serviceability index of 2.5, and assume a permanently fully drained pavement subgrade and pavement structure. The resulting pavement thicknesses consisting of Hot Mix Asphaltic Concrete (HMAC) over Crushed Limestone Base Material (CLBM), with/without lime stabilization are presented in the following table.

Recommended Pavement Thicknesses for Goforth Road Realignment			
18-Kip ESAL	**HMAC Thickness (inches)**	**CLBM Thickness (inches)**	**LSS* Thickness (inches)**
2.01M	4.5	14.0	8.0
	6.5	12.0	--
2.68M	5.0	15.0	8.0
	6.0	17.0	--
HMAC : Hot Mix Asphalt Concrete Type C or D CLBM : Crushed Limestone Base Material Type A, Grade 2 or better LSS : Lime Stabilized Subgrade * If the LSS option is selected, an optimal percent lime should be evaluated prior to construction (TEX 121 E).			

[5] City of Austin Transportation Criteria Manual - Section 3 Computerized Pavement Thickness Design
[6] E.J. Yoder & M.W. Witczak "Principles of Pavement Design" John Wiley & Sons; 2nd Edition (1 Jan 1975)

Flexible Pavement Construction

Construction of the roadway should proceed in accordance with the Texas Department of Transportation 2004 Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, and the following recommendations:

1. Remove all organics, existing pavements, any deleterious material encountered, and surficial soils to a depth of at least 6 inches.
2. Scarify and compact the cut soil subgrade to at least 95% of the maximum dry density determined using TxDOT Test Method TEX-114-E if clayey soils, and TEX-113-E if gravelly soils. Hold water contents during construction to within ±2% of the optimum water content.
3. Proofroll the prepared subgrade in accordance with Item 216 of the current TxDOT Standard Specifications. The proof rolling operation should be observed by a representative of the geotechnical engineer. Any soft or weak subgrade should be over excavated and replaced with crushed limestone base material selected and placed as recommended in Item 5 below.
4. If lime stabilization option is selected, perform lime stabilization in accordance with TxDOT 2004 Standard Specification, Item 260**.**
5. On the prepared subgrade, place the recommended thickness of crushed limestone flexible base that conforms to Item 247, Type A, Grade 1 or 2 of the TxDOT Pavement Design Guide Specifications. Compact the flexible base to 100% of the maximum dry density determined using TxDOT Test Method TEX-113-E. Hold water contents to within ±2% of the optimum, and maintain compacted lift thicknesses to 6 inches or less.
6. Provide and place the proper thickness tabulated above of hot mix asphaltic concrete which conforms to Type C or D, Item 340, Hot Mix Asphaltic Concrete Pavement, TxDOT 2004 Standard Specifications for the Construction of Highways, Streets and Bridges. Project specifications should dictate that the HMAC thickness specified in the table above be a minimum at any location rather than an average.

Pavement Drainage and Groundwater Control

Control of surface drainage and groundwater is important to the performance and life of pavements. Infiltration of water into the pavement subgrade and pavement structure will result in premature loss of serviceability. If encountered, or suspected, during construction grading operations, groundwater or the possibility of groundwater seepage should be addressed by

means of blanket drains or edge drains beneath or adjacent to roadway cuts, depending on actual conditions at the time of construction. Additionally, the placement of curbs, islands and irrigation systems should be carefully planned in a manner that will not lead to ponding and saturation of pavement base materials that extend into island areas.

Pavement Maintenance

Pavement structures constructed on high plastic fat clay soils will be subjected to vertical shrinkage and heave which will result in undulation of pavement and cracking of the HMAC surface. The severity of the undulation and cracking will be dictated by the variation of moisture content within the subgrade sols after construction and is impossible to predict now. Therefore, it is imperative that the pavement structure is adequately drained for both surface water and groundwater. In addition, pavement structures must be adequately maintained, all cracks should be sealed/filled immediately to prevent infiltration of water into the pavement structure and subgrade.

Cut Slopes

Based on proposed grading and subgrade conditions, cut slope configurations of 4H to 1V should be adequate with regard to slope stability, provided fill embankments are constructed as recommended herein, and slopes were less than 7 ft in height. If steeper slopes, taller slopes, or mechanically stabilized earth structures are planned to achieve grade separation, Fugro should be retained to provide slope stability analyses and recommendations.

Topsoil should be placed and a vegetative cover established in the cut slope face to prevent erosion of the exposed face. Grading should be established with necessary interceptor swales and diversion dikes to prevent erosion of the slope crest, face, and toe.

Maintenance of stable construction slopes for the safety of workers is the responsibility of the contractor. All temporary excavations made by the contractor should be in accordance with current OSHA regulations on trench safety. The slope ratio discussed herein is intended to be the steepest permissible for the long-term performance of the earthen-structures. The contractor is required to evaluate the suitability of all slopes for construction safety purposes and to construct flatter slopes where required.

Slope Protection

All permanent slope faces should be protected from erosion by placement of at least 6 inches of topsoil with vegetative cover, turf reinforcement mattresses, concrete rip rap, etc. Embankment slopes protected by vegetation should be periodically inspected and repaired if

necessary. Some minor, shallow sloughing and gullying should be expected and planned for in the owner's maintenance budget.

Stripping and Surface Preparation

The ground surface within the embankment footprint will require preparation prior to the start of construction. All trees, stumps, roots, brush and surficial soils should be grubbed and removed from the embankment areas.

CONDITIONS

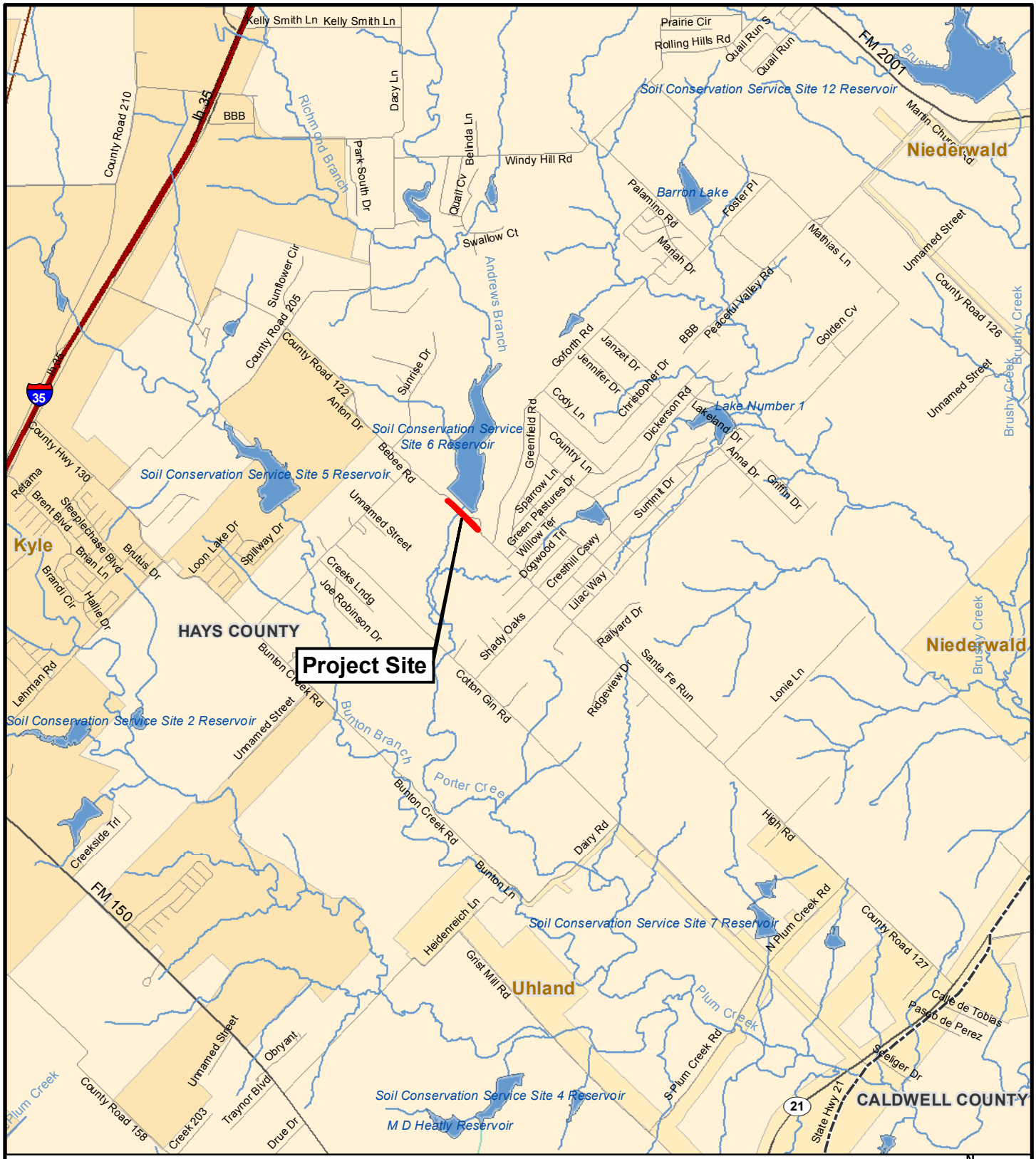
Since some variation was found in subsurface conditions at boring locations, all parties involved should take notice that even more variation may be encountered between boring locations. Statements in the report as to subsurface variation over given areas are intended only as estimations from the data obtained at specific boring locations.

It is recommended that, upon completion of the plans and specifications and the incorporation of the recommendations herein, the geotechnical engineer be retained to review such plans to ensure proper interpretation and implementation of his recommendations in the interest of the best compromise between cost and performance.

The professional services that form the basis for this report have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in the same locality. No warranty, expressed or implied, is made as the professional advice set forth. Fugro's scope of work does not include the investigation, detection, or design related to the presence of any biological pollutants. The term 'biological pollutants' includes, but is not limited to, mold, fungi, spores, bacteria, and viruses, and the byproducts of any such biological organisms.

The results, conclusions, and recommendations contained in this report are directed at, and intended to be utilized within, the scope of work contained in the agreement executed by Fugro Consultants, Inc. and client. This report is not intended to be used for any other purposes. Fugro Consultants, Inc. makes no claim or representation concerning any activity or condition falling outside the specified purposes to which this report is directed, said purposes being specifically limited to the scope of work as defined in said agreement. Inquiries as to said scope of work or concerning any activity or condition not specifically contained therein should be directed to Fugro Consultants, Inc. for a determination and, if necessary, further investigation.

PLATES



Scale: 1 inch = 4,000 feet

0 2,000 4,000 8,000 Feet

N

Coordinate System: State Plane Texas South Central FIPS 4204 Ft
Datum: D North American 1983

FUGRO
Fugro Consultants, Inc.

Goforth Road Realignment

VICINITY MAP

Hays County, Texas

Source:	Drawn By:	Date:	Project No.:	
Street map: Stratmap, 2006	DG	September 29, 2014	04.30141063	PLATE 1

Legend

- Approximate Boring Location
- New Road

Scale: 1 inch = 300 feet

0 150 300 600 Feet

Coordinate System: State Plane Texas South Central FIPS 4204 Ft
Datum: D North American 1983

Fugro Consultants, Inc.

Goforth Road Realignment

PLAN OF BORINGS

Hays County, Texas

Source:	Drawn By:	Date:	Project No.:	
Orthophotography: ArcGIS Online World Imagery, 2014	DG	September 29, 2014	04.30141063	PLATE 2

LOG OF BORING NO. B-701
Goforth Road Alignment
2700 Goforth Road
Kyle, Texas
PROJECT NO. 04.30141063

Fugro Consultants, Inc.

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 627.0 ft±								
			P = 4.5+	Dark brown sandy fat CLAY, very dense, dry, with roots. CH (Alluvium)	625.0	19	62	45	89	53		
				Tan to gray Fat CLAY, very stiff, dry to moist, with iron stains. CH (Pecan Gap Chalk)	2.0							
			P = 4.5+			13					118	14(Q)
5			P = 4.5+			17	60	42	99	88		
			P = 4.5+									
			P = 4.5+	- calcite seam at 9.0'								
10												
				- with iron stain below 13.0'								
			P = 4.5+									
15												
			P = 4.5+	- with clayey shale lense at 20.0'	607.0							
20					20.0							

NOTES:
1) The boring was advanced using dry drilling technology to the 20-ft depth and groundwater was not encountered.
2) Approximate GPS coordinates are: N30°00'3.51" W 97°49'19.68"

COMPLETION DEPTH: 20.0
DATE DRILLED: 9-29-14
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
N = Standard Penetration Test, bpf
P = Pocket Penetrometer, tsf
U = Unconfined
Q = Unconsolidated Undrained Triaxial

PLATE 3

FUGRO STD PLATE (AUSTIN) 04.30141063.GPJ FUGRO AUSTIN DATA TEMPLATE.GDT 10/9/14

LOG OF BORING NO. B-702

Goforth Road Alignment
2700 Goforth Road
Kyle, Texas
PROJECT NO. 04.30141063

Fugro Consultants, Inc.

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 611.0 ft±								
			P = 4.5+	Dark brown sandy fat CLAY, very stiff, dry, with gravel, roots, and calcareous nodules. CH (Alluvium)	609.0	25						
			P = 4.5+	Tan to gray fat CLAY, very stiff, dry to moist, with iron stains. CH (Pecan Gap Chalk)	2.0	15	56	37	100	89		
5			P = 4.5+									
			P = 4.5+			10					127	11(Q)
			P = 2.75	- sandy gravelly seam at 9.0'								
10												
			P = 4.5+		596.0							
15					15.0							
				NOTES: *1) The boring was advanced using dry drilling technology to the 15-ft depth and groundwater was not encountered.* *2) Approximate GPS coordinates are: N30°00'6.0" W 97°49'22.8"*								
20												

COMPLETION DEPTH: 15.0
DATE DRILLED: 9-29-14
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
N = Standard Penetration Test, bpf
P = Pocket Penetrometer, tsf
U = Unconfined
Q = Unconsolidated Undrained Triaxial

PLATE 4

FUGRO STD PLATE (AUSTIN) 04.30141063.GPJ FUGRO AUSTIN DATA TEMPLATE.GDT 10/9/14

LOG OF BORING NO. B-703
Goforth Road Alignment
2700 Goforth Road
Kyle, Texas
PROJECT NO. 04.30141063

Fugro Consultants, Inc.

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC./RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	COMPRESSIVE STRENGTH TSF
				SURF. ELEVATION: 612.0 ft±								
			P = 4.5+	Dark brown sandy fat CLAY, very stiff, dry, with gravel, roots, and calcareous nodules. CH (Alluvium)								
			P = 2									
5			P = 4			22					102	4.5(Q)
			P = 2			18	72	50	90	68		
					604.0							
			P = 2	Tan to gray Fat CLAY, very stiff, dry to moist, with iron stains. CH (Pecan Gap Chalk)	8.0							
10												
			P = 4.5+			26	61	38	100	95		
					597.0							
15					15.0							
				NOTES: *1) The boring was advanced using dry drilling technology to the 15-ft depth and groundwater was not encountered.* *2) Approximate GPS coordinates are: N30°00'8.6" W 97°49'25.5"*								
20												

COMPLETION DEPTH: 15.0
DATE DRILLED: 9-29-14
WATER LEVEL / SEEPAGE:
UPON COMPLETION:

KEY:
N = Standard Penetration Test, bpf
P = Pocket Penetrometer, tsf
U = Unconfined
Q = Unconsolidated Undrained Triaxial

PLATE 5

FUGRO STD PLATE (AUSTIN) 04.30141063.GPJ FUGRO AUSTIN DATA TEMPLATE.GDT 10/9/14

TERMS AND SYMBOLS USED ON BORING LOGS FOR SOIL

SOIL TYPES

FAT CLAY (CH)

LEAN CLAY (CL)

SILT (ML)

FILL

Well-Graded **SAND (SW)**

Poorly-Graded **SAND (SP)**

SILTY SAND (SM)

CLAYEY SAND (SC)

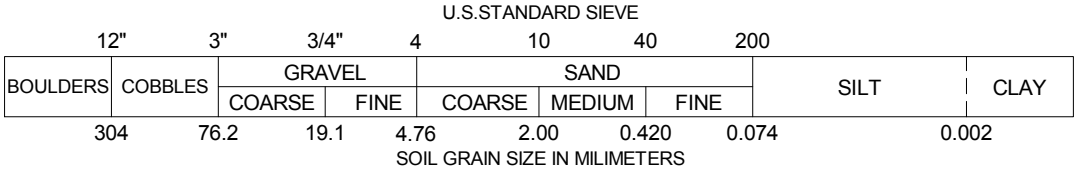
Well-Graded **GRAVEL (GW)**

Poorly-Graded **GRAVEL (GP)**

SILTY GRAVEL (GM)

CLAYEY GRAVEL (GC)

SOIL GRAIN SIZE



STRENGTH OF COHESIVE SOILS (2)

CONSISTENCY	UNDRAINED COMPRESSIVE STRENGTH Tons Per Sq. Ft.
Very Soft	Less Than 0.25
Soft	0.25 to 0.50
Firm	0.5 to 1.00
Stiff	1.00 to 2.00
Very Stiff	2.00 to 4.00
Hard	greater than 4.00

DENSITY OF GRANULAR SOILS (2)

NUMBER OF BLOWS PER FT., N	RELATIVE DENSITY
0-4	Very Loose
4-10	Loose
10-30	Medium
30-50	Dense
Over 50	Very Dense

DESCRIPTIVE TERMS FOR SOIL (1)

DESCRIPTION	CRITERIA
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick.
Laminated	Alternating layers of varying material or color with the layers less than 6 mm 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	Inclusions of small pockets of different soils.

MOISTURE

Dry	No water evident in sample; fines less than plastic limit.
Moist	Sample feels damp; fines near the plastic limit
Very Moist	Water visible on sample; fines greater plastic limit and less than liquid limit
Wet	Sample bears free water; fines greater than liquid limit.

INCLUSIONS (1)

Parting	Inclusion <1/8" thick extending through sample
Seam	Inclusion 1/8" to 3" thick extending through sample.
Layer	Inclusion >3" thick extending through sample.
Trace	<5% of sample.
Few	5% to 10% of sample.
Little	15 to 25% of sample.
With	15% to 29% of sample.

NOTE: Information on each boring log is a compilation of subsurface conditions and soil and rock classifications obtained from the field as well as from laboratory testing of samples. Strata have been interpreted from commonly accepted procedures. The stratum lines on the logs may be transitional and approximate in nature. Water level measurements refer only to those observed at the times and places indicated, and may vary with time, geologic condition or construction activity.

REFERENCES: 1) ASTM D 2488 2) Peck, Hanson and Thornburn, (1974), Foundation Engineering.

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PLATE 6

TERMS AND SYMBOLS USED ON BORING LOGS FOR ROCK

ROCK TYPES


LIMESTONE


SHALE


SANDSTONE


HIGHLY WEATHERED LIMESTONE


HIGHLY WEATHERED SHALE


WEATHERED SANDSTONE


HIGHLY WEATHERED DOLOMITIC LIMESTONE


DOLOMITIC LIMESTONE


MARL

SAMPLER TYPES


Thin-walled Tube


Rock Core


Standard Penetration Test


Auger Sample


THD Cone Penetration Test


Bag Sample

SOLUTION & VOID CONDITIONS

Void	Interstice; a general term for pore space or other openings in rock.
Cavities	Small solutional concavities.
Vuggy	Containing small cavities, usually lined with a mineral of different composition from that of the surrounding rock.
Vesicular	Containing numerous small, unlined cavities, formed by expansion of gas bubbles or steam during solidification of the rock.
Porous	Containing pore, interstices, or other openings which may or may not interconnect.
Cavernous	Containing cavities or caverns, sometimes quite large. Most frequent in limestones and dolomites.

WEATHERING GRADES OF ROCKMASS(1)

Slightly	Discoloration indicates weathering of rock material and discontinuity surfaces.
Moderately	Less than half of the rock material is decomposed or disintegrated to a soil.
Highly	More than half of the rock material is decomposed or disintegrated to a soil.
Completely	All rock material is decomposed and/or disintegrated to soil.The original mass structure is still largely intact.
Residual Soil	All rock material is converted to soil.The mass structure and material fabric are destroyed.

HARDNESS

Friable	Crumbles under hand pressure
Low Hardness	Can be carved with a knife
Moderately Hard	Can be scratched easily with a knife
Very Hard	Cannot be scratched with a knife

BEDDING THICKNESS(2)

Very Thick	>4'
Thick	2'-4'
Thin	2"-2'
Very Thin	1/2"-2"
Laminated	0.08"-1/2"
Thinly-Laminated	<0.08"

JOINT DESCRIPTION

SPACING		INCLINATION		SURFACES	
Very Close	<2"	Horizontal	0-5	Slickensided	Polished, grooved
Close	2"-12"	Shallow	5-35	Smooth	Planar
Medium Close	12"-3'	Moderate	35-65	Irregular	Undulating or granular
Wide	>3'	Steep	65-85	Rough	Jagged or pitted
		Vertical	85-90		

FUGRO
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NOTE: Information on each boring log is a compilation of subsurface conditions and soil and rock classificaitons obtained from the field as well as from laboratory testing of samples. Strata have been interpreted by commonly accepted procedures. The stratum lines on the logs may be transitional and approximate in nature. Water level measurements refer only to those observed at the times and places indicated, and may vary with time, geologic condition or construction activity.

REFERENCES: 1) British Standard(1981) Code of Practice for Site Investigation BS 5930.
2) The Bridge Division, Texas Highway Dept. Foundation Exploration & Design Manual, 2nd Edition,revised June,1974.

PLATE 7

Borehole	Depth (ft.)	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	%<#4 Sieve	%<#200 Sieve	Class-ification	Dry Density (pcf)	Unconfined Strength, (tsf)	Strain at Failure (%)
B-701	1.0	19.0	62	17	45	89	53	CH			
B-701	3.0	12.8							118.2	13.7	4.2
B-701	5.0	16.6	60	18	42	99	88	CH			
B-701	19.0	24.7	71	39	32	100	90	MH			
B-702	1.0	24.8									
B-702	3.0	14.6	56	19	37	100	89	CH			
B-702	7.0	10.2							127.1	11.3	5.0
B-702	9.0	14.2	55	34	21	85	52	MH			
B-703	5.0	22.4							101.9	4.5	9.6
B-703	7.0	18.1	72	22	50	90	68	CH			
B-703	14.0	25.7	61	23	38	100	95	CH			

Fugro Consultants, Inc

Goforth Road Alignment

LABORATORY TEST RESULTS SUMMARY

2700 Goforth Road

Kyle, Texas

Project No. **04.30141063**

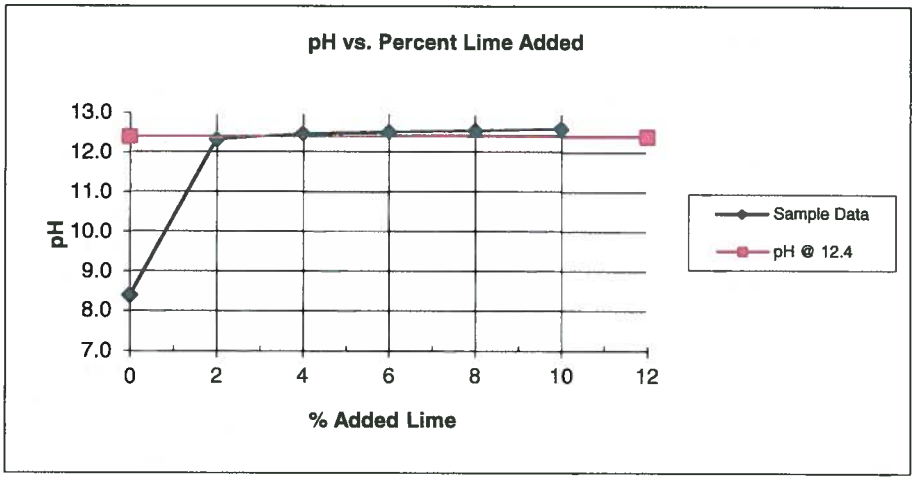
PLATE 8

Stabilization Ability of Lime by Soil pH
TEX 121-E, Part III

Fugro Consultants, Inc.
8613 Cross Park Drive
Austin, Texas 78754
Phone: 512-977-1800
Fax: 512-973-9966

Project No.: 04.30141063	Project Name: Goforth Road Alignment
Client: Freese and Nichols	Date Received: 09/29/2014
Sample ID: B703@0-2	Proposed Use: NA
Material Description: Brown	
Sampled by: Drillers	Date Sampled: 09/29/2014
Tested By: D. Massey	Date Tested: 09/29/2014
Reviewed By: D. Massey	Date Reviewed: 09/29/2014

Percentage of Lime Added	Measured pH
0	8.4
2	12.3
4	12.5
6	12.5
8	12.6
10	12.6
12	--
14	--



Plot the pH of the sample vs. the percent lime added.

If the pH readings are 12.4 or higher, the lowest percentage of added lime to achieve a pH of 12.4 is the recommended percentage required to stabilize the soil.

If the pH readings do not exceed 12.3 and 2 percentages give this reading, the lowest percentage of lime required to achieve 12.3 is the recommended percentage of lime required to stabilize the soil.

If the highest pH measured is 12.3 and only at the highest percentage of lime used measures a pH of 12.3, additional testing at higher percentages of lime is required.

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APPENDIX-A

Goforth Road Traffic - Study Report

BEFORE SCHOOL STARTS

Goforth Rd (East of Bebee Rd)

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Volume Grand Totals

Wednesday, 8/13/2014 12:00 PM - Wednesday, 8/20/2014 12:00 PM

Average Hourly Volumes

	Channel 1	Channel 2	Combined
12:00 AM	70.7	43.4	114.1
1:00 AM	36.9	26.6	63.4
2:00 AM	26.7	11.4	38.1
3:00 AM	20.1	17.0	37.1
4:00 AM	13.7	35.7	49.4
5:00 AM	19.4	134.3	153.7
6:00 AM	48.7	271.6	320.3
7:00 AM	73.3	299.3	372.6
8:00 AM	106.7	272.6	379.3
9:00 AM	124.9	238.0	362.9
10:00 AM	157.4	214.7	372.1
11:00 AM	175.1	223.4	398.6
12:00 PM	205.3	219.4	424.7
1:00 PM	222.3	221.1	443.4
2:00 PM	241.1	212.6	453.7
3:00 PM	288.3	211.9	500.1
4:00 PM	334.7	229.0	563.7
5:00 PM	388.9	226.9	615.7
6:00 PM	438.9	257.6	696.4
7:00 PM	382.7	262.6	645.3
8:00 PM	333.1	265.3	598.4
9:00 PM	285.3	205.4	490.7
10:00 PM	199.3	129.4	328.7
11:00 PM	138.1	76.1	214.3
Average Daily Traffic (ADT)	4331.7 (EAST BOUND)	4305.3 (WEST BOUND)	8637.0

Volume Totals

Channel 1	Channel 2	Combined
30322	30137	60459
50.2 %	49.8 %	

Goforth Rd. (East of Bebee Rd)

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Wednesday, 8/13/2014 12:00 PM -
Wednesday, 8/20/2014 12:00 PM

Classification Grand Totals

Hourly Averages (EAST BOUND)

Channel 1

Interval Start	Total	Motor Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi
12:00 AM	70.7	1.0	45.0	17.7	0.0	6.9	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
1:00 AM	36.9	0.1	23.9	9.3	0.0	3.4	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
2:00 AM	26.7	0.1	18.3	7.3	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3:00 AM	20.1	0.3	11.7	6.3	0.0	1.7	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
4:00 AM	13.7	0.0	7.0	5.1	0.0	1.0	0.0	0.0	0.1	0.4	0.0	0.0	0.0	0.0
5:00 AM	19.4	0.0	10.9	5.7	0.0	2.3	0.1	0.0	0.1	0.3	0.0	0.0	0.0	0.0
6:00 AM	48.7	0.0	25.6	14.1	0.3	7.6	0.1	0.0	1.0	0.0	0.0	0.0	0.0	0.0
7:00 AM	73.3	0.4	36.0	25.0	1.0	9.4	0.3	0.0	1.1	0.0	0.0	0.0	0.0	0.0
8:00 AM	106.7	0.6	52.4	36.4	2.3	12.6	0.6	0.1	1.1	0.4	0.0	0.1	0.0	0.0
9:00 AM	124.9	0.9	59.6	42.4	1.1	18.0	0.3	0.1	2.0	0.4	0.0	0.0	0.0	0.0
10:00 AM	157.4	1.3	79.6	53.6	1.7	17.3	0.3	0.0	2.7	0.9	0.1	0.0	0.0	0.0
11:00 AM	175.1	1.9	89.7	56.4	0.7	22.6	0.9	0.1	2.0	0.9	0.0	0.0	0.0	0.0
12:00 PM	205.3	1.3	105.7	68.1	0.9	25.3	0.9	0.1	2.0	1.0	0.0	0.0	0.0	0.0
1:00 PM	222.3	2.0	116.1	72.9	1.0	27.3	0.4	0.0	2.3	0.3	0.0	0.0	0.0	0.0
2:00 PM	241.1	1.3	126.9	81.7	0.7	27.4	0.6	0.1	1.9	0.6	0.0	0.0	0.0	0.0
3:00 PM	288.3	1.9	153.0	99.1	0.6	29.3	0.6	0.1	3.0	0.7	0.0	0.0	0.0	0.0
4:00 PM	334.7	2.0	171.0	110.6	1.7	43.4	0.6	0.1	3.6	1.6	0.0	0.0	0.1	0.0
5:00 PM	388.9	3.3	199.7	132.4	1.4	45.4	0.9	0.3	4.6	0.9	0.0	0.0	0.0	0.0
6:00 PM	438.9	3.1	230.0	149.4	1.6	50.3	1.1	0.0	2.4	0.9	0.0	0.0	0.0	0.0
7:00 PM	382.7	3.3	201.9	130.0	0.7	40.3	0.9	0.0	5.4	0.1	0.0	0.1	0.0	0.0
8:00 PM	333.1	3.6	172.1	108.6	1.4	43.3	0.4	0.0	3.4	0.3	0.0	0.0	0.0	0.0
9:00 PM	285.3	2.4	156.1	92.6	0.9	31.3	0.0	0.0	1.9	0.1	0.0	0.0	0.0	0.0
10:00 PM	199.3	1.0	123.0	57.4	0.3	17.3	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
11:00 PM	138.1	1.4	80.3	43.4	0.1	12.4	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Daily Average	4331.7	33.1	2295.4	1425.7	18.4	496.7	9.0	1.3	41.4	10.0	0.1	0.3	0.1	0.0

Study Grand Totals

	Total	Motor Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi
Channel 1	30322	232	16068	9980	129	3477	63	9	290	70	1	2	1	0
		0.8 %	53.0 %	32.9 %	0.4 %	11.5 %	0.2 %	0.0 %	1.0 %	0.2 %	0.0 %	0.0 %	0.0 %	0.0 %

Classification Grand Totals

Hourly Averages
Channel 2
(WEST BOUND)

Interval Start	Total	Motor Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi
12:00 AM	43.4	0.6	22.4	14.6	0.1	5.4	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
1:00 AM	26.6	0.0	13.6	9.3	0.1	3.3	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2:00 AM	11.4	0.0	4.6	4.4	0.0	2.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0
3:00 AM	17.0	0.0	8.3	6.6	0.1	1.9	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
4:00 AM	35.7	0.0	20.9	10.9	0.1	3.4	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0
5:00 AM	134.3	1.4	72.7	37.1	1.0	17.7	0.4	0.0	1.7	2.0	0.0	0.1	0.0	0.0
6:00 AM	271.6	1.4	125.7	87.6	1.4	44.7	1.7	0.0	7.3	1.6	0.0	0.1	0.0	0.0
7:00 AM	299.3	1.7	142.7	98.0	1.1	44.4	0.9	0.0	9.7	0.7	0.0	0.0	0.0	0.0
8:00 AM	272.6	1.1	134.4	96.9	2.1	33.4	0.7	0.0	3.4	0.4	0.0	0.0	0.0	0.0
9:00 AM	238.0	1.1	127.3	75.7	2.1	26.7	0.4	0.0	4.3	0.3	0.0	0.0	0.0	0.0
10:00 AM	214.7	2.3	109.0	71.9	2.1	25.0	0.7	0.0	3.1	0.4	0.0	0.1	0.0	0.0
11:00 AM	223.4	1.6	118.6	75.0	2.3	23.3	0.6	0.0	1.9	0.3	0.0	0.0	0.0	0.0
12:00 PM	219.4	2.0	109.1	78.0	2.6	24.1	0.9	0.0	2.4	0.3	0.0	0.0	0.0	0.0
1:00 PM	221.1	1.7	114.9	71.1	2.1	27.7	0.1	0.0	3.1	0.3	0.0	0.0	0.0	0.0
2:00 PM	212.6	2.4	108.1	71.6	1.9	26.0	0.1	0.0	2.3	0.1	0.0	0.0	0.0	0.0
3:00 PM	211.9	1.1	109.1	72.9	0.9	26.3	0.1	0.0	1.1	0.3	0.0	0.0	0.0	0.0
4:00 PM	229.0	2.6	117.3	74.6	2.6	28.6	0.3	0.0	3.0	0.1	0.0	0.0	0.0	0.0
5:00 PM	226.9	3.7	118.4	75.3	0.6	25.1	0.7	0.0	2.6	0.3	0.0	0.1	0.0	0.0
6:00 PM	257.6	3.0	134.9	84.0	2.7	29.9	0.0	0.0	3.0	0.1	0.0	0.0	0.0	0.0
7:00 PM	262.6	2.9	135.9	86.9	2.9	31.6	0.4	0.0	1.7	0.4	0.0	0.0	0.0	0.0
8:00 PM	265.3	2.3	127.9	95.6	3.0	33.0	0.0	0.0	3.0	0.3	0.0	0.3	0.0	0.0
9:00 PM	205.4	1.7	107.1	67.3	1.3	26.7	0.0	0.0	1.1	0.1	0.0	0.0	0.0	0.0
10:00 PM	129.4	1.0	74.6	38.9	1.0	13.1	0.0	0.0	0.7	0.1	0.0	0.0	0.0	0.0
11:00 PM	76.1	0.4	43.6	24.6	0.1	7.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0
Daily Average	4305.3	36.1	2201.0	1428.4	34.4	530.4	8.1	0.0	56.7	9.1	0.0	0.9	0.0	0.0

Study Grand Totals

	Total	Motor Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi
Channel 2	30137	253	15407	9999	241	3713	57	0	397	64	0	6	0	0
		0.8 %	51.1 %	33.2 %	0.8 %	12.3 %	0.2 %	0.0 %	1.3 %	0.2 %	0.0 %	0.0 %	0.0 %	0.0 %

Goforth Rd (EAST of Bebee Rd)

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Wednesday, 8/13/2014 12:00 PM -
Wednesday, 8/20/2014 12:00 PM

Classification Grand Totals

Hourly Averages

Combined

Interval Start	Total	Motor Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi
12:00 AM	114.1	1.6	67.4	32.3	0.1	12.3	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0
1:00 AM	63.4	0.1	37.4	18.6	0.1	6.7	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0
2:00 AM	38.1	0.1	22.9	11.7	0.0	3.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0
3:00 AM	37.1	0.3	20.0	12.9	0.1	3.6	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
4:00 AM	49.4	0.0	27.9	16.0	0.1	4.4	0.0	0.0	0.4	0.6	0.0	0.0	0.0	0.0
5:00 AM	153.7	1.4	83.6	42.9	1.0	20.0	0.6	0.0	1.9	2.3	0.0	0.1	0.0	0.0
6:00 AM	320.3	1.4	151.3	101.7	1.7	52.3	1.9	0.0	8.3	1.6	0.0	0.1	0.0	0.0
7:00 AM	372.6	2.1	178.7	123.0	2.1	53.9	1.1	0.0	10.9	0.7	0.0	0.0	0.0	0.0
8:00 AM	379.3	1.7	186.9	133.3	4.4	46.0	1.3	0.1	4.6	0.9	0.0	0.1	0.0	0.0
9:00 AM	362.9	2.0	186.9	118.1	3.3	44.7	0.7	0.1	6.3	0.7	0.0	0.0	0.0	0.0
10:00 AM	372.1	3.6	188.6	125.4	3.9	42.3	1.0	0.0	5.9	1.3	0.1	0.1	0.0	0.0
11:00 AM	398.6	3.4	208.3	131.4	3.0	45.9	1.4	0.1	3.9	1.1	0.0	0.0	0.0	0.0
12:00 PM	424.7	3.3	214.9	146.1	3.4	49.4	1.7	0.1	4.4	1.3	0.0	0.0	0.0	0.0
1:00 PM	443.4	3.7	231.0	144.0	3.1	55.0	0.6	0.0	5.4	0.6	0.0	0.0	0.0	0.0
2:00 PM	453.7	3.7	235.0	153.3	2.6	53.4	0.7	0.1	4.1	0.7	0.0	0.0	0.0	0.0
3:00 PM	500.1	3.0	262.1	172.0	1.4	55.6	0.7	0.1	4.1	1.0	0.0	0.0	0.0	0.0
4:00 PM	563.7	4.6	288.3	185.1	4.3	72.0	0.9	0.1	6.6	1.7	0.0	0.0	0.1	0.0
5:00 PM	615.7	7.0	318.1	207.7	2.0	70.6	1.6	0.3	7.1	1.1	0.0	0.1	0.0	0.0
6:00 PM	696.4	6.1	364.9	233.4	4.3	80.1	1.1	0.0	5.4	1.0	0.0	0.0	0.0	0.0
7:00 PM	645.3	6.1	337.7	216.9	3.6	71.9	1.3	0.0	7.1	0.6	0.0	0.1	0.0	0.0
8:00 PM	598.4	5.9	300.0	204.1	4.4	76.3	0.4	0.0	6.4	0.6	0.0	0.3	0.0	0.0
9:00 PM	490.7	4.1	263.3	159.9	2.1	58.0	0.0	0.0	3.0	0.3	0.0	0.0	0.0	0.0
10:00 PM	328.7	2.0	197.6	96.3	1.3	30.4	0.1	0.0	0.9	0.1	0.0	0.0	0.0	0.0
11:00 PM	214.3	1.9	123.9	68.0	0.3	19.4	0.0	0.0	0.6	0.3	0.0	0.0	0.0	0.0
Daily Average	8637.0	69.3	4496.4	2854.1	52.9	1027.1	17.1	1.3	98.1	19.1	0.1	1.1	0.1	0.0

Study Grand Totals

	Total	Motor Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi
Combined	60459	485	31475	19979	370	7190	120	9	687	134	1	8	1	0
		0.8 %	52.1 %	33.0 %	0.6 %	11.9 %	0.2 %	0.0 %	1.1 %	0.2 %	0.0 %	0.0 %	0.0 %	0.0 %
Channel 1	30322	232	16068	9980	129	3477	63	9	290	70	1	2	1	0
		0.8 %	53.0 %	32.9 %	0.4 %	11.5 %	0.2 %	0.0 %	1.0 %	0.2 %	0.0 %	0.0 %	0.0 %	0.0 %
Channel 2	30137	253	15407	9999	241	3713	57	0	397	64	0	6	0	0
		0.8 %	51.1 %	33.2 %	0.8 %	12.3 %	0.2 %	0.0 %	1.3 %	0.2 %	0.0 %	0.0 %	0.0 %	0.0 %

AFTER SCHOOL STARTED.

Goforth Rd. (East of Bebee Rd.)

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Volume Grand Totals

Wednesday, 8/20/2014 12:15 PM - Tuesday, 9/2/2014 1:30 PM

Average Hourly Volumes

	Channel 1	Channel 2	Combined
12:00 AM	48.8	23.5	72.3
1:00 AM	26.4	13.5	39.8
2:00 AM	18.3	8.2	26.5
3:00 AM	11.9	12.8	24.7
4:00 AM	8.2	26.8	35.0
5:00 AM	15.1	102.3	117.4
6:00 AM	41.8	205.8	247.6
7:00 AM	63.6	198.2	261.8
8:00 AM	91.7	208.3	300.0
9:00 AM	107.0	164.8	271.8
10:00 AM	116.1	153.6	269.7
11:00 AM	125.0	156.8	281.8
12:00 PM	140.8	148.2	288.9
1:00 PM	169.5	164.5	334.0
2:00 PM	189.6	160.0	349.6
3:00 PM	236.9	162.9	399.8
4:00 PM	269.3	176.2	445.5
5:00 PM	265.8	182.6	448.5
6:00 PM	304.4	176.6	481.0
7:00 PM	268.5	185.0	453.5
8:00 PM	232.5	174.1	406.6
9:00 PM	189.6	134.1	323.7
10:00 PM	131.9	84.0	215.9
11:00 PM	82.3	49.0	131.3
Average Daily Traffic (ADT)	3155.2 (EASTBOUND)	3071.5 (WESTBOUND)	6226.7

Volume Totals

Channel 1	Channel 2	Combined
41149	40055	81204
50.7 %	49.3 %	

Gofarth Rd. (EAST of Bebee Rd)

Wednesday, 8/20/2014 1:00 PM -
Tuesday, 9/2/2014 1:00 PM

Classification Grand Totals

Hourly Averages

Channel 1 (EAST BOUND)

Interval Start	Total	Motor Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi
12:00 AM	48.8	0.5	31.4	13.4	0.0	3.5	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
1:00 AM	26.4	0.1	17.4	7.7	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2:00 AM	18.3	0.1	12.2	5.1	0.0	0.8	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
3:00 AM	11.9	0.0	6.8	4.0	0.0	1.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
4:00 AM	8.2	0.0	4.9	1.8	0.1	1.2	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
5:00 AM	15.1	0.0	7.8	4.4	0.1	2.2	0.2	0.0	0.2	0.2	0.0	0.0	0.0	0.0
6:00 AM	41.8	0.2	19.2	9.7	3.9	8.4	0.1	0.0	0.3	0.1	0.0	0.0	0.0	0.0
7:00 AM	63.6	0.4	28.2	18.7	5.6	9.4	0.2	0.0	0.9	0.3	0.0	0.0	0.0	0.0
8:00 AM	91.7	0.7	46.5	28.6	3.5	10.8	0.4	0.0	0.8	0.3	0.0	0.0	0.0	0.0
9:00 AM	107.0	1.1	49.8	38.9	0.9	13.9	0.3	0.1	1.5	0.5	0.0	0.0	0.0	0.0
10:00 AM	116.1	0.5	56.3	37.3	1.5	18.1	0.5	0.0	1.4	0.4	0.1	0.0	0.0	0.0
11:00 AM	125.0	1.6	64.2	40.5	0.5	15.7	0.7	0.0	0.9	0.8	0.0	0.1	0.0	0.0
12:00 PM	140.8	0.5	70.8	49.3	0.7	16.0	0.6	0.1	1.8	0.8	0.0	0.1	0.0	0.0
1:00 PM	169.5	1.2	85.5	57.1	0.5	21.5	0.8	0.0	2.3	0.5	0.0	0.0	0.0	0.0
2:00 PM	189.6	1.2	94.1	67.0	1.3	22.9	0.7	0.0	1.3	1.1	0.0	0.0	0.0	0.0
3:00 PM	236.9	1.9	122.5	79.4	2.8	26.2	1.0	0.2	2.2	0.7	0.0	0.1	0.0	0.0
4:00 PM	269.3	1.5	140.5	83.3	5.7	32.1	0.6	0.2	2.8	2.5	0.0	0.1	0.0	0.0
5:00 PM	265.8	2.0	138.3	90.9	0.8	29.6	0.6	0.1	2.6	0.9	0.0	0.0	0.0	0.0
6:00 PM	304.4	2.7	159.4	100.7	1.1	35.9	0.8	0.1	3.2	0.5	0.0	0.0	0.0	0.0
7:00 PM	268.5	3.2	136.8	90.9	0.8	32.9	0.5	0.0	3.2	0.1	0.0	0.2	0.0	0.0
8:00 PM	232.5	1.8	122.8	75.4	0.8	29.2	0.0	0.0	2.2	0.3	0.0	0.0	0.0	0.0
9:00 PM	189.6	0.9	105.8	59.2	0.5	21.6	0.0	0.0	1.5	0.1	0.0	0.0	0.0	0.0
10:00 PM	131.9	0.6	79.2	40.2	0.3	11.2	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0
11:00 PM	82.3	0.5	53.7	22.6	0.2	4.9	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.0
Daily Average	3155.2	23.2	1654.2	1026.1	31.7	370.2	8.0	0.7	29.6	10.9	0.1	0.5	0.0	0.0

Study Grand Totals

	Total	Motor Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi
Channel 1	41017	301	21505	13339	412	4813	104	9	385	142	1	6	0	0
		0.7 %	52.4 %	32.5 %	1.0 %	11.7 %	0.3 %	0.0 %	0.9 %	0.3 %	0.0 %	0.0 %	0.0 %	0.0 %

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Wednesday, 8/20/2014 1:00 PM -
Tuesday, 9/2/2014 1:00 PM

Classification Grand Totals

Hourly Averages

Channel 2 (WEST BOUND)

Interval Start	Total	Motor Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi
12:00 AM	23.5	0.2	12.6	7.7	0.0	2.7	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
1:00 AM	13.5	0.4	7.5	4.1	0.0	1.2	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
2:00 AM	8.2	0.0	4.2	2.7	0.1	0.8	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0
3:00 AM	12.8	0.2	6.6	4.5	0.0	1.1	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0
4:00 AM	26.8	0.3	15.4	7.4	0.2	3.1	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.0
5:00 AM	102.3	1.8	53.9	30.2	0.5	13.2	0.1	0.0	1.2	1.4	0.0	0.0	0.0	0.0
6:00 AM	205.8	0.8	91.1	71.4	1.9	32.5	1.3	0.0	4.5	2.2	0.1	0.1	0.0	0.0
7:00 AM	198.2	0.8	96.7	60.0	2.5	29.3	0.5	0.0	7.6	0.6	0.0	0.2	0.0	0.0
8:00 AM	208.3	1.2	102.8	67.7	5.2	28.2	0.3	0.0	2.8	0.1	0.0	0.0	0.0	0.0
9:00 AM	164.8	0.7	79.6	59.9	2.3	19.8	0.4	0.0	1.9	0.1	0.0	0.0	0.0	0.0
10:00 AM	153.6	0.7	76.8	50.6	1.2	21.4	0.6	0.0	1.8	0.5	0.0	0.0	0.0	0.0
11:00 AM	156.8	1.0	78.3	52.3	2.9	18.8	0.6	0.0	2.3	0.5	0.0	0.0	0.0	0.0
12:00 PM	148.2	0.8	75.2	48.5	1.5	19.8	0.4	0.0	1.8	0.2	0.0	0.0	0.0	0.0
1:00 PM	164.5	0.9	86.8	53.1	0.7	19.4	0.5	0.0	2.6	0.5	0.0	0.0	0.0	0.0
2:00 PM	160.0	1.2	80.4	55.0	1.3	19.6	0.5	0.0	1.7	0.3	0.0	0.0	0.0	0.0
3:00 PM	162.9	1.3	81.6	52.6	2.9	21.3	1.0	0.0	2.0	0.2	0.0	0.0	0.0	0.0
4:00 PM	176.2	1.2	85.8	57.4	7.5	21.6	0.2	0.0	2.2	0.2	0.0	0.0	0.0	0.0
5:00 PM	182.6	2.6	88.6	60.6	6.0	21.5	0.5	0.0	2.5	0.2	0.0	0.0	0.0	0.0
6:00 PM	176.6	2.2	90.8	57.7	2.3	21.5	0.3	0.0	1.8	0.0	0.0	0.0	0.0	0.0
7:00 PM	185.0	2.2	93.2	63.3	1.2	22.7	0.2	0.0	1.8	0.3	0.0	0.2	0.0	0.0
8:00 PM	174.1	2.0	87.7	58.9	1.6	22.5	0.0	0.0	1.3	0.1	0.0	0.0	0.0	0.0
9:00 PM	134.1	0.7	70.6	44.5	1.5	15.3	0.0	0.0	1.4	0.2	0.0	0.0	0.0	0.0
10:00 PM	84.0	0.8	48.8	25.6	0.5	7.5	0.2	0.0	0.5	0.1	0.0	0.1	0.0	0.0
11:00 PM	49.0	0.4	28.4	14.6	0.2	4.8	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0
Daily Average	3071.5	24.2	1543.4	1010.3	43.9	389.7	7.8	0.0	43.0	8.7	0.1	0.5	0.0	0.0

Study Grand Totals

	Total	Motor Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi
Channel 2	39930	315	20064	13134	571	5066	101	0	559	113	1	6	0	0
		0.8 %	50.2 %	32.9 %	1.4 %	12.7 %	0.3 %	0.0 %	1.4 %	0.3 %	0.0 %	0.0 %	0.0 %	0.0 %

Goforth Rd. (East of Bebee Rd.)

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Wednesday, 8/20/2014 1:00 PM -
Tuesday, 9/2/2014 1:00 PM

Classification Grand Totals

Hourly Averages

Combined

Interval Start	Total	Motor Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi
12:00 AM	72.3	0.7	44.0	21.1	0.0	6.2	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
1:00 AM	39.8	0.5	24.8	11.8	0.0	2.4	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
2:00 AM	26.5	0.1	16.4	7.8	0.1	1.6	0.0	0.0	0.1	0.5	0.0	0.0	0.0	0.0
3:00 AM	24.7	0.2	13.5	8.5	0.0	2.1	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0
4:00 AM	35.0	0.3	20.3	9.2	0.2	4.3	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0
5:00 AM	117.4	1.8	61.8	34.5	0.6	15.5	0.2	0.0	1.4	1.6	0.0	0.0	0.0	0.0
6:00 AM	247.6	1.0	110.3	81.1	5.8	40.8	1.4	0.0	4.8	2.2	0.1	0.1	0.0	0.0
7:00 AM	261.8	1.2	124.8	78.7	8.2	38.7	0.6	0.0	8.5	0.9	0.0	0.2	0.0	0.0
8:00 AM	300.0	1.8	149.4	96.3	8.8	38.9	0.7	0.0	3.7	0.4	0.0	0.0	0.0	0.0
9:00 AM	271.8	1.8	129.4	98.8	3.2	33.8	0.7	0.1	3.4	0.6	0.0	0.0	0.0	0.0
10:00 AM	269.7	1.2	133.1	87.9	2.8	39.5	1.2	0.0	3.2	0.8	0.1	0.0	0.0	0.0
11:00 AM	281.8	2.6	142.5	92.8	3.4	34.5	1.3	0.0	3.2	1.3	0.0	0.1	0.0	0.0
12:00 PM	288.9	1.3	146.0	97.8	2.2	35.8	1.0	0.1	3.5	1.1	0.0	0.1	0.0	0.0
1:00 PM	334.0	2.2	172.3	110.2	1.2	40.9	1.2	0.0	4.9	1.1	0.0	0.0	0.0	0.0
2:00 PM	349.6	2.4	174.5	122.0	2.6	42.5	1.2	0.0	3.0	1.4	0.0	0.0	0.0	0.0
3:00 PM	399.8	3.2	204.1	132.0	5.8	47.5	2.0	0.2	4.2	0.8	0.0	0.1	0.0	0.0
4:00 PM	445.5	2.8	226.2	140.7	13.2	53.7	0.8	0.2	5.1	2.7	0.0	0.1	0.0	0.0
5:00 PM	448.5	4.6	226.9	151.5	6.8	51.2	1.1	0.1	5.2	1.2	0.0	0.0	0.0	0.0
6:00 PM	481.0	4.8	250.2	158.4	3.4	57.5	1.2	0.1	5.0	0.5	0.0	0.0	0.0	0.0
7:00 PM	453.5	5.4	230.0	154.2	1.9	55.6	0.8	0.0	4.9	0.4	0.0	0.3	0.0	0.0
8:00 PM	406.6	3.8	210.5	134.3	2.5	51.6	0.0	0.0	3.5	0.4	0.0	0.0	0.0	0.0
9:00 PM	323.7	1.6	176.5	103.6	2.0	36.9	0.0	0.0	2.8	0.2	0.0	0.0	0.0	0.0
10:00 PM	215.9	1.4	128.1	65.8	0.8	18.7	0.2	0.0	0.8	0.2	0.0	0.1	0.0	0.0
11:00 PM	131.3	0.8	82.1	37.2	0.3	9.8	0.0	0.0	0.6	0.5	0.0	0.0	0.0	0.0
Daily Average	6226.7	47.4	3197.6	2036.4	75.6	759.9	15.8	0.7	72.6	19.6	0.2	0.9	0.0	0.0

Study Grand Totals

	Total	Motor Bikes	Cars & Trailers	2 Axle Long	Buses	2 Axle 6 Tire	3 Axle Single	4 Axle Single	<5 Axle Double	5 Axle Double	>6 Axle Double	<6 Axle Multi	6 Axle Multi	>6 Axle Multi
Combined	80947	616	41569	26473	983	9879	205	9	944	255	2	12	0	0
		0.8 %	51.4 %	32.7 %	1.2 %	12.2 %	0.3 %	0.0 %	1.2 %	0.3 %	0.0 %	0.0 %	0.0 %	0.0 %
Channel 1	41017	301	21505	13339	412	4813	104	9	385	142	1	6	0	0
		0.7 %	52.4 %	32.5 %	1.0 %	11.7 %	0.3 %	0.0 %	0.9 %	0.3 %	0.0 %	0.0 %	0.0 %	0.0 %
Channel 2	39930	315	20064	13134	571	5066	101	0	559	113	1	6	0	0
		0.8 %	50.2 %	32.9 %	1.4 %	12.7 %	0.3 %	0.0 %	1.4 %	0.3 %	0.0 %	0.0 %	0.0 %	0.0 %

APPENDIX-B

FPS 21 V1.3 Results

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.3 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-7-2012*

PAVEMENT DESIGN TYPE # 2 -- ACP + FLEX BASE OVER SUBGRADE

PROB	DIST.-14	COUNTY-106	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**Austin**	**HAYS**	**1234**	**1**	**1**	**Goforth Rd**	**10/7/2014**	**1**

COMMENTS ABOUT THIS PROBLEM

FDR design for Goforth Road Realignment
COA - Minor Arterial Undivided, 5 - No Stabilized Subbase
ESAL for 20 year analysis period = 2.68 million

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	10.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	8.0
DESIGN CONFIDENCE LEVEL (95.0%)	C
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.5
FINAL SERVICEABILITY INDEX P2	2.5
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.0
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	9.00
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)	75.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	10.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	8000.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	16855.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	2.680
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	55.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	55.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	6.0
PERCENT TRUCKS IN ADT	9.9

PAVEMENT DESIGN TYPE # 2 -- ACP + FLEX BASE OVER SUBGRADE

PROB	DIST.-14	COUNTY-106	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**Austin**	**HAYS**	**1234**	**1**	**1**	**Goforth Rd**	**10/7/2014**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	2.0
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	8.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.90
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	150.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	0.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	10.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	2
TOTAL NUMBER OF LANES OF THE FACILITY	2
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	0
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	1
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	1.00
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.00
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	A	ASPH CONC PVMT	115.00	500000.	0.35	4.00	12.00	30.00
2	B	FLEXIBLE BASE	37.00	28900.	0.35	12.00	25.00	75.00
3	C	SUBGRADE(200)	2.00	9000.	0.40	200.00	200.00	90.00

PAVEMENT DESIGN TYPE # 2 -- ACP + FLEX BASE OVER SUBGRADE

PROB	DIST.-14	COUNTY-106	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**Austin**	**HAYS**	**1234**	**1**	**1**	**Goforth Rd**	**10/7/2014**	**3**

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

	1	2	3	4	5	6	7	8
MATERIAL ARRANGEMENT	AB	AB	AB	AB	AB	AB	AB	AB
INIT. CONST. COST	34.88	35.44	35.50	36.07	36.12	35.72	36.18	36.29
OVERLAY CONST. COST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USER COST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROUTINE MAINT. COST	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
SALVAGE VALUE	-5.27	-5.20	-5.02	-4.95	-4.77	-4.32	-4.60	-4.25
TOTAL COST	29.72	30.36	30.59	31.24	31.47	31.52	31.70	32.16
NUMBER OF LAYERS	2	2	2	2	2	2	2	2
LAYER DEPTH (INCHES)								
D(1)	4.00	4.50	5.00	5.50	6.00	7.00	6.50	7.50
D(2)	21.50	20.50	19.00	18.00	16.50	13.00	15.00	12.00
NO.OF PERF.PERIODS	1	1	1	1	1	1	1	1
PERF. TIME (YEARS)								
T(1)	21.	21.	20.	21.	20.	20.	20.	22.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)								

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 448

PAVEMENT DESIGN TYPE # 2 -- ACP + FLEX BASE OVER SUBGRADE

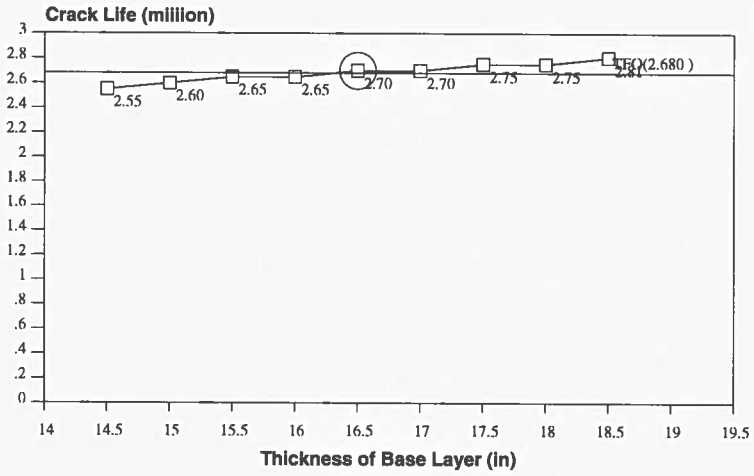
PROB	DIST.-14	COUNTY-106	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**Austin**	**HAYS**	**1234**	**1**	**1**	**Goforth Rd**	**10/7/2014**	**4**

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

	9	10	11	12	13
MATERIAL ARRANGEMENT	AB	AB	AB	AB	AB
INIT. CONST. COST	28.76	28.71	28.82	28.31	29.90
OVERLAY CONST. COST	4.06	4.06	3.79	4.87	3.55
USER COST	7.80	8.13	7.94	8.95	11.59
ROUTINE MAINT. COST	0.06	0.06	0.07	0.06	0.07
SALVAGE VALUE	-4.40	-4.57	-4.22	-4.25	-4.25
TOTAL COST	36.29	36.38	36.40	37.94	40.86
NUMBER OF LAYERS	2	2	2	2	2
LAYER DEPTH (INCHES)					
D(1)	4.50	4.00	5.00	5.00	5.50
D(2)	14.00	15.50	12.50	12.00	12.00
NO.OF PERF.PERIODS	2	2	2	2	2
PERF. TIME (YEARS)					
T(1)	10.	10.	11.	10.	12.
T(2)	20.	20.	21.	22.	23.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)					
O(1)	2.5	2.5	2.5	3.0	2.5

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 448

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
AC	6.00	500.00	0.35	ASPH CONC PVMT
Base	16.50	28.90	0.35	FLEXIBLE BASE
Subgrade	200.00	9.00	0.40	SUBGRADE(200)



Fatigue Crack Model:

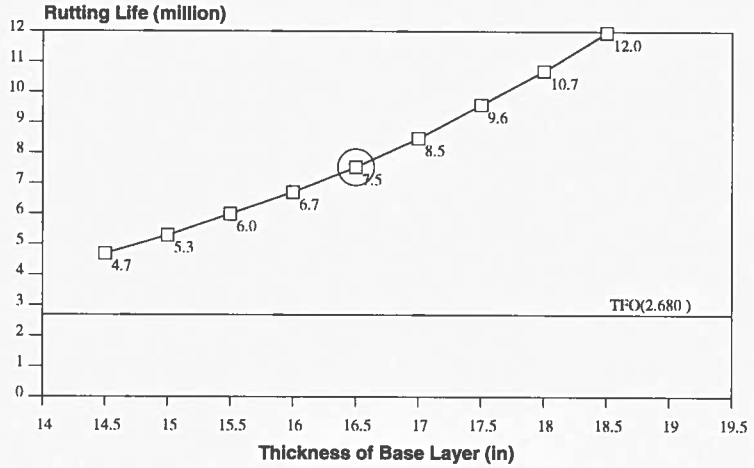
$$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$$

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): 2.68 (million)

Crack Life: 2.70 (million) ε_t = 171.00 (με)

Rut Life: 7.53 (million) ε_v = -305.00 (με)

Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:2.68millions.
Also the start ADT:8000.0 and ending ADT:16855.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.3Release:12-7-2012)			
Highway	Goforth Rd	Problem	001
C-S-J	1234 - 1 - 1	Date	10/7/2014
District	Austin	County	HAYS
Design Type:Asphalt concrete + Flexible Base over Subgrade			

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.3 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-7-2012*

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB	DIST.-14	COUNTY-106	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**Austin**	**HAYS**	**1234**	**1**	**1**	**Goforth Rd**	**10/7/2014**	**1**

COMMENTS ABOUT THIS PROBLEM

FDR design for Goforth Road Realignment
COA - Minor Arterial Undivided, 5 - Lime Stabilized Subbase
ESAL for 20 year analysis period = 2.68 million

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	10.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	8.0
DESIGN CONFIDENCE LEVEL (95.0%)	C
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.5
FINAL SERVICEABILITY INDEX P2	2.5
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.0
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	9.00
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)	75.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	10.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	8000.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	16855.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	2.680
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	55.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	55.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	6.0
PERCENT TRUCKS IN ADT	9.9

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB	DIST.-14	COUNTY-106	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**Austin**	**HAYS**	**1234**	**1**	**1**	**Goforth Rd**	**10/7/2014**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	2.0
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	8.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.90
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	150.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	0.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	10.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	2
TOTAL NUMBER OF LANES OF THE FACILITY	2
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	0
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	1
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	1.00
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.00
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	A	ASPH CONC PVMT	115.00	500000.	0.35	4.00	12.00	30.00
2	B	FLEXIBLE BASE	37.00	50000.	0.35	12.00	25.00	75.00
3	C	STABILIZED SUBGR	15.00	25000.	0.30	8.00	8.00	90.00
4	D	SUBGRADE(200)	2.00	9000.	0.40	200.00	200.00	90.00

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.3 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-7-2012*

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

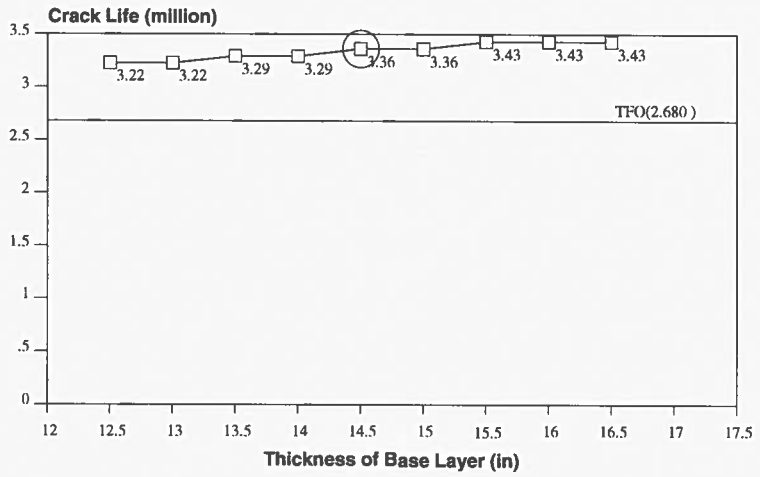
PROB	DIST.-14	COUNTY-106	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**Austin**	**HAYS**	**1234**	**1**	**1**	**Goforth Rd**	**10/7/2014**	**3**

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

	1	2	3	4	5	6
MATERIAL ARRANGEMENT	ABC	ABC	ABC	ABC	ABC	ABC
INIT. CONST. COST	33.58	34.15	34.21	34.26	34.83	28.44
OVERLAY CONST. COST	0.00	0.00	0.00	0.00	0.00	3.31
USER COST	0.00	0.00	0.00	0.00	0.00	14.00
ROUTINE MAINT. COST	0.12	0.12	0.12	0.12	0.12	0.07
SALVAGE VALUE	-5.15	-5.08	-4.90	-4.73	-4.65	-4.65
TOTAL COST	28.55	29.19	29.42	29.65	30.30	41.18
NUMBER OF LAYERS	3	3	3	3	3	3
LAYER DEPTH (INCHES)						
D(1)	4.00	4.50	5.00	5.50	6.00	4.00
D(2)	17.00	16.00	14.50	13.00	12.00	12.00
D(3)	8.00	8.00	8.00	8.00	8.00	8.00
NO.OF PERF.PERIODS	1	1	1	1	1	2
PERF. TIME (YEARS)						
T(1)	21.	21.	21.	21.	22.	13.
T(2)						25.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)						
O(1)						2.5

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 459

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
AC	5.00	500.00	0.35	ASPH CONC PVMT
Base	14.50	50.00	0.35	FLEXIBLE BASE
Subbase	8.00	25.00	0.30	STABILIZED SUBGR
Subgrade	200.00	9.00	0.40	SUBGRADE(200)



Fatigue Crack Model:

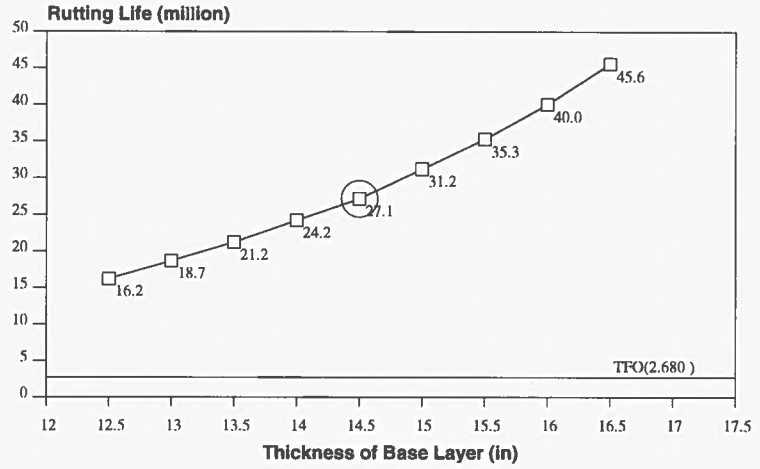
$$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$$

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): 2.68 (million)

Crack Life: 3.36 (million) ε_τ = 160.00 (με)

Rut Life: 27.15 (million) ε_v = -229.00 (με)

Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:2.68millions.
Also the start ADT:8000.0 and ending ADT:16855.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.3Release:12-7-2012)			
Highway	Goforth Rd	Problem	001
C-S-J	1234 - 1 - 1	Date	10/7/2014
District	Austin	County	HAYS
Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade			

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.3 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-7-2012*

PAVEMENT DESIGN TYPE # 2 -- ACP + FLEX BASE OVER SUBGRADE

PROB	DIST.-14	COUNTY-106	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**Austin**	**HAYS**	**1234**	**1**	**1**	**Goforth Rd**	**10/7/2014**	**1**

COMMENTS ABOUT THIS PROBLEM

FDR design for Goforth Road Realignment
COA - Primary Undivided 6-lane Collector - No Stabilized Subbase
ESAL for 20 year analysis period = 2.01 million

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	10.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	8.0
DESIGN CONFIDENCE LEVEL (95.0%)	C
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.5
FINAL SERVICEABILITY INDEX P2	2.5
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.0
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	9.00
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)	75.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	10.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	8000.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	16855.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	2.010
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	55.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	55.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	6.0
PERCENT TRUCKS IN ADT	7.5

PAVEMENT DESIGN TYPE # 2 -- ACP + FLEX BASE OVER SUBGRADE

PROB	DIST.-14	COUNTY-106	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**Austin**	**HAYS**	**1234**	**1**	**1**	**Goforth Rd**	**10/7/2014**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	2.0
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	8.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.90
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	150.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	0.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	10.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	2
TOTAL NUMBER OF LANES OF THE FACILITY	2
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	0
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	1
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	1.00
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.00
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	A	ASPH CONC PVMT	115.00	500000.	0.35	4.00	12.00	30.00
2	B	FLEXIBLE BASE	37.00	28900.	0.35	12.00	25.00	75.00
3	C	SUBGRADE(200)	2.00	9000.	0.40	200.00	200.00	90.00

PAVEMENT DESIGN TYPE # 2 -- ACP + FLEX BASE OVER SUBGRADE

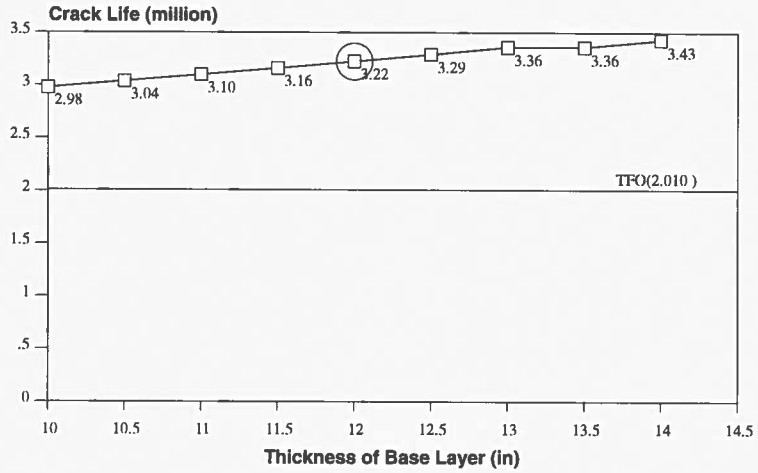
PROB	DIST.-14	COUNTY-106	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**Austin**	**HAYS**	**1234**	**1**	**1**	**Goforth Rd**	**10/7/2014**	**3**

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

	1	2	3	4	5	6	7	8
MATERIAL ARRANGEMENT	AB	AB	AB	AB	AB	AB	AB	AB
INIT. CONST. COST	32.82	33.39	33.44	33.50	33.10	33.56	26.65	26.71
OVERLAY CONST. COST	0.00	0.00	0.00	0.00	0.00	0.00	4.06	3.79
USER COST	0.00	0.00	0.00	0.00	0.00	0.00	7.90	8.16
ROUTINE MAINT. COST	0.12	0.12	0.12	0.12	0.12	0.12	0.06	0.07
SALVAGE VALUE	-4.87	-4.80	-4.62	-4.45	-4.00	-4.27	-4.18	-4.00
TOTAL COST	28.06	28.71	28.94	29.17	29.21	29.40	34.50	34.73
NUMBER OF LAYERS	2	2	2	2	2	2	2	2
LAYER DEPTH (INCHES)								
D(1)	4.00	4.50	5.00	5.50	6.50	6.00	4.00	4.50
D(2)	19.50	18.50	17.00	15.50	12.00	14.00	13.50	12.00
NO.OF PERF.PERIODS	1	1	1	1	1	1	2	2
PERF. TIME (YEARS)								
T(1)	21.	21.	20.	20.	21.	20.	10.	11.
T(2)							20.	21.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)								
O(1)							2.5	2.5

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 456

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
AC	6.50	500.00	0.35	ASPH CONC PVMT
Base	12.00	28.90	0.35	FLEXIBLE BASE
Subgrade	200.00	9.00	0.40	SUBGRADE(200)



Fatigue Crack Model:

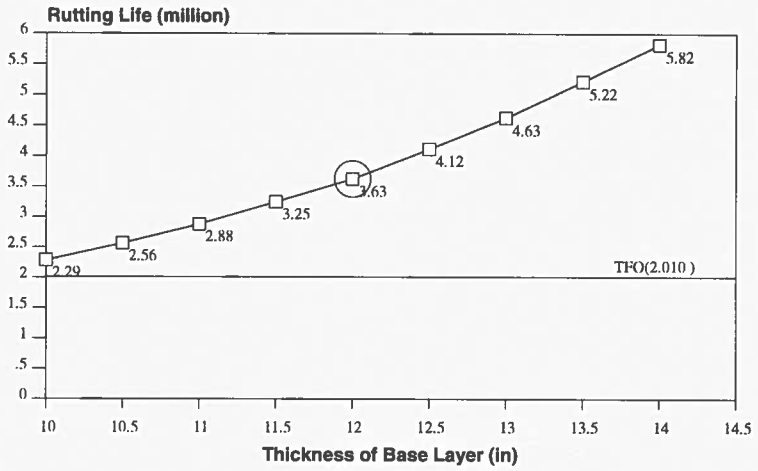
$$N_f = f_1 (\varepsilon_t)^{-f_2} (E_1)^{-f_3}$$

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): 2.01 (million)

Crack Life: 3.22 (million) ε_τ = 162.00 (με)

Rut Life: 3.63 (million) ε_v = -359.00 (με)

Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:2.01millions.
Also the start ADT:8000.0 and ending ADT:16855.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.3Release:12-7-2012)			
Highway	Goforth Rd	Problem	001
C-S-J	1234 - 1 - 1	Date	10/7/2014
District	Austin	County	HAYS
Design Type:Asphalt concrete + Flexible Base over Subgrade			

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.3 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-7-2012*

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB	DIST.-14	COUNTY-106	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**Austin**	**HAYS**	**1234**	**1**	**1**	**Goforth Rd**	**10/7/2014**	**1**

COMMENTS ABOUT THIS PROBLEM

FDR design for Goforth Road Realignment
COA - Primary Undivided 6-lane Collector - Lime Stabilized Subbase
ESAL for 20 year analysis period = 2.01 million

BASIC DESIGN CRITERIA

LENGTH OF THE ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	10.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	8.0
DESIGN CONFIDENCE LEVEL (95.0%)	C
SERVICEABILITY INDEX OF THE INITIAL STRUCTURE	4.5
FINAL SERVICEABILITY INDEX P2	2.5
SERVICEABILITY INDEX P1 AFTER AN OVERLAY	4.0
DISTRICT TEMPERATURE CONSTANT	31.0
SUBGRADE ELASTIC MODULUS by COUNTY (ksi)	9.00
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)	75.0
ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)	10.0

TRAFFIC DATA

ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)	8000.
ADT AT END OF TWENTY YEARS (VEHICLES/DAY)	16855.
ONE-DIRECTION 20YEAR 18 kip ESAL (millions)	2.010
AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)	55.0
AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)	45.0
AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)	55.0
PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)	6.0
PERCENT TRUCKS IN ADT	7.5

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB	DIST.-14	COUNTY-106	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**Austin**	**HAYS**	**1234**	**1**	**1**	**Goforth Rd**	**10/7/2014**	**2**

INPUT DATA CONTINUED

CONSTRUCTION AND MAINTENANCE DATA

MINIMUM OVERLAY THICKNESS (INCHES)	2.0
OVERLAY CONSTRUCTION TIME (HOURS/DAY)	8.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)	1.90
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)	150.0
WIDTH OF EACH LANE (FEET)	12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)	0.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)	10.00

DETOUR DESIGN FOR OVERLAYS

TRAFFIC MODEL USED DURING OVERLAYING	2
TOTAL NUMBER OF LANES OF THE FACILITY	2
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)	0
NUMBER OF OPEN LANES IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)	1
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)	1.00
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)	0.00
DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)	0.00

PAVING MATERIALS INFORMATION

LAYER	MATERIALS CODE	NAME	COST PER CY	E MODULUS	POISSON RATIO	MIN. DEPTH	MAX. DEPTH	SALVAGE PCT.
1	A	ASPH CONC PVMT	115.00	500000.	0.35	4.00	12.00	30.00
2	B	FLEXIBLE BASE	37.00	50000.	0.35	12.00	25.00	75.00
3	C	STABILIZED SUBGR	15.00	25000.	0.30	8.00	8.00	90.00
4	D	SUBGRADE(200)	2.00	9000.	0.40	200.00	200.00	90.00

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

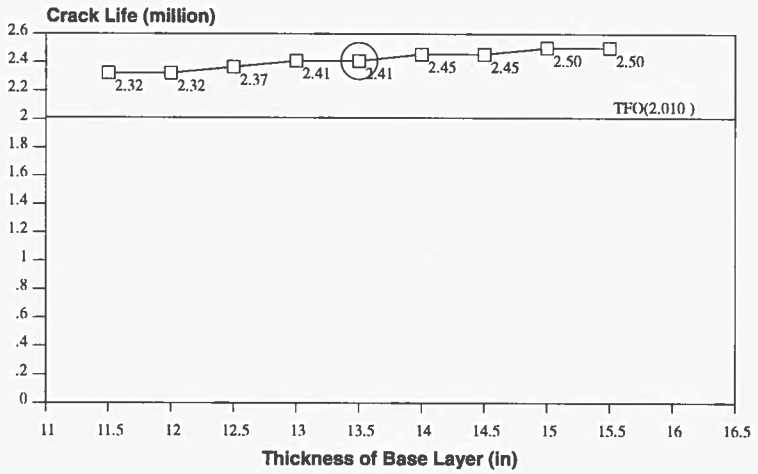
PROB	DIST.-14	COUNTY-106	CONT.	SECT.	JOB	HIGHWAY	DATE	PAGE
001	**Austin**	**HAYS**	**1234**	**1**	**1**	**Goforth Rd**	**10/7/2014**	**3**

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

	1	2	3	4
MATERIAL ARRANGEMENT	ABC	ABC	ABC	ABC
INIT. CONST. COST	31.01	31.58	31.64	28.44
OVERLAY CONST. COST	0.00	0.00	0.00	2.71
USER COST	0.00	0.00	0.00	29.62
ROUTINE MAINT. COST	0.12	0.12	0.12	0.09
SALVAGE VALUE	-4.65	-4.58	-4.40	-4.65
TOTAL COST	26.48	27.12	27.35	56.20
NUMBER OF LAYERS	3	3	3	3
LAYER DEPTH (INCHES)				
D(1)	4.00	4.50	5.00	4.00
D(2)	14.50	13.50	12.00	12.00
D(3)	8.00	8.00	8.00	8.00
NO.OF PERF.PERIODS	1	1	1	2
PERF. TIME (YEARS)				
T(1)	20.	21.	21.	16.
T(2)				30.
OVERLAY POLICY(INCH) (INCLUDING LEVEL-UP)				
O(1)				2.5

THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS 459

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
AC	4.50	500.00	0.35	ASPH CONC PVMT
Base	13.50	50.00	0.35	FLEXIBLE BASE
Subbase	8.00	25.00	0.30	STABILIZED SUBGR
Subgrade	200.00	9.00	0.40	SUBGRADE(200)



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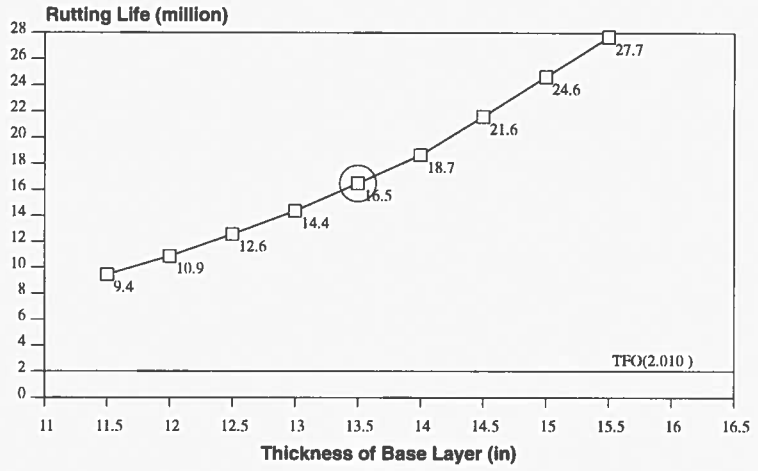

TFO(Traffic to 1st Overlay): 2.01 (million)

Crack Life: 2.41 (million) ε_t = 177.00 (με)

Rut Life: 16.48 (million) ε_v = -256.00 (με)

Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:2.01millions.
Also the start ADT:8000.0 and ending ADT:16855.0

Mechanistic Check Conclusion:

The design is OK !

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Highway	Goforth Rd	Problem	001
C-S-J	1234 - 1 - 1	Date	10/7/2014
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Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade			