Subsurface Exploration and Pavement Analysis
Proposed New Streets
90 Acre TMM Tract
Somerset Road & Watson Road
San Antonio, Texas

InTEC Project No. S201019-P
February 05, 2020

KBHOME
4800 Fredericksburg Road
San Antonio, Texas 78229

inTEC
Integrated Testing and Engineering Company of San Antonio, L.P.
Geotechnical & Environmental Engineering • Construction Services • Geologic Assessment

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February 05, 2020

KBHOME
4800 Fredericksburg Road
San Antonio, Texas 78229

Attention: **Mr. Joseph Hernandez**
Email: jchernandez@kbhome.com

Re: Subsurface Exploration and Pavement Analysis
Proposed New Streets
90 Acre TMM Tract
Somerset Road & Watson Road
San Antonio, Texas

InTEC Project No. S201019-P

Ladies & Gentlemen:

Integrated Testing and Engineering Company of San Antonio (InTEC) has completed a **subsurface exploration and pavement thickness evaluation report** at the above referenced project site. The results of the exploration are presented in this report.

We appreciate and wish to thank you for the opportunity to be of service to you on this project. If we can be of additional assistance during the foundations explorations, and materials testing-quality control phase of construction, please call us.

Sincerely,

InTEC of San Antonio, L.P.

STATE OF TEXAS
MURALI SUBRAMANIAM
102417
LICENSED
PROFESSIONAL ENGINEER
InTEC of SAN ANTONIO
F-7623

02/05/2020

Murali Subramaniam, Ph. D., P.E.

EXECUTIVE SUMMARY

The soil conditions at the location of the **proposed new streets at the 90 Acre TMM Tract at Somerset Road & Watson Road in San Antonio, Texas** were obtained from **15 borings drilled to a depth of 15 feet each.** Laboratory tests were performed on selected specimens to evaluate the engineering characteristics of various soil strata encountered in the borings.

The results of our exploration, laboratory testing and engineering evaluation indicate the underlying clays at this site are **plastic to highly plastic in character.** Potential vertical movements on the order of **4 ½ inches** were estimated.

The proposed pavements at this site may be supported by flexible pavement sections. Cut and fill information is not available for our review at this time.

Based on the field and laboratory test results, the final street subgrade may be brown clay or tan clay subgrade. The pavement subgrade should be observed and delineated for different subgrade condition at the time of construction.

At the time of construction, if the final street subgrade consists of material other than encountered in our borings, the recommendations may have to be revised. Pavement section recommendations for Local, Collector, and Arterial type streets are presented.

Ground water was not encountered in the borings at the time of drilling.

Detailed descriptions of subsurface conditions, engineering analysis, and design recommendations are included in this report.

Summary of Recommended Options
Minimum Flexible Pavement Recommendations – CBR = 2.0 **

	Asphaltic Concrete			Aggregate Base	Geogrid	Subgrade	Structural Number
Street Classification	**Type D, inches**	**Type C, Inches**	**Type B, Inches**	**Thickness, inches**		**Thickness, inches**	
Local Type A	2.00	-	-	11.00	No	Stabilized 6*	2.90
(without bus	2.00	-	-	9.00	Yes	Stabilized 6*	2.89
Traffic)	2.00	-	6.00	-	No	Stabilized 6*	3.40
Local Type A	3.00	-	-	15.00	No	Stabilized 8*	4.06
(with Bus	3.00	-	-	12.50	Yes	Stabilized 8*	4.08
Traffic)	2.00	-	8.00	-	No	Stabilized 6*	4.08
Local Type B	1.50	2.50	-	18.50	No	Stabilized 8*	4.99
	1.50	2.50	-	15.50	Yes	Stabilized 8*	5.03
	3.00	-	-	21.50	No	Stabilized 8*	4.97
	3.00	-	-	18.00	Yes	Stabilized 8*	5.02
	3.00	-	9.00	-	No	Stabilized 8*	5.02
Collector	1.50	2.50	-	21.00	No	Stabilized 8*	5.34
	1.50	2.50	-	17.50	Yes	Stabilized 8*	5.37
	3.00	-	-	24.50	No	Stabilized 8*	5.39
	3.00	-	-	20.00	Yes	Stabilized 8*	5.36
	3.00	-	10.00	-	No	Stabilized 8*	5.36
Arterial							
	2.00	3.00	-	22.50	No	Stabilized 8*	5.99
	2.00	3.00	-	18.50	Yes	Stabilized 8*	5.98
	2.00	2.00	10.50	-	No	Stabilized 8*	5.97

Subgrade Notes (*):

- Cut and fill data are not available at this time.
- Based on the thickness of the clays encountered in the borings, we anticipate the final pavement subgrade Plasticity Index value to be greater than 20. As per Bexar County / City of San Antonio requirements, subgrade stabilization is needed when the Plasticity Index values are greater than 20.
    - The subgrade soils should be tested for soil sulfate content prior to stabilization. If the soil sulfate content is higher than 3000 ppm, an alternate procedure will be needed.
    - The subgrade should be stabilized to a depth of 6 or 8 inches using 6 ½ percent lime content.
        - Lime application rate of **30.0 lbs per sq yard for 6-inch depth** of stabilization is recommended.
        - Lime application rate of **40.0 lbs per sq yard for 8-inch depth** of stabilization is recommended.
- The subgrade may also be stabilized with cement in lieu of lime. Cement application rates should be determined at the time construction.

General Notes (**):

- Input parameters used in pavement section calculations are shown in Table No. 6. Please call us to provide pavement recommendations, if needed, for different input values.
- If repetitive truck or heavy truck traffic is anticipated, please contact us for revised pavement recommendations.
- Pavement section recommendations are based on a subgrade CBR value of 2.0. The pavement recommendations are not based on the shrink / swell characteristics of the underlying soils. The pavement can experience cracking and deformation due to shrinkage and swelling characteristics of the soils as described in the Vertical Movements section of this report. Use of geogrid helps reduce the shrink / swell related cracking.
- If water is allowed to get underneath the asphalt or if moisture content of the base or subgrade changes significantly, then pavement distress will occur. Moisture penetration underneath the asphalt pavement surface may be reduced by installing a vertical moisture barrier, such as deeper curbs; curbs extending a minimum of 6 inches into subgrade.

Geogrid:

- One layer of geogrid, Tensar Triax TX5, installed on top of compacted (moisture conditioned or stabilized) subgrade as per manufacturer's guidelines

Fill Material:

- Fill used to raise the grade - approved fill material should have a minimum CBR value of 2.0 and a maximum plasticity index value of 55. Lime application rates should be re-evaluated and tested for sulfate content prior to use of the fill material.
- The fill material should be approved by the geotechnical engineer, free of deleterious material, and the gravel size should not exceed 3 inches in size. The material should be placed and compacted as per applicable city / county guidelines.

Subgrade verification:

- At the time of construction, the final pavement subgrade should be observed and delineated / verified by a representative of InTEC.

Summary of Pavement Materials

Pavement Section	Material	Stabilization or Treatment	Thickness	Installation
Subgrade	Clays	Stabilization (lime) Sulfate content should be tested prior to stabilization	As recommended in pavement options (6 or 8 inches)	As per applicable city or county guidelines
Base	TxDOT Item 247 A1-2	-	As recommended in pavement options (maximum of 6 inches per lift)	As per applicable city or county guidelines
Asphalt	Type B, C, D	-	As recommended in pavement options	As per applicable city or county guidelines
Geogrid	Tensar Triax TX5	-	One layer	As per manufacturer's recommendations

See report for more details

Applicable procedures and minimum density and moisture percentages

All applicable City of San Antonio Standard Specifications for Construction, June 2008, should be followed. Some of the relevant procedures are shown below.

Pavement Material	Procedure *	Density and Moisture Control
Subgrade fill (maximum 6 inch thick lift)	Item 107	As per construction specifications
Stabilized Subgrade	Item 108- lime	As per construction specifications
Aggregate Base TxDOT Item 247 A1-2 (maximum 6 inch thick lift)	Item 200	As per construction specifications
Asphalt HMAC Type B, C, D	Item 205, 206	As per construction specifications

(*) City of San Antonio Standard Specifications for Construction, June 2008

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INTRODUCTION

General

This report presents the results of our **subsurface exploration and pavement thickness evaluation** for the **proposed new streets at the 90 Acre TMM Tract at Somerset Road & Watson Road in San Antonio, Texas.** This project was authorized by **Mr. Joseph Hernandez.**

Purpose and Scope of Services

The purpose of our subsurface investigation was to evaluate the site's subsurface and ground water conditions and provide pavement thickness recommendations for the planning and development phases of the project. Our scope of services includes the following:

1) drilling and sampling of 15 borings – to a depth of 15 feet each;
2) evaluation of the in-place conditions of the subsurface soils through field penetration tests;
3) observation of the ground water conditions during drilling operations;
4) performing laboratory tests such as Atterberg limits, California Bearing Ratio (C.B.R.), Lime Series, and Moisture content tests;
5) review and evaluation of the field and laboratory test programs during their execution with modifications of these programs, when necessary, to adjust to subsurface conditions revealed by them;
6) compilation, generalization and analyses of the field and laboratory data in relation to the project requirements;
7) estimation of potential vertical movements;
8) preparation of pavement guidelines;
9) preparation of a written geotechnical engineering report for use by the members of the design team in their preparation of construction, contract, and specifications documents.

The Scope of Services **did not include slope stability or any environmental assessment** for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors, colors or unusual or suspicious items or conditions are strictly for the information of the client.

Project Description

The proposed project involves the development of new streets at the 90 Acre TMM Tract at Somerset Road & Watson Road in San Antonio, Texas. The proposed pavement areas are anticipated to include Local, Collector, and Arterial type streets. Cut and fill information are not available for our use at this time. Brown clay or tan clay subgrades are anticipated.

The project site is located East of IH-35 and South of Loop 410 in San Antonio, Texas. Review of the aerial map indicates a clear site with some trees in southeast portion of the property and a pond roughly in the middle of the tract. Review of the topographic map shows site is relatively flat. The geologic maps indicate the site is located within Qle, Leona Formation.

SUBSURFACE EXPLORATION

Scope

The field exploration to determine the engineering characteristics of the subsurface materials included a reconnaissance of the project site, drilling the borings, performing standard penetration tests, and recovering Split Barrel samples.

Fifteen soil test borings were drilled at the approximate locations shown on the Boring Location Plan, Plate 1 included in the Illustration Section of this report. These borings were **drilled to a depth of 15 feet each below the presently existing ground surface**. Boring locations were selected by the project Geotechnical Engineer and established in the field by the drilling crew using normal taping procedures.

Drilling and Sampling Procedures

The soil borings were performed with a drilling rig equipped with a rotary head. Conventional solid stem augers were used to advance the holes and samples of the subsurface materials were obtained **using a Split Barrel sampler.** The samples were identified according to boring number and depth, encased in polyethylene plastic wrapping to protect against moisture loss, and transported to our laboratory in special containers.

In summary, the following samples as presented in Table No. 1 were collected as a part of our field exploration procedure:

Table No. 1

Type of Sample	Number Collected
Split Barrel Samples	53
Auger Samples	22

Field Tests and Water Level Measurements

Penetration Tests – During the sampling procedures, standard penetration tests were performed in the borings in conjunction with the split-barrel sampling. The standard penetration value (N) is defined as the number of blows of a 140-pound hammer, falling thirty inches, required to advance the split-spoon sampler one foot into the soil. The sampler is lowered to the bottom of the drill hole and the number of blows recorded for each of the three successive increments of six inches penetration. The "N" value is obtained by adding the second and third incremental numbers. The results of the standard penetration test indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

Water Level Measurements – Ground water was not encountered in the borings at the time of drilling. In relatively pervious soils, such as sandy soils, the indicated elevations are considered reliable ground water levels. In relatively impervious soils, the accurate determination of the ground water elevation may not be possible even after several days of observation. Seasonal variations, temperature and recent rainfall conditions may influence the levels of the ground water table and volumes of water will depend on the permeability of the soils.

Field Logs

A field log was prepared for each boring. Each log-contained information concerning the boring method, samples attempted and recovered, indications of the presence of various materials such as silt, clay, gravel or sand and observations of ground water. It also contained an interpretation of subsurface conditions between samples. **Therefore, these logs included both factual and interpretive information.**

Presentation of the Data

The final logs represent our interpretation of **the contents of the field logs for the purpose delineated by our client.** The final logs are included on **Plates 2 thru 16** included in the Illustration section. A key to classification terms and symbols used on the logs is presented on **Plate 17.**

LABORATORY TESTING PROGRAM

Purpose

In addition to the field exploration, a supplemental laboratory testing program was conducted to determine additional **pertinent engineering characteristics** of the subsurface materials necessary in evaluating the soil parameters.

Laboratory Tests

All phases of the laboratory testing program were performed **in general accordance with the indicated applicable** ASTM Specifications as indicated in Table No. 2.

Table No. 2

Laboratory Test	Applicable Test Standard
Liquid Limit, Plastic Limit and Plasticity Index of the Soils	ASTM D 4318
Moisture Content	ASTM D 2216
California Bearing Ratio	ASTM D 1883

In the laboratory, each sample **was observed and classified by a geotechnical engineer.** As a part of this classification procedure, the natural water contents of selected specimens were determined. Liquid and plastic limit tests were performed on representative specimens to determine the plasticity characteristics of the different soil strata encountered.

Presentation of the Data

In summary, the tests presented in Table No. 3 in the following page were conducted in the laboratory to evaluate the engineering characteristics of the subsurface materials:

Table No. 3

Type of Test	Number Conducted
Natural Moisture Content	75
Atterberg Limits	14
California Bearing Ratio	1
Lime Series	1

The results of all these tests are presented on appropriate boring logs. These laboratory test results were used to classify the soils encountered generally according to the Unified Soil Classification System (ASTM D 2487).

GENERAL SUBSURFACE CONDITIONS

Soil Stratigraphy

The soils underlying the site may be grouped into **two generalized strata** with similar physical and engineering properties. The lines designating the interface between soil strata on the logs represent approximate boundaries. Transition between materials may be gradual. The soil stratigraphy information at the boring locations are presented in **Boring Logs, Plates 2 thru 16.** The soil conditions in between borings may vary across the site. We should be called upon at the time of construction to verify the soil conditions between our borings.

The engineering characteristics of the underlying soils, based the results of the laboratory tests performed in selected samples, are summarized and presented in the following paragraph.

The project site consists of dark brown clays, and tan clays. These clays are highly plastic with tested liquid limits ranging from 38 to 78 and plasticity index values varying from 23 to 56. The results of standard penetration tests performed within these clays varied from 10 to 28 blows per foot.

The above description is of a generalized nature to highlight the major soil stratification features and soil characteristics. The test boring logs should be consulted for specific information at each boring location.

Soil Stratigraphy may vary between boring locations. <u>If deviations from the noted subsurface conditions are encountered during construction, they should be brought to the attention of InTEC. We may revise the recommendations after evaluating the significance of the changed conditions.</u>

Ground Water Observations

Ground water was not encountered in the borings at the time of drilling. Short term field observations generally do not provide accurate ground water levels. The contractor should check the subsurface water conditions prior to any excavation activities. The low permeability of the soils would require several days or longer for ground water to enter and stabilize in the bore holes. Ground water levels will fluctuate with seasonal climatic variations and changes in the land use.

It is not unusual to encounter shallow groundwater during or after periods of rainfall. The surface water tends to percolate down through the surface until it encounters a relatively impervious layer.

PAVEMENTS ON EXPANSIVE SOIL

General

There are many plastic clays that swell considerably when water is added to them and then shrink with the loss of water. Pavements constructed on these clays are subjected to large uplifting forces caused by the swelling.

In the characterization of a pavement site, two major factors that contribute to potential shrink-swell problems must be considered. Problems can arise if a) the soil has expansive and shrinkage properties and b) the environmental conditions that cause moisture changes to occur in the soil.

Evaluation of the Shrink-Swell Potential of the Soils

Subsurface sampling, laboratory testing and data analyses are used in the evaluation of the shrink-swell potential of the soils under the pavements.

The Mechanism of Swelling

The mechanism of swelling in expansive clays is complex and is influenced by a number of factors. Basically, expansion is a result of changes in the soil-water system that disturbs the internal stress equilibrium. Clay particles in general have negative electrical charges on their surfaces and positively charged ends. The negative charges are balanced by actions in the soil water and give rise to an electrical interparticle force field. In addition, adsorptive forces exist between the clay crystals and water molecules, and Van Der Waals surface forces exist between particles. Thus, there exists an internal electro-chemical force system that must be in equilibrium with the externally applied stresses and capillary tension in the soil water. If the soil water chemistry is changed either by changing the amount of water or the chemical composition, the interparticle force field will change. If the change in internal forces is not balanced by a corresponding change in the state of stress, the particle spacing will change so as to adjust the interparticle forces until equilibrium is reached. This change in particle spacing manifests itself as a shrinkage or swelling.

Initial Moisture Condition and Moisture Variation

Volume change in an expansive soil mass is the result of increases or decreases in water content. The initial moisture content influences the swell and shrink potential relative to possible limits, or ranges, in moisture content. Moisture content alone is useless as an indicator or predictor of shrink-swell potential. The relationship of moisture content to limiting moisture contents such as the plastic limit and liquid limit must be known.

If the moisture content is below or near plastic limit, the soils have high potential to swell. It has been reported that expansive soils with liquidity index* in the range of 0.20 to 0.40 will tend to experience little additional swell.

The availability of water to an expansive soil profile is influenced by many environmental and manmade factors. Generally, the upper few feet of the profile are subjected to the widest ranges of moisture variation, and are least restrained against movement by overburden. This upper stratum of the profile is referred to as the active zone. Moisture variation in the active zone of a natural soil profile is affected by climatic cycles at the surface, and fluctuating groundwater levels at the lower moisture boundary. The surficial boundary moisture conditions are changed significantly simply by placing a barrier such as a building floor slab or pavement between the soil and atmospheric environment. Other obvious and direct causes of moisture variation result from altered drainage conditions or man-made sources of water, such as irrigation or leaky plumbing. The latter factors are difficult to quantify and incorporate into the analysis, but should be controlled to the extent possible for each situation. For example, proper drainage and attention to landscaping are simple means of minimizing moisture fluctuations near structures, and should always be taken into consideration.

Man Made Conditions That Can Be Altered

There are a number of factors that can influence whether a soil might shrink or swell and the magnitude of this movement. For the most part, either the owner or the designer has some control over whether the factor will be avoided altogether or if not avoided, the degree to which the factor will be allowed to influence the shrink-swell process.

> Antecedent Rainfall Ratio This is a measure of the local climate and is defined as the total monthly rainfall for the month of and the month prior to laying the pavement divided by twice the average monthly rate measured for the period. The intent of this ratio is to give a relative measure of ground moisture conditions at the time the pavement is placed. Thus, if a pavement is placed at the end of a wet period, the pavement should be expected to experience some loss of support around the perimeter as the wet soils begin to dry out and

* LIQUIDITY INDEX = {NATURAL WATER CONTENT - PLASTIC LIMIT} / {LIQUID LIMIT - PLASTIC LIMIT}

shrink. The opposite effect could be anticipated if the pavement is placed at the end of an extended dry period; as the wet season occurs, uplift around the perimeter may occur as the soil at the edge of the slab pavement in moisture content.

Age of Pavement The length of time since the pavement was cast provides an indication of the type of swelling of the soil profile that can be expected to be found beneath the pavement.

Drainage This provides a measure of the slope of the ground surface with respect to available free surface water that may accumulate around the pavement. Most builders are aware of the importance of sloping the final grade of the soil away from the pavement so that rain water is not allowed to collect and pond against or adjacent to the pavement. If water were allowed to accumulate next to the pavement, it would provide an available source of free water to the expansive soil underlying the pavement. Similarly, surface water drainage patterns or swales must not be altered so that runoff is allowed to collect next to the pavement.

Pre-Construction Vegetation Large amount of vegetation existing on a site before construction may have desiccated the site to some degree, especially where large trees grew before clearing. Constructing over a desiccated soil can produce some dramatic instances of heave and associated structural distress and damage as it wets up.

Post-Construction Vegetation The type, amount, and location of vegetation that has been allowed to grow since construction can cause localized desiccation. Planting trees or large shrubs near a pavement can result in loss of foundation support as the tree or shrub removes water from the soil and dries it out. Conversely, the opposite effect can occur if flowerbeds or shrubs are planted next to the pavement and these beds are kept well watered or flooded. This practice can result in swelling of the soil around the perimeter where the soil is kept wet.

Utilities Underneath the Pavement The utilities such as sewer, water, electricity, gas, and communication lines are often installed underneath the streets. The sewer utility construction, for example, typically involves trenching to the desired depth, installing gravel a gravel bed underneath the sewer main, installing primary backfill (gravel), and placing back the secondary backfill (generally excavated soils). The secondary backfill material is compacted in lifts. In addition, sewer service lines run laterally from each house (for a typical subdivision, approximately every 50-ft). These trenches with gravel and onsite material backfill are conducive to carrying water. In addition, the sewer service lines can carry water from behind the curb. Occasionally, the sewer line may be encased in concrete which will cause ponding of any travelling water within the sewer trenches. Any water travelling within these trenches can cause expansive clays to swell. If the backfill is not adequately compacted or if excessive water is flowing in these trenches, the trench backfill can potentially settle.

Summation

It is beyond the scope of this investigation to do more than point out that the above factors have a definite influence on the amount and type of swell to which a pavement is subjected during its useful life. The design engineer must be aware of these factors as he develops his design and make adjustments as necessary according to the results of special measurements or from his engineering experience and judgment.

DESIGN ENGINEERING ANALYSIS

Pavement Design Considerations

Review of the borings and test data indicates that the following factors will affect the pavement design and construction at this site:

1) The site is underlain by plastic to highly plastic clays. Structures supported on or within these soils will be subjected to potential vertical movements on the order of **4 ½ inches.**

2) The strengths of the underlying soils are adequate to support the proposed new streets.

3) Based on the stratigraphy observed at this site, the final street subgrade is anticipated to be in the clay subgrades. The final street subgrade should be verified by InTEC at the time of construction.

4) Ground water was not encountered in the borings at the time of drilling.

Vertical Movements

The potential vertical rise (PVR) for slab-on grade construction at the location of the structures had been estimated using Texas Department of Transportation Procedure TXDOT-124-E. This method utilizes the liquid limits, plasticity indices, and in-situ moisture contents for soils in the seasonally active zone, <u>estimated to be about ten to twelve feet</u> at the project site.

The estimated PVR value provided is based on the proposed floor system applying a sustained surcharge load of approximately 1.0 lb. per square inch on the subgrade materials**. Potential vertical movement on the order of 4 ½ inches was estimated at the existing grade elevation**. TxDOT method of estimating potential vertical movement of expansive clays is based on empirical correlations utilizing measured plasticity index values and assumed seasonal fluctuations in moisture content. Higher or lower PVR values may be estimated using other methods. However, the TxDOT method is the most widely used in the project area.

The PVR values are based on the current site grades. If cut and fill operations in excess of 6 inches are performed, the PVR values could change significantly. Higher PVR values than the above-mentioned values will occur in areas where water is allowed to pond for extended periods.

Potential vertical movements much greater than 2 to 3 times the anticipated vertical movements of 2 ½ to 3 ¾ inches may be realized under the following circumstances: a) If proper drainage is not maintained, the subgrade moisture content will increase significantly so the clay will swell and / or b) if the pavement is underlain by utility trenches and the utility line leak happens. In addition, the subgrade strength may be significantly lowered, so that pavement will deteriorate.

If the finish grade elevation is higher than the existing grade, compacted select fill should be used to raise the grade level. Any select fill should be placed and compacted as recommended under "Select Fill in the "Construction Guidelines" section of this report. Each lift should be compacted and tested by InTEC to verify Compaction Compliance.

Method to Reduce Vertical Movements

The underlying clays may be removed to a depth of **2 to 6 feet** and replaced by compacted crushed limestone select fill. The depth options and the respective anticipated movements after selection of one of the depth options are presented in Table No. 4.

Table No. 4

Depth of Existing Clay Removal and Replacement, Feet	Anticipated Potential Vertical Movements, Inches
0	4 ½
3	3
5	2
7	1

The select fill should be placed and compacted as recommended under "Select Fill" in the "Construction Guidelines" section of this report. The compacted select fill should extend a minimum of 3-ft outside the edges of the pavement. Each lift should be tested and approved by InTEC before placement of the subsequent lift.

If over excavation and select fill replacement is used to lower potential vertical movements, the bottom of excavation should be drained properly. It should not act as a bathtub and hold water in the event any accidental source of water enters the excavation. Gravel fill and perforated drainpipes with perforations at the bottom, outlet pipes with a gradient, and day-lighting the pipes with head walls should be considered for proper drainage. If additional options are required, please contact InTEC.

When the clay removal and select fill replacement method is used to reduce potential vertical movements, the select fill extending 3 to 5-ft outside the pavement area should be covered by 2-ft thick compacted impervious clay. The impervious clay (with plasticity index value 35 or greater) should be placed in 8 inch loose lifts and compacted to a minimum of 95 percent of the maximum TxDOT 114E dry density at a water content between Optimum and Optimum Plus two percentage points. The top surface of clay seal should be sloped away from the building perimeter. If other options are required to reduce PVR, please contact InTEC.

It should be noted that expansive clay does not shrink/swell without changes in moisture content, and thus good site design is very important to minimize movements. Coping with problems of shrink/swell due to expansive clays is a “fact of life” in the Texas region of south western U.S.A.

PAVEMENT GUIDELINES

General

Pavement area at this unit is expected to include Local, Collector, and Arterial type streets. The following recommendations are presented as a guideline for pavement design and construction. These recommendations are based on a) our previous experience with subgrade soils like those encountered at this site, b) pavement sections which have proved to be successful under similar design conditions, c) final pavement grades will provide adequate drainage for the pavement areas and that water will not be allowed to enter the pavement system by either edge penetration adjacent to landscape areas or penetration from the surface due to surface ponding, or inadequate maintenance of pavement joints, or surface cracks that may develop.

Pavement Design

Pavement designs provide an adequate thickness of structural sections over a particular subgrade (in order to reduce the wheel load to a distributed level so that the subgrade can support load). The support characteristics of the subgrade are based on strength characteristics of the subgrade soils and not on the shrinkage and swelling characteristics of the clays. Therefore, the pavement sections may be adequate from a structural stand point, may still experience cracking and deformation due to shrinkage and swelling characteristics of the soils. In addition, if the proposed new pavements are used to carry temporary construction traffic, then heavier sections may be needed. Please contact InTEC to discuss options.

It is very important to minimize moisture changes in the subgrade to lower the shrinkage and swell movements of the subgrade clays. The pavement and adjacent areas should be well drained. Proper maintenance should be performed by sealing the cracks as soon as they develop to prevent further water penetrations and damage. In our experience,

(a) majority of the pavement distress observed over the years were caused by changes in moisture content of the underlying subgrade and / or excessive moisture in the base section,

(b) pavements with a grade of one percent or more have performed better than the pavements with allowable minimum grade,

(c) pavements with no underground utilities have performed better than pavements with underground utilities and the associated laterals,

(d) pavements that are at a higher-grade elevation than the surrounding lots have performed better, and

(e) any design effort that minimizes moisture penetration into the pavement layers have performed better.

"Alligator" type Cracks

A layer of aggregate base is typically used underneath the concrete curbs around the pavement areas. This layer of aggregate base underneath the concrete curb is conducive to the infiltration of surface water into the pavement areas. Water infiltration into the subgrade and / or base layer can result in "alligator type" cracks especially when accompanied by construction traffic. Increased moisture content of the pavement sections will significantly impact its support characteristics. Moisture penetration into pavement layers can be reduced by (a) penetrating the concrete curbs at least three inches into the native clays soils, (b) installing French Drains on the outside of the curbs, or (c) installing a moisture barrier such as a trench filled with bentonite or flowable fill. Alligator type cracks are also caused by weak / soft pockets within the pavement layers. Thoroughly proof rolling the subgrade and base layers will help identify the soft softs and densify as needed.

Longitudinal Cracks

Asphalt pavements in highly expansive soil conditions, such as the soils encountered at this site, can develop longitudinal cracks along the pavement edges. The longitudinal cracking typically occurs about 1 to 4 feet inside of the pavement edges and they run parallel to the pavement edge. Longitudinal or reflective cracks may also be observed over utility trenches. The longitudinal cracks are generally caused by differential drying and shrinkage of the underlying expansive clays. The moisture content change of the underlying subgrade clays can be reduced by installing moisture barriers. Vertical moisture barriers along the edge of the pavement or horizontal moisture barriers such as paved sidewalks or geogrid will help control the development of the longitudinal cracks.

Periodic Maintenance

The pavements constructed on clay subgrades such as the one encountered at this site will be subjected to shrink / swell related movements. Hence, proper maintenance should be performed by sealing the cracks as soon as they develop to prevent further water penetrations and damage.

Pavement Sections

Local, Collector, and Arterial type residential streets may be designed with flexible pavements. The final finish street subgrade is expected to be in brown clay or tan clay subgrade areas. Minimum flexible pavement sections for the anticipated subgrades are presented in Table No. 5 in the following page. The project geotechnical engineer should delineate the streets for different subgrades at the time of construction. Input parameters used in the pavement section calculations are presented in Table No. 6.

- If pavement design for parameters other than those shown in Table No. 6 is needed or if repetitive / heavy truck traffic is anticipated, please contact us for additional pavement section recommendations.
- The recommended pavement sections are based on the subgrade soil support characteristics.
- The pavement sections are not based on shrink / swell characteristics of the subgrade soils.
- The subgrade soil support characteristics will be significantly affected by changes in moisture content.

The cut and fill information is not available at this time. The final street subgrade should be verified by InTEC at the time of construction.

Table No. 5 – Minimum Flexible Pavement Recommendations – CBR = 2.0 **

	Asphaltic Concrete			Aggregate Base	Geogrid	Subgrade	Structural Number
Street Classification	**Type D, inches**	**Type C, Inches**	**Type B, Inches**	**Thickness, inches**		**Thickness, inches**	
Local Type A	2.00	-	-	11.00	No	Stabilized 6*	2.90
(without bus	2.00	-	-	9.00	Yes	Stabilized 6*	2.89
Traffic)	2.00	-	6.00	-	No	Stabilized 6*	3.40
Local Type A	3.00	-	-	15.00	No	Stabilized 8*	4.06
(with Bus	3.00	-	-	12.50	Yes	Stabilized 8*	4.08
Traffic)	2.00	-	8.00	-	No	Stabilized 6*	4.08
Local Type B	1.50	2.50	-	18.50	No	Stabilized 8*	4.99
	1.50	2.50	-	15.50	Yes	Stabilized 8*	5.03
	3.00	-	-	21.50	No	Stabilized 8*	4.97
	3.00	-	-	18.00	Yes	Stabilized 8*	5.02
	3.00	-	9.00	-	No	Stabilized 8*	5.02
Collector	1.50	2.50	-	21.00	No	Stabilized 8*	5.34
	1.50	2.50	-	17.50	Yes	Stabilized 8*	5.37
	3.00	-	-	24.50	No	Stabilized 8*	5.39
	3.00	-	-	20.00	Yes	Stabilized 8*	5.36
	3.00	-	10.00	-	No	Stabilized 8*	5.36
Arterial							
	2.00	3.00	-	22.50	No	Stabilized 8*	5.99
	2.00	3.00	-	18.50	Yes	Stabilized 8*	5.98
	2.00	2.00	10.50	-	No	Stabilized 8*	5.97

Subgrade Notes (*):

- Cut and fill data are not available at this time.
- Based on the thickness of the clays encountered in the borings, we anticipate the final pavement subgrade Plasticity Index value to be greater than 20. As per Bexar County / City of San Antonio requirements, subgrade stabilization is needed when the Plasticity Index values are greater than 20.
    - The subgrade soils should be tested for soil sulfate content prior to stabilization. If the soil sulfate content is higher than 3000 ppm, an alternate procedure will be needed.
    - The subgrade should be stabilized to a depth of 6 or 8 inches using 6 ½ percent lime content.
        - Lime application rate of **30.0 lbs per sq yard for 6-inch depth** of stabilization is recommended.
        - Lime application rate of **40.0 lbs per sq yard for 8-inch depth** of stabilization is recommended.
- The subgrade may also be stabilized with cement in lieu of lime. Cement application rates should be determined at the time construction.

General Notes (**):

- Input parameters used in pavement section calculations are shown in Table No. 6. Please call us to provide pavement recommendations, if needed, for different input values.
- If repetitive truck or heavy truck traffic is anticipated, please contact us for revised pavement recommendations.
- Pavement section recommendations are based on a subgrade CBR value of 2.0. The pavement recommendations are not based on the shrink / swell characteristics of the underlying soils. The pavement can experience cracking and deformation due to shrinkage and swelling characteristics of the soils as described in the Vertical Movements section of this report. Use of geogrid helps reduce the shrink / swell related cracking.
- If water is allowed to get underneath the asphalt or if moisture content of the base or subgrade changes significantly, then pavement distress will occur. Moisture penetration underneath the asphalt pavement surface may be reduced by installing a vertical moisture barrier, such as deeper curbs; curbs extending a minimum of 6 inches into subgrade.

Geogrid:

- One layer of geogrid, Tensar Triax TX5, installed on top of compacted (moisture conditioned or stabilized) subgrade as per manufacturer's guidelines

Fill Material:

- Fill used to raise the grade - approved fill material should have a minimum CBR value of 2.0 and a maximum plasticity index value of 55. Lime application rates should be re-evaluated and tested for sulfate content prior to use of the fill material.
- The fill material should be approved by the geotechnical engineer, free of deleterious material, and the gravel size should not exceed 3 inches in size. The material should be placed and compacted as per applicable city / county guidelines.

Subgrade verification:

- At the time of construction, the final pavement subgrade should be observed and delineated / verified by a representative of InTEC.

Table No. 6 – Input Parameters used in Asphalt Pavement Section Calculation

	Local Type A Street (no bus traffic)	Local Type A Street (with bus traffic)	Local Type B Street	Collector	Arterial
ESAL	100,000	1,000,000	2,000,000	2,000,000	3,000,000
Reliability Level	R-70	R-70	R-90	R-90	R-95
Initial and Terminal Serviceability	4.2 and 2.0	4.2 and 2.0	4.2 and 2.0	4.2 and 2.5	4.2 and 2.5
Standard Deviation	0.45	0.45	0.45	0.45	0.45
Service Life	20 years	20 years	20 years	20 years	20 years

Subgrade Preparation

It is important that any existing pavement and organic and compressible soils are removed and the exposed subgrade is properly prepared prior to pavement installation. The subgrade should be prepared as described in the applicable city / county Guidelines. Base course material should be placed immediately upon completion of the subgrade compaction operation to prevent drying of the soils due to exposure.

The finish grade elevation of the subgrade should be such that water drains downward freely towards a drainage area. At the drainage area, 3x5 rock may be provided at the subgrade level and the collected water at the drainage area should be taken out (such as into the existing concrete drainage channel). If any voids in the subgrade should be filled in with the same subgrade material and compacted in lifts.

The approved fill material should be placed in 8-inch lifts (6 inches compacted) and compacted as recommended in the Site Preparation section of the Construction Guidelines presented in this report. If the fill depth exceeds 4 feet, the potential subgrade settlement should be considered. Please contact InTEC with the cut and fill information to evaluate the effect of proposed cut and fill on the recommendations and to provide fill material and compaction recommendations.

Base Course

Based on the survey of available materials in the area, a base course of crushed limestone aggregate or gravel appears to be the most practical material for asphalt pavement project. The base course should conform to Texas State Department of Highways and Public Transportation Standard Specification, Item 247, Type A, Grade 1-2. The aggregate base course should be installed as per applicable city / county Guidelines.

At a minimum the base course should be brought to near optimum moisture conditions and compacted in lifts to at least 95 percent of maximum dry density as determined by test method TxDOT 113E.

Asphaltic Concrete

The asphaltic concrete surface course should conform to City of San Antonio Standard Construction Guidelines, 2008. The asphaltic concrete should be installed as per applicable city / county Guidelines.

Perimeter Drainage

It is important that proper perimeter drainage be provided so that infiltration of surface water from compacted areas surrounding the pavement is minimized, or if this is not possible, curbs should extent through the base and into the subgrade. A crack sealant compatible to both asphalt and concrete should be installed at the concrete-asphalt interfaces.

Wherever there are drastic grade changes in the pavement area (such as from 3 to 4 percent grade to 1 to 2 percent grade) 3 x 5 inch gravel subgrade with a subsurface drain system (such as Akwadrain® on the sides of the pavement) and outlet should be considered. This aspect will provide for a better drainage system in this area. Please contact InTEC for drainage recommendations.

CONSTRUCTION GUIDELINES

Construction Monitoring

As Geotechnical Engineer of Record for this project, InTEC should be involved in monitoring the pavement construction and earth work activities. Performance of any pavement system is not only dependent on the pavement design, but is strongly influenced by the quality of construction. Please contact our office prior of construction so that a plan for pavement construction and earthwork monitoring can be incorporated in the overall project quality control program. The testing requirements shall comply with the minimum testing requirements as per applicable city and county guidelines.

Site Preparation

Site preparation will consist of **preparation of the subgrade, and placement of select structural fill.** The project geotechnical **engineer InTEC should approve the subgrade preparation, the fill materials, and the method of fill placement and compaction.**

In any areas where soil-supported concrete structure or pavement are to be used, vegetation and all loose or excessively organic material should be stripped to a minimum depth of six inches and removed from the site. Subsequent to stripping operations, the pavement subgrade should be proof rolled prior to fill placement and recompacted to as per City of San Antonio Standard Construction Guidelines, 2008. The exposed subgrade should not be allowed to dry out prior to placing structural fill. Each lift should be tested by InTEC geotechnical engineer or his representative prior to placement of the subsequent lift.

Voids caused by site preparation, such as removal of trees or disturbed areas, should be compacted as described below:

Compaction

A small pond was observed on the south west part of the tract. Any loose or wet materials should be removed. Site grading plan is not available for review at this time. If any low areas or disturbed areas encountered during construction should be appropriately prepared and compacted. Any deleterious or wet materials should be removed and wasted. The fill placement in the low areas should not be in a “bowl shape”. The sides of the fill area should be “squared up” and the excavated bottom should be proof rolled as described in *Proof Rolling* section of this report. On site material, with no deleterious material, may be used to raise the grade. After proof rolling operation, the fill should be placed in 6 inch lifts and compacted to a minimum of **95 percent of the maximum dry density as determined by ASTM D 698 test method within optimum and three percent above optimum moisture content.** Each lift should be tested by InTEC for compaction compliance and approved before placement of the subsequent lifts. The exposed subgrade should not be allowed to dry out prior to placing structural fill. It is recommended that any given lot does not straddle filled areas and natural areas to help reduce differential movement of the structures.

The excavation boundaries should be set such that building or pavement areas do not straddle fill and natural areas. The anticipated potential vertical movement may be significantly affected after the cut and fill operations are performed in this area.

Proof Rolling

Proof rolling should be accomplished in order to locate and densify any weak compressible zones under the structure and pavement areas and prior to placement of the select fill or base. A minimum of 10 passes of a 25-ton pneumatic roller should be used for planning purposes. The operating load and tire pressure should conform to the manufactures specification to produce a minimum ground contact pressure of 90 pound per square inch. Proof rolling should be performed under the observation of the InTEC Geotechnical Engineer or his representative. The soils that yield or settle under proof rolling operations should be removed, dried and compacted or replaced with compacted select fill to grade. Density tests should be conducted as specified under *Control Testing and Filed Observation* after satisfactory proof rolling operation.

Proper site drainage should be maintained during construction so that ponding of surface run-off does not occur and cause construction delays and/or inhibit site access.

Select Fill

Any select fill used under the building should have a liquid limit less than 40 and a plasticity index in between 5 and 20 and be crushed limestone. The fill should contain no particles greater than 3 inches in diameter. **The percent passing U.S. Standard Sieve No. 4 should be in between 40 and 80 percent and Sieve No. 40 passing should be in between 10 and 50 percent. The percent passing Sieve No. 200 should be less than 20 percent**.

Crushed limestone with sufficient fines to bind the aggregate together is a suitable select structural fill material. The fill materials should be placed in loose lifts not to exceed 8 inches thick (6-inches compacted) and compacted to 95 percent of the maximum dry density as determined by ASTM D 1557 procedure at a moisture content within 2 percent of the optimum water content.

General Fill

General fill materials may consist of clean on-site material, select fill materials, or any clean imported fill material. The purpose of a general fill is to provide soils with good compaction characteristics that will provide uniform support for any non-habitable structures that are not movement sensitive. The general fill may also be used underneath the pavement areas. The pavement recommendations should be re-evaluated based on the fill material characteristics. The general fill material should be free of any deleterious material, construction debris, organic material, and should not have gravels larger than 6 inches in maximum dimension. The top two feet of fill material used underneath pavement areas should not have gravels larger than 3 inches in maximum dimension.

It should be understood that the use of the general fill may result in greater than anticipated potential vertical movements and differential movements. If the greater potential vertical movements or differential soil movements cannot be tolerated, then select fill material should be used and should conform to the Select Fill recommendations.

General Fill Compaction

The general fill materials should be placed in lifts not to exceed 8 inches thick and compacted to a minimum of 95 percent of the maximum dry density as determined by test method ASTM D 698 at a moisture content within 3 percent of the optimum water content. Each lift should be compacted and tested by a representative of a geotechnical laboratory to verify compaction compliance and approved before placement of the subsequent lifts.

The general fill compaction requirements can also be discussed and determined in consultation with the owner prior to construction.

Ground Water

In any areas where significant cuts (2-ft or more) are made to establish final grades for pavement, attention should be given to possible seasonal water seepage that could occur through natural cracks and fissures in the newly exposed stratigraphy. Subsurface drains may be required to intercept seasonal groundwater seepage. The need for these or other dewatering devices on should be carefully addressed during construction. Our office could be contacted to visually inspect final pads to evaluate the need for such drains.

The ground water seepage may happen several years after construction if the rainfall rate or drainage changes within the project site or outside the project site. If seepage run off occurs towards the pavement areas an engineer should be called on to evaluate its effect and provision of French Drains at this location.

Drainage

Ground water seepage was not encountered in the borings at the time of drilling. However, minor ground water seepage may be encountered within the pavement areas and grading excavations at the time of construction, especially after periods of heavy precipitation. **Small quantities of seepage may be handled by conventional sump and pump methods of dewatering.**

Temporary Drainage Measures

Temporary drainage provisions should be established, as necessary, to minimize water runoff into the construction areas. If standing water does accumulate, it should be removed by pumping as soon as possible.

Adequate protection against sloughing of soils should be provided for workers and inspectors entering the excavations. This protection should meet O.S.H.A. and other applicable building codes.

Temporary Construction Slopes

Temporary slopes on the order of 1H to 1V may be provided for excavations through Strata I clays.

Fill slopes on the order of 1H to 1V may be used provided a) the fill materials are compacted as recommended and b) the slopes are temporary.

Fill slopes should be compacted. Compacting operations shall be continued until the slopes are stable but not too dense for planting on the slopes. Compaction of the slopes may be done in increments of 3 to 5-ft in fill height or the fill is brought to its total height for shallow fills.

Permanent Slopes

Maximum permanent slope of 1V to 3H is recommended in Stratum I clays. In areas where people walk on sloped areas, a slope of 1V to 5H is recommended.

Time of Construction

If the pavement is installed during or after an extended dry period, the subgrade may experience greater movement around the edges when the soil moisture content increases, such as due to rain or irrigation. Similarly, a pavement installed during or after a wet period may experience greater movement around the edges during the subsequent drying of the soils.

Control Testing and Field Observation

Subgrade preparation and base and asphalt placement should be monitored by the project geotechnical engineer or his representative of InTEC. As a guideline, at least one in-place density test should be **performed for every 100 lineal feet (or as per respective city and county requirements, whichever requires more frequent testing) of street of compacted surface lift.** However, a minimum of three density tests should be performed by InTEC on the subgrade or subsequent lifts of compaction. Any areas not meeting the required compaction should be re-compacted and retested until compliance is met.

DRAINAGE AND MAINTENANCE

Final drainage is very important for the performance of the proposed pavement. Landscaping, plumbing, and downspout drainage is also very important. It is vital that drainage be transported away from the pavement so that no water ponds around the pavement (such as behind the curbs) which can result in soil volume change under the pavement. Any leaks or drainage issues should be repaired as soon as possible in order to minimize the magnitude of moisture change under the pavement. Large trees and shrubs should not be planted in the immediate vicinity of the pavement, since root systems can cause a substantial reduction in soil volume in the vicinity of the trees during dry periods. Silt fences placed adjacent to the curb can potentially allow water to get into the pavement area.

Trench backfill for utilities should be properly placed and compacted as outlined in this report and in accordance with all applicable requirements such local City / County / SAWS Standards. Since granular bedding backfill is used for most utility lines, the backfilled trench should be prevented from becoming a conduit and allowing an access for surface or subsurface water to travel toward the new pavement. Concrete cut-off collars or clay plugs should be provided where utility lines cross curbs to prevent water traveling in the trench backfill and entering beneath the pavement. If concrete encasing is used around the sewer pipes, an alternate path for water to continue to drain should be installed.

In areas with sidewalks or other structures adjacent to the new pavement, a positive seal must be provided and maintained between the structures and the pavement or sidewalk to minimize seepage of water into the underlying supporting soils. **Post-construction movement of pavement and flat-work is not uncommon.** Maximum grades practical should be used for paving and flatwork to prevent areas where water can pond. In addition, allowances in final grades should take into consideration post construction movement of flatwork particularly if such movement would be critical. **Normal maintenance should include inspection of all joints in paving and sidewalks, etc. as well as re-sealing where necessary.**

Several factors relate to civil and architectural design and/or maintenance which can significantly affect future movements of the pavement systems:

1. Where positive surface drainage cannot be achieved by sloping away of the ground surface adjacent to the pavement, a drainage system should carry runoff water away from the completed pavement.

2. Planters located adjacent to the pavement should preferably be **self-contained**. Sprinkler mains should be located a minimum of five feet from the pavement.

3. Planter box structures placed adjacent to pavement should be provided with a means to assure concentrations of water are not available to the subsoils stratigraphy.

4. Large trees and shrubs should not be allowed closer to the pavement than a horizontal distance equal to roughly their mature height due to their significant moisture demand upon maturing.

5. Moisture conditions should be maintained **"constant" around the edge of the pavements.** Ponding of water in planters, in unpaved areas, and around joints in paving and sidewalks can cause movements beyond those predicted in this report and significantly reduce the subgrade support.

Adequate drainage should be provided to reduce seasonal variations in moisture content of soils around the pavement. The PVR values estimated and stated under Vertical Movements are based on provision and maintenance of positive drainage to divert water away from the pavement areas. If the drainage is not maintained, the wetted front may move below the assumed twelve feet depth, and resulting **PVR will be much greater than 2 or 3 times the stated values under Vertical Movements. Utility line leaks may contribute water and cause similar movements to occur. In addition, if the soil is allowed to dry, the associated shrinkage can cause pavement cracks. Similarly, significant changes in moisture content of the underlying pavement layers, will impact the support characteristics of the subgrade.**

Dry Periods

Close observations should be made around pavements during extreme dry periods to ensure that adequate watering is being provided to keep soil from separating or pulling back from the curb and to minimize the shrinkage related cracks.

LIMITATIONS

The analyses and recommendations submitted in this report are based upon the data obtained from **15 borings** drilled at the site. This report may not reflect the exact variations of the soil conditions across the site. Based on the noted topography within the site, cut and fill are anticipated. The pavement recommendations presented in the report should be reviewed and confirmed based on the proposed cut and fill and observation at the time of construction.

If deviations from the noted subsurface conditions are encountered during construction, they should be brought to the attention of the geotechnical engineer. The information contained in this report and on the boring logs is not intended to provide the contractor with all the information needed for proper selection of equipment, means and methods, or for cost and schedule estimation purposes. The use of information contained in the report for bidding purposes should be done at the contractor's option and risk.

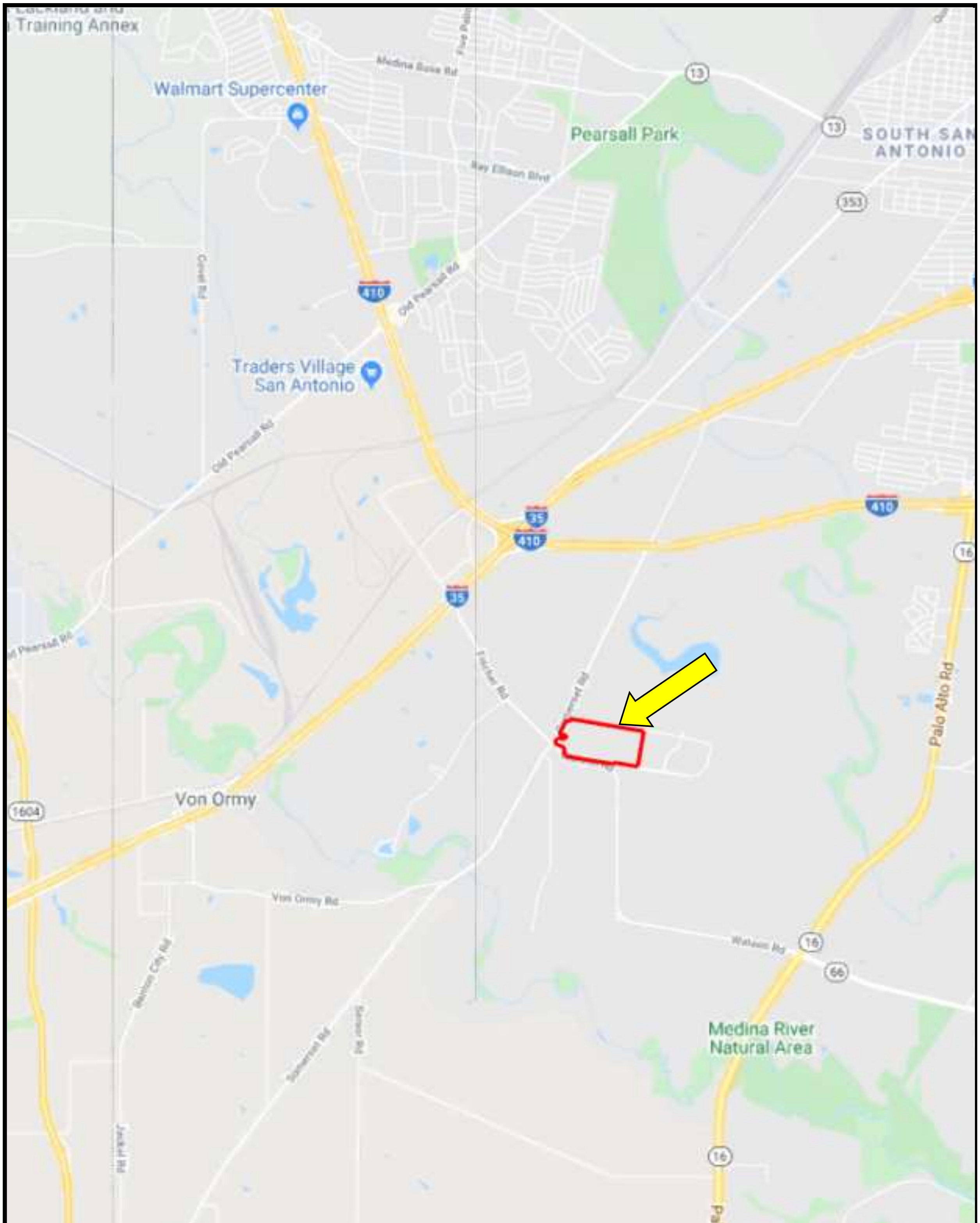
Final plans for the proposed streets should be reviewed by the project geotechnical engineer so that he may determine if changes in the recommendations are required.

The project geotechnical engineer declares that the findings, recommendations or professional advice contained herein have been made and this report prepared in accordance with generally accepted professional engineering practice in the fields of geotechnical engineering and engineering geology. The recommendations presented in this report should be reevaluated by InTEC if cut and fill operations are performed, any changes are made to drainage conditions. No other warranties are implied or expressed.

This report has been prepared for the exclusive use of **KBHOME** for pavement thickness evaluation for the **proposed new streets at the 90 Acre TMM Tract at Somerset Road & Watson Road in San Antonio, Texas.**

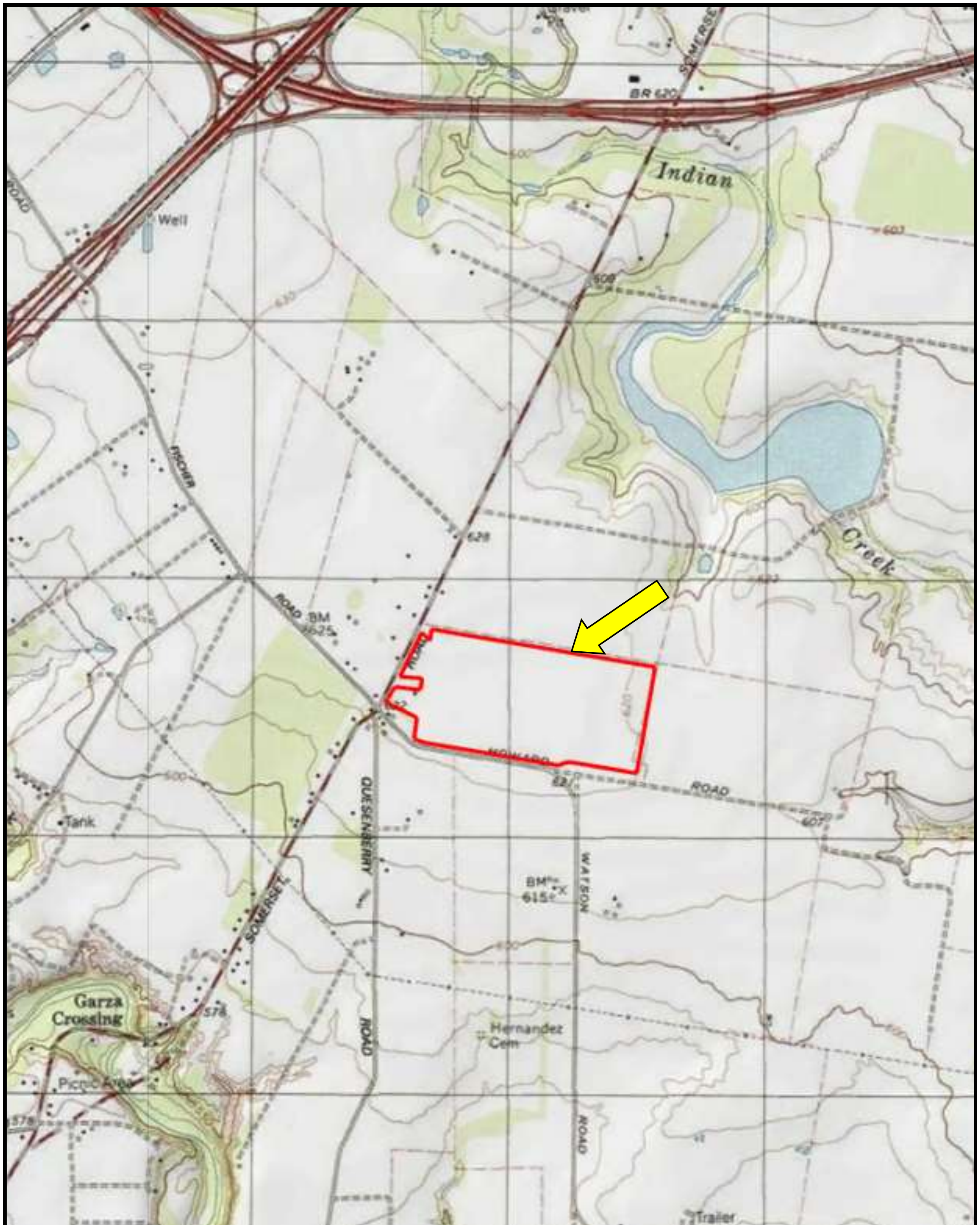
Illustration Section

Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	InTEC Project Number: **S201019-P**	Date: 01/20/2020

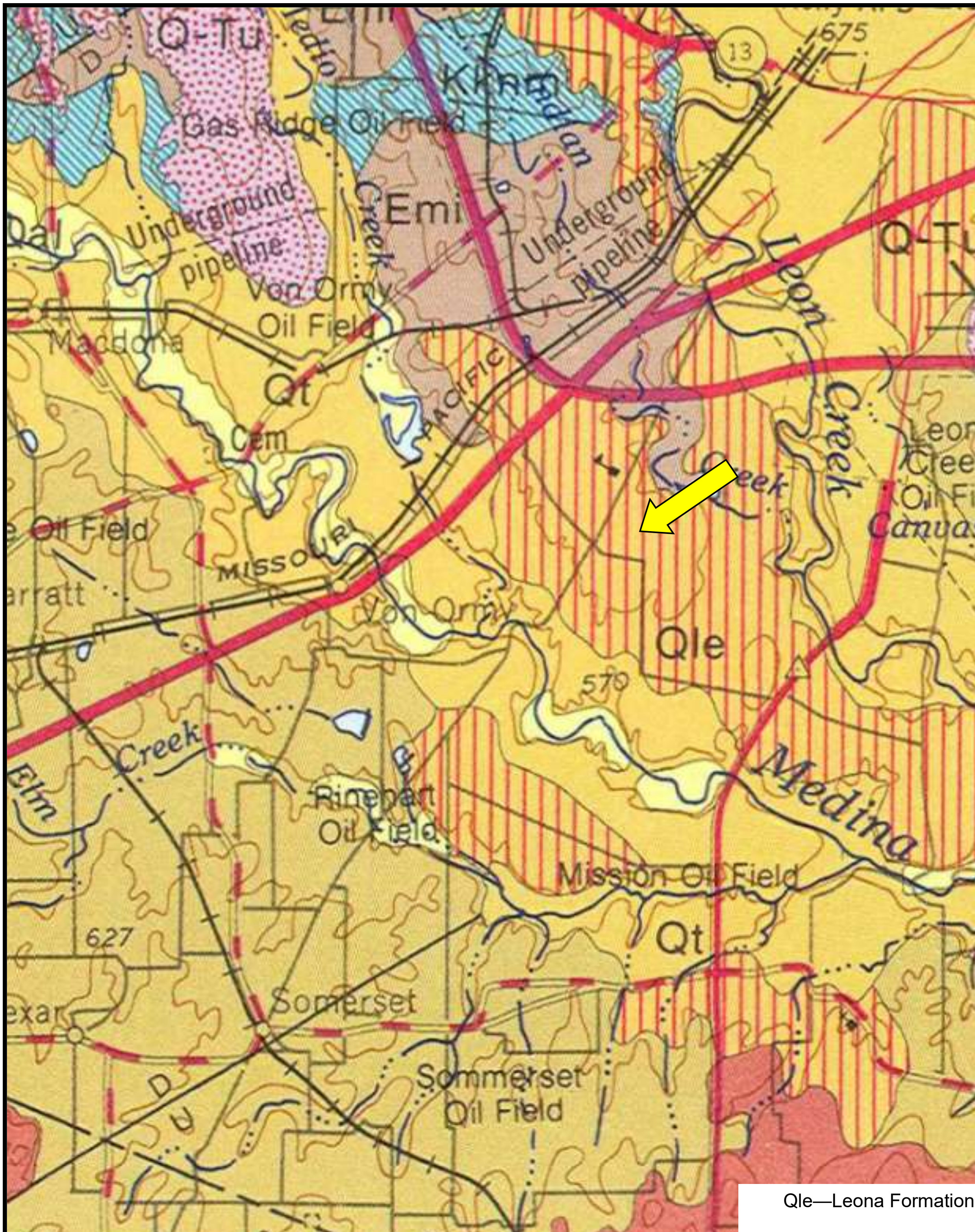


Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Vicinity Map**	
	InTEC Project Number: **S201019-P**	Date: 01/20/2020

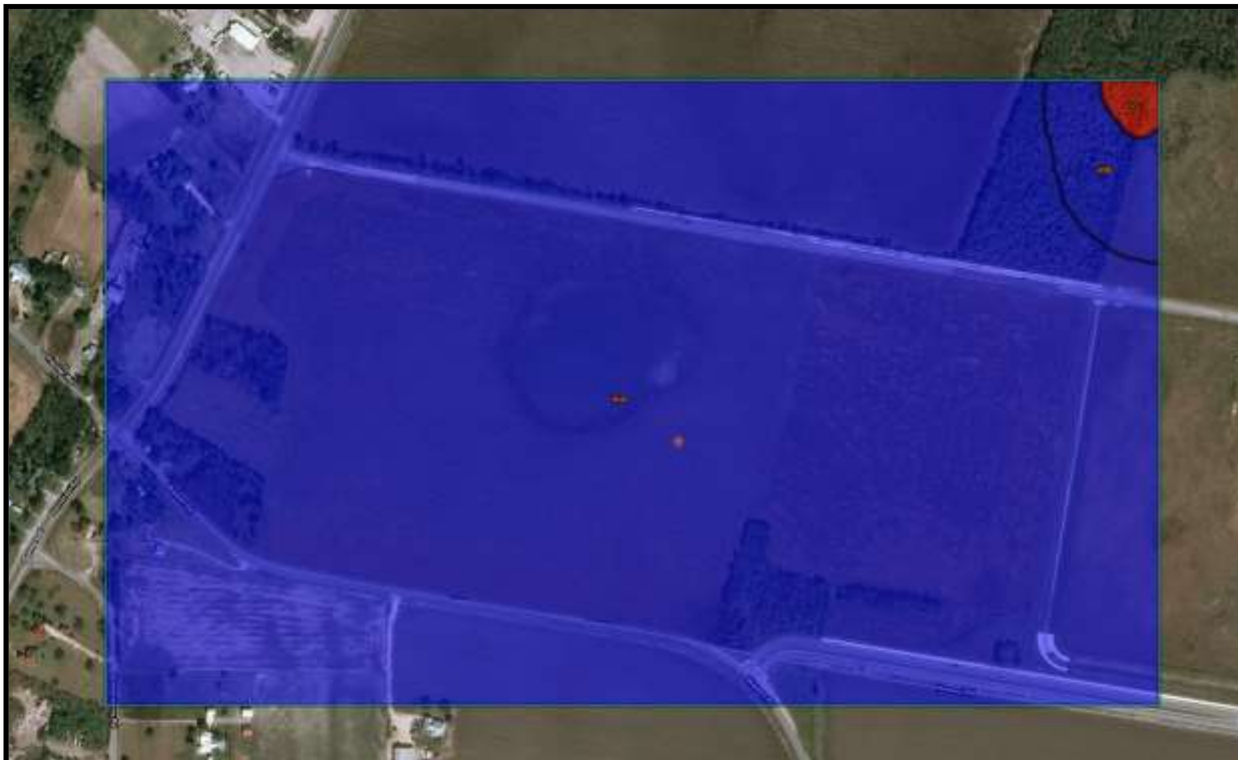
Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Aerial Map—Approximate Location**	
	InTEC Project Number: **S201019-P**	Date: 01/20/2020



Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Topographic Map—Approximate Location**	
	InTEC Project Number: **S201019-P**	Date: 01/20/2020



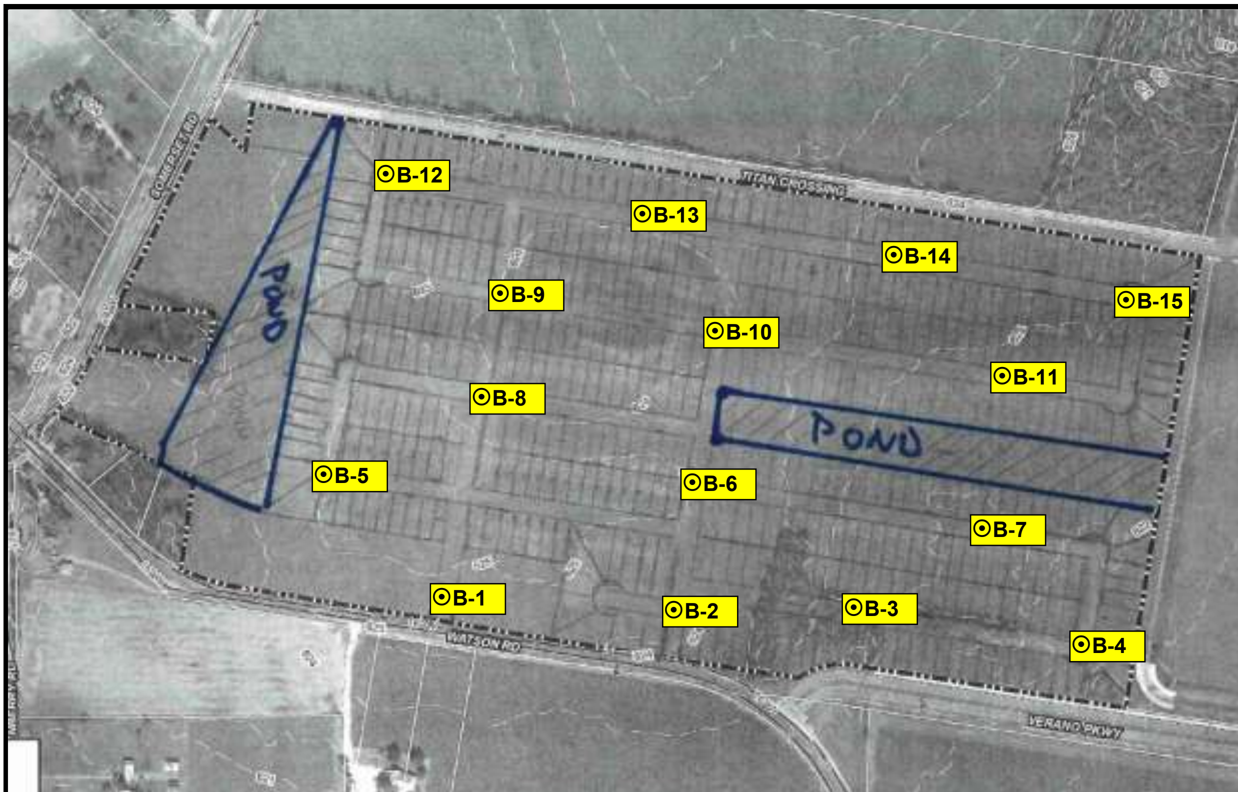
Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Geologic Map—Approximate Location**	
	InTEC Project Number: **S201019-P**	Date: 01/20/2020



Bexar County, Texas

Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				L-R-H	L-R-H	L-R-H	L-R-H	L-R-H	L-R-H	L-R-H	L-R-H
HtA—Branyon clay, 0 to 1 percent slopes														
Branyon	85	D	0-12	Clay	CH	A-7-6	0- 0- 0	0- 0- 0	94-98-100	78-92-100	73-90-100	64-79- 92	59-63 -69	35-39-43
			12-72	Silty clay, clay	CH	A-7-6	0- 0- 0	0- 0- 0	95-98-100	78-92-100	69-90-100	62-82- 94	59-69 -74	39-43-47
			72-80	Clay, clay loam, silty clay loam, silty clay	CL, CH	A-7-6, A-6	0- 0- 0	0- 0- 0	95-98-100	79-92-100	85-91-100	60-85- 97	40-60 -84	23-34-47
HtB—Branyon clay, 1 to 3 percent slopes														
Branyon	85	D	0-12	Clay	CH	A-7-6	0- 0- 0	0- 0- 0	94-98-100	78-92-100	73-90-100	64-79- 92	59-63 -69	35-39-43
			12-72	Silty clay, clay	CH	A-7-6	0- 0- 0	0- 0- 0	95-98-100	78-92-100	69-90-100	62-82- 94	59-69 -74	39-43-47
			72-80	Clay loam, silty clay loam, silty clay, clay	CL, CH	A-6, A-7-6	0- 0- 0	0- 0- 0	95-98-100	79-92-100	85-91-100	60-85- 97	40-60 -84	23-34-47
LvC—Lewisville silty clay, 3 to 5 percent slopes, eroded														
Lewisville, eroded	85	B	0-12	Silty clay	CH	A-7-6	0- 0- 0	0- 0- 0	94-98-100	94-96-100	91-95-100	87-90-100	52-52 -59	28-29-34
			12-36	Clay loam, silty clay loam, silty clay	CL, CH	A-6, A-7-6	0- 0- 0	0- 0- 0	95-98-100	95-96-100	83-93-100	79-88-100	39-49 -57	18-26-32
			36-84	Clay loam, silty clay loam, silty clay	CH, CL	A-7-6, A-6	0- 0- 0	0- 0- 0	81-89-100	81-89-100	71-88-100	65-82-100	39-50 -59	18-27-34

Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Soil Map—Approximate Location**	
	InTEC Project Number: **S201019-P**	Date: 01/20/2020



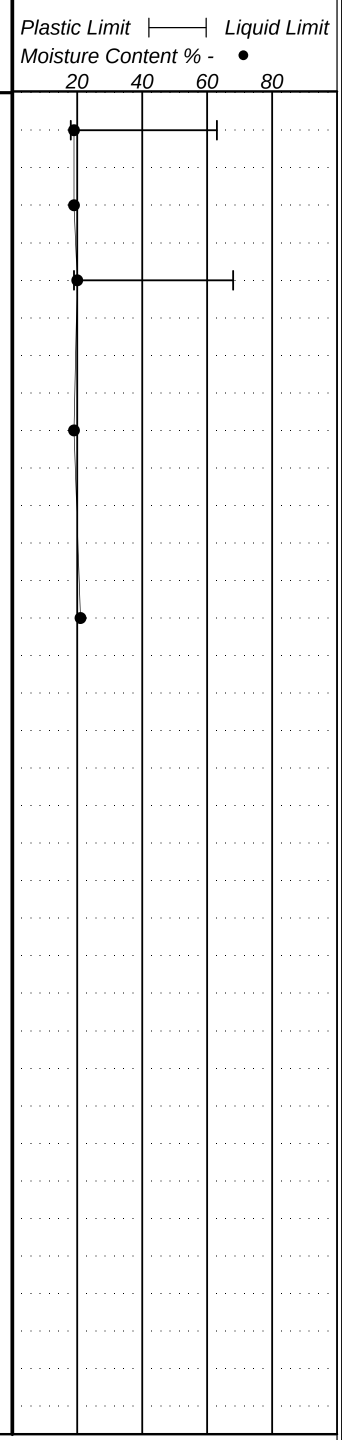
Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Approximate Boring Locations**	
	InTEC Project Number: **S201019-P**	Date: 01/20/2020

PROJECT: **90 Acre TMM Tract**
LOCATION: San Antonio, Texas
CLIENT: KB Home

PROJECT NO: **S201019**
DATE: 01-29-2020

BORING NO. B-1

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0		SS	Stiff to Very Stiff Dark Brown Clay -with a Trace of Gravel				12		63	45
		SS					13			
5		SS					15		68	49
		AU	Very Stiff Tan Clay -with a Trace of Gravel							
10										
15		SS					18			
20										
25										
30										
35										



Notes:

Ground Water Observed: No

Completion Depth (ft): 15

S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

Plate: 2

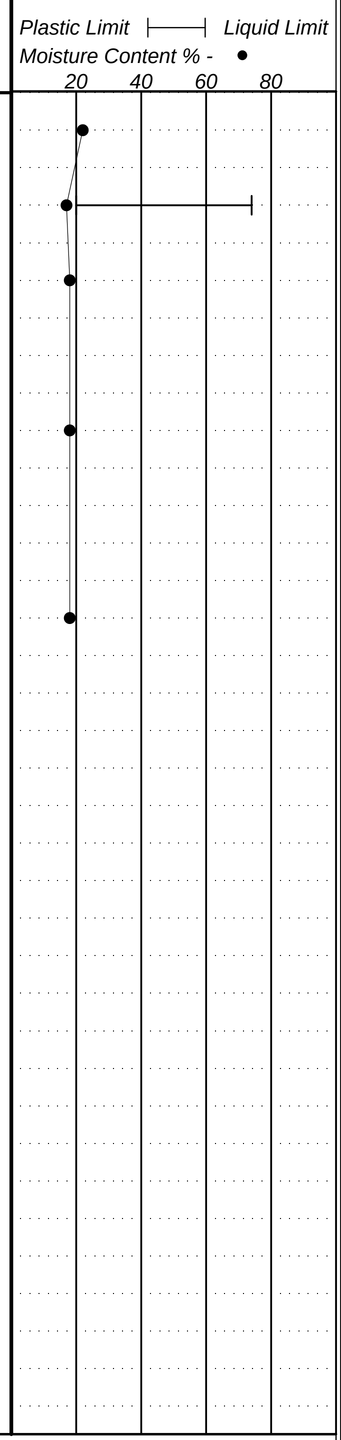
PROJECT: **90 Acre TMM Tract**
LOCATION: San Antonio, Texas
CLIENT: KB Home

PROJECT NO: **S201019**
DATE: 01-29-2020

intec

BORING NO. B-2

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0		SS	Stiff to Very Stiff Dark Brown Clay -with a Trace of Gravel				14			
		AU							74	54
5		SS					16			
			Very Stiff Tan Clay -with a Trace of Gravel							
10		AU								
15		SS					18			
20										
25										
30										
35										



Notes:

Ground Water Observed: No

Completion Depth (ft): 15

S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

Plate: 3

PROJECT: **90 Acre TMM Tract** **PROJECT NO:** **S201019**
LOCATION: San Antonio, Texas **DATE:** 01-29-2020
CLIENT: KB Home

inTEC

BORING NO. B-3

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX	Plastic Limit ├──┤ Liquid Limit; Moisture Content % - ● (20, 40, 60, 80)
0		SS	Stiff to Very Stiff Dark Brown Clay -with a Trace of Gravel				10				
		SS					12				
5		SS					16				
			Very Stiff Tan Clay -with a Trace of Gravel								
		AU							76	56	
10											
		SS					19				
15											
20											
25											
30											
35											

Notes:

Ground Water Observed: No

Completion Depth (ft): 15

S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

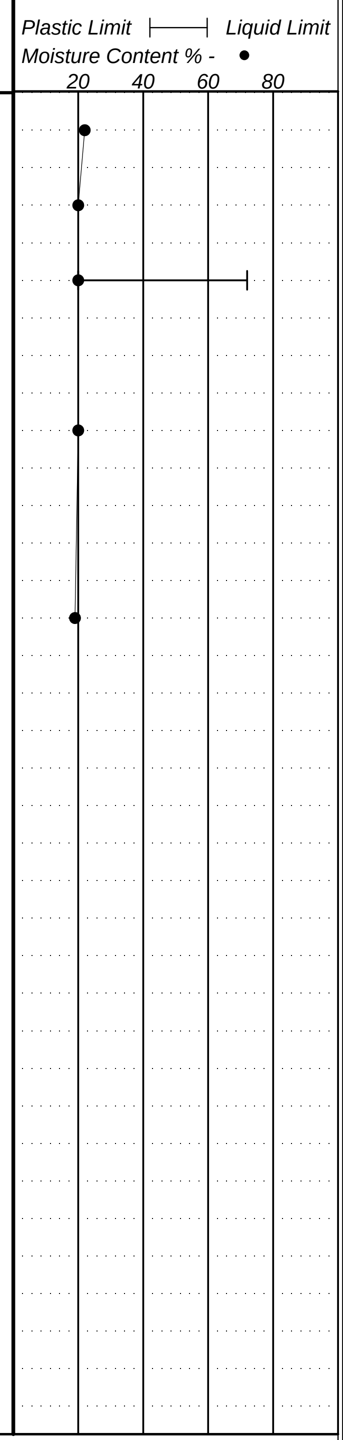
Plate: 4

PROJECT: **90 Acre TMM Tract**
LOCATION: San Antonio, Texas
CLIENT: KB Home

PROJECT NO: **S201019**
DATE: 01-29-2020

BORING NO. B-4

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0			Stiff to Very Stiff Dark Brown Clay -with a Trace of Gravel							
		SS					13			
		AU								
5		SS					16		72	52
			Very Stiff Tan Clay -with a Trace of Gravel							
10		AU								
15		SS					21			
20										
25										
30										
35										



Notes:

Ground Water Observed: No

Completion Depth (ft): 15

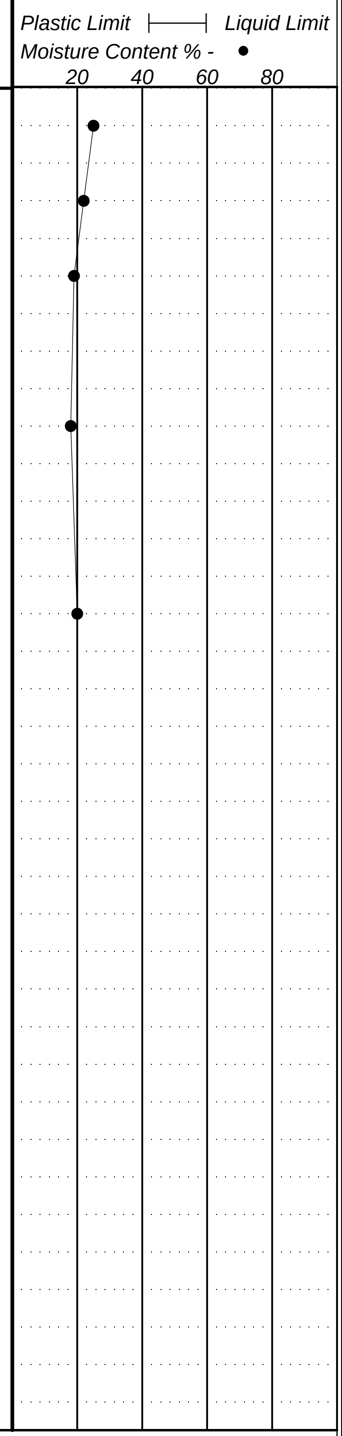
S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

Plate: 5

PROJECT: **90 Acre TMM Tract** **PROJECT NO:** **S201019**
LOCATION: San Antonio, Texas **DATE:** 01-29-2020
CLIENT: KB Home

BORING NO. B-5

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0			Stiff to Very Stiff Dark Brown Clay -with a Trace of Gravel							
		SS					14			
		SS					16			
5		AU								
			Very Stiff Tan Clay -with a Trace of Gravel							
10		AU								
15		SS					21			
20										
25										
30										
35										



Notes:

Ground Water Observed: No

Completion Depth (ft): 15

S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

Plate: 6

PROJECT: **90 Acre TMM Tract**
LOCATION: San Antonio, Texas
CLIENT: KB Home

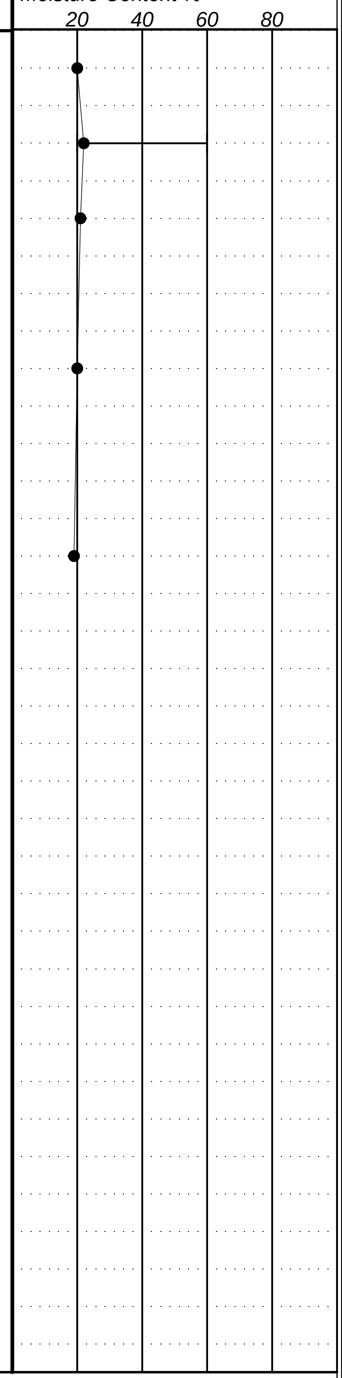
PROJECT NO: **S201019**
DATE: 01-29-2020

intec

BORING NO. B-6

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0			Very Stiff Dark Brown Clay -with a Trace of Gravel							
		SS					16			
		SS					23		60	40
5		SS	Very Stiff Tan Clay -with a Trace of Gravel				22			
		AU								
10										
		SS					21			
15										
20										
25										
30										
35										

Plastic Limit |——| *Liquid Limit*
Moisture Content % - ●



Notes:

Ground Water Observed: No

Completion Depth (ft): 15

S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

Plate: 7

PROJECT: **90 Acre TMM Tract** **PROJECT NO:** **S201019**
LOCATION: San Antonio, Texas **DATE:** 01-29-2020
CLIENT: KB Home

BORING NO. B-7

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX	Plastic Limit ├─┤ Liquid Limit; Moisture Content % - ● (20, 40, 60, 80)
0		SS	Very Stiff Dark Brown Clay -with a Trace of Gravel				16				
		SS					18				
5		AU	Very Stiff Tan Clay -with a Trace of Gravel						72	51	
10		AU									
		SS					19				
15											
20											
25											
30											
35											

Notes: **Ground Water Observed:** No **Completion Depth (ft):** 15

S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

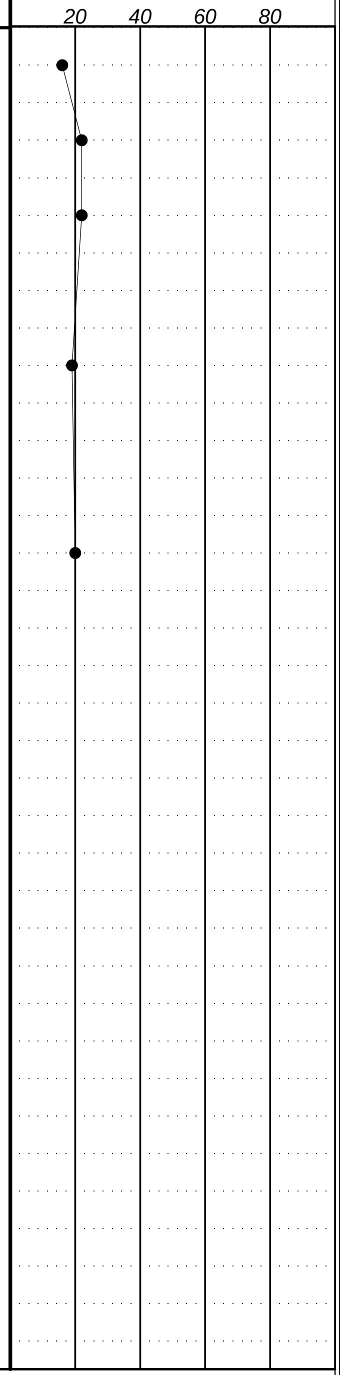
Plate: 8

PROJECT: 90 Acre TMM Tract **PROJECT NO: S201019**
LOCATION: San Antonio, Texas **DATE:** 01-29-2020
CLIENT: KB Home

BORING NO. B-8

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0		SS	Very Stiff Dark Brown Clay -with a Trace of Gravel				16			
		AU								
5		SS	Very Stiff Tan Clay -with a Trace of Gravel				19			
		AU								
10										
		SS					22			
15										
20										
25										
30										
35										

Plastic Limit ├──┤ *Liquid Limit*
Moisture Content % - ●



Notes:

Ground Water Observed: No

Completion Depth (ft): 15

S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

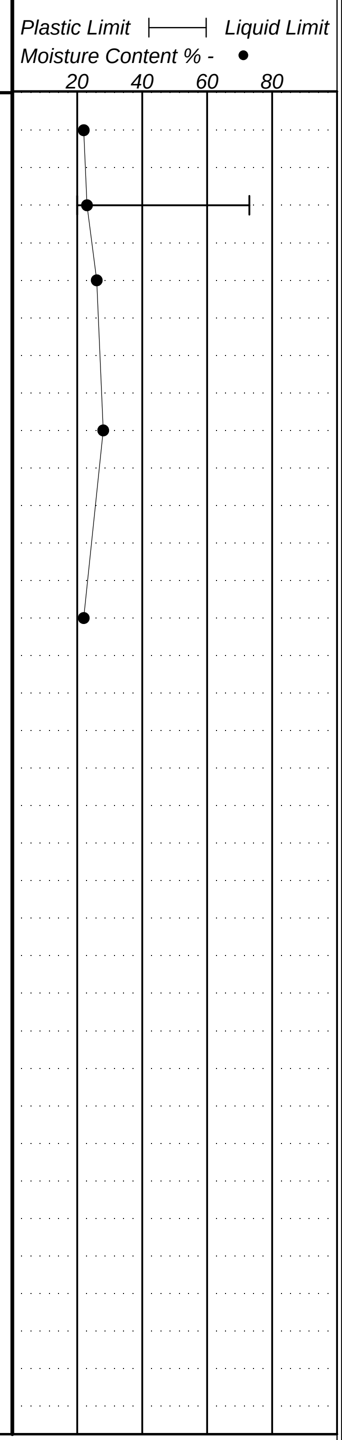
Plate: 9

PROJECT: **90 Acre TMM Tract**
LOCATION: San Antonio, Texas
CLIENT: KB Home

PROJECT NO: **S201019**
DATE: 01-29-2020

BORING NO. B-9

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0			Very Stiff Dark Brown Clay -with a Trace of Gravel							
		SS					16			
		SS					27		73	53
5		SS					28			
			Very Stiff Tan Clay -with a Trace of Gravel							
10		AU								
15		SS					23			
20										
25										
30										
35										



Notes:

Ground Water Observed: No

Completion Depth (ft): 15

S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

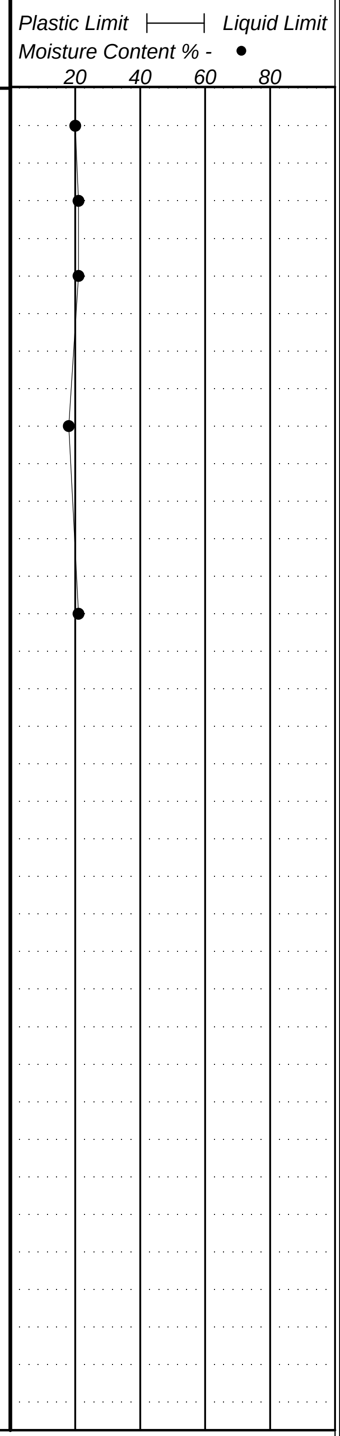
Plate: 10

PROJECT: 90 Acre TMM Tract
LOCATION: San Antonio, Texas
CLIENT: KB Home

PROJECT NO: S201019
DATE: 01-29-2020

BORING NO. B-10

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0		SS	Very Stiff Dark Brown Clay -with a Trace of Gravel				16			
		SS					19			
5		AU	Very Stiff Tan Clay -with a Trace of Gravel							
		SS					21			
10										
		SS					23			
15										
20										
25										
30										
35										



Notes:

Ground Water Observed: No

Completion Depth (ft): 15

S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

Plate: 11

PROJECT: **90 Acre TMM Tract**
LOCATION: San Antonio, Texas
CLIENT: KB Home

PROJECT NO: **S201019**
DATE: 01-29-2020

inTEC

BORING NO. B-11

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX	Plastic Limit ├──┤ Liquid Limit; Moisture Content % - ● (20, 40, 60, 80)
0			Stiff to Very Stiff Dark Brown Clay -with a Trace of Gravel								
		SS					13				
		SS					18				
5		SS					16		68	45	
			Very Stiff Tan Clay -with a Trace of Gravel								
		AU									
10											
		SS					20				
15											
20											
25											
30											
35											

Notes:

Ground Water Observed: No

Completion Depth (ft): 15

S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

Plate: 12

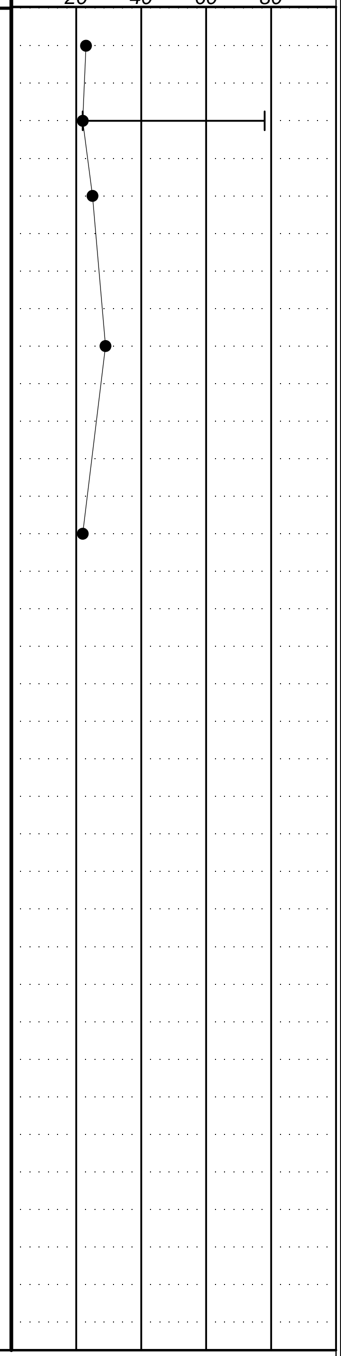
PROJECT: 90 Acre TMM Tract
LOCATION: San Antonio, Texas
CLIENT: KB Home

PROJECT NO: S201019
DATE: 01-29-2020

BORING NO. B-12

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0			Stiff to Very Stiff Dark Brown Clay -with a Trace of Gravel							
		SS					14			
		SS					16		78	56
5		SS					19			
			Very Stiff Tan Clay -with a Trace of Gravel							
		AU								
10										
		SS					21			
15										
20										
25										
30										
35										

Plastic Limit ├──┤ *Liquid Limit*
Moisture Content % - ●
20 40 60 80



Notes:

Ground Water Observed: No

Completion Depth (ft): 15

S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

Plate: 13

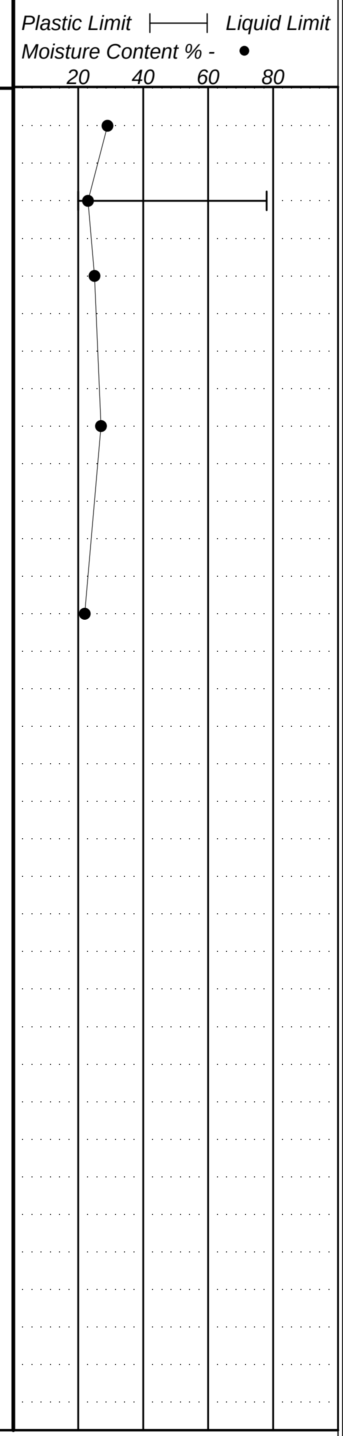
PROJECT: 90 Acre TMM Tract
LOCATION: San Antonio, Texas
CLIENT: KB Home

PROJECT NO: S201019
DATE: 01-29-2020

inTEC

BORING NO. B-13

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0			Very Stiff Dark Brown Clay -with a Trace of Gravel							
		SS					16			
		SS					15		78	58
5		SS	Very Stiff Tan Clay -with a Trace of Gravel				17			
		AU								
10										
		SS					21			
15										
20										
25										
30										
35										



Notes:

Ground Water Observed: No

Completion Depth (ft): 15

S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

Plate: 14

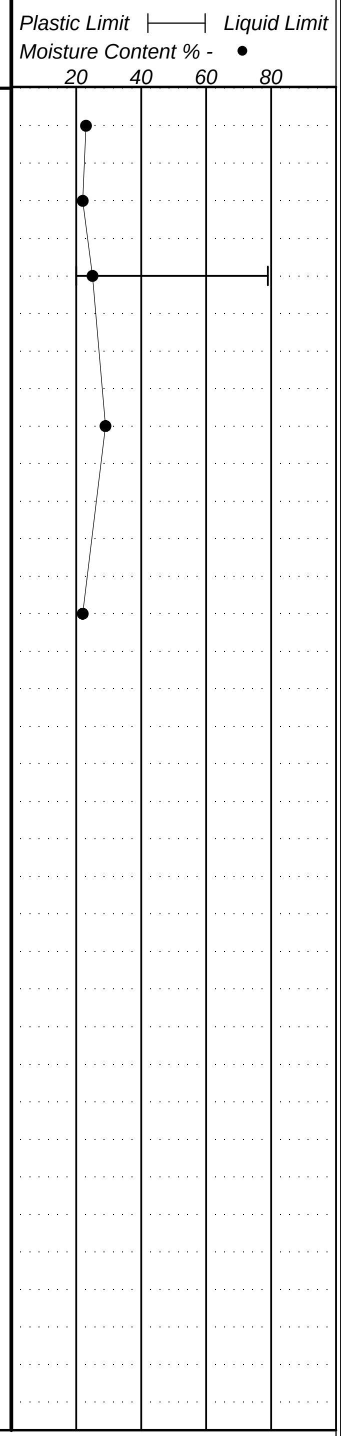
PROJECT: **90 Acre TMM Tract**
LOCATION: San Antonio, Texas
CLIENT: KB Home

PROJECT NO: **S201019**
DATE: 01-29-2020

intEC

BORING NO. B-14

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0		SS	Very Stiff Dark Brown Clay -with a Trace of Gravel				16			
		SS					18			
5		AU	Very Stiff Tan Clay -with a Trace of Gravel						79	59
10		AU								
15		SS					21			
20										
25										
30										
35										



Notes:

Ground Water Observed: No

Completion Depth (ft): 15

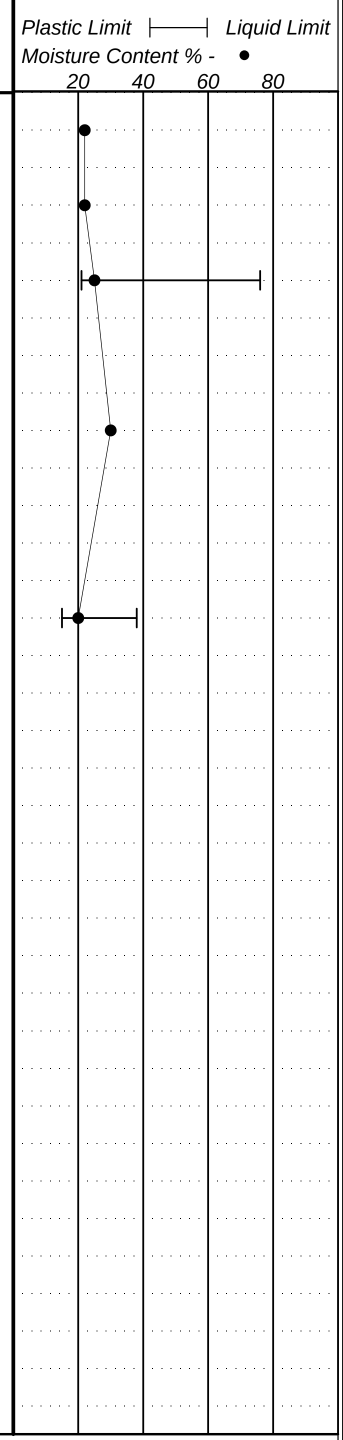
S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

Plate: 15

PROJECT: 90 Acre TMM Tract **PROJECT NO: S201019**
LOCATION: San Antonio, Texas **DATE:** 01-29-2020
CLIENT: KB Home

BORING NO. B-15

DEPTH (feet)	SYMBOL	SAMPLES	SOIL DESCRIPTION	% MINUS 200 SIEVE	UNIT DRY WT IN PCF	S.S. BY P.P	BLOWS PER FOOT	SHEAR STRENGTH TSF	LIQUID LIMIT	PLASTICITY INDEX
0		SS	Very Stiff Dark Brown Clay -with a Trace of Gravel				16			
		AU								
5		SS	Very Stiff Tan Clay -with a Trace of Gravel				19		76	55
		AU								
10										
		SS					21		38	23
15										
20										
25										
30										
35										



Notes:

Ground Water Observed: No

Completion Depth (ft): 15

S.S by P.P - Shear Strength in TSF by Hand Penetrometer
S.S. - Split Spoon Sample
S.T. - Shelby Tube Sample
HA - Hand Auger
AU - Auger Sample

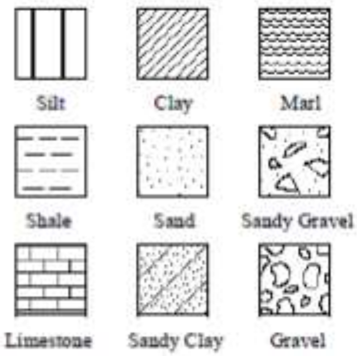
Plate: 16

KEY TO CLASSIFICATIONS AND SYMBOLS

Soil Fractions

Component	Size Range
Boulders	Greater than 12"
Cobbles	3" - 12"
Gravel	3" - #4 (4.76mm)
Coarse	3" - ¾"
Fine	¾" - #4
Sand	#4 - #200 (0.074mm)
Coarse	#4 - #10 (2.00mm)
Medium	#10 - #40 (0.42mm)
Fine	#40 - #200 (0.074mm)
Silt and Clay	Less than #200

Soil or Rock Types
(Shown in symbols column)
(Predominate Soil Types Shown Heavy)



TERMS DESCRIBING SOIL CONSISTENCY

Description (Cohesive Soils)	Unconfined Compression TSF	Blows/Ft. Std. Penetration Test	Description (Cohesionless Soils)	Blows/Ft. Std. Penetration Tests
Very Soft	0.25	<2	Very Loose	0 – 4
Soft	0.25 – 0.50	2 – 4	Loose	4 – 10
Firm	0.50 – 1.00	4 – 8	Medium Dense	10 – 30
Stiff	1.00 – 2.00	8 – 15	Dense	30 – 50
Very Stiff	2.00 – 4.00	15 – 30	Very Dense	50
Hard	>4.00	>30		

SOIL STRUCTURE

Calcareous	Containing deposits of calcium carbonate; generally nodular.
Slickenside	Having inclined planes of weakness that are slick and glossy in appearance.
Laminated	Composed of thin layers of varying color and texture.
Fissured	Containing shrinkage cracks frequently filled with fine sand or silt. Usually more or less vertical.
Interbedded	Composed of alternate layers of different soil types.
Jointed	Consisting of hair cracks that fall apart as soon as the confining pressure is removed.
Varved	Consisting of alternate thin layers of sand, silt or clay formed by variations in sedimentations during the various seasons of the year, of often exhibiting contrasting colors when partially dried. Each layer is generally less than ½" in thickness.
Stratified	Composed of, or arranged in layers (usually 1 inch or more)
Well-graded	Having a wide range of grain sizes and substantial amount of all intermediate particle sizes.
Poorly or Gap-graded	Having a range of sizes with some intermediate sizes missing.
Uniformly-graded	Predominantly of one grain size.

Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	InTEC Project Number: **S201019-P**	Date: 01/20/2020

Calculations

CBR = 2.0

Tensar.

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 70	Initial Serviceability	= 4.2
Standard Normal Deviate	= -.524	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

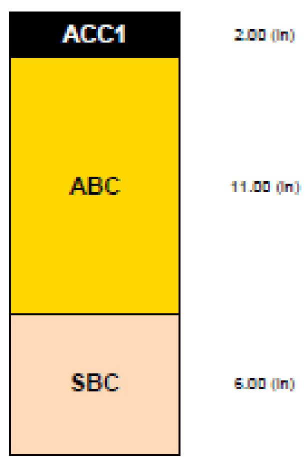
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ABC	Aggregate Base Course	20	0.140	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

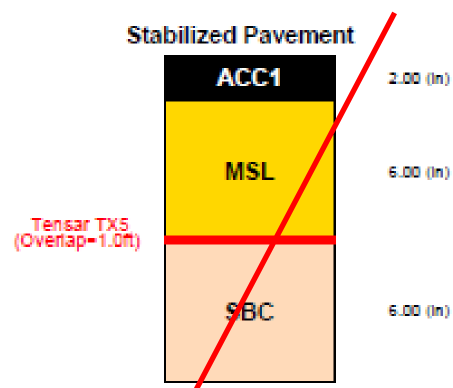
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
MSL	Mechanically Stabilized Base Cour	20	0.273	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 2.900
Calculated Traffic (ESALs) = 106,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 2.998
Calculated Traffic (ESALs) = 132,000

LIMITATIONS OF THE REPORT

The designs, illustrations, information and other content included in this report are necessarily general and conceptual in nature, and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops.

Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Local Type A without Bus Traffic**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 70	Initial Serviceability	= 4.2
Standard Normal Deviate	= -.524	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

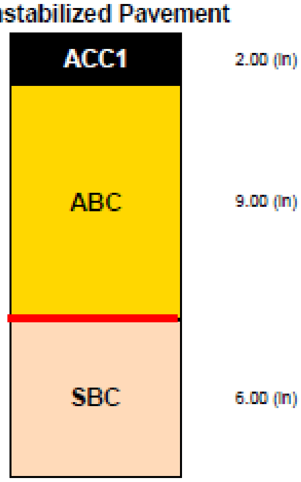
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ABC	Aggregate Base Course	20	0.170	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

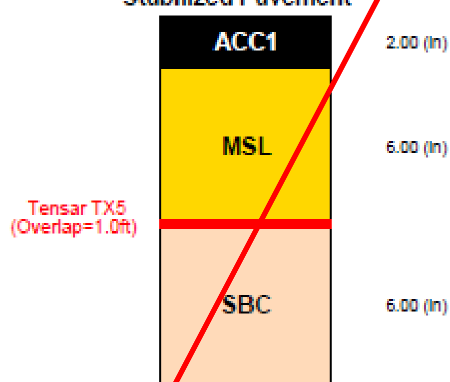
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
MSL	Mechanically Stabilized Base Cour	20	0.273	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 2.890
Calculated Traffic (ESALs) = 104,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 2.998
Calculated Traffic (ESALs) = 132,000

Geogrid option calculated with adjusted structural coefficient value

LIMITATIONS OF THE REPORT

The designs, illustrations, information and other content included in this report are necessarily general and conceptual in nature, and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops.

Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Local Type A without Bus Traffic**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 70	Initial Serviceability	= 4.2
Standard Normal Deviate	= -.524	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

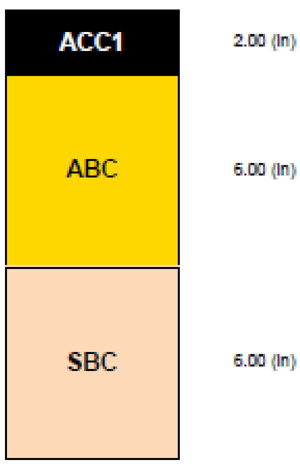
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ABC	Aggregate Base Course	20	0.340	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

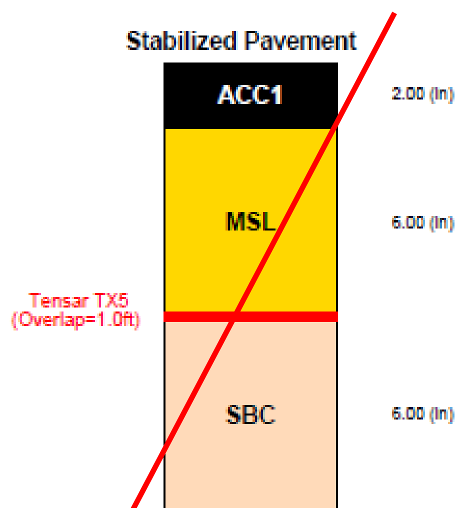
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
MSL	Mechanically Stabilized Base Cour	20	0.265	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 3.400
Calculated Traffic (ESALs) = 305,000

Stabilized Pavement



~~Subgrade Modulus = 3,000 (psi)~~
~~Structural Number = 2.910~~
~~Calculated Traffic (ESALs) = 109,000~~

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Local Type A without Bus Traffic**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 70	Initial Serviceability	= 4.2
Standard Normal Deviate	= -.524	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

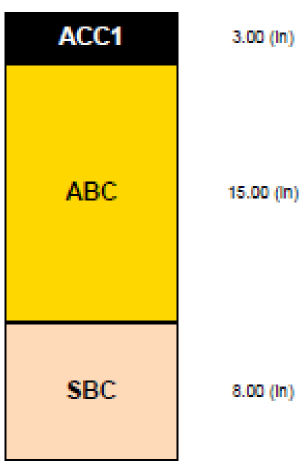
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ABC	Aggregate Base Course	20	0.140	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

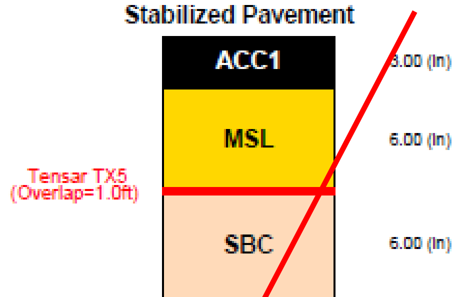
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
MSL	Mechanically Stabilized Base Cour	20	0.265	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.060
Calculated Traffic (ESALs) = 1,031,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 3.330
Calculated Traffic (ESALs) = 266,000

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Local Type A (with Bus Traffic)**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 70	Initial Serviceability	= 4.2
Standard Normal Deviate	= -.524	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

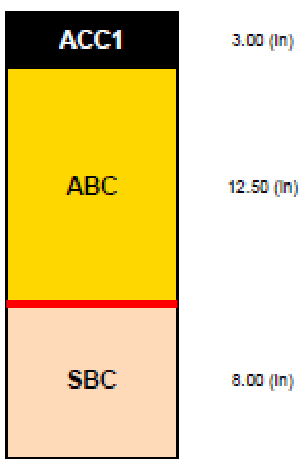
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ABC	Aggregate Base Course	20	0.170	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

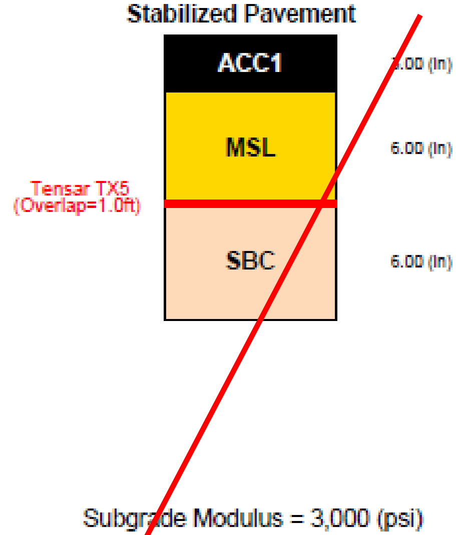
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
MSL	Mechanically Stabilized Base Cour	20	0.265	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.085
Calculated Traffic (ESALs) = 1,077,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 3.330
Calculated Traffic (ESALs) = 266,000

Geogrid option calculated with adjusted structural coefficient value

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Local Type A (with Bus Traffic)**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 70	Initial Serviceability	= 4.2
Standard Normal Deviate	= -.524	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

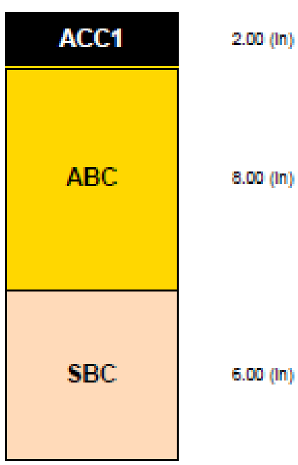
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ABC	Aggregate Base Course	20	0.340	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

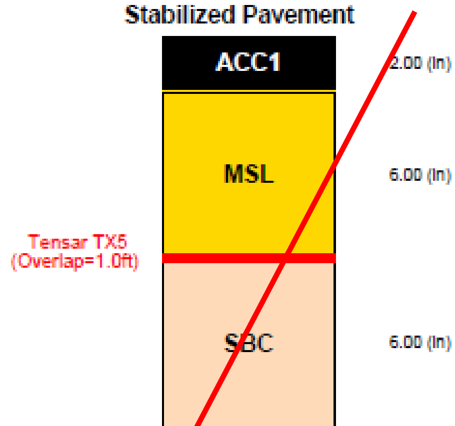
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
MSL	Mechanically Stabilized Base Cour	20	0.265	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.080
Calculated Traffic (ESALs) = 1,067,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 2.910
Calculated Traffic (ESALs) = 109,000

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Local Type A (with Bus Traffic)**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar.

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

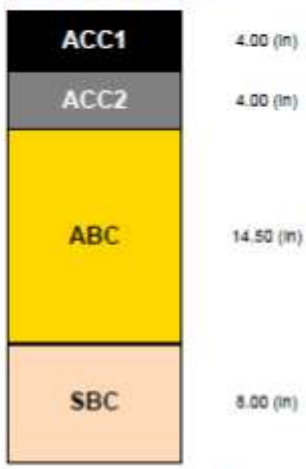
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ACC2	Dense-graded Asphalt Course	70	0.140	N/A
ABC	Aggregate Base Course	20	0.140	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

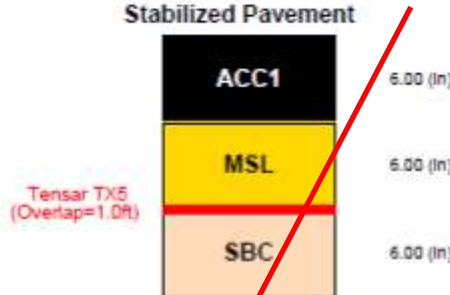
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
MSL	Mechanically Stabilized Base Cour	20	0.265	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.990
Calculated Traffic (ESALs) = 2,086,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.590
Calculated Traffic (ESALs) = 1,129,000

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Local B**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar.

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

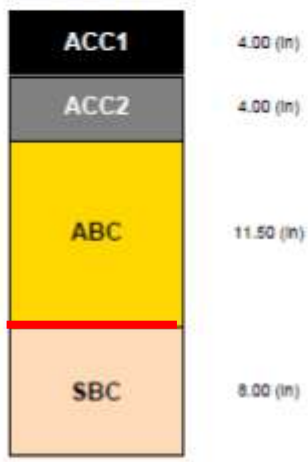
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ACC2	Dense-graded Asphalt Course	70	0.170	N/A
ABC	Aggregate Base Course	20	0.170	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

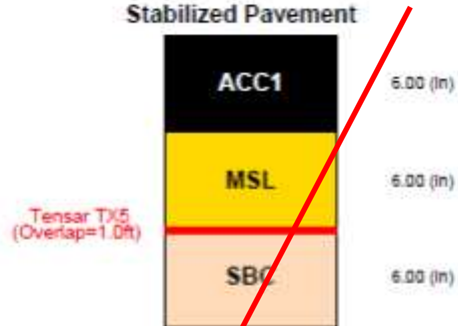
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
MSL	Mechanically Stabilized Base Cour	20	0.265	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 5.035
Calculated Traffic (ESALs) = 2,231,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.590
Calculated Traffic (ESALs) = 1,129,000

Geogrid option calculated with adjusted structural coefficient value

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Local B**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

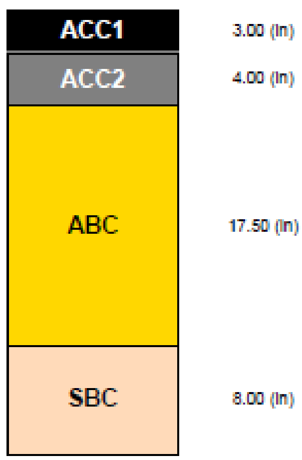
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ACC2	Dense-graded Asphalt Course	70	0.140	N/A
ABC	Aggregate Base Course	20	0.140	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

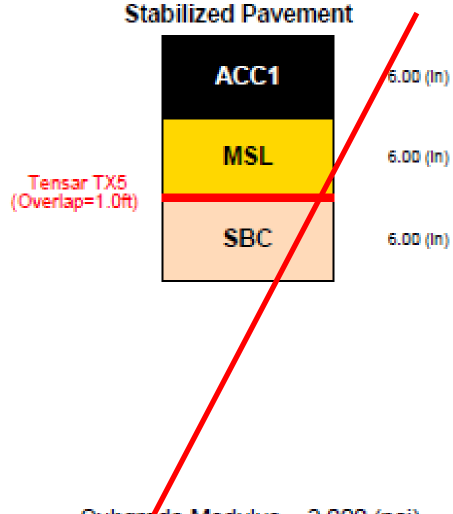
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
MSL	Mechanically Stabilized Base Cour	20	0.265	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.970
Calculated Traffic (ESALs) = 2,025,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.590
Calculated Traffic (ESALs) = 1,129,000

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Local B**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

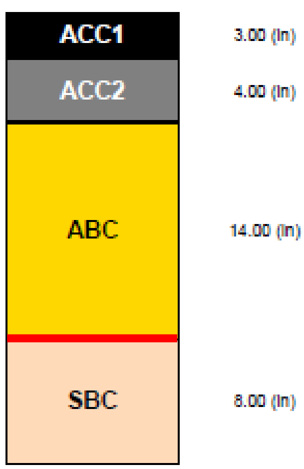
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ACC2	Dense-graded Asphalt Course	70	0.170	N/A
ABC	Aggregate Base Course	20	0.170	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

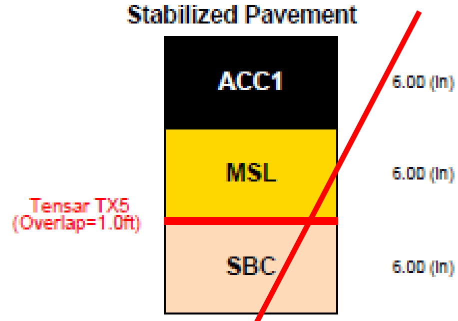
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
MSL	Mechanically Stabilized Base Cour	20	0.265	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 5.020
Calculated Traffic (ESALs) = 2,182,000

Stabilized Pavement



~~Subgrade Modulus = 3,000 (psi)~~
~~Structural Number = 4.590~~
Calculated Traffic (ESALs) = 1,129,000

Geogrid option calculated with adjusted structural coefficient value

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Local B**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar.

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

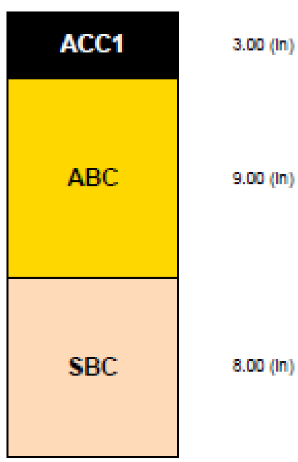
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ABC	Aggregate Base Course	20	0.340	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

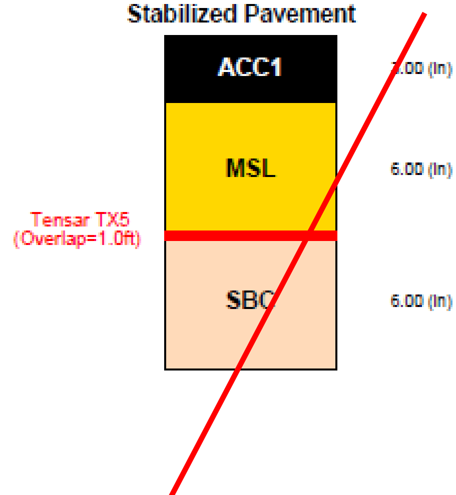
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
MSL	Mechanically Stabilized Base Cour	20	0.265	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 5.020
Calculated Traffic (ESALs) = 2,182,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 3.330
Calculated Traffic (ESALs) = 121,000

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Local B**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

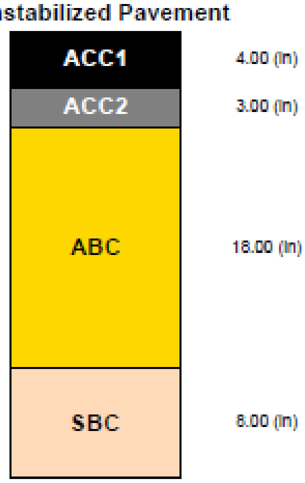
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ACC2	Dense-graded Asphalt Course	70	0.140	N/A
ABC	Aggregate Base Course	20	0.140	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

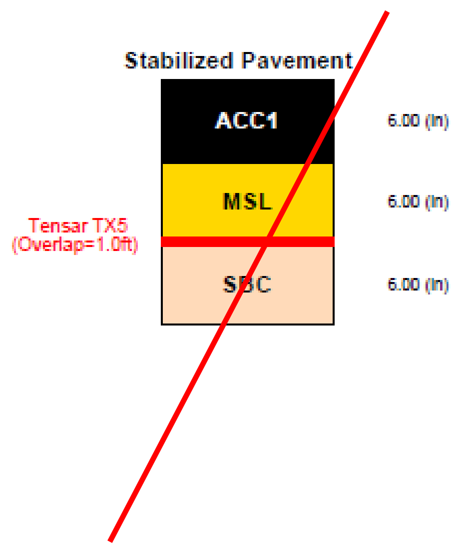
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
MSL	Mechanically Stabilized Base Cour	20	0.273	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 5.340
Calculated Traffic (ESALs) = 2,018,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.758
Calculated Traffic (ESALs) = 897,000

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Collector**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar. SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

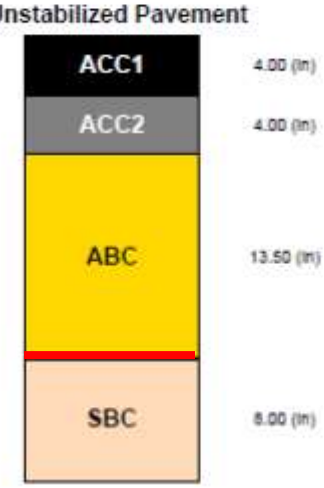
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ACC2	Dense-graded Asphalt Course	70	0.170	N/A
ABC	Aggregate Base Course	20	0.170	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

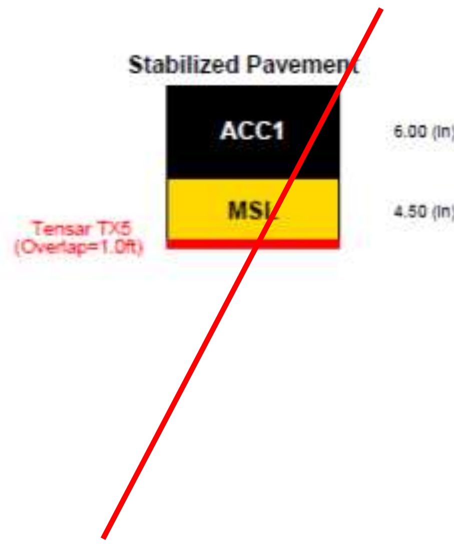
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
MSL	Mechanically Stabilized Base Cour	20	0.308	1.0
None	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 5.375
Calculated Traffic (ESALs) = 2,116,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.026
Calculated Traffic (ESALs) = 299,000

Geogrid option calculated with adjusted structural coefficient value

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Collector**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

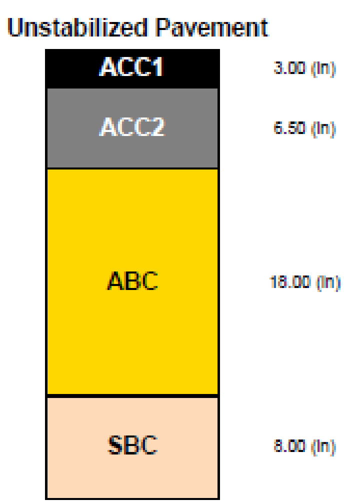
D50 <= 27mm (Base course)

Unstabilized Section Material Properties

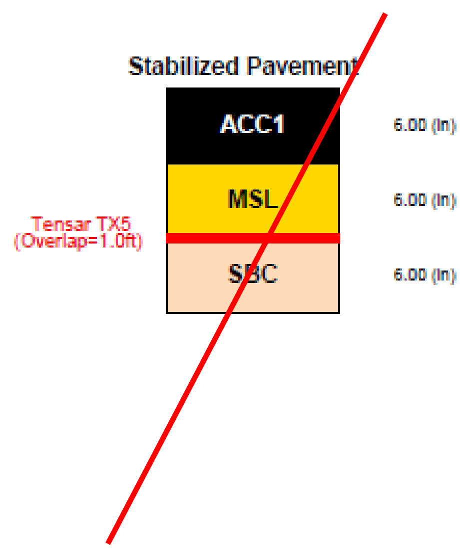
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ACC2	Dense-graded Asphalt Course	70	0.140	N/A
ABC	Aggregate Base Course	20	0.140	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
MSL	Mechanically Stabilized Base Cour	20	0.265	1.0
SBC	Subbase Course	16	0.080	1.0



Subgrade Modulus = 3,000 (psi)
Structural Number = 5.390
Calculated Traffic (ESALs) = 2,159,000



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.590
Calculated Traffic (ESALs) = 703,000

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Collector**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

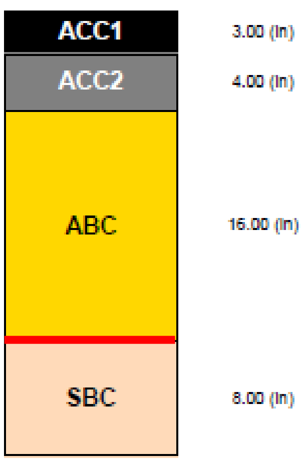
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ACC2	Dense-graded Asphalt Course	70	0.170	N/A
ABC	Aggregate Base Course	20	0.170	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

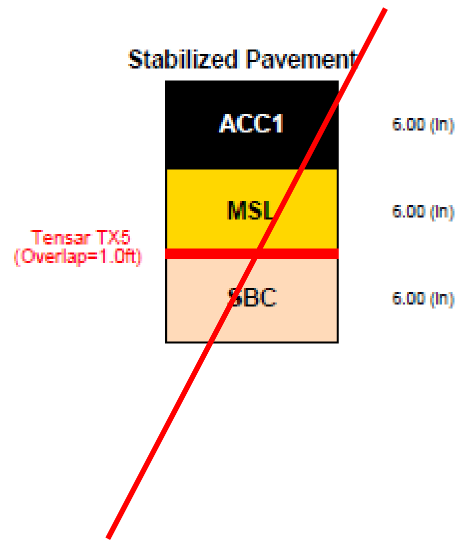
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
MSL	Mechanically Stabilized Base Cour	20	0.265	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 5.360
Calculated Traffic (ESALs) = 2,073,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.590
Calculated Traffic (ESALs) = 703,000

Geogrid option calculated with adjusted structural coefficient value

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Collector**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar

SpectraPave4 PRO™
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Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

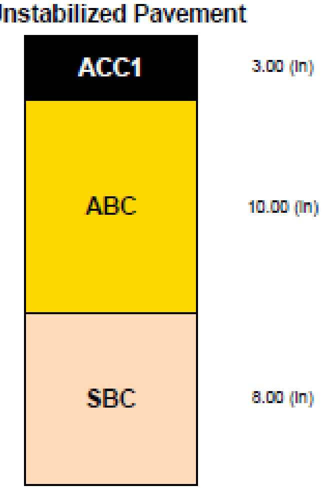
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ABC	Aggregate Base Course	20	0.340	1.0
SBC	Subbase Course	16	0.080	1.0

Stabilized Section Material Properties

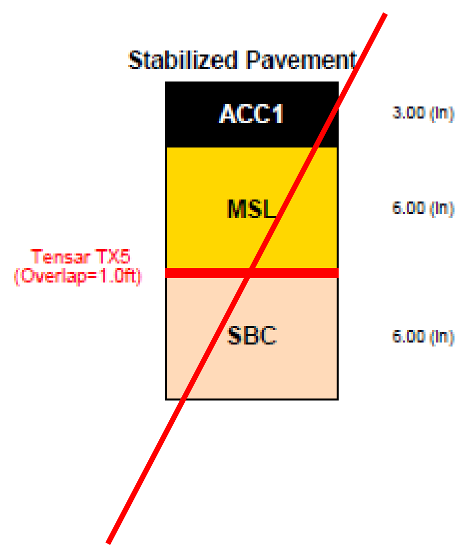
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
MSL	Mechanically Stabilized Base Cour	20	0.265	1.0
SBC	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 5.360
Calculated Traffic (ESALs) = 2,073,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 3.330
Calculated Traffic (ESALs) = 92,000

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Collector**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

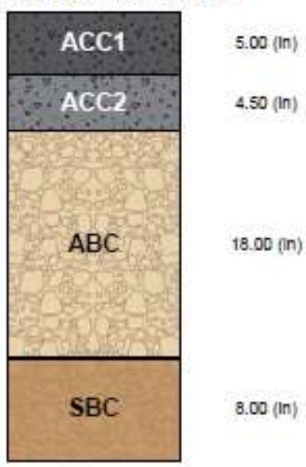
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.140	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0
SBC	Subbase Course	16.00	0.080	1.0

Stabilized Section Material Properties

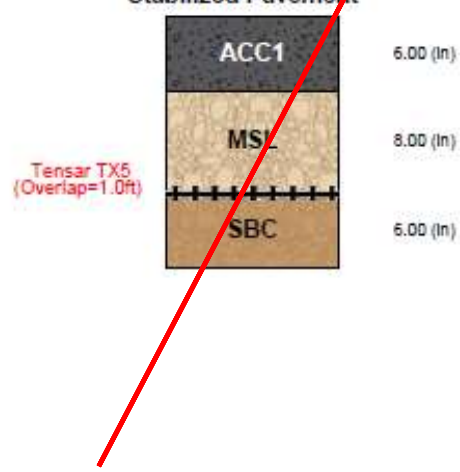
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.238	1.0
SBC	Subbase Course	16.00	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 5.990
Calculated Traffic (ESALs) = 3,235,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.904
Calculated Traffic (ESALs) = 758,000

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Arterial**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

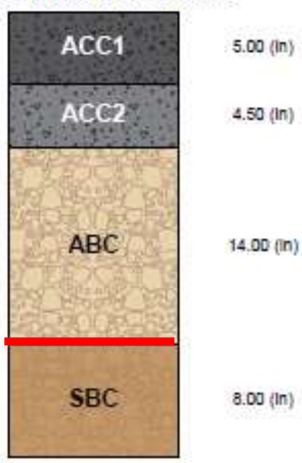
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.170	N/A
ABC	Aggregate Base Course	20.00	0.170	1.0
SBC	Subbase Course	16.00	0.080	1.0

Stabilized Section Material Properties

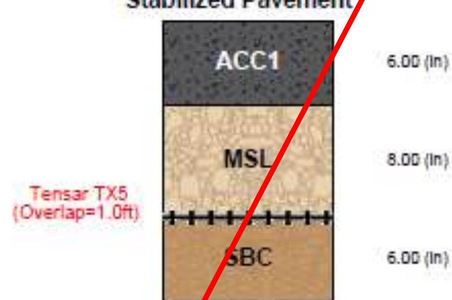
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.236	1.0
SBC	Subbase Course	16.00	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 5.985
Calculated Traffic (ESALs) = 3,215,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.904
Calculated Traffic (ESALs) = 758,000

Geogrid option calculated with adjusted structural coefficient value

LIMITATIONS OF THE REPORT

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Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Arterial**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Tensar

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

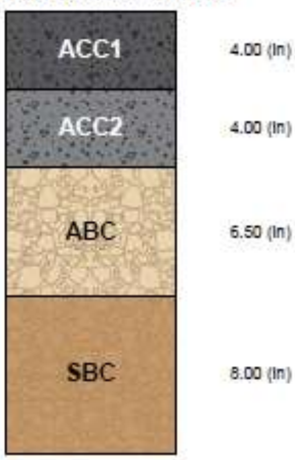
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.340	N/A
ABC	Aggregate Base Course	20.00	0.340	1.0
SBC	Subbase Course	16.00	0.080	1.0

Stabilized Section Material Properties

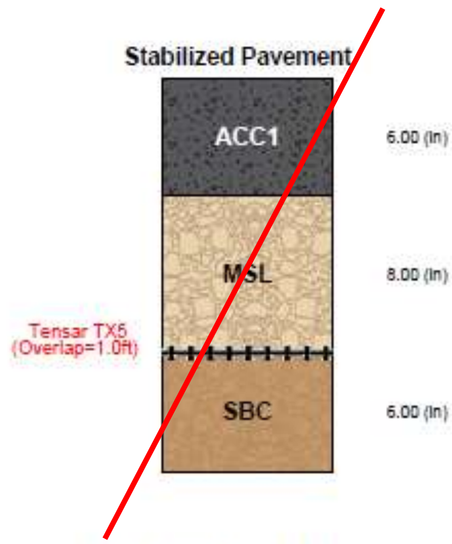
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.238	1.0
SBC	Subbase Course	16.00	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 5.970
Calculated Traffic (ESALs) = 3,154,000

Stabilized Pavement



Subgrade Modulus = 3,000 (psi)
Structural Number = 4.904
Calculated Traffic (ESALs) = 758,000

LIMITATIONS OF THE REPORT

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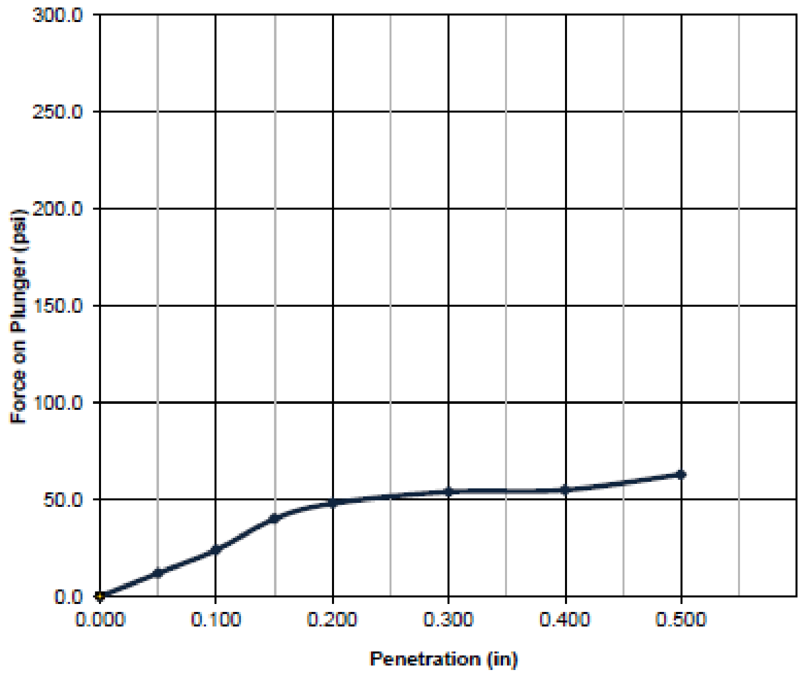
Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Arterial**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

InTEC of San Antonio

ASTM D-1883 California Bearing Ratio Test Report

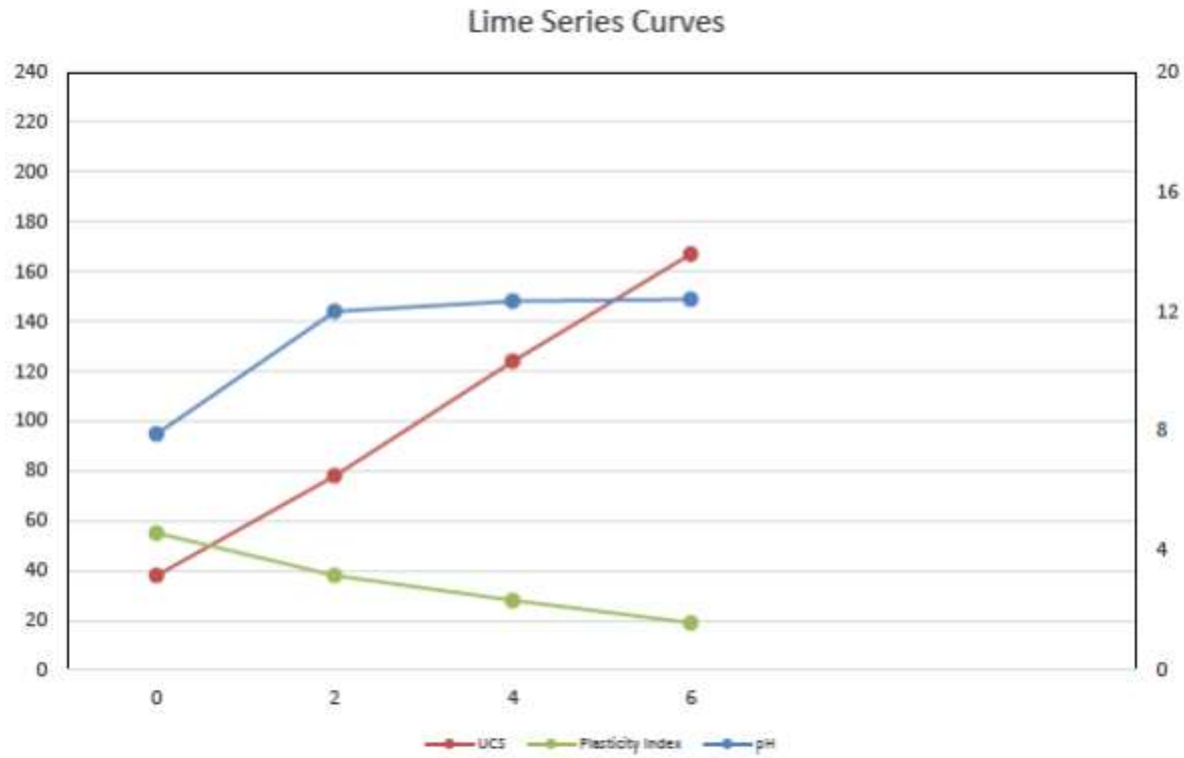
Load Penetration Curve



CBR Results					
Results	**A**	**B**	**C**	**D**	**Average**
0.1 in Pen.	2.4				
0.2 in Pen.	3.1				
Moisture (%)	20.50				
Density (pcf)	97.30				
Final Moisture (%)	27.20				
Final Density (pcf)	90.10				

Project Information			
Project Number	S201019-P	**Sample Location**	
Project Name	TIMM Tract	Specimen A	Near B-2
Date	2/5/2020	Specimen B	
Client		Specimen C	
		Specimen D	
Job Ref.		Liquid Limit:	73.0
Sample Num.		Plastic Limit:	21.0
Remarks	Dark Brown Clay		

Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**CBR Test Results**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020



Subsurface Exploration and Pavement Analysis Proposed New Streets 90 Acre TMM Tract Somerset Road & Watson Road San Antonio, Texas	**Lime Series**	
	InTEC Project Number: **S201019-P**	Date: 02/05/2020

Appendix

Important Information about This

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.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering 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 given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- 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;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the 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. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include 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 personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org