GEOTECHNICAL INVESTIGATION
Proposed Building and Pavement
12850 Bandera Road
Helotes, Texas

Reported to:
TAS III, Inc.
San Antonio, Texas

Prepared by:
Geoscience Engineering and Testing, Inc.
Houston, Texas

PROJECT NO: 18SG62052

May 2018

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May 30, 2018

TAS III, Inc.
14546 Brook Hollow, Suite No. 359
San Antonio, Texas 78232

Attention: Mr. Trent Stein

Reference: Geotechnical Investigation
Proposed Building and Pavement
12850 Bandera Road
Helotes, Texas
GETI NO: 18SG62052

Dear Mr. Stein:

GEOSCIENCE ENGINEERING & TESTING, INC. (GETI) is pleased to submit this report for the above referenced project. This study was authorized by you on May 08, 2018. This report briefly describes the procedures employed in our investigation and presents the conclusions and recommendations of our studies.

We appreciate the opportunity to work with you on this phase of the project. If you have any question concerning this report or require additional information, please contact us.

With Kindest Regards,

Ronald L. Dilly

RONALD L. DILLY
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Digitally signed by
Ronald L. Dilly, Ph.D., P.E.
Date: 2018.05.30
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Ronald L. Dilly, Ph.D., P.E.
Principal Engineer

F-4802

Copies Submitted: (1)

I. INTRODUCTION

Geoscience Engineering and Testing, Inc. (GETI) hereby submits this report of geotechnical investigation of subsurface conditions at the site of the Proposed Building and Pavement located at 12850 Bandera Road in Helotes, Texas. GETI's investigation was authorized by Mr. Trent Stein with TAS III, Inc. on May 08, 2018.

The purpose of the geotechnical investigation was to determine the subsurface soil conditions at the site of the Proposed Building and Pavement particular reference to the recommendations for the design of the pavement and foundation for the structure.

NOTE: The project photos (Plate No.10) were taken during the drilling operations. Please review and verify this is your building site. Notify GETI immediately if this not your site. (There are a few sites that are difficult to locate for a variety reasons.) We have been as diligent as possible in locating your site to assure that the recommendations given in our report correspond to your needs.

II. SUBSURFACE EXPLORATION

1. General

This report presents the results of our soil exploration and foundation analysis for the Proposed Building and Pavement located at 12850 Bandera Road in Helotes, Texas.

Scope of this investigation included a reconnaissance of the immediate site, the subsurface exploration, field and laboratory testing, an engineering analysis and evaluation of the subsurface materials. The purpose of this subsurface exploration and analysis was to determine soil profile components, the engineering characteristics of the subsurface materials and to provide criteria for use by design engineers and architects in preparing the pavement and foundation design.

The exploration and analysis of the subsurface conditions reported herein are considered in sufficient detail and scope to form a reasonable basis for the recommendations. The recommendations submitted are based on the available soil information and the preliminary design details furnished by Mr. Trent Stein with TAS III, Inc. Any revision in plans for the proposed Building and Pavement from those enumerated in this report should be brought to the attention of the soil engineer, so that he may determine, if changes in the recommendations are required. If deviations from the noted subsurface conditions are encountered during construction, they should also be brought to the attention of the soil engineer.

2. Description of the Site

The site of the proposed Building and Pavement, upon which this subsurface exploration has been made, is located at 12850 Bandera Road in Helotes, Texas. The site is flat and generally cleared, with a partial remaining area covered by grass. The proposed site was cleared of a building and pavement that was previously on the subject property. The surface of the cleared and cut area (at Borings B-1, B-3, B-4 and B-5) is approximately 6" lower than the general existing grade of the area corresponding to boring B-2. The surface soils were possible fill soils (fat clay, clayey sand and silty clayey sand) at the time of drilling operation.

Satellite images show that a structure was previously on the subject property, i.e., the site likely contains fill materials and may have buried foundation elements and lines. All cut lines should be capped.

The site geology for the geographic area corresponds to the Edwards Limestone, Cretaceous Period, Comanchean Epoch or Series[1]. Karst topography corresponding to Limestone is associated with caverns and springs. The subject property is in close proximity to Del Rio Clay.

3. Field Investigation

The field investigation, which was completed on May 14, 2018, was to determine the engineering characteristics of the subsurface materials included a reconnaissance of the project site, drilling the exploratory borings and recovering the representative soil samples.

The subsurface soil conditions were explored by advancing and sampling five (5) soil borings. The soil borings B-1 and B-2 were drilled to the depth of twenty (20) feet, boring B-3 was drilled to the depth of fifteen (15) feet, and B-4 and B-5 were drilled to the depth of six (6) feet, each, below the ground surface. The approximate soil boring location is shown on the attached soil Boring Plan, Plate No. 1.

Sample depth and description of soil classification (based on the Unified Soil Classification System) are presented on the Soil Boring Logs, Plates Nos. 2 through 6. Keys to terms and symbols used on the soil boring log are shown on Plate No. 7. Photographs appear on Plate No. 10.

The soil borings were of two-inch nominal diameter. All relatively undisturbed and disturbed soil samples were obtained at two (2) feet intervals continuously to a depth of ten (10) feet, between thirteen (13) and fifteen (15) feet and at five (5) feet intervals thereafter. The soil borings were performed with a drilling rig equipped with rotary head conventional solid-stem augers were used to advance the holes. Representative disturbed or undisturbed soil samples were obtained employing thin-walled sampling procedures in accordance with ASTM D1587. Blow counts were obtained in general accordance with ASTM D1586 Standard Penetration Test (SPT) and Split-Barrel Sampling of Soil. The obtained soil samples were extruded from the tube and visually classified in the field. Soil samples were identified according to the boring number and depth and wrapped in aluminum foil and polyethylene plastic wrapping bags to prevent moisture loss and disturbance. All of the samples were transported to our geotechnical laboratory for examination, testing and analysis. All borings were backfilled after final water readings were obtained with the soil cuttings accumulated during the drilling operation unless noted otherwise on the soil boring logs.

3.1 Field Strength Tests

During the field boring operation, samples of the cohesive soil from the thin-walled tube were frequently tested in compression by use of blow counts from the ASTM D1586 Standard Penetration Test (SPT), to aid in characterizing the soil consistency.

3.2 Water Level Measurement

The information in this report summarizes conditions as found on the date the borings were drilled. Groundwater was not encountered during the drilling operation. Long-term monitoring of the groundwater level was beyond the scope of this study. It should be noted that the groundwater table may be expected to fluctuate with environmental variations such as frequency and magnitude of rainfall and the time of the year when construction begins.

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[1] Note: USGS, TNRIS, UTBEG, GEOLOGIC ATLAS OF TEXAS

4. Surface Fault

A surface fault investigation is beyond the scope of this investigation. It should be noted that the coastal plains in this region has a complex geology, which includes active surface faulting.

5. Laboratory Testing

In addition to the field investigation, a supplemental laboratory investigation was conducted to ascertain additional pertinent engineering characteristics of the subsurface materials necessary in analyzing their behavior under the Proposed Building & Pavement loading conditions.

During the laboratory investigation all field soil samples from the boring were examined and classified by a soil engineer. Laboratory tests were then performed on selected soil samples in order to evaluate and determine the physical and engineering properties of the soils in accordance with the prescribed ASTM standards and methods. The following laboratory tests were performed:

LABORATORY TEST	TEST STANDARD
Moisture Content of Soils	ASTM D 2216
Percent Soil Particles Passing a No. 200 Sieve	ASTM D 1140
Liquid Limit, Plastic Limit, and Plasticity Index of Soils	ASTM D 4318

The type and number of the laboratory tests performed for this investigation are:

DESCRIPTIONS	No. of Test	DESCRIPTIONS	No. of Test
Moisture Content Test	26	Atterberg Limits	12
Minus Number 200 Sieve (%)	3		

The tests noted above were performed to establish the index properties and to aid in the proper classification of the subsurface soils. The test results are shown on the soil boring logs and are presented on Plate Nos. 2 through 6.

III. GENERAL DESCRIPTION OF SUBSURFACE MATERIALS

The specific subsurface stratigraphy as determined by the field exploration is shown in detail on the soil boring logs herein. However, the stratigraphy can be generalized as follow:

STRATUM NUMBER	RANGE OF DEPTH, Ft.	BORING NUMBER	SOIL DESCRIPTION Below natural grade for B-2 Below cut grade for B-1, B-3, B-4 and B-5
I	0 – 2’	B-1, B-2	Possible Fill: Dark brown FAT CLAY*
	2’ – 4’	B-4	

STRATUM NUMBER	RANGE OF DEPTH, Ft.	BORING NUMBER	SOIL DESCRIPTION Below natural grade for B-2 Below cut grade for B-1, B-3, B-4 and B-5
II	0 – 2’	B-4, B-5	Possible Fill: Tan; dark brown SILTY CLAYEY SAND and SANDY SILTY CLAY*
	2’ – 4’	B-2	
III	0 – 2’	B-3	Possible Fill: Dark brown CLAYEY SAND*
	4’ – 6’	B-4	
IV	2’ – 6’	B-5	Tan WEATHERED LIMESTONE
	2’ – 15’	B-3	
	2’ – 20’	B-1	
	4’ – 20’	B-2	

* Classification is in accordance with the Unified Soil Classification System

Laboratory tests results for the soils indicate that the Liquid Limits are ranging from 15 to 60, the Plasticity Indices (P.I.) ranging from 2 to 38 and moistures contents from 2 to 24 percent.

1. Swell Potential

Based on plasticity index (PI) values that are less than 15, the weathered limestone, and possible fill (silty clayey sand, sandy silty clay, and clayey sand) are characterized as having a low shrink swell potential; whereas the possible fill (fat clay) has a very high shrink/swell potential. The International Building Code 2015:1808.5.3 defines criteria to characterize soil as expansive. When the PI is less than 15 soils can be considered non-expansive.

Note: To provide a building site characterized as having non-expansive soil, the possible fill (fat clay) soils must be removed. In the building area this can be achieved by providing a cut grade that exposes the weathered limestone, and elevating the grade using an engineered fill that is subsequently defined.

2. Potential Vertical Rise (PVR)

The magnitude of the moisture induced vertical movement was calculated using the Texas Department of Transportation method (Tex-124-E) in conjunction with current moisture profile. Based on the aforementioned method, the potential vertical rise (PVR) at the locations of the test borings drilled is estimated to be 0.98 inches. More movement may occur in areas where the soil dries, and water subsequently ponds during or after construction. Site grading may also influence the potential for movement.

IV. FOUNDATION RECOMMENDATION

1. Foundations and Risks

Many lightly loaded foundations are designed and constructed on the basis of economics, risks, soil type, foundation shape and structural loading. Many times, due to economic considerations, higher risks are accepted in foundation design. It should be noted that some levels of risk are associated with all types of foundations. All of these foundations must be stiffened in the areas where expansive soils are present, and trees should be removed prior to construction.

2. Foundation Discussion

In general, the foundation for the structures must satisfy two independent criteria. First, the maximum design pressure exerted at foundation levels should not exceed the allowable net bearing pressure based on an adequate factor of safety with respect to soil shear strength. Second, the magnitude of total and differential settlements or heave under sustained foundation loads must be such that the structure movement is within tolerable limits.

Various types of foundation such as Slab-on-Grade, Spread Footings, Underreamed Drilled (Belled) Footings, Straight Shaft Footings etc. have been discussed for the support of the Proposed Building structure. Based on the field investigation and laboratory test results, the weathered limestone, silty clayey sand, clayey sand and fat clay subsoils are characterized as having low to very high shrink/swell potential. Details of soil strata are given in soil boring log, Plate Nos. 2 through 6. In our opinion, for this type of soil strata both Straight Shaft Footings and Shallow Foundation (Slab-on-Grade) system are considered suitable foundation systems.

2.1 Straight Shaft Footings

Based on the soil condition revealed by the field soil borings, laboratory tests and encountered materials, it is our understanding that the structure at this site can be supported on a foundation system comprised of Straight Shaft Footings bearing at least nine (9) feet below existing grade and socketed into the weathered limestone by extending at least three (3) feet or three shaft diameters, whichever is greatest. The shaft footings should bear at same elevation in the layer of tan limestone. The footing may be sized for an estimated net allowable bearing pressure of 6,000 psf for dead load plus sustained live load. The bearing pressure contains a factor of safety of 2.5 and be increased 25 percent for total load conditions, whichever is critical.

Caving of soils around the footings may occur during construction of the drilled piers due to the presence of sands. The bottom of the piers should be dry and clean. If water is encountered during installation, it should be pumped out prior to concrete placement. A tremie should be used to displace water with concrete. Temporary casings or drilling slurry may be adopted to stabilize the excavation and counteract encountered groundwater. In such cases, shaft piers are installed by placing concrete using ‘slurry displacement’ or “underwater concrete placement” method using a tremie. No pier excavation should be done at a distance less than 3 pier diameters in proximity to newly cast piers for a period of at least 24 hours. We recommend that the drilling be performed under the supervision of a qualified representative of the Geotechnical Engineer.

If the soil conditions warrant the changing of the shaft diameter, the structural engineer of record should be informed about any changes, because they may require a change in reinforcing steel. The concrete should be placed in a timely manner after drilling to minimize the potential for caving of the foundation soils. The concrete should be placed promptly after drilling to minimize the potential for caving of the foundation soils. By the end of day each drilled hole must be filled with concrete i.e., no open holes at the end of the day.

No footing should be poured, without the prior approval of the project engineer, architect or owner’s representative. Since the exact locations of the footings are not known at this time, a detailed settlement analysis was not authorized, nor performed. It is anticipated that the footing designed using the recommended allowable bearing capacity will experience small settlement that will be within the tolerable limits for the proposed structure. The bottom of the shaft should be dry and clean. If water encounters during installation, it should be pumped out prior to concrete placement. We recommend that the drilling be performed under the supervision of a Geotechnical Engineer.

Floor Slab Options for Pier Foundation System

There may be two options for floor slab:

a) **Structural Slab with Void Space and Deep Foundations (slab supported by piers only):** In this option slab is supported by only grade beams, which are supported by piers. In this case loads are applied on only piers. Slab should be raised from the ground surface by at least three (3) inches to avoid the vertical displacement of the slab. The slab should be tied and stiffened with grade beams. Details for void boxes are given below in the section "Void Boxes".

b) Stiffened Non-Structural Slab with Deep Foundations (slab supported by grade beams and sub-grade): Another option is that the slab may be supported by the grade beams and the sub-grade (soil beneath the slab). This option will require the removal of roots, organic and unsuitable materials and replacement with engineered fill as subsequently described.

Due to the soil characteristics at this site in the region of the proposed building structure, the existing possible fill materials (fat clay, silty clayey sand, sandy silty clay, and clayey sand) should be removed to expose the weathered limestone. The cut grade should be elevated using an engineered fill to provide a building pad area soil characterized as non-expansive.

Engineered fill is defined as corresponding to Texas Department of Transportation Item 247 Flexible Base corresponding to Material Type A Grade 5. The engineered fill should be compacted to at least 95% of the maximum dry density determined ASTM D698, within ±2 percentage points of the optimum moisture content as determined by ASTM D698. The engineered fill should be placed in eight-inch loose lifts with each lift compacted to 95% of ASTM D698.

Void Boxes

A void/crawl space of three (3) inches may be provided beneath the grade beams. This void space allows for movement of the expansive soils below the grade beams without distressing the structural system. Structural cardboard void forms are often used to provide this void space.

Void Boxes are typically placed under the grade beams to provide this void space, and act as a barrier separating the grade beams from the expansive soils. When the underlying expansive soils swell, the void boxes will then collapse, thus minimizing the uplift loads caused from the expansive soils on the grade beams.

These voids may act as a channel for water to travel under a foundation system with poor area drainage, however, if this condition occurs, it may result in the subsequent swelling of the soils and an increase in subsoil moisture loads on the floor slabs. It is our opinion that the determination whether or not to provide voids under the grade beams be made by the owner, builder, engineer or architect after both the positive and negative aspects are evaluated. Geoscience Engineering & Testing, Inc. from our experience with these voids, as well as the experiences of other experts, brings us to the conclusion that even though they may be effective in reducing swell pressures on the grade beams, they may provide free water which would be available for absorption by slab support soils.

2.2 Shallow Foundation (Slab-on-Grade) Design Parameters

As an alternative to the Straight Shaft Footings the structure at this site can be supported on a foundation system comprised of Slab-On-Grade (Grade-Supported Stiffened Non-Structural Slab). This option will require the removal of roots, organic and unsuitable materials and replacement with engineered fill as subsequently described.

Due to the soil characteristics at this site in the region of the proposed building structure, the existing possible fill materials (fat clay, silty clayey sand, sandy silty clay, and clayey sand) should be removed to expose the weathered limestone. The cut grade should be elevated using an engineered fill to provide a building pad area soil characterized as non-expansive.

Engineered fill is defined as corresponding to Texas Department of Transportation Item 247 Flexible Base corresponding to Material Type A Grade 5. The engineered fill should be compacted to at least 95% of the maximum dry density determined ASTM D698, within ±2 percentage points of the optimum moisture content as determined by ASTM D698. The engineered fill should be placed in eight-inch loose lifts with each lift compacted to 95% of ASTM D698.

A thickened reinforced slab stiffened with grade beams can be used for this project. The grade beam under the slab should be at least twenty-four (24) inches below the final soil grade and bear on medium dense to very dense weathered limestone.

Bearing Capacity:	Dead Load only:	2,600 psf
	Total (dead and live):	4,000 psf

Foundation slab designed in accordance with above capacity values will have a factor of safety of 3.0 and 2.0 with respect to shearing failure for dead and total loading respectively. Footing weight below final grade can be neglected in the determination of design loading.

A bedding layer of leveling sand may be placed beneath the floor slab vapor barrier. The leveling sand depth should not exceed two (2) inches; and the leveling sand must be covered with plastic sheeting. A vapor barrier consisting of six (6) mil plastic sheeting should be placed over the sand cushion to prevent water migration through the concrete slab. The excavations for grade beams should be clear and free of any loose materials prior to concrete placement.

Specifications should require a uniform fill thickness throughout the slab area and placement in accordance with our recommendation for using engineered fill. Lack of proper consideration of these factors will results in additional stresses and inferior slab performance.

In general, site preparation should consist of removing any grass, weeds and undesirable materials. The exposed subgrade should be proof-rolled to detect local weak areas which should be excavated, processed and re-compacted in loose lifts of approximately eight-inch thickness. Tree stumps, if present, should be removed below floor slab grade and backfill with structural select fill material.

V. PAVEMENT RECOMMENDATIONS

Based on our field investigation and test results in the borings at pavement area (B-4 and B-5), the surficial soils are silty clayey sand; whereas, other borings (B-1 and B-2) show fat clay. Therefore, these surface soils can be easily handled, retain compaction, and minimize or eliminate rutting if stabilized.

GETI recommends the upper 6 inch of the exposed *lean and fat clay* final subgrade be stabilized with 6% by dry weight of hydrated lime. Therefore, for a soil dry weight of 100 pounds per cubic foot, this would require for the case of subgrade thickness of 6 inches the addition of 27 pounds of lime per square yard and for the case of subgrade thickness of 8 inches the addition of 36 pounds of lime per square yard. The actual stabilization requirements may be varied in the field depending on conditions at the time of construction and should be established by running tests on the exposed subgrade soils.

The upper 6 inches of exposed *silty clayey sand and clayey sand* final subgrade may be stabilized by the addition of 3% lime and 7% fly ash. Lime and fly ash stabilization would require the addition of 15 pounds of lime and 35 pounds of fly ash per square yard based on subgrade thickness of 6 inches and a soil dry weight of 112 pounds per cubic foot (pcf). If the upper 8 inches of the exposed final subgrade are stabilized by the addition of 3% lime and 7% fly ash, then this would require the addition of 20 pounds of lime and 47 pounds of fly ash per square yard based on subgrade thickness of 8 inches and a soil dry weight of 112 pounds per cubic foot (pcf). The actual stabilization requirements may be varied in the field depending on conditions at the time of construction and should be established by running tests on the exposed subgrade soils.

The actual stabilization requirements may vary in the field depending on conditions at the time of construction and should be established by running tests on the exposed subgrade soils. The stabilized subgrade should be compacted to at least 95% of the standard proctor maximum dry density (ASTM D698) with in three percentage points of the optimum moisture content. Texas Department of Transportation 1993 Standard Specification, Item 260 and 264 should be used as a procedural guide for lime treatment of the subgrade soils; whereas Texas Department of Transportation 1993 Standard Specification, Item 265 should be used as a procedural guide for lime – fly ash treatment of the subgrade soils.

The required quantity of lime or lime – fly ash for use in stabilization as provided above is an estimated value only. The actual quantity of lime or lime – fly ash should be based on tests performed on the soils used at the time of construction.

The assumptions utilized in our pavement thickness analysis are summarized on Plate No. 8. The following pavement thicknesses are based on these assumptions and procedures published by the Portland Cement Association and the National Crushed Stone Association.

Recommendations for material properties for the paving layers are provided on Plate No. 9. It is estimated that the service life for a properly constructed and maintained pavement will be in order of 20 years. Proper civil design features such as joint design, quantity shoulder support should be incorporated into the plans and specifications. Joints for concrete pavements may be designed using the Texas Department of Highways Item 360.4 (Latest Revision). Periodic maintenance will be required.

Reinforcement for rigid pavement (5” and 6” concrete) should consist of Grade 60 No. 3 bar placed at fifteen inches on center in each direction. Control joint spacing should not exceed 15 ft. on center, and expansion joint spacing should not exceed 60 ft. on center.

Automobile Only (DI-1)	Flexible Base	Rigid Pavement
	1.5" Hot Mix Asphaltic Concrete	5.0" Reinforced Concrete
	6.0" Crushed Limestone*	6.0" Stabilized Compacted Subgrade
	6.0" Stabilized Compacted Subgrade	

Light Duty Access Lanes (DI-2)	Flexible Base	Rigid Pavement
	2.0" Hot Mix Asphaltic Concrete	6.0" Reinforced Concrete
	8.0" Crushed Limestone*	6.0" Stabilized Compacted Subgrade
	6.0" Stabilized Compacted Subgrade	

Medium Duty Access Drives (DI-3)	Flexible Base	Rigid Pavement
	3.0" Hot Mix Asphaltic Concrete	6.0" Reinforced Concrete
	8.0" Crushed Limestone*	8.0" Stabilized Compacted Subgrade
	8.0" Stabilized Compacted Subgrade	

* Plant mix, hot laid asphaltic base (black base) can be substituted on a ratio of one (1) inch of black base equal to 1.5 inches of crushed limestone.

NOTE 1. In regions where weathered limestone corresponds to the cut grade, stabilization is not required.

NOTE 2. In regions where weathered limestone corresponds to the cut grade, in lieu of lime stabilization provide a TXDOT 247 flexible base Material Grade 1-2 or Grade 5, Type A, to provide a 6-inch compacted base.

VI. GENERAL CONSTRUCTION CONSIDERATIONS

1. Site Preparation (NOTE: See Foundation Recommendation for using Engineered Fill)

Our recommendations for site preparations are summarized below:

1.1 In general, remove all vegetation, tree roots, organic topsoil and any undesirable materials from the construction area. Tree trunks and roots under the floor slabs should be removed to a root size of less than 0.5-inch. We recommend that the stripping depth be evaluated at the time of construction by a soil technician.

1.2 Any on-site fill soils, encountered in the structure areas during construction, must have records of successful compaction tests signed by a registered professional engineer that confirms the use of the fill and record of construction and earthwork testing. These tests must have been performed on all the lifts for the entire thickness of the fill. In the event that no compaction test results are available, the fill soil must be removed, processed and re-compacted in accordance with our recommendations of “Structural Fill and Subgrade Preparation”. Excavation should extend at least two (2) feet beyond the structure area and should the fill be used to elevate the existing grade, then the top of the fill area should extend to two (2) feet or to the distance equal to the height of fill above the existing grade, whichever is greater. Alternatively, the existing fill soils should be tested comprehensively to evaluate the degree of compaction in the fill soils.

1.3 The subgrade areas should then be proof-rolled with a 15-ton roller, or other equivalent suitable equipment as approved by the engineer. The proof-rolling serves to compact surficial soils and to detect any soft or loose zones. Any soils deflecting excessively under moving loads should be undercut to firm soils and re-compacted. The proof-rolling operations should be observed by an experienced geotechnician.

1.4 In the areas where expansive soils are present, rough grade the site with structural fill soils to insure positive drainage. Due to their high permeability of sands, sands should not be used for site grading where expansive soils are present.

1.5 We recommend that the site and soil conditions used in the structural design of the foundation be verified by the engineer's site visit after all of the earthwork and site preparation has been completed prior to the concrete placement.

2. Structural Fill and Subgrade Preparation (NOTE: See Foundation Recommendation for using Engineered Fill)

It is recommended that the subgrade and fill be prepared as follow:

2.1 The site should be stripped to suitable depth to remove any top soil and miscellaneous fill material. The exposed subgrade surface then should be proof-rolled. All soft or loose soils should be removed and replaced with select fill materials.

2.2 The natural subgrade should be scarified to a minimum depth of six (6) inches. The scarified soils should then be recompacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor Density Test (ASTM D698). The moisture content should range -1% to +3% of optimum moisture.

2.3 The Structural Select fill should consist of a clean Sandy Clay with Liquid Limit less than 35 and a Plasticity Index (P.I.) between 10 and 20.

2.4 The Structural Select fill material should be placed in maximum of eight (8) inch loose lift and compacted to a minimum of 95 percent of the maximum dry density as per ASTM D698. The moisture content should be with -1% to +3% of optimum moisture.

2.5 The Engineered Fill should consist of a Texas Department of Transportation Item 247 Flexible Base corresponding to Material Type A Grade 5.

2.6 The Engineered Fill should be compacted to at least 95% of the maximum dry density determined ASTM D698, within ±2 percentage points of the optimum moisture content as determined by ASTM D698. The engineered fill should be placed in eight-inch loose lifts with each lift compacted to 95% of ASTM D698.

2.7 A bedding layer of leveling sand may be placed beneath the floor slab vapor barrier. The leveling sand depth should not exceed two (2) inches; and the leveling sand must be covered with plastic sheeting. A vapor barrier consisting of six (6) mil plastic sheeting should be placed over the sand cushion to prevent water migration through the concrete slab. The excavations for the grade beams should be clear and free of any loose materials prior to concrete placement.

2.8 In cut areas, the soils should be excavated to grade and the surface soils proof rolled and scarified to a minimum depth of six inches and recompacted to the previously mentioned density tests at the time of construction.

3. Surface Drainage

It is recommended that the site drainage be well developed. Surface water should be directed away from the foundation soils (use a minimum of 2% with 10 feet away of foundation). No ponding of surface water should be allowed near the structure. The following drainage precaution should be observed during construction and at all times after the structure has been completed.

1) Backfill around the structure should be a cohesive soil material which should be moistened and compacted to at least ninety (90) percent of standard proctor density. Any cohesionless soil material accumulated around the perimeter of the structure during construction should be removed and not allowed to be mixed with or covered by the backfill material.

2) Where landscaping is to be installed next to the perimeter of grade beam, a moisture barrier or other suitable means should be installed to prevent moisture from entering the underlying clay soils.

3) Roof downspouts and drains should discharge well away from the limits of the foundation or grade beams.

4. Vegetation Control

We recommend trees not to be closer than half the canopy diameter of the mature tree from the grade beams, typically a minimum of 20 feet. This will minimize possible foundation settlement caused by the tree root systems.

VII. DISCLAIMER

The information and recommendation contained in the report summarized condition found at the site of the Proposed Building and Pavement located at 12850 Bandera Road in Helotes, Texas, specified and on the date the field exploration was completed. The attached soil boring logs are a true representation of the soils encountered at the stratigraphy as found during the field exploration and drilling of the subject site.

Reasonable variations from the subsurface information presented in this report are assumed. If conditions encountered during construction are significantly different than those presented in this report, GETI should be notified immediately.

The report was prepared for the sole and exclusive use by our client, based on specific and limited objectives. All reports, boring logs, field data, laboratory test results, and other documents prepared by GETI as instruments of service shall remain the property of GETI. Reuse of these documents is not permitted without written approval by GETI. GETI assumes no responsibility or obligation for the unauthorized use of this report by other parties and for purposes beyond the stated project objectives and work limitations.

In addition, the construction process may itself alter site soil conditions. Therefore, experienced geotechnical personnel should observe and document the construction procedures and all conditions encountered. We recommend that the owner retain Geoscience Engineering and Testing, Inc. to provide this service as well as the construction material and testing and inspection required during the construction phase of the project.

The standard of care for all professional engineering and related services performed by Geoscience Engineering & Testing, Inc. (GETI) corresponds to other geotechnical firms under similar circumstances in the project locality. GETI makes no warranties, express or implied, under this agreement or in connection with any services performed or furnished by us.

We would welcome the opportunity to discuss our recommendation with you and hope we may have the opportunity to provide any additional studies or service to complete this project. The following illustrations are attached and complete this report:

ILLUSTRATIONS	PLATE NUMBERS
Boring Locations Plan	1
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Symbols and Terms used on Boring Logs	7
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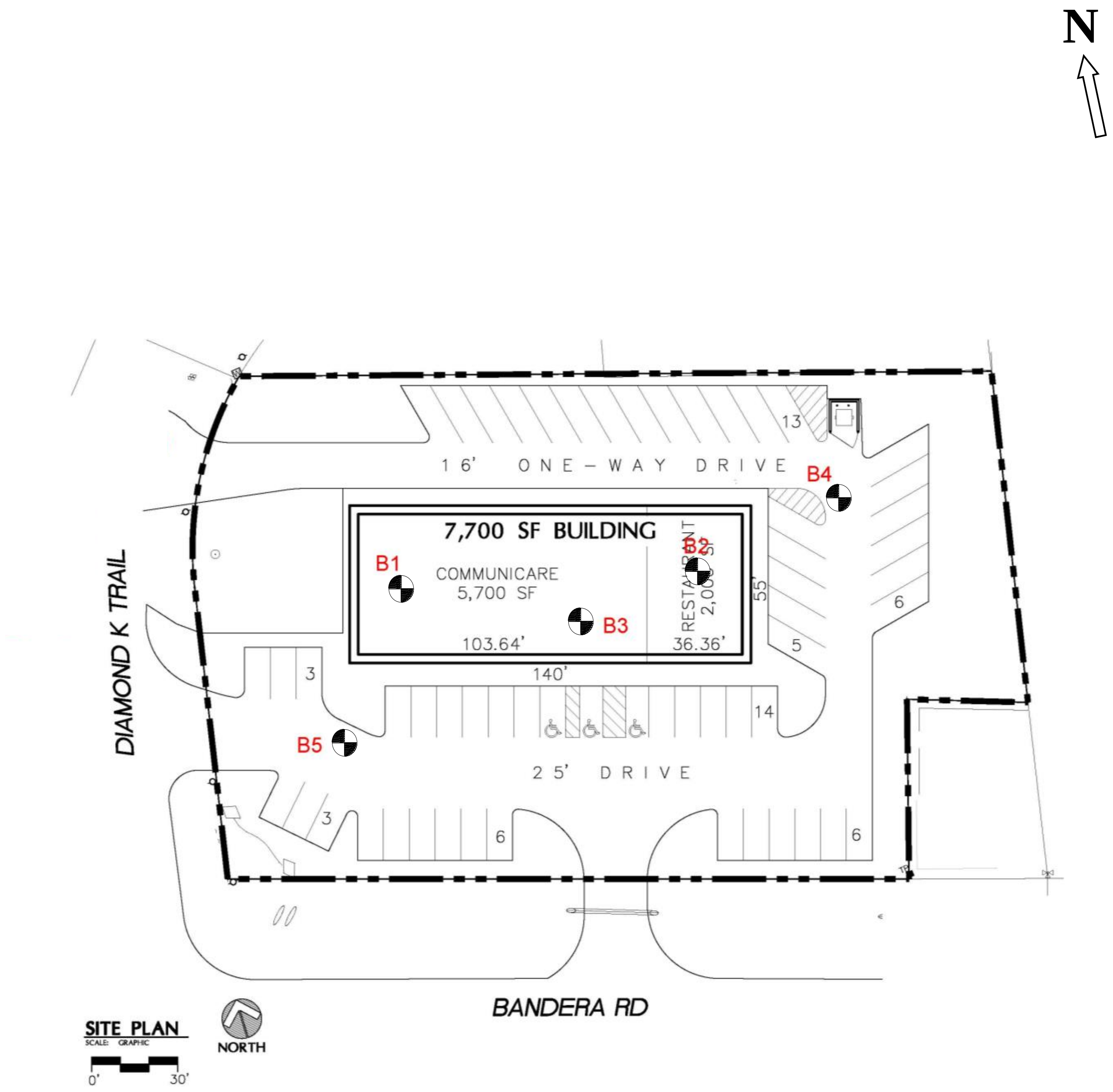
Pavement Material Recommendations	9
Site Pictures	10



◐ **Approximate Boring Locations**

NOT TO SCALE

<u>LOCATION</u>

Proposed Building and Pavement
12850 Bandera Road
Helotes, Texas
GETI NO.: 18SG62052

PLATE NO. 1

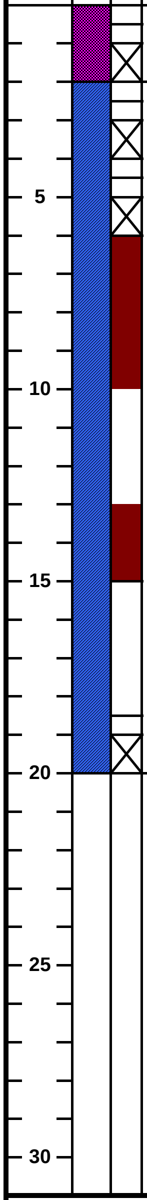
PROJECT:	**Proposed Building and Pavement** 12850 Bandera Road Helotes, Texas	BORING NO.: **B-1**	DEPTH: **20'**
		PROJECT NO. 18SG62052	DATE: May 14, 2018
CLIENT:	**TAS III, Inc.** San Antonio, Texas	Water was not encountered **during drilling operation**	

DRILLING METHOD (S)

Continuous Flight Auger & Intermittent Sampling

Legend

Clay	🟥	Lean Clay	▦	Silty Sand / Sandy Silt	🟩
Fill	🟪	Clayey Sand	🟩	Weathered Limestone	🟦



FIELD DATA				LABORATORY DATA		ATTERBERG LIMITS (%)					
N: BLOWS/FT	T: INCHES/100 BLOWS	P: TONS/SQ FT	RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT **LL**	PLASTIC LIMIT **PL**	PLASTICITY INDEX **PI**	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	**DESCRIPTION OF STRATUM** *
N=16				24		60	22	38			Possible fill: Very stiff, dark brown FAT CLAY
N>50				9							Tan WEATHERED LIMESTONE - very dense from 2' to 6'
N>50				3		19	13	6	25		
B				3							
B				2		15	12	3			
B				6							
N>50				15		16	13	3			- very dense from 18' to 20'

* Note: Boring B-1 surface approximately 0.5 feet below natural grade (existing grade) of boring B-2

N- STANDARD PENETRATION TEST RESISTANCE
T- TXDOT CONE PENETRATION RESISTANCE
P- POCKET PENETROMETER RESISTANCE
R- PERCENTAGE OF ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

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PLATE NO. 2

PROJECT: **Proposed Building and Pavement**
12850 Bandera Road
Helotes, Texas

CLIENT: **TAS III, Inc.**
San Antonio, Texas

BORING NO.: **B-2** DEPTH: **20'**
PROJECT NO. 18SG62052 DATE: May 14, 2018

Water was not encountered **during drilling operation**

DRILLING METHOD (S)
Continuous Flight Auger & Intermittent Sampling

Legend

Clay	🟥	Lean Clay	▦	Silty Sand / Sandy Silt	🟩
Fill	🟪	Clayey Sand	🟩	Weathered Limestone	🟦

FIELD DATA							LABORATORY DATA								
									ATTERBERG LIMITS (%)					
DEPTH (FEET)	SOIL SYMBOL	SAMPLES	N: BLOWS/FT	T: INCHES/100 BLOWS	P: TONS/SQ FT	RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT **LL**	PLASTIC LIMIT **PL**	PLASTICITY INDEX **PI**	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	**DESCRIPTION OF STRATUM ***
	🟪	☒	N=12				16							Possible fill: Stiff, dark brown FAT CLAY
	🟪	☒	N=10				20		18	14	4			Possible fill: Stiff, tan SILTY CLAYEY SAND and SANDY SILTY CLAY
5	🟦	☒	N=15				8							Tan WEATHERED LIMESTONE - medium dense from 4' to 6'
	🟦	■	B				4		19	14	5			
	🟦	■	B				3							
10	🟦													
	🟦	■	B				2		15	12	2	18		
15	🟦													
	🟦	■	B				2							
20														* Note: Boring B-2 surface at natural grade (existing grade)
25														
30														

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PLATE NO. 3

PROJECT: **Proposed Building and Pavement**
12850 Bandera Road
Helotes, Texas

CLIENT: **TAS III, Inc.**
San Antonio, Texas

BORING NO.: **B-3** DEPTH: **15'**

PROJECT NO. 18SG62052 DATE: May 14, 2018

Water was not encountered **during drilling operation**

DRILLING METHOD (S)

Continuous Flight Auger & Intermittent Sampling

Legend

Clay	🟥	Lean Clay	🟦	Silty Sand / Sandy Silt	🟩
Fill	🟪	Clayey Sand	🟩	Weathered Limestone	🟦

FIELD DATA							LABORATORY DATA		ATTERBERG LIMITS (%)					
DEPTH (FEET)	SOIL SYMBOL	SAMPLES	N: BLOWS/FT	T: INCHES/100 BLOWS	P: TONS/SQ FT	RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	**DESCRIPTION OF STRATUM ***
	🟪	☒	N= 8				8		25	15	10			Possible fill: Firm to stiff, dark brown CLAYEY SAND
	🟦	☒	N=21				5							Tan WEATHERED LIMESTONE - medium dense from 2' to 6'
5	🟦								21	14	7			
	🟦	☒	N=20				4							
	🟦	■	B				7							
	🟦	■	B				5		18	13	5	39		
10	🟦													
	🟦	■	B				2							
15														* Note: Boring B-3 surface approximately 0.5 feet below natural grade (existing grade) of boring B-2
20														
25														
30														

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P- POCKET PENETROMETER RESISTANCE
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PLATE NO. 4

PROJECT: **Proposed Building and Pavement**
12850 Bandera Road
Helotes, Texas

CLIENT: **TAS III, Inc.**
San Antonio, Texas

BORING NO.: **B-4** DEPTH: **6'**
PROJECT NO. 18SG62052 DATE: May 14, 2018

Water was not encountered **during drilling operation**

DRILLING METHOD (S)

Continuous Flight Auger & Intermittent Sampling

Legend

Clay	🟥	Lean Clay	▨	Silty Sand / Sandy Silt	🟩
Fill	🟪	Clayey Sand	🟩	Weathered Limestone	🟦

FIELD DATA							LABORATORY DATA							
									ATTERBERG LIMITS (%)					
DEPTH (FEET)	SOIL SYMBOL	SAMPLES	N: BLOWS/FT	T: INCHES/100 BLOWS	P: TONS/SQ FT	RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT **LL**	PLASTIC LIMIT **PL**	PLASTICITY INDEX **PI**	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	**DESCRIPTION OF STRATUM ***
	🟪	☒	N=8				18		23	16	7			Possible fill: Firm to stiff, dark brown SILTY CLAYEY SAND
	🟪	☒	N=16				19							Possible fill: Very stiff, dark brown FAT CLAY
5	🟪	☒	N=24				10							Possible fill: Very stiff, dark brown CLAYEY SAND
														* Note: Boring B-4 surface approximately 0.5 feet below natural grade (existing grade) of boring B-2
10														
15														
20														
25														
30														

N- STANDARD PENETRATION TEST RESISTANCE
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P- POCKET PENETROMETER RESISTANCE
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RQD - ROCK QUALITY DESIGNATION

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PLATE NO. 5

PROJECT: **Proposed Building and Pavement**
12850 Bandera Road
Helotes, Texas

CLIENT: **TAS III, Inc.**
San Antonio, Texas

BORING NO.: **B-5** DEPTH: **6'**

PROJECT NO. 18SG62052 DATE: May 14, 2018

Water was not encountered **during drilling operation**

DRILLING METHOD (S)

Continuous Flight Auger & Intermittent Sampling

Legend

Clay	🟥	Lean Clay	▩	Silty Sand / Sandy Silt	🟩
Fill	🟪	Clayey Sand	🟩	Weathered Limestone	🟦

FIELD DATA							LABORATORY DATA								
									ATTERBERG LIMITS (%)					
DEPTH (FEET)	SOIL SYMBOL	SAMPLES	N: BLOWS/FT	T: INCHES/100 BLOWS	P: TONS/SQ FT	RQD: PERCENT	MOISTURE CONTENT (%)	DRY DENSITY POUNDS/CU. FT	LIQUID LIMIT **LL**	PLASTIC LIMIT **PL**	PLASTICITY INDEX **PI**	MINUS NO. 200 SIEVE (%)	SHEAR STRENGTH (TSF)	**DESCRIPTION OF STRATUM ***
	🟪	☐ ☒	N=8				18							Possible fill: Firm to stiff, dark brown SILTY CLAYEY SAND
	🟦	☐ ☒	N=35				19							Tan WEATHERED LIMESTONE - dense from 2' to 4'
5	🟦	■	B				10		24	15	9			
														* Note: Boring B-5 surface approximately 0.5 feet below natural grade (existing grade) of boring B-2
10														
15														
20														
25														
30														

N- STANDARD PENETRATION TEST RESISTANCE
T- TXDOT CONE PENETRATION RESISTANCE
P- POCKET PENETROMETER RESISTANCE
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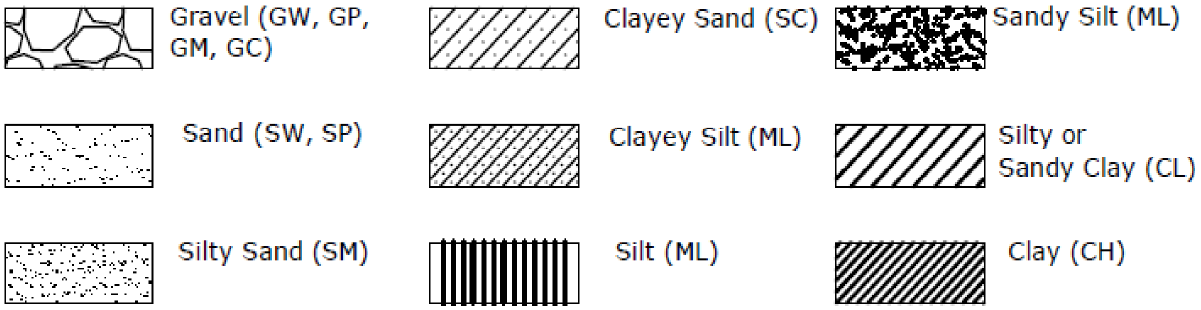
PLATE NO. 6

KEY TO SOIL CLASSIFICATION AND SYMBOLS



CONSISTENCY OF COHESIVE SOILS

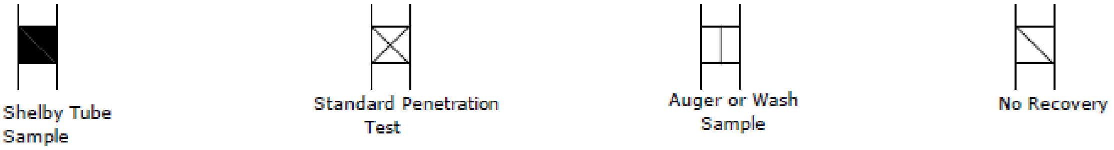
Description	Shear Strength KSF	Penetration Resistance Blows/ Ft
Very Soft	Less than 0.25	0 - 2
Soft	0.25 - 0.5	2 - 4
Firm	0.5 - 1.00	4 - 8
Stiff	1.00 - 2.00	8 - 15
VeryStiff	2.00 - 4.00	15 - 30
Hard	Greater than 4.00	>30

RELATIVE DENSITY OF COHESIONLESS SOILS

Description	Penetration Resistance Blows / Ft	Relative Density %
Very Loose	0 - 4	0 - 15
Loose	4 - 10	15 - 35
Medium dense	10 - 30	35 - 65
Dense	30 - 50	65 - 85
Very Dense	>50	85 - 100

Soil Structure

CALCAREOUS NODULES	-- Nodules of Calcium Carbonate
FERROUS NODULES	-- Nodules of Ferrous Material
SLICKENSIDED	-- Having inclined planes of weakness that are slick and glossy
BLOCKY	-- Having inclined planes of weakness that are frequent and rectangular in pattern
LAMINATED	-- Composed of thin layers of varying soil type and texture
FISSURERD	-- Containing shrinkage cracks frequently filled with fine sand
INTERBEDDED	-- Composed of alternate layers of different soil types



GROUNDWATER

▽ (24 hOurs) - Water Level after drilling (time increment after drilling)

▼ - Free Water observed during drilling

FAILURE DESCRIPTION (COMPRESSION TEST)

B - Bulge
S - Shear
M/S - Multiple Shear

SLS - Failure surface occuring along slickensided plane
SAS - Failure surface occuring along or in sand seam
SS - Failure surface occuring in or along other secondary structure such as calcareous pockets

ASSUMPTIONS FOR PAVEMENT ANALYSIS

1.0 Traffic Conditions - (National Crushed Stone Assoc.)

1.01 Parking Lots (DI-1)

Light traffic - Few vehicles heavier than cars.
No regular use by trucks.

Daily EAL = 5 or less

1.02 Parking Lots & Light duty Access Lanes (DI-2)

Medium-Light traffic - Maximum of 1000 vehicles per day, including not more than 10 percent two axle loaded trucks or larger vehicles carrying light loads or empty.

Daily EAL = 6 to 20

1.03 Medium Duty Access Drives (DI-3)

Medium traffic - Maximum of 3000 vehicles per day, including not more than 10 percent two axle trucks or 1 percent heavy trucks with three or more axles.

Daily EAL = 21 to 75

2.0 Flexible Base Pavement

2.01 Saturated CBR of natural clay subgrade: 3

2.02 CBR of imported clay subgrade: 6

3.0 Rigid Pavement

3.01 Modulus of subgrade reaction: 100 pci
(imported clay subgrade)

3.02 Modulus of rupture: 500 psi at 7 days
(concrete)

PLATE NO.: 8

PAVEMENT MATERIAL RECOMMENDATIONS

1.0 Limestone Base - Base material shall be composed of crushed limestone meeting the requirements of grade 1 in the Texas Department of Transportation (Tex DOT) 1993 Standard Specifications Item 247. The limestone shall be compacted to a minimum of 95 percent of the maximum density as determined by the Modified moisture/density relation (ASTM D1557).

2.0 Hot Mix Asphaltic Concrete Surface Course (Class "A") - The asphaltic surface course should be plant mixed, hot laid Type "D": (Fine Graded Surface Course) and meet the requirements specified in Tex DOT Item 340.

3.0 Asphalt Stabilized Base - Plant Mix - The asphaltic base should be plant mixed, hot laid and meet the requirements specified in the Tex DOT 1993 Standard Specifications Item 345.

4.0 Concrete - The materials and properties of concrete shall meet the applicable requirements in the ACI Manual of Concrete Practice. The concrete shall have a minimum modulus of rupture of 500 psi at 7 days as per ASTM C 293. It is our experience that concrete with a compressive strength of 3000 psi should meet this criteria. The mixture shall contain 3 to 5 percent entrained air.

Project No.: 18SG62052
PLATE NO.: 10