GEOTECHNICAL STUDY
PROPOSED CONCRETE ROADWAY
TIKI ISLAND COMMUNITY
GALVESTON COUNTY, TEXAS

PROJECT NO. 15-945E

TO

VILLAGE OF TIKI ISLAND
TIKI ISLAND, TEXAS

BY

GEOTECH ENGINEERING AND TESTING

SERVICING

TEXAS, LOUISIANA, NEW MEXICO, OKLAHOMA

www.geotecheng.com

DECEMBER 2015

TEXAS BOARD OF PROFESSIONAL ENGINEERS
REGISTRATION NUMBER F-001183

Village of Tiki Island
802 Tiki Drive
Tiki Island, Texas 77554

Project No. 15-945E
Report No. 1
Report Type: 37/E
December 16, 2015

Attention: Mr. Vernon Teltschick
Vice President

GEOTECHNICAL STUDY
PROPOSED CONCRETE ROADWAY
TIKI ISLAND COMMUNITY
GALVESTON COUNTY, TEXAS

Gentlemen:

Submitted here are the results of Geotech Engineering and Testing (GET) geotechnical study for the proposed pavement at the above-referenced location. This study was authorized by Mr. Vernon Teltschick on November 20, 2015.

1.0 INTRODUCTION

It is planned to construct concrete roadway at Tiki Island Community in Galveston County, Texas. A geotechnical study was performed to evaluate the subsoils and groundwater conditions and to provide recommendations for the proposed concrete roadway. This objective was met by sampling and testing five (5) soil borings at the above-referenced site, conducting laboratory testing and analyzing the test data. We understand that rigid pavement will be used at this project site. Our recommendations for pavement sections are provided in Appendix A.

This report briefly describes the field exploration and laboratory testing followed by our engineering analyses.

2.0 FIELD EXPLORATION

At the request of the client, the soil conditions were explored by conducting five (5) soil borings, located approximately as shown on Plate 1. The number of borings, depths and locations were specified by the client. The existing asphalt pavement was cored prior to drilling and sampling, except Boring B-5, where it was drilled on the ground. Soil samples were obtained continuously at each boring location from the ground surface to the completion depth at 5-ft. The cohesive soils were sampled in general accordance with the ASTM D 1587.

Soil samples were examined and classified in the field, and cohesive soil strengths were estimated using a calibrated hand penetrometer. This data, together with a classification of the soils encountered and strata limits, is presented on the soil stratigraphy profile, Plate 2, and logs of borings, Plates 3 through 7. A key to the log terms and symbols is given on Plate 8.

The borings were drilled dry, without the aid of drilling fluids, to more accurately estimate the depth to groundwater. Water level observations made during and after drilling are indicated at the bottom portion of the individual logs.

3.0 LABORATORY TESTS

3.1 General

Soil classifications and shear strengths were further evaluated by laboratory tests on representative samples of the major strata. The laboratory tests were performed in general accordance with ASTM Standards. Specifically, ASTM D 2487 is used for classification of soils for engineering purposes.

3.2 Classification Tests

As an aid to visual soil classifications, physical properties of the soils were evaluated by classification tests. These tests consisted of natural moisture content tests (ASTM D 4643) and Atterberg limit determinations (ASTM D 4318, Method B). Similarity of these properties is indicative of uniform strength and compressibility characteristics for soils of essentially the same geological origin. Results of these tests are tabulated on the boring logs at respective sample depths.

3.3 Strength Tests

Undrained shear strengths of the cohesive soils, measured in the field, were verified by calibrated hand penetrometer and torvane tests. The test results are also presented on the boring logs.

3.4 Soil Sample Storage

Soil samples tested or not tested in the laboratory will be stored for a period of seven days subsequent to submittal of this report. The samples will be discarded after this period, unless we are instructed otherwise.

4.0 GENERAL SOILS AND DESIGN CONDITIONS

4.1 Site Conditions

The project site and the surrounding areas are generally flat and exhibit topographic variation of less than three-ft. Currently, the project site is occupied by an existing asphalt pavement. Project site pictures were taken during our field exploration. These pictures are presented on Plate 9.

4.2 Soil Stratigraphy

Subsurface soils appear to be variable across the site. Details of subsurface conditions at each boring location are presented on the respective boring logs. In general, the soils can be grouped into six (6) major stratum with depths limit and characteristics as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
	0 – 0.375	ASPHALT PAVEMENT (4.5-inch in thickness)
	0.375 – 1.125	BASE MATERIALS (9-inch in thickness)
I	1.125 – 2	FILL: FAT CLAY (CH), very soft to stiff, light brown, brown, gray, greenish gray, with root fibers, moist
II	0.67 – 2	FILL: LEAN CLAY (CL), stiff, brown, greenish gray, with root fibers, sands, moist
III	0.96 – 2	FILL: SILTY SAND (SM), greenish gray, with root fibers, clay pockets, moist
IV	2 – 4	SILTY SAND (SM), medium dense, greenish gray, with root fibers, clay pockets, moist
V	2 – 5	FAT CLAY (CH), very soft, light brown, brown, gray, greenish gray, dark gray, with root fibers to 5', moist
VI	4 – 5	LEAN CLAY (CL), firm, greenish gray, with root fibers to 5', sands, moist

* Classification in general accordance with the Unified Soil Classification System (ASTM D 2487)

4.3 Soil Properties

Soil strength and index properties are summarized below:

Stratum No.	Soil Type	PI(s)	SPT	Soil Expansivity	Soil Shear Strength, tsf	Remarks
I	Fill: Fat Clay (CH)	37	–	Expansive	0.07 – 0.93	–
II	Fill: Lean Clay (CL)	25	–	Moderately Expansive	0.56	–
III	Fill: Silty Sand (SM)	–	–	Non-Expansive	–	Moisture Sensitive
IV	Silty Sand (SM)	–	13	Non-Expansive	–	Moisture Sensitive
V	Fat Clay (CH)	48 – 50	–	Expansive	0.07	–
VI	Lean Clay (CL)	–	–	Moderately Expansive	0.39	–

Legend: PI = Plasticity Index
SPT = Standard Penetration Test

4.4 Water-Level Measurements

The soil borings were dry augered to evaluate the presence of perched or free-water conditions. The level where free water was encountered in the open boreholes during the time of our field exploration is shown on the boring logs. Our groundwater measurements are as follows:

Boring No.	Groundwater Depth, ft. at the Time of Drilling	Groundwater Depth, ft. at 0.50 Hour Later
B-1 through B-5	Dry	Dry

Fluctuations in groundwater generally occur as a function of seasonal moisture variation, temperature, groundwater withdrawal and future construction activities that may alter the surface drainage and subdrainage characteristics of this site. It should also be noted that a "perched" groundwater condition could develop at this site. This could occur as the surface rainwaters are trapped in the near surface sands/silts underlain by relatively impermeable clay.

An accurate evaluation of the hydrostatic water table in the relatively impermeable clays and low permeable sands/silts requires long term observation of monitoring wells and/or piezometers. It is not possible to accurately predict the pressure and/or level of groundwater that might occur based upon short-term site exploration. The installation of piezometers/monitoring wells was beyond the scope of our study.

5.0 PAVEMENT SECTIONS

We understand that rigid pavement will be used for the project site. Our field exploration and laboratory testing data indicate that the subgrade soils in the project site consist of Fat Clay (CH) fill, Silty Sand (SM) fill and Lean Clay (CL) fill soils. Our recommendations on pavement sections are provided in Appendix A.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Surface Water Drainage

In order to minimize ponding of surface water, site drainage should be established early in project construction so that this condition will be controlled.

6.2 Site Preparation

Our site preparation recommendations are presented below:

1. In general, remove all vegetation, tree roots, organic topsoil, existing foundations, paved areas and any undesirable materials from the construction area. Tree trunks and tree 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.

2. Any on-site fill soils, encountered in the pavement areas during construction, must have records of successful compaction tests signed by a licensed 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 soils must be removed, processed and recompacted in accordance with our site preparation recommendations. Excavation should extend at least two-feet beyond the pavement area. Alternatively, the existing fill soils should be tested comprehensively to evaluate the degree of compaction in the fill soils.

3. The subgrade areas should then be proofrolled with a loaded dump truck or similar pneumatic-tired equipment with loads ranging from 25- to 50-tons. The proofrolling serves to compact surficial soils and to detect any soft or loose zones. The proofrolling should be conducted in accordance with TxDOT Standard Specification Item 216. Any soils deflecting excessively under moving loads should be undercut to firm soils and recompacted. Any subgrade stabilization should be conducted after site proofrolling is completed and approved by the geotechnical engineer. The proofrolling operations should be observed by an experienced geotechnician.

4. Scarify the subgrade, add moisture, or dry if necessary, and recompact to 95% of the maximum dry density as determined by ASTM D 698 (standard Proctor). The moisture content at the time of compaction of subgrade soils should be between optimum and +3% of the Proctor optimum value. We recommend that the degree of compaction and moisture in the subgrade soils be verified by field density tests at the time of construction. We recommend a minimum of four field density tests per lift or one every 2,500 square feet of floor slab areas, whichever is greater.

5. Off-site borrow for fill may consist of off-site inorganic lean clays with a liquid limit of less than 40 and a plasticity index between 12 and 20. Other types of structural fill available locally, and acceptable to the geotechnical engineer, can also be used.

   These soils should be placed in loose lifts not exceeding eight-inch in thickness and compacted to 95% of the maximum dry density determined by ASTM D 698 (standard Proctor). The moisture content of the fill at the time of compaction should be between optimum and +3% of the optimum value. We recommend that the degree of compaction and moisture in the fill soils be verified by field density tests at the time of construction. We recommend that the frequency of density testing be as stated in Item 4.

6. In cut areas, the soils should be excavated to grade and the surface soils proofrolled and scarified to a minimum depth of six-inches and recompacted to the previously mentioned density and moisture content.

7. The subgrade and fill moisture content and density must be maintained until paving or floor slabs are completed. We recommend that these parameters be verified by field moisture and density tests at the time of construction.

6.3 Earthwork

6.3.1 General

Difficult access and workability problems can occur in the surficial fill soils due to poor site drainage, wet season, or site geohydrology. Based on the laboratory test results, the surficial soils at the project site consist of lean clay fill soils and sandy silt fill soils. Considering the soils stratigraphy, the construction of this project should be conducted during the dry season to avoid major earthwork problems. Our recommendations for earthwork activity for areas with cohesive and cohessionless soils are provided separately in the following sections.

6.3.2 Earthwork for Cohesive Soils

Difficult access and workability problems can occur in the surficial fat clay fill and lean clay fill soils due to poor site drainage, wet season, or site geohydrology. Should this condition develop, drying of the soils for support of pavement and floor slabs may be improved by the addition of 5% lime by dry weight. The application rate corresponding to this additive amount would be approximately 23 pounds per square yard for each six-inches of compacted thickness.

Texas Department of Transportation (TxDOT) Specifications, Items 260 and 263, shall be used as procedural guides for placing, mixing, and compacting lime stabilizer and the soils.

Our recommendations on subgrade stabilization are preliminary. The actual depth and type of stabilization should be determined in the field at the time of construction just after site stripping and proofrolling. The required amount of lime for stabilization should be determined by ASTM C 977 Method. Furthermore, the type and amount of the stabilizer may vary depending on the final grade elevation and the soil type encountered.

Provided the site work is performed during dry weather and/or project schedules permit aeration of wet soils, the subgrade will be suitable for floor slab and pavement support.

6.3.3 Earthwork for Cohesionless Soils

In the event the subgrade soils become wet and experience pumping problems, they can be improved by (a) improving drainage, (b) opening up (scarifying) to dry up, (c) removing and replacing with dry cohesive soils or (d) chemically modifying and stabilizing the soils. These alternatives are discussed in the following report sections.

6.3.3.1 Improving Drainage

The project site drainage in the pumping soils can be accomplished by placing several shallow bleeder ditches (about 18-inches ±) in the surficial cohesionless soils. These bleeder ditches should be directed to a low area, such as a hole (detention pond) or another ditch in the lowest elevation area of the site. This will allow the surficial soils to drain the water and make the drying process faster. The hole/low area should not be under the building areas. The excess water can be pumped out of the hole and moved off-site.

6.3.3.2 Subgrade Drying

The on-site wet soils can be opened up so that it would dry up. However, opening up the surficial cohesionless soils for drying purposes may not be practical, due to cyclic rainfall in the Gulf-Coast area.

6.3.3.3 Removal and Replacement

The surficial cohesionless soils can be removed and replaced with select structural fill. The actual depth of removal and replacement should be evaluated in the field, but it can be whole thickness of surficial cohesionless soils. This procedure will include removal of the surficial cohesionless soils, proofrolling and compacting the subgrade cohesive soils to a minimum of 95 percent standard Proctor density (ASTM D 698). The site can then be backfilled with select structural fill, compacted to a minimum of 95 percent of standard Proctor density. The proofrolling should be in accordance with the site preparation section of this report. All of the fill soils should be placed and tested in accordance with the site preparation section of this report.

6.3.3.4 Modification/Stabilization

We recommend that the on-site cohesionless soils be modified (to dry up), using 5 to 10 percent fly ash by dry weight. The fly ash stabilization should be in accordance to Texas Department of Transportation (TxDOT) Specification, Item 265. The estimated amounts of fly ash per depth of modification are as follows:

Modification Depth, in.	Fly Ash Weight Range, lbs. per Square Yard
6	23 − 45
12	46 − 90
18	69 − 135
24	92 − 180

We recommend that five percent fly ash be used if the surficial soils are relatively moist at the time of application. Higher levels (10 percent) of fly ash should be used if wet and soggy subgrade soils are encountered.

The subgrade soils should be removed to a depth of 24-inches (or more) below existing grade. These soils should be stockpiled. The soils below a depth of 24-inches should be modified to a depth of 12-inches. These soils should be compacted to a minimum of 95 percent of standard Proctor density (ASTM D 698). The stockpiled soils should then be modified and replaced in six-inch lifts and compacted to 95 percent of maximum dry density as determined by ASTM D 698 at moisture contents within ±2 percent of optimum.

Due to poor drainage and the depth of the cohesionless soils, the depth of stabilization may be as deep as depth of cohesionless soils. A test section can be implemented for this purpose. The subgrade soils should be modified in six-inch lifts and compacted within four hours of mixing and placement. All of the subgrade soils should be compacted to a minimum of 95 percent of the standard Proctor density at the moisture content with optimum. The degree of compaction for the lifts, below a depth of 24-inches can be relaxed to 90 percent of maximum dry density to ease the construction procedures.

The subcontractor who will be doing the subgrade modification or stabilization should be experienced with stabilization procedures and methods. Furthermore, all of the earthwork at this project should be monitored by our geotechnician to assure compliance with the project specifications.

Once the subgrade is constructed, the soils at the top of subgrade should be slicked and the subgrade needs to be crowned such that the all surface water would drain away. No low areas should be left within the subgrade areas, since these areas would hold water and destroy the subgrade structure.

7.0 RECOMMENDED ADDITIONAL STUDIES

We recommend the following additional studies be conducted:

1. We recommend compaction evaluation study be conducted to evaluate the degree of compaction on fill soils.

2. This report has been based on assumed conditions/characteristics of the proposed development where specific information was not available. It is recommended that the architect, civil engineer and structural engineer along with any other design professionals involved in this project carefully review these assumptions to ensure they are consistent with the actual planned development. When discrepancies exist, they should be brought to our attention to ensure they do not affect the conclusions and recommendations provided herein. We recommend that GET be retained to review the plans and specifications to ensure that the geotechnical related conclusions and recommendations provided herein have been correctly interpreted as intended.

3. **Conduct site characterization studies.** These studies will include the following separate studies:

    - Phase I Geologic Fault Study to look for geologic faults at or near the site.
    - Phase I Environmental Site Assessment Study to evaluate the risk of contamination at the site.
    - Review additional aerial photos of the project site.
    - Review additional site topography.
    - Conduct a site visit to look for drainage features, slopes, seeps, trees and other vegetation; fence lines, ponds, stock tanks; areas of fill, etc.

8.0 STANDARD OF CARE

The recommendations described herein were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the geotechnical engineering profession practicing contemporaneously under similar conditions in the locality of the project. No other warranty or guarantee, expressed or implied, is made other than the work was performed in a proper and workmanlike manner.

9.0 REPORT DISTRIBUTION

This 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, maps and other documents prepared by GET as instruments of service shall remain the property of GET. Reuse of these documents is not permitted without written approval by GET. GET 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.

We appreciate the opportunity to be of service. Should you have any questions or need additional assistance, please call.

Very truly yours,

GEOTECH ENGINEERING AND TESTING
TBPE Registration Number F-001183

Edmund Chan, M.S.C.E., E.I.T.
Project Manager

Yongwan (Alex) Kwon, P.E.
Chief Engineer

STATE OF TEXAS
Yongwan Kwon
116911
LICENSED
PROFESSIONAL ENGINEER

Yongwan Alex Kwon
12/16/15

EC/AK/DAE/ec

Copies Submitted: (1) Hard Copy – Village of Tiki Island – Mr. Vernon Teltschick
(1) PDF Copy Email – Mr. Vernon Teltschick

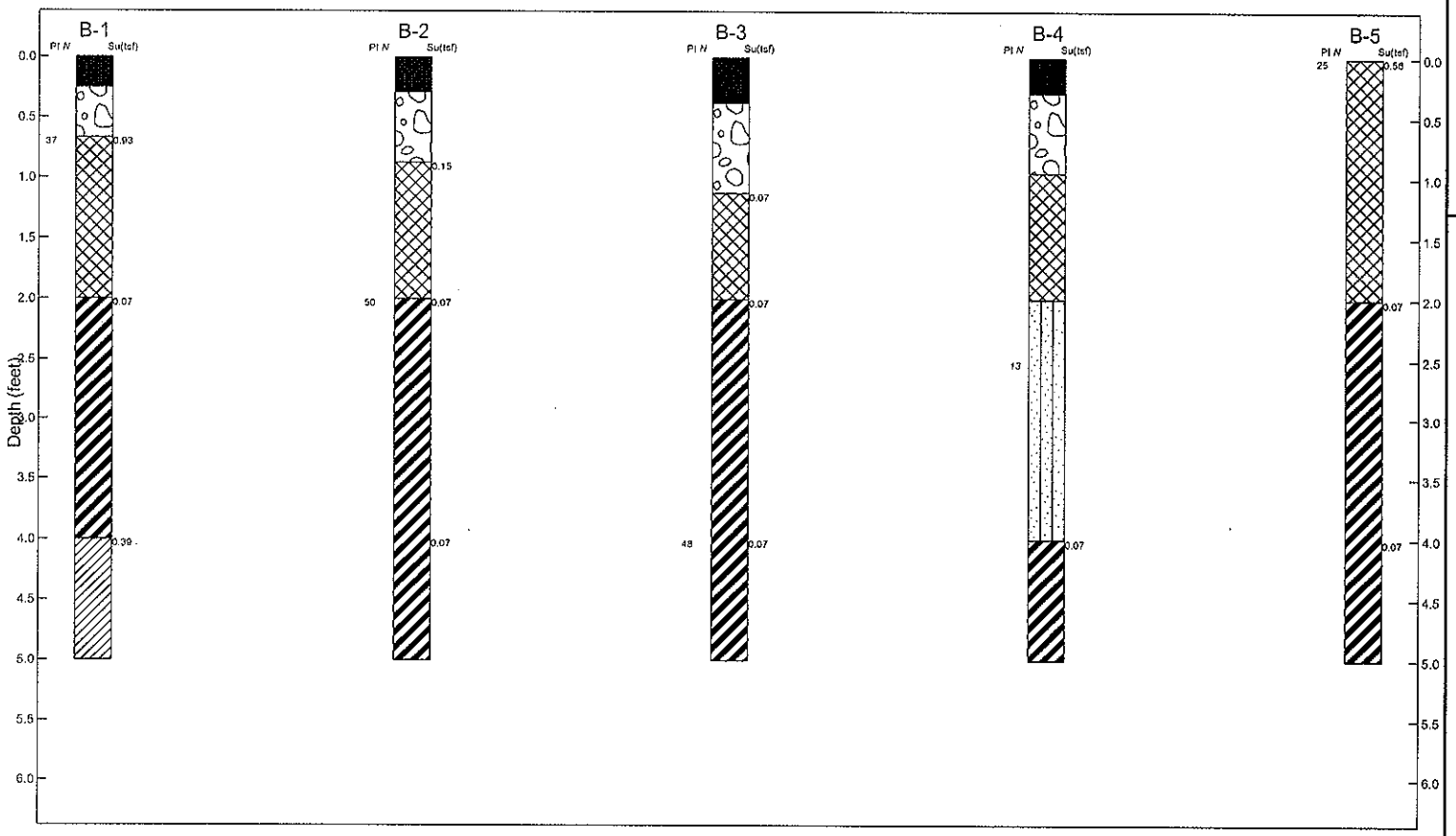
10.0 ILLUSTRATIONS

PLAN OF BORINGS (boring locations are approximate)

NORTH

PROJECT: Proposed Concrete Roadway, Tiki Island Community
Galveston County, Texas

SCALE: NOT TO SCALE	DATE: DECEMBER 2015	PROJECT NO.: 15-945E



Lithology Graphics

- Asphalt
- USCS Poorly-graded Gravel
- Fill
- Fat Clay (CH)
- Lean Clay (CL)
- Silty Sand (SM)

Explanation

B-1 — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022

Proposed Concrete Roadway, Tiki Island Community

GET GEOTECH ENGINEERING & TESTING

Galveston County, Texas

JOB NUMBER	PLATE NUMBER
15-945E	PLATE 2

LOG OF BORING NO. B-1

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Concrete Roadway, Tiki Island Community

LOCATION: Galveston County, Texas

PROJECT NO.: 15-945E STATION NO.:

DATE: 12-1-15 COMPLETION DEPTH: 5.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION / ELEVATION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (3")									
					BASE MATERIALS (5")									
					FILL: FAT CLAY (CH), stiff, brown, gray, with root fibers, moist	34	57	20	37					
					FAT CLAY (CH), very soft, light brown, greenish gray, with root fibers, moist									
5					LEAN CLAY (CL), firm, greenish gray, with root fibers to 5', clay pockets, moist									
10														

UNDRAINED SHEAR STRENGTH, tsf
- ▲ HAND PENETROMETER
- ▮ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 5 ft.
WET ROTARY: ___ TO ___ ft.

DRILLED BY: GET (T)
LOGGED BY: Chris

OVM2 15-945E.GPJ OVM.GDT 12/16/15

LOG OF BORING NO. B-2

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Concrete Roadway, Tiki Island Community

LOCATION: Galveston County, Texas

PROJECT NO.: 15-945E STATION NO.:

DATE: 12-1-15 COMPLETION DEPTH: 5.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION / ELEVATION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (3.5")									
					BASE MATERIALS (7")									
					FILL: FAT CLAY (CH), soft, brown, gray, with root fibers, moist									
					FAT CLAY (CH), very soft, greenish gray, with root fibers to 5', moist	38	72	22	50					
					- brown 4' to 5'									
5														
10														

UNDRAINED SHEAR STRENGTH, tsf

▲ HAND PENETROMETER

▮ TORVANE

● UNCONFINED COMPRESSION

○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:

NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 5 ft.

WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)

LOGGED BY: Chris

OVM2 15-945E.GPJ OVM.GDT 12/16/15

LOG OF BORING NO. B-3

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Concrete Roadway, Tiki Island Community

LOCATION: Galveston County, Texas

PROJECT NO.: 15-945E STATION NO.:

DATE: 12-1-15 COMPLETION DEPTH: 5.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION / ELEVATION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (4.5")									
					BASE MATERIALS (9")									
					FILL: FAT CLAY (CH), very soft, light brown, greenish gray, with root fibers, moist									
					FAT CLAY (CH), very soft, greenish gray, with root fibers to 5', moist									
5						50	70	22	48					
10														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 5 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Chris

OVM2 15-945E.GPJ OVM.GDT 12/16/15

LOG OF BORING NO. B-4

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Concrete Roadway, Tiki Island Community

LOCATION: Galveston County, Texas

PROJECT NO.: 15-945E STATION NO.:

DATE: 12-1-15 COMPLETION DEPTH: 5.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION / ELEVATION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (3.5")									
					BASE MATERIALS (8")									
					FILL: SILTY SAND (SM), greenish gray, with root fibers, clay pockets, moist	36				44				
	13				SILTY SAND (SM), medium dense, greenish gray, with root fibers, clay pockets, moist									
5					FAT CLAY (CH), very soft, greenish gray, dark gray, with root fibers to 5', moist									
10														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
▮ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 5 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Chris

OVM2 15-945E.GPJ OVM.GDT 12/16/15

LOG OF BORING NO. B-5

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Concrete Roadway, Tiki Island Community

LOCATION: Galveston County, Texas

PROJECT NO.: 15-945E STATION NO.:

DATE: 12-1-15 COMPLETION DEPTH: 5.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION / ELEVATION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					FILL: LEAN CLAY (CL), stiff, brown, greenish gray, with root fibers, sands, moist	22	43	18	25					
					FAT CLAY (CH), very soft, gray, greenish gray, with root fibers to 5', moist									
					- dark gray 4' to 5'									
5														
10														

UNDRAINED SHEAR STRENGTH, tsf
- ▲ HAND PENETROMETER
- ▮ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 5 ft.
WET ROTARY: ___ TO ___ ft.

DRILLED BY: GET (T)
LOGGED BY: Chris

OVM2 15-945E.GPJ OVM.GDT 12/16/15

KEY TO LOG TERMS AND SYMBOLS

UNIFIED SOIL CLASSIFICATIONS

Symbol		Material Descriptions
GW		WELL GRADED-GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GP		POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GM		SILTY GRAVELS, GRAVEL-SAND SILT MIXTURES
GC		CLAY GRAVELS, GRAVEL-SAND CLAY MIXTURES
SW		WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SP		POORLY GRADED SANDS, OR GRAVELLY SANDS, LITTLE OR NO FINES
SM		SILTY SANDS, SAND-SILT MIXTURES a
SC		CLAYEY SANDS, SAND-SILT MIXTURES b
ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS
OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
OH		ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
PT		PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT
		FILL SOILS

TERMS CHARACTERIZING SOIL STRUCTURE

Slickensided	-	Having incline planes of weakness that are slick and glossy in appearance.
Fissured	-	Containing shrinkage cracks frequently filled with fine sand or silt: usually vertical.
Laminated	-	Composed of thin layers of varying colors and soil sample texture.
Interbedded	-	Composed of alternate layers of different soil types.
Calcareous	-	Containing appreciable quantities of calcium carbonate.
Well Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Poorly Graded	-	Predominantly of one grain size, or having a range of sizes with some intermediate sizes missing.
Pocket	-	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	-	Inclusion less than ⅛-inch thick extending through the sample.
Seam	-	Inclusion ⅛- to 3-inch thick extending through the sample.
Layer	-	Inclusion greater than 3-inch thick extending through the sample.
Interlayered	-	Soils sample composed of alternating layers of different soil types.
Intermixed	-	Soil samples composed of pockets of different soil type and layered or laminated structure is not evident.

COARSE GRAINED SOILS (major portion retained on No. 200 Sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Conditions rated according to standard penetration test (SPT)* as performed in the field.

Descriptive Terms	Blows Per Foot*
Very Loose	0 – 4
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	over 50

* 140 pound weight having a free fall of 30-inch

FINE GRAINED SOILS (major portion passing No. 200 Sieve): Include (1) inorganic or organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength as indicated by hand penetrometer readings or by unconfined compression tests.

Descriptive Term	Undrained Shear Strength Ton/Sq. Ft.
Very Soft	Less than 0.13
Soft	0.13 to 0.25
Firm	0.25 to 0.50
Stiff	0.50 to 1.00
Very Stiff	1.00 to 2.00
Hard	2.00 or higher

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above because of weakness or cracks in the soil. The consistency ratings of such soils are based on hand penetrometer readings.

SOIL SAMPLERS

- SHELBY TUBE SAMPLER
- STANDARD PENETRATION TEST
- AUGER SAMPLING

TERMS CHARACTERIZING ROCK PROPERTIES

VERY SOFT OR PLASTIC	Can be remolded in hand: corresponds in consistency up to very stiff in soils.
SOFT	Can be scratched with fingernail.
MODERATELY HARD	Can be scratched easily with knife; cannot be scratched with fingernail. Difficult to scratch with knife.
VERY HARD	Cannot be scratched with knife.
POORLY CEMENTED OR FRIABLE	Easily crumbled.
CEMENTED	Bounded Together by chemically precipitated materials.
UNWEATHERED	Rock in its natural state before being exposed to atmospheric agents.
SLIGHTLY WEATHERED	Noted predominantly by color change with no disintegrated zones.
WEATHERED	Complete color change with zones of slightly decomposed rock.
EXTREMELY WEATHERED	Complete color change with consistency, texture, and general appearance or soil.

PROJECT PICTURES

Project No. 15-945E

Note: The above picture(s) indicate a snap shot of the project and the surroundings. We request that the client review the picture(s) and make sure that they represent the project area. We must be contacted immediately if any discrepancy exists.

APPENDIX A

Pavement Sections

PAVEMENT SECTIONS

The laboratory data indicates that the surficial soils are classified as Fat Clay (CH) fill, Silty Sand (SM) fill and Lean Clay (CL) fill soils by the Unified Soil Classification System. These soils have subgrade moduli, k, ranging from 100 to 140 pci and CBR values ranging from 3 to 5. Detailed traffic analysis was not conducted to evaluate the pavement sections in this report. We recommend that additional studies be conducted to evaluate the proposed pavement traffic loading. This information can be used to evaluate the required pavement sections.

Based on the subgrade soil properties, the recommended pavement thickness for rigid paving is given on Table I. Adequate site drainage is essential to pavement performance in accordance with design criteria.

It should be noted that our recommendations on subgrade stabilization assume that final paving grade will be at the top of existing subgrade. Alternative subgrade stabilization recommendations will be required if the final subgrade is different from the one assumed in this report. Actual type and quantity of subgrade stabilization should be determined at the time of construction when the pavement subgrade has been exposed.

TABLE I

Rigid Pavement (Protected Corner)		Auto/Light Truck Traffic, in	Service Drive or Heavy Truck Traffic, in
Surface:	Concrete Pavement	5	7
Subgrade:	Lime-Fly Ash Stabilized Subgrade (TxDOT Specification Item 265, See Notes 1 and 2) Compact to 95% of Maximum Standard Proctor Density (ASTM D 698) at a moisture content between optimum and +3% of optimum.	6	8

Concrete flexural strength should be at least 570 psi at 28 days. This corresponds to a compressive strength of 3000 psi at 28 days. The paving for the auto traffic should be reinforced with #4 bars at 21-inches on centers each. The paving for the heavy truck traffic should be reinforced with #4 bars at 18-inches center-to-center each way. Suggested longitudinal and transverse joint spacing for concrete paving is 15-feet. The expansion joint spacing is approximately 80-feet. Steel used for reinforcements should be grade 60.

NOTES:

1. Reference Texas Department of Transportation Specifications (TxDOT).

2. Use 2% lime and 8% fly-ash by dry weight to stabilize the upper soils. This results in application rates of 9 pounds of lime and 36 pounds of fly ash per square yard per six-inch of compacted thickness. The application rates will be approximately 12 pounds of lime and 48 pounds of fly-ash per square yard for each eight inches of compacted thickness.