11.0 PAVEMENT

11.1 GENERAL

We understand that the pavement for parking areas and drives will consist of concrete or asphalt paving. The traffic likely to use the pavement will generally consist of light automobile vehicles and medium trucks. The heaviest vehicle will consist of a daily garbage truck. The paving will be supported on existing soils. The top 6 inches of onsite soils under the paving should be lime-fly ash stabilized using 3% lime and 7% fly ash by dry weight. In lieu of lime-fly ash, 8% cement may also be used.

For the purpose of recommendations given below the light, medium and heavy vehicles should be considered based on the following weights.

Light Vehicle	up to 5,000 lbs
Medium Vehicle	5,000 lbs to 20,000 lbs
Heavy Vehicle	greater than 20,000 lbs
Very Heavy Vehicle	18-kip axle loads

The concrete and asphalt paving section thickness are given below.

11.2 CONCRETE PAVEMENT

The concrete paving thickness for the different paving areas may be taken as given below.

Paving Area	Paving Thickness
Light and Medium Vehicle Parking	5 inches
Light and Medium Vehicle Drives	6 inches
Heavy Vehicle Drive	7 inches
Very Heavy Vehicle Drive	8 inches

The concrete for the garbage dumpster pad where the garbage trucks stops and moves back and forth should be 7 inches thick. The top 6 inches must be stabilized as given in section 11.1.

The 5 inch thick concrete pavement may be reinforced using No.4 bars spaced at 24 inches center in both directions. The 6 and 7 inch thick concrete pavement may be reinforced using No. 4 bars spaced at 18 inches and 15 inches center, respectively, in both directions. The 8 inch thick concrete pavement may be reinforced using No. 5 bars spaced at 12 inches center in both directions. Other suitable thicknesses and spacing acceptable to the designer may also be used.

11.3 ASPHALT PAVEMENT

The asphalt paving section thickness for the different parking areas may be taken as given below.

Paving Area	HMAC	Base	Stabilized Subbase
Light and Medium Vehicle Parking	2 inch	6 inch	6 inch
Light and Medium Vehicle Drives	2 inch	8 inch	6 inch
Heavy Vehicle Drive	3 inch	8 inch	8 inch
Very Heavy Vehicle Drive	Use Concrete Paving		

The garbage dumpster pad where the garbage trucks stops and moves back and forth should be of concrete as given in section 11.2. The subbase/subgrade soils must be stabilized as given in section 11.1.

The base may consist of crushed limestone, gravel or crushed concrete. The HMAC should consist of TXDOT Type D, Standard Item 340.

12.0 VEGETATION CONTROL

12.1 Existing Trees

Existing trees roots absorb moisture from their surrounding soils. This results in formation of pockets of isolated dry soils around the tree roots with a moisture content significantly lower than the soil moisture contents away from these roots. When the trees are cut, the roots die and stop absorbing moisture from their surrounding soils. With time and seasonal rainfall as well as by capillary action, these dry pockets of soils will undergo increases in moisture content and as a result heave. If the tree is cut and a building or paving is immediately constructed on it, then these isolated areas of dry soils will heave more than the soils at other areas of the building or site. This will result in differential heaving under the structure or pavement. Where large trees are cut and building built over it, the slab should be stiffened to resist the higher differential heave. Alternatively, a safer option would be to structurally support the building slab on deeper footings with a void space larger than the anticipated maximum heave of the drier soils. Positive drainage should be developed and maintained all around the building at all times.

12.2 New Trees

New trees should be avoided near the building slab especially larger trees. No tree should be planted closer than 20 feet or half the canopy diameter of fully matured trees. Alternatively, root barriers may be used to prevent the migration of tree roots underneath the buildings. Use of large shrubs should be avoided immediately adjacent to the building slab.

13.0 SITE DRAINAGE

Final site drainage is very critical for long term performance of the proposed structure and pavement.

1. In general, set top of concrete at least eight inches above final adjacent soil grade for damp proofing.
2. Provide adequate drainage away from foundations (minimum ten percent slope in the first five feet). The bottom of any drainage swale should not be located within four feet of the foundations. Pervious planting beds should slope away from the foundations at least two inches per foot. Planting bed edging shall allow water to drain out of the beds. Water must not be allowed to pond anywhere close to the building or pavement.
3. Gutters or extended roof eaves may be used, especially under all roofs valleys. All extended eaves or gutter down spouts should extend at least two feet away from the foundations and past any adjacent planting beds. Roof drains should preferably discharge to storm sewers by closed pipe or extended away from the structures by 5 feet or as far as possible.
4. Any plumbing leaks must be repaired immediately.
5. Sprinkler systems if used should be used all around the building to provide a uniform water application system. Sprinkler systems should be located a minimum of five feet from the building edge.
6. Moisture conditions should be maintained "constant" around the edge of the building or pavement. Ponding of water or excessive drying should not be allowed in planter beds or anywhere adjacent to the building or pavement edge.
7. Large trees and shrubs should not be planted closer than 20 feet or half the canopy diameter of mature trees or shrubs.

14.0 CONSTRUCTION OBSERVATIONS

Texas Geotechnical Consultants, LLC (TGC) recommends implementation of a comprehensive quality control program under the supervision of a Professional Engineer. Structural integrity and stability is particularly dependent on quality foundation installation.

Construction inspection and quality control tests should be planned to verify materials and placement with accordance with the specifications. TGC should be retained to review the foundation drawings and specifications to verify that the recommendations outlined in this report have been properly interpreted and implemented. Proofrolling, subgrade compaction, fill placement, drilled footing construction and concrete strength should be monitored.

15.0 LIMITATIONS OF STUDY

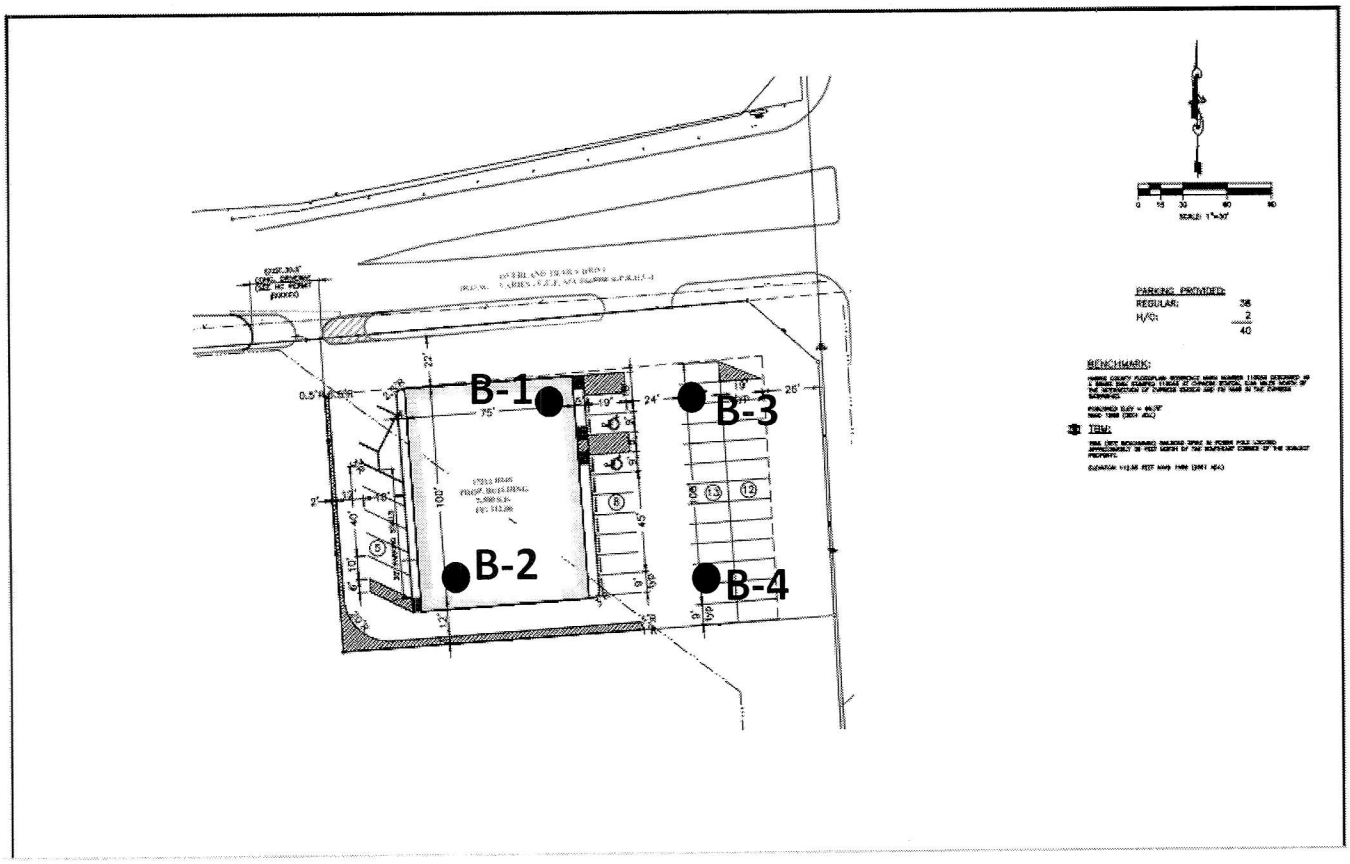
The analysis and recommendations submitted in this report are based upon the data obtained from four (4) borings drilled at the site. Soil conditions may vary across the site. If significant variations are noted during construction, TGC should be contacted to evaluate the effect of these variations on the recommendations given in this report.

TGC states that the findings, recommendations or professional opinions or advice contained in this report (and that may be given henceforth in connection with this project) have been made and this report prepared in general accordance with generally accepted professional engineering practice in the field of geotechnical engineering as based on the location, size and type of project. No other warranties, either written or verbal, are implied or expressed.

This report has been prepared for the exclusive use of the owner, the project architect, the project structural engineer and contractors for the specific application to the building at 17211 IH 45, Houston, Texas.

16.0 REFERENCES

1. "Design and Construction of a Post-Tensioned Slab-On-Ground", 3rd Edition, Post-Tensioning Institute, Phoenix, Arizona, 2004 (with 2008 supplement).
2. Snowden, Walter L (1981), Design of Slab-On-Ground Foundation, Snowden, Inc., Austin, Texas.
3. Joseph E. Bowles (1982), Foundation Analysis and Design, 3rd ed., McGraw-Hill Book Company.



Note: Boring Locations shown are Approximate.

Project Name: Proposed Commercial Building at 17211 IH 45, Houston, Texas TGC Report No. 711303 Date: 12-13-2017 Scale: Not to Scale	BORING LOCATION PLAN

TEXAS GEOTECHNICAL CONSULTANTS, LLC.

LOG OF BORING B-1

Project: Proposed Commercial Building
17211 IH 45
Houston, Texas

Client: Stewart Consulting Services

Date: 12/13/2017
Job Number: 711303
Boring Method: Dry Auger
Elevation: Existing
Driller: Drill-Tex

FIELD DATA					LABORATORY DATA							
Depth (Feet)	Samples	Soil Types	SPT (Blows Per Feet)	SOIL DESCRIPTION	Moisture Content, %	Plasticity Index	Liquid Limit	UC Shear Strength, tsf	TV Shear Strength, tsf	Hand Penetrometer, tsf	200 Sieve, %	Unit Dry Weight, pcf
1		CH		(1 inch HMAC over 6 inch base over 6 inch sand)								
2				Fill: Fat Clay (CH), brown, with ferrous nodules and sand pockets	25	33	53		2.5	1		
3		CL		Lean Clay (CL), stiff, brown, with ferrous nodules	14				0.8	1.5		
4												
5					15				0.8	1.5		
6												
7				hard, light gray below 6 feet	16	21	37		2.5	4.5		
8												
9					15			1.6	2.5	4.5		113
10												
11												
12												
13		SC		Clayey Sand (SC), medium dense, light gray								
14					8.8							
15			18									
16												
17												
18												
19					6.8							
20			24									
				Boring terminated at 20 feet								

REMARKS:
UC Shear Strength = Unconfined Compression Shear Strength
TV Shear Strength = Torvane Shear Strength

GROUNDWATER: dry

Hole Caved: no

PLATE 2

TEXAS GEOTECHNICAL CONSULTANTS, LLC.

LOG OF BORING B-2

Project: Proposed Commercial Building
17211 IH 45
Houston, Texas

Client: Stewart Consulting Services

Date: 12/13/2017
Job Number: 711303
Boring Method: Dry Auger
Elevation: Existing
Driller: Drill-Tex

FIELD DATA | **LABORATORY DATA**

Depth (Feet)	Samples	Soil Types	SPT (Blows Per Feet)	SOIL DESCRIPTION	Moisture Content, %	Plasticity Index	Liquid Limit	UC Shear Strength, tsf	TV Shear Strength, tsf	Hand Penetrometer, tsf	200 Sieve, %	Unit Dry Weight, pcf
1		SC		(1.5 inch HMAC over 6 inch base) Possible Fill: Clayey Sand (SC), brown	7.7							
2												
3		CL		Lean Clay (CL), stiff, brown, with ferrous nodules	15	10	25	0.7	1.5	2.5		110
4												
5				very stiff, tan and reddish brown below 4 feet	15				2.5	4		
6												
7					15				2	3		
8												
9				stiff below 8 feet	14	23	39		1.5	2.5		
10												
11												
12												
13		SC		Clayey Sand (SC), medium dene, gray								
14					8.4							
15			18									
16												
17												
18												
19				gray and brown below 18 feet	7.1							
20			21									
				Boring terminated at 20 feet								

REMARKS:
UC Shear Strength = Unconfined Compression Shear Strength
TV Shear Strength = Torvane Shear Strength

GROUNDWATER: dry

Hole Caved: no

PLATE 3

TEXAS GEOTECHNICAL CONSULTANTS, LLC.

LOG OF BORING B-3

Project: Proposed Commercial Building
17211 IH 45
Houston, Texas

Client: Stewart Consulting Services

Date: 12/13/2017
Job Number: 711303
Boring Method: Dry Auger
Elevation: Existing
Driller: Drill-Tex

FIELD DATA					LABORATORY DATA							
Depth (Feet)	Samples	Soil Types	SPT (Blows Per Feet)	SOIL DESCRIPTION	Moisture Content, %	Plasticity Index	Liquid Limit	UC Shear Strength, tsf	TV Shear Strength, tsf	Hand Penetrometer, tsf	200 Sieve, %	Unit Dry Weight, pcf
1		SC		(1.5 inch HMAC over 6 inch base) Possible Fill: Clayey Sand (SC), brown	7.2							
2												
3		CL		Lean Clay (CL), stiff, gray and brown, with ferrous nodules	11	8	23		1	2		
4												
5				light gray below 4 feet	12				1.5	2.5		
				Boring terminated at 5 feet								

REMARKS:
UC Shear Strength = Unconfined Compression Shear Strength
TV Shear Strength = Torvane Shear Strength

GROUNDWATER: dry

Hole Caved: no

PLATE 4

TEXAS GEOTECHNICAL CONSULTANTS, LLC.

LOG OF BORING B-4

Project: Proposed Commercial Building
17211 IH 45
Houston, Texas

Client: Stewart Consulting Services

Date: 12/13/2017
Job Number: 711303
Boring Method: Dry Auger
Elevation: Existing
Driller: Drill-Tex

FIELD DATA | **LABORATORY DATA**

Depth (Feet)	Samples	Soil Types	SPT (Blows Per Feet)	SOIL DESCRIPTION	Moisture Content, %	Plasticity Index	Liquid Limit	UC Shear Strength, tsf	TV Shear Strength, tsf	Hand Penetrometer, tsf	200 Sieve, %	Unit Dry Weight, pcf
1		SC		(1.5 inch HMAC over 6 inch base) Possible Fill: Clayey Sand (SC), brown	8.7							
2												
3		CL		Lean Clay (CL), stiff, brown, with ferrous nodules	14				1	2		
4				light gray below 4 feet								
5					12	14	30		1.5	2.5		
				Boring terminated at 5 feet								

REMARKS:
UC Shear Strength = Unconfined Compression Shear Strength
TV Shear Strength = Torvane Shear Strength

GROUNDWATER: dry

Hole Caved: no

PLATE 5

TERMS USED ON BORING LOGS

SOIL GRAIN SIZE

U.S.STANDARD SIEVE

6"	3"	¾"	#4	#10	#40	#200		
BOULDER	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		
152	76.2	19.1	4.76	1.00	0.420	0.074	0.002	

SOIL GRAIN SIZE IN MILLIMETERS

STRENGTH OF COHESIVE SOILS

Consistency	Undrained Shear Strength, Kips Per Sq. ft
Very Soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very Stiff	2.00 to 4.00
Hard	greater than 4.00

RELATIVE DENSITY OF COHESIONLESS SOILS

(From Standard Penetration Tests)

Very Loose	< 4 bpf
Loose	5-10 bpf
Medium Dense	11-30 bpf
Dense	31-50 bpf
Very Dense	>50 bpf

(bpf= blow per foot, ASTM D 1586)

SPLIT BARREL SAMPLER DRIVING RECORD

Blows per Foot	Description
25	25 blows driving sampler 12 inches after initial 6 inches of seating.
50/7"	50 blows driving sampler 7 inches after initial 6 inches of seating.
50/3"	50 blows driving sampler 3 inches after initial 6 inches of seating.

Note: To avoid damage to sampling tool, driving is limited to 50 blows during or after seating interval.

DRY STRENGTH ASTM D2488

None	Dry Specimen crumbles into powder with mere pressure of handling
Low	Dry Specimen crumbles into powder with some finger pressure
Medium	Dry Specimen breaks into pieces or crumbles with considerable pressure
High	Dry Specimen cannot be broken with finger pressure, can be broken between Thumb and hard surface
Very High	Dry Specimen cannot be broken between the thumb and hard surface

MOISTURE CONDITION ASTM D2488

Dry	Absence of Moisture
Moist	Damp but no visible water
Wet	Visible free water

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy. The degree of slickensidedness depends upon the spacing of slickensides and the easiness of breaking along these planes.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt usually more or less vertical
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample
Paring	Inclusion of less than 1/8 inch thick extending through the sample
Seam	Inclusion of 1/8 inch to 3 inches thick extending through the sample
Layer	Inclusion of greater than 3 inches thick extending through the sample
Laminated	Soil sample composed of alternating partings or seams of different soil types
Calcareous	Having appreciable quantities of calcium material
Ferrous	Having appreciable quantities of ferrous or iron nodules