GEOTEST ENGINEERING, INC.

Geotechnical Engineers & Materials Testing

5600 Bintliff Drive Houston, Texas 77036 Telephone: (713) 266-0588
Fax: (713) 266-2977

Job No. 1140197101
Trench Safety Report
November 7, 2014

Mr. Martin J. Cristofaro, P.E., R.P.L.S., CFM
R.G. Miller Engineers, Inc.
16340 Park Ten Place, Suite 350
Houston, Texas 77084

Reference: Trench Safety Design Considerations
Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

Dear Mr. Cristofaro:

We are pleased to present our geotechnical information for trench safety for the referenced project.

For trench excavation, it is essential to maintain the stability of the sides and base and not to disturb the soil below the excavation grade. This is necessary to prevent any damage to adjacent facilities as a result of either vertical or lateral movements of the soil. In addition, a satisfactory excavation procedure must include an adequate construction dewatering system to lower and maintain the water level at least 3 feet below the lowest excavation grade or a minimum of 5 feet below prevailing level of backfill during backfilling. This will minimize the potential for softening or "boiling" of the base support soil.

Trench Excavation

Based on the information provided by R.G. Miller Engineers, Inc., it is understood that the storm sewer and water line will be installed by open cut method of construction except the sanitary sewer along Wirt Road at utility crossings. The sanitary sewer along Wirt Road will be installed by trenchless method of construction at utility crossings. The following subsections

provide information for the design and construction of the storm sewer, sanitary sewer and water line by open cut method and access pits for trenchless method of construction.

Geotechnical Parameters. Based on the soil conditions revealed by the borings GB-1 through GB-15, geotechnical parameters were developed for the design of open cut method of construction for storm sewer, sanitary sewer and water line installation and auger pits for sanitary sewer trenchless method. The design parameters are provided in Table 1. For design, the groundwater level should be assumed to exist at the ground surface.

Excavation Stability. The open excavation may be shored or laid back to a stable slope or supported by some other equivalent means used to provide safety for workers and adjacent structures, if any. The excavating operations should be in accordance with OSHA Standards, OSHA 2207, Subpart P, latest revision and the City of Houston Standard Specification.

- Excavation Shallower Than 5 Feet - Excavations that are less than 5 feet deep **(critical height)** should be effectively protected when an indication of dangerous ground movement is anticipated.

- Excavations Deeper Than 5 Feet - Excavations that are deeper than 5 feet should be sloped, shored, sheeted, braced or laid back to a stable slope or supported by some other equivalent means or protection such that workers are not exposed to moving ground or cave-ins. The slopes and shoring should be in accordance with the trench safety requirements as per OSHA Standards. The following items provide design criteria for excavation stability.

  (i) OSHA Soil Type. Based on the soil conditions revealed by borings drilled for this study and assumed groundwater level at surface, OSHA soil type "C" should be used for determination of allowable maximum slope and/or the design of shoring along the alignment for full proposed depth of open excavation. For shoring deeper than 20 feet (if needed), an engineering evaluation is required and deeper soil borings will be needed.

(ii) Excavation Support Earth Pressure. Based on the subsurface conditions indicated by our field investigation and laboratory testing results, excavation support earth pressure diagrams were developed and are presented on Figures 1.1 through 1.3. These pressure diagrams can be used for the design of temporary trench bracing. For a trench box, a lateral earth pressure resulting from an equivalent fluid with a unit weight of 94 pcf can be used. The effects of any surcharge loads at the ground surface should be added to the computed lateral earth pressures. A surcharge load, q, will typically result in a lateral load equal to 0.5 q. The above value of equivalent fluid pressure is based on assumption that the groundwater level is near the ground surface, since these conditions may exist after a heavy rain or flooding.

(iii) Bottom Stability. In braced cuts, if tight sheeting is terminated at the base of the cut, the bottom of the excavation can become unstable. The parameters that govern the stability of the excavation base are the soil shear strength and the differential hydrostatic head between the groundwater level within the retained soils and the groundwater level at the interior of the trench excavation. For cut in cohesive soils as predominantly encountered for the proposed excavation depths in most of the borings, the bottom stability can be evaluated as outlined on Figure 2. However, at locations near borings GB-11, GB-12B, GB-14B and GB-15 where cohesionless soils were encountered below the depth of 8 feet, dewatering will be necessary to avoid bottom stability problems.

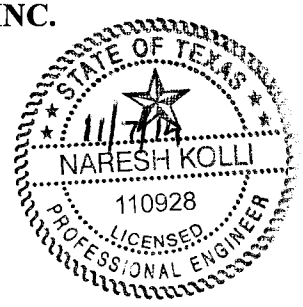
Groundwater Control. Excavations for the storm sewer, sanitary sewer and water line may encounter groundwater seepage to varying degrees depending upon the groundwater conditions at the time of construction and the location and depth of the trench. Based on the soil conditions identified in the borings for the proposed storm sewer, sanitary sewer and water line installation, all the excavations will be in cohesive soils except at borings GB-11, GB-12B, GB-14B and GB-15 where the storm sewer and sanitary sewer will be in cohesive underlain by cohesionless soils.

In general for cohesive soils as predominantly encountered for most of the borings for the excavation depths, the groundwater if encountered may be managed by collection in excavation bottom sumps for pumped disposal. However, in borings GB-11, GB-12B, GB-14B and GB-15 where cohesionless soils were encountered near the invert of the excavation; dewatering will be required. Dewatering such as vacuum well points up to 15 feet or deep wells with submersible pumps for excavation greater than 15 feet may be required to lower the groundwater level to at least 5 feet below the bottom of the excavation. It is recommended that the actual groundwater conditions should be verified by the contractor at the time of construction and that groundwater control should be performed in general accordance with the City of Houston Standard Specifications, Section 01578.

We appreciate this opportunity to be of service to you. If you have any questions regarding the report, or if we can be of further service to you, please call us.

Sincerely,
GEOTEST ENGINEERING, INC.
TBPE Registration No. F-410

Naresh Kolli, P.E.
Assistant Project Manager



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Enclosures: Trench Support Earth Pressure – Figure 1.1 thru 1.3
Stability of Bottom for Braced Cut – Figure 2
Geotechnical Design Parameter Summary: Open-cut Excavation – Table 1
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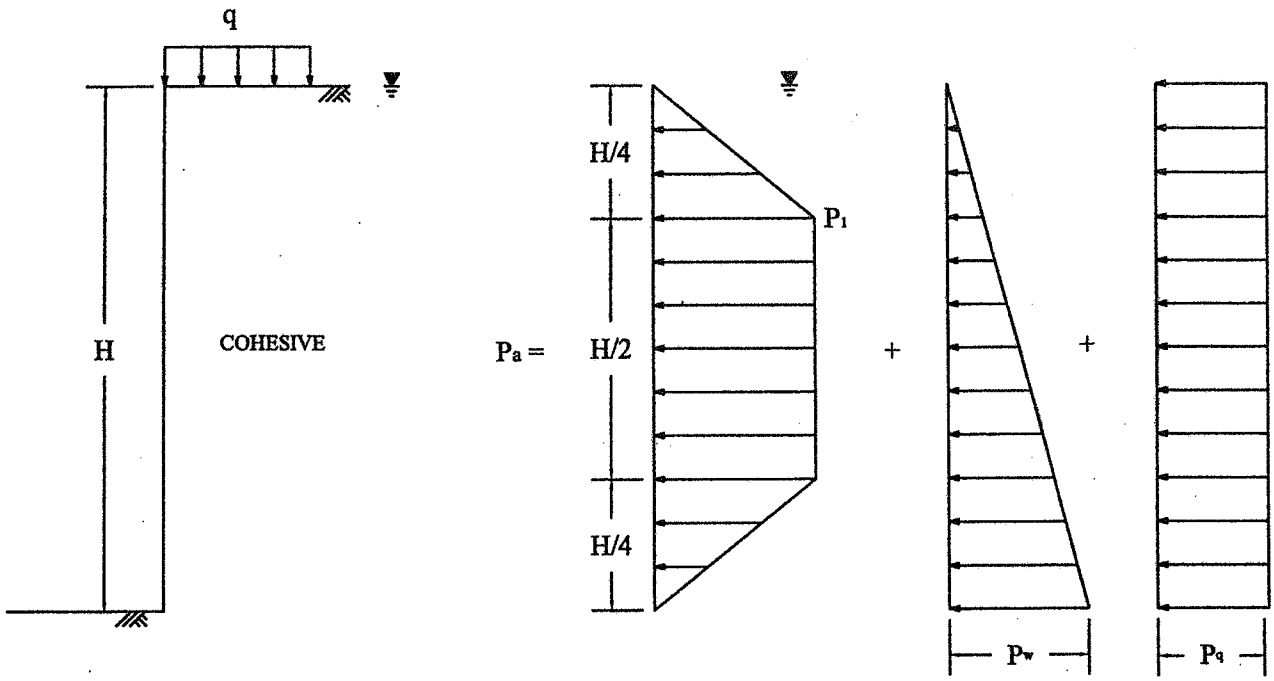
Job No. 1140197101



TYPICAL SOIL PARAMETERS

See Table 1 for typical values of soil parameters

BRACED WALL

For $\gamma H/c \leq 4$

$P_1 = 0.3\ \gamma_c' H$

$P_w = \gamma_w H = 62.4 H$

$P_q = 0.5\ q$

Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_a = Lateral pressure, psf;
P_1 = Active earth pressure, psf;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Depth of braced excavation, feet
c = Shear strength of cohesion soil, psf;

TRENCH SUPPORT EARTH PRESSURE

SUBMERGED COHESIVE SOIL

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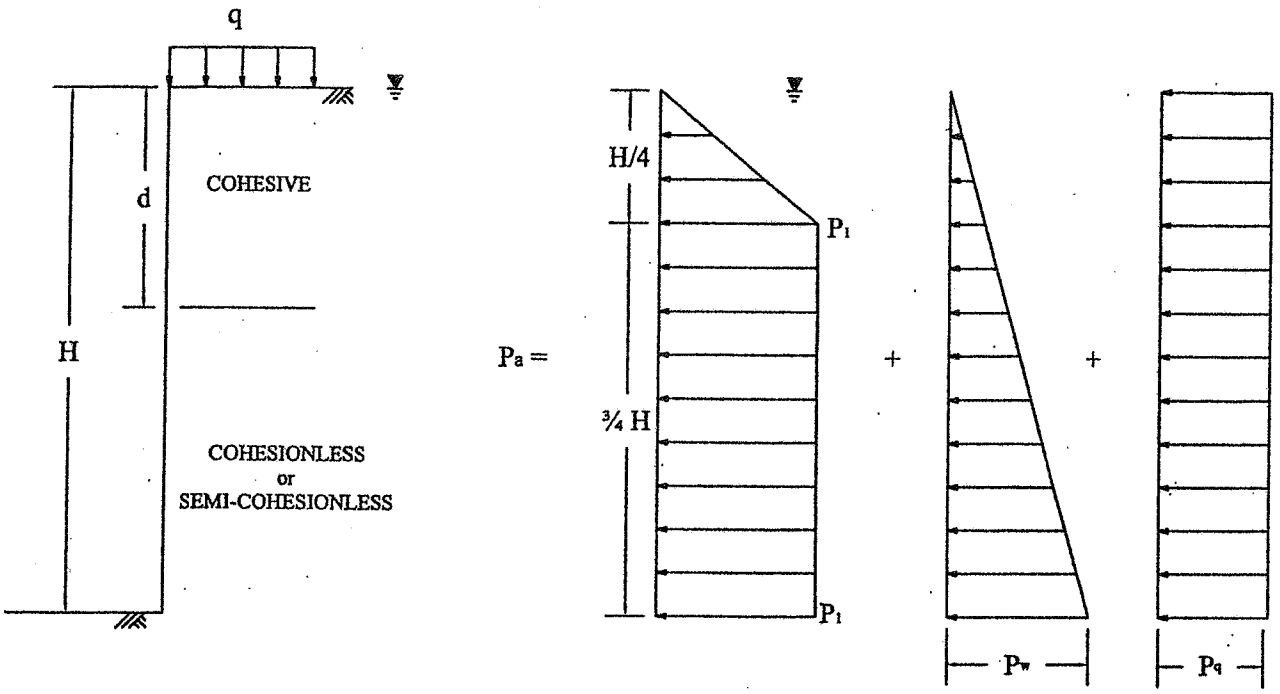


TYPICAL SOIL PARAMETERS

See Table 1 for typical values of soil parameters

$$\gamma'_{avg} = \frac{\gamma_c' \, d + \gamma_s' \, (H-d)}{H}$$

BRACED WALL

$P_1 = 0.3 \, \gamma'_{avg} \, H$
$P_w = 62.4 \, H$
$P_q = 0.5 \, q$

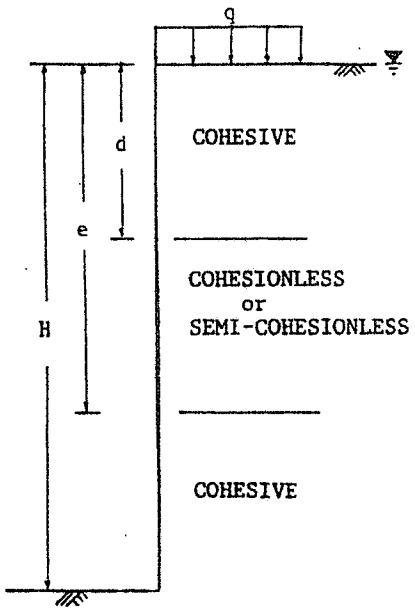
Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
γ_s' = Submerged unit weight of cohesionless soil, pcf;
γ'_{avg} = Average submerged unit weight of soils, pcf;
q = Surcharge load at surface, psf;
P_a = Lateral pressure, psf;
P_1 = Active earth pressure, psf;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Depth of braced excavation, feet

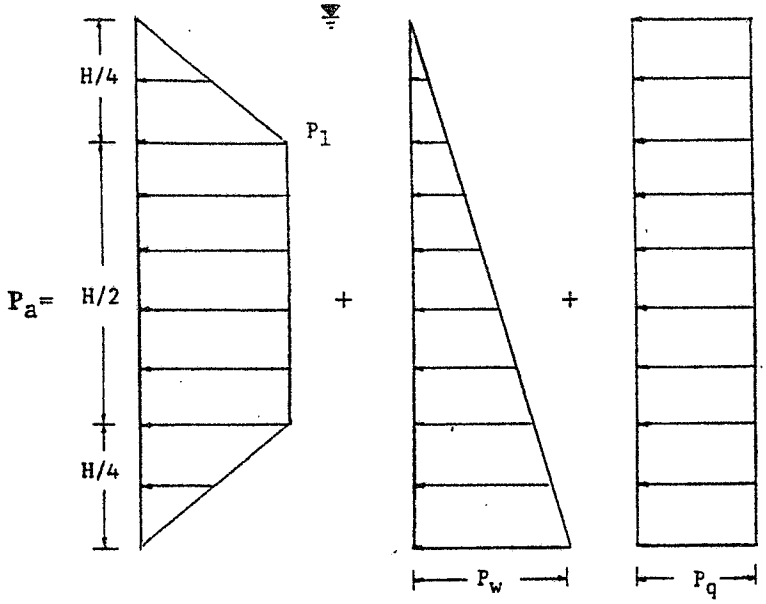
TRENCH SUPPORT EARTH PRESSURE

SUBMERGED COHESIVE SOIL OVER
COHESIONLESS OR SEMI-COHESIONLESS SOIL

Job No. 1140197101



TYPICAL SOIL PARAMETERS



BRACED WALL

See Table 1 for typical values of soil parameters

$$\gamma'_{avg} = \frac{\gamma_c' \, d + \gamma_s' \, (e-d) + \gamma_c' \, (H-e)}{H}$$

$\gamma_w = 62.4$ pcf

$P_1 = 0.3 \, \gamma'_{avg} \, H$

$P_w = \gamma_w \, H = 62.4 \, H$

$P_q = 0.5q$

Where:

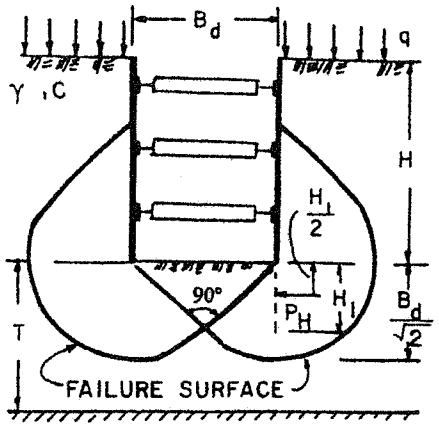
- γ_c' = Submerged unit weight of cohesive soil, pcf ;
- γ_s' = Submerged unit weight of cohesionless or semi-cohesionless soil, pcf ;
- γ_w = Unit weight of water, pcf;
- γ'_{avg} = Average submerged unit weight of soil, pcf ;
- q = Surcharge load at surface, psf;
- P_a = Lateral pressure, psf;
- P_1 = Active earth pressure, psf;
- P_q = Horizontal pressure due to surcharge, psf;
- P_w = Hydrostatic pressure due to groundwater, psf;
- H = Depth of braced excavation, feet

TRENCH SUPPORT EARTH PRESSURE

SUBMERGED COHESIVE SOIL
INTERBEDDED WITH COHESIONLESS OR
SEMI-COHESIONLESS SOIL

Job No. 1140197101

CUT IN COHESIVE SOIL,
DEPTH OF COHESIVE SOIL UNLIMITED ($T > 0.7\ B_d$)
L = LENGTH OF CUT



If sheeting terminates at base of cut:

$$\text{Safety factor, } F_S = \frac{N_C C}{\gamma H + q}$$

N_C = Bearing capacity factor, which depends on dimensions of the excavation : B_d , L and H (use N_C from graph below)

C = Undrained shear strength of clay in failure zone beneath and surrounding base of cut

γ = Wet unit weight of soil (see Table 1)

q = Surface surcharge (assumed q = 500 psf)

If safety factor is less than 1.5, sheeting or soldier piles must be carried below the base of cut to insure stability - (see note)

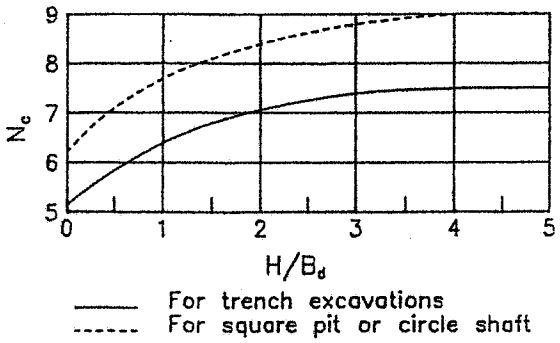
H_1 = Buried length $= \frac{B_d}{2} \geq 5$ feet

Note : If soldier piles are used, the center to center spacing should not exceed 3 times the width or diameter of soldier pile .

Force on buried length, P_H:

If $H_1 > \frac{2}{3} \frac{B_d}{\sqrt{2}}$, $P_H = 0.7\ (\gamma\ HB_d - 1.4CH - \pi CB_d)$ in lbs/ linear foot

If $H_1 < \frac{2}{3} \frac{B_d}{\sqrt{2}}$, $P_H = 1.5H_1\ (\gamma\ H - \frac{1.4CH}{B_d} - \pi C)$ in lbs/ linear foot



STABILITY OF BOTTOM FOR BRACED CUT

TABLE 1

GEOTECHNICAL DESIGN PARAMETER SUMMARY
OPEN-CUT EXCAVATION

Alignments	Boring Nos.	Stratigraphic Unit	Range of Depths, ft	Wet Unit Weight, γ, pcf	Submerged Unit Weight, γ', pcf	Undrained Cohesion, psf	Internal Friction Angle, φ, degree
48" RCP, 12"water line & 21 to 24" Sanitary Sewer along Wirt Road	GB-1	Cohesive	0-4	130	65	1,000	--
			4-12	130	65	2,200	--
			12-18	130	65	2,500	--
			15-25	125	63	1,500	--
	GB-2	Cohesive	0-4	130	65	1,000	--
			4-6	125	63	1,500	--
			6-14	130	65	2,500	--
			14-20	130	65	3,200	--
			20-25	125	63	600	--
	GB-3	Cohesive	0-4	130	65	1,500	--
			4-12	132	66	3,000	--
			12-16	128	64	1,800	--
			16-23	130	65	3,500	--
			23-25	125	63	2,000	--
	GB-4	Fill	0-6	125	63	1,000	--
		Cohesive	6-10	130	65	1,200	--
			10-25	130	65	3,000	--
	GB-5	Cohesive	0-4	125	63	1,000	--
			4-6	125	63	2,000	--
			6-13	130	65	3,500	--
			13-15	130	65	1,200	--
		Cohesionless	15-17	110	55	--	30
	GB-10	Fill	0-2	120	60	1,500	--
		Cohesive	2-8	125	63	2,000	--
			8-14	130	65	2,400	--
			14-23	125	63	3,000	--
			23-28	125	63	500	--
			28-30	130	65	4,500	--
	GB-11	Cohesive	0-8	125	63	500	--
		Cohesionless	8-14	100	50	--	30
		Cohesive	14-18	120	60	500	--
		Cohesionless	18-28	115	58	--	30
		Cohesive	28-30	125	63	3,000	--
	GB-12B	Cohesive	0-8	130	65	2,200	--
			8-16	130	65	2,400	--
			16-18	125	63	900	--
		Cohesionless	18-23.5	100	50	--	30
			23.5-36	115	58	--	35
		Cohesive	36-41.5	130	65	1,500	--
		Cohesionless	41.5-45	112	62	--	35
	GB-13B	Cohesive	0-10	125	63	1,200	--
			10-16	120	60	800	--
			16-23	132	66	1,000	--
			23-35	125	63	1,000	--
			35-45	125	63	4,000	--

TABLE 1

GEOTECHNICAL DESIGN PARAMETER SUMMARY
OPEN-CUT EXCAVATION

Alignments	Boring Nos.	Stratigraphic Unit	Range of Depths, ft	Wet Unit Weight, γ, pcf	Submerged Unit Weight, γ', pcf	Undrained Cohesion, psf	Internal Friction Angle, φ, degree
48" RCP, 12"water line & 21 to 24" Sanitary Sewer along Wirt Road	GB-14B	Cohesive	0-12	125	63	1,500	--
			12-22	132	66	2,500	--
		Cohesionless	22-43	116	58	--	30
		Cohesive	43-45	125	63	3,500	--
	GB-15	Cohesive	0-16	125	63	600	--
		Cohesionless	16-18	105	53	--	30
		Cohesive	18-23	125	63	2,400	--
			23-25	120	60	500	--
		Cohesionless	25-38.5	102	51	--	30
		Cohesive	38.5-48	125	63	3,000	--
		Cohesionless	48-53	106	53	--	28
24"-30" RCP Along Shoshone Road, Harwood Drive, Haldane Drive and Kilburn Road	GB-6 thru GB-9	Cohesive	0-4	125	63	1,000	--
			4-10	132	66	1,500	--
			10-12	125	63	1,000	--
			12-20	130	65	1,500	--

Note: 1) Cohesive soils include Fat Clay, Fat Clay with sand, Sandy Fat Clay, Lean Clay, Lean Clay with sand and Sandy Lean Clay.
2) Cohesionless soils include Silty Sand
3) Fill Soils include lean clay with sand

GEOTECHNICAL INVESTIGATION
WIRT ROAD DRAINAGE AND PAVING
SUB-PROJECT II DESIGN
WBS NO. M-000287-0002-3
HOUSTON, TEXAS

REPORT NO. 1140197101

Reported to:

R.G. MILLER ENGINEERS, INC.

Houston, Texas

Submitted by:

GEOTEST ENGINEERING, INC.

Houston, Texas

November 7, 2014

Key Map No. 451 P

GEOTEST ENGINEERING, INC.

Geotechnical Engineers & Materials Testing

5600 Bintliff Drive Houston, Texas 77036 Telephone: (713) 266-0588
Fax: (713) 266-2977

Report No. 1140197101
November 7, 2014

Mr. Martin J. Cristofaro, P.E., R.P.L.S., CFM
R.G. Miller Engineers, Inc.
16340 Park Ten Place, Suite 350
Houston, Texas 77084

Reference: Geotechnical Investigation
Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

Dear Mr. Cristofaro:

Presented herein is our final geotechnical investigation report for the referenced project. A draft report was submitted to you on March 6, 2014. A revised draft report was submitted to you on July 28, 2014. This final report supersedes all previously submitted reports, transmittals, etc., for the referenced project. This study was authorized by Professional Services Agreement dated September 30, 2013 and May 20, 2014 by accepting our proposal Nos. 1140306899 dated August 19, 2013 and 1140338599 dated February 12, 2014.

We appreciate this opportunity to be of service to you. If you have any questions regarding the report, or if we can be of further service to you, please call us.

Sincerely,
GEOTEST ENGINEERING, INC.
TBPE Registration No. F-410

Naresh Kolli, P.E.
Assistant Project Manager

Mohan Ballagere, P.E.
Vice President

MB/NK/ego
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EXECUTIVE SUMMARY

A geotechnical investigation was performed for the design and construction of the proposed Wirt Road Drainage and Paving Sub-Project II Design in Houston, Texas. The project is comprised of approximately 5,400 linear feet (lf) of 48-inch reinforced concrete pipe (RCP) storm sewer, 12 to 24-inch sanitary sewer, 12-inch water line and pavement rehabilitation along Wirt Road between Long Point and Kempwood. The sanitary sewer then turns east about 350 feet along Long Point Road to tie into the deep manhole. The project also includes approximately 2,980 lf of 24-inch and 30-inch RCP, 8 to 10-inch sanitary sewer and paving improvements in subdivision comprising of Shoshone Road, Harwood Drive, Haldane Drive and Kilburn Road. The maximum depth of utilities ranges from 6 to 30 feet along Wirt Road and Long Point and about 14 feet along the other streets in the subdivision. The proposed utilities will be installed by open cut method of construction except the sanitary sewer line along Wirt Road at utility crossings. The sanitary sewer along Wirt Road will be installed by trenchless method of construction at utility crossings. The existing pavement will be replaced with concrete pavement with curb and gutter.

The purposes of this study were to evaluate soil and groundwater conditions and to provide geotechnical recommendations for the proposed Drainage and Paving Improvements for Wirt Road. The investigation included drilling and sampling fifteen (15) borings (including additional borings) to depths ranging from 17 to 53 feet, installing piezometers in three (3) existing borings, performing laboratory tests on soil samples recovered from the borings, performing engineering analyses and developing geotechnical recommendations and preparing a geotechnical report.

The principal findings and conclusions developed from this investigation are as follows:

- The subsurface conditions as revealed by borings GB-1 through GB-15 along Wirt Road and Long Point Road and other streets in the subdivision for the project alignments is summarized below:
    - Wirt Road and Long Point Road. The subsurface soil beneath pavement as encountered in borings GB-1 through GB-5 and GB-10 through GB-15 along Wirt Road and Long Point Road consists of cohesive soils and cohesive soils with intermittent cohesionless soils to the explored depths of 17 to 53 feet. Fill material

consisting of medium stiff to hard gray and brown lean clay with sand was encountered to depths of 2 to 6 feet below the existing pavement in borings GB-4 and GB-10. Cohesive soils consists of soft to hard dark gray, gray, brown, yellowish brown and reddish brown sandy lean clay, lean clay with sand, lean clay, sandy fat clay, fat clay with sand and fat clay. The cohesionless soils consist of fine sand with silt, silty sand, sandy silt, silt with sand and silt.

Other Streets (Shoshone Road, Harwood Drive, Kilburn Road). The subsurface soil beneath pavement as encountered in borings GB-6 through GB-9 drilled along Shoshone Road, Harwood Drive, Kilburn Road consist of stiff to hard dark gray, gray, brown, yellowish brown and reddish brown sandy lean clay, lean clay with sand and fat clay with sand to explored depth of 20 feet.

- Based on the available information from U.S. Geological Survey (USGS) Maps and information contained in house records relating to geologic faults for the project area, the Long Point Fault crosses Wirt Road approximately 1500 feet south of Hammerly. Based on the location of the fault, a Phase I Geological Fault Study is recommended for this project.

- Groundwater was encountered in borings GB-1, GB-2, GB-3, GB-4, GB-5 and GB-9 through GB-15 to depths ranging from 16 to 25 feet during drilling. The groundwater level, measured 15 to 20 minutes after water was first encountered, ranged from 8.7 to 17.6 feet in these borings. No groundwater was encountered in other borings GB-6, GB-7 and GB-8 drilled for this study. In piezometer borings GB-1P and GB-9P, the water level measured ranged from 12.9 to 13.8 feet on November 7, 2013. The water level was measured at 16 feet in piezometer boring GB-14P on July 22, 2014.

- The existing paving along Wirt Road consists of 2 to 2.5 inches of asphalt over 6 inches of concrete in borings GB-1 through GB-5 and 7 to 8.5 inches of concrete over 0 to 6 inches of lime stabilized sandy clay in borings GB-9 through GB-14. The existing paving along Long Point Road is about 10.5 inches of concrete in boring GB-15. The

existing paving as obtained in borings GB-6 through GB-9 on subdivision streets consist of 3 to 6 inches of asphalt over 7 to 14 inches of oyster shell, sand and gravel mix.

- All excavation operations should be carried out in accordance with OSHA standards and the City of Houston Standard Specifications.

- In general, excavation and backfill for utilities should be designed and constructed in accordance with City of Houston Standard Specification No. 02317.

- The bedding and backfill for sanitary sewer, storm sewer and water line should be in accordance with City of Houston Standard Specification Section 02317 and Drawing Nos. 02317-02, 02317-03 and 02317-04.

- The recommended pavement sections for Wirt Road project are given below:

Street	**Pavement Section**
Wirt Road	10" Reinforced Concrete over 8" Lime Stabilized Subgrade
Shoshone Road, Harwood Drive, Haldane Road and Kilburn Road	6" Reinforced Concrete over 6" Lime Stabilized Subgrade

The details of pavement section are provided in Section 5.4 of this report.

1.0 INTRODUCTION

1.1 General

The City of Houston selected R.J. Miller Engineers, Inc. to perform engineering services for design and construction of Wirt Road Drainage and Paving Sub-Project II Design in Houston, Texas. R.J. Miller Engineers, Inc. retained Geotest Engineering, Inc. as a part of the design team to perform geotechnical investigation for the above project.

1.2 Authorization

This study was authorized by Professional Services Agreement dated September 30, 2013 and May 20, 2014 by accepting our proposal Nos. 1140306899 dated August 19, 2013 and 1140338599 dated February 12, 2014.

1.3 Location and Description of Project

The project is located along Wirt Road between Long Point and Kempwood in Houston, Texas. The project alignment runs along Wirt Road, Shoshone Road, Harwood Drive, Haldane Road and Kilburn Road in Key Map and Grid 451 P.

The project is comprised of approximately 5,400 linear feet (lf) of 48-inch reinforced concrete pipe (RCP) storm sewer, 12 to24-inch sanitary sewer, 12-inch water line and pavement rehabilitation along Wirt Road between Long Point and Kempwood. The sanitary sewer turns east about 350 feet Long Point Road to tie into the manhole. The project also includes approximately 2,980 lf of 24-inch and 30-inch RCP, 8 to 10-inch sanitary sewer and paving improvements in subdivision comprising of Shoshone Road, Harwood Drive, Haldane Drive and Kilburn Road. The maximum depth of utilities ranges from 6 to 30 feet along Wirt Road and Long Point and about 14 feet along the other streets in the subdivision. The proposed utilities will be installed by open cut method of construction except the sanitary sewer line along Wirt Road at utility crossings. The sanitary sewer along Wirt Road will be installed by trenchless method of construction at utility crossings. The existing pavement will be

replaced with concrete pavement with curb and gutter. The vicinity map of the project area is shown on Figure 1.

1.4 Purpose and Scope

The purposes of this study were to evaluate soil and groundwater conditions and to provide geotechnical recommendations for the design and construction of the proposed Wirt Road Drainage and Paving Sub-Project II Design. The scope of this investigation consisted of the following:

- Performed concrete coring at eleven (11) boring locations for borings access.
- Drilled and sampled fifteen (15) borings each to depths ranging from 17 to 53 feet.
- Converted three (3) borings into piezometers to monitor long term ground water level.
- Performed appropriate laboratory tests in accordance with ASTM methods on selected samples to develop engineering properties of the soil.
- Reviewed available fault information to evaluate the potential for known active faults that may impact the project.
- Performed engineering analyses in accordance with the City of Houston Design Manual (July 2012) to develop geotechnical recommendations for the design and construction of the proposed Wirt Road Drainage and Paving Sub-Project II Design.
- Prepared a geotechnical report that will include all field data, laboratory test data and geotechnical recommendations.
- Prepared a separate soil type report for trench (open cut) excavation.

2.0 FIELD INVESTIGATION

2.1 General

After obtaining the utilities clearance of proposed fifteen (15) marked borings in the field, existing concrete pavement was cored at eleven (11) boring locations for boring access and borings were drilled to the explored depths utilizing a truck mounted drilling rig. Traffic control devices and personnel were utilized during coring and drilling to maintain safety of drill crew and people driving in the streets. All the drilling and sampling were performed in accordance with appropriate ASTM procedures. It should be noted that after completion of the field work (October 2013 and June 2014), the sanitary sewer (including increased depth) was also included (July 2014) along the entire Wirt Road project alignment from Kempwood to Long Point and other streets in the subdivision as part of the design of the project. At boring locations, GB-1 through GB-15, except boring GB-5, GB-12, GB-13, GB-14 and GB-15, the depth of borings does not meet City of Houston criteria. However, the City will provide soil boring information (in the vicinity of borings GB-1 through GB-4 and GB-6 through GB-11) performed by others to design consultant for the design of sanitary sewer.

2.2 Geotechnical Borings

Subsurface conditions for the project area were explored by drilling and sampling nine (9) soil borings (designated as GB-1 through GB-9) each to depths ranging from17 to 25 feet during initial investigation. Six (6) additional borings GB-10 through GB-15 were drilled to depths ranging from 30 to 53 feet. The approximate boring locations are shown on Figure 2, Plan of Borings. Survey information (Northing and Easting coordinates and ground surface elevation) of completed borings was provided to us by R.G. Miller Engineers, Inc. The survey information of completed borings is summarized in Table 1.

In general, samples were obtained continuously to the depth of 20 feet, and intermittent sampling at 5 foot intervals to the termination depth of 25 feet. **During field investigation due to encounter of strong Hydrocarbon Odor in boring GB-5, the boring was terminated at 17 feet.**

At boring locations GB-12, GB-13 and GB-14, hard obstructions were encountered at depths ranging from 2 to 6 feet, and the borings were offset to borings GB-12A, GB-13B and GB-14B. In boring GB-12A, due to loss of circulation at 20 feet, the boring was offset to GB-12B and drilled to explored depth of 45 feet. Cohesive soils were obtained with a 3-inch thin-walled tube sampler in general accordance with ASTM Method D 1587. Samples of cohesionless or granular soils were obtained with a 2-inch diameter split-barrel sampler in general accordance with ASTM Method D 1586. Each sample was removed from the sampler in the field, carefully examined and then logged by an experienced soils technician. Suitable portions of each sample were sealed and packaged for transportation to Geotest's Laboratory. The shear strength of cohesive soil samples was estimated using a pocket penetrometer in the field. Driving resistances for the split-barrel sampler were recorded as "blows per foot" on the boring logs. All the borings, except the ones converted to piezometers, were grouted with cement-bentonite grout after completion of drilling and obtaining water level measurements.

Detailed descriptions of the soils encountered in the borings are given on the boring logs presented on Figures A-1 through A-15 in Appendix A. A key to symbols and terms used on boring logs is given on Figure A-16 in Appendix A.

2.3 Piezometer Installation

During the field investigation, piezometers were installed in the open borehole of borings GB-1, GB-9 and GB-14. The location of the piezometers designated as GB-1P, GB-9P and GB-14BP, are shown on Figure 2, Plan of Borings. The piezometer installation report showing the details of the construction of the piezometers are provided on Figures A-17 through A-19 in Appendix A.

The piezometers GB-1P, GB-9P and GB-14BP were abandoned in place after completion of final water level readings. The piezometer installation and abandonment information were submitted to Texas Department of Licensing and Regulations (TDLR). The TDLR installation and abandonment reports are presented in Appendix C.

3.0 LABORATORY TESTING

The laboratory testing program was designed to evaluate the pertinent physical properties and shear strength characteristics of the subsurface soils. Classification tests were performed on selected samples to aid in soil classification. All the tests were performed in accordance with ASTM Standards.

Undrained shear strengths of selected cohesive samples were measured by unconsolidated undrained (UU) triaxial compression tests (ASTM D 2850). The results of the UU triaxial compression tests are plotted on the boring logs as solid squares. The shear strength of cohesive samples was measured in the field with a calibrated hand pocket penetrometer and also in the laboratory with a Torvane. The shear strength values obtained from the penetrometer and Torvane are plotted on the boring logs as open circles and triangles, respectively.

Measurements of moisture content and dry unit weight were taken for each UU triaxial compression test sample. Moisture content (ASTM D 2216) measurements were also made on other samples to define the moisture profile at each boring location. The liquid and plastic limit tests (ASTM D 4318). Sieve analyses (ASTM D422) and percent passing No. 200 sieves (ASTM D 1140) were performed on appropriate samples.

The result of all tests are tabulated or summarized on the boring logs presented on Figures A-1 through A-15 in Appendix A. The summary of laboratory tests is also presented in a tabular form on Figures B-1 through B-15 in Appendix B. The grain size distribution curves are presented on Figures B-16 and B-17 in Appendix B.

4.0 SUBSURFACE CONDITIONS

4.1 Geology

The project area lies in the Beaumont Formation. The clays and sands of the Beaumont Formation are over-consolidated as a result of desiccation from frequent rising and lowering of the sea level and the groundwater table. Consequently, clays of this formation have moderate to high shear strength and relatively low compressibility. The sands of the Beaumont Formation are typically very fine and often silty. Further, there is occasional evidence in the Houston area of the occurrence of cemented material (sandstone and siltstone) deposits within the Beaumont Formation.

4.2 General Fault Information

A review of information in the Geotest library, relating to known surface and subsurface geologic faults in the general area of the project alignments, was undertaken. The available information consisted of U.S. Geological and NASA maps, open file reports and information contained in our files relating to geologic faults in the project area.

Based on the available information from U.S. Geological Survey (USGS) Maps and information contained in house records relating to geologic faults for the project area, the Long Point Fault crosses Wirt Road approximately 1500 feet south of Hammerly. A detailed fault study is not part of the project scope. Based on the location of the fault, a Phase I Geological Fault Study is recommended for this project.

4.3 Existing Paving

The existing paving along Wirt Road consists of 2 to 2.5 inches of asphalt over 6 inches of concrete in borings GB-1 through GB-5 and 7 to 8.5 inches of concrete over 0 to 6 inches of lime stabilized sandy clay in borings GB-9 through GB-14. The existing paving along Long Point Road is about 10.5 inches of concrete in boring GB-15. The existing paving as obtained in borings GB-6 through GB-9 on subdivision streets consist of 3 to 6 inches of asphalt over 7 to 14 inches of oyster shell, sand and gravel mix.

The details of the existing pavement thickness at each of the boring locations for Project area are summarized below:

Boring Nos.	Asphalt Thickness (in.)	Concrete Thickness (in.)	Base Thickness (in.)	Subbase Thickness (in.)	Total (in.)
GB-1 (GB-1P)	2.25	6.0	--	--	8.25
GB-2	2.0	6.0	--	--	8.0
GB-3	2.0	6.0	--	--	8.0
GB-4	2.0	6.0	--	--	8.0
GB-5	2.0	6.0	--	--	8.0
GB-6	6.0	--	7.0	--	13.0
GB-7	6.0	--	7.0	--	13.0
GB-8	5.0	--	7.0	--	12.0
GB-9 (GB-9P)	3.0	--	14.0	--	17.0
GB-10	--	8.0	--	--	8.0
GB-11	--	8.5	--	--	8.5
GB-12B	--	7.25	--	--	7.25
GB-13B	--	7.0	--	--	7.0
GB-14B	--	7.25	--	6.0	13.25
GB-15	--	10.5	--	--	10.5

Note: The base includes sand, oyster shell and gravel mix.
The subbase includes lime stabilized sandy clay.

4.4 Soils Stratigraphy

Based on the subsurface soils encountered in the boreholes, five (5) boring log profiles were developed and are presented on Figures 3.1 through 3.5. To the left of each boring shown on the profile is an indication of the consistency or density of each stratum. More than one consistency for an individual stratum indicates that the consistency is different at different depths within the stratum. For cohesive soils, consistency is related to the undrained shear strength of the soil. For cohesionless soils, the relative density of soil is measured by standard penetration test blows of the soil. To the right of each boring shown on the profile is the overall classification of the soil contained within each stratum. The symbols and abbreviations used on the boring log profile are given on Figure 4. The soil classification is based on ASTM Standards.

Wirt Road and Long Point Road The subsurface soils beneath pavement as encountered in borings GB-1 through GB-5 and GB-10 through GB-15 and as shown on boring log profiles 3.1 and 3.2

consist of cohesive soils and cohesive soils with intermittent cohesionless soils to the explored depths of 17 to 53 feet. Fill material consisting of medium stiff to hard gray and brown lean clay with sand was encountered to depths of 2 to 6 feet below the existing pavement in borings GB-4 and GB-10. Cohesive soils consists of soft to hard dark gray, gray, brown, yellowish brown and reddish brown sandy lean clay, lean clay with sand, lean clay, sandy fat clay, fat clay with sand and fat clay. The cohesionless soils consist of fine sand with silt, silty sand, sandy silt, silt with sand and silt.

The Fat Clay, Fat Clay with sand and Sandy Fat Clay are of high to very high plasticity with liquid limits ranging from 50 to 81 and a plasticity indices ranging from 29 to 52. The Sandy Lean Clay, Lean Clay with sand and Lean Clay is of low to high plasticity with liquid limits ranging from 26 to 49 and a plasticity indices ranging from 8 to 30. The percent fines (percent passing No. 200 sieve) of Fat Clay and Lean Clay ranges from 85 to 100 percent. The percent fines of Fat Clay with sand and Lean Clay with sand ranges from 72 to 84 percent. The percent fines of Sandy Lean Clay and Sandy Fat Clay ranges from 51 to 70 percent. The percent fines of fine sand with silt is about 6 percent. The percent fines of silty sand ranges from 24 to 46 percent. The percent fines of sandy silt ranges from 51 to 54 percent; the percent fines of silt with sand is about 72 percent and the percent fines of silt is about 99 percent.

Other Streets (Shoshone Road, Harwood Drive, Kilburn Road). The subsurface soil beneath pavement as encountered in borings GB-6 through GB-9 as shown on boring log profiles 3.3 through 3.5 drilled along Shoshone Road, Harwood Drive, Kilburn Road consist of stiff to hard dark gray, gray, brown, yellowish brown and reddish brown sandy lean clay, lean clay with sand and fat clay with sand to explored depth of 20 feet.

The Fat Clay with sand are of high to very high plasticity with liquid limits ranging from 59 to 69 and a plasticity indices ranging from 36 to 43. The Sandy Lean Clay and Lean Clay with sand are of medium to high plasticity with liquid limits ranging from 32 to 46 and plasticity indices ranging from 19 to 28. The percent fines (passing number 200 sieve) of fat clay with sand and lean clay with sand ranges from 73 to 90 percent. The percent fines of sandy lean clay ranges from 51 to 70 percent.

4.5 Range of Weak Soils Encountered at Pipe Invert Level in Borings

The range of loose cohesionless and soft cohesive soils encountered in the borings are given below:

Boring No.	Location/Street	Range of Depth of Weak Soils Encountered, ft.		Soil Type
		From	To	
GB-11	Wirt Road	8	14	Loose Fine Sand w/silt
		14	18	Soft to stiff Sandy Lean Clay
GB-12		12	14	Very loose Sandy Silt
GB-15		23	25	Soft Lean Clay w/sand

Thus, extra precaution should be carried out by using appropriate construction equipment and methods to protect ground during the installation of utilities through the weak soils.

4.6 Water Levels

Groundwater was encountered in borings GB-1, GB-2, GB-3, GB-4, GB-5 and GB-9 through GB-15 to depths ranging from 16 to 25 feet during drilling. The groundwater level, measured 15 to 20 minutes after water was first encountered, ranged from 8.7 to 17.6 feet in these borings. No groundwater was encountered in other borings GB-6, GB-7 and GB-8 drilled for this study. In piezometer borings GB-1P and GB-9P, the water level measured ranged from 12.9 to 13.8 feet on November 7, 2013. The water level was measured at 16 feet in piezometer boring GB-14P on July 22, 2014.

The water level encountered in borings is summarized below.

Boring No.	Location/Street Name	Groundwater Depth During Drilling (ft)	Groundwater Depth 30 Days After Drilling (ft)
GB-1 (GB-1P)	Wirt Road	17.6	13.8 (11-7-13)
GB-2	Wirt Road	17.0	N/A
GB-3	Wirt Road	16.5	N/A
GB-4	Wirt Road	13.5	N/A
GB-5	Wirt Road	8.7	N/A
GB-6	Shoshone Road	Dry	N/A
GB-7	Shoshone Road	Dry	N/A
GB-8	Harwood Drive	Dry	N/A
GB-9 (GB-9P)	Kilburn Road	18.0	12.9 (11-7-13)
GB-10	Wirt Road	15.5	--
GB-11	Wirt Road	15.2	--
GB-12B	Wirt Road	14.2	--
GB-13B	Wirt Road	16.8	--
GB-14B (GB-14BP)	Wirt Road	16.6	16 (7-22-14)
GB-15	Long Point Road	16.2	--

However, it should be noted that various environmental and man-made factors such as amount of precipitation, nearby subsurface construction activities, and change in area drainage can substantially influence the groundwater level.

4.7 Environmental Concerns

In boring GB-5 below 15 feet, strong Hydrocarbon Odor was noticed during drilling and the boring was terminated at 17 feet. The project design consultant was notified regarding the hydrocarbon odor and project environmental consultant will be notified by the design consultant.

5.0 ENGINEERING ANALYSES AND RECOMMENDATIONS

5.1 General

The project is comprised of approximately 5,400 linear feet (lf) of 48-inch reinforced concrete pipe (RCP) storm sewer, 12 to24-inch sanitary sewer, 12-inch water line and pavement rehabilitation along Wirt Road between Long Point and Kempwood. The sanitary sewer turns east about 350 feet Long Point Road to tie into the manhole. The project also includes approximately 2,980 lf of 24-inch and 30-inch RCP, 8 to 10-inch sanitary sewer and paving improvements in subdivision comprising of Shoshone Road, Harwood Drive, Haldane Drive and Kilburn Road. The maximum depth of utilities is about 6 to 30 feet along Wirt Road and about 14 feet along the other streets in the subdivision. The proposed utilities will be installed by open cut method of construction except the sanitary sewer line along Wirt Road at utility crossings. The sanitary sewer along Wirt Road will be installed by trenchless method of construction at utility crossings. The existing pavement will be replaced with concrete pavement with curb and gutter.

5.2 Trench Excavation

Based on the information provided by R.G. Miller Engineers, Inc., it is understood that the storm sewer and water line will be installed by open cut method of construction except the sanitary sewer along Wirt Road at utility crossings. The sanitary sewer along Wirt Road will be installed by trenchless method of construction at utility crossings. The following subsections provide information for the design and construction of the storm sewer, sanitary sewer and water line by open cut method and access pits for trenchless method of construction.

5.2.1 Geotechnical Parameters. Based on the soil conditions revealed by the borings GB-1 through GB-15, geotechnical parameters were developed for the design of open cut method of construction for storm sewer, sanitary sewer and water line installation and auger pits for sanitary sewer trenchless method. The design parameters are provided in Table 2. For design, the groundwater level should be assumed to exist at the ground surface.

5.2.2 Excavation Stability. The open excavation may be shored or laid back to a stable slope or supported by some other equivalent means used to provide safety for workers and adjacent structures, if any. The excavating operations should be in accordance with OSHA Standards, OSHA 2207, Subpart P, latest revision and the City of Houston Standard Specification.

- Excavation Shallower Than 5 Feet - Excavations that are less than 5 feet deep **(critical height)** should be effectively protected when an indication of dangerous ground movement is anticipated.

- Excavations Deeper Than 5 Feet - Excavations that are deeper than 5 feet should be sloped, shored, sheeted, braced or laid back to a stable slope or supported by some other equivalent means or protection such that workers are not exposed to moving ground or cave-ins. The slopes and shoring should be in accordance with the trench safety requirements as per OSHA Standards. The following items provide design criteria for excavation stability.

  (i) OSHA Soil Type. Based on the soil conditions revealed by borings drilled for this study and assumed groundwater level at surface, OSHA soil type "C" should be used for determination of allowable maximum slope and/or the design of shoring along the alignment for full proposed depth of open excavation. For shoring deeper than 20 feet (if needed), an engineering evaluation is required and deeper soil borings will be needed.

  (ii) Excavation Support Earth Pressure. Based on the subsurface conditions indicated by our field investigation and laboratory testing results, excavation support earth pressure diagrams were developed and are presented on Figures 5.1 through 5.3. These pressure diagrams can be used for the design of temporary trench bracing. For a trench box, a lateral earth pressure resulting from an equivalent fluid with a unit weight of 94 pcf can be used. The effects of any surcharge loads at the ground surface should be added to the computed lateral earth pressures. A surcharge load, q, will typically result in a lateral load equal to 0.5 q. The above value of equivalent

fluid pressure is based on assumption that the groundwater level is near the ground surface, since these conditions may exist after a heavy rain or flooding.

(iii) Bottom Stability. In braced cuts, if tight sheeting is terminated at the base of the cut, the bottom of the excavation can become unstable. The parameters that govern the stability of the excavation base are the soil shear strength and the differential hydrostatic head between the groundwater level within the retained soils and the groundwater level at the interior of the trench excavation. For cut in cohesive soils as predominantly encountered for the proposed excavation depths in most of the borings, the bottom stability can be evaluated as outlined on Figure 6. However, at locations near borings GB-11, GB-12B, GB-14B and GB-15 where cohesionless soils were encountered below the depth of 8 feet, dewatering will be necessary to avoid bottom stability problems.

5.2.3 Groundwater Control. Excavations for the storm sewer, sanitary sewer and water line may encounter groundwater seepage to varying degrees depending upon the groundwater conditions at the time of construction and the location and depth of the trench. Based on the soil conditions identified in the borings for the proposed storm sewer, sanitary sewer and water line installation, all the excavations will be in cohesive soils except at borings GB-11, GB-12B, GB-14B and GB-15 where the storm sewer and sanitary sewer will be in cohesive underlain by cohesionless soils.

In general for cohesive soils as predominantly encountered for most of the borings for the excavation depths, the groundwater if encountered may be managed by collection in excavation bottom sumps for pumped disposal. However, in borings GB-11, GB-12B, GB-14B and GB-15 where cohesionless soils were encountered near the invert of the excavation; dewatering will be required. Dewatering such as vacuum well points up to 15 feet or deep wells with submersible pumps for excavation greater than 15 feet may be required to lower the groundwater level to at least 5 feet below the bottom of the excavation. It is recommended that the actual groundwater conditions should be verified by the contractor at the time of construction and that groundwater control should be performed in general accordance with the City of Houston Standard Specifications, Section 01578.

5.2.4 Bedding and Backfill for Storm Sewer, Sanitary Sewer and Water Line. In general, excavation and backfill for utilities should be designed and constructed in accordance with the City of Houston Standard Specification No. 02317, Subsections3.09 and 3.10 "Excavation and Backfill for Utilities."

The bedding and backfill for storm sewer, sanitary sewer, and water line should be in accordance with City of Houston Standard Specification Section 02317 and Drawing Nos. 02317-02, 02317-03 and 02317-04.

5.2.5 Auger Pit Backfill. The excavated auger pits should be backfilled per the City of Houston Standard Specification, Section 02447, "Augering Pipe and Conduit" Subsection 3.04.

5.3 Trenchless Installation

It is understood that the proposed sanitary sewer along Wirt Road will be installed using trenchless method (pipe and casing augering) at the utility crossings.

5.3.1 Geotechnical Parameters for Pipe and Auger Casing. Based on the soil conditions revealed by borings GB-1 through GB-5 and GB-10 through GB-15 and laboratory test data, geotechnical design parameters were developed for cohesive soils and cohesionless soils for Pipe and Auger Casing installation and are provided in Table 3. For design conditions, the groundwater levels should be assumed to exist at the ground surface.

5.3.2 Earth Pressure on Auger Casing. The earth pressures on the auger casing should be determined from Figure 7. Equations to calculate the tunnel liner loads are also shown in Figure 7. For crossing under the major roads, the stress due to traffic loads should be considered.

5.3.3 Live Loads on Pipeline Due to Traffic. Loads on the pipe due to traffic should be considered. A graph providing calculated vertical stress on pipe due to traffic loads is given on Figure 8.

5.3.4 Carrier Pipe Design Parameters. Carrier pipe must be sufficiently strong to withstand anticipated long-term ground loads and must not be subject to deterioration by substance either in the ground or in the auger casing. The carrier pipe design should include consideration of not only the loads applied to the pipe but also factors other than soil loading. These factors could include minimum structural code requirements, loading from pipe jacking operations and other construction loads. The drained geotechnical design parameters given in Table 3 should be used in analyzing the soil structure interaction of the carrier pipe.

5.3.5 Influence of Augering on Adjacent Structure. Surface and near-surface structures near the tunnel alignment consist primarily of private properties, city streets and public and private utilities.

Ground movement, in terms of loss of ground or ground lost, is commonly associated with soft ground augering. If such ground movement is excessive, it may cause damage to the structures, roads and services located above the auger casing. While ground movement cannot be eliminated, it can be controlled within certain limits by the use of proper construction techniques and good quality workmanship. These include, but are not limited to, prevention of excessive ground loss during augering with the use of grouting and filling the annular space between the pipe or casing and the surrounding soil and prevention of undue loss of fines through dewatering.

The selection and execution of augering methods that are best suited to anticipated ground conditions along the proposed auger casing are, in fact, the contractor's primary contribution to successful completion of the proposed auger casing. On review of the boring logs, the ground conditions for augering (excavation face) will be primarily through cohesive soils and interface of cohesive and cohesionless soils. The cohesive soils are stiff to very stiff and the ground in this area may be expected to behave as firm to raveling ground near the invert. Cohesionless soils consisting of medium dense to dense silty sand and sandy silt was encountered near or within 3 feet of the proposed invert depths of trenchless installation in borings GB-11, GB-12B, GB-14B and GB-15. The ground at these locations may be expected to behave raveling to running ground near the invert depths. Hence, extra precautions will be required at these locations during the trenchless installation to prevent any

excessive ground loss due to the disturbance and removal of the cohesionless soils. Close monitoring of ground movement should be carried out during the trenchless installation.

At locations near borings GB-11, GB-12B, GB-14B and GB-15, the ground conditions for trenchless operation (excavation face) will be through cohesive soil interface with cohesionless soils. In such conditions, dewatering will be required for trenchless operations. However due to spacing of borings, soil conditions other than those encountered in borings could exist.

The proposed augering is parallel with or cross beneath utility lines. The largest potential problems from utilities may result from:

- Leaking water pipes
- Gas pipe breakage leading to a potential explosion
- Breakage of storm or sanitary sewers

In general, it is the contractor's responsibility to investigate these and other possible third party interactions along the proposed pipe and casing augering alignment and to accommodate all of these interactions with the use of good construction methods.

5.3.6 Groundwater Control. The groundwater control should be performed in accordance with Section mentioned in 5.2.3 of this report.

5.4 Structures

5.4.1 Description. The structure associated with this project will be new manholes. The new manholes for storm sewer will be placed at depths ranging from 13 to 15 feet and the manholes for sanitary sewer will be placed at depths ranging from 18 to 35 feet.

5.4.2 Foundation Conditions. Based on the soil conditions revealed by the borings GB-1 through GB-15, the manholes bottom will be in stiff to very stiff lean clay, sandy lean clay, fat clay, sandy fat clay and silty sand.

5.4.3 Foundation Design Recommendations. The following items provide recommendations and design criteria for construction of the new manholes.

- Allowable Bearing Pressures. The mat foundation for supporting the new manholes placed at a depths ranging from 13 to 35 feet [into stiff to very stiff lean clay, sandy lean clay, fat clay, sandy fat clay and silty sand] should be designed for an allowable (net) bearing pressure of 2,500 psf (for manholes placed between 13 and 15 feet) and 3,000 psf (for manholes placed between 18 to 35 feet) for total loads. These allowable bearing pressures include a safety factor of 2.0. The above recommendations assume that the final bearing surfaces consist of undisturbed natural soils and that underlying semi-transmissive zones are properly pressure-relieved and stable undisturbed bearing surfaces are attained.

- Bottom Stability. In braced cut, if sheeting is terminated at the base of the cut, the bottom of the excavation can become unstable under a certain condition. This condition is governed by the shear strength of the soils and by the differential hydrostatic head. For cuts in cohesive soils (sandy lean clay, lean clay w/sand, fat clay, sandy fat clay and fat clay with sand), as predominantly encountered in the excavation depths of 13 and 35 feet for most of the borings, the stability of the bottom can be evaluated in accordance with the procedure outlined in Figure 6. However, at location near boring GB-11, GB-12B, GB-14B and GB-15, where cohesionless soils (such as silty sand and silty sand) were encountered below the depth of 8 feet, dewatering will be necessary to avoid bottom stability problems if the excavation is planned after or during a heavy rainfall season.

- Lateral Earth Pressure. The pressure diagram presented on Figures 5.1 through 5.3 can be used for the design of braced excavation. The lateral earth pressure diagram presented on Figures 9.1 though 9.3 is applicable for the design of the permanent walls.

- Hydrostatic Uplift Resistance. Structures extending below the groundwater level should be designed to resist uplift pressure resulting from excess piezometric head.

Design uplift pressures should be computed based on the assumption that the water table is at ground surface. To resist the hydrostatic uplift at the bottom of the structure, one of the following sources of resistance can be utilized in each of the designs.

a. Dead weight of structure,
b. Weight of soil above base extensions plus weight of structure, or
c. Soil-wall friction plus dead weight of structure.

The uplift force and resistance to uplift should be computed as detailed on Figure 10. In determining the configuration and dimensions of the structure using one of the approaches presented on Figure 10, the following factors of safety are recommended.

a. Dead weight of concrete structure, $S_{f1} = 1.10$,
b. Weight of soil (backfill) above base extension, $S_{f2} = 1.5$, and
c. Soil-wall friction, $S_{f3} = 3.0$.

Friction resistance should be discounted for the upper 5 feet, since this zone is affected by seasonal moisture changes.

5.4.4 Protection of Below Grade Structures. The design of the proper means for protection of below grade structures will depend upon the potential of the aggressivity or corrosivity of soil and groundwater properties. The aggressivity testing was not within the scope of this study. The design of the protection of below grade structures is beyond the scope of services for this study.

5.4.5 Groundwater Control During Construction. The groundwater control should be followed in accordance with section 5.2.3 of this report.

5.4.6 Structure Backfill. Excavations for the proposed structures should be backfilled in accordance with the City of Houston Standard Specifications, Section 02316, "Excavation and Backfill for Structures."

5.5 Pavement Structure Design

It is understood that approximately 2,300 linear feet of existing pavement along Wirt Road and 2,980 feet of existing pavement along other streets (Shoshone Road, Harwood Drive, Kilburn Road and Haldane Road) will be reconstructed with a rigid pavement. The pavement design presented below was developed in accordance with "AASHTO Guide for Design of Pavement Structures," 1993 Edition.

5.5.1 Design Parameters

Subgrade Soil Properties. Based on the laboratory test data obtained from the natural subgrade soils (predominantly high plasticity fat clay and lean clay), the effective roadbed soil resilient modulus (M_R) is estimated to be about 1,941 psi. Based on an estimated resilient modulus of the 8-inch lime-stabilized subgrade along Wirt Road, the effective modulus of subgrade reaction (k) is estimated to be about 49 pci. Based on the estimated resilient modulus of the 6-inch lime stabilized subgrade along other streets, the effective modulus of subgrade reaction (k) is estimated to be about 46 pci.

Traffic Data. Traffic data is provided to us for the Wirt Road. Based on Houston Regional Traffic Counts Map, the traffic data is assumed for other streets in the project area. The details were given below.

A traffic data of 11×10^6 – 18 kips ESAL (W_{18}) and 0.5×10^6 – 18 kips ESAL over a 20 year design period was utilized for the pavement design of Wirt Road (from Kempwood to Long Point) and all other streets (Shoshone Road, Harwood Drive, Kilburn Road and Haldane Road) respectively. **This traffic volume is based on provided average daily traffic (ADT) volume of 17,323 vehicles for Wirt Road and assumed traffic volume of 1,500 vehicles for the remaining streets in the project area. A distribution of 97% passenger cars, 2% light trucks and 1% heavy trucks were assumed for the vehicle breakdown for Wirt Road and distribution of 96% passenger cars, 3.5% light trucks and 0.5% heavy trucks**

were assumed for all other streets in the project area.

Other Design Parameters. Other design parameters used in the development of rigid pavement thickness are given below:

Material Properties of Concrete:

Modulus of Elasticity of Concrete (E_c): 3,372,166 psi

Mean value of Modulus of Rupture of Concrete after 28 days (S'_c): 600 psi (based on compressive strength of 3,500 psi)

Load Transfer coefficient (J): 3.2

Drainage coefficient (C_d): 1.2

Overall Standard Deviation (S_o): 0.35

Reliability Level (R): 85 to 95%

Serviceability Index

Initial (P_o): 4.5

Terminal (P_t): 2.0 to 2.25

Reinforcement Variables

Allowable Working Stress (f_s): 45,000 psi (grade 60 steel)

Friction Factor (F): 1.8

5.5.2 Recommended Pavement Section

Based on the design parameters described above and the AASHTO design procedures, the thickness of rigid pavement was determined. The recommended pavement section is given below:

Wirt Road

Course	**Thickness, inches**
Reinforced Concrete	10
6% Lime-stabilized subgrade	8

However, for cross streets, which are mainly residential and entire pavement width will be replaced with new pavement, the recommended pavement section is given below:

Cross Streets

Course	**Thickness, inches**
Reinforced Concrete	6
6% Lime-stabilized subgrade	6

Based on the reinforcement variables and recommended pavement section, the required longitudinal and transverse reinforcing steel (No. 4, Grade 60 Steel) can be determined from the City of Houston drawings.

5.5.3 Preparation of Pavement Subgrade

Based on the field and laboratory test data, the subgrade soils at the finished grade of the project site consists of fat clay with sand, sandy fat clay, lean clay and sandy lean clay. These soils have a medium to high volume change potential. Hence, lime stabilization of the clay subgrade will be required to reduce the swell potential of clay subgrade due to volume changes and to accelerate the construction and provide a stable subgrade on which to construct the pavement section. The subgrade soils should be stabilized with approximately 6 percent lime to a depth of at least 8 inches along Wirt Road and 6 inches along all the other streets. This corresponds to approximately 37 pounds and 28 pounds of hydrated lime per square yard based upon a soil dry unit weight of 103 pcf, respectively. The actual percentage of lime must be confirmed by laboratory tests at the time of construction.

Subgrade preparation for the proposed pavement after removing the existing pavement should consist of stripping, proof-rolling, and stabilization. The following procedures for subgrade preparation are recommended:

1. Strip the surficial soils to a suitable depth to remove all surficial vegetation and achieve grade. In isolated areas where soft, compressible, or very loose soils are encountered, additional stripping may be required. Stripping should extend to a

minimum of 2 feet beyond the edge of the proposed pavement (where possible).

2. After stripping, the exposed surface should be proof-rolled with a minimum of 3 passes of a 30-ton pneumatic-tired roller or a partially loaded truck utilizing a tire pressure of approximately 90 psi. If rutting develops, the tire pressure should be reduced. The purpose of the proof-rolling operation is to identify any underlying zones or pockets of soft soils so these weak materials can be removed and replaced.

3. Lime stabilization of cohesive subgrade (fat clay and lean clay) should be performed in accordance with City of Houston Standard Specification No. 02336, "Lime-Stabilized Subgrade."

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Groundwater Control

Excavations for the storm sewer, sanitary sewer and water line may encounter groundwater seepage to varying degrees depending upon the groundwater conditions at the time of construction and the location and depth of the trench. Based on the soil conditions identified in the borings for the proposed storm sewer, sanitary sewer and water line installation, all the excavations will be in cohesive soils except at borings GB-11, GB-12B, GB-14B and GB-15 where the storm sewer and sanitary sewer will be in cohesive underlain by cohesionless soils.

In general for cohesive soils as predominantly encountered for most of the borings for the excavation depths, the groundwater if encountered may be managed by collection in excavation bottom sumps for pumped disposal. However, in borings GB-11, GB-12B, GB-14B and GB-15 where cohesionless soils were encountered near the invert of the excavation; dewatering will be required. Dewatering such as vacuum well points up to 15 feet or deep wells with submersible pumps for excavation greater than 15 feet may be required to lower the groundwater level to at least 5 feet below the bottom of the excavation. It is recommended that the actual groundwater conditions should be verified by the contractor at the time of construction and that groundwater control should be performed in general accordance with the City of Houston Standard Specifications, Section 01578.

7.0 LIMITATIONS

The description of subsurface conditions and the design information contained in this report are based on the soil borings made at the time of drilling at specific locations. However, some variation in soil conditions may occur between soil borings. Should any subsurface conditions other than those described in our boring logs be encountered, Geotest should be immediately notified so that further investigation and supplemental recommendations can be provided. The depth of the groundwater level may vary with changes in environmental conditions such as frequency and magnitude of rainfall. The stratification lines on the log of borings represent the approximate boundaries between soil types, however, the transition between soil types may be more gradual than depicted.

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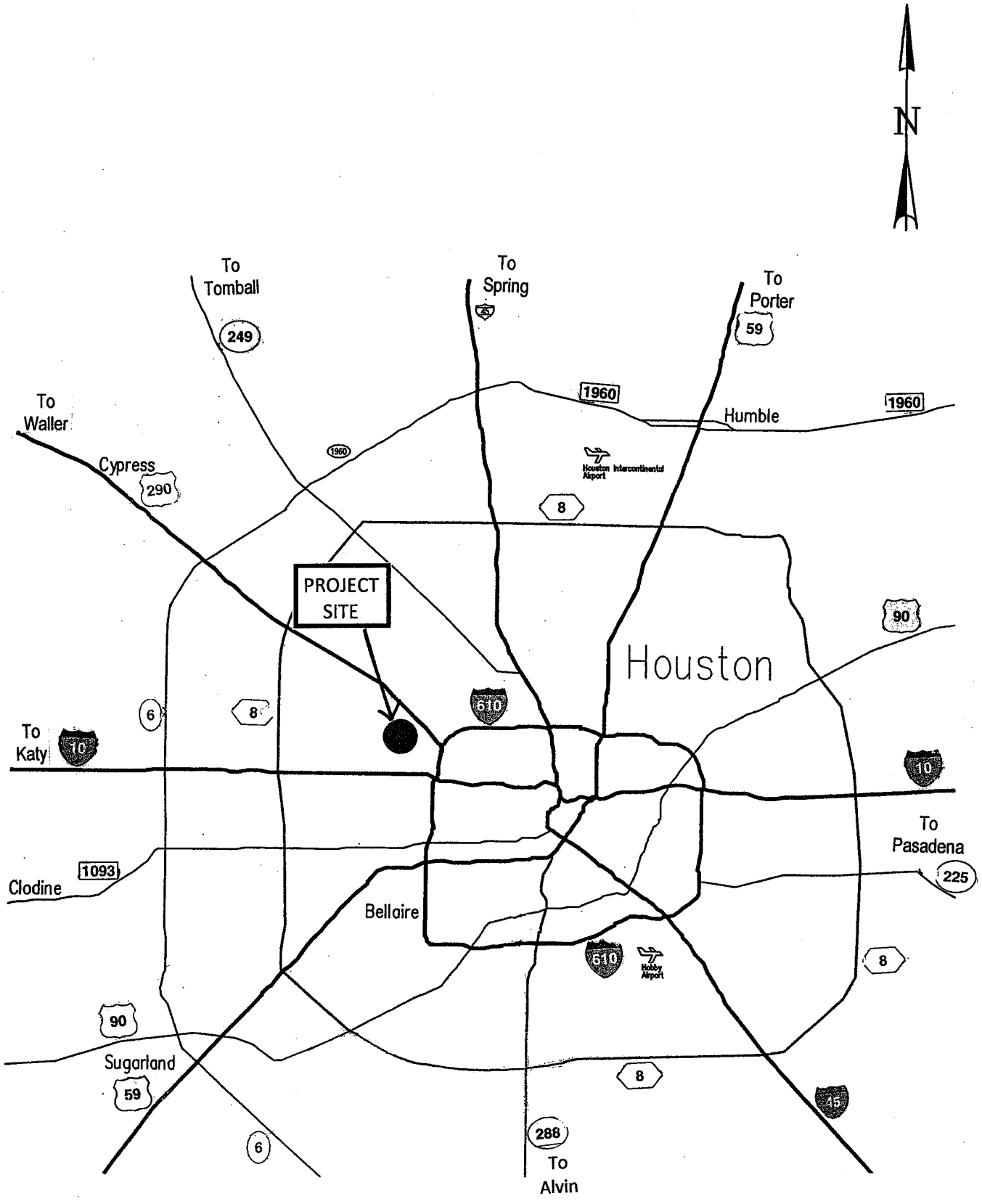
ILLUSTRATIONS

Job No. 1140197101

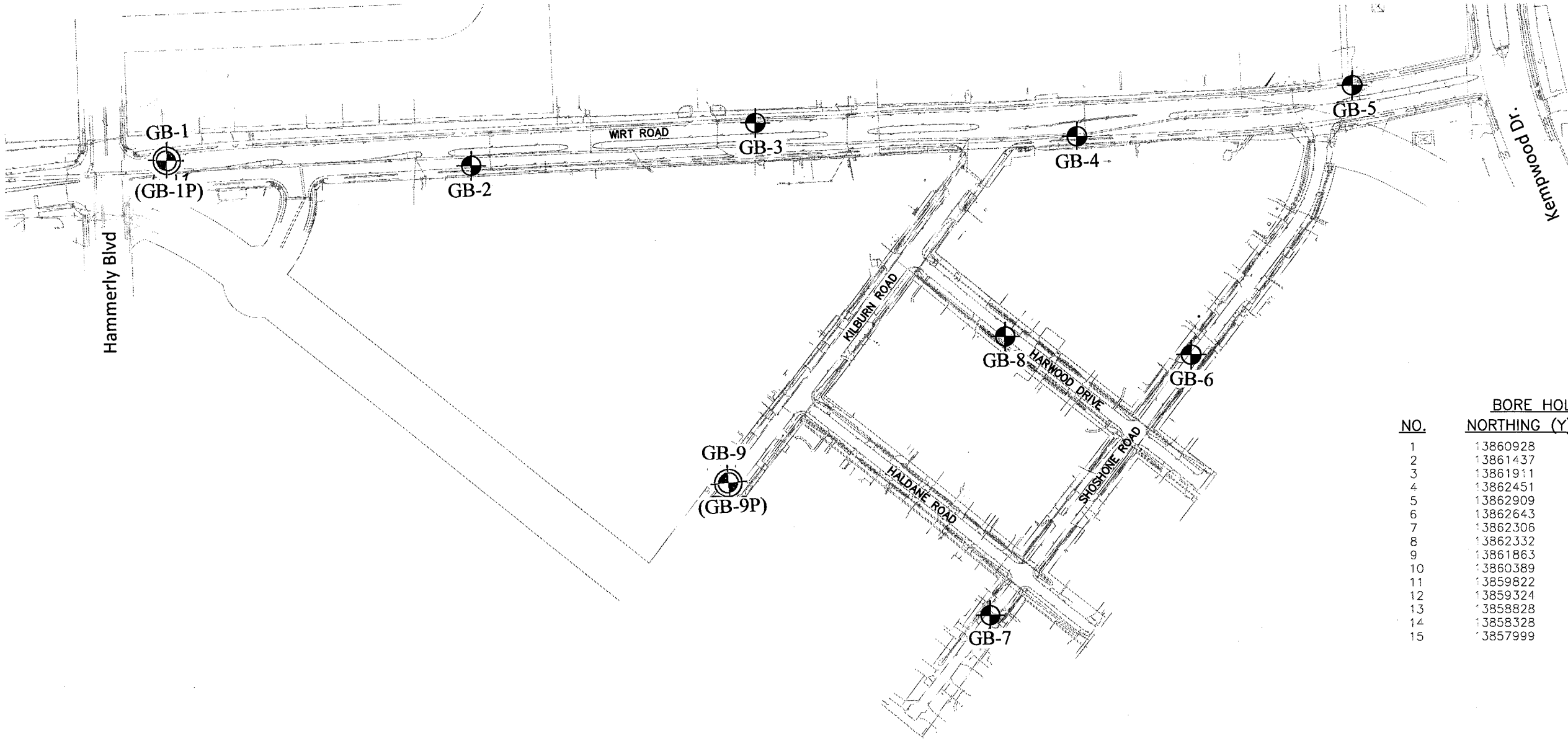


VICINITY MAP

(NOT TO SCALE)

Geotest Engineering, Inc.

FIGURE 1



200 100 0 200 400 600

SCALE IN FEET
1" = 200'

BORE HOLE COORDINATE TABLE

NO.	NORTHING (Y)	EASTING (X)	ELEVATION (Z)
1	13860928	3083375	75.70
2	13861437	308339[illegible]	75.76
3	13861911	3083320	76.19
4	13862451	3083343	75.90
5	13862909	3083257	74.77
6	13862643	3083707	77.49
7	13862306	3084143	77.30
8	13862332	3083675	77.51
9	13861863	30839[illegible]6	77.32
10	13860389	3083424	75.64
11	13859822	3083446	73.97
12	13859324	3083484	74.11
13	13858828	3083503	70.31
14	13858328	3083523	69.78
15	13857999	30839[illegible]2	68.78

PLAN OF BORINGS

FIGURE 2

r.g.miller engineers
since 1946
16340 Park Ten Place Suite 350
Houston, Texas 77084
(713) 461-9600
Texas Firm Registration No. F-487

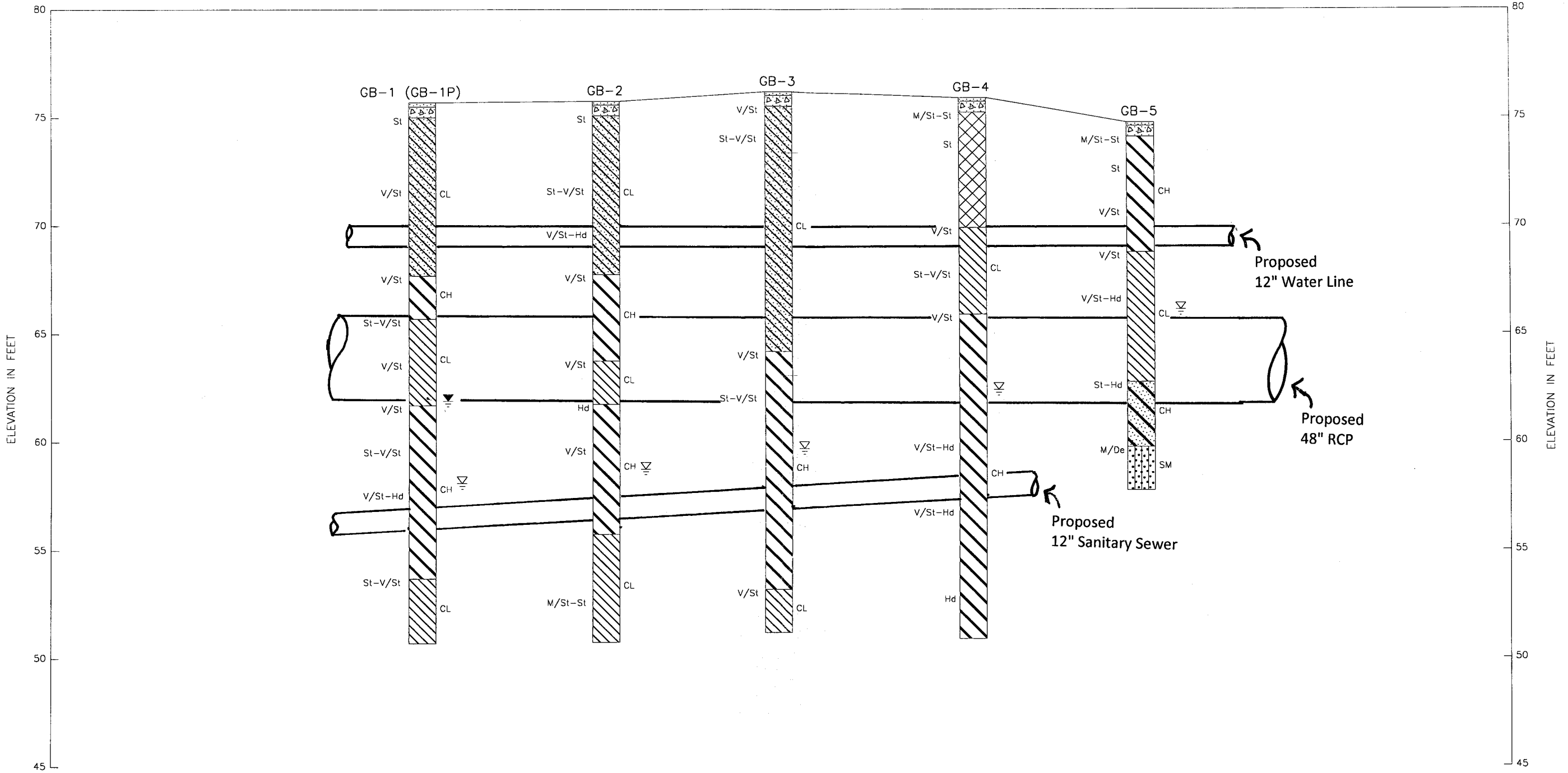
SURVEYED BY: KUO
FB NO.

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WIRT ROAD DRAINAGE AND PAVING SUB-PROJECT II

BORE LAYOUT EXHIBIT

WBS NO.	
M-000287-0002-3	
DRAWING SCALE	
1"=200'	
CITY OF HOUSTON PM	
ANA TREJO	
SHEET NO. OF	



GENERAL NOTES:

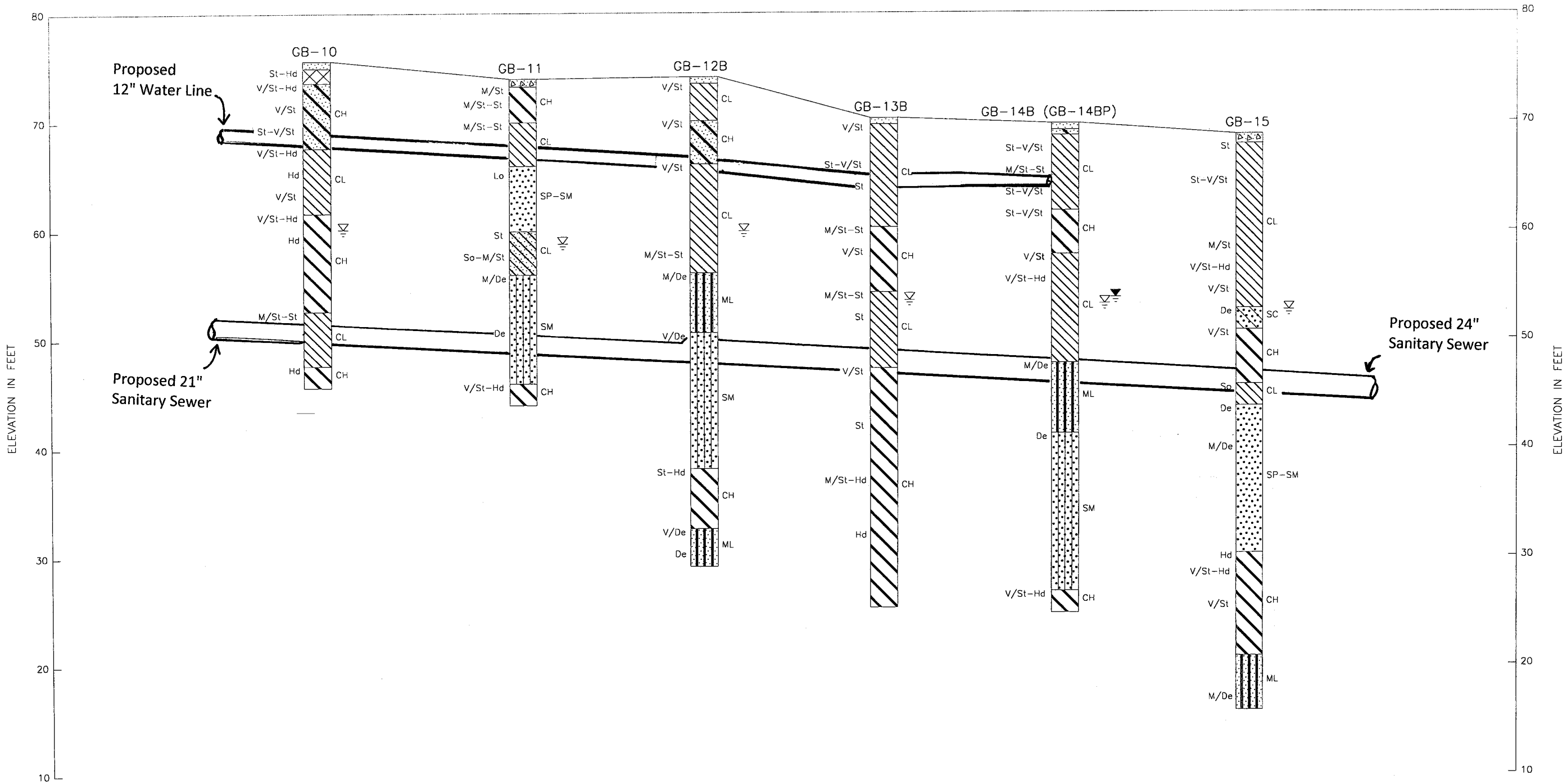
1. See Figure 2 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by R.G.Miller Engineers, Inc.

BORING LOG PROFILE

WIRT ROAD

0 150 300 450 600

HORIZONTAL SCALE IN FEET



GENERAL NOTES:

1. See Figure 2 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by R.G. Miller Engineers, Inc.

BORING LOG PROFILE

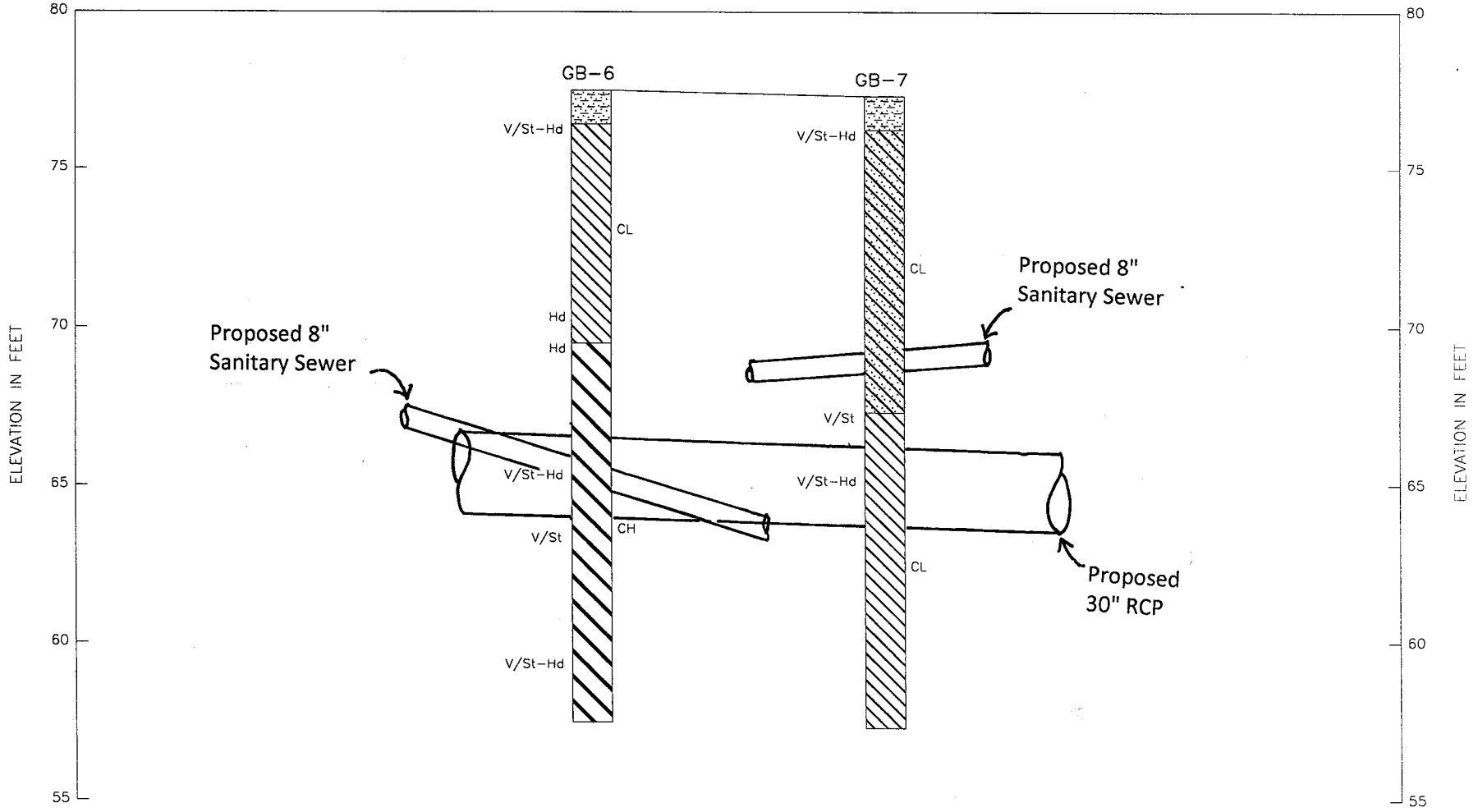
Wirt Road

0 150 300 450 600

HORIZONTAL SCALE IN FEET

Job No. 114019701

Geotest Engineering, Inc.



GENERAL NOTES:

1. See Figure 2 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by R.G. Miller Engineers, Inc.

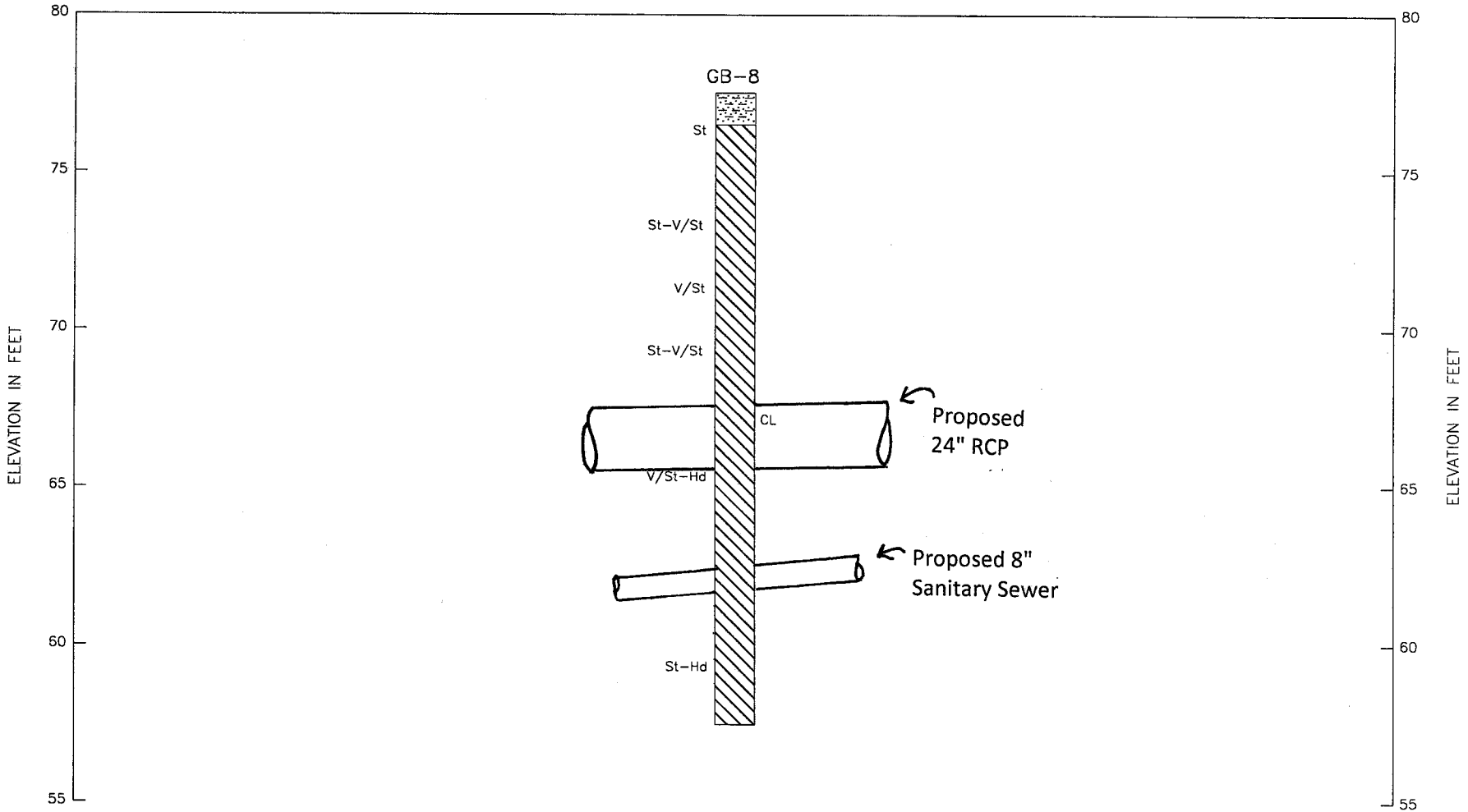
BORING LOG PROFILE
SHOSHONE ROAD

0 150 300 450 600

HORIZONTAL SCALE IN FEET

FIGURE 3.3

Job No. 114019/101



GENERAL NOTES:

1. See Figure 2 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by R.G. Miller Engineers, Inc.

BORING LOG PROFILE
HARWOOD DRIVE

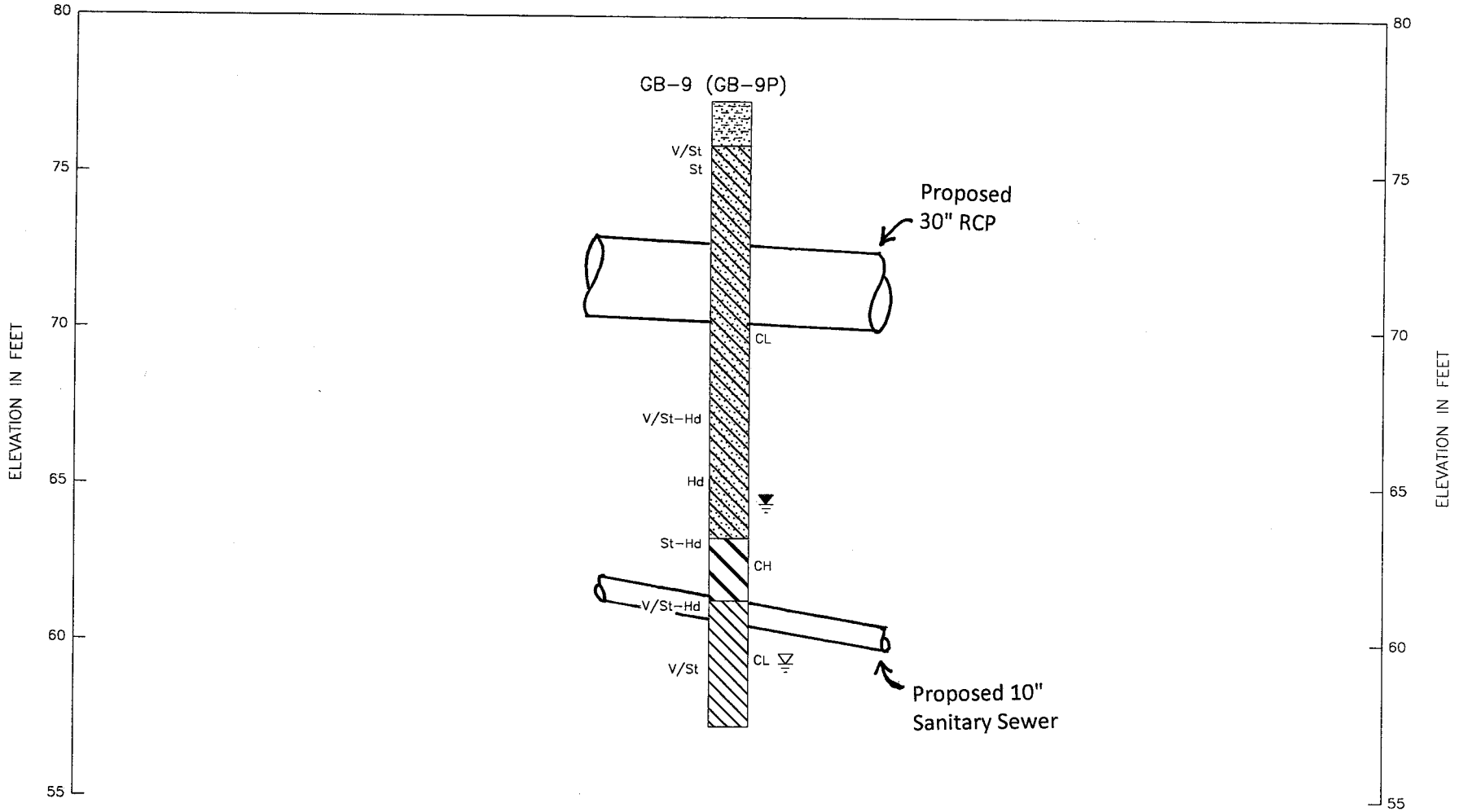
0 150 300 450 600

HORIZONTAL SCALE IN FEET

Geotest Engineering, Inc.

FIGURE 3.4

Job No. 114019/101



GENERAL NOTES:

1. See Figure 2 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by R.G. Miller Engineers, Inc.

BORING LOG PROFILE

KILBURN ROAD

0 150 300 450 600

HORIZONTAL SCALE IN FEET

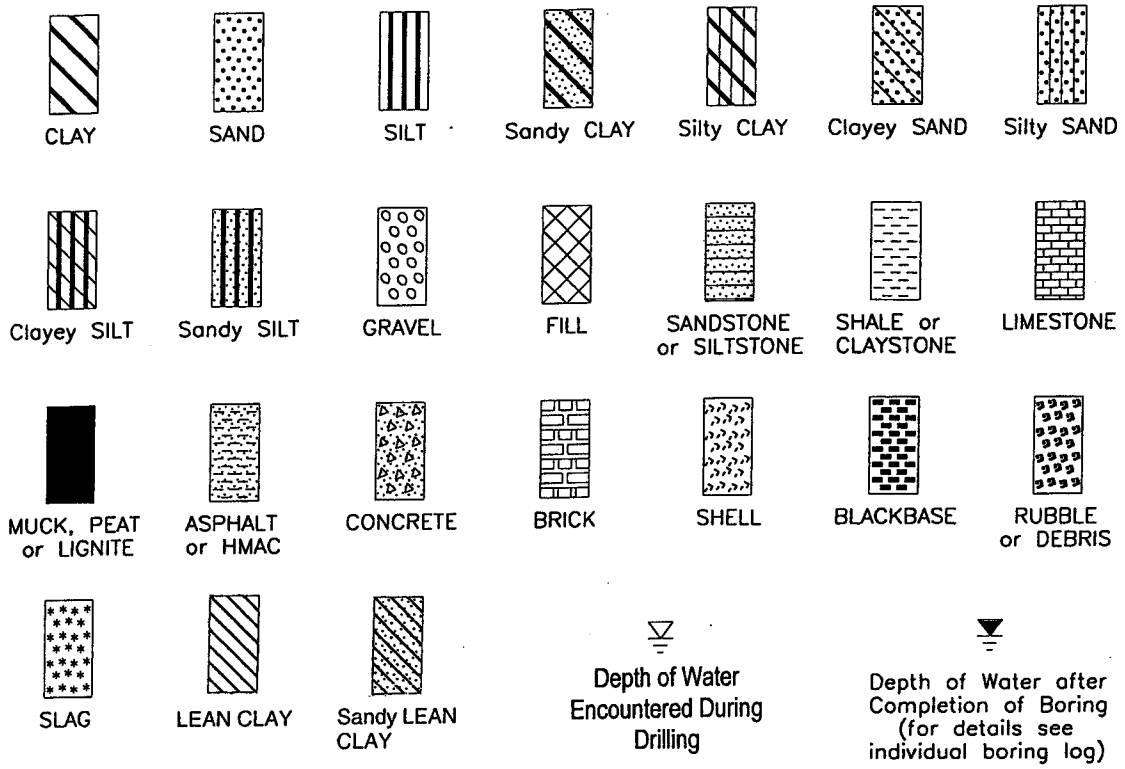
Geotest Engineering, Inc.

FIGURE 3.5

Job No. 1140197101

SYMBOLS AND ABBREVIATIONS USED ON BORING LOG PROFILE

LEGEND



ABBREVIATIONS USED FOR CONSISTENCY/DENSITY

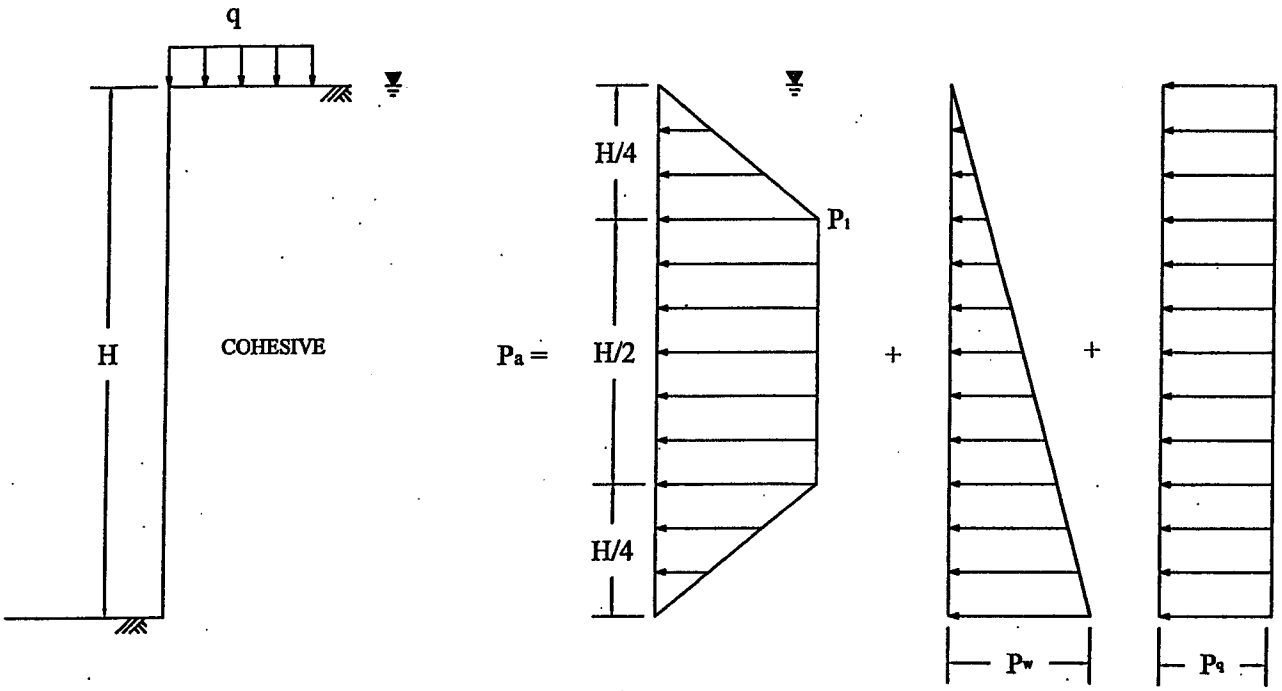
COHESIVE SOILS

V/So	:	Very Soft
So	:	Soft
Fm	:	Firm
M/St	:	Medium Stiff
St	:	Stiff
V/St	:	Very Stiff
Hd	:	Hard
V/Hd	:	Very Hard

COHESIONLESS SOILS

V/Lo	:	Very Loose
Lo	:	Loose
S/Co	:	Slightly Compact
Co	:	Compact
M/De	:	Medium Dense
De	:	Dense
V/De	:	Very Dense

Job No. 1140197101



TYPICAL SOIL PARAMETERS

See Table 2 for typical values of soil parameters

BRACED WALL

For $\gamma H/c \leq 4$

$P_1 = 0.3\ \gamma_c' H$
$P_w = \gamma_w H = 62.4 H$
$P_q = 0.5\ q$

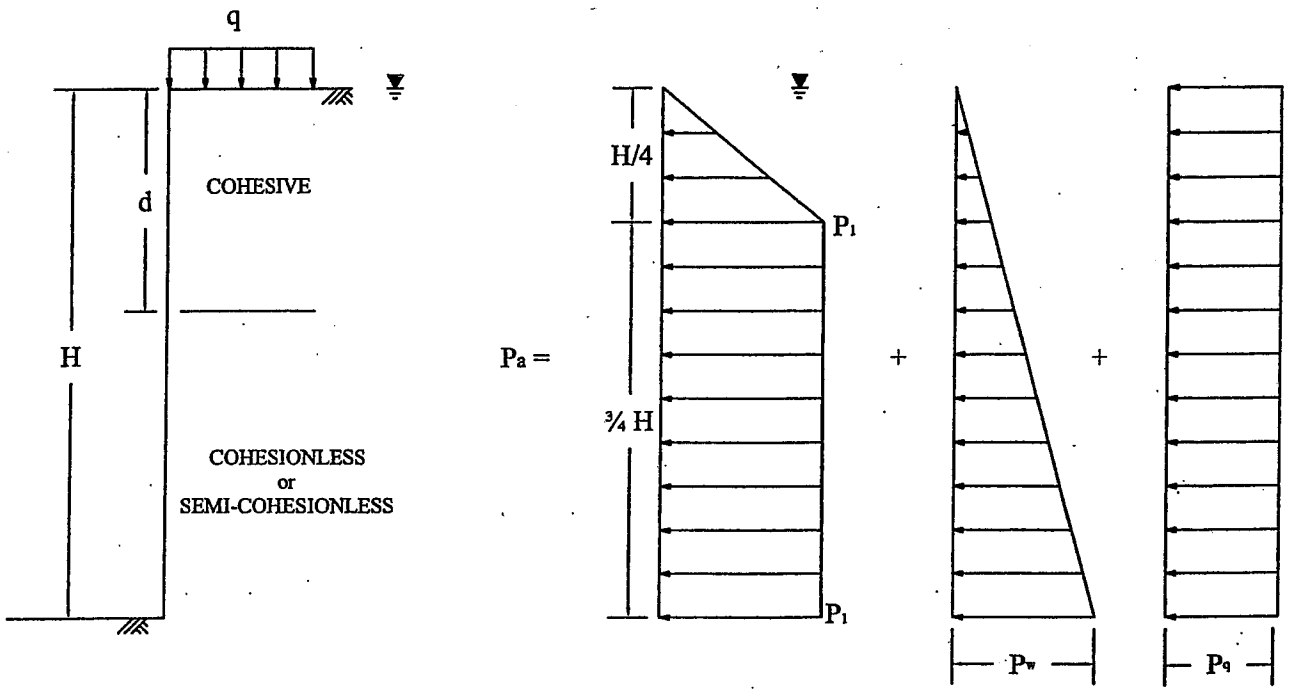
Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_a = Lateral pressure, psf;
P_1 = Active earth pressure, psf;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Depth of braced excavation, feet
c = Shear strength of cohesion soil, psf;

TRENCH SUPPORT EARTH PRESSURE

SUBMERGED COHESIVE SOIL

Job No. 1140197101



TYPICAL SOIL PARAMETERS

BRACED WALL

See Table 2 for typical values of soil parameters

$$\gamma'_{avg} = \frac{\gamma_c' \, d + \gamma_s' \, (H-d)}{H}$$

$P_1 = 0.3 \, \gamma'_{avg} \, H$
$P_w = 62.4 \, H$
$P_q = 0.5 \, q$

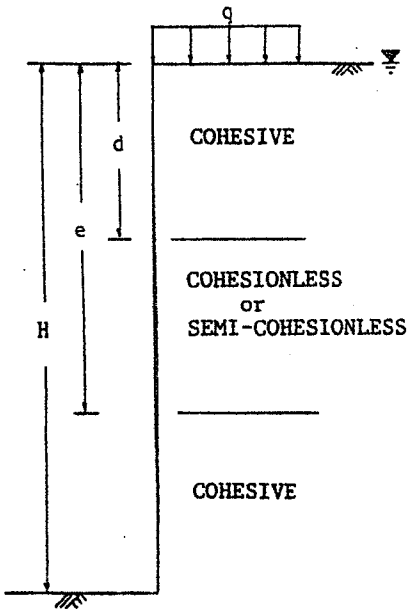
Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
γ_s' = Submerged unit weight of cohesionless soil, pcf;
γ'_{avg} = Average submerged unit weight of soils, pcf;
q = Surcharge load at surface, psf;
P_a = Lateral pressure, psf;
P_1 = Active earth pressure, psf;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Depth of braced excavation, feet

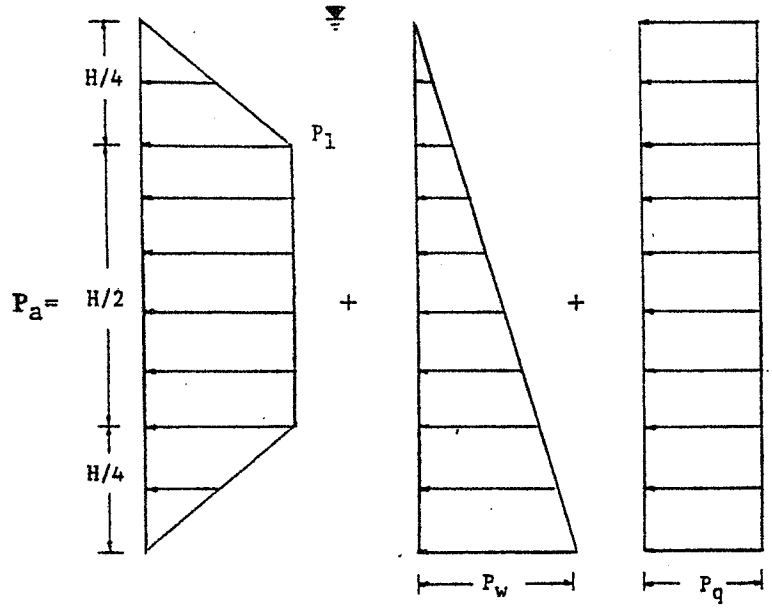
TRENCH SUPPORT EARTH PRESSURE

SUBMERGED COHESIVE SOIL OVER
COHESIONLESS OR SEMI-COHESIONLESS SOIL

Job No. 1140197101



TYPICAL SOIL PARAMETERS



BRACED WALL

See Table 2 for typical values of soil parameters

$$\gamma'_{avg} = \frac{\gamma_c' \, d + \gamma_s' \, (e-d) + \gamma_c' \, (H-e)}{H}$$

γ_w = 62.4 pcf

$P_1 = 0.3 \, \gamma'_{avg} \, H$

$P_w = \gamma_w \, H = 62.4 \, H$

$P_q = 0.5q$

Where:

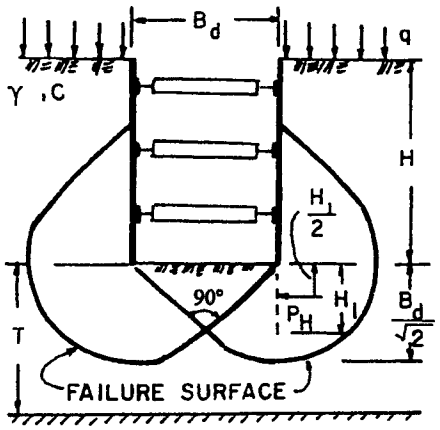
- γ_c' = Submerged unit weight of cohesive soil, pcf ;
- γ_s' = Submerged unit weight of cohesionless or semi-cohesionless soil, pcf ;
- γ_w = Unit weight of water, pcf;
- γ'_{avg} = Average submerged unit weight of soil, pcf ;
- q = Surcharge load at surface, psf;
- P_a = Lateral pressure, psf;
- P_1 = Active earth pressure, psf;
- P_q = Horizontal pressure due to surcharge, psf;
- P_w = Hydrostatic pressure due to groundwater, psf;
- H = Depth of braced excavation, feet

TRENCH SUPPORT EARTH PRESSURE

SUBMERGED COHESIVE SOIL INTERBEDDED WITH COHESIONLESS OR SEMI-COHESIONLESS SOIL

Job No. 1140197101

CUT IN COHESIVE SOIL,
DEPTH OF COHESIVE SOIL UNLIMITED ($T > 0.7\ B_d$)
L = LENGTH OF CUT



If sheeting terminates at base of cut:

$$\text{Safety factor, } F_S = \frac{N_C C}{\gamma H + q}$$

N_C = Bearing capacity factor, which depends on dimensions of the excavation : B_d , L and H (use N_C from graph below)

C = Undrained shear strength of clay in failure zone beneath and surrounding base of cut

γ = Wet unit weight of soil (see Table 2)

q = Surface surcharge (assume q = 500 psf)

If safety factor is less than 1.5, sheeting or soldier piles must be carried below the base of cut to insure stability - (see note)

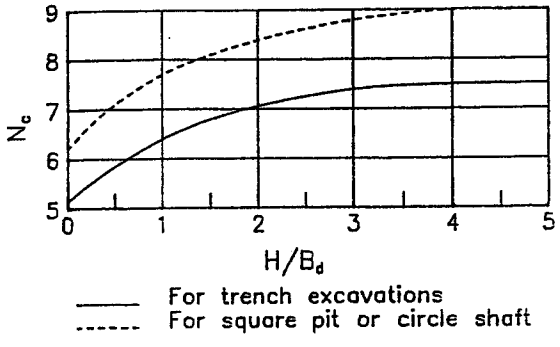
H_1 = Buried length = $\frac{B_d}{2} \geq 5$ feet

Note : If soldier piles are used, the center to center spacing should not exceed 3 times the width or diameter of soldier pile .

Force on buried length, P_H:

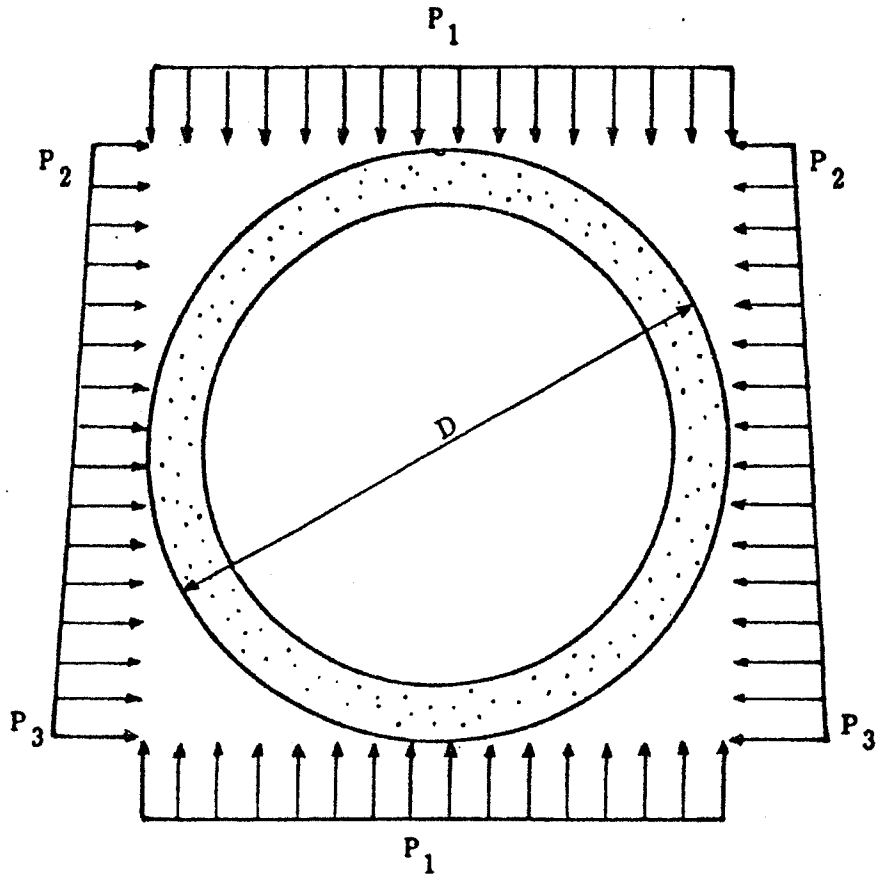
If $H_1 > \frac{2}{3}\frac{B_d}{\sqrt{2}}$, $P_H = 0.7\ (\gamma\ HB_d - 1.4CH - \pi CB_d)$ in lbs/ linear foot

If $H_1 < \frac{2}{3}\frac{B_d}{\sqrt{2}}$, $P_H = 1.5H_1\ (\gamma\ H - \frac{1.4CH}{B_d} - \pi C)$ in lbs/ linear foot



STABILITY OF BOTTOM
FOR
BRACED CUT

Job No. 1140197101



$$P_1 = [(H + \frac{D}{2}) \times (\gamma - \gamma_w) + D_w \times \gamma_w] + q_s \text{ , for } D_w < H + \frac{D}{2}$$

$$P_1 = [(H + \frac{D}{2}) \times \gamma] + q_s \text{ , for } D_w \geq H + \frac{D}{2}$$

$$P_2 = (H \times \gamma) + q_s$$

$$P_3 = [(H + D) \times \gamma] + q_s$$

Where: P_1, P_2, P_3 = Tunnel liner load, psf.

D = Tunnel outside diameter, ft.

H = Depth to top of tunnel; ft.

D_w = Depth to ground water level; ft.

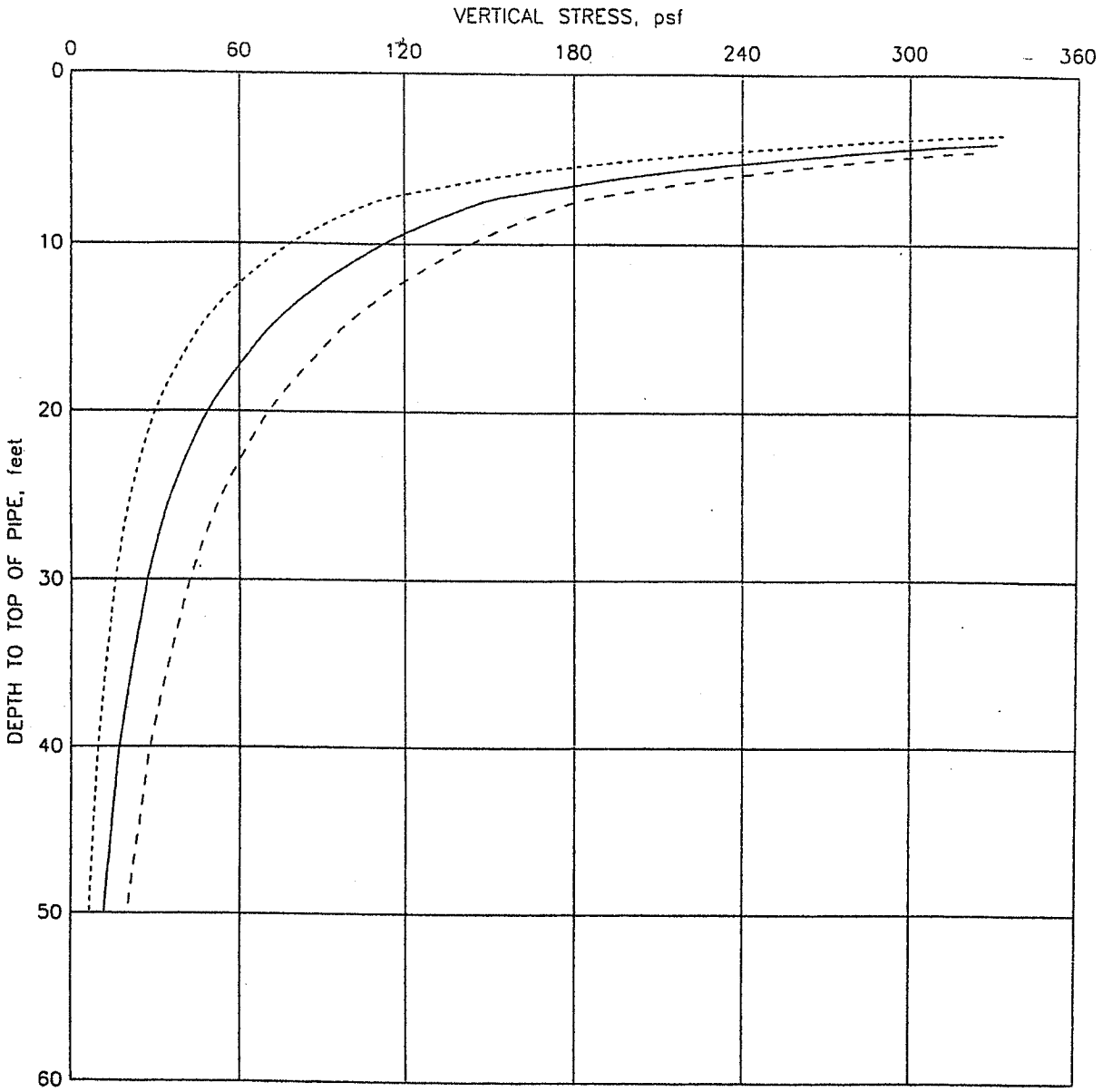
γ = Wet unit weight of soil, pcf (see Table 3)

γ_w = Unit weight of water, 62.4 pcf

q_s = Surcharge load, psf.

EARTH PRESSURE ON PIPE AND CASING AUGERING

Job No. 1140197101



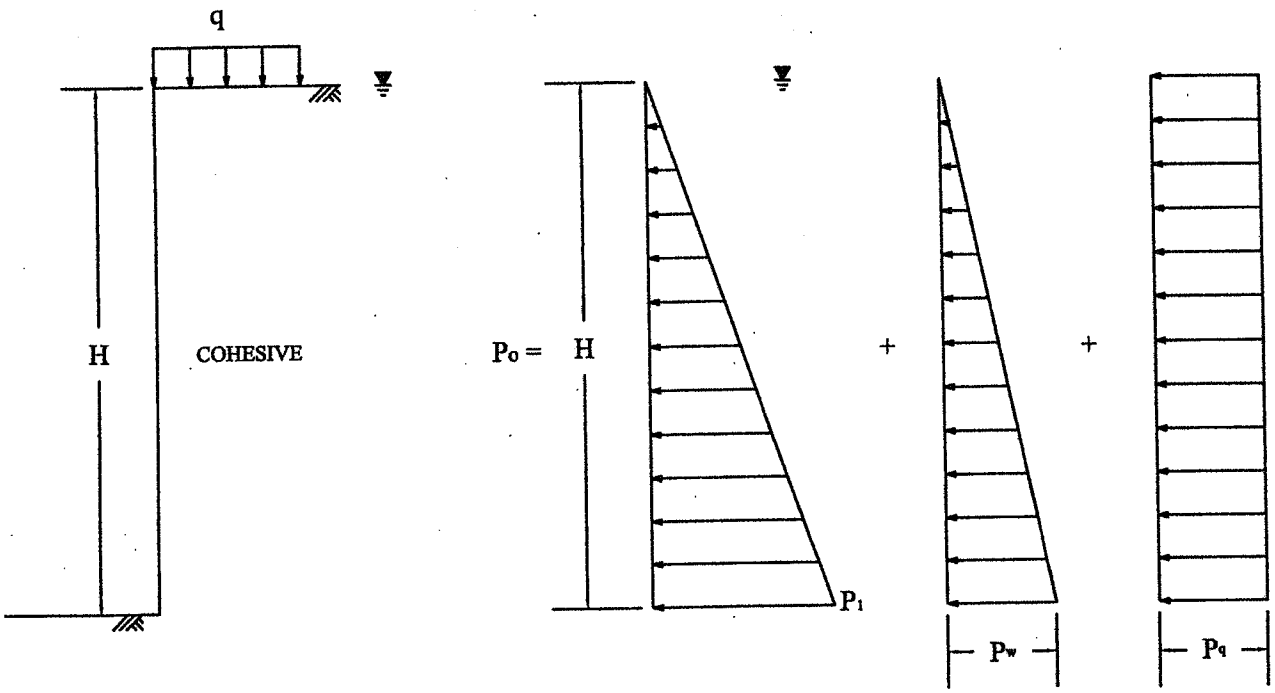
Legend:

------ One passing truck
——— Two passing trucks
– – – Four passing trucks

Notes: 1. The vertical stress was estimated using AASHTO H20 or HS20 truck axle loadings on paved surfaces.
2. Impact factor was included in the vertical stress.

VERTICAL STRESS ON PIPES DUE TO TRAFFIC LOADS

Job No. 1140197101



TYPICAL SOIL PARAMETERS

See Table 2 for typical values of soil parameters

$K_{oc} = 1.0$

PERMANENT WALL

$P_1 = K_{oc}\,\gamma_c'\,H$
$P_w = \gamma_w\,H = 62.4\,H$
$P_q = 0.5\,q$

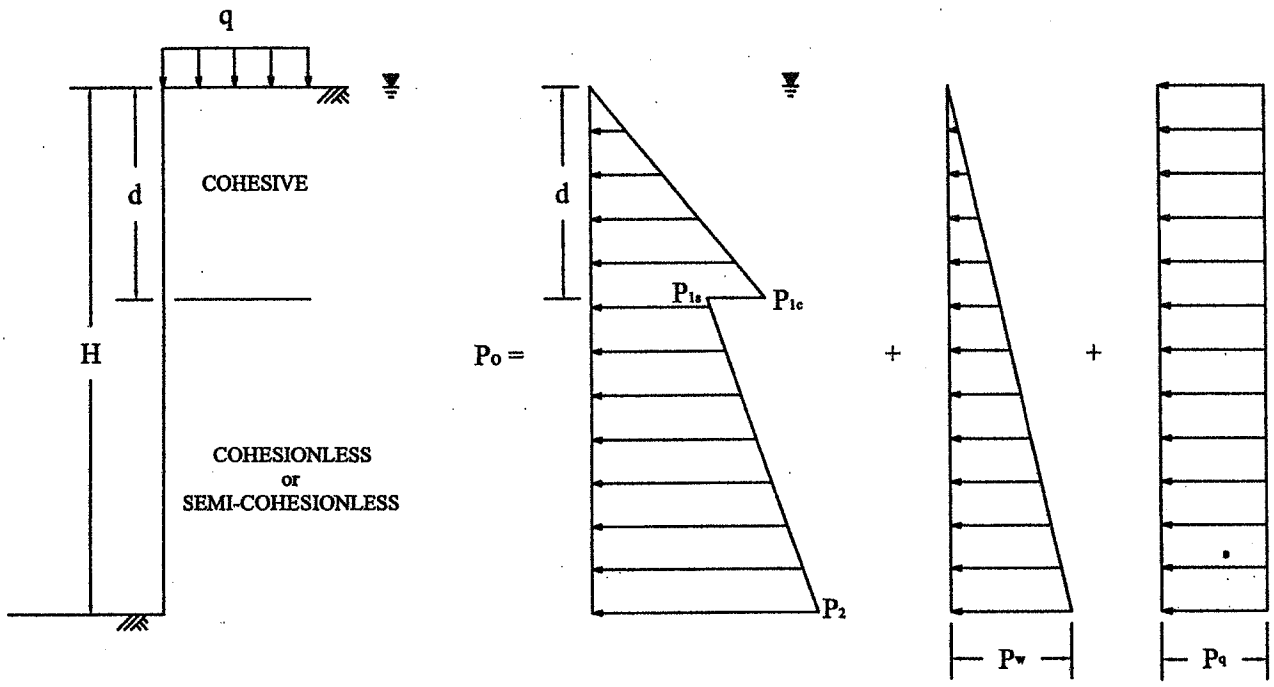
Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
K_{oc} = Coefficient of at-rest earth pressure in cohesive soil;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_o = Lateral pressure, psf;
P_1 = At-rest earth pressure, psf;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Depth of excavation, feet

LATERAL EARTH PRESSURE DIAGRAM FOR PERMANENT WALL

SUBMERGED COHESIVE SOIL

Job No. 1140197101



TYPICAL SOIL PARAMETERS

PERMANANT WALL

See Table 2 for typical values of soil parameters

$K_{oc} = 1.0$

$K_{os} = 1\text{-}\sin\phi_s$

$P_{1c} = \gamma_c' \, d \, K_{oc}$

$P_{1s} = \gamma_c' \, d \, K_{os}$

$P_2 = [\gamma_c' \, d + \gamma_s' \, (H\text{-}d)] \, K_{os}$

$P_w = \gamma_w \, H = 62.4 \, H$

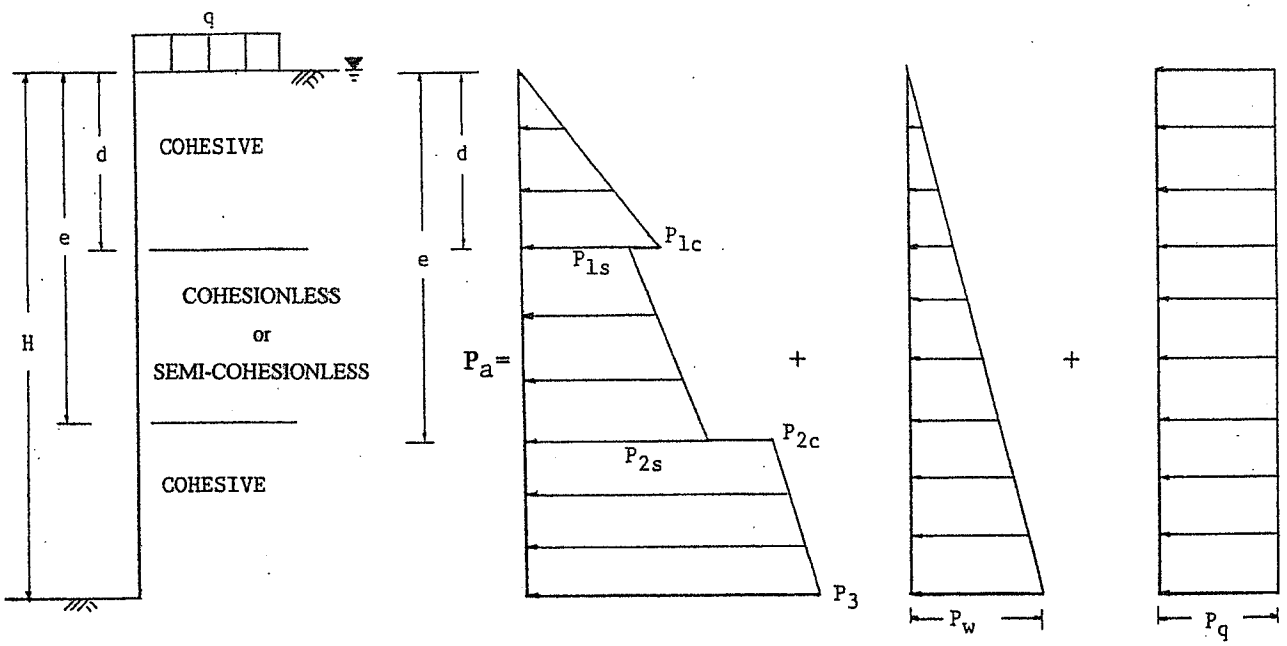
$P_q = 0.5 \, q$

Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
γ_s' = Submerged unit weight of cohesionless or semi-cohesionless soil, pcf;
ϕ_s = Internal friction angle of cohesionless or semi-cohesionless soil, degree;
K_{oc} = Coefficient of at-rest earth pressure in cohesive soil;
K_{os} = Coefficient of at-rest earth pressure in cohesionless or semi-cohesionless soil;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_o = Lateral pressure, psf;
P_i, P_{ic}, P_{is} = At-rest earth pressure, psf; i = 1, 2;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Height of wall, feet

LATERAL EARTH PRESSURE DIAGRAM FOR PERMANENT WALL

SUBMERGED COHESIVE SOIL OVER
COHESIONLESS OR SEMI-COHESIONLESS SOIL



TYPICAL SOIL PARAMETERS

See Table 2 for typical values of soil parameters

$K_{oc} = 1.0$

$K_{os} = 1 - \sin\phi_s$

$\gamma_w = 62.4$ psf

PERMANENT WALL

$P_{1c} = \gamma'_c \, d \, K_{oc}$

$P_{1s} = \gamma'_c \, d \, K_{os}$

$P_{2s} = P_{1s} + \gamma'_s \, (e-d) \, K_{os}$

$P_{2c} = [\gamma'_c \, d + \gamma'_s \, (e-d)] \, K_{oc}$

$P_3 = [\gamma'_c \, d + \gamma'_s \, (e-d) + \gamma'_c \, (H-e)] \, K_{oc}$

$P_w = \gamma_w \, H = 62.4 \, H$

$P_q = 0.5 \, q$

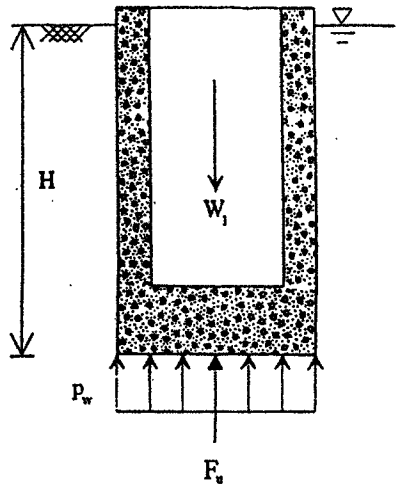
Where:

γ_c' = Effective unit weight of cohesive soil, pcf;
γ_s' = Effective unit weight of cohesionless or semi-cohesionless soil, pcf;
ϕ_s = Internal friction angle of cohesionless or semi-cohesionless soil, degree;
K_{oc} = Coefficient of earth pressure at rest in cohesive soils;
Ko_{as} = Coefficient of earth pressure at rest in cohesionless or semi-cohesionless soil;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_a = Lateral pressure, psf;
P_i, P_{ic}, P_{is} = Earth pressure at rest, psf; i = 1, 2, 3;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Height of wall, feet

LATERAL EARTH PRESSURE DIAGRAM FOR PERMANENT WALL

SUBMERGED COHESIVE SOIL
INTERBEDDED WITH COHESIONLESS
OR SEMI-COHESIONLESS SOIL

(a) DEAD WEIGHT OF STRUCTURE



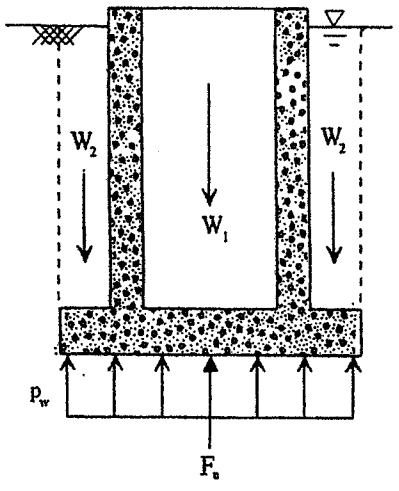
$p_w = H\gamma_w$

$F_u = A_b p_w$

$\frac{W_1}{Sf_1} = F_u$

See Table 2 for typical values of soil parameters

(b) WEIGHT OF SOIL ABOVE BASE EXTENSION PLUS DEAD WEIGHT OF STRUCTURE

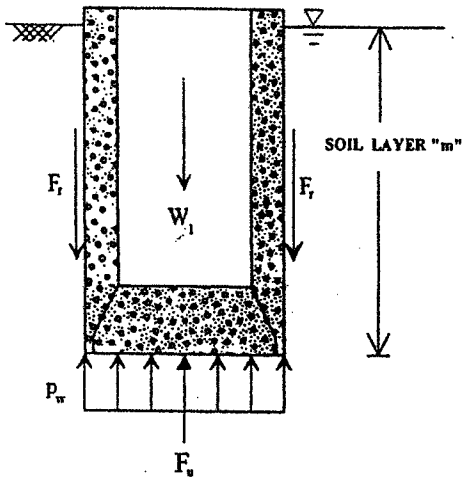


$p_w = H\gamma_w$

$F_u = A_b p_w$

$\frac{W_1}{Sf_1} + \frac{W_2}{Sf_2} = F_u$

(c) SOIL-WALL FRICTION PLUS DEAD WEIGHT OF STRUCTURE



$p_w = H\gamma_w$

$F_u = A_b p_w$

$\frac{W_1}{Sf_1} + \frac{F_r}{Sf_3} = F_u$

Predominantly Cohesive Soils, $F_r = \alpha\, c_m\, A_m$

Predominantly Cohesionless Soils, $F_r = p_m A_m K \tan \delta_m$

Where:

A_b	=	area of base, sq. ft.
A_m	=	cylindrical surface area of layer "m" , sq. ft.
c_m	=	undrained cohesion of soil layer "m", psf.
F_u	=	hydrostatic uplift force, lbs.
F_r	=	frictional resistance, lbs.
H	=	height of buried structure, ft.
K	=	coefficient of lateral pressure = 0.5.
p_m	=	average overburden pressure for layer "m," psf.
p_w	=	hydrostatic uplift pressure, psf.
$Sf_{1, 2, 3}$	=	factor of safety.
W_1	=	dead weight of concrete structure, lbs.
W_2	=	weight of backfill above base extension, lbs.
α	=	cohesion reduction factor = 0.5.
δ_m	=	friction angle between soil layer "m" and concrete wall, degrees = 0.75 ϕ_m
ϕ_m	=	internal angle of friction of soil layer "m", degrees.
γ_w	=	unit weight of water = 62.4 pcf.

UPLIFT PRESSURE AND RESISTANCE

TABLES

TABLE 1

SUMMARY OF BORING INFORMATION

Boring No.	Depth (feet)	Street	Northing	Easting	Elevation (feet)
GB-1 (GB-1P)	25	Wirt Road	13860928	3083375	75.70
GB-2	25	Wirt Road	13861437	3083391	75.76
GB-3	25	Wirt Road	13861911	3083320	76.19
GB-4	25	Wirt Road	13862451	3083343	75.90
GB-5	17	Wirt Road	13862909	3083257	74.77
GB-6	20	Shoshone Road	13862643	3083707	77.49
GB-7	20	Shoshone Road	13862306	3084143	77.30
GB-8	20	Harwood Drive	13862332	3083675	77.51
GB-9 (GB-9P)	20	Kilburn Road	13861863	3083916	77.32
GB-10	30	Wirt Road	13860389	3083424	75.64
GB-11	30	Wirt Road	13859822	3083446	73.97
GB-12B	45	Wirt Road	13859324	3083484	74.11
GB-13B	45	Wirt Road	13858828	3083503	70.31
GB-14B (GB-14BP)	45	Wirt Road	13858328	3083523	69.78
GB-15	53	Longpoint Road	13857999	3083912	68.78

TABLE 2

GEOTECHNICAL DESIGN PARAMETER SUMMARY
OPEN-CUT EXCAVATION

Alignments	Boring Nos.	Stratigraphic Unit	Range of Depths, ft	Wet Unit Weight, γ, pcf	Submerged Unit Weight, γ', pcf	Undrained Cohesion, psf	Internal Friction Angle, φ, degree
48" RCP, 12"water line & 21 to 24" Sanitary Sewer along Wirt Road	GB-1	Cohesive	0-4	130	65	1,000	--
			4-12	130	65	2,200	--
			12-18	130	65	2,500	--
			15-25	125	63	1,500	--
	GB-2	Cohesive	0-4	130	65	1,000	--
			4-6	125	63	1,500	--
			6-14	130	65	2,500	--
			14-20	130	65	3,200	--
			20-25	125	63	600	--
	GB-3	Cohesive	0-4	130	65	1,500	--
			4-12	132	66	3,000	--
			12-16	128	64	1,800	--
			16-23	130	65	3,500	--
			23-25	125	63	2,000	--
	GB-4	Fill	0-6	125	63	1,000	--
		Cohesive	6-10	130	65	1,200	--
			10-25	130	65	3,000	--
	GB-5	Cohesive	0-4	125	63	1,000	--
			4-6	125	63	2,000	--
			6-13	130	65	3,500	--
			13-15	130	65	1,200	--
		Cohesionless	15-17	110	55	--	30
	GB-10	Fill	0-2	120	60	1,500	--
		Cohesive	2-8	125	63	2,000	--
			8-14	130	65	2,400	--
			14-23	125	63	3,000	--
			23-28	125	63	500	--
			28-30	130	65	4,500	--
	GB-11	Cohesive	0-8	125	63	500	--
		Cohesionless	8-14	100	50	--	30
		Cohesive	14-18	120	60	500	--
		Cohesionless	18-28	115	58	--	30
		Cohesive	28-30	125	63	3,000	--
	GB-12B	Cohesive	0-8	130	65	2,200	--
			8-16	130	65	2,400	--
			16-18	125	63	900	--
		Cohesionless	18-23.5	100	50	--	30
			23.5-36	115	58	--	35
		Cohesive	36-41.5	130	65	1,500	--
		Cohesionless	41.5-45	112	62	--	35
	GB-13B	Cohesive	0-10	125	63	1,200	--
			10-16	120	60	800	--
			16-23	132	66	1,000	--
			23-35	125	63	1,000	--
			35-45	125	63	4,000	--

TABLE 2

GEOTECHNICAL DESIGN PARAMETER SUMMARY
OPEN-CUT EXCAVATION

Alignments	Boring Nos.	Stratigraphic Unit	Range of Depths, ft	Wet Unit Weight, γ, pcf	Submerged Unit Weight, γ', pcf	Undrained Cohesion, psf	Internal Friction Angle, φ, degree
48" RCP, 12"water line & 21 to 24" Sanitary Sewer along Wirt Road	GB-14B	Cohesive	0-12	125	63	1,500	--
			12-22	132	66	2,500	--
		Cohesionless	22-43	116	58	--	30
		Cohesive	43-45	125	63	3,500	--
	GB-15	Cohesive	0-16	125	63	600	--
		Cohesionless	16-18	105	53	--	30
		Cohesive	18-23	125	63	2,400	--
			23-25	120	60	500	--
		Cohesionless	25-38.5	102	51	--	30
		Cohesive	38.5-48	125	63	3,000	--
		Cohesionless	48-53	106	53	--	28
24"-30" RCP Along Shoshone Road, Harwood Drive, Haldane Drive and Kilburn Road	GB-6 thru GB-9	Cohesive	0-4	125	63	1,000	--
			4-10	132	66	1,500	--
			10-12	125	63	1,000	--
			12-20	130	65	1,500	--

Note: 1) Cohesive soils include Fat Clay, Fat Clay with sand, Sandy Fat Clay, Lean Clay, Lean Clay with sand and Sandy Lean Clay.
2) Cohesionless soils include Silty Sand
3) Fill Soils include lean clay with sand

TABLE 3
GEOTECHNICAL DESIGN PARAMETER SUMMARY
TRENCHLESS INSTALLATION
(Borings GB-1 through GB-4 and GB-9 through GB-15)

PROPERTY		COHESIVE SOILS [1]	COHESIONLESS SOILS [2]
Wet Unit Weight, γ, pcf	0-2 ft.	120	--
	2- 4 ft.	120	--
	4-8 ft.	125	--
	8-14 ft.	128	100 (GB-11 only)
	14-16 ft	125	--
	16-18 ft	125	100(GB-12B & GB-15 only)
	18-22 ft.	120	100 (GB-11 & GB-12B only)
	22-25 ft	120	116 (GB-12B & GB-14B only)
	25-28 ft	125	110 (GB-12B, GB-11, GB-14B & GB-15 only)
	28-36 ft.	128	116 (GB-12B, GB-14B & GB-15 only)
	36-38.5 ft	130	110 (GB-14B & GB-15 only)
	38.5-41.5 ft.	125	116 (GB-14B only)
	41.5-43 ft	130	112 (GB-12B & GB-14B only)
	43-45 ft	130	112 (GB-12B only)
	45-48 ft	130	--
	48-53 ft	--	106 (GB-15 only)
Submerged Unit Weight, γ', pcf	0-2 ft.	60	--
	2- 4 ft.	60	--
	4-8 ft.	63	--
	8-14 ft.	64	50 (GB-11 only)
	14-16 ft	63	--
	16-18 ft	63	50(GB-12B & GB-15 only)
	18-22 ft.	60	50 (GB-11 & GB-12B only)
	22-25 ft	60	58 (GB-12B & GB-14B only)
	25-28 ft	63	55 (GB-12B, GB-11, GB-14B & GB-15 only)
	28-36 ft.	64	58 (GB-12B, GB-14B & GB-15 only)
	36-38.5 ft	65	55 (GB-14B & GB-15 only)
	38.5-41.5 ft.	63	58 (GB-14B only)
	41.5-43 ft	65	56 (GB-12B & GB-14B only)
	43-45 ft	65	56 (GB-12B only)
	45-48 ft	65	--
	48-53 ft	--	53 (GB-15 only)
Moisture Content (%)	0-2 ft.	11	--
	2- 4 ft.	15	--
	4-8 ft.	18	--
	8-14 ft.	25	12 (GB-11 only)
	14-16 ft	24	--
	16-18 ft	14	15(GB-12B & GB-15 only)
	18-22 ft.	13	18 (GB-11 & GB-12B only)
	22-25 ft	16	16 (GB-12B & GB-14B only)
	25-28 ft	22	22 (GB-12B, GB-11, GB-14B & GB-15 only)
	28-36 ft.	23	24 (GB-12B, GB-14B & GB-15 only)
	36-38.5 ft	26	24 (GB-14B & GB-15 only)
	38.5-41.5 ft.	22	22 (GB-14B only)
	41.5-43 ft	21	23 (GB-12B & GB-14B only)
	43-45 ft	22	24 (GB-12B only)
	45-48 ft	22	--
	48-53 ft	--	24 (GB-15 only)
UNDRAINED PROPERTIES *			
Undrained Cohesion, C_u, psf	14-16 ft*	500	--
	16-18 ft*	500	--
	18-22 ft*.	1,000	--
	22-25 ft*	1,000	--
	25-28 ft*	1,000	--
	28-36 ft*.	1,000	--
	36-38.5 ft*	3,000	--
	38.5-41.5 ft*.	3,000	--
	41.5-43 ft*	3,000	--

TABLE 3 (cont'd)
GEOTECHNICAL DESIGN PARAMETER SUMMARY
TRENCHLESS INSTALLATION

PROPERTY		COHESIVE SOILS [1]	COHESIONLESS SOILS [2]
Angle of Internal, ϕ, degrees	14-16 ft*	--	--
	16-18 ft*	--	30(GB-12B & GB-15 only)
	18-22 ft*.	--	30 (GB-11 & GB-12B only)
	22-25 ft*	--	30 (GB-12B & GB-14B only)
	25-28 ft*	--	30 (GB-12B, GB-11, GB-14B & GB-15 only)
.	28-36 ft*.	--	30(GB-12B, GB-14B & GB-15 only)
	36-38.5 ft*	--	30 (GB-11, GB-14B & GB-15 only)
	38.5-41.5 ft*.	--	30 (GB-14B only)
	41.5-43 ft*	--	30 (GB-12B & GB-14B only)
Elastic Modulus, E, psf	14-16 ft*	150,000	--
	16-18 ft*	150,000	350,000 (GB-12B & GB-15 only)
	18-22 ft*.	300,000	350,000 (GB-11 & GB-12B only)
	22-25 ft*	300,000	350,000 (GB-12B & GB-14B only)
	25-28 ft*	300,000	304,000 (GB-12B, GB-11, GB-14B & GB-15 only)
.	28-36 ft*.	300,000	350,000 (GB-12B, GB-14B & GB-15 only)
	36-38.5 ft*	900,000	560,000 (GB-11, GB-14B & GB-15 only)
	38.5-41.5 ft*.	900,000	350,000 (GB-14B only)
	41.5-43 ft*	900,000	560,000 (GB-12B & GB-14B only)
Coefficient of Lateral Earth Pressure at Rest, K_o	14-16 ft*	1.2	--
	16-18 ft*	1.2	0.4
	18-22 ft*.	1.2	0.4
	22-25 ft*	1.2	0.4
	25-28 ft*	1.2	0.4
.	28-36 ft*.	1.2	0.4
	36-38.5 ft*	1.2	0.4
	38.5-41.5 ft*.	1.2	0.4
	41.5-43 ft*	1.2	0.4
Poisson's Ratio		0.45	0.3
DRAINED PROPERTIES *			
Drained Cohesion, C', psf	14-16 ft*	0	--
	16-18 ft*	0	--
	18-22 ft*.	0	--
	22-25 ft*	0	--
	25-28 ft*	0	--
.	28-36 ft*.	0	--
	36-38.5 ft*	0	--
	38.5-41.5 ft*.	0	--
	41.5-43 ft*	0	--
Angle of Internal Friction, ϕ', degrees	14-16 ft*	21	--
	16-18 ft*	21	30(GB-12B & GB-15 only)
	18-22 ft*.	21	30 (GB-11 & GB-12B only)
	22-25 ft*	21	30 (GB-12B & GB-14B only)
	25-28 ft*	21	30 (GB-12B, GB-11, GB-14B & GB-15 only)
.	28-36 ft*.	20	30(GB-12B, GB-14B & GB-15 only)
	36-38.5 ft*	20	30 (GB-11, GB-14B & GB-15 only)
	38.5-41.5 ft*.	20	30 (GB-14B only)
	41.5-43 ft*	20	30 (GB-12B & GB-14B only)
Elastic Modulus, E, psf	14-16 ft*	90,000	--
	16-18 ft*	90,000	350,000 (GB-12B & GB-15 only)
	18-22 ft*.	180,000	350,000 (GB-11 & GB-12B only)
	22-25 ft*	180,000	350,000 (GB-12B & GB-14B only)
	25-28 ft*	180,000	304,000 (GB-12B, GB-11, GB-14B & GB-15 only)
.	28-36 ft*.	180,000	350,000 (GB-12B, GB-14B & GB-15 only)
	36-38.5 ft*	540,000	560,000 (GB-11, GB-14B & GB-15 only)
	38.5-41.5 ft*.	540,000	350,000 (GB-14B only)
	41.5-43 ft*	540,000	560,000 (GB-12B & GB-14B only)

Notes:
1. Cohesive soils include Fat Clay, Fat Clay w/sand, Lean Clay Lean Clay w/sand and Sandy Lean Clay.
2. Cohesionless soils include Fine Sand w/silt, Silty Sand and Sandy Silt.

* Within tunneling zone (one bore diameter, but not less than 6 feet, above and below tunnel bore).

APPENDIX A

LOG OF BORING NO. GB-1 (GB-1P)

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13860928, E 3083375
Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 25.0 FT.

SURFACE ELEVATION : 75.70 FT.

DATE : 10-03-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 25.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
75.7	0								
75.5		2.25" Asphalt							
75.0		6" Concrete							
		Stiff gray SANDY LEAN CLAY (CL) w/sand seams				18			
		-very stiff yellowish brown and gray w/ferrous nodules 4'-8'				15			
	5			65	115	16	46	16	30
67.7						17			
		Very stiff reddish brown and gray FAT CLAY (CH) w/sand and ferrous nodules				25			
65.7	10								
		Stiff to very stiff yellowish brown and gray LEAN CLAY (CL) w/sand and calcareous nodules				15			
		-very stiff 12'-14'		77	116	17	41	15	26
61.7									
	15	Very stiff reddish brown and gray FAT CLAY (CH) w/silt seams and calcareous nodules				26			
		-stiff to very stiff 16'-18'		96	100	24	66	25	41
		-very stiff to hard 18'-20'				23			
	20								
53.7		Stiff to very stiff reddish brown and gray LEAN CLAY (CL) w/sand							
50.7	25					21			
		NOTE : See Piezometer GB-1P for water level measurements.							
	30								
	35								

SAMPLES

SYMBOL

UNDRAINED SHEAR STRENGTH, TSF
- ○ HAND PENETROMETER
- ● UNCONFINED COMPRESSION
- ■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- △ TORVANE

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 25.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 17.6 FT.
▽: WATER DEPTH AT 13.8 FT., HOLE OPEN TO 25.0 FT. ON 11-07-13.

Geotest Engineering, Inc.

FIGURE A-1

LOG OF BORING NO. GB-2

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13861437, E 3083391
Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 25.0 FT.

SURFACE ELEVATION : 75.76 FT.

DATE : 10-03-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 25.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
75.8	0	2" Asphalt							
75.6									
75.1		6" Concrete							
		Stiff gray SANDY LEAN CLAY (CL) w/sand seams -w/rock 2'-4' -stiff to very stiff 4'-6' -yellowish brown and gray 4'-8' -very stiff to hard 6'-8'		70	114	17 17 16	42	20	22
67.8	10	Very stiff reddish brown and gray FAT CLAY (CH) w/sand seams -yellowish brown and gray 10'-12'				15 30 28			
63.8		Very stiff reddish brown and gray LEAN CLAY (CL) w/sand		82	112	18	45	19	26
61.8	15	Hard reddish brown and gray FAT CLAY (CH) -very stiff 16'-20' -w/calcareous nodules 18'-20'				22 25			
55.8	20	Reddish brown and gray LEAN CLAY (CL) w/sand		92		23	65	25	40
50.8	25	-medium stiff to stiff w/silt seams 23'-25'				23 24			
	30								
	35								

UNDRAINED SHEAR STRENGTH, TSF
- ○ HAND PENETROMETER
- ● UNCONFINED COMPRESSION
- ■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- △ TORVANE

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 25.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 17.0 FT.
HOLE OPEN TO 25.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-2

LOG OF BORING NO. GB-3

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13861911, E 3083320
See Plan of Borings (Figure 2)

COMPLETION DEPTH : 25.0 FT.

SURFACE ELEVATION : 76.19 FT.

DATE : 10-02-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 25.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
76.2	0	2" Asphalt							
75.5		6" Concrete							
		Very stiff gray SANDY LEAN CLAY (CL) w/sand seams, calcareous and ferrous nodules -stiff to very stiff 2'-4' -yellowish brown and gray 4'-12'				17			
	5					17			
						14			
				68	121	15	40	17	23
	10					15			
64.2		Very stiff yellowish brown and gray FAT CLAY (CH) w/calcareous nodules -stiff to very stiff 14'-16'				16			
						21			
	15			88	102	26	68	26	42
						22			
	20					23			
53.2		Very stiff reddish brown and gray LEAN CLAY (CL) w/sand							
51.2	25					21			
	30								
	35								

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

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 25.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 16.5 FT.
HOLE OPEN TO 25.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-3

LOG OF BORING NO. GB-4

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13862451, E 3083343
Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 25.0 FT.

SURFACE ELEVATION : 75.90 FT.

DATE : 10-03-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 22.0 FT.
WET ROTARY : 22.0 TO 25.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
75.9	0	2" Asphalt							
75.7		6" Concrete							
75.2		FILL: medium stiff to stiff gray lean clay w/sand -stiff 2'-6'				18			
	5	-brown sand w/clay seams 5'-6'				20			
69.9		Very stiff yellowish brown and gray LEAN CLAY (CL) w/sand and calcareous nodules -stiff to very stiff 8'-10'		77	115	18	47	17	30
65.9	10	Very stiff gray and reddish brown FAT CLAY (CH) w/calcareous nodules				15			
						17			
						21			
	15	-very stiff to hard 16'-18'				18			
						23			
				97	107	27	64	25	39
		-very stiff to hard 19'-20'				23			
	20					18			
		-hard 23'-25'				23			
50.9	25					19			
	30								
	35								

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

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 22.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 13.5 FT.
HOLE OPEN TO 25.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-4

LOG OF BORING NO. GB-5

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13862909, E 3083257
Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 17.0 FT.

SURFACE ELEVATION : 74.77 FT.

DATE : 10-02-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 17.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
74.8	0								
74.6		2" Asphalt							
74.1		6" Concrete							
		Medium stiff to stiff gray FAT CLAY (CH) w/sand -stiff 2'-4' -very stiff 4'-6'				23			
	5					22			
68.8		Very stiff yellowish brown and gray LEAN CLAY (CL) w/sand and ferrous nodules -very stiff to hard 8'-12'		84	106	20	50	21	29
						15			
	10			74		13	44	19	25
62.8		Stiff to hard gray SANDY FAT CLAY (CH) w/ferrous nodules and slickensided				16			
				66	109	20	52	21	31
59.8	15	Medium dense gray SILTY SAND (SM) w/HYDROCARBON ODOR	14			22			
57.8									
		NOTE : Boring was terminated due to strong HYDROCARBON ODOR.							
	20								
	25								
	30								
	35								

SAMPLES

UNDRAINED SHEAR STRENGTH, TSF
- ○ HAND PENETROMETER
- ● UNCONFINED COMPRESSION
- ■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- △ TORVANE

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 16.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 8.7 FT.
HOLE OPEN TO 17.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-5

LOG OF BORING NO. GB-6

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13862643, E 3083707
Shoshone Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 20.0 FT.

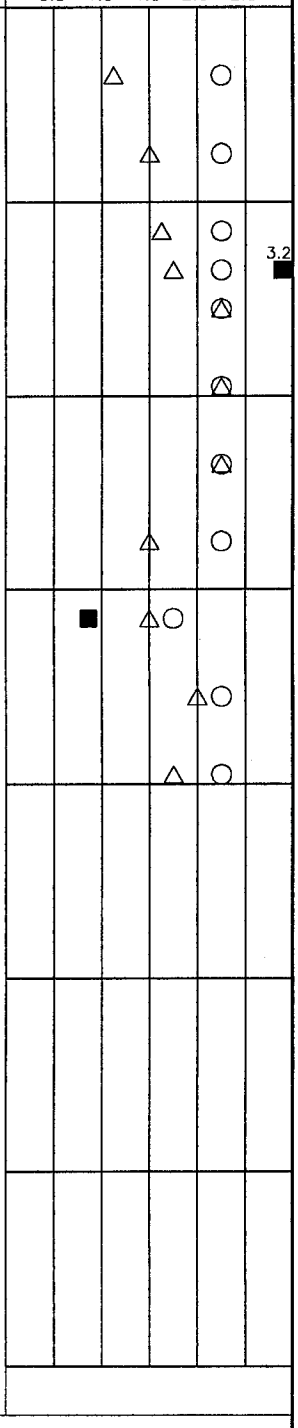
SURFACE ELEVATION : 77.49 FT.

DATE : 10-01-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 20.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
77.5	0	6" Asphalt over 7" Oyster Shell/Sand Mix							
76.4		Very stiff to hard dark gray LEAN CLAY (CL) w/sand and calcareous nodules				13			
		-yellow and gray 2'-4'				12			
	5	-w/ferrous stains 4'-8'				9			
		-hard 7'-8'		77	123	11	46	18	28
69.5		Hard yellowish brown and gray FAT CLAY (CH) w/sand seams				11			
	10					14			
		-very stiff to hard 12'-14'				12			
		-very stiff 14'-16'				15			
	15	-yellowish brown and gray 14'-20'		90	97	28	69	26	43
		-very stiff to hard 18'-20'				24			
57.5	20					25			
	25								
	30								
	35								

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



DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 20.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-6

LOG OF BORING NO. GB-7

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13862306, E 3084143
Shoshone Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 20.0 FT.

SURFACE ELEVATION : 77.30 FT.

DATE : 10-01-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 20.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
77.3	0	6" Asphalt over 7" Oyster Shell/Sand Mix							
76.2		Very stiff to hard dark gray SANDY LEAN CLAY (CL) w/sand seams -yellowish brown and gray w/ferrous nodules 2'-10'				12			
	5					10			
				70	123	10	32	13	19
						13			
						15			
67.3	10	Very stiff yellowish brown and gray LEAN CLAY (CL) w/sand and calcareous nodules -very stiff to hard 12'-20'				15			
				75	118	16	47	18	29
	15					19			
						21			
57.3	20					17			
	25								
	30								
	35								

UNDRAINED SHEAR STRENGTH, TSF
- ○ HAND PENETROMETER
- ● UNCONFINED COMPRESSION
- ■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- △ TORVANE

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 20.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-7

LOG OF BORING NO. GB-8

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13862332, E 3083675
Harwood Drive; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 20.0 FT.

SURFACE ELEVATION : 77.51 FT.

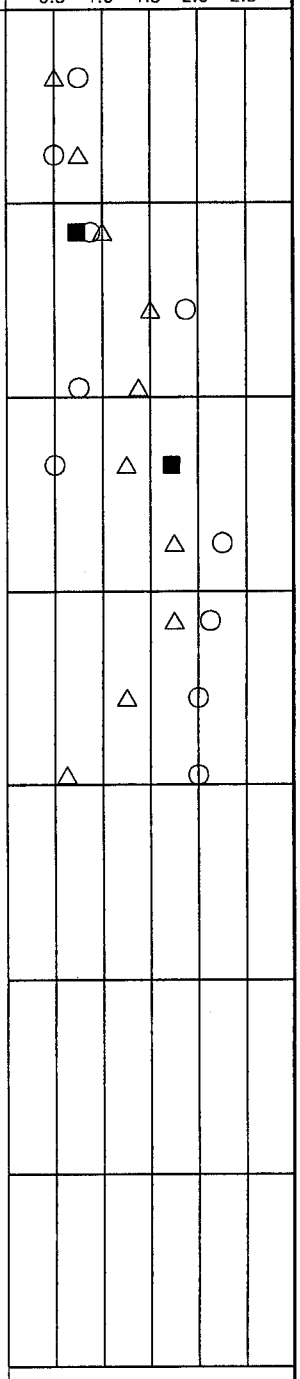
DATE : 10-01-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 20.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
77.5	0	5" Asphalt over 7" Oyster Shell/Sand Mix							
76.5		Stiff gray LEAN CLAY (CL) w/sand, calcareous and ferrous nodules				17			
		-stiff to very stiff 4'-6'				16			
	5	-very stiff 6'-8'		73	120	15	39	15	24
		-yellowish brown and gray 6'-20'				16			
		-stiff to very stiff 8'-12'				18			
	10	-very stiff to hard 12'-18'		74	117	15	42	15	27
						15			
	15					15			
		-stiff to hard very sandy clay w/sand seams 18'-20'				17			
57.5	20					18			
	25								
	30								
	35								

UNDRAINED SHEAR STRENGTH, TSF
- ○ HAND PENETROMETER
- ● UNCONFINED COMPRESSION
- ■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- △ TORVANE

0.5 1.0 1.5 2.0 2.5



DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 20.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-8

LOG OF BORING NO. GB-9 (GB-9P)

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13861863, E 3083916
Kilburn Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 20.0 FT.

SURFACE ELEVATION : 77.32 FT.

DATE : 10-01-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 20.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
77.3	0	3" Asphalt over 14" Oyster Shell/Sand Gravel Mix							
75.9		Very stiff dark gray SANDY LEAN CLAY (CL) w/ferrous nodules and ferrous stains -stiff 2'-4' -w/vertical sand seams 2'-12' -yellowish brown and gray 2'-14'		51	121	15 20 16 14	38	16	22
	5								
	10	-very stiff to hard 10'-12' -hard 12'-14'				22 15 15			
63.3	15	Stiff to hard reddish brown and gray FAT CLAY (CH) w/sand, slickensided		80	106	21	59	23	36
61.3		Very stiff to hard reddish brown and gray LEAN CLAY (CL) w/sand -very stiff 18'-20'				19 17			
57.3	20								
	25								
	30								
	35								

NOTE :
See Piezometer GB-19P for water level readings.

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

DEPTH TO WATER IN BORING :
▽: FREE WATER ENCOUNTERED AT 18.0 FT. DURING DRILLING.
▼: WATER DEPTH AT 12.9 FT., HOLE OPEN TO 20.0 FT. ON 11-07-13.

Geotest Engineering, Inc.

FIGURE A-9

LOG OF BORING NO. GB-10

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13860389, E 3083424
Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 30.0 FT.

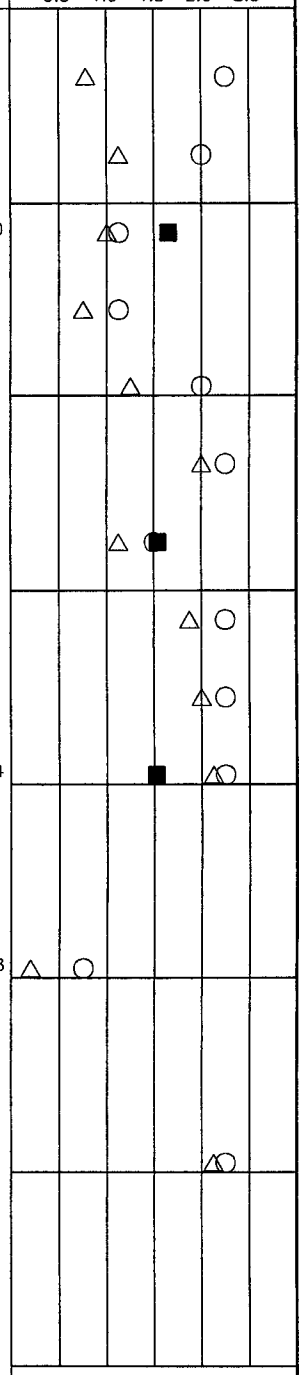
SURFACE ELEVATION : 75.64 FT.

DATE : 05-23-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 25.0 FT.
WET ROTARY : 25.0 TO 30.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
75.6	0	8" Concrete							
75.0		FILL: stiff to hard gray and dark brown lean clay w/asphalt and sand				21			
73.6						16			
	5	Very stiff to hard gray, yellow, and brown SANDY FAT CLAY (CH) w/ferrous stains and sand pockets -very stiff 4'-6' -stiff to very stiff 6'-8'		61	115	17	50	20	30
67.6						25			
	10	Very stiff to hard reddish brown and gray LEAN CLAY (CL) w/sand and calcareous nodules -hard 10'-12' -very stiff 12'-14'				16			
						16			
61.6					112	21			
	15	Very stiff to hard reddish brown and gray FAT CLAY (CH) w/calcareous nodules -hard 16'-18'				21			
						23			
	20			94	106	21	56	22	34
52.6		Medium stiff to stiff reddish brown and gray LEAN CLAY (CL) w/sand, ferrous nodules, and ferrous stains		73		20	26	18	8
	25								
47.6		Hard gray and reddish brown FAT CLAY (CH) w/sand seams				28			
45.6	30								
	35								

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



DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 23.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 15.5 FT.
HOLE OPEN TO 30.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-10

LOG OF BORING NO. GB-11

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13859822, E 3083446
Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION : 73.97 FT.

DATE : 05-23-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 20.0 FT.
WET ROTARY : 20.0 TO 30.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
74.0	0	8.5" Concrete							
73.3		Medium stiff dark gray FAT CLAY (CH) w/sand and calcareous nodules -medium stiff to stiff 2'-4'		72	102	28 27	60	24	36
70.0	5	Medium stiff to stiff gray and brown LEAN CLAY (CL) w/sand seams				21 25			
66.0	10	Brown FINE SAND (SP-SM) w/silt -loose 8.5'-10'	9	10		13 11			
60.0	15	Stiff reddish brown and gray SANDY LEAN CLAY (CL) -soft to medium stiff 16'-18'		56	112	11 18	29	17	12
56.0	20	Medium dense brown SILTY SAND (SM)	19	43		21 19			
	25	-dense w/sand stones 23'-25'	42			18			
46.0	30	Very stiff to hard red and brown FAT CLAY (CH) w/sand				28			
44.0	35								

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

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 18.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 15.2 FT.
HOLE OPEN TO 30.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-11

LOG OF BORING NO. GB-12

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 10.0 FT.

SURFACE ELEVATION : Existing Grade

DATE : 05-23-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 10.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	0			8" Concrete
				Very stiff brown and gray SANDY LEAN CLAY (CL)
				-medium stiff 2'-4'
				-w/sand seams 2'-10'
				-soft 4'-6'
	5			-stiff 6'-8'
				-medium stiff 8'-10'
	10			NOTE : Hard Obstruction was encountered at 10 feet, boring was offset to GB-12A.
	15			
	20			
	25			
	30			
	35			

STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %

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

DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 10.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-12

LOG OF BORING NO. GB-12A

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 20.0 FT.

SURFACE ELEVATION : Existing Grade

DATE : 05-30-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 16.0 FT.
WET ROTARY : 16.0 TO 20.0 FT.

ELEVATION, FEET	DEPTH, FEET	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
	0			7.5" Concrete							
				Very stiff gray SANDY LEAN CLAY (CL) -w/calcareous nodules 7.5"-6' -stiff 2'-10'							
	5										
	10										
	15			Very loose brown SANDY SILT (ML) -dense 14.5'-16'	2						
				-medium dense 16.5'-18'	33						
				-very dense 18.5'-20'	29						
	20				55						
				NOTE : Due to loss of circulation at 18 feet, the boring was terminated at 20 feet and offset to boring GB-12B.							
	25										
	30										
	35										

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

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 16.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 12.5 FT.
HOLE OPEN TO 20.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-12A

LOG OF BORING NO. GB-12B

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13859324, E 3083484
Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 45.0 FT.

SURFACE ELEVATION : 74.11 FT.

DATE : 06-02-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 22.0 FT.
WET ROTARY : 22.0 TO 45.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
74.1	0	7.25" Concrete				21			
73.5		Very stiff dark gray LEAN CLAY (CL) w/sand and ferrous nodules -yellowish brown and gray 2'-4'				19			
70.1	5			70	114	17	52	21	31
66.1		Very stiff gray and brown SANDY FAT CLAY (CH) w/calcareous and ferrous nodules				20			
	10					17			
		Very stiff gray and yellowish brown LEAN CLAY (CL) w/sand, ferrous nodules, and ferrous stains				18			
						19			
	15				114	19			
56.1		-w/calcareous nodules 12'-16'				19			
		-medium stiff to stiff 16'-18'	23	54		22			
	20								
50.6		Medium dense gray and brown SANDY SILT (ML) w/clay and sand seams							
			52	24		19			
	25	Very dense brown SILTY SAND (SM)							
	30		78			21			
		-w/gravel and sand stones 33.5'-35'							
	35		100/5.0"			23			
38.1		Stiff to hard reddish brown FAT CLAY (CH) -very stiff 38'-40'		100	104	26	56	22	34
	40					23			
32.6		Very dense red SANDY SILT (ML) -dense 43.5'-45'	59	51		24			
29.1	45		48			23			
	50								

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

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 22.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 14.2 FT.
HOLE OPEN TO 45.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-12B

LOG OF BORING NO. GB-13

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 6.0 FT.

SURFACE ELEVATION : Existing Grade

DATE : 05-23-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 6.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
	0			8.5" Concrete							
				Stiff reddish brown FAT CLAY (CH) w/sand and pockets of Asphalt							
	5										
				NOTE : Hard obstruction was encountered at 6 feet and boring was offset to GB-13A.							
	10										
	15										
	20										
	25										
	30										
	35										

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

DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 6.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-13

LOG OF BORING NO. GB-13A

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 2.0 FT.

SURFACE ELEVATION : Existing Grade

DATE : 05-23-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 2.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
	0			7.25" Concrete							
				Dark gray SANDY CLAY (CL)							
				NOTE : Hard obstruction was encountered at 2 feet and boring was offset to GB-13B.							
	5										
	10										
	15										
	20										
	25										
	30										
	35										

UNDRAINED SHEAR STRENGTH, TSF
- ○ HAND PENETROMETER
- ● UNCONFINED COMPRESSION
- ■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- △ TORVANE

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 2.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-13A

LOG OF BORING NO. GB-13B

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13858828, E 3083503
Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 45.0 FT.

SURFACE ELEVATION : 70.31 FT.

DATE : 06-18-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 24.0 FT.
WET ROTARY : 24.0 TO 45.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
70.3	0								
69.7		7" Concrete							
		Stiff to very stiff brown and gray LEAN CLAY (CL) w/sand, calcareous and ferrous nodules, and ferrous stains				19			
						19			
	5	-stiff gray and brown 6'-10'		76	109	19	47	20	27
						22			
						28			
60.3	10	Medium stiff to stiff reddish brown and gray FAT CLAY (CH) w/calcareous nodules		94	88	36	76	28	48
		-slickensided 10'-12'				30			
	15	-very stiff 12'-16'				28			
54.3		-gray and brown 14'-16'				17			
		Medium stiff to stiff brown and gray LEAN CLAY (CL) w/sand		79	121	14	28	14	14
	20	-stiff gray 18'-20'							
47.3		Very stiff reddish brown and gray FAT CLAY (CH) w/ferrous stains				27			
	25	-w/sand seams 23'-25'							
		-slickensided 27'-45'							
		-stiff 28'-30'				32			
	30								
		-medium stiff to hard 33'-35'		99	97	28	71	26	45
	35								
		-hard 38'-45'							
						26			
	40								
25.3	45					32			
	50								

UNDRAINED SHEAR STRENGTH, TSF
- ○ HAND PENETROMETER
- ● UNCONFINED COMPRESSION
- ■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- △ TORVANE

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 24.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 16.8 FT.
HOLE OPEN TO 45.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-13B

LOG OF BORING NO. GB-14

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 6.0 FT.

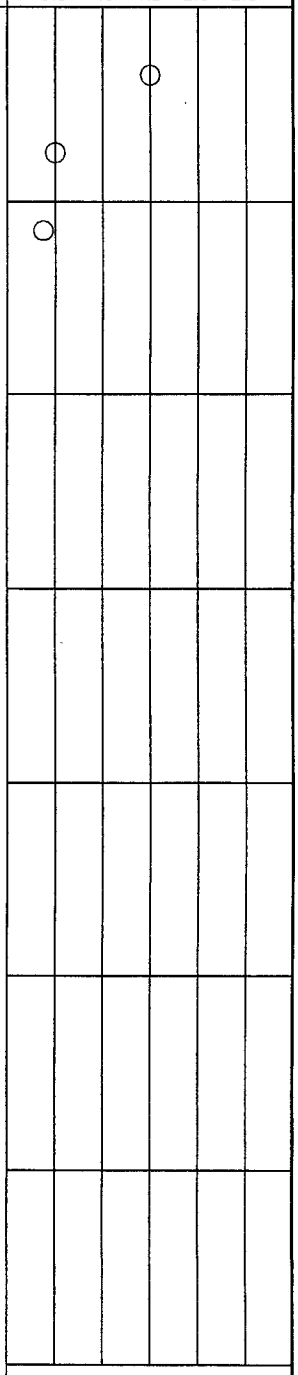
SURFACE ELEVATION : Existing Grade

DATE : 05-23-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 6.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
	0			6.5" Concrete							
				Dark gray SAND (SM) w/clay							
	5			Very stiff brown and gray SANDY LEAN CLAY (CL) -stiff 2'-4' -brown and gray silty clay w/calcareous nodules 4'-6'							
	10			NOTE : Hard obstruction was encountered at 6 feet and boring was offset to GB-14A.							
	15										
	20										
	25										
	30										
	35										

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



DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 6.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-14

LOG OF BORING NO. GB-14A

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 6.0 FT.

SURFACE ELEVATION : Existing Grade

DATE : 05-23-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 6.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	0			12" Concrete
				6" Stabilized Sandy Clay
	5			Gray SANDY LEAN CLAY (CL) w/shell -brown and gray 2'-4' -w/calcareous nodules 2'-6' -yellow and gray 4'-6'
	10			NOTE : Hard obstruction was encountered at 6 feet and boring was offset to GB-14B.
	15			
	20			
	25			
	30			
	35			

STANDARD PENETRATION TEST, BLOWS PER FOOT
PERCENT PASSING NO. 200 SIEVE
DRY UNIT WEIGHT, PCF
NATURAL MOISTURE CONTENT, %
LIQUID LIMIT, %
PLASTIC LIMIT, %
PLASTICITY INDEX, %

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

DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 6.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-14A

LOG OF BORING NO. GB-14B (GB-14BP)

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13858328, E 3083523
Wirt Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 45.0 FT.

SURFACE ELEVATION : 69.78 FT.

DATE : 06-02-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 26.0 FT.
WET ROTARY : 26.0 TO 45.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
69.8	0	7.25" Concrete							
68.7		6" Lime Stabilized Sandy Clay				19			
						19			
	5	Dark gray LEAN CLAY (CL) w/sand and calcareous nodules -stiff to very stiff 2'-4'		77	107	20	49	20	29
61.8		-medium stiff to stiff yellowish brown and gray 4'-6'				18			
	10			86	94	30	81	29	52
57.8		-stiff to very stiff 6'-8'				33			
		Stiff to very stiff gray and brown FAT CLAY (CH) w/calcareous nodules and sand seams -stiff 10'-12'				16			
	15				120	14			
						15			
		Very stiff brown and gray LEAN CLAY (CL) w/sand -very stiff to hard 14'-18'		72	113	17	34	17	17
	20								
47.8		-gray and brown 16'-22'							
		Medium dense brown and gray SANDY SILT (ML) w/clay seams	22			17			
	25		20			19			
41.3									
		Dense gray and brown SILTY SAND (SM) w/clay seams	36	43		22			
	30								
	35		31			20			
	40		40			19			
26.8									
24.8	45	Very stiff to hard reddish brown and gray FAT CLAY (CH) w/calcareous and ferrous nodules				28			
	50								

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

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 25.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 16.6 FT.
▼: WATER DEPTH AT 16.0 FT., HOLE OPEN TO 45.0 FT. ON 07-22-14.

Geotest Engineering, Inc.

FIGURE A-14B

LOG OF BORING NO. GB-15

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13857999, E 3083912
Long Point Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 53.0 FT.

SURFACE ELEVATION : 68.78 FT.

DATE : 05-29-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 26.0 FT.
WET ROTARY : 26.0 TO 53.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
68.8	0	10.5" Concrete							
67.9		Stiff gray and brown LEAN CLAY (CL) w/sand and calcareous nodules				24			
	5	-brown and gray 2'-4'				20			
		-stiff to very stiff 4'-6'		78	103	22	48	18	30
						24			
						23			
	10	-medium stiff 10'-12'							
		-very stiff to hard 12'-14'		78	98	24	35	15	20
						16			
		-very stiff 14'-16'							
	15					17			
52.8		Dense gray SILT (ML) w/sand and clayey seams	49	72		16			
50.8		Very stiff reddish brown and gray FAT CLAY (CH) w/sand seams				31			
	20								
45.8		Soft gray LEAN CLAY (CL) w/sand layers		85	95	25	30	18	12
43.8	25	Dense brown FINE SAND (SP-SM) w/silt	34			21			
		-medium dense 28.5'-30'	23			23			
	30								
			44	6		21			
	35								
30.3		Hard reddish brown FAT CLAY (CH)	41			30			
	40	-very stiff to hard 40'-42'		99	94	30	74	27	47
		-very stiff 43'-45'							
	45					29			
20.8									
18.8	50	Reddish brown SANDY SILT (ML) -w/clay seams 48'-50'				24	23	20	3

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

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 25.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 16.2 FT.
HOLE OPEN TO 53.0 FT. AT END OF DRILLING.

Continued on Figure A-15a

Geotest Engineering, Inc.

FIGURE A-15

LOG OF BORING NO. GB-15 Cont'd

PROJECT : Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas

PROJECT NO. : 1140197101

LOCATION : N 13857999, E 3083912
Long Point Road; See Plan of Borings (Figure 2)

COMPLETION DEPTH : 53.0 FT.

SURFACE ELEVATION : 68.78 FT.

DATE : 05-29-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 26.0 FT.
WET ROTARY : 26.0 TO 53.0 FT.

ELEVATION, FEET	DEPTH, FEET	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
18.8	50			Reddish brown SANDY SILT (ML)							
15.8				-medium dense 51.5'-53'	27			26			
	55										
	60										
	65										
	70										
	75										
	80										
	85										
	90										
	95										
	100										

UNDRAINED SHEAR STRENGTH, TSF
- ○ HAND PENETROMETER
- ● UNCONFINED COMPRESSION
- ■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- △ TORVANE

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 25.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 16.2 FT.
HOLE OPEN TO 53.0 FT. AT END OF DRILLING.

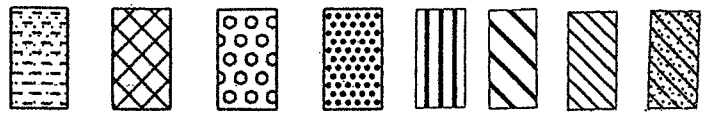
Geotest Engineering, Inc.

FIGURE A-15a

Job No. 1140197101

SYMBOLS AND TERMS USED ON BORING LOGS

SOIL TYPES
(SHOWN IN SYMBOL COLUMN)



Asphaltic Concrete | Fill | Gravel | Sand | SILT | CLAY | LEAN CLAY | Sandy LEAN CLAY

Predominant type shown heavy

SAMPLER TYPES
(SHOWN IN SAMPLES COLUMN)

Pitcher Barrel | Nx Core | Shelby Tube | Piston | Split Spoon | No Recovery | Auger

TERMS DESCRIBING CONSISTENCY OR CONDITION

Basic Soil Type	Density or Consistency	Standard Penetration Resistance, [1] Blows/ft.	Unconfined Compressive Strength (q_u), [2] Tons/sq. ft.
Cohesionless	Very loose	Less than 4	Not applicable
	Loose	4 to <10	Not applicable
	Medium dense	10 to <30	Not applicable
	Dense	30 to <50	Not applicable
	Very dense	50 or greater	Not applicable
Cohesive	Very soft	Less than 2	Less than 0.25
	Soft	2 to <4	0.25 to <0.5
	Firm/Medium stiff	4 to <8	0.5 to <1.0
	Stiff	8 to <15	1.0 to <2.0
	Very stiff	15 to <30	2.0 to <4.0
	Hard	30 or greater	4 or greater

(1) Number of blows from 140-lb. weight falling 30-in. to drive 2-in. OD, 1-3/8-in. ID, split barrel sampler (ASTM D1586)

(2) q_u may also be approximated using a pocket penetrometer

TERMS CHARACTERIZING SOIL STRUCTURE

Parting: -paper thin in size Seam: -1/8" to 3" thick Layer: -greater than 3"

Slickensided	- having inclined planes of weakness that are slick and glossy in appearance.
Fissured	- containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated	- composed of thin layers of varying color and 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 size missing.
Flocculated	- pertaining to cohesive soils that exhibit a loose knit or flakey structure.

Job No. 1140197101

PIEZOMETER INSTALLATION REPORT

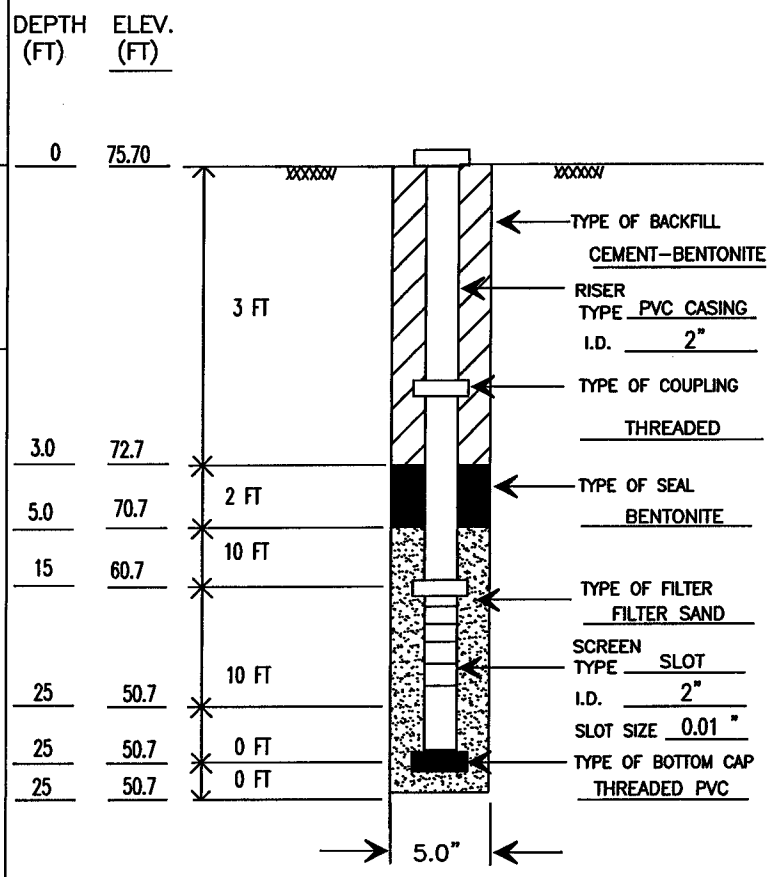
PROJECT NAME: WIRT ROAD DRAINAGE AND PAVING SUB-PROJECT II DESIGN WBS NO. M-000287-0002-3		PIEZOMETER NUMBER: GB-1P
GEOTECHNICAL CONSULTANT GEOTEST ENGINEERING, INC.	DESIGN CONSULTANT R.G.MILLER ENGINEERS, INC.	HOUSTON, TEXAS

COMPLETION DATE 10-03-13
DRY AUGERED 0 TO 25 FT
WASH BORED -- TO -- FT
DRILLING FLUID: WATER

DEVELOPMENT DATE: 10-03-13
METHOD OF DEVELOPMENT:
BAILING

WATER LEVEL READINGS:

DATE	DEPTH (TOG)	ELEVATION
10-04-13	14.8	60.9
11-7-13	13.8	61.9



(NOT TO SCALE)

REMARKS:

NOTES:
1. DIMENSIONS NOMINAL UNLESS OTHERWISE NOTED
2. TOG = TOP OF GROUND

DRILLED BY: MG	STARTED: 10-03-13	NORTHING: 13860928 EASTING: 3083375
LOGGED BY: TM	COMPLETED: 10-03-13	GROUND LEVEL (MSL): 75.70 FT
CHECKED BY: NK	APPROVED BY: MB	SHEET 1 OF 1

Job No. 1140197101

PIEZOMETER INSTALLATION REPORT

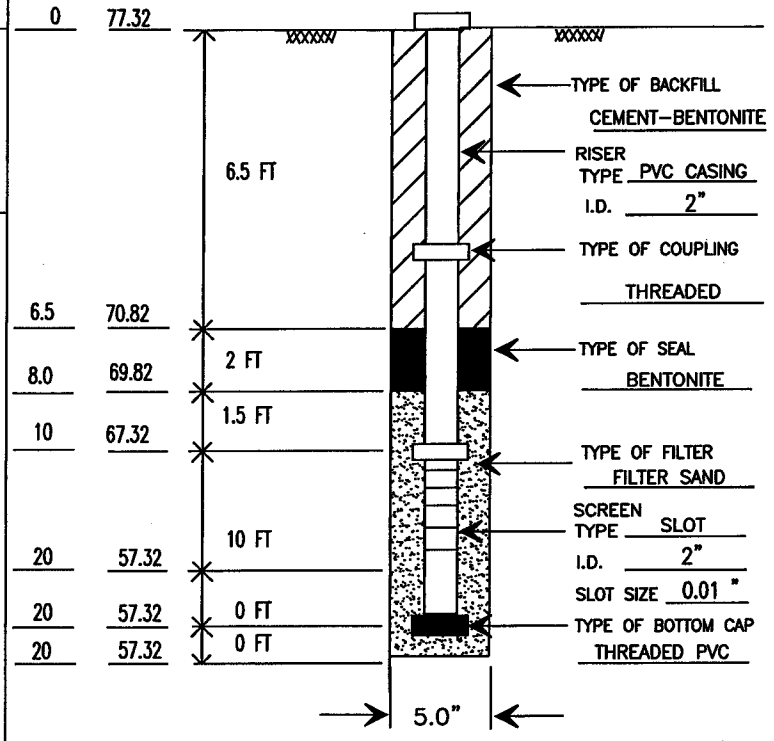
PROJECT NAME: WIRT ROAD DRAINAGE AND PAVING SUB-PROJECT II DESIGN WBS NO. M-000287-0002-3		PIEZOMETER NUMBER: GB-9P
GEOTECHNICAL CONSULTANT GEOTEST ENGINEERING, INC.	DESIGN CONSULTANT R.G.MILLER ENGINEERS, INC.	HOUSTON, TEXAS

COMPLETION DATE: 10-01-13
DRY AUGERED 0 TO 20 FT
WASH BORED -- TO -- FT
DRILLING FLUID: WATER

DEVELOPMENT DATE: 10-01-13
METHOD OF DEVELOPMENT: BAILING

WATER LEVEL READINGS:

DATE	DEPTH (TOG)	ELEVATION
10-02-13	13.3	64.0
11-7-13	12.9	64.4



(NOT TO SCALE)

REMARKS:

NOTES:
1. DIMENSIONS NOMINAL UNLESS OTHERWISE NOTED
2. TOG = TOP OF GROUND

DRILLED BY: MG	STARTED: 10-01-13	NORTHING: 13861863 EASTING: 3083916
LOGGED BY: TM	COMPLETED: 10-01-13	GROUND LEVEL (MSL): 77.32 FT
CHECKED BY: NK	APPROVED BY: MB	SHEET 1 OF 1

Job No. 1140197101

PIEZOMETER INSTALLATION REPORT

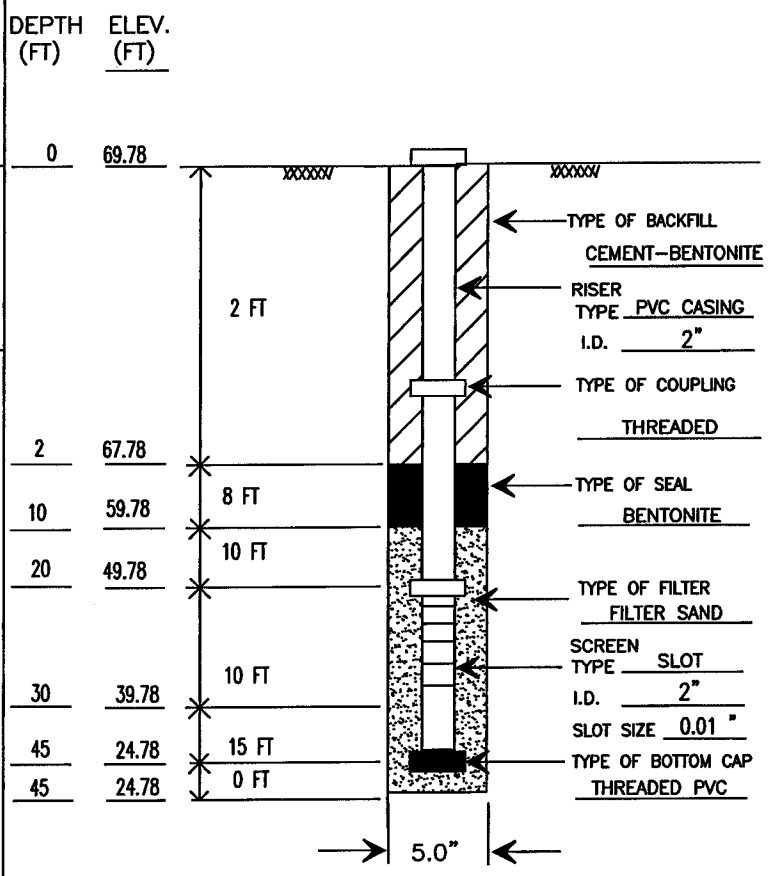
PROJECT NAME: WIRT ROAD DRAINAGE AND PAVING SUB-PROJECT II DESIGN WBS NO. M-000287-0002-3	PIEZOMETER NUMBER: GB-14BP
GEOTECHNICAL CONSULTANT GEOTEST ENGINEERING, INC.	DESIGN CONSULTANT R.G.MILLER ENGINEERS, INC. — HOUSTON, TEXAS

COMPLETION DATE 06-02-14
DRY AUGERED 0 TO 26 FT
WASH BORED 26 TO 45 FT
DRILLING FLUID: WATER

DEVELOPMENT DATE: 06-02-14
METHOD OF DEVELOPMENT:
BAILING

WATER LEVEL READINGS:

DATE	DEPTH (TOG)	ELEVATION
06-3-14	15.8	54.0
7-22-14	16.0	53.8



(NOT TO SCALE)

REMARKS:

NOTES:
1. DIMENSIONS NOMINAL UNLESS OTHERWISE NOTED
2. TOG = TOP OF GROUND

DRILLED BY: MG	STARTED: 06-02-14	NORTHING: 13858328 EASTING: 3083523
LOGGED BY: TM	COMPLETED: 06-02-14	GROUND LEVEL (MSL): 69.78 FT
CHECKED BY: NK	APPROVED BY: MB	SHEET 1 OF 1

APPENDIX B

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-1 (GB-1P)	2	0.7	2.0	UD		18									0.75	0.50	Sandy Lean Clay
	3	2.0	4.0	UD		15									0.65	0.88	Sandy Lean Clay
	4	4.0	6.0	UD		16	115	46	16	30	65		1.12	0.43	1.38	1.50	Sandy Lean Clay
	5	6.0	8.0	UD		17									1.50	1.75	Sandy Lean Clay
	6	8.0	10.0	UD		25									1.50	1.13	Fat Clay
	7	10.0	12.0	UD		15									1.13	0.75	Lean Clay
	8	12.0	14.0	UD		17	116	41	15	26	77		1.30	1.01	1.75	2.00	Lean Clay
	9	14.0	16.0	UD		26									1.50	1.50	Fat Clay
	10	16.0	18.0	UD		24	100	66	25	41	96		0.79	1.30	1.75	1.88	Fat Clay
	11	18.0	20.0	UD		23									1.75	2.00	Fat Clay
	13	23.0	25.0	UD		21									0.63	1.25	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-1

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
GB-2	2	0.7	2.0	UD		17									0.75	0.75	Sandy Lean Clay
	3	2.0	4.0	UD		17									0.70	0.50	Sandy Lean Clay
	4	4.0	6.0	UD		16	114	42	20	22	70		0.93	0.43	1.00	0.88	Sandy Lean Clay
	5	6.0	8.0	UD		15									1.75	2.25	Sandy Lean Clay
	6	8.0	10.0	UD		30									1.25	1.25	Fat Clay
	7	10.0	12.0	UD		28									1.25	1.25	Fat Clay
	8	12.0	14.0	UD		18	112	45	19	26	82		1.62	1.01	1.50	1.38	Lean Clay
	9	14.0	16.0	UD		22									2.00	2.00	Fat Clay
	10	16.0	18.0	UD		25									1.63	1.75	Fat Clay
	11	18.0	20.0	UD		23		65	25	40	92				1.63	1.75	Fat Clay
	12	23.0	24.0	UD		23									0.25	0.75	Lean Clay
	13	24.0	25.0	UD		24											Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-2

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-3	2	0.7	2.0	UD		17									1.00	1.00	Sandy Lean Clay
	3	2.0	4.0	UD		17									1.00	0.75	Sandy Lean Clay
	4	4.0	6.0	UD		14									1.50	1.88	Sandy Lean Clay
	5	6.0	8.0	UD		15	121	40	17	23	68		1.44	0.58	1.50	1.75	Sandy Lean Clay
	6	8.0	10.0	UD		15									1.50	1.75	Sandy Lean Clay
	7	10.0	12.0	UD		16									1.63	1.75	Sandy Lean Clay
	8	12.0	14.0	UD		21									1.25	1.25	Fat Clay
	9	14.0	16.0	UD		26	129	68	26	42	88		0.92	1.15	1.25	1.25	Fat Clay
	10	16.0	18.0	UD		22									1.63	1.75	Fat Clay
	11	18.0	20.0	UD		23									1.75	1.88	Fat Clay
	12	23.0	25.0	UD		21									1.00	1.13	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-3

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
GB-4	2	0.7	2.0	UD		18									0.50	0.38	Fill
	3	2.0	4.0	UD		20									0.50	0.50	Fill
	4	4.0	6.0	UD		18									0.60	0.63	Fill
	5	6.0	8.0	UD		15	115	47	17	30	77		1.47	0.58		1.13	Lean Clay
	6	8.0	10.0	UD		17									1.00	0.63	Lean Clay
	7	10.0	12.0	UD		21									1.50	1.50	Fat Clay
	8	12.0	14.0	UD		18									1.50	1.50	Fat Clay
	9	14.0	16.0	UD		23									1.50	1.38	Fat Clay
	10	16.0	18.0	UD		27	107	64	25	39	97		2.14	1.30	1.38	1.38	Fat Clay
	11	18.0	19.0	UD		23									1.50	1.38	Fat Clay
	12	19.0	20.0	UD		18									1.25	2.25	Fat Clay
	13	22.0	23.0	UD		23											Fat Clay
	14	23.0	25.0	UD		19											Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-4

SUMMARY OF LABORATORY TEST RESULTS

CEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-5	2	0.7	2.0	UD		23									0.65	0.38	Fat Clay
	3	2.0	4.0	UD		22									0.60	0.50	Fat Clay
	4	4.0	6.0	UD		20	106	50	21	29	84		1.06	0.43	1.00	1.00	Fat Clay
	5	6.0	8.0	UD		15									1.75	1.75	Lean Clay
	6	8.0	10.0	UD		13		44	19	25	74				1.75	2.25	Lean Clay
	7	10.0	12.0	UD		16									1.75	2.25	Lean Clay
	8	12.0	14.0	UD		20	109	52	21	31	66		0.65	1.01	1.63	2.25	Sandy Fat Clay
	10	15.5	17.0	SS	14	22											Silty Sand

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-5

SUMMARY OF LABORATORY TEST RESULTS

CEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-6	2	1.1	2.0	UD		13									1.13	2.25	Lean Clay
	3	2.0	4.0	UD		12									1.50	2.25	Lean Clay
	5	5.0	6.0	UD		9									1.63	2.25	Lean Clay
	6	6.0	7.0	UD		11	123	46	18	28	77		3.21	0.50	1.75	2.25	Lean Clay
	7	7.0	8.0	UD		11									2.25	2.25	Lean Clay
	8	8.0	10.0	UD		14									2.25	2.25	Fat Clay
	9	10.0	12.0	UD		12									2.25	2.25	Fat Clay
	10	12.0	14.0	UD		15									1.50	2.25	Fat Clay
	11	14.0	16.0	UD		28	97	69	26	43	90		0.86	1.15	1.50	1.75	Fat Clay
	12	16.0	18.0	UD		24									2.00	2.25	Fat Clay
	13	18.0	20.0	UD		25									1.75	2.25	Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-6

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-7	2	1.1	2.0	UD		12									1.00	2.25	Sandy Lean Clay
	3	2.0	4.0	UD		10									1.50	2.25	Sandy Lean Clay
	4	4.0	6.0	UD		10	123	32	13	19	70		2.36	0.43	1.75	2.25	Sandy Lean Clay
	5	6.0	8.0	UD		13									1.88	2.25	Sandy Lean Clay
	6	8.0	10.0	UD		15									1.50	2.25	Sandy Lean Clay
	7	10.0	12.0	UD		15									1.88	1.50	Lean Clay
	8	12.0	14.0	UD		16	118	47	18	29	75		1.93	1.01	1.75	2.25	Lean Clay
	9	14.0	16.0	UD		19									1.75	2.25	Lean Clay
	10	16.0	18.0	UD		21									1.50	2.25	Lean Clay
	11	18.0	20.0	UD		17									1.13	2.25	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-7

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-8	2	1.0	2.0	UD		17									0.50	0.75	Lean Clay
	3	2.0	4.0	UD		16									0.75	0.50	Lean Clay
	4	4.0	6.0	UD		15	120	39	15	24	73		0.73	0.43	1.00	0.88	Lean Clay
	5	6.0	8.0	UD		16									1.50	1.88	Lean Clay
	6	8.0	10.0	UD		18									1.38	0.75	Lean Clay
	7	10.0	12.0	UD		15	117	42	15	27	74		1.72	0.86	1.25	0.50	Lean Clay
	8	12.0	14.0	UD		15									1.75	2.25	Lean Clay
	9	14.0	16.0	UD		15									1.75	2.13	Lean Clay
	10	16.0	18.0	UD		17									1.25	2.00	Lean Clay
	11	18.0	20.0	UD		18									0.63	2.00	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-8

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-9 (GB-9P)	3	1.4	2.0	UD		15									1.00	1.25	Sandy Lean Clay
	4	2.0	4.0	UD		20									0.50	0.75	Sandy Lean Clay
	5	4.0	6.0	UD		16									1.13	1.38	Sandy Lean Clay
	6	6.0	8.0	UD		14	121	38	16	22	51		1.11	0.58	1.50	1.63	Sandy Lean Clay
	7	8.0	10.0	UD		22									1.00	1.13	Sandy Lean Clay
	8	10.0	12.0	UD		15									1.75	2.00	Sandy Lean Clay
	9	12.0	14.0	UD		15									2.00	2.25	Sandy Lean Clay
	10	14.0	16.0	UD		21	106	59	23	36	80		0.74	1.15	2.00	2.25	Fat Clay
	11	16.0	18.0	UD		19									1.75	2.00	Lean Clay
	12	18.0	20.0	UD		17									1.50	1.88	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-9

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE No.	SAMPLE Depth (ft.) Top	SAMPLE Depth (ft.) Bottom	SAMPLE Type	SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Shear Strength (tsf)	TRIAXIAL COMPRESSION TEST (U-U) Conf. Press. (tsf)	TORVANE Shear Strength (tsf)	POCKET PENE-TROMETER Shear Strength (tsf)	TYPE OF MATERIAL
GB-10	2	0.7	2.0	UD		21									0.79	2.25	Fill
	3	2.0	4.0	UD		16									1.13	2.00	Sandy Fat Clay
	4	4.0	6.0	UD		17	115	50	20	30	61		1.65	0.43	1.00	1.13	Sandy Fat Clay
	5	6.0	8.0	UD		25									0.75	1.13	Sandy Fat Clay
	6	8.0	10.0	UD		16		52	21	31	81				1.25	2.00	Fat Clay
	7	10.0	12.0	UD		16									2.00	2.25	Fat Clay
	8	12.0	14.0	UD		21	112						1.54	1.01	1.13	1.50	Fat Clay
	9	14.0	16.0	UD		21									1.88	2.25	Fat Clay
	10	16.0	18.0	UD		23									2.00	2.25	Fat Clay
	11	18.0	20.0	UD		21	106	56	22	34	94		1.52	1.44	2.13	2.25	Fat Clay
	12	23.0	25.0	UD		20		26	18	8	73				0.20	0.75	Lean Clay
	13	28.0	30.0	UD		28									2.13	2.25	Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-10

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub–Project II Design
WBS No. M–000287–0002–3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U–U)		TORVANE	POCKET PENE–TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB–11	2	0.7	2.0	UD		28									0.40	0.25	Fat Clay
	3	2.0	4.0	UD		27	102	60	24	36	72		0.41	0.29	0.50	0.25	Fat Clay
	4	4.0	6.0	UD		21									0.50	0.25	Sandy Lean Clay
	5	6.0	8.0	UD		25		47	20	27	70				0.50	0.25	Sandy Lean Clay
	6	8.0	10.0	UD		13											Sand
	7	10.5	12.0	SS	9	11					10						Sand
	8	12.0	14.0	UD		11											Sand
	9	14.0	16.0	UD		18	112	29	17	12	56		0.77	1.15	0.45	0.50	Sandy Lean Clay
	10	16.0	18.0	UD		21									0.20	0.25	Sandy Lean Clay
	11	18.5	20.0	SS	19	19					43						Silty Sand
	12	23.5	25.0	SS	42	18					24						Silty Sand
	13	28.0	30.0	UD		28									1.50	2.13	Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx–DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B–11

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-12B	2	0.6	2.0	UD		21									1.25	1.00	Fat Clay
	3	2.0	4.0	UD		19		55	20	35	73				1.25	1.13	Fat Clay
	4	4.0	6.0	UD		17	114	52	21	31	70		1.48	0.43	1.75	1.75	Sandy Fat Clay
	5	6.0	8.0	UD		20									1.38	1.13	Sandy Fat Clay
	6	8.0	10.0	UD		17									1.88	1.75	Lean Clay
	7	10.0	12.0	UD		18		46	20	26	79				1.63	1.38	Lean Clay
	8	12.0	14.0	UD		19									1.25	1.25	Lean Clay
	9	14.0	16.0	UD		19	114						1.17	1.15	1.63	1.88	Lean Clay
	10	16.0	18.0	UD		19									0.45	0.75	Lean Clay
	11	18.5	20.0	SS	23	22					54						Sandy Silt
	12	23.5	25.0	SS	52	19											Silty Sand
	13	28.5	30.0	SS	78	21											Silty Sand
	14	33.5	35.0	SS	100/5.0"	23											Silty Sand
	15	36.0	38.0	UD		26	104	56	22	34	100		0.73	2.74	1.88	2.00	Fat Clay
	16	38.0	40.0	UD		23									1.25	1.13	Fat Clay
	17	41.5	43.0	SS	59	24					51						Sandy Silt
	18	43.5	45.0	SS	48	23											Sandy Silt

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-12B

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-13B	2	0.6	2.0	UD		19									0.75	1.00	Lean Clay
	3	2.0	4.0	UD		19									0.63	1.00	Lean Clay
	4	4.0	6.0	UD		19	109	47	20	27	76		0.91	0.43	1.00	0.88	Lean Clay
	5	6.0	8.0	UD		22									0.60	0.75	Lean Clay
	6	8.0	10.0	UD		28									0.70	0.63	Lean Clay
	7	10.0	12.0	UD		36	88	76	28	48	94		0.26	0.86	0.75	0.63	Fat Clay
	8	12.0	14.0	UD		30									1.00	1.25	Fat Clay
	9	14.0	16.0	UD		28									1.25	1.50	Fat Clay
	10	16.0	18.0	UD		17									0.40	0.50	Lean Clay
	11	18.0	20.0	UD		14	121	28	14	14	79		0.50	1.44	0.75	0.75	Lean Clay
	12	23.0	25.0	UD		27									1.25	1.63	Fat Clay
	13	28.0	30.0	UD		32									0.60	0.63	Fat Clay
	14	33.0	35.0	UD		28	97	71	26	45	99		0.44	2.52	1.75	2.13	Fat Clay
	15	38.0	40.0	UD		26									2.00	2.25	Fat Clay
	16	43.0	45.0	UD		32									2.00	2.00	Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-13B

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
CB-149 (CB-149P)	3	0.0	2.0	UD		19											Lean Clay
	4	2.0	4.0	UD		19									1.00	0.75	Lean Clay
	5	4.0	6.0	UD		20	107	49	20	29	77		0.73	0.43	0.75	0.38	Lean Clay
	6	6.0	8.0	UD		18									1.25	1.00	Lean Clay
	7	8.0	10.0	UD		30	94	81	29	52	86		0.80	0.72	1.00	0.63	Fat Clay
	8	10.0	12.0	UD		33									0.80	0.75	Fat Clay
	9	12.0	14.0	UD		16									1.75	1.38	Lean Clay
	10	14.0	16.0	UD		14	120						1.89	1.15	2.38	2.25	Lean Clay
	11	16.0	18.0	UD		15									1.50	2.25	Lean Clay
	12	18.0	20.0	UD		17	113	34	17	17	72		1.20	1.44	1.38	1.75	Lean Clay
	13	22.5	24.0	SS	22	17											Sandy Silt
	14	24.5	26.0	SS	20	19											Sandy Silt
	15	28.5	30.0	SS	36	22					43						Silty Sand
	16	33.5	35.0	SS	31	20											Silty Sand
	17	38.5	40.0	SS	40	19											Silty Sand
	18	43.0	45.0	UD		28									1.75	2.00	Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-14B

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Wirt Road Drainage and Paving Sub-Project II Design
WBS No. M-000287-0002-3
Houston, Texas
PROJECT NUMBER: 1140197101

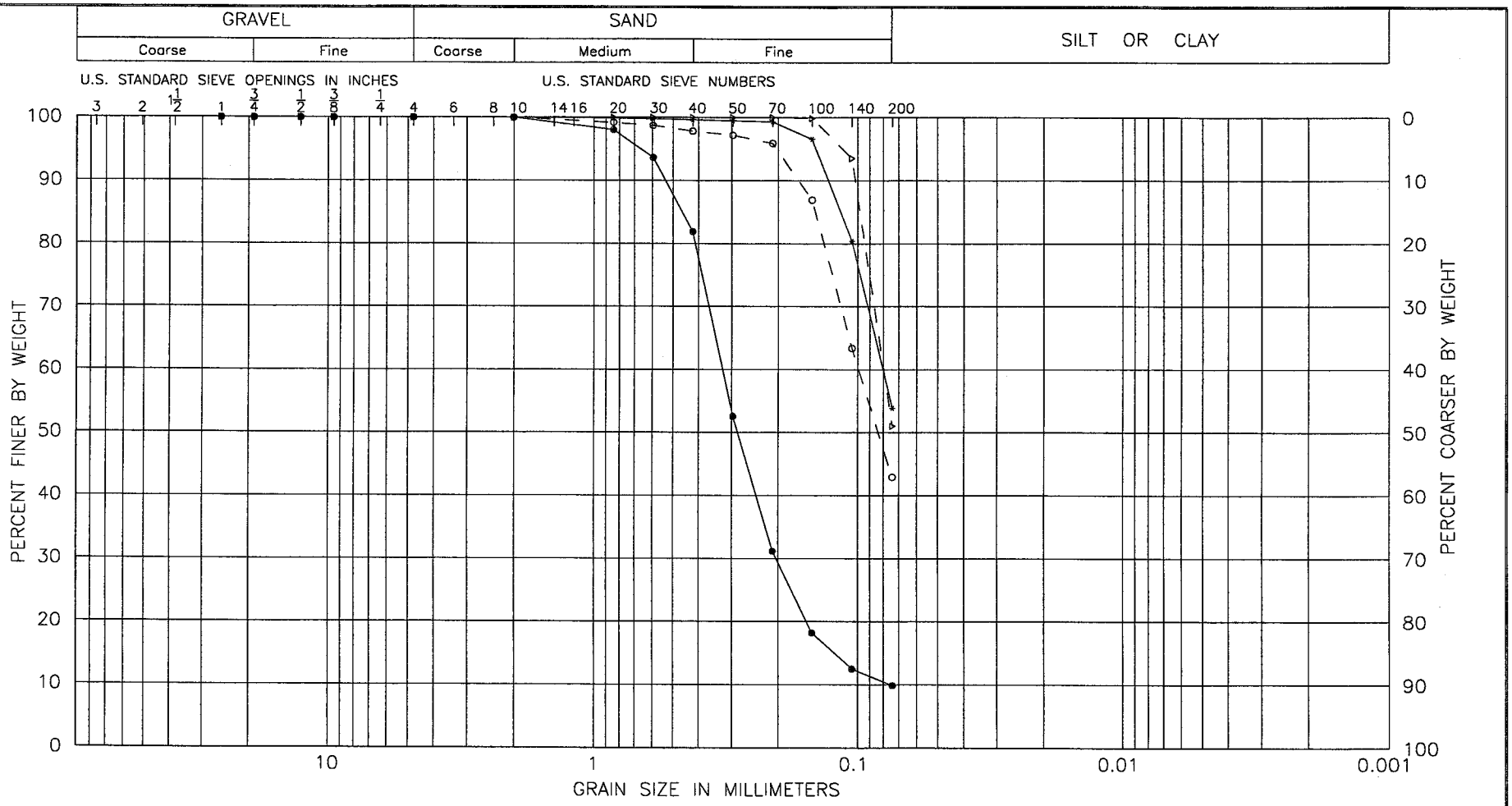
BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-15	2	0.9	2.0	UD		24											Lean Clay
	3	2.0	4.0	UD		20									0.75	0.63	Lean Clay
	4	4.0	6.0	UD		22	103	48	18	30	78		0.77	0.43	1.00	1.50	Lean Clay
	5	6.0	8.0	UD		24									0.60	0.75	Lean Clay
	6	8.0	10.0	UD		23									0.50	0.50	Lean Clay
	7	10.0	12.0	UD		24	98	35	15	20	78		0.39	0.86	0.25	0.38	Lean Clay
	8	12.0	14.0	UD		16									1.00	2.25	Lean Clay
	9	14.0	16.0	UD		17									1.00	1.88	Lean Clay
	10	16.5	18.0	SS	49	16					72						Clayey Sand
	11	18.0	20.0	UD		31									1.38	1.88	Fat Clay
	12	23.0	25.0	UD		25	95	30	18	12	85		0.27	1.80	0.15		Lean Clay
	13	25.5	27.0	SS	34	21											Sand
	14	28.5	30.0	SS	23	23											Sand
	15	33.5	35.0	SS	44	21					6						Sand
	16	38.5	40.0	SS	41	30											Fat Clay
	17	40.0	42.0	UD		30	94	74	27	47	99		1.59	3.02	2.00	2.00	Fat Clay
	18	43.0	45.0	UD		29									1.50	1.75	Fat Clay
	19	48.0	50.0	UD		24		23	20	3	99				0.15	0.50	Silt
	20	51.5	53.0	SS	27	26											Silt

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-15

Job No. 1140197101



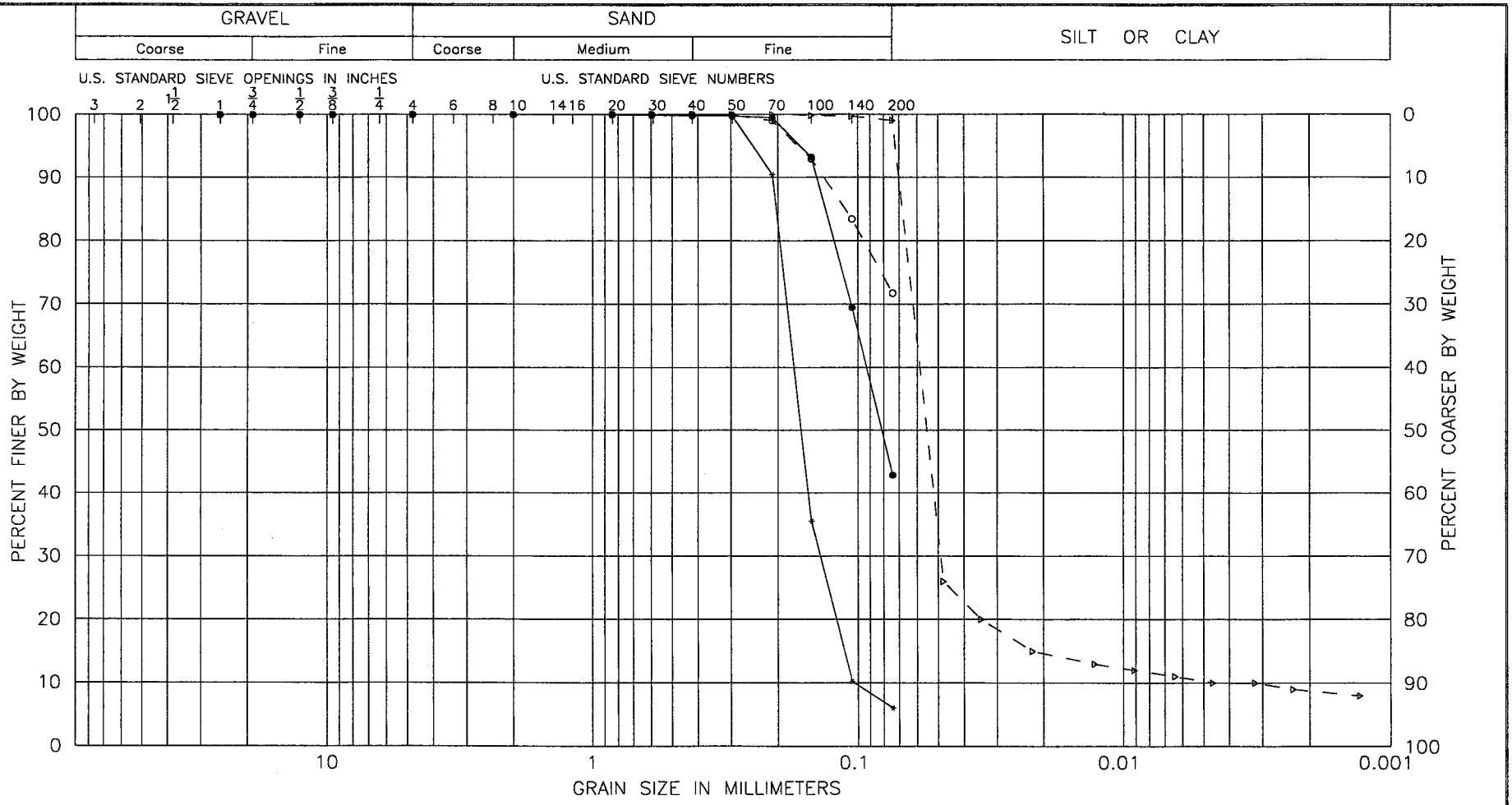
LEGEND	BORING NO.	SAMPLE NO.	DEPTH FT.	SAMPLE DESCRIPTION
●—●—●	GB–11	S–6	10.5–12.0	Brown fine sand w/silt
○—○—○	GB–11	S–10	18.5–20.0	Brown silty sand
×—×—×	GB–12B	S–10	18.5–20.0	Gray and brown sandy silt w/clay and sand seams
▷—▷—▷	GB–12B	S–16	41.5–43.0	Red sandy silt

GRAIN SIZE DISTRIBUTION CURVES

Geotest Engineering, Inc.

FIGURE B–16

Job No. 1140197101



LEGEND	BORING NO.	SAMPLE NO.	DEPTH FT.	SAMPLE DESCRIPTION
●●●●●	GB-14B	S-13	28.5-30.0	Gray and brown silty sand w/clay seams
o-o-o-o	GB-15	S-9	16.5-18.0	Gray clayey sand
x-x-x-x	GB-15	S-14	33.5-35.0	Brown fine sand w/silt
▷▷▷▷	GB-15	S-18	48.0-50.0	Reddish brown silt

GRAIN SIZE DISTRIBUTION CURVES

Geotest Engineering, Inc.

FIGURE B-17

APPENDIX C

Piezometer Abandonment Reports

STATE OF TEXAS WELL REPORT for Tracking #349211

Owner:	**Geotest Engineering, Inc.**	Owner Well #:	**GB - 1 -PZ**
Address:	**5600 Bintliff Dr.** **Houston , TX 77036**	Grid #:	**65-13-4**
Well Location:	**Wirt & Hammerly** **Houston , TX 77055**	Latitude:	**29° 48' 39" N**
Well County:	**Harris**	Longitude:	**095° 29' 59" W**
Elevation:	**No Data**	GPS Brand Used:	**Lowrance XOG**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Date: Started: **10/3/2013**
Completed: **10/3/2013**

Diameter of Hole: Diameter: **5 in From Surface To 25 ft**

Drilling Method: Other: **Auger**

Borehole Completion: **Straight Wall**

Annular Seal Data: 1st Interval: **From 0 ft to 2 ft with 1 Portland (#sacks and material)**
2nd Interval: **From 2 ft to 5 ft with 1 Bentonite (#sacks and material)**
3rd Interval: **No Data**
Method Used: **Poured**
Cemented By: **Dempsey Gearen Jr.**
Distance to Septic Field or other Concentrated Contamination: **na ft**
Distance to Property Line: **na ft**
Method of Verification: **No Data**
Approved by Variance: **No Data**

Surface Completion: **Alternative Procedure Used**

Water Level: Static level: **17.5 ft. below land surface on 10/3/2013**
Artesian flow: **No Data**

Packers: **Homemade 5'**

Plugging Info: Casing or Cement/Bentonite left in well: **No Data**

Type Of Pump: **Other: none**
Depth to pump bowl: **(No Data) ft**

Well Tests: **Bailer**
Yield: **.25 GPM with (No Data) ft drawdown after (No Data) hours**

Water Quality: Type of Water: **good**
Depth of Strata: **1 ft.**
Chemical Analysis Made: **No**
Did the driller knowingly penetrate any strata which contained undesirable constituents: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.

Company Information: **Gearen Drilling**
32126 Rochen Rd.
Waller , TX 77484

Driller License Number:	**2836**
Licensed Well Driller Signature:	**Dempsey Gearen Jr.**
Registered Driller Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Comments:	**Piezometer**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking number (Tracking **#349211**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

DESC. & COLOR OF FORMATION MATERIAL

From (ft) To (ft) Description
0 - 2.5" Asphalt
2.5" - 8.5" Concrete
8.5" - 8' G Sandy Clay
8 - 12 Red & G Clay
12 - 14 Yellow & G Si Clay
14 - 22 R & G Clay
22 - 23 R Clay Sand
32 - 25 R Si Clay & Clay Si
Piezometer

CASING, BLANK PIPE & WELL SCREEN DATA

Dia. New/Used Type Setting From/To
2 New PVC Blank 0 - 15 Sch. 40
2 New PVC Slotted 15 - 25 .010

STATE OF TEXAS PLUGGING REPORT for Tracking #93504

Owner:	**Geotest Engineering, Inc.**	Owner Well #:	**GB - 1 - PZ**
Address:	**5600 Bintliff Dr. Houston , TX 77036**	Grid #:	**65-13-4**
Well Location:	**Wirt & Hammerly Houston , TX 77055**	Latitude:	**29° 48' 39" N**
Well County:	**Harris**	Longitude:	**095° 29' 59" W**
		GPS Brand Used:	**Lowrance XOG**
Well Type:	**Monitor**		

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller:	**Dempsey Gearen Jr.**
Driller's License Number of Original Well Driller:	**2836**
Date Well Drilled:	**10/3/2013**
Well Report Tracking Number:	**349211**
Diameter of Borehole:	**5 inches**
Total Depth of Borehole:	**25' feet**
Date Well Plugged:	**3/6/2014**
Person Actually Performing Plugging Operation:	**Dempsey Gearen Jr.**
License Number of Plugging Operator:	**2836**
Plugging Method:	**Tremmie pipe cement from bottom to top.**
Plugging Variance #:	**No Data**
Casing Left Data:	1st Interval: **0 inches diameter, From 0 ft to (No Data) ft** 2nd Interval: **No Data** 3rd Interval: **No Data**
Cement/Bentonite Plugs Placed in Well:	1st Interval: **From 0 ft to 25 ft; Sack(s)/type of cement used: 2 1/2 Portland** 2nd Interval: **No Data** 3rd Interval: **No Data** 4th Interval: **No Data** 5th Interval: **No Data**
Certification Data:	The plug installer certified that the plug installer plugged this well (or the well was plugged under the plug installer's direct supervision) and that each and all of the statements herein are true and correct. The plug installer understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.
Company Information:	**Gearen Drilling 32126 Rochen Rd. Waller , TX 77484**
Plug Installer License Number:	**2836**

Licensed Plug Installer Signature:	**Dempsey Gearen Jr.**
Registered Plug Installer Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Plugging Method Comments:	**No Data**

Please include the plugging report's tracking number (Tracking **#93504**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

STATE OF TEXAS WELL REPORT for Tracking #349199

Owner:	**Geotest Engineering, Inc.**	Owner Well #:	**GB - 9 -PZ**
Address:	**5600 Bintliff Dr. Houston , TX 77036**	Grid #:	**65-13-4**
Well Location:	**Kiburn Houston , TX 77055**	Latitude:	**29° 48' 48" N**
Well County:	**Harris**	Longitude:	**095° 29' 00" W**
Elevation:	**No Data**	GPS Brand Used:	**Lowrance XOG**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Date:	Started: **10/1/2013** Completed: **10/1/2013**
Diameter of Hole:	Diameter: **5 in From Surface To 20 ft**
Drilling Method:	Other: **Auger**
Borehole Completion:	**Straight Wall**
Annular Seal Data:	1st Interval: **From 0 ft to 8.5 ft with 2 Portland & Be (#sacks and material)** 2nd Interval: **No Data** 3rd Interval: **No Data** Method Used: **Poured** Cemented By: **Dempsey Gearen Jr.** Distance to Septic Field or other Concentrated Contamination: **na ft** Distance to Property Line: **na ft** Method of Verification: **No Data** Approved by Variance: **No Data**
Surface Completion:	**Alternative Procedure Used**
Water Level:	Static level: **18 ft. below land surface on 10/1/2013** Artesian flow: **No Data**
Packers:	**Homemade 8.5'**
Plugging Info:	Casing or Cement/Bentonite left in well: **No Data**
Type Of Pump:	**Other: none** Depth to pump bowl: **(No Data) ft**
Well Tests:	**Bailer** Yield: **.25 GPM with (No Data) ft drawdown after (No Data) hours**
Water Quality:	Type of Water: **good** Depth of Strata: **1 ft.** Chemical Analysis Made: **No** Did the driller knowingly penetrate any strata which contained undesirable constituents: **No**
Certification Data:	The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.
Company Information:	

	Gearen Drilling **32126 Rochen Rd.** **Waller , TX 77484**
Driller License Number:	**2836**
Licensed Well Driller Signature:	**Dempsey Gearen Jr.**
Registered Driller Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Comments:	**Piezometer**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Please include the report's Tracking number (Tracking **#349199**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

DESC. & COLOR OF FORMATION MATERIAL

From (ft)	To (ft)	Description
0	**3"**	**Asphalt**
3"	**17"**	**Base**
17"	**14'**	**Dk G Sa Cl**
14'	**16'**	**Rd G Cl**
16	**20**	**Rd G Sa Cl**
Piezometer		

CASING, BLANK PIPE & WELL SCREEN DATA

Dia.	New/Used	Type	Setting From/To
2	**New**	**PVC Blank**	**0 - 10 Sch. 40**
2	**New**	**PVC Slotted**	**10 - 20 .010**

STATE OF TEXAS PLUGGING REPORT for Tracking #93506

Owner:	**Geotest Engineering, Inc.**	Owner Well #:	**GB - 9 - PZ**
Address:	**5600 Bintliff Dr. Houston , TX 77036**	Grid #:	**65-13-4**
Well Location:	**Kilburn Houston , TX 77055**	Latitude:	**29° 48' 48" N**
Well County:	**Harris**	Longitude:	**095° 29' 00" W**
		GPS Brand Used:	**Lowrance XOG**
Well Type:	**Monitor**		

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller:	**Dempsey Gearen Jr.**
Driller's License Number of Original Well Driller:	**2836**
Date Well Drilled:	**12/1/2013**
Well Report Tracking Number:	**349199**
Diameter of Borehole:	**5" inches**
Total Depth of Borehole:	**20' feet**
Date Well Plugged:	**3/6/2014**
Person Actually Performing Plugging Operation:	**Dempsey Gearen Jr.**
License Number of Plugging Operator:	**2836**
Plugging Method:	**Tremmie pipe cement from bottom to top.**
Plugging Variance #:	**No Data**
Casing Left Data:	1st Interval: **0 inches diameter, From 0 ft to (No Data) ft** 2nd Interval: **No Data** 3rd Interval: **No Data**
Cement/Bentonite Plugs Placed in Well:	1st Interval: **From 0 ft to 20 ft; Sack(s)/type of cement used: 2 Portland** 2nd Interval: **No Data** 3rd Interval: **No Data** 4th Interval: **No Data** 5th Interval: **No Data**
Certification Data:	The plug installer certified that the plug installer plugged this well (or the well was plugged under the plug installer's direct supervision) and that each and all of the statements herein are true and correct. The plug installer understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.
Company Information:	**Gearen Drilling 32126 Rochen Rd. Waller , TX 77484**
Plug Installer License Number:	**2836**

Licensed Plug Installer Signature:	**Dempsey Gearen Jr.**
Registered Plug Installer Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Plugging Method Comments:	**No Data**

Please include the plugging report's tracking number (Tracking **#93506**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

STATE OF TEXAS WELL REPORT for Tracking #381676

Owner:	**Geotest Engineering**	Owner Well #:	**GB 14 B-1971**
Address:	**5600 Bintliff Road Houston , TX 77036**	Grid #:	**65-13-4**
Well Location:	**7846 Wirt Road Houston , TX**	Latitude:	**29° 48' 13" N**
Well County:	**Harris**	Longitude:	**095° 29' 06" W**
Elevation:	**No Data**	GPS Brand Used:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Date: Started: **6/2/2014** Completed: **6/2/2014**

Diameter of Hole: Diameter: **8.25 in From Surface To 45 ft**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Open Hole**

Annular Seal Data: 1st Interval: **No Data** 2nd Interval: **No Data** 3rd Interval: **No Data**

Surface Completion: **No Data**

Water Level: Static level: **25 ft. below land surface on (No Data)** Artesian flow: **No Data**

Packers: **No Data**

Plugging Info: Casing or Cement/Bentonite left in well: **No Data**

Type Of Pump: **No Data**

Well Tests: **No Data**

Water Quality: Type of Water: **No Data** Depth of Strata: **No Data** Chemical Analysis Made: **No Data** Did the driller knowingly penetrate any strata which contained undesirable constituents: **No Data**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.

Company Information: **Envirotech Drilling Services 2718 S. Brompton Drive Pearland , TX 77584**

Driller License Number: **58171**

Licensed Well Driller Signature:	**Jaime Vasquez**
Registered Driller Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Comments:	**No Data**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking number (Tracking **#381676**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

DESC. & COLOR OF FORMATION MATERIAL

From (ft) To (ft) Description
0 to 8- Gray, sandy clay.
8 to 12- Clay.
12 to 22- Gray, sandy clay.
22 to 28.5- Gray clay.
28.5 to 41- Gray sand.
41 to 45- Red clay.

CASING, BLANK PIPE & WELL SCREEN DATA

Dia. New/Used Type Setting From/To
2 in New PVC Casing 0 to 20
2 in New PVC Screen 20 to 45

STATE OF TEXAS PLUGGING REPORT for Tracking #98090

Owner:	**Geotest Engineering**	Owner Well #:	**GB-14**
Address:	**5600 Bintliff Road Houston , TX 77036**	Grid #:	**65-13-4**
Well Location:	**7846 Wirt Road Houston , TX**	Latitude:	**29° 48' 13" N**
Well County:	**Harris**	Longitude:	**095° 29' 06" W**
		GPS Brand Used:	**No Data**

Well Type: **Monitor**

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller: **Jaim Vasquez**

Driller's License Number of Original Well Driller: **58171**

Date Well Drilled: **6/2/2014**

Well Report Tracking Number: **381676**

Diameter of Borehole: **8.25 in inches**

Total Depth of Borehole: **45 ft feet**

Date Well Plugged: **7/23/2014**

Person Actually Performing Plugging Operation: **Jaime Vasquez**

License Number of Plugging Operator: **58171**

Plugging Method: **Pour in 3/8 bentonite chips when standing water in well is less than 100 feet in depth, cement top 2 feet.**

Plugging Variance #: **No Data**

Casing Left Data: 1st Interval: **No Data**
2nd Interval: **No Data**
3rd Interval: **No Data**

Cement/Bentonite 1st Interval: **No Data**

Plugs Placed in Well:	2nd Interval: **No Data** 3rd Interval: **No Data** 4th Interval: **No Data** 5th Interval: **No Data**

Certification Data:	The plug installer certified that the plug installer plugged this well (or the well was plugged under the plug installer's direct supervision) and that each and all of the statements herein are true and correct. The plug installer understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.
Company Information:	**Envirotech Drilling Services** **2718 S. Brompton Drive** **Pearland , TX 77584**
Plug Installer License Number:	**58171**
Licensed Plug Installer Signature:	**Jaime Vasquez**
Registered Plug Installer Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Plugging Method Comments:	**No Data**

Please include the plugging report's tracking number (Tracking #**98090**) on your written request.

Texas Department of Licensing & Regulation
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Austin, TX 78711
(512) 463-7880