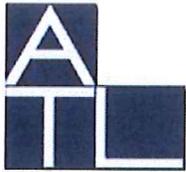


**FINAL REPORT  
GEOTECHNICAL INVESTIGATION  
NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS  
SUNSET BOULEVARD, UNIVERSITY BOULEVARD  
AND WESTHEIMER STREET  
WBS NO. R-002011-0055-3  
HOUSTON, TEXAS  
CONSTRUCTION WBS NO. R-002011-0065-4**

**PREPARED BY  
ASSOCIATED TESTING LABORATORIES, INC.  
HOUSTON, TEXAS**

**ATL REPORT NO. G14-109  
April 25, 2014**



ESTABLISHED 1959

**TBPE Firm No. 4560**

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April 25, 2014

ATL Job No: G14-109

Amani Engineering, Inc.  
8313 Southwest Freeway, Suite 350  
Houston, Texas 77074

Attention: Mr. Mahesh Dutta, P.E.

Reference: Geotechnical Investigation Report  
Proposed Neighborhood Sewer Systems Improvements  
Sunset Boulevard, University Boulevard and Westheimer Street  
WBS No. R-002011-0055-3  
Houston, Texas

Dear Mr. Duta:

We have completed the report for the geotechnical investigation for the above-referenced project. Our findings, geotechnical engineering analyses and recommendations are presented in this report.

It has been a pleasure working with you on this project. Should you have any questions concerning this project work, please call us at (713) 748-3717.

Sincerely,

**ASSOCIATED TESTING LABORATORIES, INC.**

Peng Sia Tang, P. E.  
Manager, Geotechnical Services



Jasbir Singh, P.E.  
President

**GEOTECHNICAL INVESTIGATION**  
**NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS**  
**SUNSET BOULEVARD, UNIVERSITY BOULEVARD**  
**AND WESTHEIMER STREET**  
**HOUSTON, TEXAS**

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**GEOTECHNICAL INVESTIGATION**  
**NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS**  
**SUNSET BOULEVARD, UNIVERSITY BOULEVARD**  
**AND WESTHEIMER STREET**  
**HOUSTON, TEXAS**

**EXECUTIVE SUMMARY**

**Associated Testing Laboratories, Inc. (ATL)** has completed the geotechnical study for the proposed Neighborhood Sanitary Sewer Systems Improvements project along the project alignments shown in Figures 1a and 1b and Figures 2a through 2c. The project entails constructing new 8-, 12 and 15-inch diameter sanitary sewers to replaced existing ones along the project alignments, and restoring/resurfacing existing pavements, and replacing existing curbs and gutters, sidewalks and driveways. The new sanitary sewers will be installed at depths ranging from about 8 to 14 feet below the existing grade.

Both open cut/trenching and trenchless installation technique will be employed. The subsurface conditions, investigated by 20 soil borings to a depth of 15 to 25 feet below existing grade along the project alignments, consists mostly of stiff to hard Lean Clays (CL) and Fat Clays (CH), with local areas with soft to firm consistency. A stratum of loose to medium dense Silty Sand (SM) exists in the following borings: B-3 (10' to 16'); B-4 (8' to 18'); B-5 (14' to 16'); B-7 (12' to 16'); B-8 (14' to 15.5'); and, in B-11 (12' to 15.5'). Detailed subsurface soils and stratigraphy are shown in the individual boring logs in Appendix 3 and in the Boring Log Profiles in Figures 4a through 4f.

Free water was encountered during drilling operation in Borings B-1 through B-5 and B-7 at a depth of about 18, 21, 14, 14, 14 and 16 feet below existing grade, respectively, and at a depth of about 13, 13, 12.5, 13.5, 13 and 14 feet, respectively at completion of drilling. Borings B-1, B-5, B-6 and B-14 were converted into Piezometer PZ-1 through PZ-4 after completion of drilling and soil sampling. Water level in PZ-1 through PZ-4 was measured after 24-hour at a depth of about 8, 10, 6 and 13 feet, respectively. Water level in PZ-1 through PZ-4 was measured after 7 days at a depth of about

8.5, 11, 6.5 and 14 feet, respectively. Water level in PZ-1 through PZ-4 was measured after 30 days at a depth of about 7, 8.5, 5 and 7.5 feet, respectively.

Our main geotechnical findings and recommendations are summarized below:

1. Light hydrocarbon-like odor was noted in soil samples recovered from Borings B-5, B-6 and B-8: B-5 (16.5” to 2 ft); B-6 (8” to 20 ft); B-8 (11” to 15.5 ft). No observable unusual staining or hydrocarbon-like odor was noted in the soil samples recovered from the remaining soil borings drilled in this geotechnical investigation. This information was forwarded to the Environmental Consultant of this project.
2. A preliminary fault evaluation based on review of available fault maps and literature review indicated that no documented geologic faults are located in the vicinity of the project alignments. Therefore, a Phase I Fault Study is not recommended.
3. Based on proposed flow line depths and the subsurface conditions (see Figures 4a through 4f), the sanitary sewer installation excavations will be advanced mostly in stiff to hard clays. However, granular soils and soft clays and soils with limited cohesion will likely or may be encountered at (but not limited to) locations identified in Table C and D in Section 5.1.2.
4. Based on the proposed invert elevation and the gathered groundwater information, the sanitary sewer construction excavations will have a possibility of encountering groundwater when the excavation depths exceed about 5 feet along project alignments, especially when the excavations are left open for more than 24 hours. It should be noted that groundwater level will fluctuate with the amount of precipitation prior to and during the construction.
5. Geotechnical parameters/information and construction recommendations for the proposed open cut/trenching and trenchless installation of the proposed sanitary sewers, as well as the pavement restoration and resurfacing are presented in Section 5.1.
6. Construction considerations are provided in Section 6 of this report.

**GEOTECHNICAL INVESTIGATION**  
**NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS**  
**SUNSET BOULEVARD, UNIVERSITY BOULEVARD**  
**AND WESTHEIMER STREET**  
**HOUSTON, TEXAS**

**1.0**     **INTRODUCTION**

**1.1**     **General**

The geotechnical investigation for the Neighborhood Sewer Systems Improvements along Sunset Boulevard, University Boulevard and Westheimer Street was authorized by Mr. H. Prasad Kolluru, P.E. of **Amani Engineers, Inc. (AEI)** on January 17, 2014, and with the acceptance of the **Associated Testing Laboratories, Inc., (ATL)** Proposal No. CP14-0101 (dated January 8, 2014). Project details were provided to ATL by Amani Engineers, Inc. This report includes results of the field investigation, laboratory testing, geotechnical engineering analysis and recommendations for the proposed neighborhood sewer systems improvements for this project.

**1.2**     **Location and Description of the Project**

The project alignments are located in a mainly residential neighborhood, a Site Vicinity Map showing the project alignments is presented in Figures 1a and 1b. ATL understands that as part of the City of Houston Neighborhood Sewer Systems Improvements (NSSI) Program, existing sanitary sewers will be abandoned and new ones will be constructed along the project alignments (using both open cut and trenchless techniques), and restoring/resurfacing existing pavements, and replacing existing curbs and gutters, sidewalks and driveways.

The alignments of the proposed improvements are summarized below:

| Project Name                                | Street               | From           | To          | Length, LF | Invert Depths, ft. | Proposed Diameter, in. |
|---|----------------------|----------------|-------------|------------|--------------------|------------------------|
| Westheimer Street<br>(Key Map 491 U & V)    | Westheimer Street    | South Post Oak | Westcreek   | 2,400      | 10 to 14           | 12                     |
| University Boulevard<br>(Key Map 532 C & G) | University Boulevard | Kirby          | Morningside | 4,225      | 5 to 8             | 15                     |
|   | Shakespeare          | Kirby          | Morningside |            | 5 to 10            | 8                      |
|   | Dryden               | Kirby          | Morningside |            | 5 to 10            | 8                      |
| Sunset Boulevard<br>(Key Map 532 C)         | Sunset Boulevard     | Kirby          | Morningside | 2800       | 5 to 8             | 8                      |
|   | Nottingham           | Kirby          | Morningside |            |                    |                        |

The proposed project alignments total approximately 9,425 linear feet and traverse streets in the Key Map 491 U and V, 532 C and G and 532 C, and are shown in Figures 2a through 2c. Photographs of the project sites were taken at the time of our site visit, and some are presented in Appendix 1.

### 1.3 Scope of Work

A geotechnical investigation was conducted to determine subsurface soil conditions along the proposed project alignments and to develop geotechnical engineering recommendations for the construction of new underground utilities consisting of sanitary sewers and pavement resurfacing and reconstruction. **Associated Testing Laboratories, Inc. (ATL)** has completed a subsurface exploration program for this project consisted of the following scope:

- Coring through existing pavements at borings located within streets with portland cement concrete (PCC) pavements (some with asphaltic concrete (AC) overlay) and asphaltic concrete (AC) pavements with cement-treated base using a pavement coring machine.
- Drilling and sampling a total of twenty (20) borings (Borings B-1 through B-20), to depths of

15, 20 and 25 feet below existing grade, for a total of 370 linear feet of drilling, and converting four borings into piezometers (totaling 85 linear feet) upon completion of drilling and sampling.

- Conducting laboratory tests on selected soil samples recovered from the soil borings.
- Developing boring logs and boring log profiles to present the general subsurface soil and groundwater conditions.
- Conducting a preliminary fault review of the project area based on review of available fault maps and literature.

Based on results from the field investigation, laboratory testing and gathered geological information, ATL performed geotechnical analyses to develop geotechnical recommendations for the proposed neighborhood sewer systems and other associated improvements.

## **2.0 SUBSURFACE INVESTIGATION PROGRAM**

The field investigation for this project consisted of drilling and sampling a total of twenty (20) soil borings and installing four (4) piezometers along the project alignments. The boring/piezometer locations and depths were approved during the proposal phase. The proposed borings and piezometers were selected based on criteria for borings and piezometers specified in City of Houston Department of Public Works and Engineering Design Manual, Chapter 11 “Geotechnical and Environmental Requirements”.

All 20 borings were located within existing portland cement concrete (PCC) pavements, some of which are overlaid with asphaltic concrete (AC). The existing PCC pavements were cored through using a pavement coring machine. The information from our boring/piezometer and depths and the coordinates (northing and easting) are presented in the table below.

**TABLE A: BORING AND PIEZOMETER INFORMATION**

| Boring |            | Piezometer |            | Location              | Northing      | Easting      |
|--------|------------|------------|------------|-----------------------|---------------|--------------|
| No.    | Depth, ft. | No.        | Depth, ft. |                       |               |              |
| B-1    | 25         | PZ-1       | 25         | Westheimer Street.    | 13,834,129.53 | 3,093,321.42 |
| B-2    | 25         | --         | --         | Westheimer Street.    | 13,834,090.37 | 3,092,896.11 |
| B-3    | 20         | --         | --         | Westheimer Street.    | 13,834,075.08 | 3,092,592.38 |
| B-4    | 20         | --         | --         | Westheimer Street.    | 13,834,016.20 | 3,092,011.47 |
| B-5    | 25         | PZ-2       | 25         | Westheimer Street.    | 13,833,974.74 | 3,091,525.81 |
| B-6    | 20         | PZ-3       | 20         | University Boulevard. | 13,824,965.25 | 3,106,236.09 |
| B-7    | 20         | --         | --         | University Boulevard. | 13,824,971.17 | 3,105,689.28 |
| B-8    | 15.5       | --         | --         | University Boulevard. | 13,824,956.69 | 3,105,327.66 |
| B-9    | 20         | --         | --         | Shakespeare Street.   | 13,824,682.71 | 3,106,258.44 |
| B-10   | 20         | --         | --         | Shakespeare Street.   | 13,824,664.97 | 3,105,769.20 |
| B-11   | 15.5       | --         | --         | Shakespeare Street.   | 13,824,647.38 | 3,105,325.05 |
| B-12   | 20         | --         | --         | Dryden Road.          | 13,824,371.47 | 3,106,258.98 |
| B-13   | 20         | --         | --         | Dryden Road.          | 13,824,372.45 | 3,105,835.34 |
| B-14   | 15         | PZ-4       | 15         | Dryden Road.          | 13,824,354.09 | 3,105,375.59 |
| B-15   | 15         | --         | --         | Sunset Boulevard.     | 13,827,835.28 | 3,106,221.02 |
| B-16   | 15         | --         | --         | Sunset Boulevard.     | 13,827,884.71 | 3,105,576.97 |
| B-17   | 15         | --         | --         | Sunset Boulevard.     | 13,827,880.07 | 3,105,225.78 |
| B-18   | 15         | --         | 25         | Nottingham Street.    | 13,827,599.23 | 3,106,141.66 |
| B-19   | 15         | --         | --         | Nottingham Street.    | 13,827,580.62 | 3,105,680.54 |
| B-20   | 15         | --         | --         | Nottingham Street.    | 13,827,560.25 | 3,105,178.19 |

Boring locations drilled in this geotechnical exploration are shown on Figures 2a through 2c. The boreholes were drilled dry to the bottom of the boring or to a depth where a borehole started caving in, after which rotary wash boring technique was carried out. In cohesive soils, undisturbed soil

samples were collected using a conventional 3-inch O.D. Shelby tube in accordance with ASTM D1587. Cohesionless soils were sampled using split spoon sampler in accordance with ASTM D1586. All soil samples were examined, classified and logged in the field. A representative portion of each sample was packed in containers to prevent moisture loss. All soil samples were properly labeled and subsequently transported to the ATL laboratory.

Boring B-1, B-5, B-6 and B-14 were converted into piezometer PZ-1 through PZ-4 upon the completion of drilling and sampling. The groundwater level information encountered in the boreholes during and at completion of drilling, and the water level in the piezometer after 24 hours, 7 and 30 days are presented in Table 2. The piezometers were pulled and plugged with cement-bentonite grout after the 30-day water level reading. The piezometer installation and plugging reports are presented in Appendix 2.

Upon completion of drilling, the borings where no piezometer was to be installed were backfilled using cement-bentonite grout using a tremie. The cored PCC pavements were patched using portland cement concrete, and the augered AC pavements were patched using cold-mixed asphaltic concrete.

All soil samples were classified according to Unified Soil Classification System (ASTM D-2487). The soil and groundwater information found in each boring are shown on the individual boring logs presented in Appendix 3. A Key to Log Terms and Symbols is also presented in Appendix 3.

### **3.0 LABORATORY TESTING PROGRAM**

Samples obtained from the field were again examined and classified in our laboratory by the geotechnical technician under the supervision of an engineer. Laboratory testing was performed on selected soil samples collected during the field investigation. The laboratory testing program included Atterberg Limits (ASTM D-4318), Density, Moisture Content (ASTM D-2216), Unconfined Compressive Strength (ASTM D-2166), Unconsolidated Undrained Triaxial (ASTM D-

2850) and Percent Finer Than No. 200 Sieve (ASTM D-1140) tests. The results of laboratory tests are presented in the boring logs in Appendix 3 and summarized in Table 3. Overall numbers and types of tests performed for this study for this project are presented below:

**TABLE B: SUMMARY OF LABORATORY SOIL TESTS**

| <b>TYPE OF TEST</b>               | <b>NUMBER OF TEST</b> |
|-----------------------------------|-----------------------|
| Dry Density                       | 36                    |
| Moisture Content                  | 185                   |
| Atterberg Limits                  | 46                    |
| Sieve Analysis #200 Sieve         | 43                    |
| Unconsolidated Undrained Triaxial | 5                     |
| Unconfined Compression            | 31                    |

**4.0 SUBSURFACE AND SITE CONDITIONS**

**4.1 Geology of Coastal Plain**

The proposed project area is located within the Gulf Coast Structural Province, a huge sedimentary basin containing several thousand feet of sediments. In general, these sediments consist of loose sands, silts and clays which slope gently toward the Gulf of Mexico.

The site is underlain mostly by the Beaumont Formation of Pleistocene age. This formation consists of over consolidated clays, silts and sands with some shell calcium carbonate and iron oxides. These formations are quite strong and extend to an approximate depth of 100 feet. The near surface materials are often weakened by the weathering process.

#### **4.2 Geologic Faults**

Among the geologic and geomorphological features in this region are sedimentary deposits broken by structure such as normal faults, salt domes, etc. The sedimentary deposits slope gently toward the Gulf of Mexico. They are broken by normal faults, most of which dip toward the Gulf and extend downward many thousands of feet. The earth movements that caused these faults took place within the last 50,000 years. In general, the regional faults in the Houston area trend parallel to the Gulf Coast. Only the local faults over the salt domes show a radial pattern associated with the upthrust of the salt mass. There are numerous faults and fault systems in the Greater Houston and surrounding area. The movements of many of these faults has been affected in recent history by area subsidence.

The subsidence is theorized to have been associated with the removal of oil and groundwater. As much as nine (9) feet of subsidence has occurred in the area east of Houston in the last 70 years. Conversion to surface water usage and the limiting of oil production has greatly reduced the subsidence rate in the area east of Houston.

Figure 3a shows the principal active faults in the Houston area. Figure 3b shows the active surface faults of the Houston area interpreted on LIDAR Imagery (Khan and Engelkemeir). Based on these maps, no documented geologic faults are located in the vicinity of the project alignments. Therefore, a Phase I Fault Study is not recommended.

#### **4.3 Subsurface Soil Stratigraphy and Geotechnical Characterization**

**Existing Pavement Material:** All 20 boring were located mostly within existing portland cement concrete (PCC) pavements, some with asphaltic concrete (AC) overlay. The existing PCC pavements and were cored through using a pavement coring machine. A summary of the existing pavement sections encountered at each boring location is presented in Table 1.

Based on the pavement information gathered from our field investigation, the existing PCC pavements (with gravel, crushed limestone, and some with crushed shell aggregate) at the boring locations have PCC thicknesses ranging from about 4.5 to 12.5 inches, a couple with about 0.5 to 1 inches of sand base, one with about 4 inches of stabilized soil base; some of the PCC pavements were overlaid with between about 1.5 to 3.5 inches of AC surface. At B-7, the pavement consists of about 2.5 inches of AC surface over about 5 inches of lightly cement-treated crushed shell. The actual pavement material and thicknesses in the field, at or near the boring locations, may differ from those described in the Table 1.

**Potentially Hazardous Materials:** Light hydrocarbon-like odor was noted in soil samples recovered from Borings B-5, B-6 and B-8:

| <u>Boring No.</u> | <u>Depth, ft.</u> |
|-------------------|-------------------|
| B-5               | 16.5" to 2        |
| B-6               | 8" to 20          |
| B-8               | 11" to 15.5       |

No observable unusual staining or hydrocarbon-like odor was noted in the soil samples recovered from the remaining soil borings drilled in this geotechnical investigation. This information was forwarded to the Environmental Consultant of this project.

**Subsurface Soil Stratigraphy:** Based on our soil borings, the subsurface soils along the project alignments consists generally of the following:

**Along Westheimer Street (Profile 4a):** The subsurface soils below the existing PCC pavements with AC overlay, as found in Borings B-1 through B-5, consist predominantly of firm to hard Lean Clays (CL) and Fat Clays (CH) to the bottom of borings at 20 to 25 feet below existing grade. In Boring B-1, a stratum of soft Fat Clay (CH) with sand and shell was found between depths of about 8 and 10

feet. In Borings B-3 and B-4, a stratum of loose to medium dense Silty Sand (SM) was found between depths of about 10 and 16 feet, and between 8 and 18 feet, respectively. The top 12 feet of the Fat Clays found in Boring B-1 are fill.

Along University Boulevard (Profile 4b): The subsurface soils below the existing pavements with AC overlay, as found in Borings B-6 through B-8, consist predominantly of firm to very stiff Lean Clays (CL) and Fat Clays (CH) to a depth of about 14 feet in Boring B-8, and to the bottom of Borings B-6 and B-7 at 20 feet below the existing grade. In Boring B-7, a stratum of loose to medium dense Silty Sand (SM) exists between depths of about 12 and 16 feet; in Boring B-8, loose Silty Sand was found below a depth of about 14 to the bottom of boring at 15.5 feet.

Along Shakespeare Street (Profile 4c): The subsurface soils below the existing PCC pavements, as found in Borings B-9 through B-11, consist predominantly of firm to hard Lean Clays (CL) and Fat Clays (CH) to a depth of about 12 feet in Boring B-11, and to the bottom of Borings B-9 and B-10 at 20 feet below the existing grade. In Boring B-11, a stratum of Silty Sand (SM) exists below a depth of about 12 feet to the bottom of boring at 15.5 feet.

Along Dryden Road (Profile 4d): The subsurface soils below the existing PCC pavements with AC overlay, as found in Borings B-12 through B-14, consist of stiff to hard Lean Clays (CL) and Fat Clays (CH) to the bottom of the borings at a depth of 15 to 20 feet below the existing grade.

Along Sunset Boulevard (Profile 4e): The subsurface soils below the existing PCC pavements with AC overlay, as found in Borings B-15 through B-17, consist of firm to very stiff Lean Clays (CL) and Fat Clays (CH) to the bottom of borings at 15 feet below the existing grade.

Along Nottingham Street (Profile 4f): The subsurface soils below the existing existing PCC pavements with AC overlay, as found in Borings B-18 through B-20, consist of stiff to hard Fat Clays (CH) and Lean Clays (CL) that exist to the bottom of borings at a depth of 15 feet below the

existing grade.

The detailed subsurface soils and stratigraphy are shown in the individual boring logs in Appendix 3 and in the Boring Log Profiles in Figures 4a through 4f. “CL”, “CH” and “SM” are classes of soils described in the Unified Soil Classification System.

The lean clays (CL) found in the soil borings have liquid limits ranging between about 25 and 45%, and plasticity indices (PI) ranging between about 10 and 27%. Clean non-expansive sandy lean clay soils (plasticity index between about 10 and 20) can be used as select fill in their present condition. The fat clay (CH) soils found in the soil borings have liquid limits ranging between about 51 and 77%, and plasticity indices ranging between about 36 and 54%. High plasticity fat and lean clays (PI>20) are not suitable for use as select fill in their present condition; however, these soils in their present conditions may be used as random fill. High plasticity clay soils, if clean, can be treated with appropriate amount of lime and used as select fill; a lime dosage of 6% by weight is recommended for preliminary estimate purposes, but lime vs. pH and/or lime vs. PI series tests should be conducted to determine the optimum lime dosage.

#### **4.4 Groundwater**

Free water was encountered during drilling operation in Borings B-1 through B-5 and B-7 at a depth of about 18, 21, 14, 14, 14 and 16 feet below existing grade, respectively, and at a depth of about 13, 13, 12.5, 13.5, 13 and 14 feet, respectively at completion of drilling. Borings B-1, B-5, B-6 and B-14 were converted into Piezometer PZ-1 through PZ-4 after completion of drilling and soil sampling. Water level in PZ-1 through PZ-4 was measured after 24-hour at a depth of about 8, 10, 6 and 13 feet, respectively. Water level in PZ-1 through PZ-4 was measured after 7 days at a depth of about 8.5, 11, 6.5 and 14 feet, respectively. Water level in PZ-1 through PZ-4 was measured after 30 days at a depth of about 7, 8.5, 5 and 7.5 feet, respectively.

The groundwater information encountered during and at the end of drilling in the boreholes, and in the piezometer after 24 hours, 7 and 30 days are presented in Table 2. It should be noted that the groundwater conditions will fluctuate according to the amount of precipitation and the environments conditions at the site.

Perched water table may exist in permeable sand/silt lenses/seams/layers within clay stratum that can form pathways for percolated and infiltrated water. The rate of flow of groundwater produced by these layers will depend upon the weather conditions such as locations of size and continuity of the permeable layers/seams/lenses, and the amount of precipitation and ambient temperature etc., at the time of construction.

## **5.0 GEOTECHNICAL ANALYSES AND RECOMMENDATIONS**

The proposed Neighborhood Sewer Systems Improvements project entails replacing existing sanitary sewers with new 8-, 12- and 15-inch diameters sanitary sewers along the project alignments (see Figure 2a through 2c), and restoring and resurfacing existing pavements, and replacing existing curbs and gutters, sidewalks and driveways.

### **5.1 Sanitary Sewer Construction**

The proposed sanitary sewers installation will involve both open cut/trenching and augering, one of many trenchless construction technique. Construction of access pits (auger pits) will likely involve open cut/trench excavation. Based on the preliminary project information, the proposed 8-, 12- and 15-inch diameter sanitary sewers are proposed to be installed at depths of about 5 to 14 feet below existing grade.

### 5.1.1 OSHA Soil Types

At the federal level, Occupational Safety and Health Act (OSHA) requires protective systems for all trenches exceeding 5 feet in depth. OSHA has developed a soil classification system to be used as a guideline in determining sloping and protective system requirements for trench excavations. This system has set forth a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing amounts of stability.

Stable Rock: Natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Type A: Cohesive soils with an unconfined compressive strength of 1.5 ton per square foot (tsf) or greater.

However, no soil is Type A if:

- The soil is fissured; or
- The soil is subject to vibrations from heavy traffic, pile driving, or similar effects; or
- The soil has been previously disturbed; or
- The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four (4) horizontal to one (1) vertical or greater; or
- The material is subject to other factors that would require it to be classified as a less stable material.

Type B:

- Cohesive soil with an unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf; or
- Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or
- Dry rock that is not stable; or

- Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

Type C:

- Cohesive soil with an unconfined compressive strength of 0.5 tsf or less; or
- Granular, including gravel, sand, and loamy sand; or
- Submerged soil or soil from which water is freely seeping; or
- Submerged rock that is not stable;. or
- Material is a sloped, layered system where the layers dip into the excavation on a slope of four (4) horizontal to one (1) vertical or steeper.

Based on the soil conditions from the borings and groundwater information from the borings and piezometers, ATL recommends classifying the top 5 feet of the onsite clay soils (CL/CH) that are soft to firm as OSHA Soil Type “C”, and those that are stiff to hard as OSHA Soil Type “B” for the determination of allowable maximum slope or selection and design of the protective system. All onsite clay soils below a depth of 5 feet shall be classified as OSHA Soil Type “C”. Fill soils, sands (SP/SM/SC), silts (ML), silty clays (CL-ML), clay soils containing a significant amount of sand/silt/gravel/calcareous nodules/other granular or low cohesion materials, and any soils subject to hydraulic pressure or vibrations shall be classified as OSHA Soil Type “C”.

**5.1.2 Open Cut/Trench Excavation**

The proposed sanitary sewers installation will involve construction using both open cut/trenching and trenchless techniques. Construction of auger pits will also involve open cut/trench excavation.

The approximate flow line depths and the subsurface conditions found in the soil borings are shown in the Boring Log Profiles on Figures 4a through 4f. Accordingly, the sanitary sewers installation excavation will be advanced mostly in stiff to hard clays (CL/CH), with local firm stratum. However,

locations identified in Table C and D below (but not limited to) will likely or may encounter granular soils and/or soft clays during the construction excavation:

**TABLE C: LOCATIONS WHERE SANITARY SEWERS INSTALLATION WILL LIKELY TO OR MAY ENCOUNTER SANDS**

| At/Near Boring | Approximate Maximum Invert Depth, ft. | Depth of Silty Sand Stratum |       |
|----------------|---------------------------------------|-----------------------------|-------|
|                |                                       | From                        | To    |
| B-3            | 14                                    | 10                          | 16    |
| B-4            | 14                                    | 8                           | 18    |
| B-5            | 14                                    | 14                          | 16*** |

- \* denotes bottom of boring
- \*\* denotes sands exist above the proposed flow line, and may be encountered during open cut and/or auger pit excavation
- \*\*\* denotes sands exist right below the flow line; the possibility that sands may be encountered during sanitary sewer installation exists depending on mode/size of excavation and/or potential for variations in soil stratigraphy and other factors
- \*\*\*\* denotes sands exist within one foot of the flow line; the possibility that sands may be encountered during sanitary sewer installation exists depending on mode/size of excavation and/or potential for variations in soil stratigraphy and other factors
- \*\*\*\*\* denotes sands exist within two foot of the flow line; the possibility that sands may be encountered during sanitary sewer installation exists depending on mode/size of excavation and/or potential for variations in soil stratigraphy and other factors

**TABLE D: LOCATIONS WHERE SANITARY SEWERS INSTALLATION WILL LIKELY TO OR MAY ENCOUNTER SOFT CLAYS**

| At/Near Boring | Approximate Maximum Invert Depth, ft. | Depth of Soft Clay Stratum |      |
|----------------|---------------------------------------|----------------------------|------|
|                |                                       | From                       | To   |
| B-1            | 14                                    | 8                          | 10** |

- \* denotes bottom of boring
- \*\* denotes soft clays exist above the proposed flow line, and may be encountered during open cut and/or auger pit excavation
- \*\*\* denotes soft clays exist right below the flow line; the possibility that soft clays may be encountered during sanitary sewer installation exists depending on mode/size of excavation and/or potential for variations in soil stratigraphy and other factors
- \*\*\*\* denotes soft clays exist within one foot of the flow line; the possibility that soft clays may be encountered during sanitary sewer installation exists depending on mode/size of excavation and/or potential for variations in soil stratigraphy and other factors
- \*\*\*\*\* denotes soft clays exist within two foot of the flow line; the possibility that soft clays may be encountered during sanitary sewer installation exists depending on mode/size of excavation and/or potential for variations in soil stratigraphy and other factors

The trench excavations can be made using cut slopes stepped back to stable slope, vertical cuts supported with sheet piles or other suitably designed retaining system. The excavation should be performed in accordance with the current OSHA 29 CFR Part 1926 of OSHA (Trench Safety System) and City of Houston Standard Specification, Section 02317 – Excavation and Backfill for Utilities.

Trenches should be provided with a proper trench support system. For the trench supporting system, the lateral pressures exerted on trench walls by stiff clays and cohesionless soils are presented in Figure 5a. Where soft to firm cohesive soils are encountered, the lateral pressure may be computed as given in Figure 5b. Where cohesive soils are underlain by sandy soils, the lateral pressure may be computed as given in Figure 5c. Temporary earth retaining walls are sometimes designed assuming an equivalent fluid pressure, in such cases, a lateral earth pressure equivalent imposed by a 84 PCF and 102 PCF fluid is recommended for clay soils above and below the water table, respectively; in sandy soils, a lateral earth pressure equivalent imposed by a 48 PCF and 85 PCF fluid is recommended for soils above and below the water table, respectively. Timber shoring as outlined in 29 CFR Part 1926 of OSHA recommendation may be used in the construction of trench supporting system. Trench boxes are commonly used for trench safety without shoring or bracing in open-cut excavations with vertical walls. In all cases, excavations should conform to OSHA guidelines.

Vehicular and Other Surcharge Loadings: Under normal loading conditions, a surcharge magnitude of  $q$  psf can result in lateral earth pressure of about  $0.5q$  in cohesive soils and about  $0.4q$  in sandy soils. All surcharge loads to a distance of 0.5 times the wall height should be considered. Due to the likely presence of roadways along the proposed pipeline alignment, the effects of vehicular traffic should be considered while designing the lateral supporting systems. The highway loading imposed by a H20 truck on a pipe under various depths of soil cover is presented in Figure 6. Figure 7 presents Boussinesq's equation for computing both horizontal and vertical stresses imposed by a surface surcharge load.

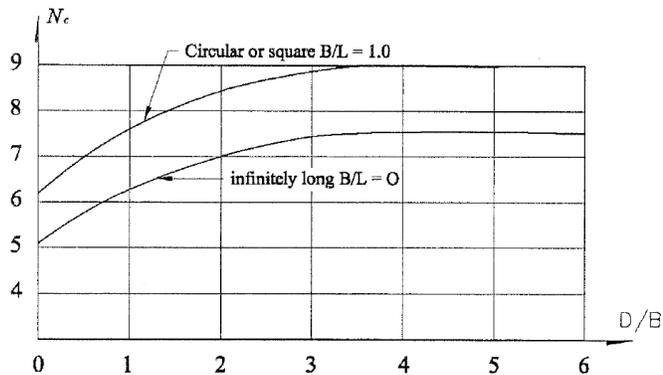
Stockpiling of excavated material should not be allowed near the excavation. Generally, a distance of at least one-half the excavation depth on both sides of the trench should be kept clear of any excavated material and height of stockpile should be limited to no more than 3 feet. If this is not possible due to space limitations then the retaining system design should be designed to take into account the surcharge loads.

In stable cohesive soils and where groundwater is lowered at least 3 feet below the excavation bottom, and if the sheeting terminates at the base of cut, the trench bottom stability can be evaluated in the following manner:

$$\text{Factor of safety } (F_s) = \frac{(N_c) C}{(\gamma) D + q}$$

Where,

$N_c$  = Bearing capacity factor that depends on dimensions of the excavation:



$$N_c \text{ rectangular} = (0.84 + 0.16B/L)N_c \text{ square}$$

$C$  = Average undrained shear strength of clay in failure zone beneath and surrounding base of cut, psf.

$\gamma'$  = Average effective unit weight of soils above trench bottom, pcf.

$q$  = Surface surcharge, psf.

$D$  = Depth of trench, ft.

$L$  = Length of trench, ft.

$B$  = Width of trench, ft.

If the factor of safety is less than 1.5, sheeting should be extended below the base of the cut to insure stability. The extended sheeting depth should be at least 1.5 times the trench width.

### 5.1.3 Groundwater Control

Groundwater information gathered from the soil borings during and at completion of drilling, as well as the 24-hour, 7 and 30 day water level readings in the piezometers were presented in Section 4.4. It should also be noted that groundwater levels will fluctuate as a result of seasonal rainfall variations.

The approximate flow line depths and the subsurface conditions as found in the soil borings are shown in the Boring Log Profiles on Figures 4a through 4f. Based on the proposed invert elevation and the groundwater information gathered during our field investigation, the sanitary sewer construction excavations will have a possibility to encounter groundwater when the excavation depths exceed about 5 feet along project alignments, especially when the excavations are left open for more than 24 hours. It should be noted that groundwater level will fluctuate with the amount of precipitation and the prevailing environmental conditions prior to and during construction.

Seepage rate in clay soils, if exists, will likely be low, but seepage rate in sands (if exists) will be higher. Groundwater control for excavation in cohesive soils up to a depth of 15 feet, if required, can usually be accomplished by sump and pump arrangements because the seepage is relatively slow. For dewatering below the depth of about fifteen (15) feet multi-staged pumps will be required. When excavations extend into water-bearing sands/silts, then dewatering using well points will be necessary. Criteria and requirements of City of Houston Standard Specification, Section 01578 – Control of Ground Water and Surface Water should be followed.

Seams and pockets of sand, silt, ferrous nodules, and calcareous nodules that may exist in cohesive soil layers may form communicative drainage paths for the groundwater, leading to potential water-bearing/perched water condition, and as a result, accelerated the rate of seepage. If such unexpected phenomenon is observed during the trench excavation and construction, appropriate measures, such as proper dewatering and shoring methods, may have to be implemented under supervision of a

Professional Civil/Geotechnical Engineer.

#### **5.1.4 Bedding Criteria**

For sewers, in areas where dry and stable subgrade is encountered, the trench bottom should be excavated to a minimum of 12 inches below the pipe placement depth. The trench bottom should be shaped to receive the pipe. The bedding details should be in accordance with the latest City of Houston Specifications. City of Houston Drawing No. 02317-04 should be used for the water line construction bedding and backfill; City of Houston Drawing No. 02447-01 should be used for auger pit and auger hole backfill for water line installed using augering technique. City of Houston Drawing No. 02317-03 should be used for the storm and sanitary sewer bedding and backfill for dry stable trench conditions; in areas where wet subgrade is encountered, City of Houston Drawing No. 02317-02 crushed stone foundation should be provided for the storm and sanitary sewer bedding. Soft and/or wet soils, if encountered at trench bottom, should be handled according to requirements specified in City of Houston Standard Specifications Section 02317, Subsection 3.07, A and B.

The embedment material between the pipe and the trench (bedding, haunching and initial backfill) may consist of cement-stabilized sand. Cement stabilized sand shall be placed in maximum 6 inches compacted lifts and compacted to at least 95 percent of the ASTM D 558 maximum dry density at a moisture content on the dry side of optimum.

#### **5.1.5 Trench Backfill**

The backfill should conform to standard City of Houston Specification, Section 02317 – Excavation and Backfill for Utilities. The backfill materials should conform to standard City of Houston Specification, Section 02320 – Utility Backfill Materials.

Trench zone backfill for water, storm and sanitary sewers shall be in accordance with COHSS

Section 02317, Section 3.09. Trench zone backfill under pavements or structures shall be placed to 12 inches below the bottom of the pavement structure, and compacted select fill shall be placed to the design pavement subgrade elevation.

Suitable onsite soils may consist of clean onsite soils (excluding ML, CL-ML, OH, OL type soils). Trench zone soils (including select fill) should be placed in maximum 12 inches loose lifts and compacted by vibratory equipment to a minimum of 95 percent of the maximum dry density at moisture content within zero and +5 percent of optimum as determined by ASTM D698. Cement stabilized sand shall be placed in maximum 12 inches compacted lifts and compacted to at least 95 percent of the ASTM D 558 maximum dry density at a moisture content on the dry side of optimum.

Trench zone backfill outside of pavements or other structures shall be placed in 9 inches maximum compacted lifts for clay soils and 12 inches maximum compacted lifts for granular soils, to a at least 90 percent of the maximum dry density as determined by Standard Proctor (ASTM D 698) method, at a moisture content that is conducive to achieving the required density.

#### **5.1.6 Loads on Buried Conduits**

The pipelines placed at depths under the ground will be subject to loads due to backfill (earth loads) and loads due to vehicular traffic (live loads).

Earth Load: The earth loads on a buried pipe can be calculated based on Marston's formulae (Ref: 1 through 3). The Marston's equation for buried conduits are generally given as:

$$W_d = C_d \gamma B_d^2 \quad \text{- for rigid pipes}$$

$$W_d = C_d \gamma B_d B_c \quad \text{- for flexible pipes}$$

Where,  $W_d$  = fill load, in pounds per linear foot of pipe

$C_d$  = Marston's soil coefficient

$\gamma$  = Unit weight of fill material, pcf (use 120 pcf)

$B_d$  = Width of trench at or slightly below top of pipe, in feet

$B_c$  = Width of pipe, in feet

The above equation is valid when the conduit is placed in a trench not wider than 2.0 to 3.0 times its outside width. Marston's soil coefficient  $C_d$  can be obtained from Table 4.  $K$  is the active earth pressure coefficient and  $\mu$  is the coefficient of sliding friction between the fill material and the sides of the trench. The height of fill and the horizontal width of trench should be considered from the top of the conduit. For the above equation for flexible pipes, an assumption of equal stiffness of soil and pipe has been used for its development and the equation generally gives a minimum load value. Hence, for flexible pipes including ones installed using trenchless construction, the earth loads may be conservatively calculated using the prism load theory. The prism load (Ref: 1 through 3) determines the weight of the soil column directly above the pipe and neglecting factors such as side wall friction and/or the cohesion of the soils. The prism load (in psf) may be calculated by multiplying the total unit weight of soil above the pipe (say 120 pcf) by the height,  $H$  (ft) of the soil fill. The prism load generally gives higher loading on the pipe and simulates the long term load imposed on the pipe.

Vehicular Load: For calculation of live loads, the width of the loaded area should be taken as the outside horizontal width of the pipe. Loading due to H20 vehicle should be considered for vehicular traffic. The estimated highway loading on a buried conduit imposed by a H20 truck, under various soil cover, is presented on Figure 6.

Surcharge Load: The stresses imposed by a surcharge load can be estimated using Boussinesq's Equation presented on Figure 7.

### **5.1.7 Trenchless Construction**

Segments of the proposed storm and sanitary sewers will be installed using trenchless technique. In general, trenchless installation may involve dry auger or slurry auger method. In the dry auger method, the casing is advanced by jacking while soils are excavated at the advancing end of the casing. In the slurry auger method, a small diameter pilot hole is first drilled between the access shafts, followed by reaming the pilot hole to full diameter by augering with slurry and installing casing or pipe by pull-back or jacking techniques. Applicable requirements of City of Houston Standard Specification, Section 02448 “Pipe and Casing Augering for Sewers”, shall be followed.

The proposed storm and sanitary sewers will be installed mostly in stiff to very stiff clays, in which case the excavation face are anticipated to be stable. However, silty sands and soft clays may be present at/near Boring B-3 through B-5 (but not limited to) as identified in Table C and D of Section 5.1.2. Groundwater conditions observed in open boreholes during the field investigation and in piezometers are presented in Section 4.4.

Excavation face in granular soils (sand/silt/gravel), soft clay soils or clay soils with slight/low plasticity or containing a significant amount of sands, and other caving soils, if encountered at/near the excavation face, will likely experience some degree of instability if the excavation face is unsupported, especially when these soils are saturated and/or subject to seepage pressure. In such cases, the following mitigating measures can be employed to improve the excavation stability:

- 1) Lower the groundwater table to at least 3 feet below the excavation bottom, and use colloidal drilling fluid (usually bentonite slurry) under controlled pressure to improve stability of the excavation.
- 2) In conditions where mitigation measures employed in Item 1 above cannot adequately provide the excavation stability, a casing can be installed at the same time of the slurry augering to provide stability of the excavation and reduce settlement at the surface.

- 3) In ground conditions where highly unstable soils and/or high inflow rate/pressure exist, microtunneling machine equipped with face shield and pressure-balancing colloidal drilling fluid may be used to maintain the stability of the excavation face.
- 4) Alternatively, open cut with shoring or other methods approved by City of Houston Department of Public Works and Engineering, along with groundwater control, and other stabilizing techniques such as chemical grouting, may be used at locations with difficult subsurface conditions or site constraints.

It is the responsibility of the Contractor to select a trenchless technique for the installation of the proposed storm and sanitary sewers by taking into account the soil types and stratigraphy and the groundwater conditions as found in the soil borings; the Contractor should have a work crew with experience in working with the selected trenchless construction technique in subsurface conditions similar to those found along the project alignments. If necessary, the Contractor may conduct additional geotechnical investigation to provide more detailed subsurface conditions.

Shoring systems for the auger pits may be designed based on the lateral earth pressures and other considerations discussed in Section 5.1.2.

#### **5.1.8 Effects of Trenchless Construction on Surrounding Structures**

A properly designed and controlled augering/trenchless construction operation can reduce immediate soil movement and subsidence to a tolerable level. Nevertheless, some ground loss should be expected during any augering/trenchless construction operations. With good construction techniques, ground loss can be mitigated to acceptable levels. Augering/trenchless construction below pavement and buried utilities may lead to some future settlement due to loosening of the subgrade or bedding condition. Large ground loss can result from uncontrolled flowing ground. Such conditions may occur if water-bearing sands or silts were encountered (not encountered in our soil borings, but may be present away from the borings drilled) in the excavations along the augering/trenchless

construction alignment. Measures to mitigate ground loss and other impacts of trenchless construction were addressed in Section 5.1.7.

The zone of influence of the augering/tunnel roughly extends to a distance equal to the invert depth on each side of the centerline of the augering/trenchless construction alignment. The amounts of settlement due to augering/trenchless construction are difficult to estimate. We anticipate that if good construction practices and control are exercised, the amount of ground settlements should be small. Establishing monitoring points on existing roadways, buildings and other important structures along the augering/trenchless construction alignments, and record coordinates and elevations prior to, during and after construction to monitor the amount of settlements or lateral movements due to augering/trenchless construction, and adjust augering/trenchless construction technique accordingly to mitigate the movements as necessary. Existing damages to the surrounding structures should be documented prior to starting of the augering/trenchless construction operations.

### ***5.1.9 Thrust Restraint***

Unbalanced thrust forces result from changes in flow directions and/or velocity in a pressurized pipe system (see Figure 8). The unbalanced thrust force and magnitude of thrust block force T is defined as follows:

$$T = 2 PA \text{ Sin } (\theta/2)$$

Where, P = internal fluid pressure (psi);  
A = cross-sectional area of pipe (in<sup>2</sup>);  
 $\theta$  = deflection angle of bend; and,  
T = thrust force (pounds)

Adequate restraint may be achieved by using thrust blocks, restraint joints, tie rods, or a combination of these systems. The unbalanced force acting on a pipe system is transmitted by a thrust block and

resisted by the bearing area between the pipe and the foundation soils. The unbalanced force acting on a pipe system with restraint joints are resisted by the frictional forces between the pipe/soil interface across the pipe sections restrained to act integrally.

Thrust Blocks: Thrust blocks are commonly used to increase the bearing area to allow the fittings to resist movement. The procedures for thrust block design are given in detail in AWWA M9 (Ref. 1). The required thrust block bearing area is calculated based on the bearing capacity of the soil:

$$\text{Required Bearing Area of Thrust Block} = T/F$$

Where,        T        =        thrust force (lb); and,  
                  F        =        safe bearing value for soil (lb/sq.ft)

A safe bearing value of 1,500 psf can be used for thrust block design bearing on compacted soils. This value includes a factor of safety of 3. The blocks must be placed against undisturbed or compacted soils and the face of the block must be perpendicular to the direction of and centered on the line of action of the thrust. Proper care must be exercised after construction to prevent failure due to any future excavations behind the blocks.

Restrained Joints: Restrained joints are typically used to avoid the uncertainties of thrust blocking like future excavations, etc. A detailed procedure for designing restrained joints including example calculations is outlined in the AWWA design manual M9 (Ref. 1). The following soil parameters are recommended for the design of the restrained joint(s):

Average unit weight of soil,  $\gamma$         = 120 pcf  
Cohesion of soils, C                        = 250/500/1000 psf    (for soft/firm/stiff clays)

For coefficient of friction between pipe and granular soils,  $f$ , use 0.25 for smooth PVC and steel pipes, and use 0.3 for concrete pipes.

### 5.1.10 Flexible Pipe Deflection

The deflection of a flexible pipe may be determined using the modified Iowa formula of Watkins and Spangler (Ref. 2) as given below:

$$\Delta x = D_1 [ KW r^3 / (EI + 0.061 E' r^3 ) ]$$

Here EI is the pipe wall stiffness (in-lb.), r is the radius (in.) and W is the load per unit of pipe length (lb/in. in. of pipe). Where prism loads (i.e. weight of soil above the pipe) are used for pipe earth loads, a deflection lag factor, D<sub>1</sub> of 1.0 may be used. Otherwise, deflection lag factor, D<sub>1</sub> of 1.5 should be used. The bedding constant, K, may be taken as 0.1. The following typical soil parameters are recommended:

| Soil Type                               | Soil Consistency      | Unit Weight, pcf | Shear Strength (c), psf or SPT Blow Counts, blows/ft | Modulus of Soil Reaction, psi/in |
|---|-----------------------|------------------|--|----------------------------------|
| Fat Clays and Lean Clays                | Soft                  | 120              | c ≤ 250  | 100                              |
|   | Firm                  | 124              | c ≤ 500  | 300                              |
|   | Stiff                 | 128              | c ≤ 1,000  | 600                              |
|   | Very Stiff            | 130              | c ≤ 2,000  | 1,000                            |
|   | Hard                  | 132              | c > 2,000  | 2,000                            |
| Granular Soils: Sands, Silts and Gravel | Loose                 | 110              | 2 ≤ N <sub>SPT</sub> ≤ 7                             | 300                              |
|   | Loose to Medium Dense | 113              | 8 ≤ N <sub>SPT</sub> ≤ 15                            | 600                              |
|   | Medium Dense          | 115              | 16 ≤ N <sub>SPT</sub> ≤ 30                           | 1,000                            |
|   | Dense                 | 118              | N <sub>SPT</sub> > 30                                | 2,000                            |

\* Buoyant soil unit weight is computed by subtracting unit weight of water from the soil unit weight

### 5.1.11 Buoyant Uplift

Portion of a buried structure located below the water table is subject to an upward hydrostatic pressure, called the *buoyant uplift pressure*. Resistance to buoyant uplift pressure is provided by the

following components:

- *Weight of the structure (W)*
- *Weight of the soil above the base extension beyond the wall( $W_s$ )*
- *Frictional force between the soil and foundation ( $F_s$ ).*

$$\text{Buoyant Uplift Resistance} = W + W_s + F_s$$

W and  $W_s$  are can be readily computed. The computation of the buoyant uplift, and the skin friction resistance are shown in Figure 9. If base extension option is used, we recommend using a buoyant unit weight of backfill soil above the base extension of 65 pcf when computing  $W_s$ .

#### **5.1.12 Street Cut and Repair**

Any street cut necessary for this project should be restored to its original condition or better using material similar in nature and thickness to the existing streets. Recommendations outlined in City of Houston Standard Specification, Section 02951 – Pavement Repair and Resurfacing should be followed. The top 8 inches of the subgrade soils in the pavement repair areas should be stabilized. ATL recommends stabilizing subgrade clay soils with plasticity indices above 15 and above 25 with at least 5 and 6 percent lime, respectively, and stabilizing granular soils and clay soils with plasticity indices of less than 15 with at least 3 percent lime and 7 percent fly ash, on a weight basis; optimum amount of stabilization shall be determined by conducting laboratory testing.

The lime and lime-fly ash stabilization should be carried out in accordance with City of Houston Standard Specifications Section 02336 and 02337, respectively.

### **6.0 CONSTRUCTION CONSIDERATION**

The proposed sanitary sewer installation will involve both open cut/trenching and trenchless construction techniques. Accordingly, the sanitary sewer installation excavations will be installed

mostly in stiff to hard clay soils with local areas of firm stratum. However, granular soils or soft clays and soils with limited cohesion will likely be present at (but not limited to) locations identified in Table C and D of Section 5.1.2.

Excavation face in granular soils (sand/silt/gravel), soils with only slight plasticity and other caving soils (if encountered), will likely experience some degree of instability if the excavation face is unsupported, especially when these soils are saturated and/or subject to seepage pressure. In such cases, mitigating measures as discussed in Section 5.1.7 of this report can be employed to improve the excavation stability.

Based on the proposed invert elevation and the groundwater information gathered during our field investigation, the proposed sanitary sewer construction excavations will have a possibility of encountering groundwater if the excavation depth exceeds about 5 feet, especially when the excavations are left open for 24 hours or more. It should be noted that groundwater level will fluctuate with the amount of precipitation and the amount of precipitations prior to and during construction. For sanitary sewer installation excavation advanced in clay soils, the seepage rates are usually low, and groundwater control can usually be controlled by sumping and pumping. However, for excavations advanced in water-bearing sands/silts stratum (not encountered in our soil borings, but may be present away from our soil borings and/or after heavy rainfalls), where water inflow rate is high, dewatering using well points will be required to provide a dry working platform and to prevent soil boiling.

It is the responsibility of the Contractor to select a trenchless technique for the installation of the proposed sanitary sewers by taking into account the soil types and stratigraphy and the groundwater conditions as found in the soil borings; the Contractor should have a work crew experienced at working with the selected trenchless construction technique in subsurface conditions similar to those found in along the project alignments. If necessary, the Contractor may conduct additional geotechnical investigation to provide more detailed subsurface conditions.

## **6.1 Quality Control**

Associated Testing Laboratories, Inc. (ATL) recommends implementation of a comprehensive quality control program under the supervision of a Professional Engineer due to the fact that a considerable amount of excavation and back filling may be required in the proposed project area. Structural integrity and stability is particularly dependent on quality foundation installation, bedding and subgrade preparations. An independent testing laboratory should be assigned to test and inspect construction materials during the construction phase.

To ensure that excavation will remain stable, to provide sufficient headroom for working, to provide worker's safety and to protect adjacent structures, the excavations will have to be provided with sufficient side slopes or shored in accordance with OSHA "Trench Safety Systems" (29 CFR Part 1926), as published in the Federal Register, Vol. 52, No.72, Section 1926-650 through 1926-653. Excavation of the trenches and access pits should be carried out under the supervision of an experienced construction supervisor and necessary shoring and/or bracing of the trenches should be properly installed. In temporary braced or shored excavations and in access pits where the sheeting terminates at the base of the trench, lateral earth pressure, surcharge, and seepage pressure caused by a differential hydrostatic head moving upward to the bottom of the trench can cause trench bottom instability. Therefore, it is recommended that, if the bottom stability evaluation yields a factor of safety less than 1.5, the sheeting should be extended below the base of cut. Before filling operations take place, representative samples of the proposed fill material should be tested by an independent laboratory to determine the compaction and classification characteristics.

## **6.2 Monitoring**

Despite the thoroughness of this geotechnical exploration, there is always the possibility that actual subsurface conditions may differ from the predicted conditions because conditions between soil

borings can be different from those at specific boring locations.

Any excessive ground movements like settlement and lateral movement should be monitored and controlled. This can be done by performing a preconstruction survey including photography and documentation of existing conditions like elevations, cracks, etc., and by installing ground movement monitoring devices such as inclinometers, crack monitors, and establishing elevation monitor stations along the proposed sanitary sewer alignments to monitor the ground movement after commencement of the excavation.

Associated Testing Laboratory, Inc. (ATL) recommends a regular inspection and overall project monitoring by a geotechnical engineer during the construction phase. The purpose of inspection is to provide sound engineering and judgement alternatives during construction should unanticipated conditions occur.

## **7.0 LIMITATIONS**

The information, findings and recommendations contained in this report are based on data obtained from test borings at the locations shown in Figures 2a through 2c, a reasonable volume of laboratory tests, and professional interpretation and evaluation of the field and laboratory data, and consideration of the project information furnished. Should it become apparent during construction that soil conditions differ significantly from those discussed in this report, this office should be notified immediately so that further evaluation and any necessary adjustments can be made.

## 8.0

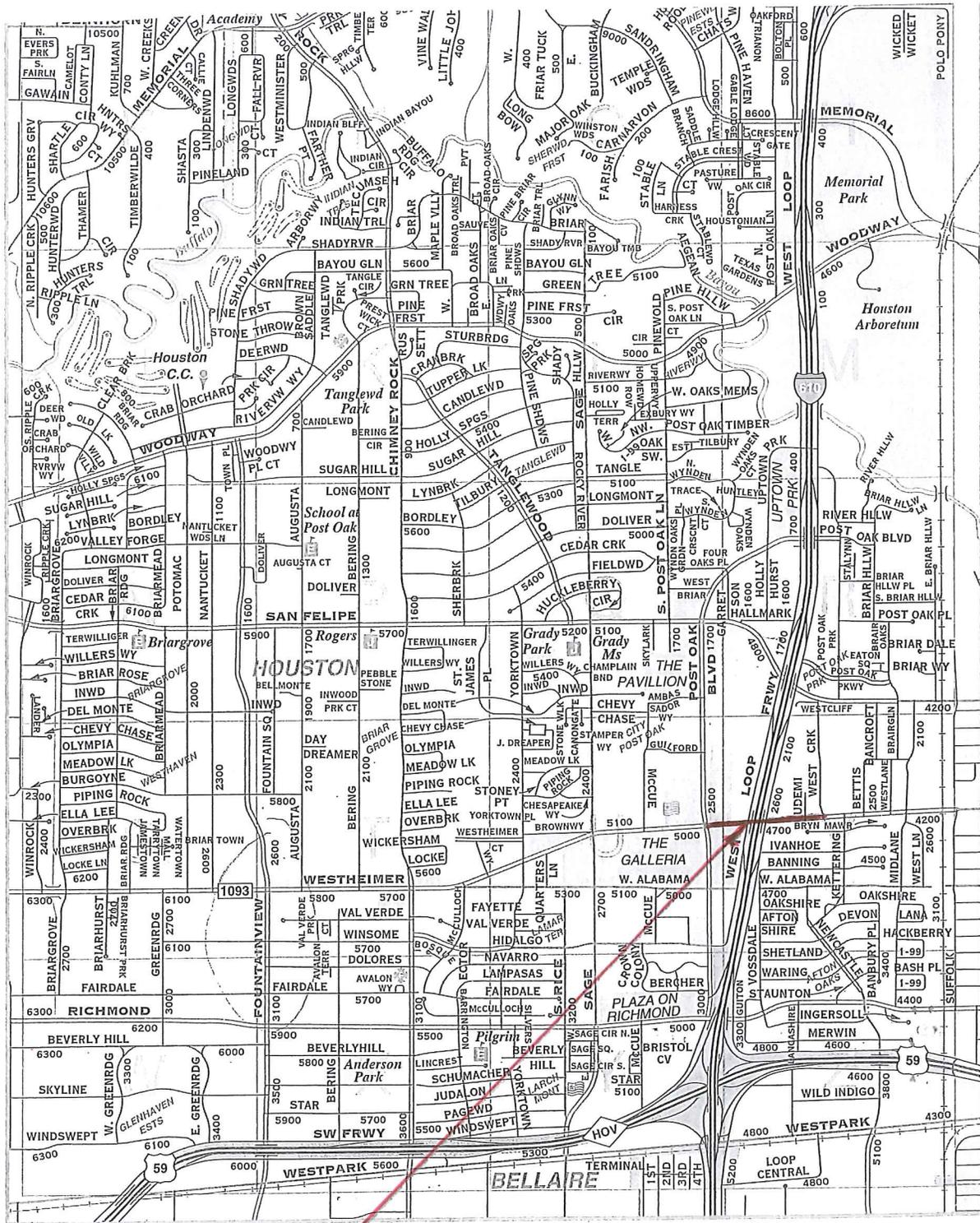
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SITE LOCATION

## SITE VICINITY MAP

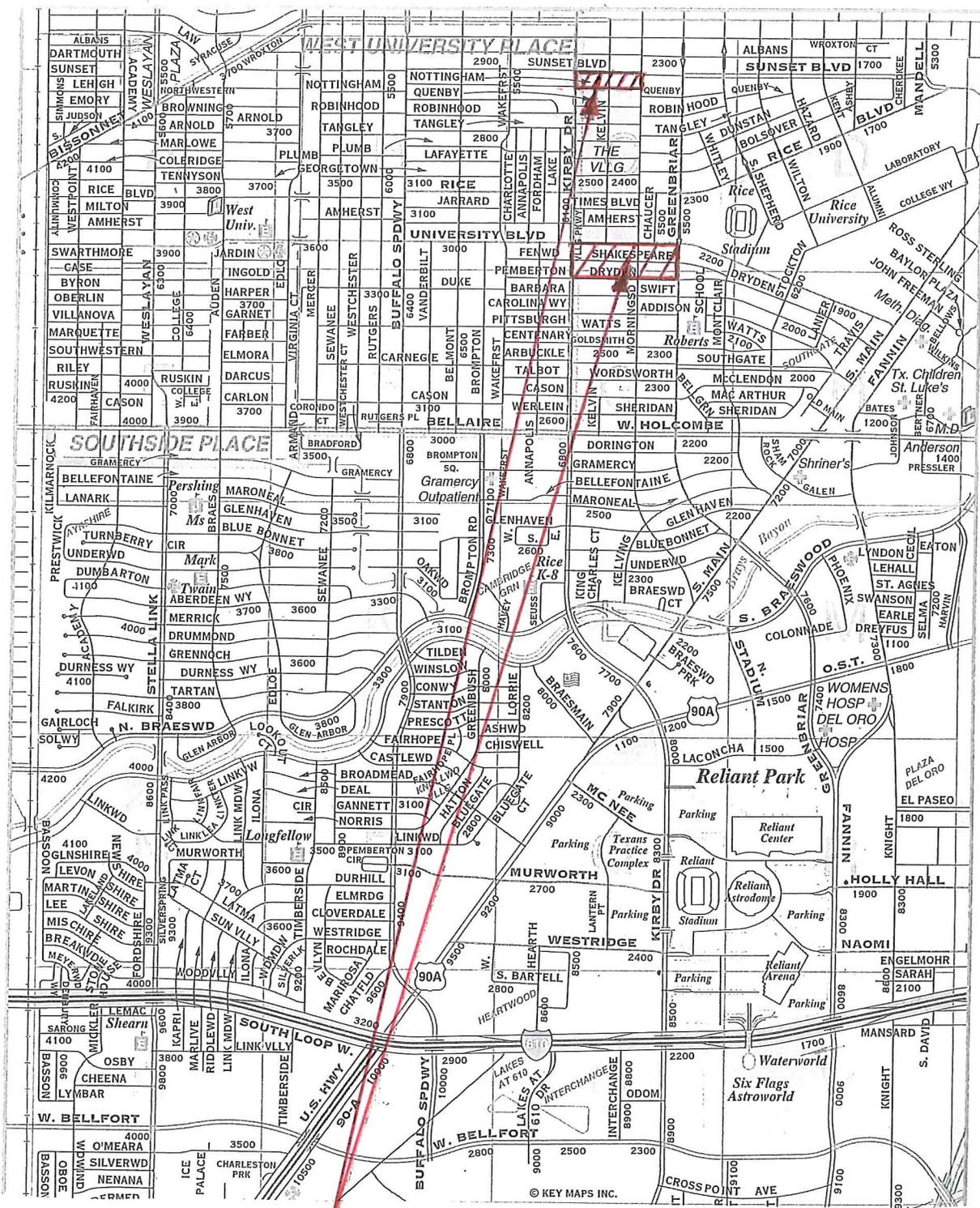
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 SYSTEMS IMPROVEMENTS  
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 BOULEVARD AND WESTHEIMER STREET

WBS No.: R-002011-0055-3

PROJECT NO. G14-109

FIGURE. 1a



**SITE LOCATION**

# SITE VICINITY MAP

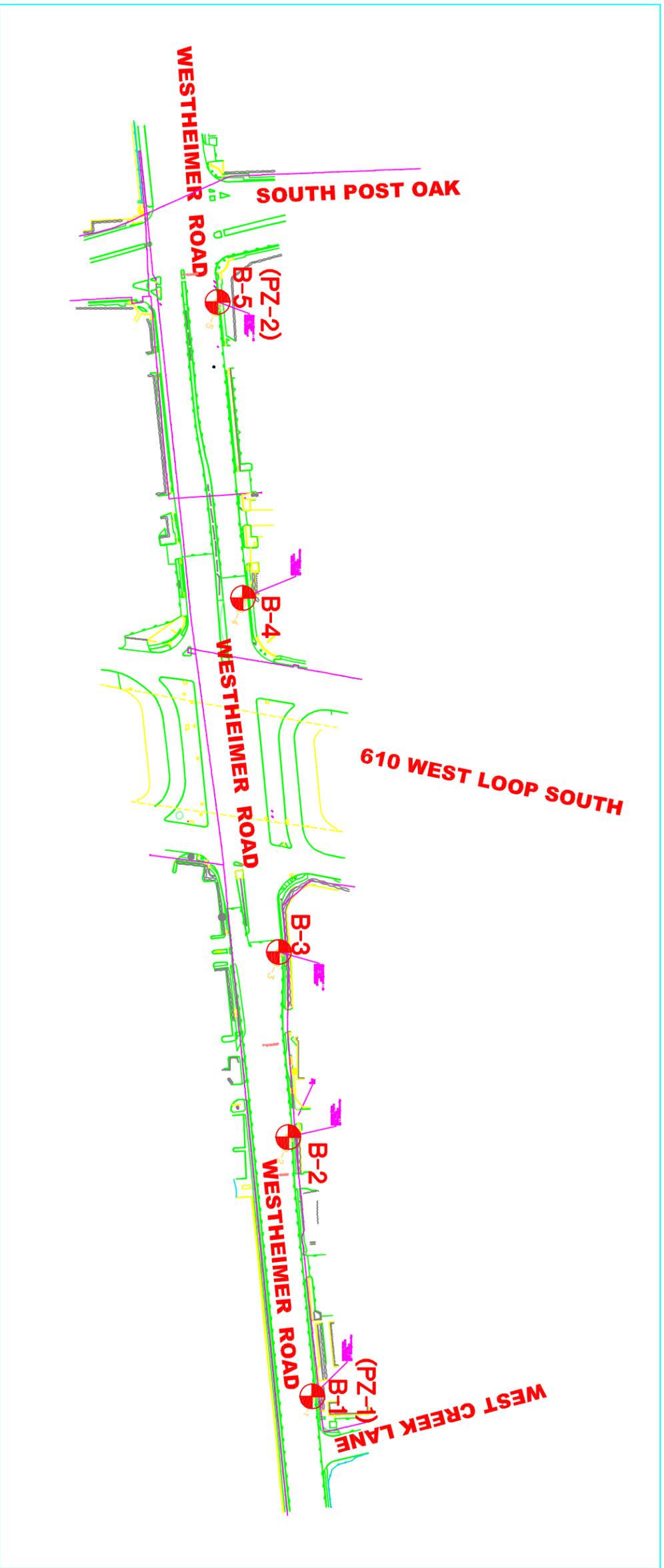
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FIGURE. 1b



# LOCATION OF BORINGS

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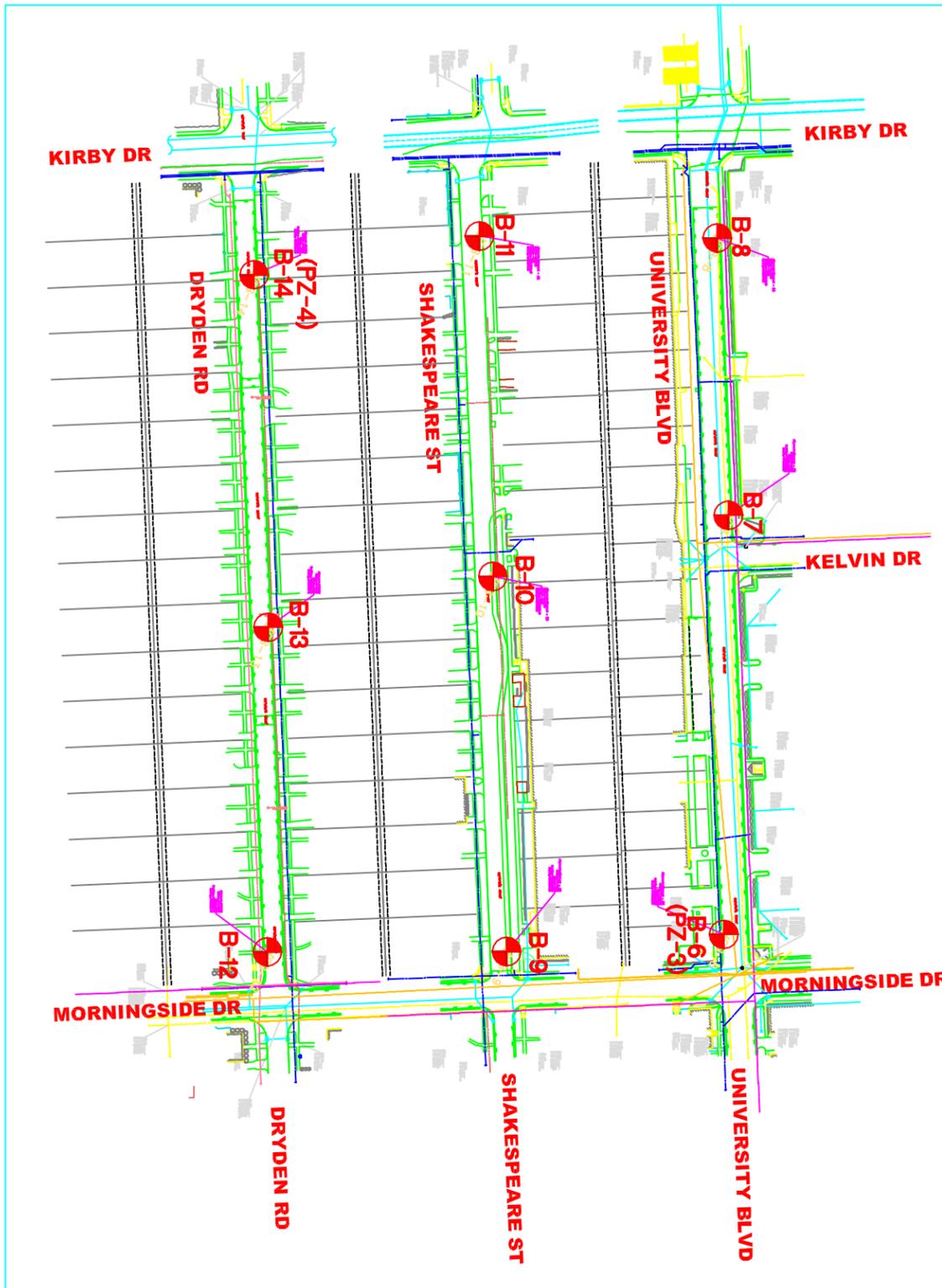
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SCALE: 1" = 200'

PROJECT NO. G14-109

FIGURE. 2a



*LOCATION OF BORINGS*

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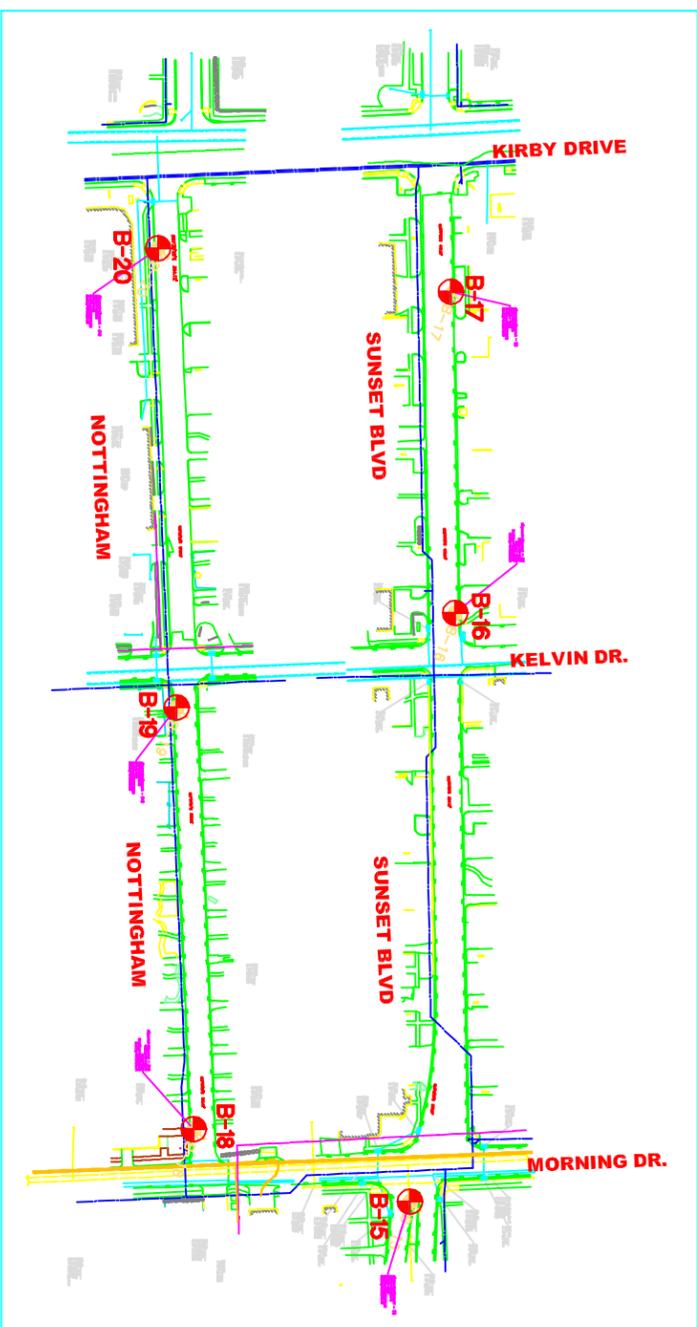
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*WBS No.: R-002011-0055-3*

*SCALE: 1"= 200'*

*PROJECT NO. G14-109*

*FIGURE. 2b*



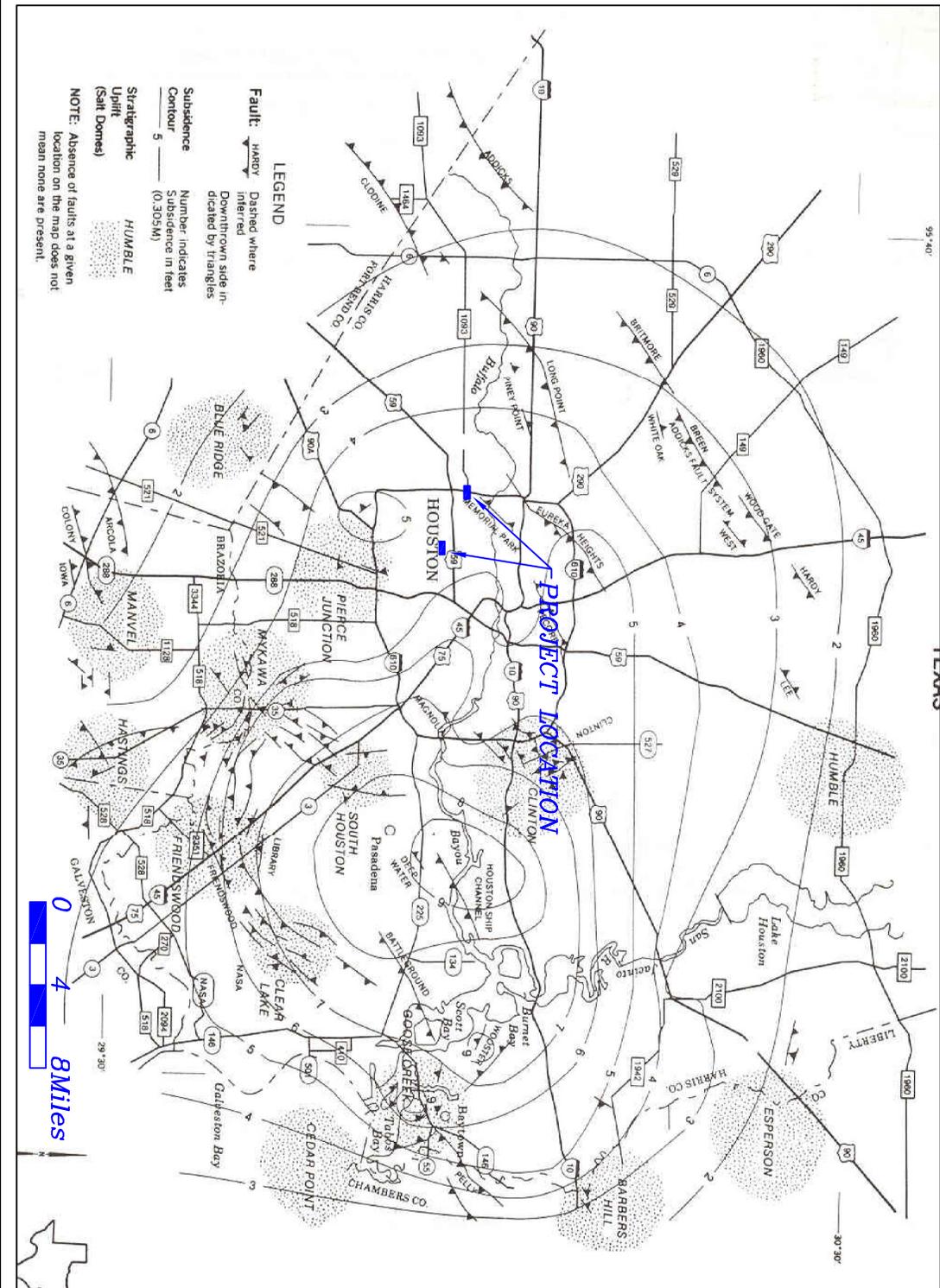
# LOCATION OF BORINGS

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WBS No.: R-002011-0055-3 SCALE: 1" = 200'

PROJECT NO. G14-109 FIGURE. 2c



**PRINCIPAL ACTIVE FAULTS  
IN HOUSTON AREA**

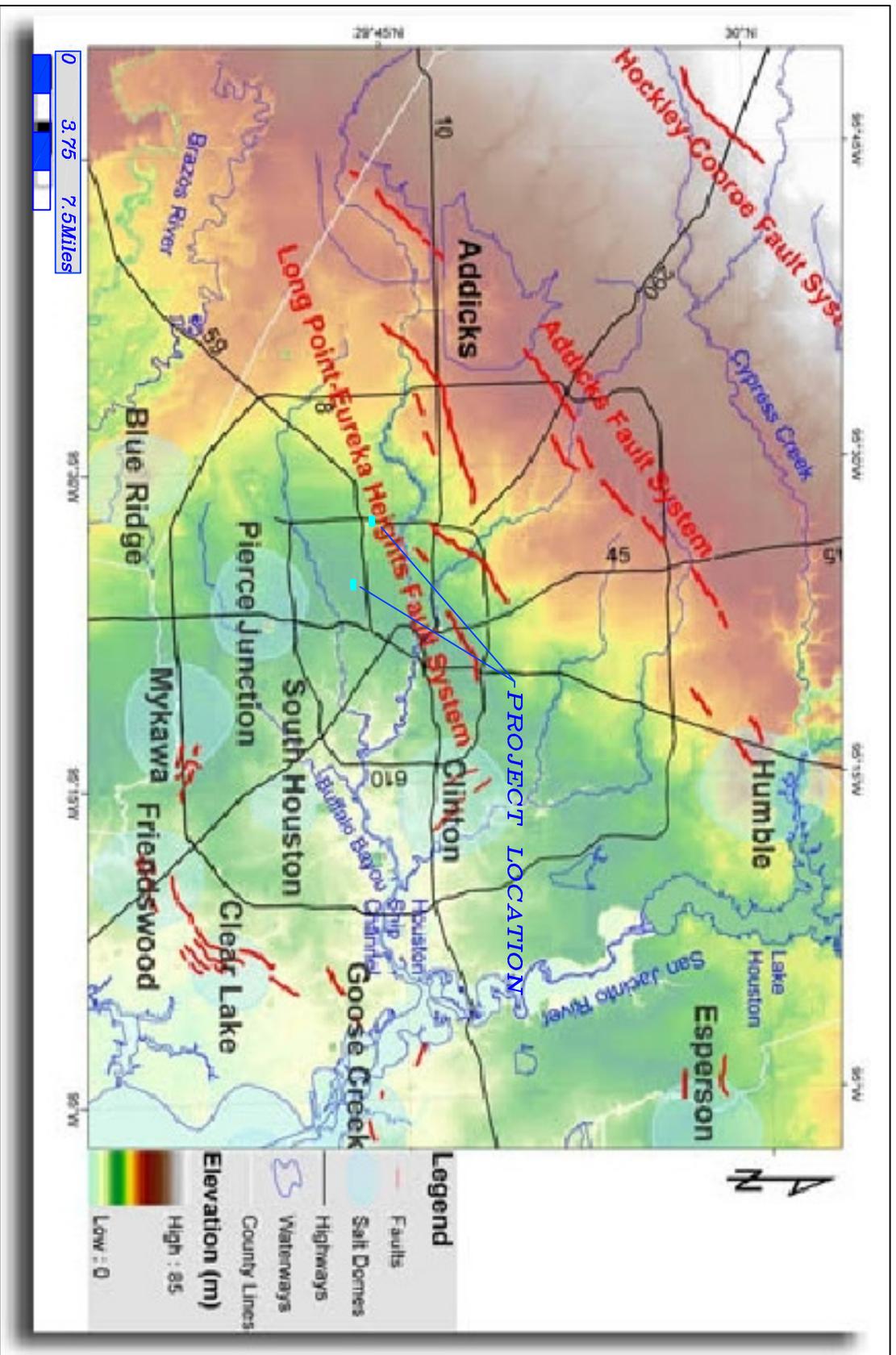
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**FIGURE 3a**



**ACTIVE SURFACE FAULTS  
ON LIDAR IMAGERY**

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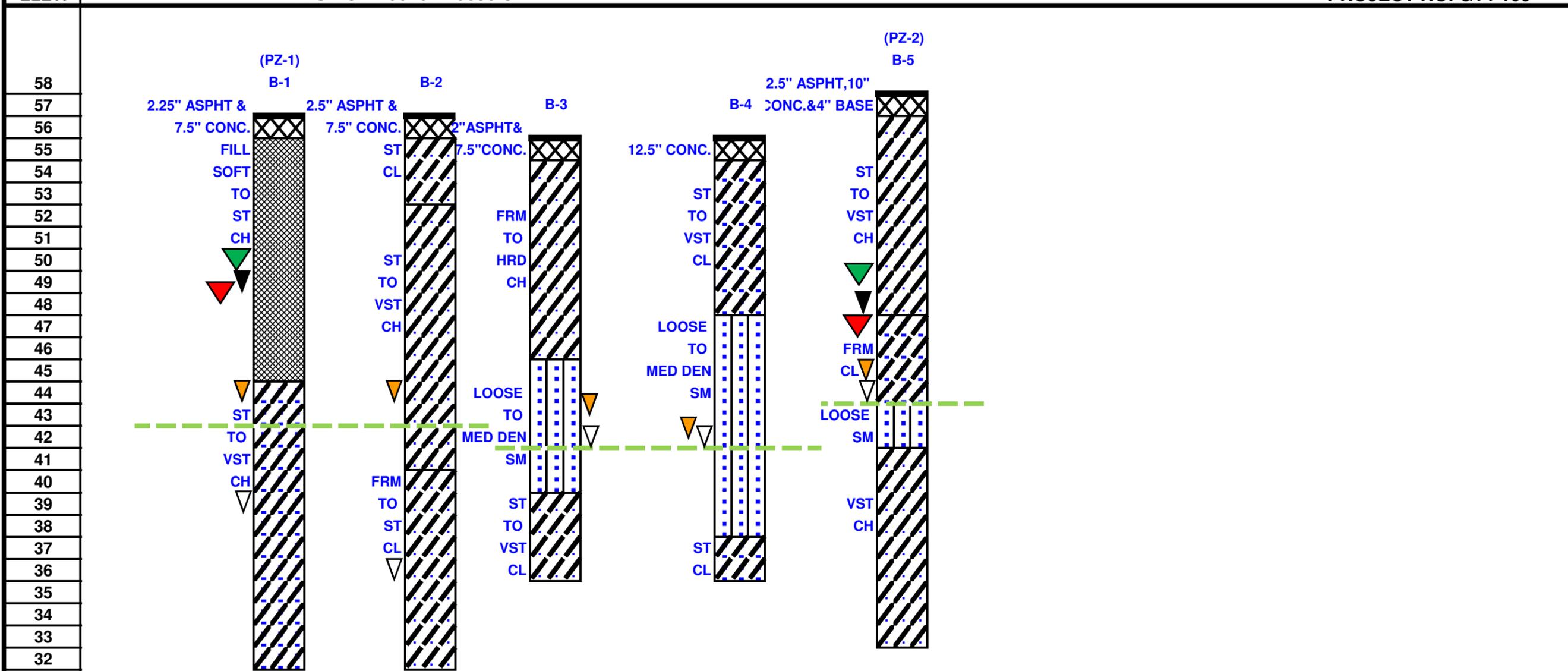
FIGURE 3b

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**PROJECT NAME: PROPOSED NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS SUNSET BOULEVARD, UNIVERSITY BOULEVARD AND WESTHEIMER STREET**

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**PROJECT NO. G14-109**



**PROFILE ALONG WESTHEIMER STREET**

|  |                              |
|--|------------------------------|
|  | Water First Noticed          |
|  | Depth To Water At Completion |
|  | 24 hr. Water Level           |
|  | PZ Water Level (2-14-14)     |
|  | PZ Water Level (3-7-14)      |

|                         |  |                        |
|-------------------------|--|------------------------|
| CH- Fat Clay            |  | ST - Stiff             |
| CH- Fat Clay With Sand  |  | VST - Very Stiff       |
| CL- Lean Clay With sand |  | FRM - Firm             |
| CL- Sandy Lean Clay     |  | HRD - Hard             |
| SM- Silty Sand          |  | MED DEN - Medium Dense |

|                      |  |
|----------------------|--|
| <b>SCALE</b>         |  |
| Horizontal: 1"= 500' |  |
| Vertical: 1"= 5'     |  |

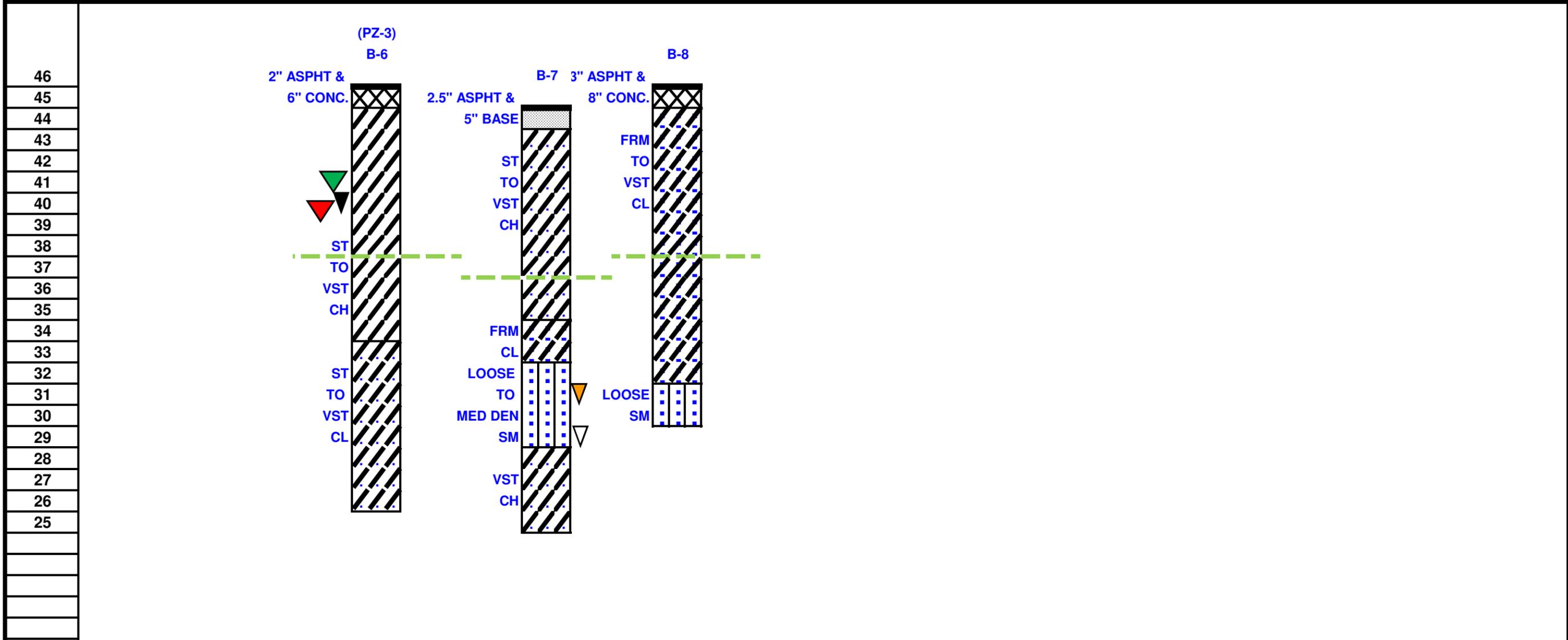
Figure-4a

**ASSOCIATED TESTING LABORATORIES, INC.**

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**PROJECT NO. G14-109**



**PROFILE ALONG UNIVERSITY BOULEVARD**

**KEY**

|  |                              |
|--|------------------------------|
|  | Water First Noticed          |
|  | Depth To Water At Completion |
|  | 24 hr. Water Level           |
|  | PZ Water Level (2-14-14)     |
|  | PZ Water Level (3-7-14)      |

|                         |  |                        |
|-------------------------|--|------------------------|
| CH- Fat Clay            |  | ST - Stiff             |
| CH- Fat Clay With Sand  |  | VST - Very Stiff       |
| CL- Lean Clay With sand |  | FRM - Firm             |
| CL- Sandy Lean Clay     |  | HRD - Hard             |
| SM- Silty Sand          |  | MED DEN - Medium Dense |

|                      |
|----------------------|
| <b>SCALE</b>         |
| Horizontal: 1"= 500' |
| Vertical: 1"= 5'     |

Figure-4b

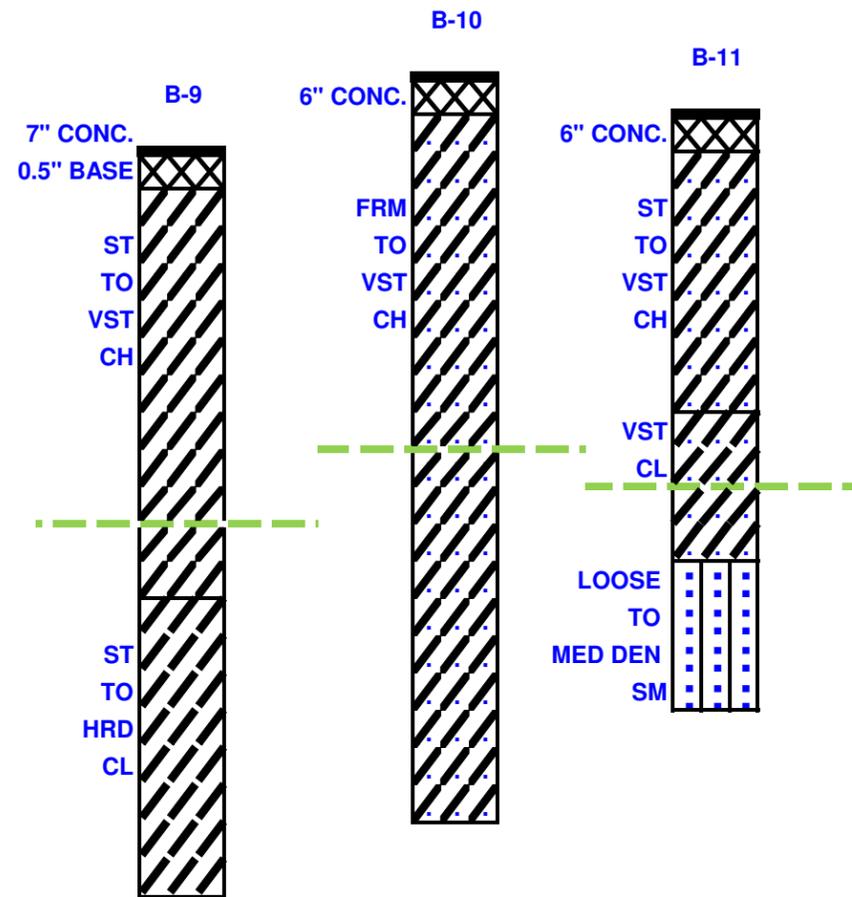
**ASSOCIATED TESTING LABORATORIES, INC.**

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**ELEV. WBS No. R-002011-0055-3**

**PROJECT NO. G14-109**

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| 25 |



**PROFILE ALONG SHAKESPEARE STREET**

**KEY**

|   |                                     |
|---|-------------------------------------|
| ▽ | <b>Water First Noticed</b>          |
| ▽ | <b>Depth To Water At Completion</b> |

|                         |  |                        |
|-------------------------|--|------------------------|
| CH- Fat Clay            |  | ST - Stiff             |
| CH- Fat Clay With Sand  |  | VST - Very Stiff       |
| CL- Lean Clay With sand |  | FRM - Firm             |
| CL- Sandy Lean Clay     |  | HRD - Hard             |
| SM- Silty Sand          |  | MED DEN - Medium Dense |

|                      |
|----------------------|
| <b>SCALE</b>         |
| Horizontal: 1"= 500' |
| Vertical: 1"= 5'     |

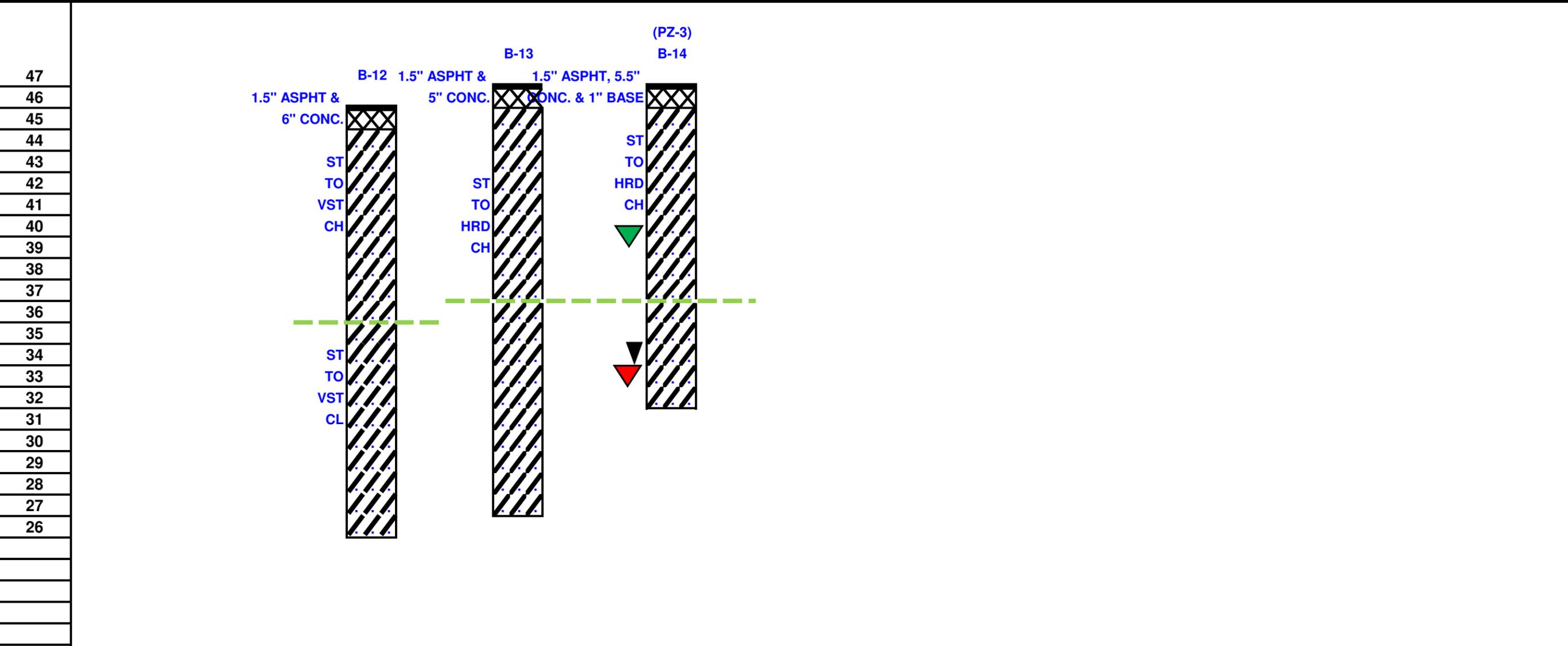
Figure-4c

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**ELEV. WBS No. R-002011-0055-3**

**PROJECT NO. G14-109**



**PROFILE ALONG DRYDEN ROAD**

**KEY**

|  |                              |
|--|------------------------------|
|  | Water First Noticed          |
|  | Depth To Water At Completion |
|  | 24 hr. Water Level           |
|  | PZ Water Level (2-14-14)     |
|  | PZ Water Level (3-7-14)      |

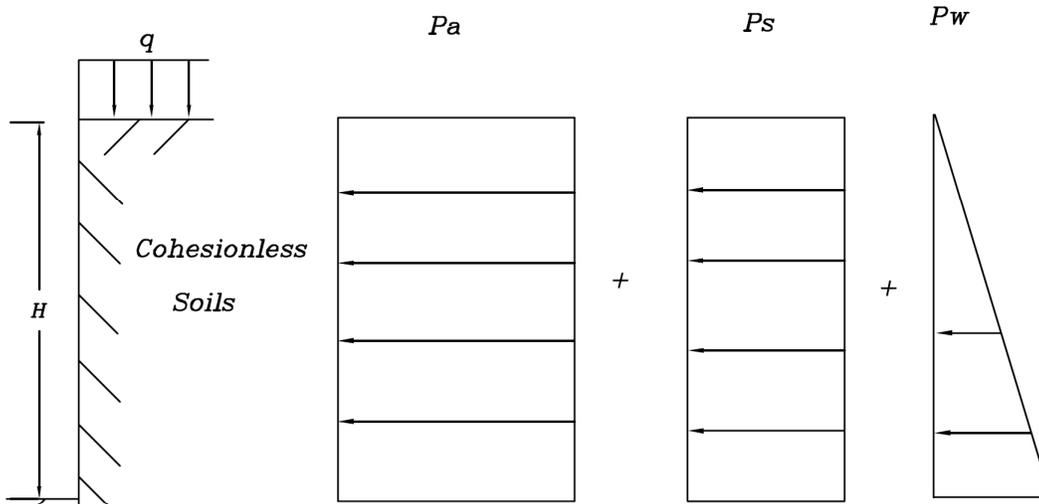
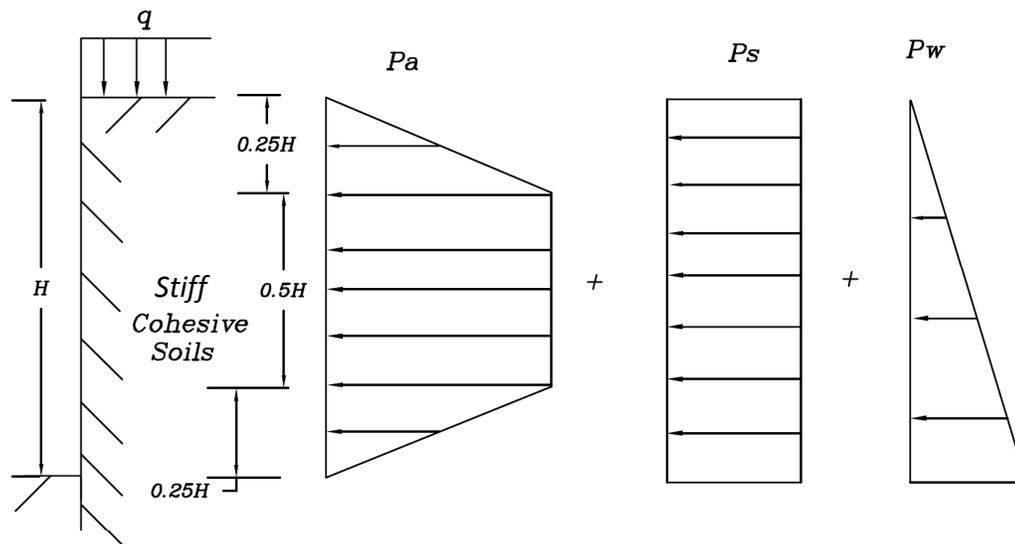
|                         |  |                        |
|-------------------------|--|------------------------|
| CH- Fat Clay            |  | ST - Stiff             |
| CH- Fat Clay With Sand  |  | VST - Very Stiff       |
| CL- Lean Clay With sand |  | FRM - Firm             |
| CL- Sandy Lean Clay     |  | HRD - Hard             |
| SM- Silty Sand          |  | MED DEN - Medium Dense |

|                      |
|----------------------|
| <b>SCALE</b>         |
| Horizontal: 1"= 500' |
| Vertical: 1"= 5'     |

Figure-4d







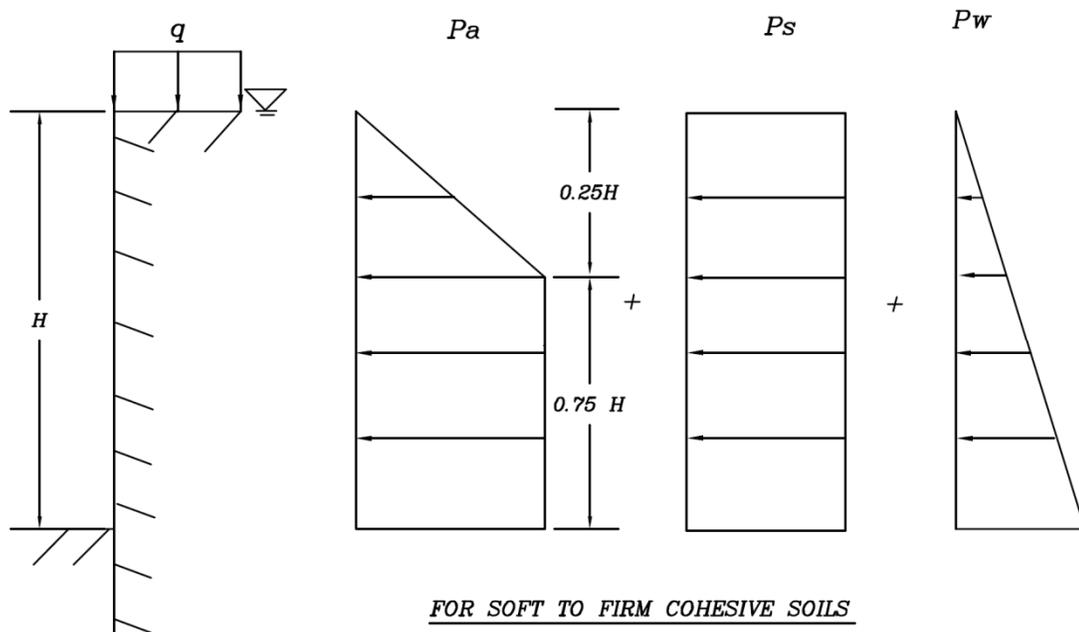
$$P = P_a + P_s + P_w$$

EARTH PRESSURE DIAGRAM

- Where  $P$  = Total lateral pressure (psf)  
 $P_a$  = Active earth pressure (psf) =  $K_A \gamma H = 0.4 \gamma H$  for Stiff Clays  
 $= 0.65 K_A \gamma H = 0.25 \gamma H$  for cohesionless Sands ( $0.33 \gamma H$  for loose sand)  
 $P_s$  = Lateral pressure due to surcharge load (psf) =  $0.5q$  for Clays  
 $= 0.4q$  for Sands  
 $P_w$  = Hydrostatic pressure (psf) =  $62.4 \times$  water depth  
 $H$  = Depth of braced excavation (ft)  
 $q$  = Surcharge load (psf) usually taken as 500 psf  
 $\gamma$  = Submerged density of soils (pcf) = use 60 pcf (use 50 pcf for loose Sands)

Source: Peck, R.B. 1969. "Deep Excavations and Tunneling in Soft Ground".

|   |  |           |
|---|--|-----------|
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| NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS<br>SUNSET BLVD, UNIVERSITY BLVD AND WESTHEIMER ST | WBS NO. R-002011-0055-3  |           |
|   | PROJECT NO. : G14-109  | FIGURE 5a |



Where  $P$  = Total lateral pressure (psf)

$P_a$  = Active earth pressure (psf) =  $1.0K_a\gamma H$  for soft clays

$K_a$  = Active Earth pressure coefficient

$$= 1 - m \frac{2q_u}{\gamma H} = 1 - m \frac{4C}{\gamma H} \text{ (taking } C = \frac{q_u}{2} \text{)}$$

Here  $m=1$  for  $N < 4$  and  $m=0.4$  for  $N > 5$

$N$  = Stability number =  $\gamma H / C$

$P_s$  = Lateral pressure due to surcharge load (psf) =  $K_a$  for clays

$P_w$  = Hydrostatic pressure (psf) =  $62.4 \times$  water depth

$H$  = Depth of braced excavation (ft)

$q$  = Surcharge load (psf) usually taken as 500 psf

$\gamma$  = density of soils (pcf) = use 50 pcf below groundwater and 110 pcf above groundwater

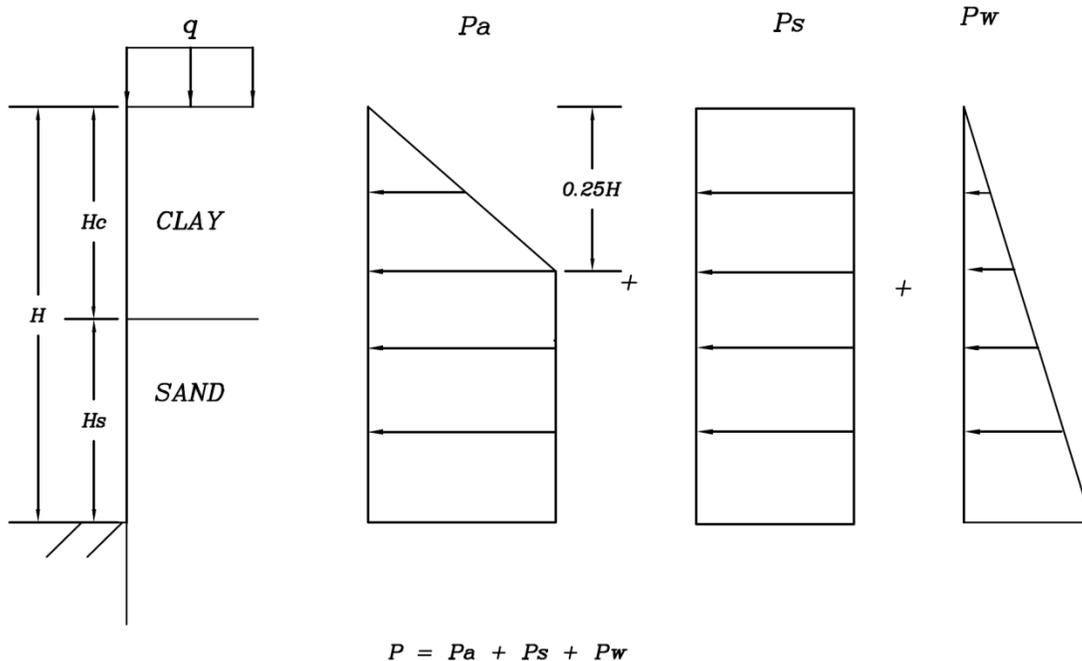
$q_u$  = Unconfined compressive strength, psf

$C$  = Undrained shear strength, psf

Note: Neglect hydrostatic pressure above groundwater level

Source: Peck, R.B. 1969. "Deep Excavations and Tunneling in Soft Ground".

|   |  |           |
|---|--|-----------|
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|   | PROJECT NO. : G14-109  | FIGURE 5b |



Where  $P$  = Total lateral pressure (psf)

$$P_a = \text{Active earth pressure (psf)} = K_A \gamma H = 0.4 \gamma H$$

$$P_s = \text{Lateral pressure due to surcharge load (psf)} = 0.5q$$

$$P_w = \text{Hydrostatic pressure (psf)} = 62.4 * \text{water depth}$$

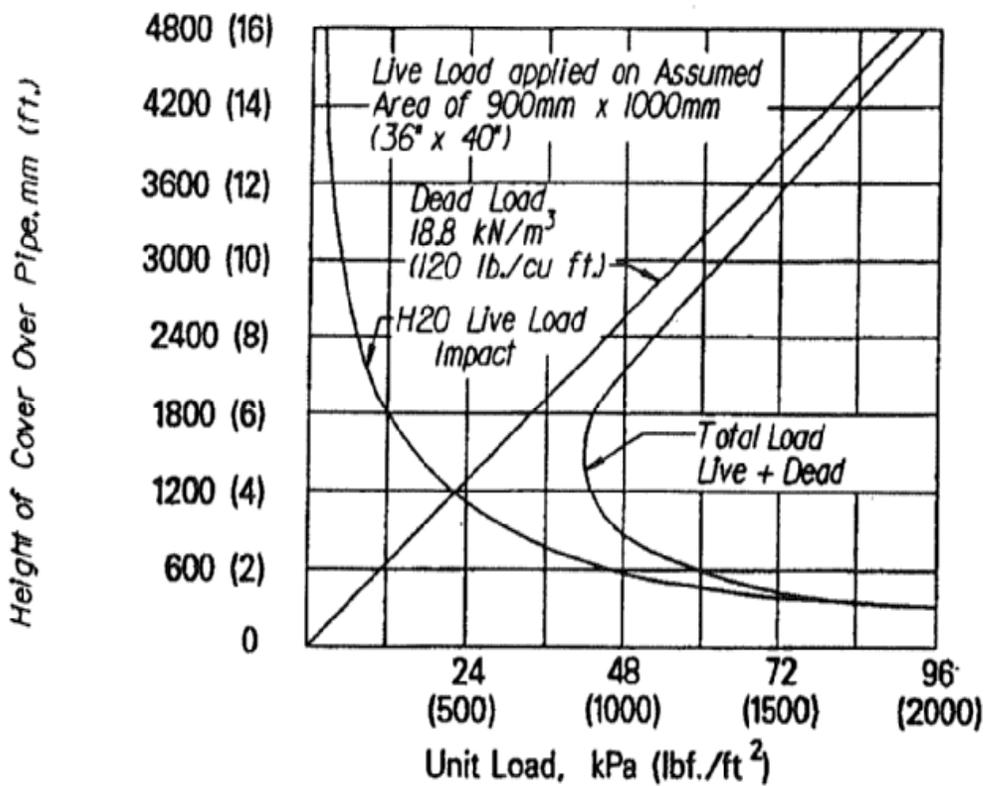
$$H = \text{Depth of braced excavation (ft)}$$

$$q = \text{Surcharge load (psf) usually taken as 500 psf}$$

$$\gamma = \text{Submerged density of soils (pcf) = use 60 pcf}$$

Source: Peck, R.B. 1969. "Deep Excavations and Tunneling in Soft Ground".

|   |  |           |
|---|--|-----------|
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|   | PROJECT NO. : G14-109  | FIGURE 5c |



*Combined H20 highway live load and dead load is a minimum at about 1500mm (5 ft.) of cover, applied through a pavement 300mm (1 ft.) thick.*

HIGHWAY LOADING ON A PIPE UNDER VARIOUS SOIL COVER

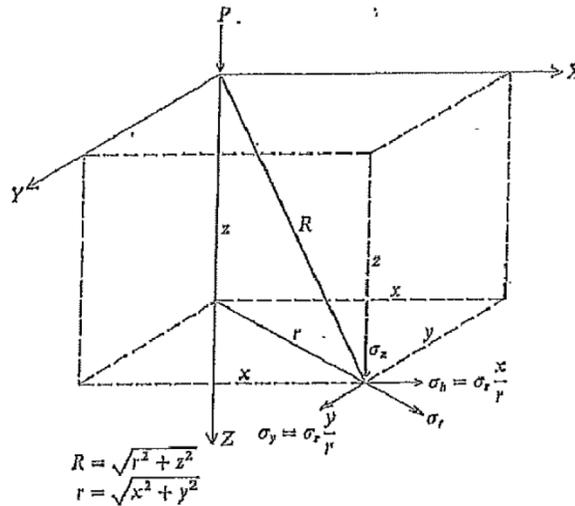
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FIGURE 6



Later Pressure,  $\sigma_r$ :

$$\sigma_r = (P/2\pi) \{3r^2z/R^5\} - \{[1-2\mu]/R[R+z]\}$$

For  $\mu = 0.5$ ,

$$\sigma_r = P/2\pi (2r^2z/R^5)$$

Vertical Pressure,  $\sigma_z$  :

$$\sigma_z = 3 P z^3 / 2\pi R^5$$

$P$  = Point load surcharge

$\mu$  = Poisson's ratio if soils, use 0.5

$X, y, z$  = distance in  $x, y$  and  $z$  direction, respectively

BOUSSINESQ'S EQUATION FOR POINT  
LOAD SURCHARGE

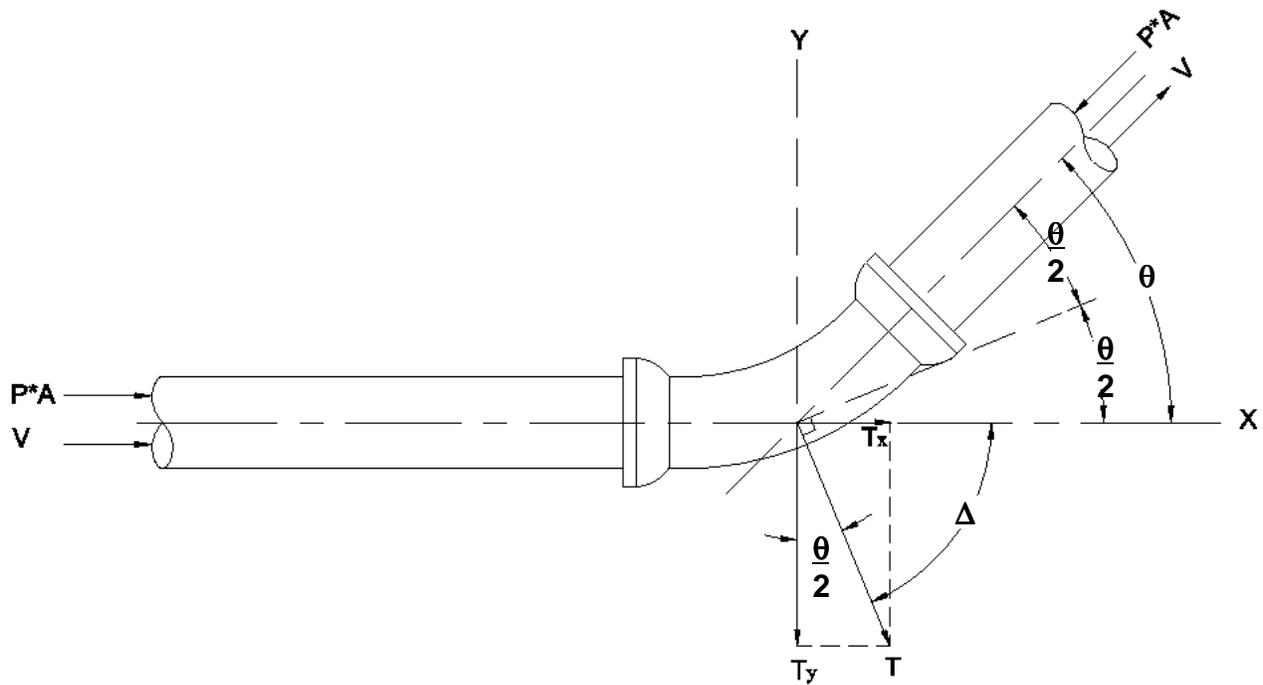
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WBS NO. R-002011-0055-3

PROJECT NO. : G14-109

FIGURE 7



$$T = 2 P A \sin \frac{\theta}{2}$$

$$T_x = P A (1 - \cos \theta)$$

$$T_y = P A \sin \theta$$

Where:

|          |   |  |
|----------|---|--|
| T        | = | Resultant thrust force, lbs                        |
| $T_x$    | = | Resultant thrust force component along x-axis, lbs |
| $T_y$    | = | Resultant thrust force component along y-axis, lbs |
| P        | = | Maximum sustain pressure of fluid in pipe, psi     |
| A        | = | Cross-section area of pipe, square inches          |
| D        | = | Inside diameter of pipe, inches                    |
| $\theta$ | = | Angle of the pipe bend, degrees                    |
| $\Delta$ | = | Angle between x-axis and resultant force           |
|          | = | $\tan^{-1} (T_y/T_x)$ , degrees                    |
| V        | = | Fluid velocity                                     |

Source: American Water Works Association, "Concrete Pressure Pipes", AWWA Manual M9.

THRUST FORCE AT A PIPE BEND

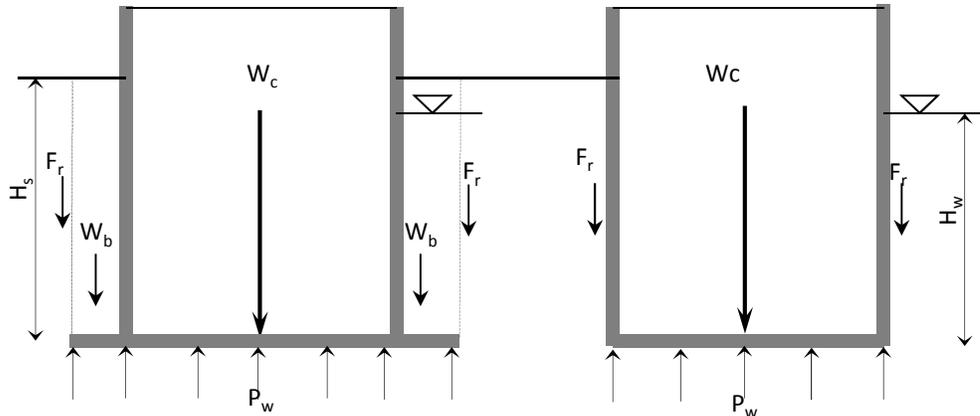
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FIGURE 8



Dead Weight of Structure + Dead Weight of Backfill Above Base Extension + Frictional Resistance

$$P_w = H_w \gamma_w$$

$$F_u = A_b P_w$$

$$W_c / S_{fa} + W_b / S_{fb} + F_r / S_{fc} \geq F_u$$

( $S_{fa} = 1.1$ ;  $S_{fb} = 1.5$ ;  $S_{fc} = 3.0$ )

Dead Weight of Structure + Frictional Resistance

$$P_w = H_w \gamma_w$$

$$F_u = A_b P_w$$

$$W_c / S_{fa} + F_r / S_{fc} \geq F_u$$

( $S_{fa} = 1.1$ ;  $S_{fc} = 3.0$ )

For cohesive soils:

$$F_r = \alpha c_n A_n$$

For cohesionless soils,

$$F_r = p_n K \tan \delta_n A_n$$

Where,

|              |   |  |
|--------------|---|--|
| $H_s$        | = | Buried depth of wall, ft   |
| $H_w$        | = | Height of water table above base of structure, ft  |
| $P_w$        | = | Total uplift pressure = $62.4 \times H_w$ , psf  |
| $F_u$        | = | Total uplift force exerted on base of structure = $P_w \times A_b$   |
| $W_c$        | = | Dead weight of structure, lbs  |
| $W_b$        | = | Weight of backfill above base of structure, lbs  |
| $A_b$        | = | Area of base, $ft^2$   |
| $F_r$        | = | Friction resistance developed at the soil/wall interface, lbs  |
| $A_n$        | = | Contact area between the soil/wall interface in layer "n"  |
| $c_n$        | = | Undrained shear strength of cohesive soils at layer "n" at soil/wall interface. See individual boring logs. $c_n$ for the top 8 ft of clays with PI higher than 20 percent should be discounted because of the shrink-swell characteristics of high plasticity clays.    |
| $\alpha$     | = | Adhesion factor, to be multiplied with $c_n$ to obtain the adhesion between the soil/wall interface. Use 0.75 if $c_n$ is less than 0.25 tsf, use 0.67 if $c_n$ is between 0.25 and 0.5 tsf, use 0.5 if $c_n$ is greater than 0.5 tsf but limit the adhesion to 1.5 ksf. |
| $K$          | = | Coefficient of lateral earth pressure of cohesionless soils. Use 0.4.  |
| $p_n$        | = | Average overburden stress at the mid-depth of cohesionless soil layer "n", psf   |
| $\delta_n$   | = | Average frictional angle between cohesionless soil layer "n" and the walls of the structure, use 0.75 of the angle of internal friction ( $\phi$ ) of the cohesionless soil. A $\phi$ of 28 degrees may be used if no specific value is given.                           |
| $S_{fa,b,c}$ | = | Factors of safety against buoyant uplift force.  |

**BUOYANT UPLIFT RESISTANCE OF A BURIED STRUCTURE**

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WBS NO. R-002011-0055-3

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FIGURE 9

## **LIST OF TABLES**

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|---------|---|
| TABLE 1 | SUMMARY OF EXISTING PAVEMENT MEASUREMENTS         |
| TABLE 2 | SUMMARY OF GROUNDWATER MEASUREMENTS               |
| TABLE 3 | SUMMARY OF TEST RESULTS                           |
| TABLE 4 | MARSTON SOIL COEFFICIENT (Cd) FOR TRENCH CONDUITS |

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**TABLE 1**  
**SUMMARY OF PAVEMENT MEASUREMENTS**  
**NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS**  
**SUNSET BOULEVARD, UNIVERSITY BOULEVARD AND WESTHEIMER STREET**  
**CITY OF HOUSTON, TEXAS**  
**WBS NO. R-002011-0055-3**  
**ATL PROJECT NO. G14-109**

| Boring Number | Boring Depth (ft) | Piezometer |            | Asphalt Paving (inch) | Concrete Paving (inch)        | Base Material (inch)            |
|---------------|-------------------|------------|------------|-----------------------|-------------------------------|---------------------------------|
|               |                   | No.        | Depth (ft) |                       |                               |                                 |
| B-1           | 25                | PZ-1       | 25         | 2.25                  | 7.5                           | --                              |
| B-2           | 25                | --         | --         | 2.5                   | 7.5                           | --                              |
| B-3           | 20                | --         | --         | 2                     | 7.5                           | --                              |
| B-4           | 20                | --         | --         | --                    | 12.5                          | --                              |
| B-5           | 25                | PZ-2       | 25         | 2.5                   | 10                            | 4" Stabilized soil              |
| B-6           | 20                | PZ-3       | 20         | 2                     | 6<br>(with shell aggregate)   | --                              |
| B-7           | 20                | --         | --         | 2.5                   | --                            | 5" Lightly cement-treated shell |
| B-8           | 15.5              | --         | --         | 3                     | 8                             | --                              |
| B-9           | 20                | --         | --         | --                    | 7<br>(with shell aggregate)   | 0.5" Sand                       |
| B-10          | 20                | --         | --         | --                    | 6<br>(with shell aggregate)   | --                              |
| B-11          | 15.5              | --         | --         | --                    | 6<br>(with shell aggregate)   | --                              |
| B-12          | 20                | --         | --         | 1.5                   | 6<br>(with shell aggregate)   | --                              |
| B-13          | 20                | --         | --         | 1.5                   | 5<br>(with shell aggregate)   | --                              |
| B-14          | 15                | PZ-4       | 15         | 1.5                   | 5.5<br>(with shell aggregate) | 1" Sand                         |
| B-15          | 15                | --         | --         | 2                     | 6                             | --                              |
| B-16          | 15                | --         | --         | 2                     | 6                             | --                              |
| B-17          | 15                | --         | --         | 3.5                   | 5                             | --                              |
| B-18          | 15                | --         | --         | 2                     | 4.5                           | --                              |
| B-19          | 15                | --         | --         | 2                     | 6                             | --                              |
| B-20          | 15                | --         | --         | 2                     | 4.5                           | --                              |

**TABLE 2**  
**SUMMARY OF GROUNDWATER MEASUREMENTS**  
**NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS**  
**SUNSET BOULEVARD, UNIVERSITY BOULEVARD AND WESTHEIMER STREET**  
**CITY OF HOUSTON, TEXAS**  
**WBS NO. R-002011-0055-3**  
**ATL PROJECT NO. G14-109**

| Boring Number  | Location              | Ground water during drilling | Ground water upon completion of drilling | Ground water in Piezometer ( after 24 hrs ) | Ground water in Piezometer ( after 7 days ) | Ground water in Piezometer ( after 30 days ) |
|----------------|-----------------------|------------------------------|--|---|---|--|
| B-1<br>(PZ-1)  | Westheimer Street.    | 18'                          | 13'                                      | ( 02/09/2014)<br>8'                         | (02/14/2014)<br>8.5'                        | (03/07/2014)<br>7'                           |
| B-2            | Westheimer Street.    | 21'                          | 13'                                      | --  | --  | --   |
| B-3            | Westheimer Street.    | 14'                          | 12.5'                                    | --  | --  | --   |
| B-4            | Westheimer Street.    | 14'                          | 13.5'                                    | --  | --  | --   |
| B-5<br>(PZ-2)  | Westheimer Street.    | 14'                          | 13'                                      | ( 02/09/2014)<br>10'                        | (02/14/2014)<br>11'                         | (03/07/2014)<br>8.5'                         |
| B-6<br>(PZ-3)  | University Boulevard. | Dry                          | Dry                                      | ( 02/06/2014)<br>6'                         | (02/14/2014)<br>6.5'                        | (03/07/2014)<br>5'                           |
| B-7            | University Boulevard. | 16'                          | 14'                                      | --  | --  | --   |
| B-8            | University Boulevard. | Dry                          | Dry                                      | --  | --  | --   |
| B-9            | Shakespeare Street.   | Dry                          | Dry                                      | --  | --  | --   |
| B-10           | Shakespeare Street.   | Dry                          | Dry                                      | --  | --  | --   |
| B-11           | Shakespeare Street.   | Dry                          | Dry                                      | --  | --  | --   |
| B-12           | Dryden Road.          | Dry                          | Dry                                      | --  | --  | --   |
| B-13           | Dryden Road.          | Dry                          | Dry                                      | --  | --  | --   |
| B-14<br>(PZ-4) | Dryden Road.          | Dry                          | Dry                                      | ( 02/06/2014)<br>13'                        | (02/14/2014)<br>14'                         | (03/07/2014)<br>7.5                          |
| B-15           | Sunset Boulevard.     | Dry                          | Dry                                      | --  | --  | --   |
| B-16           | Sunset Boulevard.     | Dry                          | Dry                                      | --  | --  | --   |
| B-17           | Sunset Boulevard.     | Dry                          | Dry                                      | --  | --  | --   |
| B-18           | Nottingham Street.    | Dry                          | Dry                                      | --  | --  | --   |
| B-19           | Nottingham Street.    | Dry                          | Dry                                      | --  | --  | --   |
| B-20           | Nottingham Street.    | Dry                          | Dry                                      | --  | --  | --   |

**TABLE 3**

| ASSOCIATED TESTING LABORATORIES, INC.<br>3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052<br>TEL: (713) 748-3717 FAX: (713) 748-3748 |        |            |      |                |                   |                   | PROJECT NAME : PROPOSED NEIGHBORHOOD SEWER SYSTEM IMPROVEMNET<br>SUNSET BOULEVARD, UNIVESRITY BOULEVARD AND WESTHEIMER STREET<br>WBS NO. R-002011-0055-3, CONSULTANT PROJECT NUMBER: G14-109 |    |    |                               |                                   |  |         |                      |                          |
|--|--------|------------|------|----------------|-------------------|-------------------|--|----|----|-------------------------------|-----------------------------------|--|---------|----------------------|--------------------------|
| BORING NO.   | Sample |            |      | SPT (blows/ft) | WATER CONTENT (%) | DRY DENSITY (pcf) | Atterberg Limits   |    |    | PERCENT PASSING SIEVE 200 (%) | UNDRAINED SHEAR STRENGTH (TSF)    |  |         |                      | TYPE OF MATERIAL         |
|  | NO.    | DEPTH (ft) | TYPE |                |                   |                   | LL   | PL | PI |                               | UNCONFINED COMPRESSION TEST (TSF) | UU TEST ( CONFINING PRESSURE ) ( TSF ) | TORVANE | POCKET PENETRO-METER |                          |
| B-1  | 1      | 0-2        | UD   |                | 21                |                   | 56   | 20 | 36 | 87                            |                                   |  |         | 2.00                 | Fat Clay (CH) Fill       |
|  | 2      | 2-4        | UD   |                | 23                |                   |  |    |    |                               |                                   |  |         | 1.75                 | Fat Clay (CH) Fill       |
|  | 3      | 4-6        | UD   |                | 23                |                   |  |    |    |                               |                                   |  |         | 1.50                 | Fat Clay (CH) Fill       |
|  | 4      | 6-8        | UD   |                | 28                |                   |  |    |    |                               |                                   |  |         | 0.75                 | Fat Clay (CH) Fill       |
|  | 5      | 8-10       | UD   |                | 26                |                   |  |    |    |                               |                                   |  |         | 0.25                 | Fat Clay (CH) Fill       |
|  | 6      | 10-12      | SS   | 5              | 25                |                   | 62   | 21 | 41 | 97                            |                                   |  |         |                      | Fat Clay (CH) Fill       |
|  | 7      | 12-14      | UD   |                | 24                | 101               |  |    |    |                               | 0.80                              |  |         | 2.00                 | Sandy Fat Clay (CH)      |
|  | 8      | 14-16      | UD   |                | 26                |                   |  |    |    |                               |                                   |  |         | 3.00                 | Sandy Fat Clay (CH)      |
|  | 9      | 16-18      | UD   |                | 22                | 104               |  |    |    |                               | 1.25                              |  |         | 3.50                 | Sandy Fat Clay (CH)      |
|  | 10     | 18-20      | UD   |                | 16                |                   |  |    |    |                               |                                   |  |         | 3.00                 | Sandy Fat Clay (CH)      |
|  | 11     | 23-25      | UD   |                | 16                |                   | 53   | 19 | 34 | 62                            |                                   |  |         | 3.25                 | Sandy Fat Clay (CH)      |
| B-2  | 1      | 0-2        | UD   |                | 25                |                   |  |    |    |                               |                                   |  |         | 1.75                 | Lean Clay with sand (CL) |
|  | 2      | 2-4        | UD   |                | 20                |                   | 43   | 18 | 25 | 74                            |                                   |  |         | 2.00                 | Lean Clay with sand (CL) |
|  | 3      | 4-6        | UD   |                | 22                |                   |  |    |    |                               |                                   |  |         | 2.50                 | Fat Clay with Sand (CH)  |
|  | 4      | 6-8        | UD   |                | 22                | 106               |  |    |    |                               | 1.10                              |  |         | 3.50                 | Fat Clay with Sand (CH)  |
|  | 5      | 8-10       | UD   |                | 26                |                   |  |    |    |                               |                                   |  |         | 4.00                 | Fat Clay with Sand (CH)  |
|  | 6      | 10-12      | UD   |                | 25                |                   | 58   | 20 | 38 | 83                            |                                   |  |         | 3.50                 | Fat Clay with Sand (CH)  |
|  | 7      | 12-14      | UD   |                | 27                |                   |  |    |    |                               |                                   |  |         | 3.00                 | Fat Clay with Sand (CH)  |
|  | 8      | 14-16      | UD   |                | 27                | 98                |  |    |    |                               | 0.90                              |  |         | 2.00                 | Fat Clay with Sand (CH)  |
|  | 9      | 16-18      | UD   |                | 25                |                   |  |    |    |                               |                                   |  |         | 1.00                 | Lean Clay with sand (CL) |
|  | 10     | 18-20      | UD   |                | 24                |                   |  |    |    |                               |                                   |  |         | 2.00                 | Lean Clay with sand (CL) |
|  | 11     | 23-25      | AU   |                | 29                |                   | 48   | 18 | 30 |                               |                                   |  |         |                      | Lean Clay with sand (CL) |

**Legend:** UD - Undisturbed Sample Extruded in Field      AG - Auger Cutting in Field  
 UL - Undisturbed Sample Extruded in Lab              SS - Split Spoon Sample  
 Designates consolidation test Performed              SPT - Standard Penetration Test

**TABLE 3** (cont'd)

| ASSOCIATED TESTING LABORATORIES, INC.<br>3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052<br>TEL: (713) 748-3717 FAX: (713) 748-3748 |        |            |      |                |                   |                   | PROJECT NAME : PROPOSED NEIGHBORHOOD SEWER SYSTEM IMPROVEMNET<br>SUNSET BOULEVARD, UNIVESRITY BOULEVARD AND WESTHEIMER STREET<br>WBS NO. R-002011-0055-3, CONSULTANT PROJECT NUMBER: G14-109 |    |    |                               |                                   |  |         |                      |                          |
|--|--------|------------|------|----------------|-------------------|-------------------|--|----|----|-------------------------------|-----------------------------------|--|---------|----------------------|--------------------------|
| BORING NO.   | Sample |            |      | SPT (blows/ft) | WATER CONTENT (%) | DRY DENSITY (pcf) | Atterberg Limits   |    |    | PERCENT PASSING SIEVE 200 (%) | UNDRAINED SHEAR STRENGTH (TSF)    |  |         |                      | TYPE OF MATERIAL         |
|  | NO.    | DEPTH (ft) | TYPE |                |                   |                   | LL   | PL | PI |                               | UNCONFINED COMPRESSION TEST (TSF) | UU TEST ( CONFINING PRESSURE ) ( TSF ) | TORVANE | POCKET PENETRO-METER |                          |
| B-3  | 1      | 0-2        | UD   |                | 19                |                   | 52   | 19 | 33 | 83                            |                                   |  |         | 4.00                 | Fat Clay with Sand (CH)  |
|  | 2      | 2-4        | UD   |                | 21                | 110               |  |    |    |                               | 0.70                              |  |         | 2.00                 | Fat Clay with Sand (CH)  |
|  | 3      | 4-6        | UD   |                | 19                |                   |  |    |    |                               |                                   |  |         | 4.50                 | Fat Clay with Sand (CH)  |
|  | 4      | 6-8        | UD   |                | 21                |                   |  |    |    |                               |                                   |  |         | 3.75                 | Fat Clay with Sand (CH)  |
|  | 5      | 8-10       | UD   |                | 16                | 112               |  |    |    |                               | 0.30                              |  |         | 1.00                 | Fat Clay with Sand (CH)  |
|  | 6      | 10-12      | SS   | 6              | 13                |                   |  |    |    |                               |                                   |  |         |                      | Silty Sand (SM)          |
|  | 7      | 12-14      | SS   | 8              | 26                |                   |  |    |    |                               |                                   |  |         |                      | Silty Sand (SM)          |
|  | 8      | 14-16      | SS   | 12             | 29                |                   |  |    |    | 48                            |                                   |  |         |                      | Silty Sand (SM)          |
|  | 9      | 16-18      | SS   | 12             | 22                |                   | 45   | 18 | 27 |                               |                                   |  |         |                      | Lean Clay with Sand (CL) |
|  | 10     | 18-20      | UD   |                | 18                |                   | 38   | 17 | 21 |                               |                                   |  |         | 4.00                 | Lean Clay with Sand (CL) |
| B-4  | 1      | 0-2        | UD   |                | 17                |                   |  |    |    |                               |                                   |  |         | 4.00                 | Sandy Lean Clay (CL)     |
|  | 2      | 2-4        | UD   |                | 16                | 116               |  |    |    |                               | 1.55                              |  |         | 4.00                 | Sandy Lean Clay (CL)     |
|  | 3      | 4-6        | UD   |                | 16                |                   | 32   | 16 | 16 | 54                            |                                   |  |         | 3.50                 | Sandy Lean Clay (CL)     |
|  | 4      | 6-8        | UD   |                | 17                | 112               |  |    |    |                               | 0.60                              |  |         | 2.00                 | Sandy Lean Clay (CL)     |
|  | 5      | 8-10       | SS   | 13             | 22                |                   |  |    |    |                               |                                   |  |         |                      | Silty Sand (SM)          |
|  | 6      | 10-12      | SS   | 14             | 23                |                   |  |    |    |                               |                                   |  |         |                      | Silty Sand (SM)          |
|  | 7      | 12-14      | SS   | 11             | 25                |                   |  |    |    | 25                            |                                   |  |         |                      | Silty Sand (SM)          |
|  | 8      | 14-16      | SS   | 8              | 25                |                   |  |    |    |                               |                                   |  |         |                      | Silty Sand (SM)          |
|  | 9      | 16-18      | SS   | 9              | 25                |                   |  |    |    |                               |                                   |  |         |                      | Silty Sand (SM)          |
|  | 10     | 18-20      | UD   |                | 22                |                   | 25   | 15 | 10 |                               |                                   |  |         | 2.00                 | Sandy Lean Clay (CL)     |

**Legend:** UD - Undisturbed Sample Extruded in Field  
 UL - Undisturbed Sample Extruded in Lab  
 Designates consolidation test Performed

AG - Auger Cutting in Field  
 SS - Split Spoon Sample  
 SPT - Standard Penetration Test

**TABLE 3** (cont'd)

| ASSOCIATED TESTING LABORATORIES, INC.        |        |            |      | PROJECT NAME : PROPOSED NEIGHBORHOOD SEWER SYSTEM IMPROVEMNET |                   |                   |                  |    |    |                               |                                   |  |         |                      |                          |                 |
|--|--------|------------|------|---|-------------------|-------------------|------------------|----|----|-------------------------------|-----------------------------------|--|---------|----------------------|--------------------------|-----------------|
| 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052 |        |            |      | SUNSET BOULEVARD, UNIVESRITY BOULEVARD AND WESTHEIMER STREET  |                   |                   |                  |    |    |                               |                                   |  |         |                      |                          |                 |
| TEL: (713) 748-3717 FAX: (713) 748-3748      |        |            |      | WBS NO. R-002011-0055-3, CONSULTANT PROJECT NUMBER: G14-109   |                   |                   |                  |    |    |                               |                                   |  |         |                      |                          |                 |
| BORING NO.                                   | Sample |            |      | SPT (blows/ft)  | WATER CONTENT (%) | DRY DENSITY (pcf) | Atterberg Limits |    |    | PERCENT PASSING SIEVE 200 (%) | UNDRAINED SHEAR STRENGTH (TSF)    |  |         |                      | TYPE OF MATERIAL         |                 |
|  | NO.    | DEPTH (ft) | TYPE |   |                   |                   | LL               | PL | PI |                               | UNCONFINED COMPRESSION TEST (TSF) | UU TEST ( CONFINING PRESSURE ) ( TSF ) | TORVANE | POCKET PENETRO-METER |                          |                 |
| B-5  | 1      | 0-2        | UD   |   | 27                |                   |                  |    |    |                               |                                   |  |         | 2.75                 | Fat Clay with sand (CH)  |                 |
|  | 2      | 2-4        | UD   |   | 19                |                   |                  |    |    |                               |                                   |  |         | 3.50                 | Fat Clay with sand (CH)  |                 |
|  | 3      | 4-6        | UD   |   | 21                |                   | 62               | 21 | 41 | 80                            |                                   |  |         | 3.00                 | Fat Clay with sand (CH)  |                 |
|  | 4      | 6-8        | UD   |   | 21                |                   |                  |    |    |                               |                                   |  |         | 1.50                 | Fat Clay with sand (CH)  |                 |
|  | 5      | 8-10       | UD   |   | 21                | 106               |                  |    |    |                               | 0.70                              |  |         | 2.00                 | Fat Clay with sand (CH)  |                 |
|  | 6      | 10-12      | UD   |   | 26                |                   | 43               | 18 | 25 |                               |                                   |  |         | 1.00                 | Sandy Lean Clay (CL)     |                 |
|  | 7      | 12-14      | UD   |   | 23                |                   |                  |    |    |                               |                                   |  |         | 1.00                 | Sandy Lean Clay (CL)     |                 |
|  | 8      | 14-16      | SS   | 7   | 24                |                   |                  |    |    | 45                            |                                   |  |         |                      |                          | Silty Sand (SM) |
|  | 9      | 16-18      | UD   |   | 21                |                   |                  |    |    |                               |                                   |  |         | 3.00                 | Fat Clay with sand (CH)  |                 |
|  | 10     | 18-20      | UD   |   | 23                | 107               |                  |    |    |                               | 1.25                              |  |         | 3.50                 | Fat Clay with sand (CH)  |                 |
|  | 11     | 23-25      | UD   |   | 17                |                   | 51               | 19 | 32 | 83                            |                                   |  |         | 4.00                 | Fat Clay with sand (CH)  |                 |
| B-6  | 1      | 0-2        | UD   |   | 28                |                   |                  |    |    |                               |                                   |  |         | 2.50                 | Fat Clay (CH)            |                 |
|  | 2      | 2-4        | UD   |   | 19                |                   |                  |    |    |                               |                                   |  |         | 3.00                 | Fat Clay (CH)            |                 |
|  | 3      | 4-6        | UD   |   | 23                |                   | 66               | 21 | 45 | 90                            |                                   |  |         | 2.75                 | Fat Clay (CH)            |                 |
|  | 4      | 6-8        | UD   |   | 24                | 103               |                  |    |    |                               | 0.85                              |  |         | 2.00                 | Fat Clay (CH)            |                 |
|  | 5      | 8-10       | UD   |   | 27                |                   |                  |    |    |                               |                                   |  |         | 3.50                 | Fat Clay (CH)            |                 |
|  | 6      | 10-12      | UD   |   | 20                |                   |                  |    |    |                               |                                   |  |         | 3.00                 | Fat Clay (CH)            |                 |
|  | 7      | 12-14      | UD   |   | 19                |                   | 32               | 16 | 16 | 85                            |                                   |  |         | 2.00                 | Lean Clay with Sand (CL) |                 |
|  | 8      | 14-16      | UD   |   | 18                | 112               |                  |    |    |                               | 0.50                              |  |         | 2.00                 | Lean Clay with Sand (CL) |                 |
|  | 9      | 16-18      | UD   |   | 19                |                   |                  |    |    |                               |                                   |  |         | 2.50                 | Lean Clay with Sand (CL) |                 |
|  | 10     | 18-20      | UD   |   | 17                | 114               |                  |    |    |                               |                                   | 1.05(0.86)                             |         | 2.75                 | Lean Clay with Sand (CL) |                 |

**Legend:** UD - Undisturbed Sample Extruded in Field  
 UL - Undisturbed Sample Extruded in Lab  
 Designates consolidation test Performed

AG - Auger Cutting in Field  
 SS - Split Spoon Sample  
 SPT - Standard Penetration Test

**TABLE 3** (cont'd)

| ASSOCIATED TESTING LABORATORIES, INC.<br>3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052<br>TEL: (713) 748-3717 FAX: (713) 748-3748 |        |            |      |                |                   |                   |                  |    |    | PROJECT NAME : PROPOSED NEIGHBORHOOD SEWER SYSTEM IMPROVEMNET<br>SUNSET BOULEVARD, UNIVESRITY BOULEVARD AND WESTHEIMER STREET<br>WBS NO. R-002011-0055-3, CONSULTANT PROJECT NUMBER: G14-109 |                                   |  |         |                      |                         |
|--|--------|------------|------|----------------|-------------------|-------------------|------------------|----|----|--|-----------------------------------|--|---------|----------------------|-------------------------|
| BORING NO.   | Sample |            |      | SPT (blows/ft) | WATER CONTENT (%) | DRY DENSITY (pcf) | Atterberg Limits |    |    | PERCENT PASSING SIEVE 200 (%)  | UNDRAINED SHEAR STRENGTH (TSF)    |  |         |                      | TYPE OF MATERIAL        |
|  | NO.    | DEPTH (ft) | TYPE |                |                   |                   | LL               | PL | PI |  | UNCONFINED COMPRESSION TEST (TSF) | UU TEST ( CONFINING PRESSURE ) ( TSF ) | TORVANE | POCKET PENETRO-METER |                         |
| B-7  | 1      | 0-2        | UD   |                | 28                |                   | 65               | 21 | 44 | 74   |                                   |  |         | 1.50                 | Fat Clay with Sand (CH) |
|  | 2      | 2-4        | UD   |                | 25                | 98                |                  |    |    |  | 0.60                              |  |         | 2.00                 | Fat Clay with Sand (CH) |
|  | 3      | 4-6        | UD   |                | 26                |                   |                  |    |    |  |                                   |  |         | 1.75                 | Fat Clay with Sand (CH) |
|  | 4      | 6-8        | UD   |                | 26                | 99                |                  |    |    |  | 0.55                              |  |         | 2.00                 | Fat Clay with Sand (CH) |
|  | 5      | 8-10       | UD   |                | 23                |                   | 54               | 19 | 35 | 77   |                                   |  |         | 3.00                 | Fat Clay with Sand (CH) |
|  | 6      | 10-12      | UD   |                | 13                |                   | 33               | 16 | 17 |  |                                   |  |         | 1.00                 | Sandy Lean Clay (CL)    |
|  | 7      | 12-14      | SS   | 7              | 17                |                   |                  |    |    | 15   |                                   |  |         |                      | Silty Sand (SM)         |
|  | 8      | 14-16      | SS   | 17             | 23                |                   |                  |    |    |  |                                   |  |         |                      | Silty Sand (SM)         |
|  | 9      | 16-18      | UD   |                | 17                | 114               |                  |    |    |  |                                   | 1.46(0.79)                             |         | 3.75                 | Fat Clay with Sand (CH) |
|  | 10     | 18-20      | UD   |                | 20                |                   | 53               | 19 | 34 |  |                                   |  |         | 4.00                 | Fat Clay with Sand (CH) |
| B-8  | 1      | 0-2        | UD   |                | 22                |                   |                  |    |    |  |                                   |  |         | 3.25                 | Sandy Lean Clay (CL)    |
|  | 2      | 2-4        | UD   |                | 18                |                   | 43               | 18 | 25 | 52   |                                   |  |         | 3.00                 | Sandy Lean Clay (CL)    |
|  | 3      | 4-6        | UD   |                | 23                |                   |                  |    |    |  |                                   |  |         | 2.50                 | Sandy Lean Clay (CL)    |
|  | 4      | 6-8        | UD   |                | 18                | 109               |                  |    |    |  | 0.50                              |  |         | 2.00                 | Sandy Lean Clay (CL)    |
|  | 5      | 8-10       | UD   |                | 21                |                   |                  |    |    |  |                                   |  |         | 1.75                 | Sandy Lean Clay (CL)    |
|  | 6      | 10-12      | UD   |                | 21                |                   | 42               | 18 | 24 |  |                                   |  |         | 2.00                 | Sandy Lean Clay (CL)    |
|  | 7      | 12-14      | UD   |                | 22                |                   |                  |    |    |  |                                   |  |         | 1.00                 | Sandy Lean Clay (CL)    |
|  | 8      | 14-15.5    | SS   | 9              | 25                |                   |                  |    |    | 22   |                                   |  |         |                      | Silty Sand (SM)         |

**Legend:** UD - Undisturbed Sample Extruded in Field  
 UL - Undisturbed Sample Extruded in Lab  
 Designates consolidation test Performed

AG - Auger Cutting in Field  
 SS - Split Spoon Sample  
 SPT - Standard Penetration Test

**TABLE 3** (cont'd)

| ASSOCIATED TESTING LABORATORIES, INC.<br>3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052<br>TEL: (713) 748-3717 FAX: (713) 748-3748 |        |            |      |                |                   |                   | PROJECT NAME : PROPOSED NEIGHBORHOOD SEWER SYSTEM IMPROVEMNET<br>SUNSET BOULEVARD, UNIVESRITY BOULEVARD AND WESTHEIMER STREET<br>WBS NO. R-002011-0055-3, CONSULTANT PROJECT NUMBER: G14-109 |    |    |                               |                                   |  |         |                      |                         |
|--|--------|------------|------|----------------|-------------------|-------------------|--|----|----|-------------------------------|-----------------------------------|--|---------|----------------------|-------------------------|
| BORING NO.   | Sample |            |      | SPT (blows/ft) | WATER CONTENT (%) | DRY DENSITY (pcf) | Atterberg Limits   |    |    | PERCENT PASSING SIEVE 200 (%) | UNDRAINED SHEAR STRENGTH (TSF)    |  |         |                      | TYPE OF MATERIAL        |
|  | NO.    | DEPTH (ft) | TYPE |                |                   |                   | LL   | PL | PI |                               | UNCONFINED COMPRESSION TEST (TSF) | UU TEST ( CONFINING PRESSURE ) ( TSF ) | TORVANE | POCKET PENETRO-METER |                         |
| B-9  | 1      | 0-2        | UD   |                | 24                |                   | 64   | 21 | 43 | 87                            |                                   |  |         | 1.50                 | Fat Clay (CH)           |
|  | 2      | 2-4        | UD   |                | 23                |                   |  |    |    |                               |                                   |  |         | 1.75                 | Fat Clay (CH)           |
|  | 3      | 4-6        | UD   |                | 23                |                   |  |    |    |                               |                                   |  |         | 2.00                 | Fat Clay (CH)           |
|  | 4      | 6-8        | UD   |                | 26                | 98                |  |    |    |                               | 1.05                              |  |         | 3.50                 | Fat Clay (CH)           |
|  | 5      | 8-10       | UD   |                | 29                |                   |  |    |    |                               |                                   |  |         | 3.00                 | Fat Clay (CH)           |
|  | 6      | 10-12      | UD   |                | 22                |                   |  |    |    |                               |                                   |  |         | 3.25                 | Fat Clay (CH)           |
|  | 7      | 12-14      | UD   |                | 18                | 111               |  |    |    |                               | 0.55                              |  |         | 2.00                 | Lean Clay (CL)          |
|  | 8      | 14-16      | UD   |                | 16                |                   | 45   | 18 | 27 | 87                            |                                   |  |         | 3.00                 | Lean Clay (CL)          |
|  | 9      | 16-18      | UD   |                | 18                |                   |  |    |    |                               |                                   |  |         | 4.00                 | Lean Clay (CL)          |
|  | 10     | 18-20      | UD   |                | 16                | 121               |  |    |    |                               |                                   | 3.34(0.86)                             |         | 4.50                 | Lean Clay (CL)          |
| B-10   | 1      | 0-2        | UD   |                | 31                |                   |  |    |    |                               |                                   |  |         | 1.00                 | Fat Clay with Sand (CH) |
|  | 2      | 2-4        | UD   |                | 31                | 95                |  |    |    |                               | 0.50                              |  |         | 2.00                 | Fat Clay with Sand (CH) |
|  | 3      | 4-6        | UD   |                | 30                |                   | 77   | 23 | 54 | 84                            |                                   |  |         | 1.50                 | Fat Clay with Sand (CH) |
|  | 4      | 6-8        | UD   |                | 29                |                   |  |    |    |                               |                                   |  |         | 2.00                 | Fat Clay with Sand (CH) |
|  | 5      | 8-10       | UD   |                | 29                |                   |  |    |    |                               |                                   |  |         | 2.00                 | Fat Clay with Sand (CH) |
|  | 6      | 10-12      | UD   |                | 28                | 101               |  |    |    |                               | 1.10                              |  |         | 3.50                 | Fat Clay with Sand (CH) |
|  | 7      | 12-14      | UD   |                | 20                |                   |  |    |    |                               |                                   |  |         | 1.75                 | Fat Clay with Sand (CH) |
|  | 8      | 14-16      | UD   |                | 20                | 113               |  |    |    |                               |                                   | 1.31(0.65)                             |         | 3.50                 | Fat Clay with Sand (CH) |
|  | 9      | 16-18      | UD   |                | 20                |                   | 66   | 21 | 45 | 81                            |                                   |  |         | 2.50                 | Fat Clay with Sand (CH) |
|  | 10     | 18-20      | UD   |                | 20                |                   |  |    |    |                               |                                   |  |         | 3.75                 | Fat Clay with Sand (CH) |

**Legend:** UD - Undisturbed Sample Extruded in Field  
UL - Undisturbed Sample Extruded in Lab  
Designates consolidation test Performed

AG - Auger Cutting in Field  
SS - Split Spoon Sample  
SPT - Standard Penetration Test

**TABLE 3** (cont'd)

| ASSOCIATED TESTING LABORATORIES, INC.<br>3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052<br>TEL: (713) 748-3717 FAX: (713) 748-3748 |        |            |      |                |                   |                   |                  |    |    | PROJECT NAME : PROPOSED NEIGHBORHOOD SEWER SYSTEM IMPROVEMNET<br>SUNSET BOULEVARD, UNIVESRITY BOULEVARD AND WESTHEIMER STREET<br>WBS NO. R-002011-0055-3, CONSULTANT PROJECT NUMBER: G14-109 |                                   |  |         |                      |                          |
|--|--------|------------|------|----------------|-------------------|-------------------|------------------|----|----|--|-----------------------------------|--|---------|----------------------|--------------------------|
| BORING NO.   | Sample |            |      | SPT (blows/ft) | WATER CONTENT (%) | DRY DENSITY (pcf) | Atterberg Limits |    |    | PERCENT PASSING SIEVE 200 (%)  | UNDRAINED SHEAR STRENGTH (TSF)    |  |         |                      | TYPE OF MATERIAL         |
|  | NO.    | DEPTH (ft) | TYPE |                |                   |                   | LL               | PL | PI |  | UNCONFINED COMPRESSION TEST (TSF) | UU TEST ( CONFINING PRESSURE ) ( TSF ) | TORVANE | POCKET PENETRO-METER |                          |
| B-11   | 1      | 0-2        | UD   |                | 29                |                   | 76               | 23 | 53 | 78   |                                   |  |         | 1.50                 | Fat Clay with Sand (CH)  |
|  | 2      | 2-4        | UD   |                | 29                |                   |                  |    |    |  |                                   |  |         | 1.50                 | Fat Clay with Sand (CH)  |
|  | 3      | 4-6        | UD   |                | 28                |                   |                  |    |    |  |                                   |  |         | 1.75                 | Fat Clay with Sand (CH)  |
|  | 4      | 6-8        | UD   |                | 23                | 106               |                  |    |    |  | 1.05                              |  |         | 3.50                 | Fat Clay with Sand (CH)  |
|  | 5      | 8-10       | UD   |                | 21                |                   | 44               | 18 | 26 |  |                                   |  |         | 3.00                 | Lean Clay with sand (CL) |
|  | 6      | 10-12      | UD   |                | 20                |                   |                  |    |    |  |                                   |  |         | 2.00                 | Lean Clay with sand (CL) |
|  | 7      | 12-13.5    | SS   | 10             | 18                |                   |                  |    |    |  |                                   |  |         |                      | Silty Sand (SM)          |
|  | 8      | 13.5-15    | SS   | 20             | 19                |                   |                  |    |    | 19   |                                   |  |         |                      | Silty Sand (SM)          |
| B-12   | 1      | 0-2        | UD   |                | 24                |                   |                  |    |    |  |                                   |  |         | 1.75                 | Fat Clay with Sand (CH)  |
|  | 2      | 2-4        | UD   |                | 24                |                   | 69               | 22 | 47 | 80   |                                   |  |         | 4.00                 | Fat Clay with Sand (CH)  |
|  | 3      | 4-6        | UD   |                | 19                |                   |                  |    |    |  |                                   |  |         | 3.00                 | Fat Clay with Sand (CH)  |
|  | 4      | 6-8        | UD   |                | 23                |                   |                  |    |    |  |                                   |  |         | 3.50                 | Fat Clay with Sand (CH)  |
|  | 5      | 8-10       | UD   |                | 23                | 106               |                  |    |    |  | 0.90                              |  |         | 2.00                 | Fat Clay with Sand (CH)  |
|  | 6      | 10-12      | UD   |                | 18                |                   |                  |    |    |  |                                   |  |         | 3.25                 | Lean Clay with Sand (CL) |
|  | 7      | 12-14      | UD   |                | 18                |                   |                  |    |    |  |                                   |  |         | 4.00                 | Lean Clay with Sand (CL) |
|  | 8      | 14-16      | UD   |                | 14                |                   | 36               | 17 | 19 | 82   |                                   |  |         | 3.50                 | Lean Clay with Sand (CL) |
|  | 9      | 16-18      | UD   |                | 21                | 109               |                  |    |    |  | 0.70                              |  |         | 2.00                 | Lean Clay with Sand (CL) |
|  | 10     | 18-20      | UD   |                | 21                |                   |                  |    |    |  |                                   |  |         | 1.50                 | Lean Clay with Sand (CL) |

**Legend:** UD - Undisturbed Sample Extruded in Field  
UL - Undisturbed Sample Extruded in Lab  
Designates consolidation test Performed

AG - Auger Cutting in Field  
SS - Split Spoon Sample  
SPT - Standard Penetration Test

**TABLE 3** (cont'd)

| ASSOCIATED TESTING LABORATORIES, INC.<br>3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052<br>TEL: (713) 748-3717 FAX: (713) 748-3748 |        |            |      |                |                   |                   | PROJECT NAME : PROPOSED NEIGHBORHOOD SEWER SYSTEM IMPROVEMNET<br>SUNSET BOULEVARD, UNIVESRITY BOULEVARD AND WESTHEIMER STREET<br>WBS NO. R-002011-0055-3, CONSULTANT PROJECT NUMBER: G14-109 |    |    |                               |                                   |  |         |                      |                         |
|--|--------|------------|------|----------------|-------------------|-------------------|--|----|----|-------------------------------|-----------------------------------|--|---------|----------------------|-------------------------|
| BORING NO.   | Sample |            |      | SPT (blows/ft) | WATER CONTENT (%) | DRY DENSITY (pcf) | Atterberg Limits   |    |    | PERCENT PASSING SIEVE 200 (%) | UNDRAINED SHEAR STRENGTH (TSF)    |  |         |                      | TYPE OF MATERIAL        |
|  | NO.    | DEPTH (ft) | TYPE |                |                   |                   | LL   | PL | PI |                               | UNCONFINED COMPRESSION TEST (TSF) | UU TEST ( CONFINING PRESSURE ) ( TSF ) | TORVANE | POCKET PENETRO-METER |                         |
| B-13   | 1      | 0-2        | UD   |                | 25                |                   | 63   | 21 | 42 | 81                            |                                   |  |         | 1.50                 | Fat Clay with Sand (CH) |
|  | 2      | 2-4        | UD   |                | 24                |                   |  |    |    |                               |                                   |  |         | 1.50                 | Fat Clay with Sand (CH) |
|  | 3      | 4-6        | UD   |                | 25                | 100               |  |    |    |                               | 0.65                              |  |         | 2.00                 | Fat Clay with Sand (CH) |
|  | 4      | 6-8        | UD   |                | 28                |                   |  |    |    |                               |                                   |  |         | 1.50                 | Fat Clay with Sand (CH) |
|  | 5      | 8-10       | UD   |                | 24                |                   |  |    |    |                               |                                   |  |         | 2.00                 | Fat Clay with Sand (CH) |
|  | 6      | 10-12      | UD   |                | 25                | 104               |  |    |    |                               | 0.75                              |  |         | 2.00                 | Fat Clay with Sand (CH) |
|  | 7      | 12-14      | UD   |                | 24                |                   |  |    |    |                               |                                   |  |         | 3.75                 | Fat Clay with Sand (CH) |
|  | 8      | 14-16      | UD   |                | 19                |                   | 61   | 21 | 40 | 83                            |                                   |  |         | 4.00                 | Fat Clay with Sand (CH) |
|  | 9      | 16-18      | UD   |                | 18                | 117               |  |    |    |                               |                                   | 2.10(0.79)                             |         | 4.25                 | Fat Clay with Sand (CH) |
|  | 10     | 18-20      | UD   |                | 17                |                   |  |    |    |                               |                                   |  |         | 3.75                 | Fat Clay with Sand (CH) |
| B-14   | 1      | 0-2        | UD   |                | 29                |                   | 71   | 22 | 49 | 71                            |                                   |  |         | 1.75                 | Fat Clay with Sand (CH) |
|  | 2      | 2-4        | UD   |                | 26                |                   |  |    |    |                               |                                   |  |         | 2.00                 | Fat Clay with Sand (CH) |
|  | 3      | 4-6        | UD   |                | 22                |                   |  |    |    |                               |                                   |  |         | 2.50                 | Fat Clay with Sand (CH) |
|  | 4      | 6-8        | UD   |                | 19                | 112               |  |    |    |                               | 2.10                              |  |         | 4.50                 | Fat Clay with Sand (CH) |
|  | 5      | 8-10       | UD   |                | 19                |                   |  |    |    |                               |                                   |  |         | 4.50                 | Fat Clay with Sand (CH) |
|  | 6      | 10-12      | UD   |                | 22                |                   |  |    |    |                               |                                   |  |         | 3.50                 | Fat Clay with Sand (CH) |
|  | 7      | 12-14      | UD   |                | 25                |                   | 70   | 22 | 48 | 82                            |                                   |  |         | 3.50                 | Fat Clay with Sand (CH) |
|  | 8      | 14-15      | UD   |                | 19                |                   |  |    |    |                               |                                   |  |         | 3.00                 | Fat Clay with Sand (CH) |

**Legend:** UD - Undisturbed Sample Extruded in Field  
UL - Undisturbed Sample Extruded in Lab  
Designates consolidation test Performed

AG - Auger Cutting in Field  
SS - Split Spoon Sample  
SPT - Standard Penetration Test

**TABLE 3** (cont'd)

| ASSOCIATED TESTING LABORATORIES, INC.<br>3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052<br>TEL: (713) 748-3717 FAX: (713) 748-3748 |        |            |      |                |                   |                   | PROJECT NAME : PROPOSED NEIGHBORHOOD SEWER SYSTEM IMPROVEMNET<br>SUNSET BOULEVARD, UNIVESRITY BOULEVARD AND WESTHEIMER STREET<br>WBS NO. R-002011-0055-3, CONSULTANT PROJECT NUMBER: G14-109 |    |    |                               |                                   |  |         |                      |                          |
|--|--------|------------|------|----------------|-------------------|-------------------|--|----|----|-------------------------------|-----------------------------------|--|---------|----------------------|--------------------------|
| BORING NO.   | Sample |            |      | SPT (blows/ft) | WATER CONTENT (%) | DRY DENSITY (pcf) | Atterberg Limits   |    |    | PERCENT PASSING SIEVE 200 (%) | UNDRAINED SHEAR STRENGTH (TSF)    |  |         |                      | TYPE OF MATERIAL         |
|  | NO.    | DEPTH (ft) | TYPE |                |                   |                   | LL   | PL | PI |                               | UNCONFINED COMPRESSION TEST (TSF) | UU TEST ( CONFINING PRESSURE ) ( TSF ) | TORVANE | POCKET PENETRO-METER |                          |
| B-15   | 1      | 0-2        | UD   |                | 26                |                   | 62   | 21 | 41 | 84                            |                                   |  |         | 1.50                 | Fat Clay with Sand (CH)  |
|  | 2      | 2-4        | UD   |                | 26                |                   |  |    |    |                               |                                   |  |         | 1.50                 | Fat Clay with Sand (CH)  |
|  | 3      | 4-6        | UD   |                | 23                |                   |  |    |    |                               |                                   |  |         | 2.00                 | Fat Clay with Sand (CH)  |
|  | 4      | 6-8        | UD   |                | 22                | 106               |  |    |    |                               | 0.80                              |  |         | 2.00                 | Fat Clay with Sand (CH)  |
|  | 5      | 8-10       | UD   |                | 24                |                   |  |    |    |                               |                                   |  |         | 3.25                 | Fat Clay with Sand (CH)  |
|  | 6      | 10-12      | UD   |                | 18                |                   | 36   | 17 | 19 | 72                            |                                   |  |         | 2.00                 | Lean Clay with Sand (CL) |
|  | 7      | 12-14      | UD   |                | 19                |                   |  |    |    |                               |                                   |  |         | 1.50                 | Lean Clay with Sand (CL) |
|  | 8      | 14-15      | UD   |                | 17                |                   |  |    |    |                               |                                   |  |         | 2.00                 | Lean Clay with Sand (CL) |
| B-16   | 1      | 0-2        | UD   |                | 25                |                   |  |    |    |                               |                                   |  |         | 1.00                 | Fat Clay with Sand (CH)  |
|  | 2      | 2-4        | UD   |                | 25                |                   | 57   | 20 | 37 | 76                            |                                   |  |         | 1.50                 | Fat Clay with Sand (CH)  |
|  | 3      | 4-6        | UD   |                | 22                |                   |  |    |    |                               |                                   |  |         | 1.50                 | Fat Clay with Sand (CH)  |
|  | 4      | 6-8        | UD   |                | 22                |                   |  |    |    |                               |                                   |  |         | 2.00                 | Fat Clay with Sand (CH)  |
|  | 5      | 8-10       | UD   |                | 25                | 97                |  |    |    |                               | 0.50                              |  |         | 2.00                 | Fat Clay with Sand (CH)  |
|  | 6      | 10-12      | UD   |                | 19                |                   |  |    |    |                               |                                   |  |         | 2.50                 | Fat Clay with Sand (CH)  |
|  | 7      | 12-14      | UD   |                | 20                |                   | 36   | 17 | 19 | 80                            |                                   |  |         | 1.50                 | Lean Clay with Sand (CL) |
|  | 8      | 14-15      | UD   |                | 18                |                   |  |    |    |                               |                                   |  |         | 2.00                 | Lean Clay with Sand (CL) |

**Legend:** UD - Undisturbed Sample Extruded in Field  
UL - Undisturbed Sample Extruded in Lab  
Designates consolidation test Performed

AG - Auger Cutting in Field  
SS - Split Spoon Sample  
SPT - Standard Penetration Test

**TABLE 3** (cont'd)

| <b>ASSOCIATED TESTING LABORATORIES, INC.</b><br>3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052<br>TEL: (713) 748-3717      FAX: (713) 748-3748 |        |            |      |                |                   | <b>PROJECT NAME : PROPOSED NEIGHBORHOOD SEWER SYSTEM IMPROVEMNET</b><br><b>SUNSET BOULEVARD, UNIVESRITY BOULEVARD AND WESTHEIMER STREET</b><br><b>WBS NO. R-002011-0055-3, CONSULTANT PROJECT NUMBER: G14-109</b> |                  |    |    |                               |                                   |  |         |                      |                          |
|--|--------|------------|------|----------------|-------------------|---|------------------|----|----|-------------------------------|-----------------------------------|--|---------|----------------------|--------------------------|
| BORING NO.   | Sample |            |      | SPT (blows/ft) | WATER CONTENT (%) | DRY DENSITY (pcf)   | Atterberg Limits |    |    | PERCENT PASSING SIEVE 200 (%) | UNDRAINED SHEAR STRENGTH (TSF)    |  |         |                      | TYPE OF MATERIAL         |
|  | NO.    | DEPTH (ft) | TYPE |                |                   |   | LL               | PL | PI |                               | UNCONFINED COMPRESSION TEST (TSF) | UU TEST ( CONFINING PRESSURE ) ( TSF ) | TORVANE | POCKET PENETRO-METER |                          |
| B-17   | 1      | 0-2        | UD   |                | 37                |   |                  |    |    |                               |                                   |  |         | 1.00                 | Fat Clay with Sand (CH)  |
|  | 2      | 2-4        | UD   |                | 32                |   | 78               | 23 | 55 | 82                            |                                   |  |         | 1.00                 | Fat Clay with Sand (CH)  |
|  | 3      | 4-6        | UD   |                | 29                |   |                  |    |    |                               |                                   |  |         | 1.75                 | Fat Clay with Sand (CH)  |
|  | 4      | 6-8        | UD   |                | 35                |   |                  |    |    |                               |                                   |  |         | 1.50                 | Fat Clay with Sand (CH)  |
|  | 5      | 8-10       | UD   |                | 22                | 103   |                  |    |    |                               | 0.80                              |  |         | 2.00                 | Fat Clay with Sand (CH)  |
|  | 6      | 10-12      | UD   |                | 19                |   |                  |    |    |                               |                                   |  |         | 1.75                 | Lean Clay with Sand (CL) |
|  | 7      | 12-14      | UD   |                | 19                |   |                  |    |    |                               |                                   |  |         | 1.75                 | Lean Clay with Sand (CL) |
|  | 8      | 14-15      | UD   |                | 17                |   | 45               | 18 | 27 | 74                            |                                   |  |         | 3.75                 | Lean Clay with Sand (CL) |
|  |        |            |      |                |                   |   |                  |    |    |                               |                                   |  |         |                      |                          |
|  |        |            |      |                |                   |   |                  |    |    |                               |                                   |  |         |                      |                          |
| B-18   | 1      | 0-2        | UD   |                | 24                |   |                  |    |    |                               |                                   |  |         | 1.50                 | Fat Clay with Sand (CH)  |
|  | 2      | 2-4        | UD   |                | 23                |   |                  |    |    |                               |                                   |  |         | 2.00                 | Fat Clay with Sand (CH)  |
|  | 3      | 4-6        | UD   |                | 19                |   | 56               | 20 | 36 | 80                            |                                   |  |         | 2.00                 | Fat Clay with Sand (CH)  |
|  | 4      | 6-8        | UD   |                | 32                |   |                  |    |    |                               |                                   |  |         | 1.50                 | Fat Clay with Sand (CH)  |
|  | 5      | 8-10       | UD   |                | 29                |   |                  |    |    |                               |                                   |  |         | 1.50                 | Fat Clay with Sand (CH)  |
|  | 6      | 10-12      | UD   |                | 19                | 112   |                  |    |    |                               | 0.85                              |  |         | 2.00                 | Lean Clay with Sand (CL) |
|  | 7      | 12-14      | UD   |                | 19                |   |                  |    |    |                               |                                   |  |         | 2.75                 | Lean Clay with Sand (CL) |
|  | 8      | 14-15      | UD   |                | 17                |   | 46               | 18 | 28 | 79                            |                                   |  |         | 3.00                 | Lean Clay with Sand (CL) |
|  |        |            |      |                |                   |   |                  |    |    |                               |                                   |  |         |                      |                          |
|  |        |            |      |                |                   |   |                  |    |    |                               |                                   |  |         |                      |                          |

**Legend:**      UD - Undisturbed Sample Extruded in Field      AG - Auger Cutting in Field  
 UL - Undisturbed Sample Extruded in Lab      SS - Split Spoon Sample  
 Designates consolidation test Performed      SPT - Standard Penetration Test

**TABLE 3** (cont'd)

| ASSOCIATED TESTING LABORATORIES, INC.<br>3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052<br>TEL: (713) 748-3717 FAX: (713) 748-3748 |        |            |      |                |                   | PROJECT NAME : PROPOSED NEIGHBORHOOD SEWER SYSTEM IMPROVEMNET<br>SUNSET BOULEVARD, UNIVESRITY BOULEVARD AND WESTHEIMER STREET<br>WBS NO. R-002011-0055-3, CONSULTANT PROJECT NUMBER: G14-109 |                  |    |    |                               |                                   |  |         |                      |                          |
|--|--------|------------|------|----------------|-------------------|--|------------------|----|----|-------------------------------|-----------------------------------|--|---------|----------------------|--------------------------|
| BORING NO.   | Sample |            |      | SPT (blows/ft) | WATER CONTENT (%) | DRY DENSITY (pcf)  | Atterberg Limits |    |    | PERCENT PASSING SIEVE 200 (%) | UNDRAINED SHEAR STRENGTH (TSF)    |  |         |                      | TYPE OF MATERIAL         |
|  | NO.    | DEPTH (ft) | TYPE |                |                   |  | LL               | PL | PI |                               | UNCONFINED COMPRESSION TEST (TSF) | UU TEST ( CONFINING PRESSURE ) ( TSF ) | TORVANE | POCKET PENETRO-METER |                          |
| B-19   | 1      | 0-2        | UD   |                | 24                |  |                  |    |    |                               |                                   |  |         | 3.25                 | Fat Clay with Sand (CH)  |
|  | 2      | 2-4        | UD   |                | 16                |  | 61               | 21 | 40 | 83                            |                                   |  |         | 4.50                 | Fat Clay with Sand (CH)  |
|  | 3      | 4-6        | UD   |                | 20                | 108  |                  |    |    |                               | 2.20                              |  |         | 4.50                 | Fat Clay with Sand (CH)  |
|  | 4      | 6-8        | UD   |                | 22                |  |                  |    |    |                               |                                   |  |         | 4.50                 | Fat Clay with Sand (CH)  |
|  | 5      | 8-10       | UD   |                | 20                |  |                  |    |    |                               |                                   |  |         | 4.50                 | Fat Clay with Sand (CH)  |
|  | 6      | 10-12      | UD   |                | 20                |  |                  |    |    |                               |                                   |  |         | 3.25                 | Fat Clay with Sand (CH)  |
|  | 7      | 12-14      | UD   |                | 13                |  |                  |    |    |                               |                                   |  |         | 4.50                 | Fat Clay with Sand (CH)  |
|  | 8      | 14-16      | UD   |                | 14                |  | 51               | 19 | 32 | 82                            |                                   |  |         | 4.50                 | Fat Clay with Sand (CH)  |
|  |        |            |      |                |                   |  |                  |    |    |                               |                                   |  |         |                      |                          |
|  |        |            |      |                |                   |  |                  |    |    |                               |                                   |  |         |                      |                          |
| B-20   | 1      | 0-2        | UD   |                | 31                |  |                  |    |    |                               |                                   |  |         | 1.75                 | Fat Clay with Sand (CH)  |
|  | 2      | 2-4        | UD   |                | 27                |  | 71               | 22 | 49 | 76                            |                                   |  |         | 2.00                 | Fat Clay with Sand (CH)  |
|  | 3      | 4-6        | UD   |                | 29                |  |                  |    |    |                               |                                   |  |         | 1.50                 | Fat Clay with Sand (CH)  |
|  | 4      | 6-8        | UD   |                | 33                |  |                  |    |    |                               |                                   |  |         | 1.75                 | Fat Clay with Sand (CH)  |
|  | 5      | 8-10       | UD   |                | 36                | 88   |                  |    |    |                               | 0.65                              |  |         | 2.00                 | Fat Clay with Sand (CH)  |
|  | 6      | 10-12      | UD   |                | 28                |  |                  |    |    |                               |                                   |  |         | 1.75                 | Fat Clay with Sand (CH)  |
|  | 7      | 12-14      | UD   |                | 21                |  | 36               | 17 | 19 | 82                            |                                   |  |         | 1.50                 | Lean Clay with Sand (CL) |
|  | 8      | 14-16      | UD   |                | 18                |  |                  |    |    |                               |                                   |  |         | 4.00                 | Lean Clay with Sand (CL) |
|  |        |            |      |                |                   |  |                  |    |    |                               |                                   |  |         |                      |                          |
|  |        |            |      |                |                   |  |                  |    |    |                               |                                   |  |         |                      |                          |

**Legend:** UD - Undisturbed Sample Extruded in Field  
 UL - Undisturbed Sample Extruded in Lab  
 Designates consolidation test Performed

AG - Auger Cutting in Field  
 SS - Split Spoon Sample  
 SPT - Standard Penetration Test

**TABLE 4  
MARSTON SOIL COEFFICIENTS (Cd) FOR TRENCH CONDUITS**

A =  $K_u' = 0.1924$  Granular materials without cohesion  
 B =  $K_u' = 0.165$  Maximum for sand and gravel  
 C =  $K_u' = 0.150$  Maximum for saturated top soil

D =  $K_u' = 0.130$  Ordinary maximum for clay  
 E =  $K_u' = 0.110$  Maximum for saturated clay

| H/B <sub>d</sub> | A     | B     | C     | D     | E     |
|------------------|-------|-------|-------|-------|-------|
| 0.05             | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 |
| 0.10             | 0.098 | 0.098 | 0.099 | 0.099 | 0.099 |
| 0.15             | 0.146 | 0.146 | 0.147 | 0.147 | 0.148 |
| 0.20             | 0.192 | 0.194 | 0.194 | 0.195 | 0.196 |
| 0.25             | 0.238 | 0.240 | 0.241 | 0.242 | 0.243 |
| 0.30             | 0.283 | 0.286 | 0.287 | 0.289 | 0.290 |
| 0.35             | 0.327 | 0.331 | 0.332 | 0.335 | 0.337 |
| 0.40             | 0.371 | 0.375 | 0.377 | 0.380 | 0.383 |
| 0.45             | 0.413 | 0.418 | 0.421 | 0.425 | 0.428 |
| 0.50             | 0.455 | 0.461 | 0.464 | 0.469 | 0.473 |
| 0.55             | 0.496 | 0.503 | 0.507 | 0.512 | 0.518 |
| 0.60             | 0.536 | 0.544 | 0.549 | 0.555 | 0.562 |
| 0.65             | 0.575 | 0.585 | 0.591 | 0.598 | 0.606 |
| 0.70             | 0.614 | 0.625 | 0.631 | 0.640 | 0.649 |
| 0.75             | 0.651 | 0.664 | 0.672 | 0.681 | 0.691 |
| 0.80             | 0.689 | 0.703 | 0.711 | 0.722 | 0.734 |
| 0.85             | 0.725 | 0.741 | 0.750 | 0.763 | 0.775 |
| 0.90             | 0.761 | 0.779 | 0.789 | 0.802 | 0.817 |
| 0.95             | 0.796 | 0.816 | 0.827 | 0.842 | 0.857 |
| 1.00             | 0.830 | 0.852 | 0.864 | 0.881 | 0.898 |
| 1.05             | 0.864 | 0.887 | 0.901 | 0.919 | 0.938 |
| 1.10             | 0.897 | 0.922 | 0.937 | 0.957 | 0.977 |
| 1.15             | 0.929 | 0.957 | 0.973 | 0.994 | 1.016 |
| 1.20             | 0.961 | 0.991 | 1.008 | 1.031 | 1.055 |
| 1.25             | 0.992 | 1.024 | 1.042 | 1.067 | 1.093 |
| 1.30             | 1.023 | 1.057 | 1.076 | 1.103 | 1.131 |
| 1.35             | 1.053 | 1.089 | 1.110 | 1.139 | 1.168 |
| 1.40             | 1.082 | 1.121 | 1.143 | 1.173 | 1.205 |
| 1.45             | 1.111 | 1.152 | 1.176 | 1.208 | 1.241 |
| 1.50             | 1.140 | 1.183 | 1.208 | 1.242 | 1.278 |
| 1.55             | 1.167 | 1.213 | 1.240 | 1.276 | 1.313 |
| 1.60             | 1.195 | 1.243 | 1.271 | 1.309 | 1.349 |
| 1.65             | 1.221 | 1.272 | 1.301 | 1.342 | 1.384 |
| 1.70             | 1.248 | 1.301 | 1.332 | 1.374 | 1.418 |
| 1.75             | 1.273 | 1.329 | 1.361 | 1.406 | 1.452 |
| 1.80             | 1.299 | 1.357 | 1.391 | 1.437 | 1.486 |
| 1.85             | 1.323 | 1.385 | 1.420 | 1.469 | 1.520 |
| 1.90             | 1.348 | 1.412 | 1.448 | 1.499 | 1.553 |
| 1.95             | 1.372 | 1.438 | 1.476 | 1.530 | 1.586 |
| 2.00             | 1.395 | 1.464 | 1.504 | 1.560 | 1.618 |
| 2.10             | 1.440 | 1.515 | 1.558 | 1.618 | 1.682 |
| 2.20             | 1.484 | 1.564 | 1.610 | 1.675 | 1.744 |
| 2.30             | 1.526 | 1.612 | 1.661 | 1.731 | 1.805 |
| 2.40             | 1.567 | 1.658 | 1.711 | 1.785 | 1.865 |
| 2.50             | 1.606 | 1.702 | 1.759 | 1.838 | 1.923 |
| 2.60             | 1.643 | 1.745 | 1.805 | 1.890 | 1.980 |
| 2.70             | 1.679 | 1.787 | 1.850 | 1.940 | 2.036 |
| 2.80             | 1.714 | 1.827 | 1.894 | 1.989 | 2.090 |
| 2.90             | 1.747 | 1.867 | 1.937 | 2.037 | 2.144 |

| H/B <sub>d</sub> | A     | B     | C     | D     | E     |
|------------------|-------|-------|-------|-------|-------|
| 3.00             | 1.780 | 1.904 | 1.978 | 2.083 | 2.196 |
| 3.10             | 1.810 | 1.941 | 2.018 | 2.128 | 2.247 |
| 3.20             | 1.840 | 1.976 | 2.057 | 2.172 | 2.297 |
| 3.30             | 1.869 | 2.010 | 2.095 | 2.215 | 2.346 |
| 3.40             | 1.896 | 2.044 | 2.131 | 2.257 | 2.394 |
| 3.50             | 1.923 | 2.076 | 2.167 | 2.298 | 2.441 |
| 3.60             | 1.948 | 2.107 | 2.201 | 2.338 | 2.487 |
| 3.70             | 1.973 | 2.137 | 2.235 | 2.376 | 2.531 |
| 3.80             | 1.997 | 2.166 | 2.267 | 2.414 | 2.575 |
| 3.90             | 2.019 | 2.194 | 2.299 | 2.451 | 2.618 |
| 4.00             | 2.041 | 2.221 | 2.329 | 2.487 | 2.660 |
| 4.10             | 2.062 | 2.247 | 2.359 | 2.522 | 2.701 |
| 4.20             | 2.082 | 2.273 | 2.388 | 2.556 | 2.741 |
| 4.30             | 2.102 | 2.297 | 2.416 | 2.589 | 2.780 |
| 4.40             | 2.121 | 2.321 | 2.443 | 2.621 | 2.819 |
| 4.50             | 2.139 | 2.344 | 2.469 | 2.652 | 2.856 |
| 4.60             | 2.156 | 2.366 | 2.495 | 2.683 | 2.893 |
| 4.70             | 2.173 | 2.388 | 2.520 | 2.713 | 2.929 |
| 4.80             | 2.189 | 2.409 | 2.543 | 2.742 | 2.964 |
| 4.90             | 2.204 | 2.429 | 2.567 | 2.770 | 2.999 |
| 5.00             | 2.219 | 2.448 | 2.590 | 2.798 | 3.032 |
| 5.10             | 2.234 | 2.467 | 2.612 | 2.825 | 3.065 |
| 5.20             | 2.247 | 2.486 | 2.633 | 2.851 | 3.098 |
| 5.30             | 2.261 | 2.503 | 2.654 | 2.877 | 3.129 |
| 5.40             | 2.273 | 2.520 | 2.674 | 2.901 | 3.160 |
| 5.50             | 2.286 | 2.537 | 2.693 | 2.926 | 3.190 |
| 5.60             | 2.298 | 2.553 | 2.712 | 2.949 | 3.220 |
| 5.70             | 2.309 | 2.568 | 2.730 | 2.972 | 3.248 |
| 5.80             | 2.320 | 2.583 | 2.748 | 2.995 | 3.277 |
| 5.90             | 2.330 | 2.598 | 2.766 | 3.017 | 3.304 |
| 6.00             | 2.340 | 2.612 | 2.782 | 3.038 | 3.331 |
| 6.20             | 2.360 | 2.639 | 2.814 | 3.079 | 3.383 |
| 6.40             | 2.377 | 2.664 | 2.845 | 3.118 | 3.433 |
| 6.60             | 2.394 | 2.687 | 2.873 | 3.155 | 3.481 |
| 6.80             | 2.409 | 2.709 | 2.900 | 3.190 | 3.527 |
| 7.00             | 2.423 | 2.730 | 2.925 | 3.223 | 3.571 |
| 7.20             | 2.436 | 2.749 | 2.949 | 3.255 | 3.613 |
| 7.40             | 2.448 | 2.767 | 2.971 | 3.285 | 3.653 |
| 7.60             | 2.459 | 2.784 | 2.992 | 3.313 | 3.691 |
| 7.80             | 2.470 | 2.799 | 3.012 | 3.340 | 3.728 |
| 8.00             | 2.479 | 2.814 | 3.031 | 3.366 | 3.763 |
| 8.50             | 2.500 | 2.847 | 3.073 | 3.424 | 3.845 |
| 9.00             | 2.517 | 2.875 | 3.109 | 3.476 | 3.918 |
| 9.50             | 2.532 | 2.898 | 3.141 | 3.521 | 3.983 |
| 10.00            | 2.543 | 2.919 | 3.167 | 3.560 | 4.042 |
| 15.00            | 2.591 | 3.009 | 3.296 | 3.768 | 4.378 |
| 20.00            | 2.598 | 3.026 | 3.325 | 3.825 | 4.490 |
| 30.00            | 2.599 | 3.030 | 3.333 | 3.845 | 4.539 |
| 40.00            | 2.599 | 3.030 | 3.333 | 3.846 | 4.545 |

Source: American Water Works Association, Manual of Water Supply Practices, "Concrete Pressure Pipe, AMMA M9"

**MARSTON SOIL COEFFICIENTS (C<sub>d</sub>)  
FOR TRENCH CONDUITS**

ASSOCIATED TESTING LABORATORIES, INC.  
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS  
TEL: (713) 748-3717 Fax: (713) 748-3748

**NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS  
SUNSET BLVD, UNIVERSITY BLVD AND WESTHEIMER ST**

WBS NO. R-002011-0055-3

PROJECT NO. : G14-109

TABLE 4

**APPENDIX 1**  
**PHOTOGRAPHS OF THE PROJECT SITE**

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PHOTOGRAPHS OF THE PROJECT SITE  
ATL PROJECT No.: G14-109 WBS No: R-002011-0055-3  
PROPOSED NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS



Looking East On Dryden Road From Kirby Drive



PHOTOGRAPHS OF THE PROJECT SITE  
ATL PROJECT No.: G14-109 WBS No: R-002011-0055-3  
PROPOSED NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS

Looking West On University Boulevard From Morningside Drive



Looking West On Nottingham Street From Morningside Drive



PHOTOGRAPHS OF THE PROJECT SITE  
ATL PROJECT No.: G14-109 WBS No: R-002011-0055-3  
PROPOSED NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS

Looking East On Sunset Boulevard From Kirby Drive



Looking West On Westheimer Road From Westcreek Lane



**APPENDIX 2**  
**PIEZOMETER INSTALLATION AND PLUGGING REPORTS**

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# PIEZOMETER INSTALLATION REPORT

|   |                            |
|---|----------------------------|
| <b>PROJECT NAME:</b> PROPOSED NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS<br>SUNSET BOULEVARD, UNIVERSITY BOULEVARD AND WESTHEIMER STREET<br>WBS No.: R-002011-0055-3 | PIEZOMETER NO.: B-1 (PZ-1) |
|---|----------------------------|

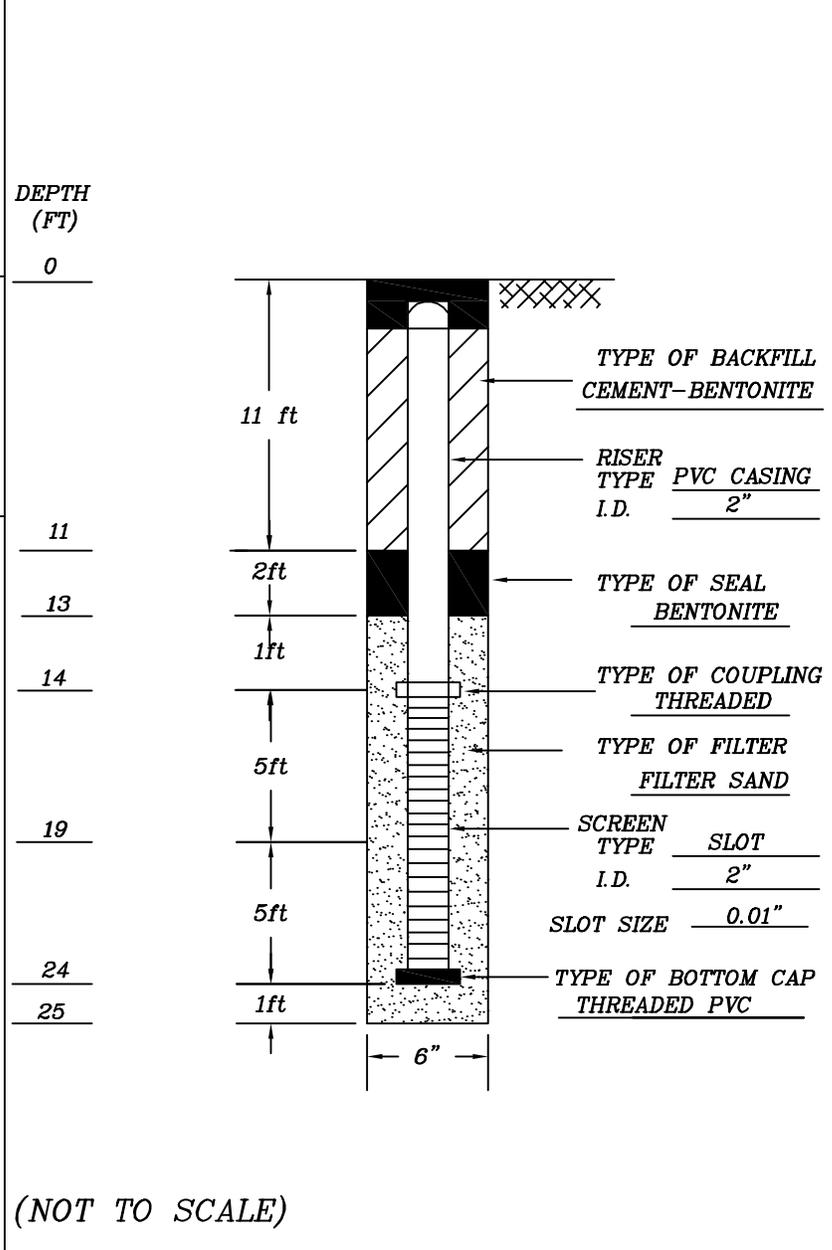
|  |  |                 |
|--|--|-----------------|
| GEOTECHNICAL CONSULTANT<br>ASSOCIATED TESTING LABORATORIES, INC. | DESIGN CONSULTANT<br>AMANI ENGINEERING, INC. | CITY OF HOUSTON |
|--|--|-----------------|

COMPLETION DATE: 2-8-14  
 DRY AUGERED 0 TO 25 FT  
 WASH BORED \_\_\_\_\_ TO \_\_\_\_\_ FT  
 DRILING FLUID: \_\_\_\_\_

DEVELOPMENT DATE: 2-8-14  
 METHOD OF DEVELOPMENT: BAILING

WATER LEVEL READING:

| DATE    | READING |
|---------|---------|
| 2-9-14  | 8'      |
| 2-14-14 | 8.5'    |
| 3-7-14  | 7'      |



REMARKS:

|        |                            |                      |                            |
|--------|----------------------------|----------------------|----------------------------|
| NOTES: | DRILLED BY:<br>Soltek, LLC | STARTED:<br>2-8-14   | ATL job No. G14-109        |
|        | LOGGED BY:<br>PV           | COMPLETED:<br>2-8-14 |                            |
|        | CHECKED BY:<br>JITU        | APPROVED BY:<br>PST  | SHEET <u>1</u> OF <u>4</u> |

# PIEZOMETER INSTALLATION REPORT

|   |  |
|---|--|
| <b>PROJECT NAME:</b> <i>PROPOSED NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS</i><br><i>SUNSET BOULEVARD, UNIVERSITY BOULEVARD AND WESTHEIMER STREET</i><br><b>WBS No.:</b> <i>R-002011-0055-3</i> | <b>PIEZOMETER NO.:</b> <i>B-5 (PZ-2)</i> |
|---|--|

|  |  |                        |
|--|--|------------------------|
| <b>GEOTECHNICAL CONSULTANT</b><br><i>ASSOCIATED TESTING LABORATORIES, INC.</i> | <b>DESIGN CONSULTANT</b><br><i>AMANI ENGINEERING, INC.</i> | <b>CITY OF HOUSTON</b> |
|--|--|------------------------|

**COMPLETION DATE:** 2-8-14

**DRY AUGERED** 0 **TO** 25 **FT**

**WASH BORED** \_\_\_\_\_ **TO** \_\_\_\_\_ **FT**

**DRILING FLUID:** \_\_\_\_\_

**DEVELOPMENT DATE:** 2-8-14

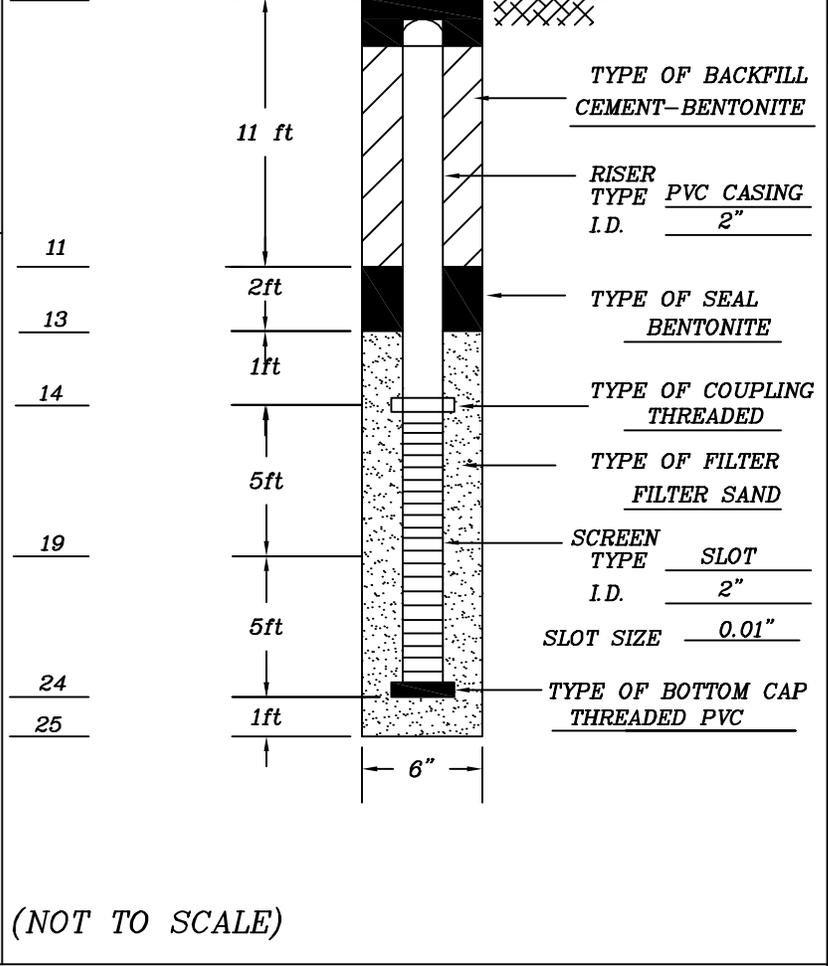
**METHOD OF DEVELOPMENT:** BAILING

**WATER LEVEL READING:**

| DATE    | READING |
|---------|---------|
| 2-9-14  | 10'     |
| 2-14-14 | 11'     |
| 3-7-14  | 8.5'    |

**DEPTH (FT)**

0



**REMARKS:**

|               |  |                                    |                            |
|---------------|--|------------------------------------|----------------------------|
| <b>NOTES:</b> | <b>DRILLED BY:</b><br><i>Soltek, LLC</i> | <b>STARTED:</b><br><i>2-8-14</i>   | <i>ATL job No. G14-109</i> |
|               | <b>LOGGED BY:</b><br><i>PV</i>           | <b>COMPLETED:</b><br><i>2-8-14</i> |                            |
|               | <b>CHECKED BY:</b><br><i>JITU</i>        | <b>APPROVED BY:</b><br><i>PST</i>  |                            |
|               |  |                                    | SHEET <u>2</u> OF <u>4</u> |

# PIEZOMETER INSTALLATION REPORT

|   |                                   |
|---|-----------------------------------|
| PROJECT <b>IMPROVEMENTS</b><br>NAME: <b>SUNSET BOULEVARD, UNIVERSITY BOULEVARD AND WESTHEIMER STREET</b><br>WBS No.: <b>R-002011-0055-3</b> | PIEZOMETER NO.: <b>B-6 (PZ-3)</b> |
|---|-----------------------------------|

|  |  |                 |
|--|--|-----------------|
| GEOTECHNICAL CONSULTANT<br>ASSOCIATED TESTING LABORATORIES, INC. | DESIGN CONSULTANT<br>AMANI ENGINEERING, INC. | CITY OF HOUSTON |
|--|--|-----------------|

COMPLETION DATE: 2-5-14

DRY AUGERED 0 TO 20 FT

WASH BORED \_\_\_\_\_ TO \_\_\_\_\_ FT

DRILING FLUID: \_\_\_\_\_

DEPTH (FT)

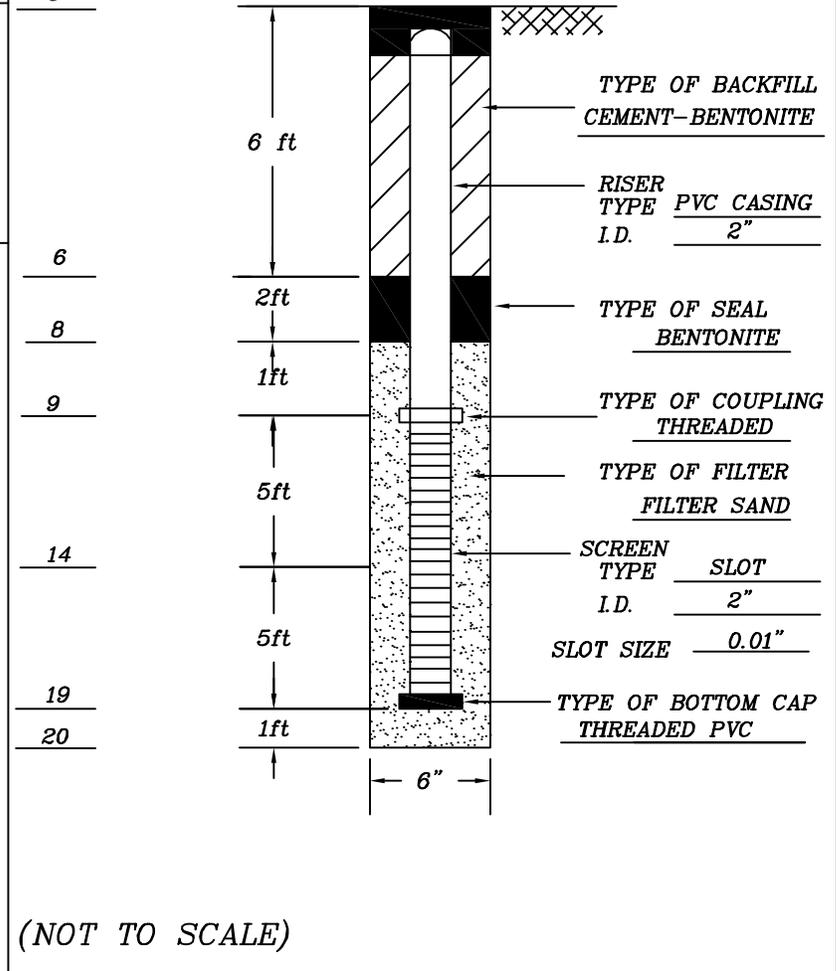
0

DEVELOPMENT DATE: 2-5-14

METHOD OF DEVELOPMENT: BAILING

WATER LEVEL READING:

| DATE    | READING |
|---------|---------|
| 2-6-14  | 6'      |
| 2-14-14 | 6.5'    |
| 3-7-14  | 5'      |



REMARKS:

|        |                            |                      |                            |
|--------|----------------------------|----------------------|----------------------------|
| NOTES: | DRILLED BY:<br>Soltek, LLC | STARTED:<br>2-5-14   | ATL job No. G14-109        |
|        | LOGGED BY:<br>PV           | COMPLETED:<br>2-5-14 |                            |
|        | CHECKED BY:<br>JITU        | APPROVED BY:<br>PST  |                            |
|        |                            |                      | SHEET <u>3</u> OF <u>4</u> |

# PIEZOMETER INSTALLATION REPORT

|   |                             |
|---|-----------------------------|
| <b>PROJECT NAME:</b> PROPOSED NEIGHBORHOOD SEWER SYSTEMS IMPROVEMENTS<br>SUNSET BOULEVARD, UNIVERSITY BOULEVARD AND WESTHEIMER STREET<br>WBS No.: R-002011-0055-3 | PIEZOMETER NO.: B-14 (PZ-4) |
|---|-----------------------------|

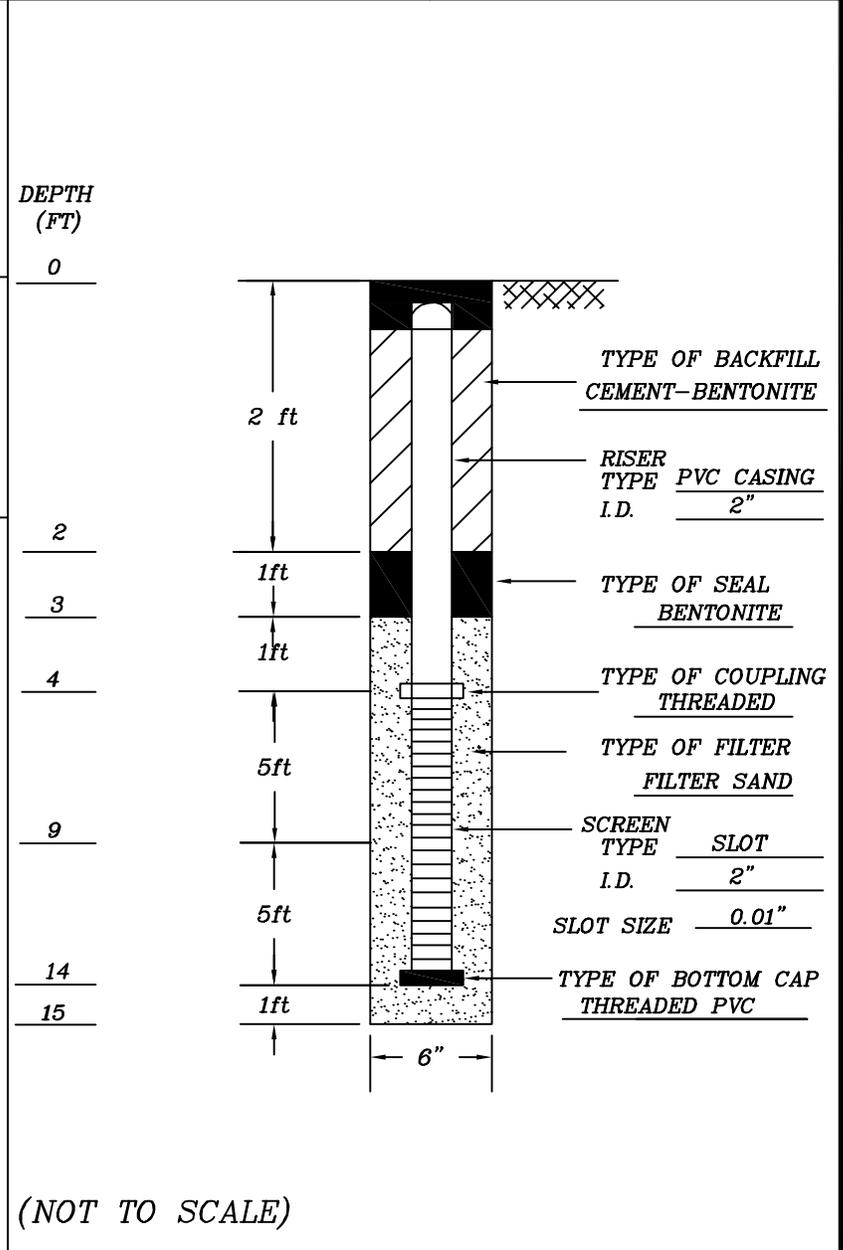
|   |   |                 |
|---|---|-----------------|
| <b>GEOTECHNICAL CONSULTANT</b><br>ASSOCIATED TESTING LABORATORIES, INC. | <b>DESIGN CONSULTANT</b><br>AMANI ENGINEERING, INC. | CITY OF HOUSTON |
|---|---|-----------------|

**COMPLETION DATE:** 2-5-14  
**DRY AUGERED** 0 TO 15 FT  
**WASH BORED** \_\_\_\_\_ TO \_\_\_\_\_ FT  
**DRILLING FLUID:** \_\_\_\_\_

**DEVELOPMENT DATE:** 2-5-14  
**METHOD OF DEVELOPMENT:** BAILING

**WATER LEVEL READING:**

| DATE    | READING |
|---------|---------|
| 2-6-14  | 13'     |
| 2-14-14 | 14'     |
| 3-7-14  | 7.5'    |



**REMARKS:**

|               |                                   |                             |                            |
|---------------|-----------------------------------|-----------------------------|----------------------------|
| <b>NOTES:</b> | <b>DRILLED BY:</b><br>Soltek, LLC | <b>STARTED:</b><br>2-5-14   | ATL job No. G14-109        |
|               | <b>LOGGED BY:</b><br>PV           | <b>COMPLETED:</b><br>2-5-14 |                            |
|               | <b>CHECKED BY:</b><br>JITU        | <b>APPROVED BY:</b><br>PST  |                            |
|               |                                   |                             | SHEET <u>4</u> OF <u>4</u> |

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**STATE OF TEXAS WELL REPORT for Tracking #357110**


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|                |   |                 |                       |
|----------------|---|-----------------|-----------------------|
| Owner:         | <b>City of Houston Geo Dept.</b>                        | Owner Well #:   | <b>B-1</b>            |
| Address:       | <b>611 Walker<br/>Houston , TX 77002</b>                | Grid #:         | <b>65-21-2</b>        |
| Well Location: | <b>Westcreek Ln @ Westheimer<br/>Houston , TX 77027</b> | Latitude:       | <b>29° 44' 17" N</b>  |
| Well County:   | <b>Harris</b>   | Longitude:      | <b>095° 27' 10" W</b> |
| Elevation:     | <b>No Data</b>  | GPS Brand Used: | <b>Magellan</b>       |

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|               |                 |               |                |
|---------------|-----------------|---------------|----------------|
| Type of Work: | <b>New Well</b> | Proposed Use: | <b>Monitor</b> |
|---------------|-----------------|---------------|----------------|

|                      |   |
|----------------------|---|
| Drilling Date:       | Started: <b>2/8/2014</b><br>Completed: <b>2/8/2014</b>  |
| Diameter of Hole:    | Diameter: <b>4" in From Surface To 25 ft</b>  |
| Drilling Method:     | <b>Mud Rotary</b>   |
| Borehole Completion: | Other: <b>(No Data)</b>   |
| Annular Seal Data:   | 1st Interval: <b>From 0 ft to 13 ft with 1 bentonite (#sacks and material)</b><br>2nd Interval: <b>No Data</b><br>3rd Interval: <b>No Data</b><br>Method Used: <b>No Data</b><br>Cemented By: <b>No Data</b><br>Distance to Septic Field or other Concentrated Contamination: <b>No Data</b><br>Distance to Property Line: <b>No Data</b><br>Method of Verification: <b>No Data</b><br>Approved by Variance: <b>No Data</b> |
| Surface Completion:  | <b>Surface Sleeve Installed</b>   |

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|                |   |
|----------------|---|
| Water Level:   | Static level: <b>No Data</b><br>Artesian flow: <b>No Data</b> |
| Packers:       | <b>20/40 13-25</b>  |
| Plugging Info: | Casing or Cement/Bentonite left in well: <b>No Data</b>       |
| Type Of Pump:  | <b>No Data</b>  |
| Well Tests:    | <b>No Data</b>  |

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|                |   |
|----------------|---|
| Water Quality: | Type of Water: <b>No Data</b><br>Depth of Strata: <b>No Data</b><br>Chemical Analysis Made: <b>No</b><br>Did the driller knowingly penetrate any strata which contained undesirable constituents: <b>No</b> |
|----------------|---|

|                     |  |
|---------------------|--|
| 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 South 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 #357110) 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  
**0-10 Grey sandy clay**  
**10-18 Brown sandy clay**  
**18-25 Brown clay**

**CASING, BLANK PIPE & WELL SCREEN DATA**

| Dia. | New/Used | Type       | Setting From/To |
|------|----------|------------|-----------------|
| 2"   | New      | PVC Riser  | 0-15 Sch. 40    |
| 2"   | New      | PVC Screen | 15-25 0.010     |

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**STATE OF TEXAS WELL REPORT for Tracking #357112**


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|                |   |                 |                       |
|----------------|---|-----------------|-----------------------|
| Owner:         | <b>City of Houston Geo Dept.</b>                    | Owner Well #:   | <b>B-5</b>            |
| Address:       | <b>611 Walker<br/>Houston , TX 77002</b>            | Grid #:         | <b>65-21-2</b>        |
| Well Location: | <b>Westheimer @ Post Oak<br/>Houston , TX 77027</b> | Latitude:       | <b>29° 44' 16" N</b>  |
| Well County:   | <b>Harris</b>                                       | Longitude:      | <b>095° 27' 23" W</b> |
| Elevation:     | <b>No Data</b>                                      | GPS Brand Used: | <b>Magellan</b>       |

---

|               |                 |               |                |
|---------------|-----------------|---------------|----------------|
| Type of Work: | <b>New Well</b> | Proposed Use: | <b>Monitor</b> |
|---------------|-----------------|---------------|----------------|

|                      |   |
|----------------------|---|
| Drilling Date:       | Started: <b>2/8/2014</b><br>Completed: <b>2/8/2014</b>  |
| Diameter of Hole:    | Diameter: <b>4 in From Surface To 25 ft</b>   |
| Drilling Method:     | <b>Mud Rotary</b>   |
| Borehole Completion: | Other: <b>(No Data)</b>   |
| Annular Seal Data:   | 1st Interval: <b>From 0 ft to 13 ft with 1 bentonite (#sacks and material)</b><br>2nd Interval: <b>No Data</b><br>3rd Interval: <b>No Data</b><br>Method Used: <b>No Data</b><br>Cemented By: <b>No Data</b><br>Distance to Septic Field or other Concentrated Contamination: <b>No Data</b><br>Distance to Property Line: <b>No Data</b><br>Method of Verification: <b>No Data</b><br>Approved by Variance: <b>No Data</b> |
| Surface Completion:  | <b>Surface Sleeve Installed</b>   |

---

|                |   |
|----------------|---|
| Water Level:   | Static level: <b>No Data</b><br>Artesian flow: <b>No Data</b> |
| Packers:       | <b>20/40 13-25</b>  |
| Plugging Info: | Casing or Cement/Bentonite left in well: <b>No Data</b>       |
| Type Of Pump:  | <b>No Data</b>  |
| Well Tests:    | <b>No Data</b>  |

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|                |   |
|----------------|---|
| Water Quality: | Type of Water: <b>No Data</b><br>Depth of Strata: <b>No Data</b><br>Chemical Analysis Made: <b>No</b><br>Did the driller knowingly penetrate any strata which contained undesirable constituents: <b>No</b> |
|----------------|---|

|                     |  |
|---------------------|--|
| 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 South 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 #357112) 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    |
|-----------|---------|----------------|
| 0-6       |         | Grey clay      |
| 6-14      |         | Tan sandy clay |
| 14-16     |         | Tan sand       |
| 16-25     |         | Br sandy clay  |

**CASING, BLANK PIPE & WELL SCREEN DATA**

| Dia. | New/Used | Type       | Setting From/To |
|------|----------|------------|-----------------|
| 2"   | New      | PVC Riser  | 0-15 Sch. 40    |
| 2"   | New      | PVC Screen | 15-25 0.010     |

## STATE OF TEXAS WELL REPORT for Tracking #357116

|                |   |                 |                |
|----------------|---|-----------------|----------------|
| Owner:         | City of Houston Geo Dept.                       | Owner Well #:   | B-6            |
| Address:       | 611 Walker<br>Houston , TX 77002                | Grid #:         | 65-21-3        |
| Well Location: | Morning side @ University<br>Houston , TX 77027 | Latitude:       | 29° 42' 33" N  |
| Well County:   | Harris  | Longitude:      | 095° 24' 32" W |
| Elevation:     | No Data   | GPS Brand Used: | Magellan       |
| <hr/>          |   |                 |                |
| Type of Work:  | New Well  | Proposed Use:   | Monitor        |

Drilling Date: Started: **2/5/2014**  
Completed: **2/5/2014**

Diameter of Hole: Diameter: **4 in From Surface To 20 ft**

Drilling Method: Other: **Auger**

Borehole Completion: Other: **(No Data)**

Annular Seal Data: 1st Interval: **From 0 ft to 8 ft with 1 bentonite (#sacks and material)**  
2nd Interval: **No Data**  
3rd Interval: **No Data**  
Method Used: **No Data**  
Cemented By: **No Data**  
Distance to Septic Field or other Concentrated Contamination: **No Data**  
Distance to Property Line: **No Data**  
Method of Verification: **No Data**  
Approved by Variance: **No Data**

Surface Completion: **Surface Sleeve Installed**

---

Water Level: Static level: **No Data**  
Artesian flow: **No Data**

Packers: **20/40 8-20**

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

Type Of Pump: **No Data**

Well Tests: **No Data**

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Water Quality: Type of Water: **No Data**  
Depth of Strata: **No Data**  
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: **Envirotech Drilling Services  
2718 South 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 #357116) on your written request.

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

**DESC. & COLOR OF FORMATION MATERIAL**

**CASING, BLANK PIPE & WELL SCREEN DATA**

From (ft) To (ft) Description  
**0-20 Brown + grey sandy clay**

Dia. New/Used Type Setting From/To  
**2" New PVC Riser 0-10 Sch. 40  
2" New PVC Screen 10-20 0.010**

## STATE OF TEXAS WELL REPORT for Tracking #357117

|                |                                      |                 |                |
|----------------|--------------------------------------|-----------------|----------------|
| Owner:         | City of Houston Geo Dept.            | Owner Well #:   | B-14           |
| Address:       | 611 Walker<br>Houston , TX 77002     | Grid #:         | 65-24-4        |
| Well Location: | Dryden @ Kirby<br>Houston , TX 77027 | Latitude:       | 29° 42' 29" N  |
| Well County:   | Harris                               | Longitude:      | 095° 05' 36" W |
| Elevation:     | No Data                              | GPS Brand Used: | Magellan       |
| <hr/>          |                                      |                 |                |
| Type of Work:  | New Well                             | Proposed Use:   | Monitor        |

|                      |  |
|----------------------|--|
| Drilling Date:       | Started: <b>2/5/2014</b><br>Completed: <b>2/5/2014</b>   |
| Diameter of Hole:    | Diameter: <b>4 in From Surface To 15 ft</b>  |
| Drilling Method:     | Other: <b>Auger</b>  |
| Borehole Completion: | Other: <b>(No Data)</b>  |
| Annular Seal Data:   | 1st Interval: <b>From 0 ft to 8 ft with 1 bentonite (#sacks and material)</b><br>2nd Interval: <b>No Data</b><br>3rd Interval: <b>No Data</b><br>Method Used: <b>No Data</b><br>Cemented By: <b>No Data</b><br>Distance to Septic Field or other Concentrated Contamination: <b>No Data</b><br>Distance to Property Line: <b>No Data</b><br>Method of Verification: <b>No Data</b><br>Approved by Variance: <b>No Data</b> |
| Surface Completion:  | <b>Surface Sleeve Installed</b>  |

|                |   |
|----------------|---|
| Water Level:   | Static level: <b>No Data</b><br>Artesian flow: <b>No Data</b> |
| Packers:       | <b>20/40 8-15</b>   |
| Plugging Info: | Casing or Cement/Bentonite left in well: <b>No Data</b>       |
| Type Of Pump:  | <b>No Data</b>  |
| Well Tests:    | <b>No Data</b>  |

|                |   |
|----------------|---|
| Water Quality: | Type of Water: <b>No Data</b><br>Depth of Strata: <b>No Data</b><br>Chemical Analysis Made: <b>No</b><br>Did the driller knowingly penetrate any strata which contained undesirable constituents: <b>No</b> |
|----------------|---|

|                     |  |
|---------------------|--|
| 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 South 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 #357117) on your written request.

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

**DESC. & COLOR OF FORMATION MATERIAL**

**CASING, BLANK PIPE & WELL SCREEN DATA**

From (ft) To (ft) Description

**0-15 Grey and bizion sandy clay**

Dia. New/Used Type Setting From/To

**2" New PVC Riser 0-10 Sch. 40**

**2" New PVC Screen 10-15 0.010**

### STATE OF TEXAS PLUGGING REPORT for Tracking #94072

|                |   |                 |                |
|----------------|---|-----------------|----------------|
| Owner:         | City Of Houston Geo Dept                  | Owner Well #:   | B-1            |
| Address:       | 611 Walker<br>Houston, TX 77002           | Grid #:         | 65-21-2        |
| Well Location: | Westcreek Ln @ Westtheimer<br>Houston, TX | Latitude:       | 29° 44' 17" N  |
| Well County:   | Harris                                    | Longitude:      | 095° 27' 10" W |
|                |   | GPS Brand Used: | Magellan       |

Well Type: **Monitor**

#### HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller: **Jaime Vasquez**

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

Date Well Drilled: **2/8/2014**

Well Report Tracking Number: **357110**

Diameter of Borehole: **4 inches**

Total Depth of Borehole: **25' feet**

Date Well Plugged: **4/14/2014**

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: **2 inches diameter, From 0 ft to 2 ft**  
2nd Interval: **(No Data) inches diameter, From 2 ft to 25 ft**  
3rd Interval: **No Data**

Cement/Bentonite 1st Interval: **From 0 ft to 25 ft; Sack(s)/type of cement used: 1-cement**

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 South 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 #94072) on your written request.

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

### STATE OF TEXAS PLUGGING REPORT for Tracking #94073

|                |                                     |                 |                |
|----------------|-------------------------------------|-----------------|----------------|
| Owner:         | City Of Houston Geo Dept            | Owner Well #:   | B-5            |
| Address:       | 611 Walker<br>Houston, TX 77002     | Grid #:         | 65-21-2        |
| Well Location: | Westheimer @ Postaok<br>Houston, TX | Latitude:       | 29° 44' 16" N  |
| Well County:   | Harris                              | Longitude:      | 095° 27' 23" W |
|                |                                     | GPS Brand Used: | Magellan       |

---

Well Type: **Monitor**

#### HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller: **Jaime Vasquez**

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

Date Well Drilled: **2/8/2014**

Well Report Tracking Number: **357112**

Diameter of Borehole: **4 inches**

Total Depth of Borehole: **25' feet**

---

Date Well Plugged: **4/14/2014**

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: **2 inches diameter, From 0 ft to 2 ft**  
 2nd Interval: **(No Data) inches diameter, From 2 ft to 25 ft**  
 3rd Interval: **No Data**

Cement/Bentonite 1st Interval: **From 0 ft to 25 ft; Sack(s)/type of cement used: 1-cement**

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 South 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 #94073) on your written request.

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

### STATE OF TEXAS PLUGGING REPORT for Tracking #94074

|                |  |                 |                |
|----------------|--|-----------------|----------------|
| Owner:         | City Of Houston Geo Dept                   | Owner Well #:   | B-6            |
| Address:       | 611 Walker<br>Houston , TX 77002           | Grid #:         | 65-21-3        |
| Well Location: | Morning side @ Univeersity<br>Houston , TX | Latitude:       | 29° 42' 33" N  |
| Well County:   | Harris                                     | Longitude:      | 095° 24' 32" W |
|                |  | GPS Brand Used: | Magellan       |

Well Type: **Monitor**

#### HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller: **Jaime Vasquez**

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

Date Well Drilled: **2/5/2014**

Well Report Tracking Number: **357116**

Diameter of Borehole: **4 inches**

Total Depth of Borehole: **20' feet**

Date Well Plugged: **4/14/2014**

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: **2 inches diameter, From 0 ft to 2 ft**  
2nd Interval: **(No Data) inches diameter, From 2 ft to 20 ft**  
3rd Interval: **No Data**

Cement/Bentonite 1st Interval: **From 0 ft to 20 ft; Sack(s)/type of cement used: 1-cement**

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 South 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 #94074) on your written request.

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

### STATE OF TEXAS PLUGGING REPORT for Tracking #94075

|                |                                 |                 |                |
|----------------|---------------------------------|-----------------|----------------|
| Owner:         | City Of Houston Geo Dept        | Owner Well #:   | B-14           |
| Address:       | 611 Walker<br>Houston, TX 77002 | Grid #:         | 65-21-5        |
| Well Location: | Dryden @ Kirby<br>Houston, TX   | Latitude:       | 29° 42' 29" N  |
| Well County:   | Harris                          | Longitude:      | 095° 25' 36" W |
|                |                                 | GPS Brand Used: | Magellan       |

---

Well Type: **Monitor**

#### HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller: **Jaime Vasquez**

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

Date Well Drilled: **2/5/2014**

Well Report Tracking Number: **357117**

Diameter of Borehole: **4 inches**

Total Depth of Borehole: **15' feet**

---

Date Well Plugged: **4/14/2014**

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: **2 inches diameter, From 0 ft to 2 ft**  
 2nd Interval: **(No Data) inches diameter, From 2 ft to 15 ft**  
 3rd Interval: **No Data**

Cement/Bentonite 1st Interval: **From 0 ft to 15 ft; Sack(s)/type of cement used: 1-cement**

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

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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 South 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 #94075) on your written request.

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

**APPENDIX 3**  
**BORING LOGS AND KEY TO LOG TERMS AND SYMBOLS**

---



# LOG OF BORING B-2

DATE: 02/08/2014  
 SURFACE ELEVATION: 57.12

**Associated Testing Laboratories, Inc.**  
 3143 Yellowstone Blvd  
 Houston, Texas-77054

PROJECT: Neighborhood Sewer Systems Improvements Sunset Blvd, University Blvd & Westheimer St. Houston, TX WBS No. R-002011-005503

PROJECT NO.: G14-109 BORING TYPE: Auger

| DEPTH (ft.) | SAMPLES | USC | WATER LEVEL | LOCATION   |  | POCKET | PENETROMETER (tsf) | BLOW COUNT (N, Blows/Foot) | N (blows/ft) |    |    |    | DRY DENSITY (pcf) | UNCONFINED COMP. STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | Natural Moisture Content and Atterberg Limits |                  |              | MOISTURE CONTENT (%) | ATTERBERG LIMITS (%) |               |                  | ESTIMATED ANGLE OF INTERNAL FRICTION (°) | OTHER TESTS & REMARKS |
|-------------|---------|-----|-------------|--|--|--------|--------------------|----------------------------|--------------|----|----|----|-------------------|---------------------------------|--------------------|--------------------------|---|------------------|--------------|----------------------|----------------------|---------------|------------------|--|-----------------------|
|             |         |     |             | Westheimer Rd.   | Northing: 13834090.37<br>Easting: 3092896.11 |        |                    |                            | 20           | 40 | 60 | 80 |                   |                                 |                    |                          | Plastic Limit                                 | Moisture Content | Liquid Limit |                      | LIQUID LIMIT         | PLASTIC LIMIT | PLASTICITY INDEX |  |                       |
| 0           |         |     |             | 2.5" Asphalt   |  |        |                    |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |
|             |         |     |             | 7.5" Concrete  |  |        |                    |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |
| 0           |         | CL  |             | Lean Clay with Sand (CL), stiff, high plasticity, light gray and tan     |  |        |                    |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |
| 5           |         | CH  |             | Fat Clay with Sand (CH), very stiff, high plasticity, light gray and tan |  |        |                    |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |
|             |         |     |             | ..with calcareous nodules below 6'                                       |  |        |                    |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |
|             |         |     |             | ..reddish brown below 8'   |  |        |                    |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |
| 10          |         | CH  |             | ..with ferrous nodules below 10'   |  |        |                    |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |
| 15          |         |     |             | ..stiff below 14'  |  |        |                    |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |
| 20          |         | CL  |             | Lean Clay with Sand (CL), firm, high plasticity, light gray and tan      |  |        |                    |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |
|             |         |     |             | ..stiff below 18'  |  |        |                    |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |
| 25          |         |     |             | ..reddish brown below 23'  |  |        |                    |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |

Water Level Initial: 21' After Drilling: 13' 24 Hrs: 13'  
 Water Observations: Initial Water Level: 21'; After Drilling Water Level: 13'

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:  
 N - SPT Data (Blows/Ft)  
 P - Pocket Penetrometer (tsf)  
 T - Torvane (psf)  
 Q<sub>u</sub> - Unconfined Comp. Strength (tsf)  
 DD - Dry Density (pcf)

Notes:  
 Augered Dry to 25', Hole Caved at 22', Hole Grouted after Drilling. Drilled By: Soltek, LLC, Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST



**Associated Testing Laboratories, Inc.**  
**3143 Yellowstone Blvd**  
**Houston, Texas-77054**

**LOG OF BORING B-4**

DATE: 02/08/2014  
 SURFACE ELEVATION: 55.91

PROJECT: Neighborhood Sewer Systems Improvements Sunset Blvd, University Blvd & Westheimer St. Houston, TX WBS No. R-002011-005503  
 PROJECT NO.: G14-109 BORING TYPE: Auger

| DEPTH (ft.) | SAMPLES | USC | WATER LEVEL | LOCATION  |                  | POCKET PENETROMETER (P, tsf) | BLOW COUNT (N, Blows/Foot) | N (blows/ft)<br>20 40 60 80 | Q <sub>u</sub> (tsf)<br>1.0 2.0 3.0 4.0 | DD (pcf)<br>90 100 110 120 | P (tsf)<br>1.0 2.0 3.0 4.0 | DRY DENSITY (pcf) | UNCONFINED COMP. STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | Natural Moisture Content and Atterberg Limits |              |               | MOISTURE CONTENT (%) | ATTERBERG LIMITS (%) |    |    | PASSING #200 SIEVE (%) | ESTIMATED ANGLE OF INTERNAL FRICTION (°)<br>OTHER TESTS & REMARKS |  |  |
|-------------|---------|-----|-------------|---|------------------|------------------------------|----------------------------|-----------------------------|---|----------------------------|----------------------------|-------------------|---------------------------------|--------------------|--------------------------|---|--------------|---------------|----------------------|----------------------|----|----|------------------------|---|--|--|
|             |         |     |             | Plastic Limit   | Moisture Content |                              |                            |                             |   |                            |                            |                   |                                 |                    |                          | Liquid Limit                                  | LIQUID LIMIT | PLASTIC LIMIT |                      | PLASTICITY INDEX     |    |    |                        |   |  |  |
| 0           |         |     |             | Westheimer Rd.<br>Northing: 13834016.2<br>Easting: 3092011.47   |                  |                              |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |    |                        |   |  |  |
|             |         |     |             | <b>MATERIAL DESCRIPTION</b>   |                  |                              |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |    |                        |   |  |  |
|             |         |     |             | 12.5" Concrete  |                  |                              |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |    |                        |   |  |  |
|             |         |     |             | Sandy Lean Clay (CL), very stiff, medium plasticity, light gray and tan ..with ferrous nodules below 2' |                  | 4.0                          |                            |                             |   |                            |                            | 116               | 1.55                            |                    |                          |   |              |               | 17                   |                      |    |    |                        |   |  |  |
|             |         |     |             | ..stiff below 6'  |                  | 4.0                          |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               | 16                   |                      |    |    |                        |   |  |  |
| 5           |         | CL  |             |   |                  | 3.5                          |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               | 16                   | 32                   | 16 | 16 | 54                     |   |  |  |
|             |         |     |             | Silty Sand (SM), medium dense, non plastic, light gray and tan  |                  | 2.0                          |                            |                             |   |                            |                            | 112               | 0.6                             |                    |                          |   |              |               | 17                   |                      |    |    |                        |   |  |  |
|             |         |     |             | ..loose below 14'   |                  | 13                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               | 22                   |                      |    |    |                        |   |  |  |
| 10          |         | SM  |             |   |                  | 14                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               | 23                   |                      |    |    |                        |   |  |  |
|             |         |     |             |   |                  | 11                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               | 25                   |                      |    |    | 25                     |   |  |  |
| 15          |         |     |             |   |                  | 8                            |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               | 25                   |                      |    |    |                        |   |  |  |
|             |         |     |             |   |                  | 9                            |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               | 25                   |                      |    |    |                        |   |  |  |
|             |         |     |             | Sandy Lean Clay (CL), stiff, slight plasticity, light gray and tan                                      |                  | 2.0                          |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               | 22                   | 25                   | 15 | 10 |                        |   |  |  |
| 20          |         | CL  |             |   |                  |                              |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |    |                        |   |  |  |

Water Level Initial: 14' After Drilling: 13.5' 24 Hrs: 13.5'  
 Water Observations: Initial Water Level: 14', After Drilling Water Level: 13.5'

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:  
 N - SPT Data (Blows/Ft)  
 P - Pocket Penetrometer (tsf)  
 T - Torvane (psf)  
 Q<sub>u</sub> - Unconfined Comp. Strength (tsf)  
 DD - Dry Density (pcf)

Notes:  
 Augered Dry to 20', Hole Grouted after Drilling. Drilled By: Soltek, LLC, Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST



**Associated Testing Laboratories, Inc.**  
**3143 Yellowstone Blvd**  
**Houston, Texas-77054**

**LOG OF BORING B-6 (PZ-3)**

DATE: 02/05/2014  
 SURFACE ELEVATION: 45.56

PROJECT: Neighborhood Sewer Systems Improvements Sunset Blvd, University Blvd & Westheimer St. Houston, TX WBS No. R-002011-005503  
 PROJECT NO.: G14-109 BORING TYPE: Auger

| DEPTH (ft.) | SAMPLES | USC | WATER LEVEL | LOCATION   |  | POCKET | PENETROMETER (tsf) | BLOW COUNT (N, Blows/Foot) | N (blows/ft)<br>20 40 60 80 | Q <sub>u</sub> (tsf) | DD (pcf) | P (tsf) | DRY DENSITY (pcf) | UNCONFINED COMP. STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | Natural Moisture Content and Atterberg Limits |                  |              | MOISTURE CONTENT (%) | PASSING #200 SIEVE (%) | ESTIMATED ANGLE OF INTERNAL FRICTION (°) | OTHER TESTS & REMARKS |
|-------------|---------|-----|-------------|--|--|--------|--------------------|----------------------------|-----------------------------|----------------------|----------|---------|-------------------|---------------------------------|--------------------|--------------------------|---|------------------|--------------|----------------------|------------------------|--|-----------------------|
|             |         |     |             | University Blvd.<br>Northing: 13824965.25<br>Easting: 3106236.09 | MATERIAL DESCRIPTION   |        |                    |                            |                             |                      |          |         |                   |                                 |                    |                          | Plastic Limit                                 | Moisture Content | Liquid Limit |                      |                        |  |                       |
| 0           |         |     |             |  | 2" Asphalt   |        |                    |                            |                             |                      |          |         |                   |                                 |                    |                          |   |                  |              |                      |                        |  |                       |
| 0           |         |     |             |  | 6" Concrete with shell aggregate   |        |                    |                            |                             |                      |          |         |                   |                                 |                    |                          |   |                  |              |                      |                        |  |                       |
| 0           |         |     |             |  | Fat Clay (CH), very stiff, very high plasticity, light gray and tan (with light hydrocarbon-like odor to 20 feet) ..with calcareous nodules below 4' |        |                    |                            |                             |                      |          |         |                   |                                 |                    |                          |   |                  |              |                      |                        |  |                       |
| 5           |         |     |             |  | ..stiff, reddish brown below 6' (slickensided)   |        |                    |                            |                             |                      |          |         | 103               | 0.85                            | 0                  |                          |   |                  |              |                      |                        |  |                       |
| 5           |         |     |             |  | ..very stiff below 8'  |        |                    |                            |                             |                      |          |         |                   |                                 |                    |                          |   |                  |              |                      |                        |  |                       |
| 10          |         |     |             |  | Lean Clay with Sand (CL), stiff, medium plasticity, light gray and tan (with light hydrocarbon-like odor to 20 feet)                                 |        |                    |                            |                             |                      |          |         |                   |                                 |                    |                          |   |                  |              |                      |                        |  |                       |
| 10          |         |     |             |  | ..very stiff with ferrous nodules below 16'  |        |                    |                            |                             |                      |          |         |                   |                                 |                    |                          |   |                  |              |                      |                        |  |                       |
| 15          |         |     |             |  |  |        |                    |                            |                             |                      |          |         | 112               | 0.5                             | 0                  |                          |   |                  |              |                      |                        |  |                       |
| 15          |         |     |             |  |  |        |                    |                            |                             |                      |          |         |                   |                                 |                    |                          |   |                  |              |                      |                        |  |                       |
| 20          |         |     |             |  |  |        |                    |                            |                             |                      |          |         | 114               | 1.05                            | 12                 |                          |   |                  |              |                      |                        |  |                       |
| 20          |         |     |             |  |  |        |                    |                            |                             |                      |          |         |                   |                                 |                    |                          |   |                  |              |                      |                        |  |                       |
| 25          |         |     |             |  |  |        |                    |                            |                             |                      |          |         |                   |                                 |                    |                          |   |                  |              |                      |                        |  |                       |

Water Level Initial: ▽ After Drilling ▽ 24 Hrs: ▽  
 Water Observations: Initial Water Level: Dry, After Drilling Water Level: Dry, 24 hrs Water Level: 6', 7 days Water Level: 6.5', 30 days Water Level: 5'  
 Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:  
 N - SPT Data (Blows/Ft)  
 P - Pocket Penetrometer (tsf)  
 T - Torvane (psi)  
 Q<sub>u</sub> - Unconfined Comp. Strength (tsf)  
 DD - Dry Density (pcf)

Notes:  
 Augered Dry to 20'; PZ water level: 6' (02/06/2014); PZ water level: 6.5' (02/14/2014); PZ water level: 5' (03/07/2014) Drilled By: Soltek, LLC, Logged By: PV, Checked By: Jitu/John, QC/QA By: PST

# LOG OF BORING B-7

DATE: 02/05/2014  
 SURFACE ELEVATION: 44.94

**Associated Testing Laboratories, Inc.**  
 3143 Yellowstone Blvd  
 Houston, Texas-77054

PROJECT: Neighborhood Sewer Systems Improvements Sunset Blvd, University Blvd & Westheimer St. Houston, TX WBS No. R-002011-005503  
 PROJECT NO.: G14-109 BORING TYPE: Auger

| DEPTH (ft.) | SAMPLES | USC | WATER LEVEL | LOCATION   |                  | POCKET PENETROMETER (tsf) | BLOW COUNT (N, Blows/Foot) | N (blows/ft)<br>20 40 60 80 | Q <sub>u</sub> (tsf)<br>1.0 2.0 3.0 4.0 | DD (pcf)<br>90 100 110 120 | P (tsf)<br>1.0 2.0 3.0 4.0 | DRY DENSITY (pcf) | UNCONFINED COMP. STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | Natural Moisture Content and Atterberg Limits |    |    | MOISTURE CONTENT (%) | ATTERBERG LIMITS (%) |  |  | PASSING #200 SIEVE (%) | ESTIMATED ANGLE OF INTERNAL FRICTION (°)<br>OTHER TESTS & REMARKS |  |
|-------------|---------|-----|-------------|--|------------------|---------------------------|----------------------------|-----------------------------|---|----------------------------|----------------------------|-------------------|---------------------------------|--------------------|--------------------------|---|----|----|----------------------|----------------------|--|--|------------------------|---|--|
|             |         |     |             | Plastic Limit  | Moisture Content |                           |                            |                             |   |                            |                            |                   |                                 |                    |                          | Liquid Limit                                  | LL | PL |                      | PI                   |  |  |                        |   |  |
| 0           |         |     |             | University Blvd.<br>Northing: 13824971.17<br>Easting: 3105689.28         |                  |                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |    |    |                      |                      |  |  |                        |   |  |
|             |         |     |             | <b>MATERIAL DESCRIPTION</b>  |                  |                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |    |    |                      |                      |  |  |                        |   |  |
| 0           |         |     |             | 2.5" Asphalt   |                  |                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |    |    |                      |                      |  |  |                        |   |  |
| 0           |         |     |             | 5" Lightly cement-treated shell base                                     |                  |                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |    |    |                      |                      |  |  |                        |   |  |
| 0           |         |     |             | Fat Clay with Sand (CH), stiff, very high plasticity, light gray and tan |                  |                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |    |    |                      |                      |  |  |                        |   |  |
| 0           |         |     |             | ..with calcareous nodules below 4'                                       |                  |                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |    |    |                      |                      |  |  |                        |   |  |
| 5           |         | CH  |             | ..very stiff with ferrous nodules below 6'                               |                  |                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |    |    |                      |                      |  |  |                        |   |  |
| 10          |         | CL  |             | Sandy Lean Clay (CL), firm, medium plasticity, light gray and tan        |                  |                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |    |    |                      |                      |  |  |                        |   |  |
| 10          |         | SM  |             | Silty Sand (SM), loose, non plastic, light gray and tan                  |                  |                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |    |    |                      |                      |  |  |                        |   |  |
| 15          |         |     |             | ..medium dense below 14'   |                  |                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |    |    |                      |                      |  |  |                        |   |  |
| 15          |         | CH  |             | Fat Clay with Sand (CH), very stiff, high plasticity, light gray and tan |                  |                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |    |    |                      |                      |  |  |                        |   |  |
| 20          |         |     |             |  |                  |                           |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |    |    |                      |                      |  |  |                        |   |  |

Water Level Initial: ▾ After Drilling ▾ 24 Hrs: ▾  
 Water Observations: Initial Water Level: 16', After Drilling Water Level: 14'

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:  
 N - SPT Data (Blows/Ft)  
 P - Pocket Penetrometer (tsf)  
 T - Torvane (psf)  
 Q<sub>u</sub> - Unconfined Comp. Strength (tsf)  
 DD - Dry Density (pcf)

Notes:  
 Augered Dry to 20', Hole Grouted after Drilling. Drilled By: Soltek, LLC, Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST



**Associated Testing Laboratories, Inc.**  
**3143 Yellowstone Blvd**  
**Houston, Texas-77054**

**LOG OF BORING B-9**

DATE: 02/03/2014  
 SURFACE ELEVATION: 45.26

PROJECT: Neighborhood Sewer Systems Improvements Sunset Blvd, University Blvd & Westheimer St. Houston, TX WBS No. R-002011-005503  
 PROJECT NO.: G14-109 BORING TYPE: Auger

| DEPTH (ft.) | SAMPLES | USC | WATER LEVEL | LOCATION  |                  | POCKET | PENETROMETER (tsf) | BLOW COUNT (N, Blows/Foot) | N (blows/ft)<br>20 40 60 80 | Q <sub>u</sub> (tsf)<br>1.0 2.0 3.0 4.0 | DD (pcf)<br>90 100 110 120 | P (tsf)<br>1.0 2.0 3.0 4.0 | DRY DENSITY (pcf) | UNCONFINED COMP. STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | Natural Moisture Content and Atterberg Limits |              |               | MOISTURE CONTENT (%) | ATTERBERG LIMITS (%) |    |                        | ESTIMATED ANGLE OF INTERNAL FRICTION (°) | OTHER TESTS & REMARKS |
|-------------|---------|-----|-------------|---|------------------|--------|--------------------|----------------------------|-----------------------------|---|----------------------------|----------------------------|-------------------|---------------------------------|--------------------|--------------------------|---|--------------|---------------|----------------------|----------------------|----|------------------------|--|-----------------------|
|             |         |     |             | Plastic Limit   | Moisture Content |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          | Liquid Limit                                  | LIQUID LIMIT | PLASTIC LIMIT |                      | PLASTICITY INDEX     |    |                        |  |                       |
|             |         |     |             | 20  | 40               |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          | 60  | 80           | LL            |                      | PL                   | PI | PASSING #200 SIEVE (%) |  |                       |
| 0           |         |     |             | Shakespeare St.<br>Northing: 13824682.71<br>Easting: 3106258.44 |                  |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |                        |  |                       |
|             |         |     |             | <b>MATERIAL DESCRIPTION</b>                                     |                  |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |                        |  |                       |
|             |         |     |             | 7" Concrete with shell aggregate                                |                  |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |                        |  |                       |
|             |         |     |             | 0.5" Sand base  |                  |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |                        |  |                       |
|             |         |     |             | Fat Clay (CH), stiff, very high plasticity, dark gray           |                  |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |                        |  |                       |
|             |         |     |             | ..light gray and tan below 2'                                   |                  |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |                        |  |                       |
|             |         |     |             | ..with calcareous nodules below 4'                              |                  |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |                        |  |                       |
| 5           |         |     |             | ..very stiff below 6'   |                  |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |                        |  |                       |
|             |         |     |             | Lean Clay (CL), stiff, high plasticity, light gray and tan      |                  |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |                        |  |                       |
|             |         |     |             | ..very stiff below 14'  |                  |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |                        |  |                       |
|             |         |     |             | ..with ferrous nodules below 16'                                |                  |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |                        |  |                       |
|             |         |     |             | ..hard below 18'  |                  |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |                        |  |                       |
| 20          |         |     |             |   |                  |        |                    |                            |                             |   |                            |                            |                   |                                 |                    |                          |   |              |               |                      |                      |    |                        |  |                       |

Water Level Initial: ▽ After Drilling ▽ 24 Hrs: ▽  
 Water Observations: Initial Water Level: Dry, After Drilling Water Level: Dry  
 Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:  
 N - SPT Data (Blows/Ft)  
 P - Pocket Penetrometer (tsf)  
 T - Torvane (psf)  
 Q<sub>u</sub> - Unconfined Comp. Strength (tsf)  
 DD - Dry Density (pcf)

Notes:  
 Augered Dry to 20', Hole Grouted after Drilling. Drilled By: Soltek, LLC, Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST





# LOG OF BORING B-12

DATE: 02/08/2014

**Associated Testing Laboratories, Inc.**  
**3143 Yellowstone Blvd**  
**Houston, Texas-77054**

PROJECT: Neighborhood Sewer Systems Improvements Sunset Blvd, University Blvd & Westheimer St. Houston, TX WBS No. R-002011-005503

SURFACE ELEVATION: 46.35

PROJECT NO.: G14-109

BORING TYPE: Auger

| DEPTH (ft.)          | SAMPLES | USC | WATER LEVEL | LOCATION   |  | POCKET          | PENETROMETER (tsf) | BLOW COUNT (N, Blows/Foot) | N (blows/ft)    |     |                      |                  | DRY DENSITY (pcf) | UNCONFINED COMP. STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | Natural Moisture Content and Atterberg Limits |  |  | MOISTURE CONTENT (%) | ESTIMATED ANGLE OF INTERNAL FRICTION (°) | OTHER TESTS & REMARKS |
|----------------------|---------|-----|-------------|--|--|-----------------|--------------------|----------------------------|-----------------|-----|----------------------|------------------|-------------------|---------------------------------|--------------------|--------------------------|---|--|--|----------------------|--|-----------------------|
|                      |         |     |             | Dryden Rd.   |  |                 |                    |                            | 20 40 60 80     |     | Plastic Limit        | Moisture Content |                   |                                 |                    |                          | Liquid Limit                                  |  |  |                      |  |                       |
|                      |         |     |             | Northing: 13824371.47<br>Easting: 3106258.98   |  |                 |                    |                            | 1.0 2.0 3.0 4.0 |     |                      |                  |                   |                                 |                    |                          |   |  |  |                      |  |                       |
| MATERIAL DESCRIPTION |         |     |             | DD (pcf)   |  | P (tsf)         |                    |                            |                 |     | ATTERBERG LIMITS (%) |                  |                   |                                 |                    |                          |   |  |  |                      |  |                       |
|                      |         |     |             | 90 100 110 120   |  | 1.0 2.0 3.0 4.0 |                    |                            |                 |     | LL                   | PL               | PI                | PASSING #200 SIEVE (%)          |                    |                          |   |  |  |                      |  |                       |
| 0                    |         |     |             | 1.5" Asphalt   |  |                 |                    |                            |                 |     |                      |                  |                   |                                 |                    |                          |   |  |  |                      |  |                       |
| 0                    |         |     |             | 6" Concrete with shell aggregate   |  | 1.75            |                    |                            |                 |     |                      |                  |                   |                                 |                    |                          |   |  |  |                      |  |                       |
| 0                    |         |     |             | Fat Clay with Sand (CH), stiff, very high plasticity, dark gray<br>..very stiff, light gray and tan below 2' |  | 4.0             |                    |                            |                 |     |                      |                  |                   |                                 |                    |                          |   |  |  |                      |  |                       |
| 0                    |         |     |             | ..with calcareous nodules below 4'   |  | 3.0             |                    |                            |                 |     |                      |                  |                   |                                 |                    |                          |   |  |  |                      |  |                       |
| 5                    |         | CH  |             | ..with ferrous nodules below 6'  |  | 3.5             |                    |                            |                 |     |                      |                  |                   |                                 |                    |                          |   |  |  |                      |  |                       |
| 5                    |         |     |             | ..stiff, reddish brown below 8'  |  | 2.0             |                    |                            |                 | 106 | 0.9                  | 0                |                   |                                 |                    |                          |   |  |  |                      |  |                       |
| 10                   |         |     |             | Lean Clay with Sand (CL), very stiff, medium plasticity, light gray and tan                                  |  | 3.25            |                    |                            |                 |     |                      |                  |                   |                                 |                    |                          |   |  |  |                      |  |                       |
| 10                   |         |     |             | ..with ferrous nodules below 12'   |  | 4.0             |                    |                            |                 |     |                      |                  |                   |                                 |                    |                          |   |  |  |                      |  |                       |
| 15                   |         | CL  |             | ..stiff with calcareous nodules below 16'  |  | 3.5             |                    |                            |                 |     |                      |                  |                   |                                 |                    |                          |   |  |  |                      |  |                       |
| 15                   |         |     |             |  |  | 2.0             |                    |                            |                 | 109 | 0.7                  | 0                |                   |                                 |                    |                          |   |  |  |                      |  |                       |
| 20                   |         |     |             |  |  | 1.5             |                    |                            |                 |     |                      |                  |                   |                                 |                    |                          |   |  |  |                      |  |                       |

Water Level Initial:  $\nabla$  After Drilling  $\nabla$  24 Hrs:  $\nabla$   
 Water Observations: Initial Water Level: Dry, After Drilling Water Level: Dry  
 Sample Key:  $\boxtimes$  SPT  $\square$  Shelby Tube  $\square$  Disturbed

Key to Abbreviations:  
 N - SPT Data (Blows/Ft)  
 P - Pocket Penetrometer (tsf)  
 T - Torvane (psf)  
 Q<sub>u</sub> - Unconfined Comp. Strength (tsf)  
 DD - Dry Density (pcf)

Notes:  
 Augered Dry to 20', Hole Grouted after Drilling. Drilled By: Soltek, LLC, Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

# LOG OF BORING B-13

DATE: 02/03/2014  
 SURFACE ELEVATION: 47.24

**Associated Testing Laboratories, Inc.**  
 3143 Yellowstone Blvd  
 Houston, Texas-77054

PROJECT: Neighborhood Sewer Systems Improvements Sunset Blvd, University Blvd & Westheimer St. Houston, TX WBS No. R-002011-005503

PROJECT NO.: G14-109 BORING TYPE: Auger

| DEPTH (ft.) | SAMPLES | USC | WATER LEVEL | LOCATION  |  | POCKET PENETROMETER (tsf) | BLOW COUNT (N, Blows/Foot) | N (blows/ft) |     |          |     | DRY DENSITY (pcf) | UNCONFINED COMP. STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | Natural Moisture Content and Atterberg Limits |                  |              | MOISTURE CONTENT (%) | ATTERBERG LIMITS (%) |               |                  | ESTIMATED ANGLE OF INTERNAL FRICTION (°) | OTHER TESTS & REMARKS |                        |
|-------------|---------|-----|-------------|---|--|---------------------------|----------------------------|--------------|-----|----------|-----|-------------------|---------------------------------|--------------------|--------------------------|---|------------------|--------------|----------------------|----------------------|---------------|------------------|--|-----------------------|------------------------|
|             |         |     |             | Dryden Rd.  |  |                           |                            | 20           | 40  | 60       | 80  |                   |                                 |                    |                          | Plastic Limit                                 | Moisture Content | Liquid Limit |                      | LIQUID LIMIT         | PLASTIC LIMIT | PLASTICITY INDEX |  |                       | PASSING #200 SIEVE (%) |
|             |         |     |             | Northing: 13824372.45<br>Easting: 3105835.34  |  |                           |                            | 1.0          | 2.0 | 3.0      | 4.0 |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |
|             |         |     |             | MATERIAL DESCRIPTION  |  | Q <sub>u</sub> (tsf)      |                            |              |     | DD (pcf) |     |                   |                                 | P (tsf)            |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |
| 0           |         |     |             | 1.5" Asphalt  |  |                           |                            |              |     |          |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |
|             |         |     |             | 5" Concrete with shell aggregate  |  |                           |                            |              |     |          |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |
|             |         |     |             | Fat Clay with Sand (CH), stiff, very high plasticity, light gray and tan ..dark gray below 2' |  |                           |                            |              |     |          |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |
|             |         |     |             | ..light gray and tan below 4'   |  |                           |                            |              |     |          |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |
| 5           |         |     |             | ..with ferrous nodules below 6'   |  |                           |                            |              |     |          |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |
|             |         |     |             | ..with calcareous nodules below 8'  |  |                           |                            |              |     |          |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |
| 10          |         |     |             | ..reddish brown below 10'   |  |                           |                            |              |     |          |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |
|             |         |     |             | ..very stiff, light gray and tan below 12'  |  |                           |                            |              |     |          |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |
| 15          |         |     |             | ..hard below 16'  |  |                           |                            |              |     |          |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |
|             |         |     |             | ..very stiff below 18'  |  |                           |                            |              |     |          |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |
| 20          |         |     |             |   |  |                           |                            |              |     |          |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |

Water Level Initial:  $\nabla$  After Drilling  $\nabla$  24 Hrs:  $\nabla$   
 Water Observations: Initial Water Level: Dry, After Drilling Water Level: Dry  
 Sample Key:  $\boxtimes$  SPT  $\boxplus$  Shelby Tube  $\boxminus$  Disturbed

Key to Abbreviations:  
 N - SPT Data (Blows/Ft)  
 P - Pocket Penetrometer (tsf)  
 T - Torvane (psf)  
 Q<sub>u</sub> - Unconfined Comp. Strength (tsf)  
 DD - Dry Density (pcf)

Notes:  
 Augered Dry to 20', Hole Grouted after Drilling. Drilled By: Soltek, LLC, Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST



**Associated Testing Laboratories, Inc.**  
**3143 Yellowstone Blvd**  
**Houston, Texas-77054**

**LOG OF BORING B-15**

DATE: **02/03/2014**  
 SURFACE ELEVATION: **47.00**

PROJECT: **Neighborhood Sewer Systems Improvements Sunset Blvd, University Blvd & Westheimer St. Houston, TX WBS No. R-002011-005503**  
 PROJECT NO.: **G14-109** BORING TYPE: **Auger**

| DEPTH (ft.)          | SAMPLES | USC | WATER LEVEL | LOCATION   |  | POCKET PENETROMETER (P, tsf) | BLOW COUNT (N, Blows/Foot) | N (blows/ft) |     |     |     | DRY DENSITY (pcf) | UNCONFINED COMP. STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | Natural Moisture Content and Atterberg Limits |                  |              | MOISTURE CONTENT (%) | ATTERBERG LIMITS (%) |               |                  | PASSING #200 SIEVE (%) | ESTIMATED ANGLE OF INTERNAL FRICTION (°)<br>OTHER TESTS & REMARKS |    |    |
|----------------------|---------|-----|-------------|--|--|------------------------------|----------------------------|--------------|-----|-----|-----|-------------------|---------------------------------|--------------------|--------------------------|---|------------------|--------------|----------------------|----------------------|---------------|------------------|------------------------|---|----|----|
|                      |         |     |             | Sunset Blvd.   |  |                              |                            | 20           | 40  | 60  | 80  |                   |                                 |                    |                          | Plastic Limit                                 | Moisture Content | Liquid Limit |                      | LIQUID LIMIT         | PLASTIC LIMIT | PLASTICITY INDEX |                        |   |    |    |
|                      |         |     |             | Northing: 13827835.28<br>Easting: 3106221.02                             |  |                              |                            | 1.0          | 2.0 | 3.0 | 4.0 |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |                        |   | LL | PL |
| MATERIAL DESCRIPTION |         |     |             | P  |  |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |                        |   |    |    |
| 0                    |         |     |             | 2" Asphalt   |  |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |                        |   |    |    |
|                      |         |     |             | 6" Concrete  |  |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |                        |   |    |    |
|                      |         |     |             | Fat Clay with Sand (CH), stiff, very high plasticity, light gray and tan |  |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |                        |   |    |    |
|                      |         |     |             | ..with calcareous and ferrous nodules below 6'                           |  |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |                        |   |    |    |
|                      |         |     |             | ..very stiff, reddish brown below 8'                                     |  |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |                        |   |    |    |
| 5                    |         | CH  |             |  |  |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |                        |   |    |    |
|                      |         |     |             | Lean Clay with Sand (CL), stiff, medium plasticity, light gray and tan   |  |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |                        |   |    |    |
|                      |         |     |             | ..with ferrous nodules below 12'   |  |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |                        |   |    |    |
| 10                   |         | CL  |             |  |  |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |                        |   |    |    |
|                      |         |     |             |  |  |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |                        |   |    |    |
| 15                   |         |     |             |  |  |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |                        |   |    |    |

Water Level Initial:  $\nabla$  After Drilling  $\nabla$  24 Hrs:  $\nabla$   
 Water Observations: Initial Water Level: Dry, After Drilling Water Level: Dry  
 Sample Key:  $\boxtimes$  SPT  $\boxplus$  Shelby Tube  $\boxminus$  Disturbed

Key to Abbreviations:  
 N - SPT Data (Blows/Ft)  
 P - Pocket Penetrometer (tsf)  
 T - Torvane (psf)  
 Q<sub>u</sub> - Unconfined Comp. Strength (tsf)  
 DD - Dry Density (pcf)

Notes:  
 Augered Dry to 15', Hole Grouted after Drilling. Drilled By: Soltek, LLC, Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

**Associated Testing Laboratories, Inc.**  
**3143 Yellowstone Blvd**  
**Houston, Texas-77054**

**LOG OF BORING B-16**

DATE: **02/03/2014**  
 SURFACE ELEVATION: **48.36**

PROJECT: **Neighborhood Sewer Systems Improvements Sunset Blvd, University Blvd & Westheimer St. Houston, TX WBS No. R-002011-005503**  
 PROJECT NO.: **G14-109** BORING TYPE: **Auger**

| DEPTH (ft.) | SAMPLES | USC | WATER LEVEL | LOCATION  |  | POCKET PENETROMETER (P, tsf) | BLOW COUNT (N, Blows/Foot) | N (blows/ft) |    |    |    | DRY DENSITY (pcf) | UNCONFINED COMP. STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | Natural Moisture Content and Atterberg Limits |                  |              | MOISTURE CONTENT (%) | ATTERBERG LIMITS (%) |               |                  | ESTIMATED ANGLE OF INTERNAL FRICTION (°) | OTHER TESTS & REMARKS |  |  |
|-------------|---------|-----|-------------|---|--|------------------------------|----------------------------|--------------|----|----|----|-------------------|---------------------------------|--------------------|--------------------------|---|------------------|--------------|----------------------|----------------------|---------------|------------------|--|-----------------------|--|--|
|             |         |     |             | Sunset Blvd.<br>Northing: 13827884.71<br>Easting: 3105576.97  |  |                              |                            | 20           | 40 | 60 | 80 |                   |                                 |                    |                          | Plastic Limit                                 | Moisture Content | Liquid Limit |                      | LIQUID LIMIT         | PLASTIC LIMIT | PLASTICITY INDEX |  |                       |  |  |
| 0           |         |     |             | <b>MATERIAL DESCRIPTION</b>   |  |                              |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |  |  |
|             |         |     |             | 2" Asphalt  |  |                              |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |  |  |
|             |         |     |             | 6" Concrete   |  |                              |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |  |  |
|             |         |     |             | Fat Clay with Sand (CH), firm, high plasticity, light gray and tan<br>...stiff with calcareous nodules below 2' |  |                              |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |  |  |
|             |         |     |             | ..with ferrous nodules below 6'   |  |                              |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |  |  |
| 5           |         |     |             | ..very stiff below 10'  |  |                              |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |  |  |
| 10          |         |     |             | Lean Clay with Sand (CL), stiff, medium plasticity, light gray and tan<br>..with ferrous nodules below 14'      |  |                              |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |  |  |
| 15          |         |     |             |   |  |                              |                            |              |    |    |    |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |  |  |

Water Level Initial:  $\nabla$  After Drilling  $\nabla$  24 Hrs:  $\nabla$   
 Water Observations: Initial Water Level: Dry, After Drilling Water Level: Dry  
 Sample Key:  $\boxtimes$  SPT  $\boxplus$  Shelby Tube  $\boxminus$  Disturbed

Key to Abbreviations:  
 N - SPT Data (Blows/Ft)  
 P - Pocket Penetrometer (tsf)  
 T - Torvane (psf)  
 Q<sub>u</sub> - Unconfined Comp. Strength (tsf)  
 DD - Dry Density (pcf)

Notes:  
 Augered Dry to 15', Hole Grouted after Drilling. Drilled By: Soltek, LLC, Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

# LOG OF BORING B-17

DATE: 02/05/2014  
 SURFACE ELEVATION: 49.13

**Associated Testing Laboratories, Inc.**  
 3143 Yellowstone Blvd  
 Houston, Texas-77054

PROJECT: Neighborhood Sewer Systems Improvements Sunset Blvd, University Blvd & Westheimer St. Houston, TX WBS No. R-002011-005503  
 PROJECT NO.: G14-109 BORING TYPE: Auger

| DEPTH (ft.) | SAMPLES | USC | WATER LEVEL | LOCATION   |   | POCKET PENETROMETER (P, tsf) | BLOW COUNT (N, Blows/Foot) | N (blows/ft) |     |     |     | DRY DENSITY (pcf) | UNCONFINED COMP. STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | Natural Moisture Content and Atterberg Limits |                  |              | MOISTURE CONTENT (%) | ATTERBERG LIMITS (%) |               |                  | ESTIMATED ANGLE OF INTERNAL FRICTION (°) | OTHER TESTS & REMARKS |                        |              |
|-------------|---------|-----|-------------|--|---|------------------------------|----------------------------|--------------|-----|-----|-----|-------------------|---------------------------------|--------------------|--------------------------|---|------------------|--------------|----------------------|----------------------|---------------|------------------|--|-----------------------|------------------------|--------------|
|             |         |     |             | Sunset Blvd.<br>Northing: 13827880.07<br>Easting: 3105225.78 |   |                              |                            | 20           | 40  | 60  | 80  |                   |                                 |                    |                          | Plastic Limit                                 | Moisture Content | Liquid Limit |                      | LIQUID LIMIT         | PLASTIC LIMIT | PLASTICITY INDEX |  |                       | PASSING #200 SIEVE (%) |              |
|             |         |     |             | MATERIAL DESCRIPTION   |   |                              |                            | 1.0          | 2.0 | 3.0 | 4.0 |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        | ★ DD (pcf) ★ |
| 0           |         |     |             |  | 3.5" Asphalt  |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |              |
|             |         |     |             |  | 5" Concrete   |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |              |
|             |         |     |             |  | Fat Clay with Sand (CH), firm, very high plasticity, dark gray<br>..light gray and tan below 2' | 1.0                          |                            | ◆            |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      | 37            |                  |  |                       |                        |              |
|             |         |     |             |  | ..stiff with calcareous nodules below 4'  | 1.0                          |                            | ◆            |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      | 32            | 78               | 23                                       | 55                    | 82                     |              |
| 5           |         |     |             |  | ..with ferrous nodules below 6'   | 1.5                          |                            | ◆            |     |     |     |                   |                                 |                    |                          |   |                  |              |                      | 29                   |               |                  |  |                       |                        |              |
|             |         | CH  |             |  | Lean Clay with Sand (CL), stiff, high plasticity, light gray and tan                            | 1.75                         |                            | ◆            |     |     |     |                   |                                 |                    |                          |   |                  |              |                      | 35                   |               |                  |  |                       |                        |              |
|             |         |     |             |  | ..with ferrous nodules below 12'  | 1.75                         |                            | ◆            |     |     |     |                   |                                 |                    |                          |   |                  |              |                      | 19                   |               |                  |  |                       |                        |              |
| 10          |         |     |             |  | ..very stiff below 14'  | 3.75                         |                            | ◆            |     |     |     |                   |                                 |                    |                          |   |                  |              |                      | 17                   | 45            | 18               | 27                                       | 74                    |                        |              |
| 15          |         |     |             |  |   |                              |                            |              |     |     |     |                   |                                 |                    |                          |   |                  |              |                      |                      |               |                  |  |                       |                        |              |

Water Level Initial: ▽ After Drilling ▽ 24 Hrs: ▽  
 Water Observations: Initial Water Level: Dry, After Drilling Water Level: Dry  
 Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:  
 N - SPT Data (Blows/Ft)  
 P - Pocket Penetrometer (tsf)  
 T - Torvane (psf)  
 Q<sub>u</sub> - Unconfined Comp. Strength (tsf)  
 DD - Dry Density (pcf)

Notes:  
 Augered Dry to 15', Hole Grouted after Drilling. Drilled By: Soltek, LLC, Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

**Associated Testing Laboratories, Inc.**  
**3143 Yellowstone Blvd**  
**Houston, Texas-77054**

**LOG OF BORING B-18**

DATE: 02/03/2014  
 SURFACE ELEVATION: 46.60

PROJECT: Neighborhood Sewer Systems Improvements Sunset Blvd, University Blvd & Westheimer St. Houston, TX WBS No. R-002011-005503  
 PROJECT NO.: G14-109 BORING TYPE: Auger

| DEPTH (ft.)          | SAMPLES | USC | WATER LEVEL | LOCATION   |  | POCKET PENETROMETER (P, tsf) | BLOW COUNT (N, Blows/Foot) | N (blows/ft)                                |  |     |                        | DRY DENSITY (pcf) | UNCONFINED COMP. STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | Natural Moisture Content and Atterberg Limits |  |  | MOISTURE CONTENT (%) | ATTERBERG LIMITS (%) |               |                  | ESTIMATED ANGLE OF INTERNAL FRICTION (°) | OTHER TESTS & REMARKS |    |    |
|----------------------|---------|-----|-------------|--|--|------------------------------|----------------------------|---|--|-----|------------------------|-------------------|---------------------------------|--------------------|--------------------------|---|--|--|----------------------|----------------------|---------------|------------------|--|-----------------------|----|----|
|                      |         |     |             | Nottingham St.   |  |                              |                            | ● 20 40 60 80                               |  |     |                        |                   |                                 |                    |                          | Plastic Limit Moisture Content Liquid Limit   |  |  |                      | LIQUID LIMIT         | PLASTIC LIMIT | PLASTICITY INDEX |  |                       |    |    |
|                      |         |     |             | Northing: 13827599.23<br>Easting: 3106141.66                         |  |                              |                            | ▲ Q <sub>u</sub> (tsf) ▲<br>1.0 2.0 3.0 4.0 |  |     |                        |                   |                                 |                    |                          | ★ DD (pcf) ★<br>90 100 110 120                |  |  |                      |                      |               |                  |  |                       | LL | PL |
| MATERIAL DESCRIPTION |         |     |             | ◆ P (tsf) ◆<br>1.0 2.0 3.0 4.0                                       |  |                              |                            | 20 40 60 80                                 |  |     | PASSING #200 SIEVE (%) |                   |                                 |                    |                          |   |  |  |                      |                      |               |                  |  |                       |    |    |
| 0                    |         |     |             | 2" Asphalt   |  |                              |                            |   |  |     |                        |                   |                                 |                    |                          |   |  |  |                      |                      |               |                  |  |                       |    |    |
|                      |         |     |             | 4.5" Concrete  |  |                              |                            |   |  |     |                        |                   |                                 |                    |                          |   |  |  |                      |                      |               |                  |  |                       |    |    |
|                      |         |     |             | Fat Clay with Sand (CH), stiff, high plasticity, light gray and tan  |  |                              |                            |   |  |     |                        |                   |                                 |                    |                          |   |  |  |                      |                      |               |                  |  |                       |    |    |
|                      |         |     |             | ..with calcareous nodules below 4'                                   |  |                              |                            |   |  |     |                        |                   |                                 |                    |                          |   |  |  |                      |                      |               |                  |  |                       |    |    |
| 5                    |         | CH  |             | ..with ferrous nodules below 6'                                      |  |                              |                            |   |  |     |                        |                   |                                 |                    |                          |   |  |  |                      |                      |               |                  |  |                       |    |    |
|                      |         |     |             | Lean Clay with Sand (CL), stiff, high plasticity, light gray and tan |  |                              |                            |   |  | 112 | 0.85                   | 0                 |                                 |                    |                          |   |  |  |                      |                      |               |                  |  |                       |    |    |
|                      |         |     |             | ..very stiff with calcareous nodules below 12'                       |  |                              |                            |   |  |     |                        |                   |                                 |                    |                          |   |  |  |                      |                      |               |                  |  |                       |    |    |
| 10                   |         | CL  |             |  |  |                              |                            |   |  |     |                        |                   |                                 |                    |                          |   |  |  |                      |                      |               |                  |  |                       |    |    |
| 15                   |         |     |             |  |  |                              |                            |   |  |     |                        |                   |                                 |                    |                          |   |  |  |                      |                      |               |                  |  |                       |    |    |

Water Level Initial: ▽ After Drilling ▽ 24 Hrs: ▽  
 Water Observations: Initial Water Level: Dry, After Drilling Water Level: Dry  
 Sample Key: ⊠ SPT ⊡ Shelby Tube ⊢ Disturbed

Key to Abbreviations:  
 N - SPT Data (Blows/Ft)  
 P - Pocket Penetrometer (tsf)  
 T - Torvane (psf)  
 Q<sub>u</sub> - Unconfined Comp. Strength (tsf)  
 DD - Dry Density (pcf)

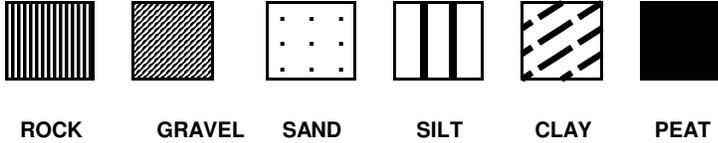
Notes:  
 Augered Dry to 15', Hole Grouted after Drilling. Drilled By: Soltek, LLC, Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST



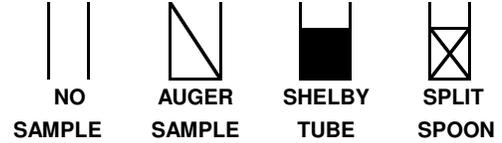


## KEY TO LOG TERMS AND SYMBOLS

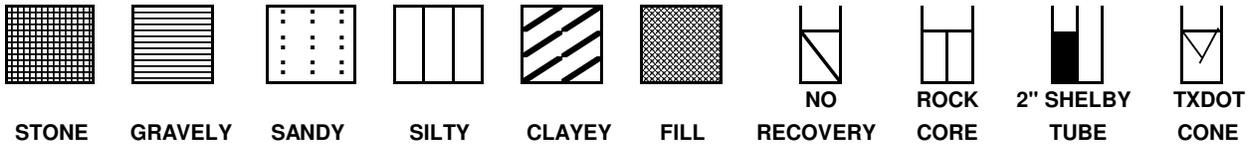
### SOIL TYPE



### SAMPLER TYPE



### MODIFIER



### UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D 2487

| MAJOR DIVISIONS  |   |   | LETTER SYMBOL | TYPICAL DESCRIPTIONS   |
|--|---|---|---------------|--|
| COARSE GRAINED SOILS LESS THAN 50% PASSING No. 200 SIEVE | GRAVEL & GRAVELY SOILS LESS THAN 50% PASSING No.4 SIEVE | CLEAN GRAVELS LITTLE OR NO FINES              | GW            | WELL GRADEED GRAVELS, GRAVELSAND MIXTURES WITH LITTLE OR NO FINES                            |
|  |   | W/ APPRECIATEBLE FINES                        | GP            | POORLY GRADED GRAVELS, GRAVEL SAND MIXTURES WITH LITTLE OR NO FINES                          |
|  |   |   | GM            | SILTY GRAVELS, GRAVEL SAND-SILT MIXTURES   |
|  | SANDS MORE THAN 50% PASSING No.4 SIEVE                  | CLEAN SANDS LITTLE FINES                      | SW            | WELL GRADED SAND, GRAVELY SAND (LITTLE FINES)  |
|  |   | SANDS WITH APPREA. FINES                      | SP            | POORLY GRADED SANDS, GRAVELY SAND(L. FINES)  |
|  |   |   | SM            | SILTY SANDS, SAND-SILT MIXTURES  |
| FINE GRAINED SOILS LESS THAN 50% PASSING NO. 200 SIEVE   | SILTS AND CLAYS LIQUID LIMIT LESS THAN 50               |   | SC            | CLAYEY SANDS, SAND-CLAY MIXTURES   |
|  |   |   | ML            | INORGANIC SILTS & VERY FINE SANDS, ROCK FLOUR SILTY OR CLAYEY FINE SANDS OR CLAYEY SILT W/PI |
|  |   |   | CL            | INORGANIC CLAY OF LOW TO MEDIUM PI LEAN CLAY, GRAVELY CLAYS, SANDY CLAYS, SILTY CLAYS        |
|  | SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50            |   | OL            | ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PI  |
|  |   |   | MH            | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS          |
|  |   |   | CH            | INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS   |
|  | OH  | ORGANIC CLAYS OF MED TO HIGH PI, ORGANIC SILT |               |  |
| HIGHLY ORGANIC SOIL                                      |   |   | FT            | PEAT AND OTHER HIGHLY ORGANIC SOILS  |
| UNCLASSIFIED FILL MATERIALS                              |   |   |               | ARTIFICIALLY DEPOSITED AND OTHER UNCLASSIFIED SOILS FILL MATERIALS                           |

### CONSISTENCY OF COHESIVE SOILS

| CONSISTENCY | UNCONFINED COMP. STRENGTH IN TSF |
|-------------|----------------------------------|
| VERY SOFT   | LESS THAN 0.25                   |
| SOFT        | 0.25 TO 0.5                      |
| FIRM        | 0.5 TO 1.0                       |
| STIFF       | 1.0 TO 2.0                       |
| VERY STIFF  | 2.0 TO 4.0                       |
| HARD        | GREATER THAN 4.0                 |

| CONSISTENCY | UNCORR. POCKET PENTROMETER READ. |
|-------------|----------------------------------|
| VERY SOFT   | LESS THAN 0.25                   |
| SOFT        | 0.25 TO 0.5                      |
| FIRM        | > 0.50 TO 1.50                   |
| STIFF       | > 1.50 TO 3.00                   |
| VERY STIFF  | > 3.0 TO 4.50                    |
| HARD        | 4.5+                             |

### RELATIVE DENSITY - GRANULAR SOILS

| CONSISTENCY  | N-VALUE (BLOWS PER FT) |
|--------------|------------------------|
| VERY LOOSE   | <4                     |
| LOOSE        | 5-10                   |
| MEDIUM DENSE | 11-30                  |
| DENSE        | 31-50                  |
| VERY DENSE   | >50 OR 50+             |

### CLASSIFICATION OF GRANULAR SOILS

#### U.S. STANDARD SIEVE SIZE(S)

| 6"       | 3"      | 3/4"   | 4    | 10     | 40     | 200   |              |       |
|----------|---------|--------|------|--------|--------|-------|--------------|-------|
| BOULDERS | COBBLES | GRAVEL |      | SAND   |        |       | SILT OR CLAY | CLAY  |
|          |         | COARSE | FINE | COARSE | MEDIUM | FINE  |              |       |
| 152      | 76.2    | 19.1   | 4.76 | 2.0    | 0.42   | 0.074 |              | 0.002 |

GRAIN SIZE IN MM