FINAL REPORT
GEOTECHNICAL INVESTIGATION
WATER LINE REPLACEMENT
IN SHEPHERD FOREST II AREA
WBS NO. S-000035-0192-4
HOUSTON, TEXAS

PREPARED BY

ASSOCIATED TESTING LABORATORIES, INC.
HOUSTON, TEXAS

ATL REPORT NO. G13-196
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December 18, 2013

ATL Job No: G13-196

Isani Consultants, LP
3143 Yellowstone Boulevard
Houston, Texas 77054

Attention: Mr. Vincent Jacob, P.E.

Reference: Final Geotechnical Investigation Report
Proposed Water Line Replacement in Shepherd Forest II Area
WBS No. S-000035-0192-4
Houston, Texas

Dear Mr. Jacob:

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.

STATE OF TEXAS
PENG SIA TANG
81150
REGISTERED PROFESSIONAL ENGINEER
12/18/13

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

Jasbir Singh, P.E.
President

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GEOTECHNICAL INVESTIGATION

WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA

HOUSTON, TEXAS

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GEOTECHNICAL INVESTIGATION
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
HOUSTON, TEXAS

EXECUTIVE SUMMARY

Associated Testing Laboratories, Inc. (ATL) has completed the geotechnical study for the proposed replacement of existing water lines in the Shepherd Forest II Area, as shown in Figure 1. The project entails replacing approximately 31,935 LF of existing water lines with new 8- and 12-inch diameter water lines, at depths ranging from about 5 to about 20 feet below existing grade (see Figures 2a to 2e).

Trenchless installation technique will mostly be employed. Open cut/trench excavation will be carried out at access pits (auger pits), and possibly in local areas where underground obstructions or site conditions warrant open cut/trenching. The subsurface conditions investigated by 51 soil borings (to depths of 10 to 25 feet below existing grade) along the project alignments, consists predominantly of stiff to hard Lean Clays (CL) and Fat Clays (CH), with local areas with firm consistency. Silty/Clayey Sands (SM, SC, SC-SM) were found in the following borings: B-2 (12 to 16* feet); B-10 (top 4 feet, 14 to 23 feet); B-11 (2 to 4 feet); B-13 (10 to 12 feet); B-14 (top 2 feet); B-21 (12 to 14 feet); B-22 (top 2 feet, 12 to 18 feet); B-23 (8 to 20* feet); B-24 (10 to 18 feet); B-27 (top 2 feet); B-29 (top 1 foot); B-31 (top 2 feet), and in B-32 (top 2 feet). * indicates the bottom of borings. 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 4l.

Free water was encountered during drilling operation in Borings B-2, B-17, B-21, B-22, B-23, B-24, B-28, B-32 and B-38 at a depth of about 14, 10.5, 14.5, 14, 12, 18, 10, 14 and 16.5 feet, and was measured at the completion of drilling in Borings B-17, B-21, B-23, B-24, B-28, B-32 and B-38 at a depth of about 12.5, 14, 11.5, 14, 11.5, 16.5 and 13.5 feet, respectively. Free water was not encountered in the remainder of the borings. Borings B-1, B-10, B-23 and B-41 were converted into

Piezometer PZ-1 through PZ-4 after completion of drilling and soil sampling. Water level in PZ-1, PZ-3 and PZ-4 was measured after 24-hour at a depth of about 13.5, 1 and 11.5 feet, respectively; PZ-2 was dry. Water level in PZ-1, PZ-3 and PZ-4 was measured after 7 days at a depth of about 14, 12 and 12 feet; PZ-2 was dry. Water level in PZ-1 through PZ-4 was measured at a depth of about 13, 18, 12 and 11 feet after 30 days, respectively.

Our main geotechnical findings and recommendations are summarized below:

1. No unusual staining or hydrocarbon-like odor was noted in the soil samples recovered from the soil borings drilled in ATL's geotechnical investigation.
2. A preliminary fault evaluation based on review of available fault maps and literature review, it appears that the NE-SW trending Eureka Heights Fault crosses the project area in the vicinity of the intersection of Alba Road and W. 30th Street. Therefore, ATL recommends that a Phase I Fault Study be conducted by a Professional Geologist knowledgeable with Eureka Heights Fault to further investigate and verify the presence and locations (zones) of active faulting in the project area.
3. Based on proposed flow line depths and the subsurface conditions (see Figures 4a through 4l), the water line installation excavations will be advanced mostly in stiff to hard clays with local stratum of firm clays. However, granular soils or soils with limited cohesion will likely or may be encountered at the location identified in Table C in Section 5.2 (but not limited to), or at locations away from the locations investigated in this project.
4. Based on the proposed invert elevation and the gathered groundwater information, the water line construction excavations exceeding 10 feet in depth will likely to encounter groundwater, especially when the excavations stay open for 24 hours or more. However, 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 water lines are presented in Section 5. Construction considerations are provided in Section 6.

GEOTECHNICAL INVESTIGATION
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
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1.0 INTRODUCTION

1.1 General

The geotechnical investigation for Water Line Replacement in Shepherd Forest II Area was authorized on August 6, 2013 with the acceptance of the **Associated Testing Laboratories, Inc., (ATL)** Proposal No. CP13-0703 dated July 25, 2013. Project details were provided to ATL by Isani Consultants, LP This report includes results of the field investigation, laboratory testing, geotechnical engineering analysis and recommendations for the proposed water line replacement for this project.

1.2 Location and Description of the Project

The project sites of this project are located in a mixed residential and commercial neighborhood, a Site Vicinity Map showing the project alignments is presented in Figure 1. Photographs of the project sites were taken at the time of our site visit, and some are presented in Appendix 1.

The project entails replacing the existing water lines with approximately 31,935 linear feet of 8- and 12-inch diameter water lines in the Shepherd Forest II Area in the City of Houston, Texas. The project alignments traverse streets in the Key Map 452 P, Q and R area, and are shown in Figures 2a to 2e.

The approximate invert depths of the proposed water lines at the proposed boring locations, based on information provided by Isani Consultants, LP, the water lines are proposed to be installed at a

typical depth of about 5 to about 8 feet below existing grade. However, local areas with deeper underpass (at depths of about 10 to 20 feet) exist at street/utility lines and ditch crossings. For this geotechnical proposal, ATL understands that the proposed water lines will cross the existing HCFCD ditches without disturbing the existing ditches.

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 water lines. **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) and asphaltic concrete (AC) pavements using a pavement coring machine and the drill rig auger, respectively.
- Original scope of drilling and sampling entails a total of fifty one (51) borings (Borings B-1 through B-51), to depths ranging from 10 to 25 feet below existing grade, for a total of 676 lineal feet of drilling, and converting four borings into piezometers (totaling 80 lineal feet) after completion of drilling and sampling. The actual total drilling footage was 681.5 lineal feet, with Borings B-2 and B-24 drilled an additional 0.5 and 5 feet below proposed depth, respectively.
- 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 water lines replacement construction.

2.0 SUBSURFACE INVESTIGATION PROGRAM

The field investigation for this project consisted of drilling and sampling a total of fifty one (51) 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".

Thirty nine (39) borings are located within existing streets with PCC pavements (with or without AC overlay), and ten (10) borings are located in the existing streets with AC pavements; two (2) were drilled outside paved area. The existing PCC pavements at boring locations were cored through using a pavement coring machine, and the existing AC pavements were augered through using the drill rig auger. 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	15	PZ-1	15	Stonecrest Dr.	13862515.95	3102215.78
B-2	15.5	--	--	Stonecrest Dr.	13862479.22	3102316.91
B-3	13	--	--	W. 31st St.	13862095.82	3102246.29
B-4	13	--	--	W. 31st St.	13862691.01	3102874.47
B-5	10	--	--	W. 31st St.	13862713.98	3103483.23

Boring		Piezometer		Location	Northing	Easting
No.	Depth, ft.	No.	Depth, ft.			
B-6	10	--	--	Stonecrest Dr.	13862414.88	3103110.20
B-7	10	--	--	Stonecrest Dr.	13862439.78	3103740.52
B-8	10	--	--	W. 30th St.	13862113.91	3102623.62
B-9	10	--	--	W. 30th St.	13862139.72	3103318.01
B-10	25	PZ-2	25	Alba Rd.	13864230.23	3103765.01
B-11	25	--	--	Alba Rd.	13864118.18	3103769.69
B-12	13	--	--	Alba Rd.	13863770.54	3103780.55
B-13	15	--	--	Alba Rd.	13863084.87	3103776.41
B-14	13	--	--	W. 30th St.	13862159.37	3103886.22
B-15	10	--	--	Stonecrest Dr.	13862456.68	3104189.44
B-16	13	--	--	W. 30th St.	13862182.83	3104511.79
B-17	13	--	--	Stonecrest Dr.	13862477.59	3104754.58
B-18	10	--	--	W. 31st St.	13862767.23	3104945.56
B-19	10	--	--	W. 30th St.	13862203.68	3105075.59
B-20	10	--	--	Stonecrest Dr.	13862495.66	3105258.09
B-21	20	--	--	W. 31st St.	13862766.48	3105630.02
B-22	20	--	--	W. 31st St.	13862765.70	3105713.00
B-23	20	PZ-3	20	W. 30th St.	13862282.31	3105682.37
B-24	25	--	--	W. 30th St.	13862297.03	3105725.31
B-25	12	--	--	Randall St.	13863490.92	3106471.28
B-26	10	--	--	Randall St.	13862887.92	3106505.29
B-27	10	--	--	W. 30th St.	13862327.51	3106468.71
B-28	13	--	--	W. 30th St.	13862358.62	3107146.05
B-29	12	--	--	W. 34th St.	13863636.42	3107113.47
B-30	10	--	--	Lawrence St.	13863201.66	3107367.91
B-31	10	--	--	Lawrence St	13862748.52	3107394.19
B-32	17	--	--	W. 30th St.	13862369.74	3107726.97
B-33	10	--	--	W. 34th St.	13863862.58	3107673.87

Boring		Piezometer		Location	Northing	Easting
No.	Depth, ft.	No.	Depth, ft.			
B-34	10	--	--	W. 32ND	13863130.33	3108054.16
B-35	10	--	--	W. 30th St.	13862354.94	3108344.55
B-36	10	--	--	W. 34th St.	13863993.68	3108167.45
B-37	10	--	--	W. 32ND	13863208.48	3108619.81
B-38	20	--	--	W. 34th St.	13864025.41	3108682.51
B-39	20	--	--	Ashland St.	13863503.56	3108880.04
B-40	20	--	--	Ashland St.	13862911.64	3108937.95
B-41	20	PZ-4	20	W. 30th St.	13862396.66	3109110.70
B-42	10	--	--	W. 34th St.	13864024.39	3109118.86
B-43	10	--	--	W. 32ND	13863233.08	3109144.12
B-44	10	--	--	W. 33rd St.	13863619.81	3109345.30
B-45	10	--	--	W. 32ND	13863239.13	3109703.11
B-46	10	--	--	W. 30th St.	13862422.86	3109625.83
B-47	10	--	--	W. 34th St.	13864040.20	3109706.36
B-48	10	--	--	W. 33rd St.	13863647.99	3110143.82
B-49	13	--	--	W. 34th St.	13864073.18	3110232.91
B-50	13	--	--	W. 32ND	13863238.62	3110264.43
B-51	13	--	--	W. 30th St.	13862429.75	3110293.63

Boring locations drilled in this geotechnical exploration are shown on Figures 2a to 2e. 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-10, B-23 and B-41 were converted into Piezometer PZ-1 through PZ-4 after 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 and 7 days are presented in Table 2. The piezometers will be pulled and plugged with cement-bentonite grout after the 30-day water level reading. The piezometer installation 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

TYPE OF TEST	NUMBER OF TEST
Dry Density	64
Moisture Content	343
Atterberg Limits	78
Unconsolidated Undrained Triaxial	13
Percent Fines Passing a No. 200 Sieve	70
Unconfined Compression	51

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 proposed project site is underlain by the Beaumont Formation of the 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 surface materials are often weakened by the weathering process.

The materials of Beaumont Formation were deposited during the last of the interglacial periods. During interglacial periods when water from the melting glaciers flowed back into the ocean, the sea rose, the depended valley backfilled and several Pleistocene formations were deposited. Beaumont

Formation may have been deposited during a mid-Wisconsin interglacial interval or during the Sangamon Stage, an interval between the Wisconsin and Illinoian Glaciations. The Sangamon Stage is estimated to be about 70,000 years ago. The Beaumont formation is the youngest formation of Pleistocene age that crops out in the proposed project area. Its origins are mainly fluvial and deltaic, but probably some small areas originated as coastal marsh and lagoonal deposits.

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, it appears that the NE-SW trending Eureka Heights Fault crosses the project area in the vicinity of the intersection of Alba Road and W. 30th Street. Therefore, ATL recommends that a Phase I Fault Study be conducted by a Professional Geologist knowledgeable with Eureka Heights Fault to further investigate and verify the presence and locations (zones) of active faulting in the

project area.

4.3 Subsurface Soil Stratigraphy and Geotechnical Characterization

***Existing Pavement Material*:** Thirty nine (39) borings are located within existing streets with PCC pavements (PCC) of which some are with AC overlay, and 10 borings are located in the existing streets with AC pavements. The PCC pavements were cored through using a pavement coring machine prior to drilling, and the existing AC pavements were augered through using the drill rig auger.. 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 at the boring locations have thicknesses ranging from about 3 to 8 inches, some with 1 to 4 inches of AC overlay. The existing AC pavements consist between about 1 to 5 inches of AC surface over about 5 to 13 inches of base consisting of crushed stone/limestone/shell and cement-treated 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*:** No unusual staining or hydrocarbon-like odor was noted in the soil samples recovered from the soil borings drilled in ATL's geotechnical investigation.

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

Along Stonecrest Dr. (Profile 4a): The subsurface soils below the existing PCC pavements with AC overlay, consist predominantly of firm to hard Lean Clays (CL) and Fat Clays (CH) to the bottom of Borings B-1, B-6, B-7, B-15, B-17 and B-20 at a depth of 15, 10, 10, 10, 12.5 and 10 feet below existing grade, respectively. In Boring B-2, a stratum of very stiff to hard Lean Clays (CL) and Fat

Clays (CH) exists to a depth of about 12 feet, and is underlain by a stratum of medium dense Silty Sand (SM) to the bottom of boring at 16 feet below the existing grade.

Along W. 31st St. (Profile 4b): The subsurface soils below the existing PCC pavements with AC overlay, consist predominantly of stiff to hard Lean Clays (CL) and Clays (CH) to the bottom of the Borings B-3, B-4, B-5, B-18, B-21, B-22 and B-26 at a depth of 13, 13, 10, 10, 20, 20, and 10 feet below existing grade, respectively. A stratum of medium dense to dense Silty Sand (SM) exists between depths of about 12 and 14 feet in Boring B-21, and about 12 and 18 feet in Boring B-22, respectively.

Along Alba Road (Profile 4c): The subsurface soils below the existing PCC pavements with AC overlay and AC pavements, consist predominantly of stiff to hard Lean Clays (CL) and Clays (CH) that exist to the bottom of Borings B-10 through B-13, B-7 and B-14 at a depth of about 25, 25, 13, 14, 10 and 13 feet below existing grade, respectively. An upper Silty Sand (SM) stratum exists between depths of about 2 and 4 feet in Boring B-11, and below the pavements to a depth of about 2 feet in Boring B-14. A lower Silty Sand (SM) stratum exists between depths of about 10 and 12 feet in Boring B-13. In Boring B-10, a stratum of medium dense Clayey Sand (SC) exists between depths of about 14 and 23 feet.

Along Randall Street (Profile 4d): The subsurface soils below the existing PCC pavements with AC overlay, consist of firm to very stiff Lean Clays (CL) that exist to the bottom of the Borings B-25 and B-26 at 12 and 10 feet below the existing grade, respectively.

Along Lawrence Street (Profile 4e): The subsurface soils below the existing AC/PCC pavements and ground surface, consist predominantly of stiff to hard Lean Clays (CL) that exist to the bottom of Borings B-29 through B-32 at a depth of 12, 10, 10 and 12 feet below the existing grade, respectively. A minor stratum of Silty Sand (SM) exists in the top 2 feet at locations of Borings B-29, B-31 and B-32.

Along W. 30th Street – 1 of 2 (Profile 4f): The subsurface soils below the existing PCC pavements with AC overlay consist predominantly of firm to hard Lean Clays (CL) and Fat Clays (CH) that exist to the bottom of Borings B-8, B-9, B-14, B-16, B-19 and B-24 at a depth of 10, 10, 13, 13, 10 and 25 feet below the existing grade, respectively. A medium dense to dense Silty Sand (SM) stratum exists below a depth of about 8 feet and exists to the bottom of boring at 20 feet in Boring B-23, and between depths of about 10 and 18 feet in Boring B-24.

Along W. 30th Street – 2 o f 2 (Profile 4g): The subsurface soils below the existing AC/PCC pavements and ground surface consist predominantly of firm to hard Lean Clays (CL) to the bottom of Borings B-27, B-28, B-32, B-35, B-41, B-46 and B-51 at 10, 13, 17, 10, 20, 10 and 13 feet below existing grade. A minor Silty Sand (SM) stratum exists below the existing pavements to a depth of about 2 feet in Borings B-27 and B-32.

Along 34th Street (Profile 4h): The subsurface soils below the existing PCC pavements with AC overlay and ground surface consist of firm to hard Lean Clays (CL) and Fat Clays (CH) that exist to the bottom of Borings B-29, B-33, B-36, B-38, B-42, B-47 and B-49 at 12, 10, 10, 20, 10, 10 and 13 feet below the existing grade, respectively.

Along Ashland Street (Profile 4i): The subsurface soils below the existing AC/PCC pavements consist of firm to hard Lean Clays (CL) that exist to the bottom of the Borings B-38 through B-41 at 20 feet.

Along W. 33rd Street (Profile 4j): The subsurface soils below the existing PCC pavements with AC overlay consist of stiff to very stiff Lean Clays (CL) and Fat Clays (CH) that exist to the bottom of Borings B-39, B-44 and B-48 at 20, 10 and 10 feet below the existing grade, respectively.

Along W. 32nd Street (Profile 4k): The subsurface soils below the existing PCC pavements with

AC overlay consist of firm to hard Lean Clays (CL) and Fat Clays (CH) that exist to the bottom of Borings B-31, B-34, B-37, B-43, B-45 and B-50 at 10, 10, 10, 10, 10 and 13 feet below existing grade, respectively.

Along Yale Street (Profile 4l): The subsurface soils below the existing PCC pavements with AC overlay and ground surface consist of firm to hard Lean Clays (CL) and Fat Clays (CH) that exist to bottom of Borings B-49 through B-51 at a depth of 13 feet.

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 4l. "CL", "CH", "SM", "SC" and "SC-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 24 and 49%, and plasticity indices (PI) ranging between about 9 and 30%. Clean non-expansive 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 50 and 84%, and plasticity indices ranging between about 35 and 60%. 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-2, B-17, B-21, B-22, B-23, B-24, B-28, B-32 and B-38 at a depth of about 14, 10.5, 14.5, 14, 12, 18, 10, 14 and 16.5 feet, and was measured at the completion of drilling in Borings B-17, B-21, B-23, B-24, B-28, B-32 and B-38 at a

depth of about 12.5, 14, 11.5, 14, 11.5, 16.5 and 13.5 feet, respectively. Free water was not encountered in the remainder of the borings. Borings B-1, B-10, B-23 and B-41 were converted into Piezometer PZ-1 through PZ-4 after completion of drilling and soil sampling. Water level in PZ-1, PZ-3 and PZ-4 was measured after 24-hour at a depth of about 13.5, 1 and 11.5 feet, respectively; PZ-2 was dry. Water level in PZ-1, PZ-3 and PZ-4 was measured after 7 days at a depth of about 14, 12 and 12 feet; PZ-2 was dry. Water level in PZ-1 through PZ-4 was measured at a depth of about 13, 18, 12 and 11 feet after 30 days, respectively.

The groundwater information encountered during and at the end of drilling in the boreholes, and in the piezometer after 24 hours and 7 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 water line installation will likely involve augering, one of many trenchless construction techniques. Construction of access pits (auger pits) will likely involve open cut/trench excavation; it is also possible that open cut/trenching construction may be carried out in local areas where underground obstructions or site conditions warrant the construction technique. Based on the plan and profile drawings, the water lines are proposed to be installed at a typical depth of about 5 to about8 feet below existing grade. However, local areas with deeper underpass (at depths of about 10 to 20 feet) exist at street/utility lines and ditch crossings. ATL understands that the proposed water

lines will cross the existing HCFCD ditches without disturbing the existing ditch.

5.1 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, and with proper groundwater control, ATL recommends classifying the top 8 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 8 feet shall be classified as OSHA Soil Type "C". Fill soils, sands (SP/SM/SC), silts (ML), silty clays (CL-ML), and any soils subject to hydraulic pressure or vibrations shall be classified as OSHA Soil Type "C".

5.2 Open Cut/Trench Excavation

The proposed water line installation will involve construction using trenchless techniques. However, construction of auger pits for the proposed water line installation will involve open cut/trench excavation, it is also possible that open cut and trenching may be carried out in local areas where underground obstructions or site conditions warrant such a construction technique.

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 4l. Accordingly, the water line installation excavation will be advanced mostly in stiff to hard clays (CL/CH), with local firm stratum. However, location identified in Table C below (but not limited to) will likely encounter granular soils during the construction excavation:

TABLE C: LOCATION WHERE WATER LINE INSTALLATION WILL LIKELY OR MAY ENCOUNTER SANDS

At/Near Boring	Approximate Water Line Invert Depth, ft.	Depth of Silty Sand Stratum	
		From	To
B-10	20	14	23
B-13	10	10	12
B-21	15	12****	14
B-22	15	12	18
B-23	15	8	20*
B-24	15	10	18

* denotes bottom of boring

** denotes sands exist above the proposed flow line, and may be encountered during open cur and/or auger pit excavation

*** denotes sands exist right below the flow line; the possibility that sands may be encountered during water line 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 water line 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 water line 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.

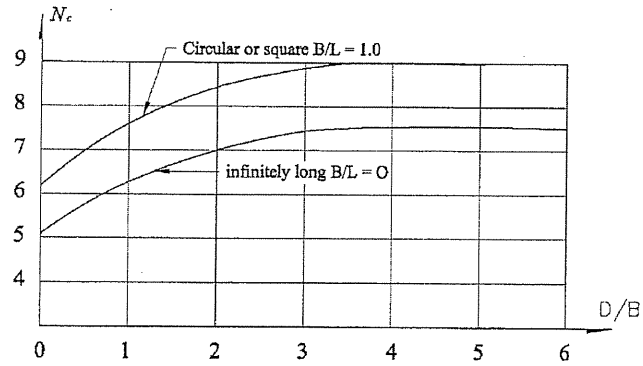
Stockpiling of excavated material should not be allowed near the excavation. Generally, a distance of at least one-half the excavation depth on both sides of the trench should be kept clear of any excavated material and height of stockpile should be limited to no more than 3 feet. If this is not possible 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:

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

Where,

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



N_c rectangular = (0.84 + 0.16B/L)N_c square

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

ϒ' = 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.

5.3 ***Groundwater Control***

Groundwater information gathered from the soil borings during and at completion of drilling, as well as the 24-hour and 7-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 4l. Based on the proposed invert elevation and the groundwater information gathered during our field investigation, the water line construction excavations exceeding 10 feet in depth will likely to encounter groundwater, especially when the excavations stay open for 24 hours or more. 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 (not found in soil borings drilled in this investigation, but may be present away from the borings drilled or after heavy rainfalls), 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.

5.4 Bedding Criteria

Where water line is installed using open cut method, the trench bottom for water line placement should be over-excavated to a minimum of 12 inches. For auger pits the over excavation should be

to a minimum of 6 inches. The space should be filled with bank sand to a depth of at least 12-inches above the pipe top and compacted to a minimum of 95 percent of the Standard Proctor (ASTM D 698) maximum dry density at a moisture content between -3 to +5 percent of the optimum moisture content. The trench bottom should be shaped to receive the water pipe. The bedding details should be in accordance with the latest City of Houston Construction Details. City of Houston Drawing No. 02317-04 should be used for the water main bedding and backfill. The bedding and backfill for auger pit should be in accordance with City of Houston Drawing No. 02447-01.

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.

5.5 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.

The embedment material between the pipe and the trench (bedding, haunching and initial backfill) may consist of bank run sand placed in maximum six-inches compacted lift thickness and compacted to a minimum of 95 percent of the maximum dry density as determined by Standard Proctor test (ASTM D698) at –3 to +5 percent of the optimum moisture content.

In the trench zone within the pavement area, the backfill may consist of bank run sand or select fill. The bank run sand should be placed in maximum 12 inches loose lift thickness and compacted by vibratory equipment to a minimum of 95 percent of the maximum dry density at moisture content within zero percent to -3 and +5 percent of optimum as determined by ASTM D698. The select fill may be placed in maximum 6-inch compacted lift thickness and compacted to a minimum of 95 percent of the maximum dry density at moisture contents within 0 and +5 percent of optimum as

determined according to ASTM D 698. The cut pavement should be replaced to match the existing pavement type and the thickness should be equal or greater then the existing pavement thickness. The finished pavement surface must be even with existing pavement elevation. In the trench zone outside the pavement area, a random backfill of suitable material (clayey soils) may be used. The random backfill may be placed in maximum 12 inches loose lift thickness for clayey soils and compacted to a minimum of 90 percent of the maximum dry density as determined by ASTM D 698 at moisture content necessary to achieve the density.

5.6 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:

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

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

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

C_d = Marston's soil coefficient

Υ = 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 μ 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.

5.7 Trenchless Construction

The proposed water lines 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. Requirements of City of Houston Standard Specification, Section 02447 – Augering Pipe and Conduit, should be followed.

The water line will be installed mostly in stiff to hard clays (with local firm stratum), in which case the excavation face are anticipated to be stable. However, granular soils or soils with limited cohesion may be present at (but not limited to) locations identified in Table C of Section 5.2. 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), 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 water line 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.

Auger pit construction criteria provided in City of Houston Standard Specification, Section 02447 – Augering Pipe and Conduit, should be followed. Shoring systems for the auger pits may be designed based on the lateral earth pressures and other considerations discussed in Section 5.2.

5.8 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 5.7.

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.

5.9 ***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:

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

Where,

	P	= internal fluid pressure (psi);
	A	= cross-sectional area of pipe (in^2);
	θ	= 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, γ	= 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.

5.10 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:

$$\Delta x = D_l \, [\, KWr^3 / (EI + 0.061\, E'\, r^3)\,]$$

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_l of 1.0 may be used. Otherwise, deflection lag factor, D_l 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	$c \leq 250$	100
	Firm	124	$c \leq 500$	300
	Stiff	128	$c \leq 1{,}000$	600
	Very Stiff	130	$c \leq 2{,}000$	1,000
	Hard	132	$c > 2{,}000$	2,000
Granular Soils: Sands, Silts and Gravel	Loose	110	$2 \leq N_{SPT} \leq 7$	300
	Loose to Medium Dense	113	$8 \leq N_{SPT} \leq 15$	600
	Medium Dense	115	$16 \leq N_{SPT} \leq 30$	1,000
	Dense	118	$N_{SPT} > 30$	2,000

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

5.11 ***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(Ws)*
- *Frictional force between the soil and foundation (Fs).*

Buoyant Uplift Resistance = W + Ws + Fs

W and Ws 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 Ws.

5.12 Street Cut and Repair

Any street cut necessary for this project should be restored to its original condition 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 6 and 7 percent lime, respectively, and stabilizing granular soils and clay soils with plasticity indices of less than 15 with at least 4 percent lime and 8 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 water line installation will involve mostly trenchless construction techniques and some open cut/trenching construction. Accordingly, the water line installation excavations will be installed mostly in stiff to hard clay soils with local areas of firm stratum. However, granular soils or soils with limited cohesion will likely be present at (but not limited to) locations identified in Table C of Section 5.2.

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 5.7 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 water line construction excavations will not likely to encounter groundwater. However, 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 water line installation excavation advanced in clay soils, the seepage rates are usually low, and groundwater control can usually be controlled by sump 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 water line 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 waterline alignment 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, if 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 to 2e, 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 ***REFERENCES***

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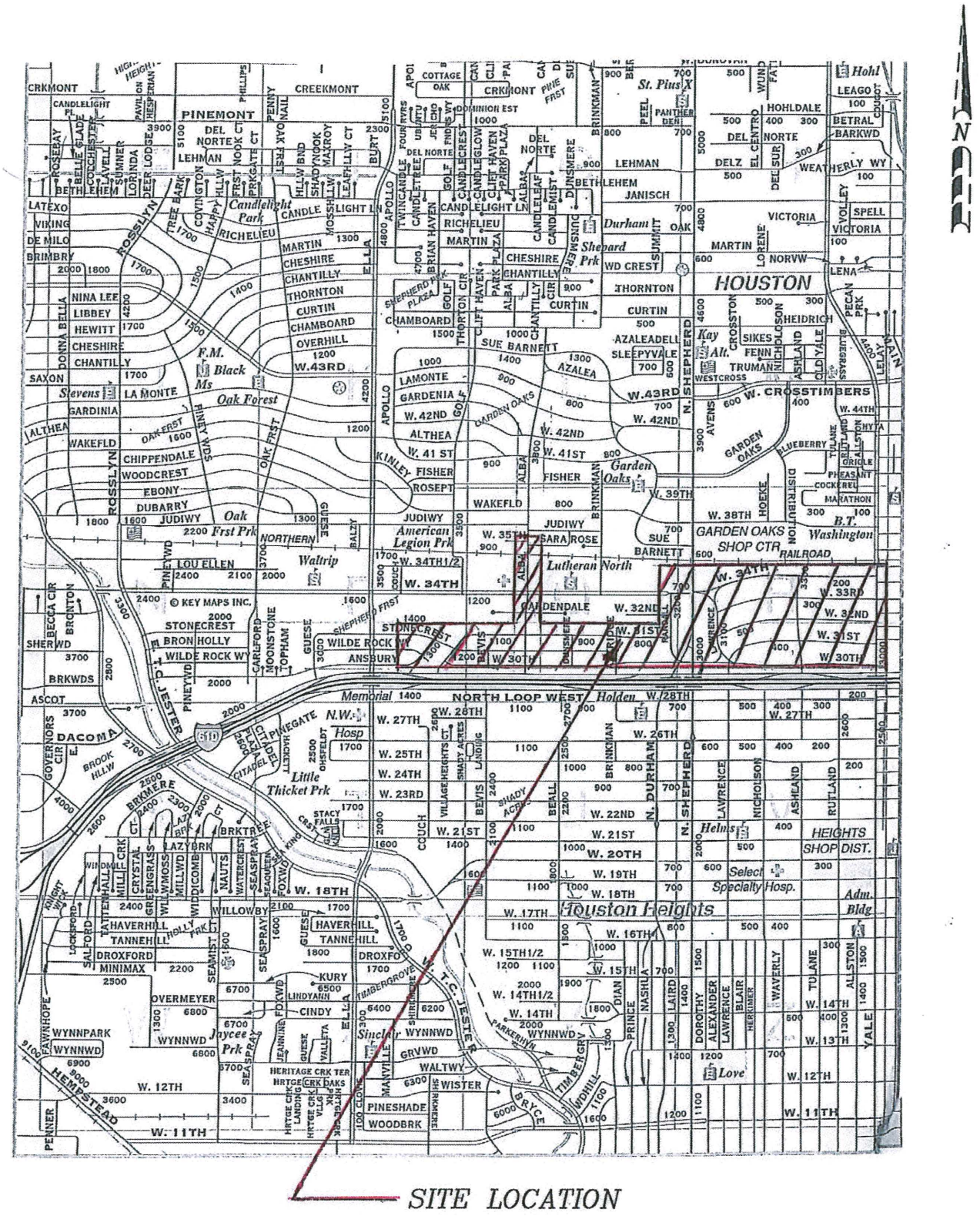
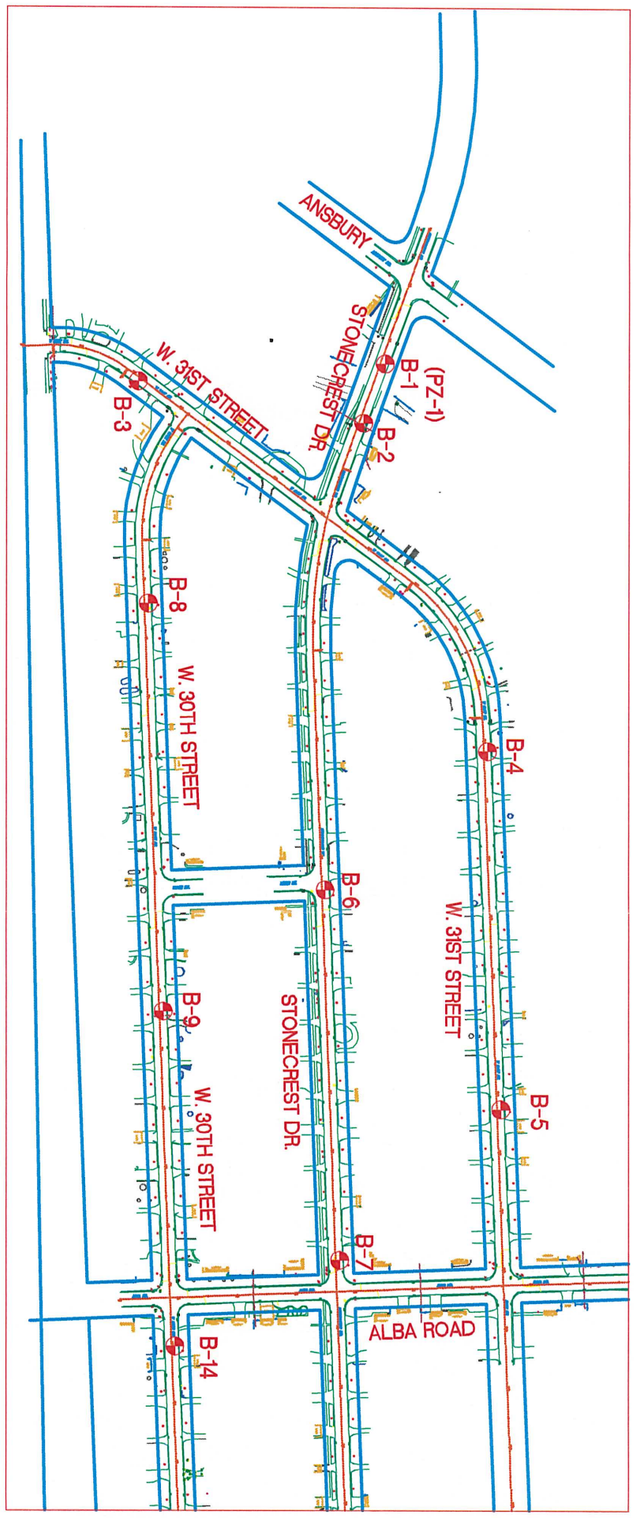
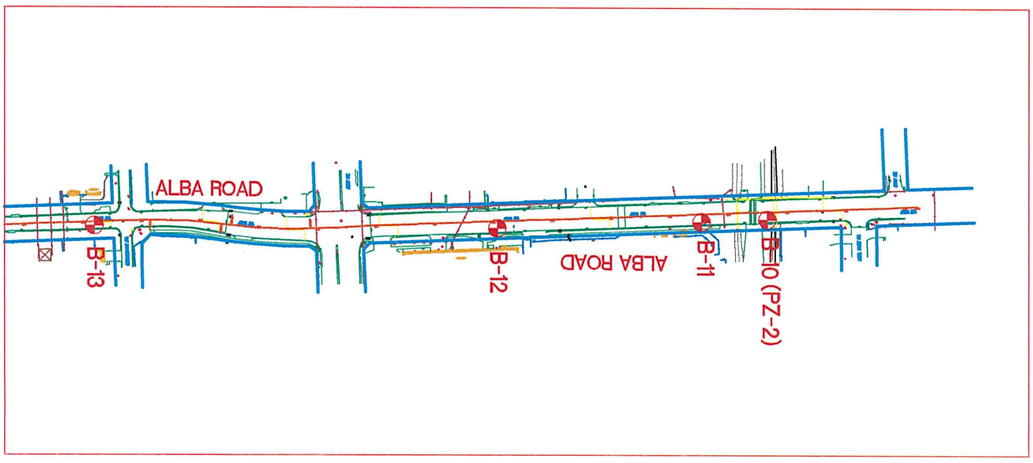


SITE VICINITY MAP	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA	WBS NO. S-000035-0192-4
	PROJECT NO. : G13-196 / FIGURE 1

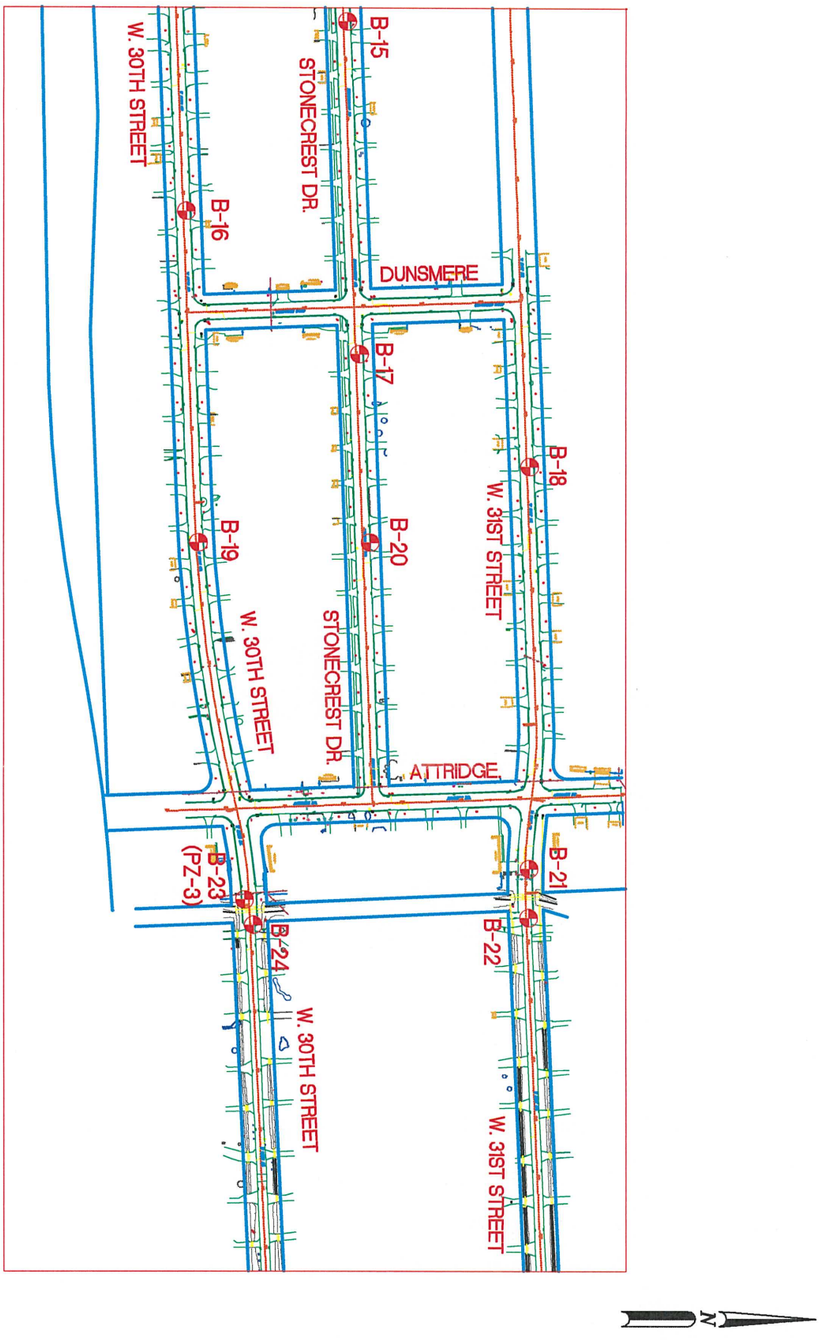
PST 8/28/12



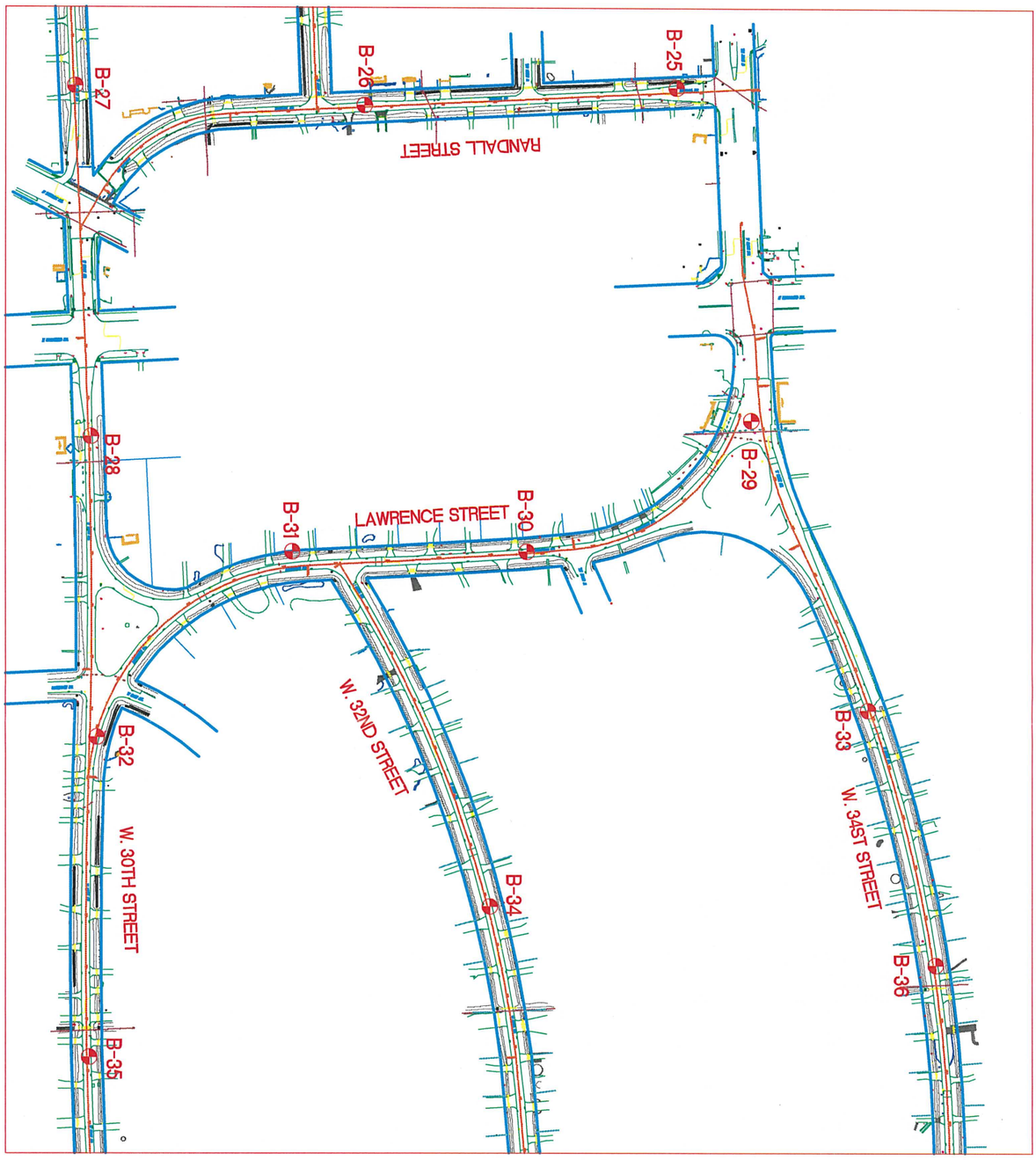
LOCATION OF BORINGS	Associated Testing Laboratories, Inc. 3143 Yellowstone Blvd. Houston, Texas Tel: (713) 748-3717 Fax: (713) 748-3748	
WATER LINE REPLACEMENT IN	WBS No.: S-000035-0192-4	SCALE: 1"= 250'
SHEPHERD FOREST II AREA	PROJECT NO. G13-196	FIGURE. 2a



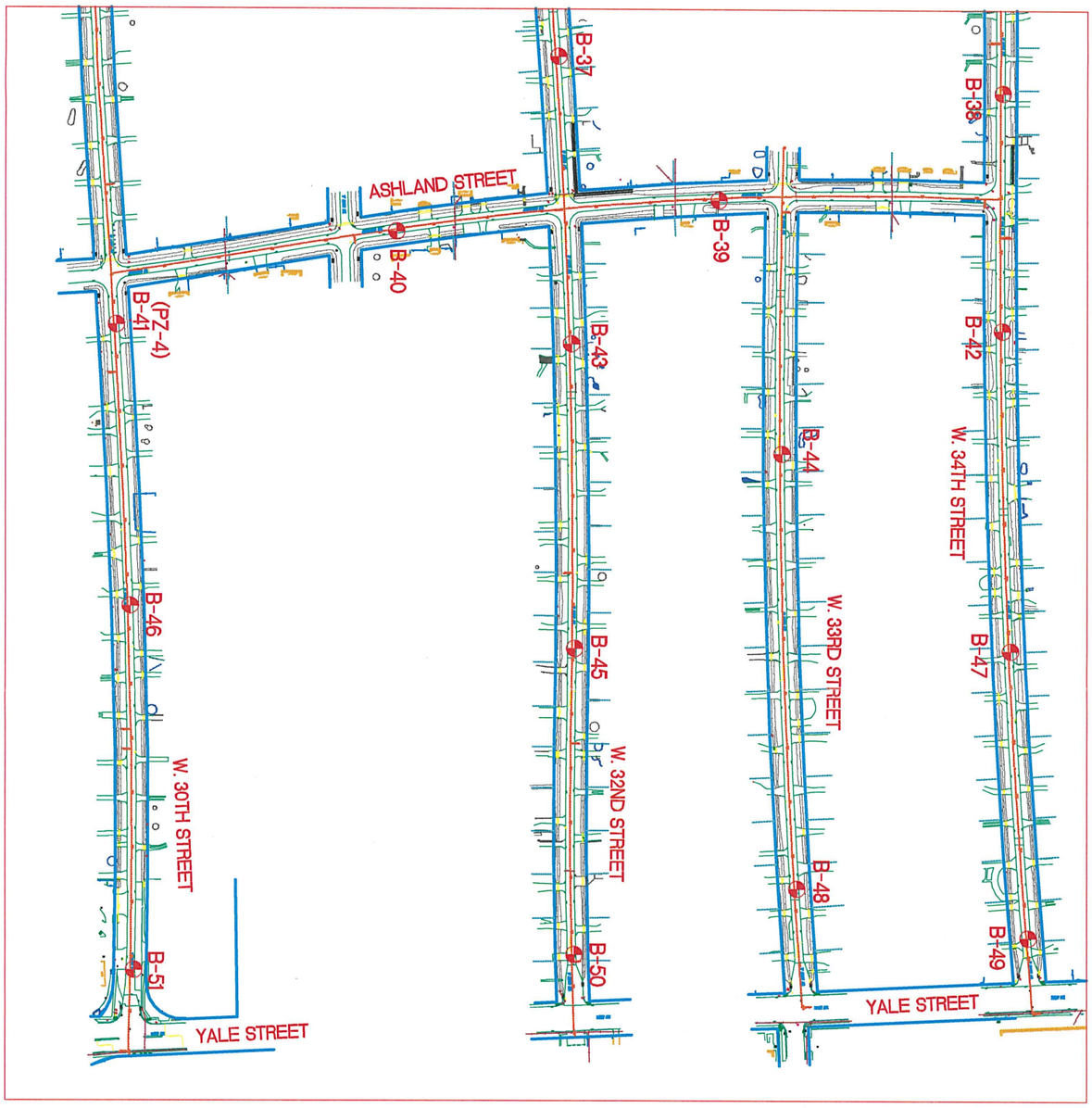
LOCATION OF BORINGS	Associated Testing Laboratories, Inc. 3143 Yellowstone Blvd. Houston, Texas Tel: (713) 748-3717 Fax: (713) 748-3748	
WATER LINE REPLACEMENT IN	WBS No.: S-000035-0192-4	SCALE: 1"= 250'
SHEPHERD FOREST II AREA	PROJECT NO. G13-196	FIGURE. 2b



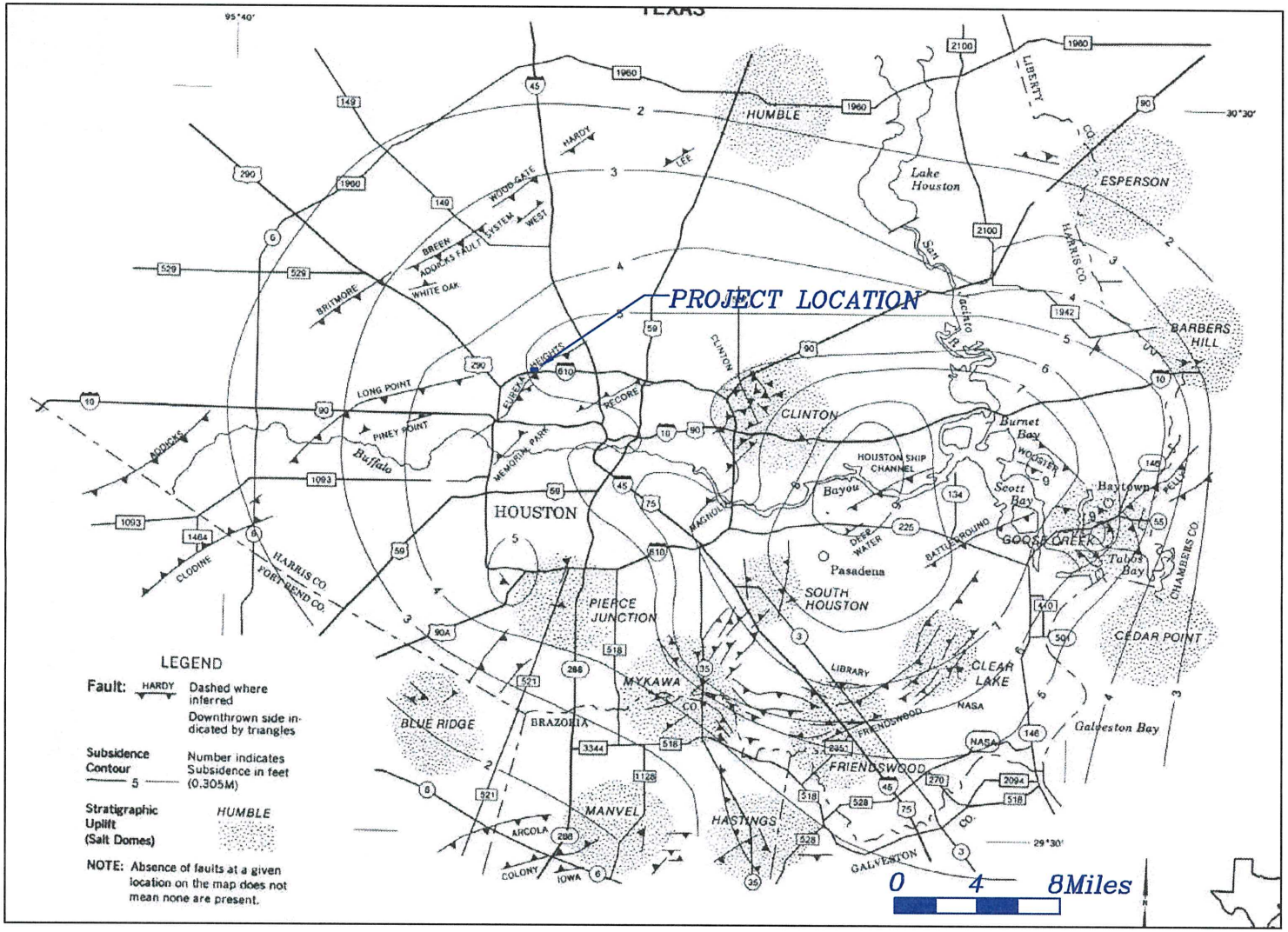
LOCATION OF BORINGS	Associated Testing Laboratories, Inc. 3143 Yellowstone Blvd. Houston, Texas Tel: (713) 748-3717 Fax: (713) 748-3748	
WATER LINE REPLACEMENT IN	WBS No.: S-000035-0192-4	SCALE: 1"= 250'
SHEPHERD FOREST II AREA	PROJECT NO. G13-196	FIGURE. 2c



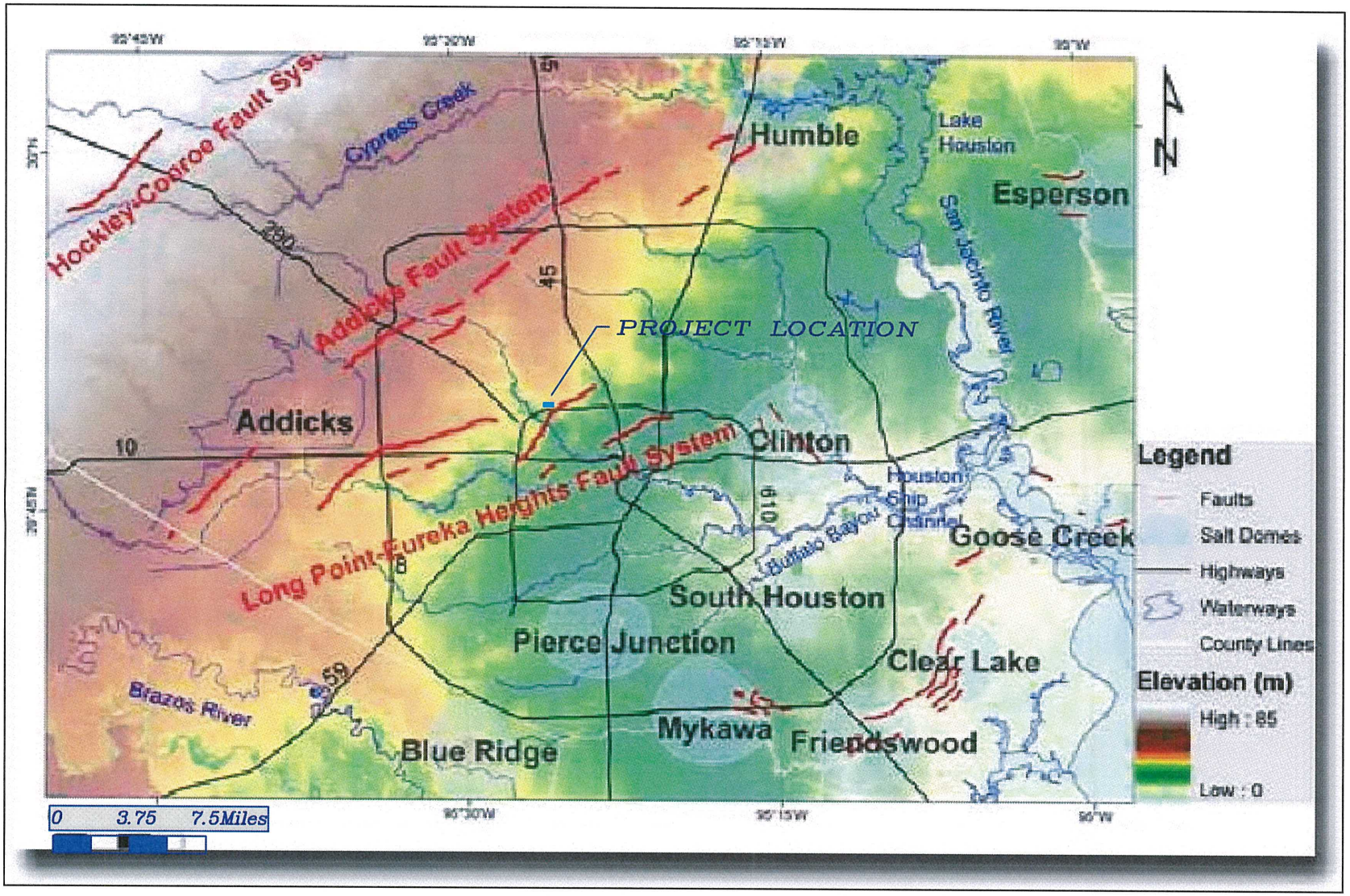
LOCATION OF BORINGS	Associated Testing Laboratories, Inc. 3143 Yellowstone Blvd. Houston, Texas Tel: (713) 748-3717 Fax: (713) 748-3748	
WATER LINE REPLACEMENT IN	WBS No.: S-000035-0192-4	SCALE: 1"= 250'
SHEPHERD FOREST II AREA	PROJECT NO. G13-196	FIGURE. 2d



LOCATION OF BORINGS	Associated Testing Laboratories, Inc. 3143 Yellowstone Blvd. Houston, Texas Tel: (713) 748-3717 Fax: (713) 748-3748	
WATER LINE REPLACEMENT IN	WBS No.: S-000035-0192-4	SCALE: 1"= 250'
SHEPHERD FOREST II AREA	PROJECT NO. G13-196	FIGURE. 2e



PRINCIPAL ACTIVE FAULTS IN HOUSTON AREA	Associated Testing Laboratories, Inc. 3143 Yellowstone Blvd. Houston, Texas Tel: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA	WBS No.: S-000035-0192-4
	PROJECT NO. G13-196 FIGURE. 3a

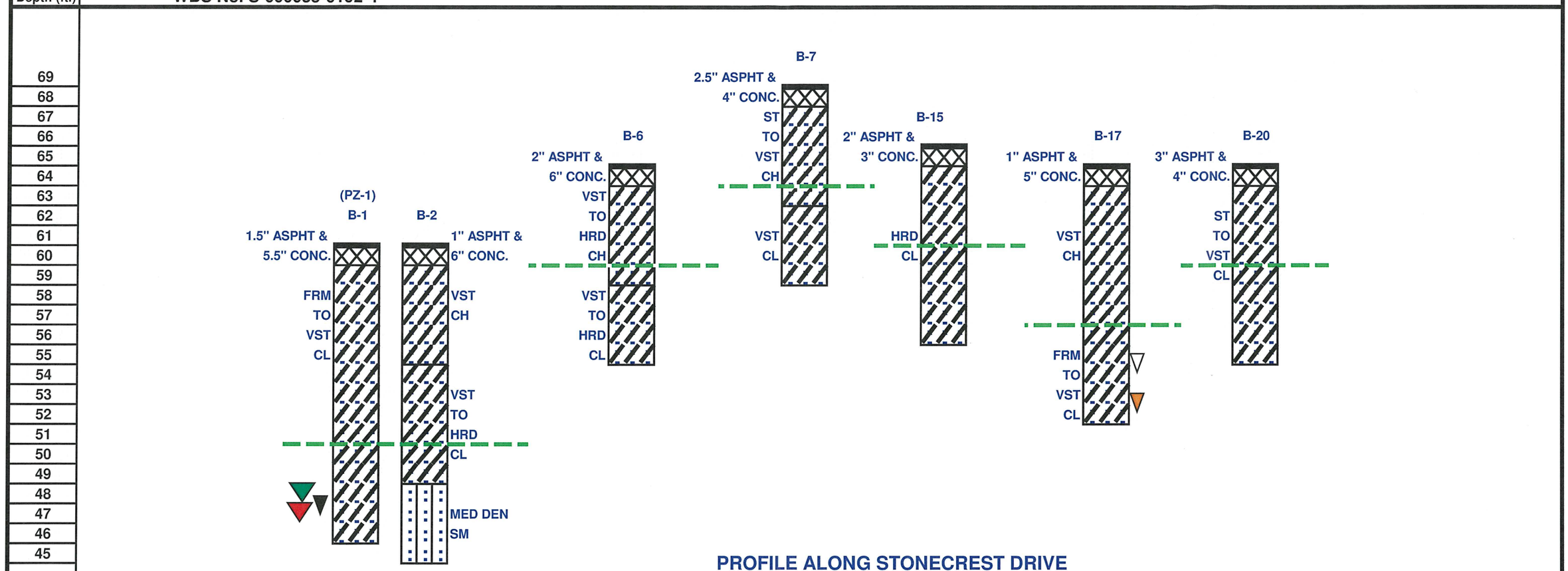


ACTIVE SURFACE FAULTS ON LIDAR IMAGERY	Associated Testing Laboratories, Inc. 3143 Yellowstone Blvd. Houston, Texas Tel: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA	WBS No.: S-000035-0192-4
	PROJECT NO. G13-196 — FIGURE. 3b

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA — PROJECT NO. G13-196

WBS No. S-000035-0192-4



PROFILE ALONG STONECREST DRIVE

▽	Water First Noticed
▼	Depth To Water At Completion
▼	24 hr. Water Level
▼	PZ Water Level (10-8-13)
▼	PZ Water Level (10-30-13)

KEY

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

SCALE
Horizontal: 1"= 500'
Vertical: 1"= 5'

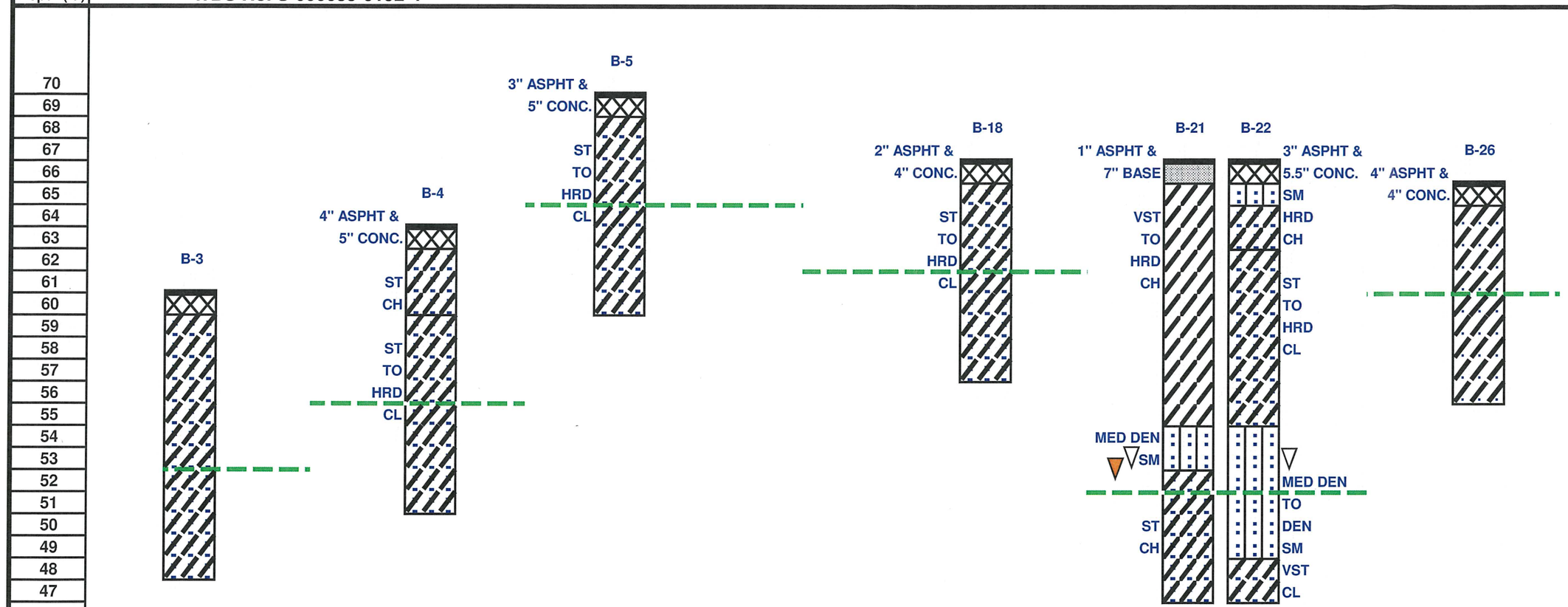
Figure-4a

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA

PROJECT NO. G13-196

WBS No. S-000035-0192-4



PROFILE ALONG WEST 31st STREET

▽	Water First Noticed
▼	Depth To Water At Completion

KEY

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

SCALE
Horizontal: 1"= 500'
Vertical: 1"= 5'

Figure-4b

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA

PROJECT NO. G13-196

WBS No. S-000035-0192-4

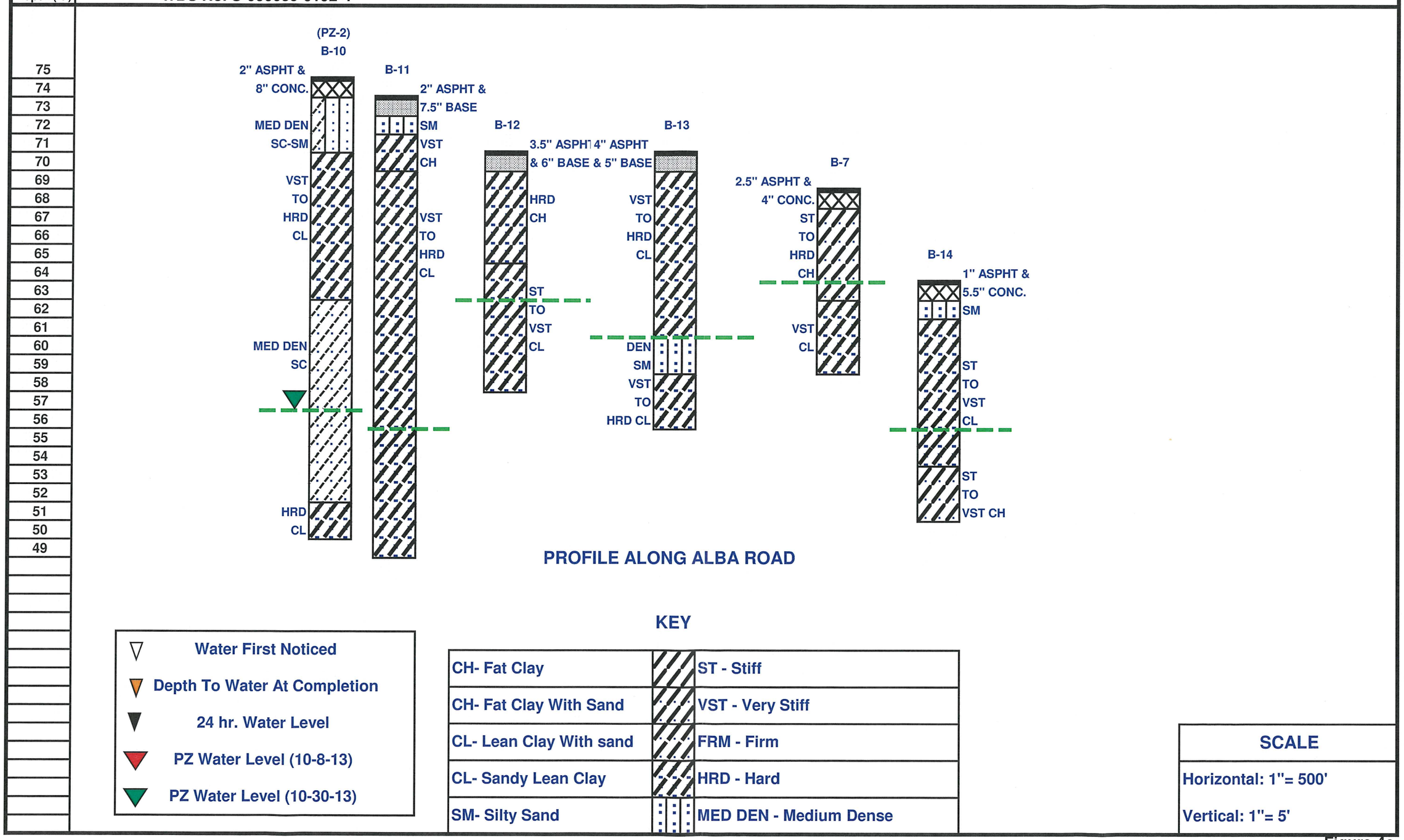


Figure-4c

ASSOCIATED TESTING LABORATORIES, INC.

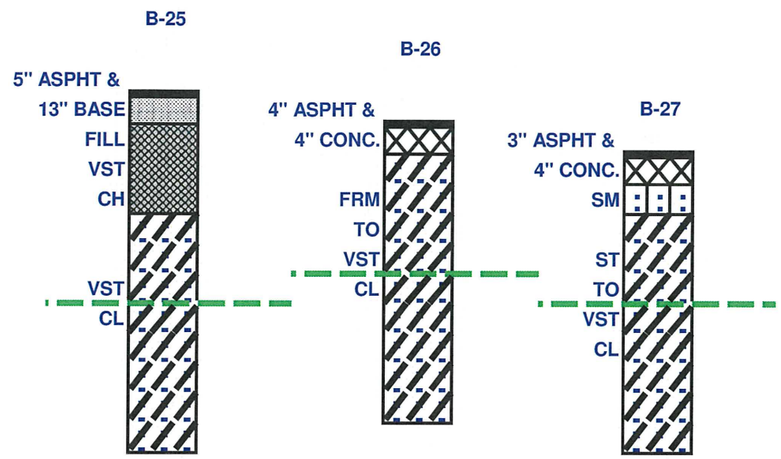
PROJECT NAME: WATER LINE REPLACEMENT IN N SHEPHERD FOREST II AREA

PROJECT NO. G13-196

WBS No. S-000035-0192-4

Depth (ft.)

67
66
65
64
63
62
61
60
59
58
57
56
55



PROFILE ALONG RANDALL STREET

Water First Noticed

Depth To Water At Completion

KEY

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

SCALE
Horizontal: 1"= 500'
Vertical: 1"= 5'

Figure-4d

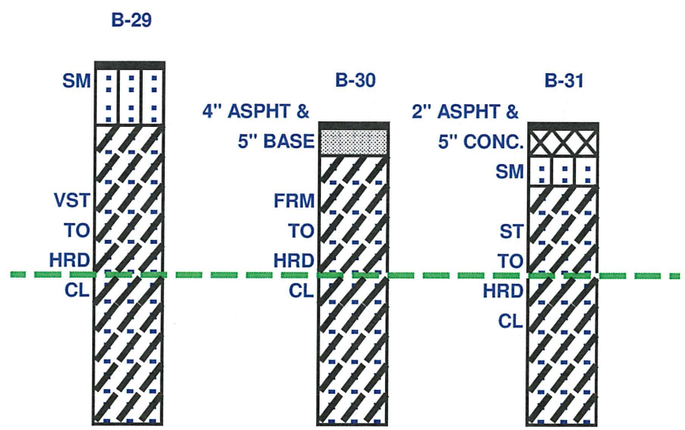
ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN N SHEPHERD FOREST II AREA

PROJECT NO. G13-196

WBS No. S-000035-0192-4

Depth (ft.): 66, 65, 64, 63, 62, 61, 60, 59, 58, 57, 56, 55, 54, 53, 52, 51, 50, 49, 48, 47



PROFILE ALONG LAWRENCE

Water First Noticed

Depth To Water At Completion

KEY

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 Dens

SCALE

Horizontal: 1"= 500'

Vertical: 1"= 5'

Figure-4e

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA — PROJECT NO. G13-196

WBS No. S-000035-0192-4

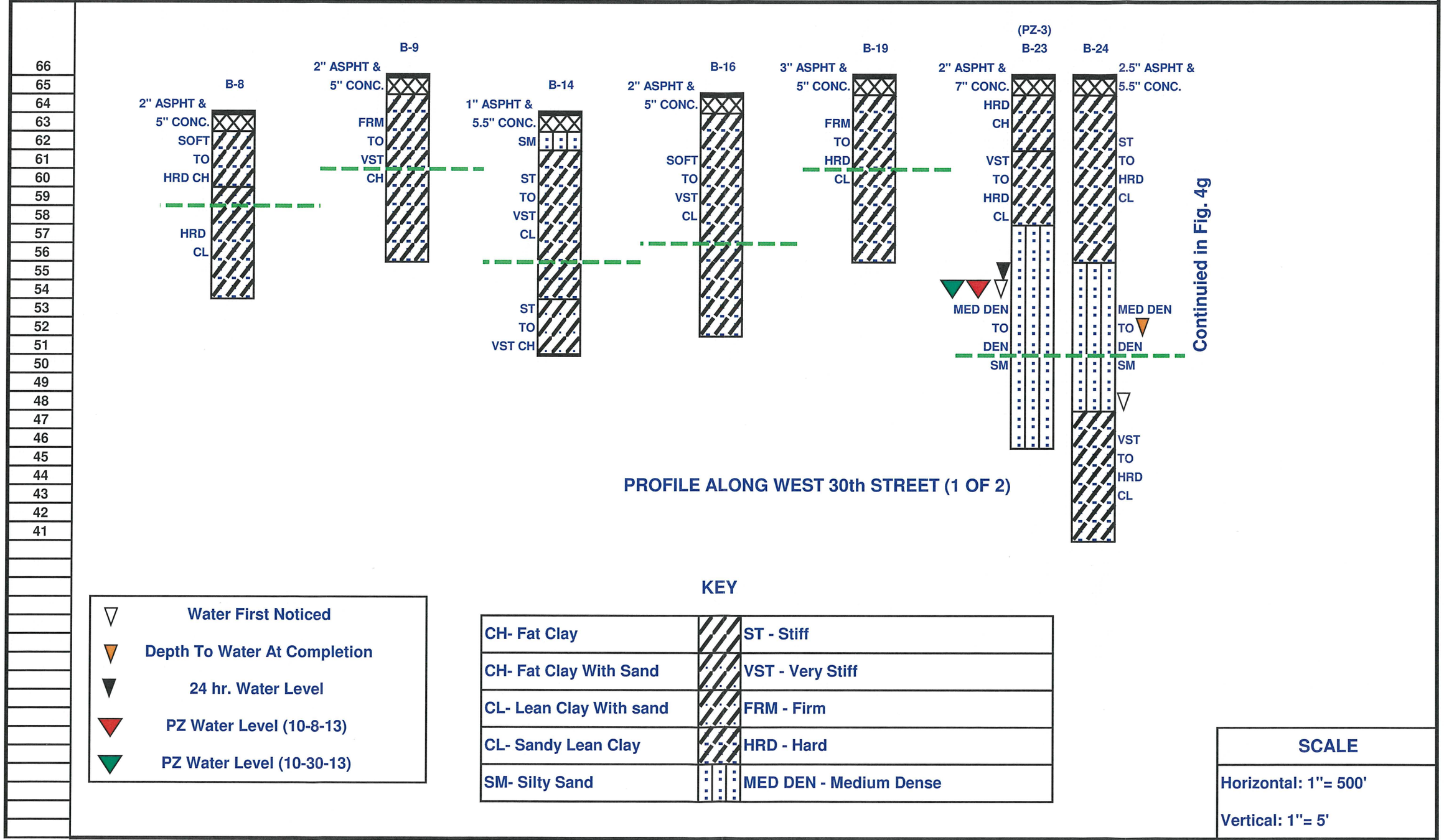


Figure-4f

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA

PROJECT NO. G13-196

WBS No. S-000035-0192-4

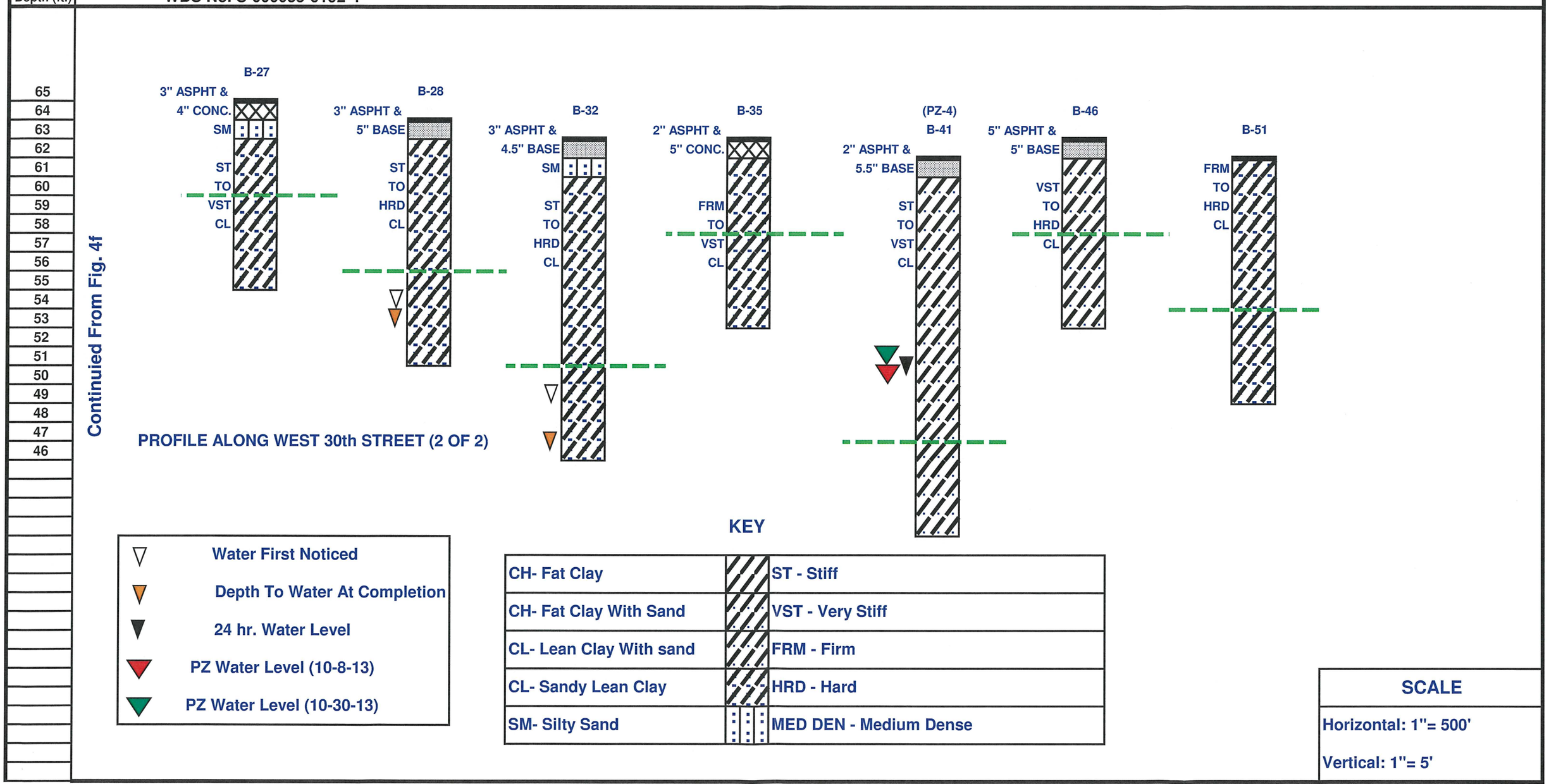


Figure-4g

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA

PROJECT NO. G13-196

WBS No. S-000035-0192-4

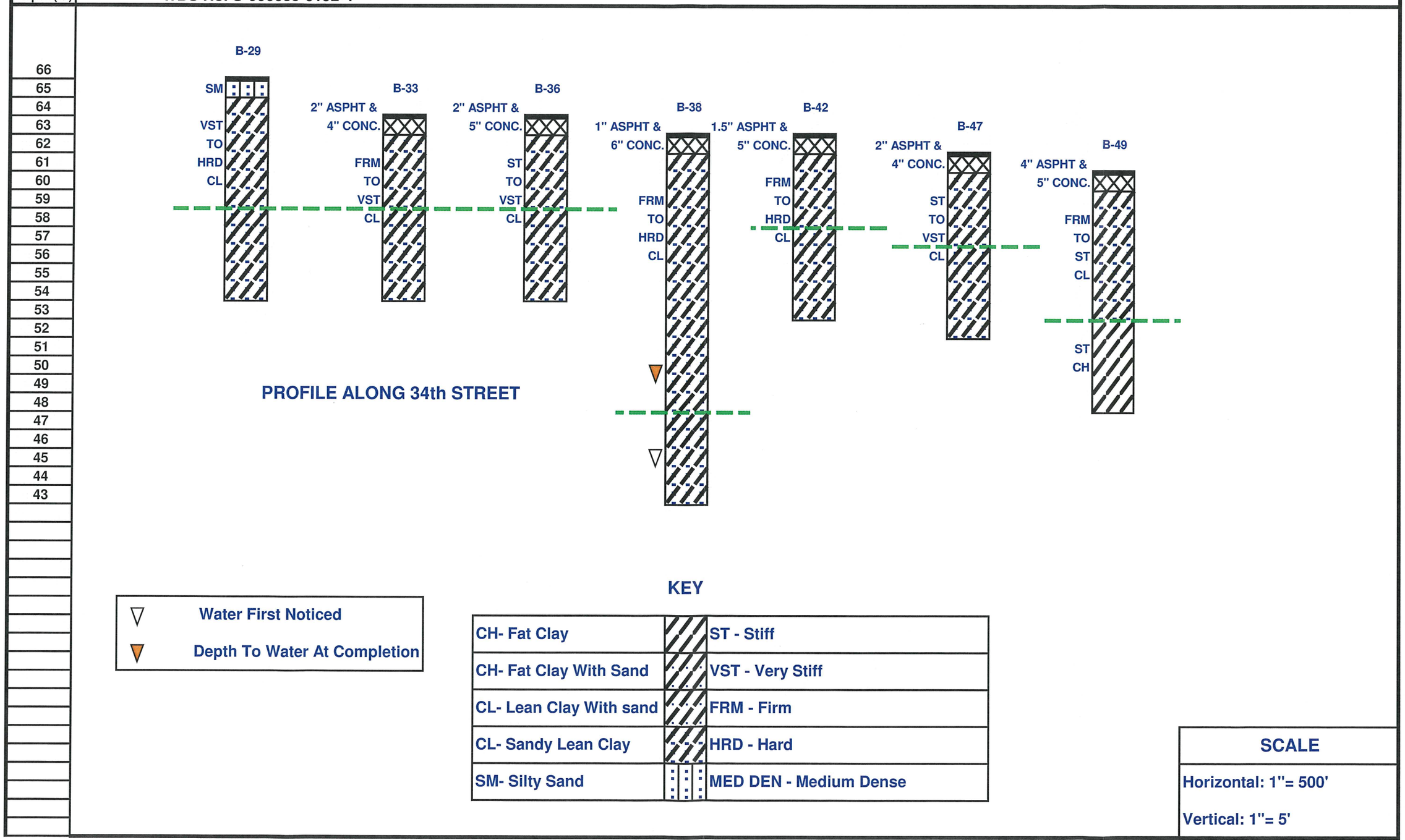


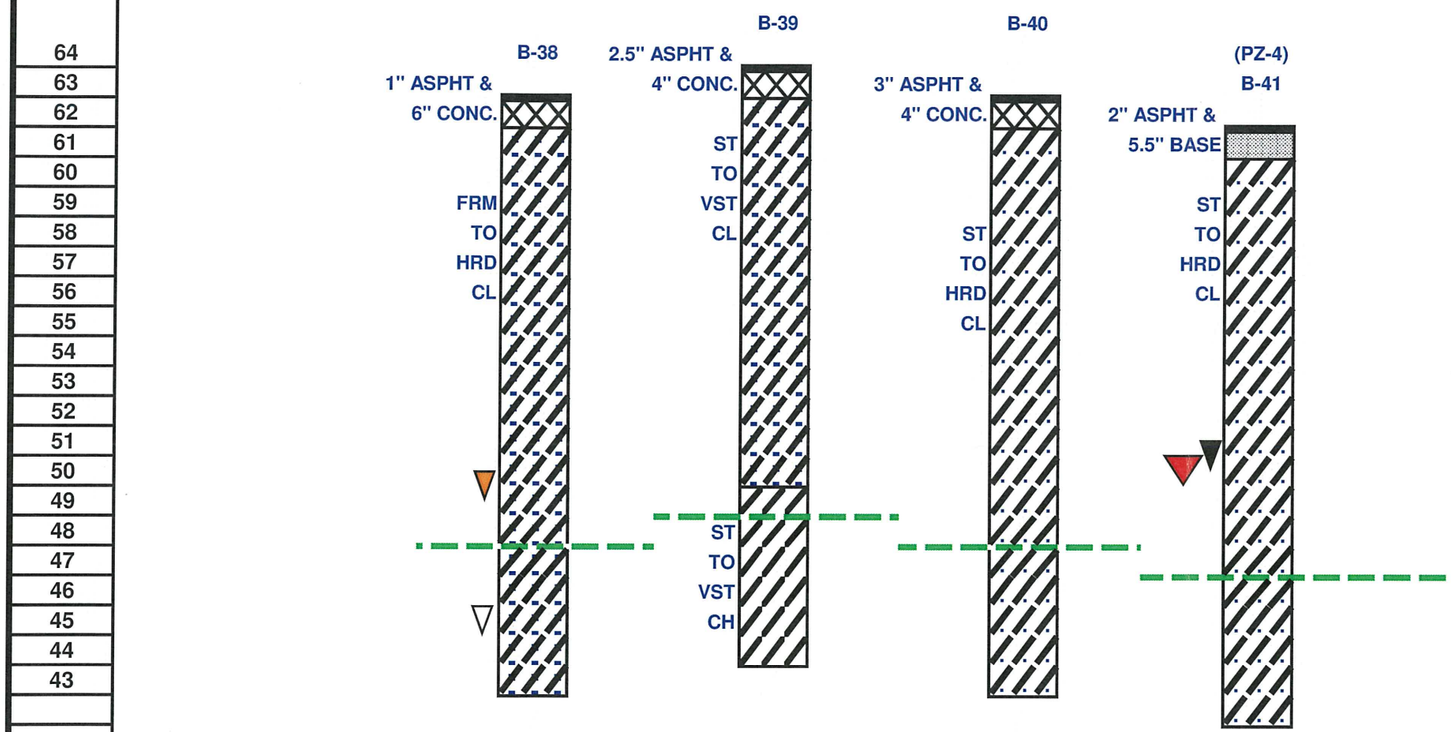
Figure-4h

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN N SHEPHERD FOREST II AREA

PROJECT NO. G13-196

WBS No. S-000035-0192-4



PROFILE ALONG ASHLAND STREET

KEY

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

- Water First Noticed
- Depth To Water At Completion
- 24 hr. Water Level
- PZ Water Level (10-8-13)
- PZ Water Level (10-30-13)

SCALE

Horizontal: 1"= 500'

Vertical: 1"= 5'

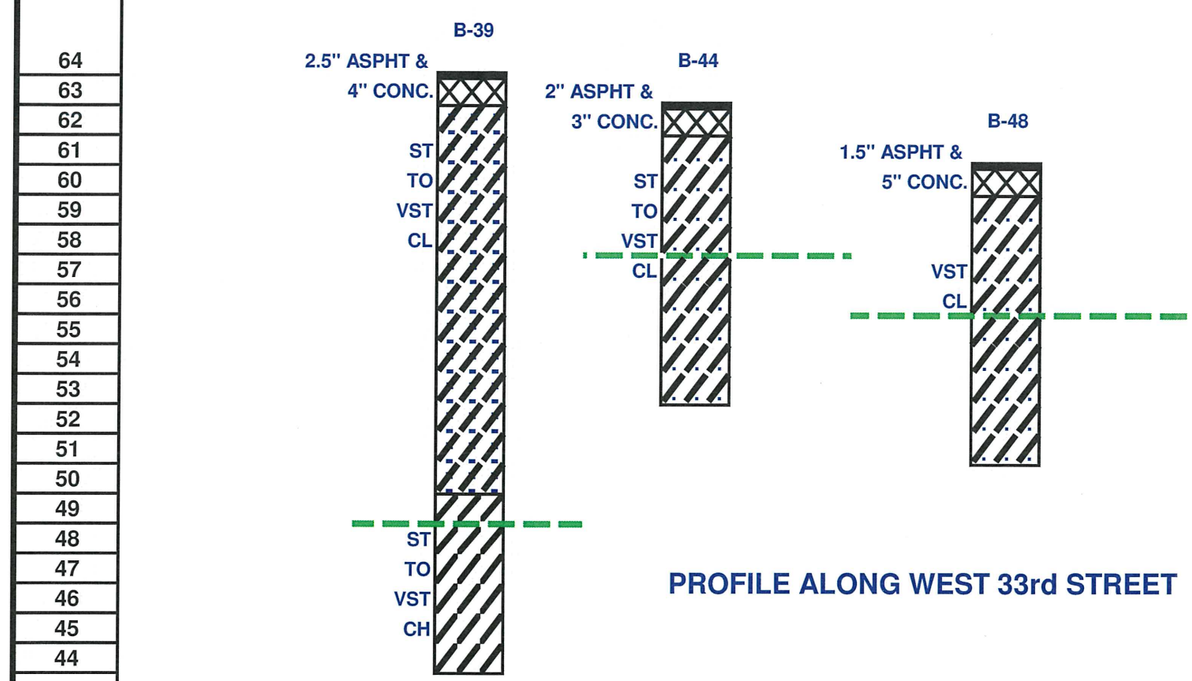
Figure-4i

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN N SHEPHERD FOREST II AREA

PROJECT NO. G13-196

WBS No. S-000035-0192-4



PROFILE ALONG WEST 33rd STREET

Water First Noticed

Depth To Water At Completion

KEY

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

SCALE
Horizontal: 1"= 500'
Vertical: 1"= 5'

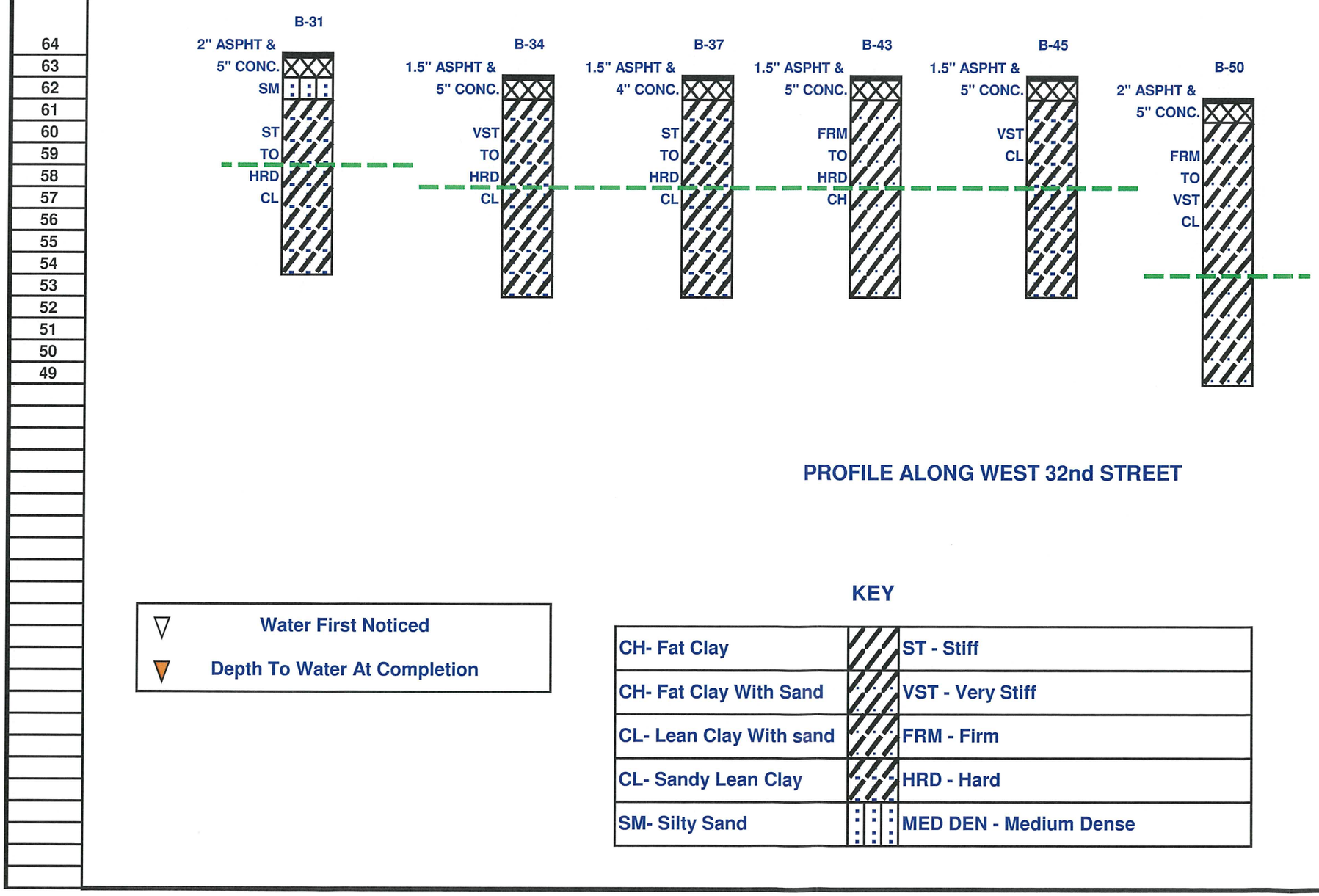
Figure-4j

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA

PROJECT NO. G13-196

WBS No. S-000035-0192-4



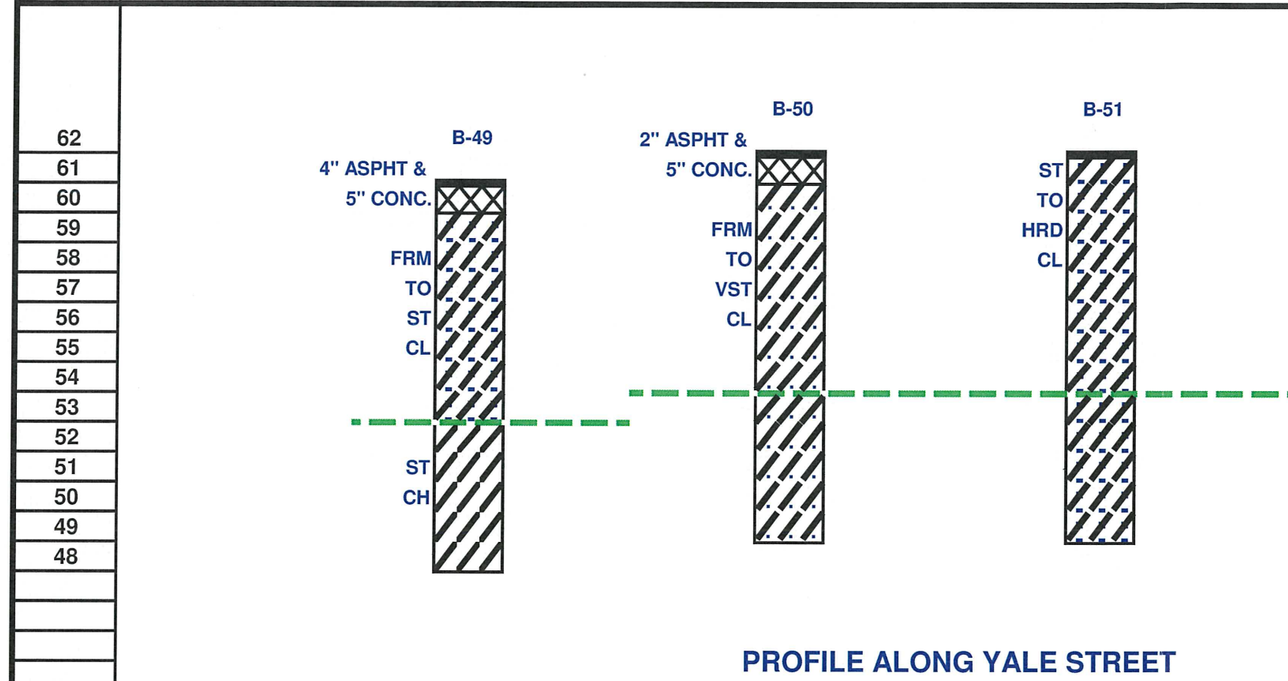
PROFILE ALONG WEST 32nd STREET

Figure-4k

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN N SHEPHERD FOREST II AREA

WBS No. S-000035-0192-4



PROFILE ALONG YALE STREET

Water First Noticed

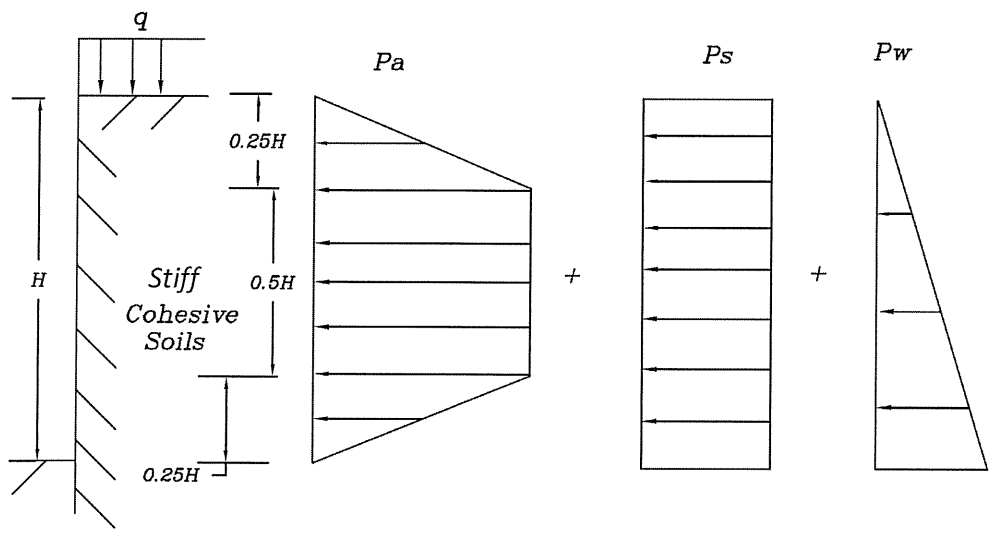
Depth To Water At Completion

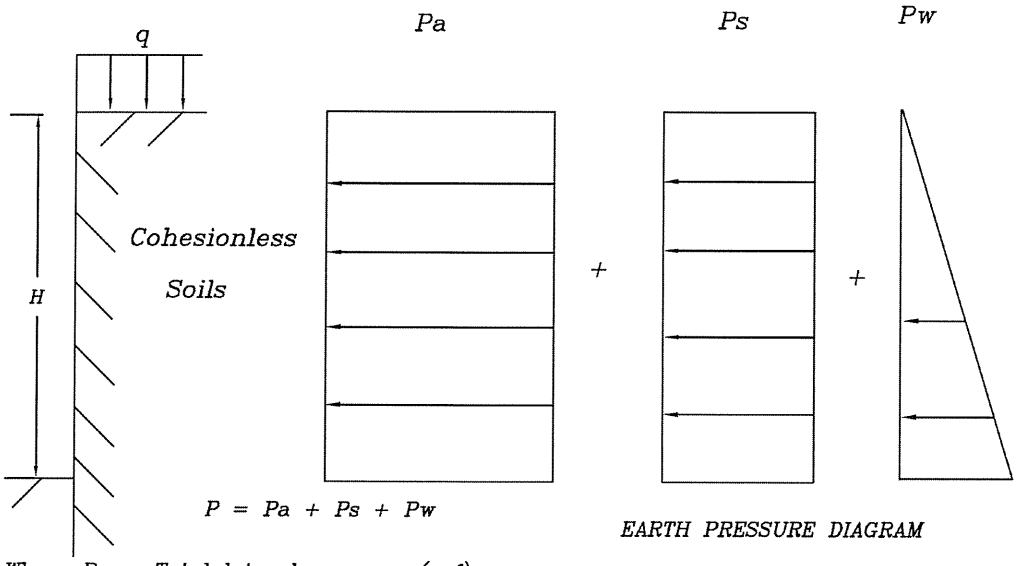
KEY

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

SCALE
Horizontal: 1"= 500'
Vertical: 1"= 5'

Figure-4I





$P = Pa + Ps + Pw$

EARTH PRESSURE DIAGRAM

Where P = Total lateral pressure (psf)

Pa = 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)

Ps = Lateral pressure due to surcharge load (psf) = $0.5q$ for Clays

= $0.4q$ for Sands (0.5q for loose Sands)

Pw = Hydrostatic pressure (psf) = 62.4* water depth

H = Depth of braced excavation (ft)

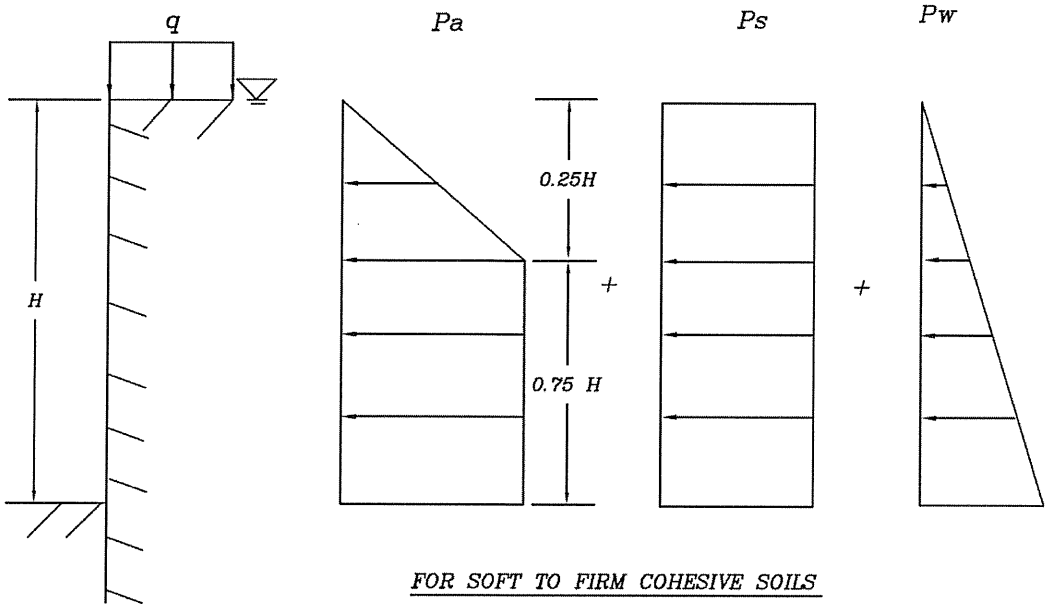
q = Surcharge load (psf) usually taken as 500 psf

γ = 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".

EARTH PRESSURE DIAGRAM	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA	WBS NO. S-00035-0192-4
	PROJECT NO. : G13-196 / FIGURE 5a

PST 8/28/12



FOR SOFT TO FIRM COHESIVE SOILS

Where P = Total lateral pressure (psf)

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

K_a = Active Earth pressure coefficient

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

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

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

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

Pw = Hydrostatic pressure (psf) = 62.4* water depth

H = Depth of braced excavation (ft)

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

γ = density of soils (pcf) = use 50 pcf below groundwater and 110 pcf above groundwater

q_u = Unconfined compressive strength, psf

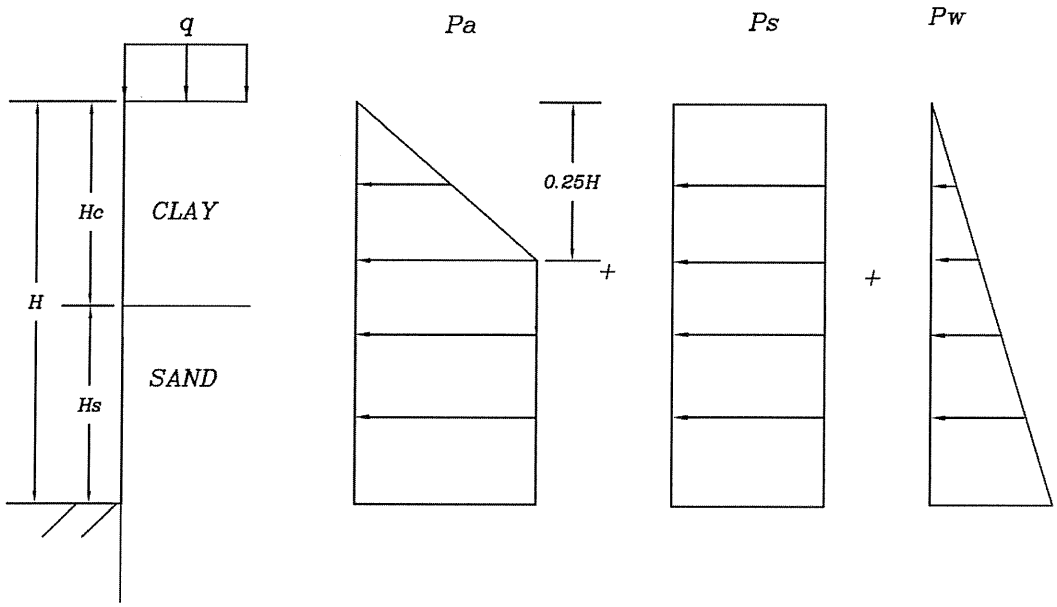
C = Undrained shear strength, psf

Note: Neglect hydrostatic pressure above groundwater level

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

EARTH PRESSURE DIAGRAM	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA	WBS NO. S-00035-0192-4
	PROJECT NO. : G13-196 / FIGURE 5b

PST 8/28/12



$$P = Pa + Ps + Pw$$

Where P = Total lateral pressure (psf)

Pa = Active earth pressure(psf) = $K_A \gamma H = 0.4 \gamma H$

Ps = Lateral pressure due to surcharge load (psf) = $0.5q$

Pw = Hydrostatic pressure (psf) = 62.4* water depth

H = Depth of braced excavation (ft)

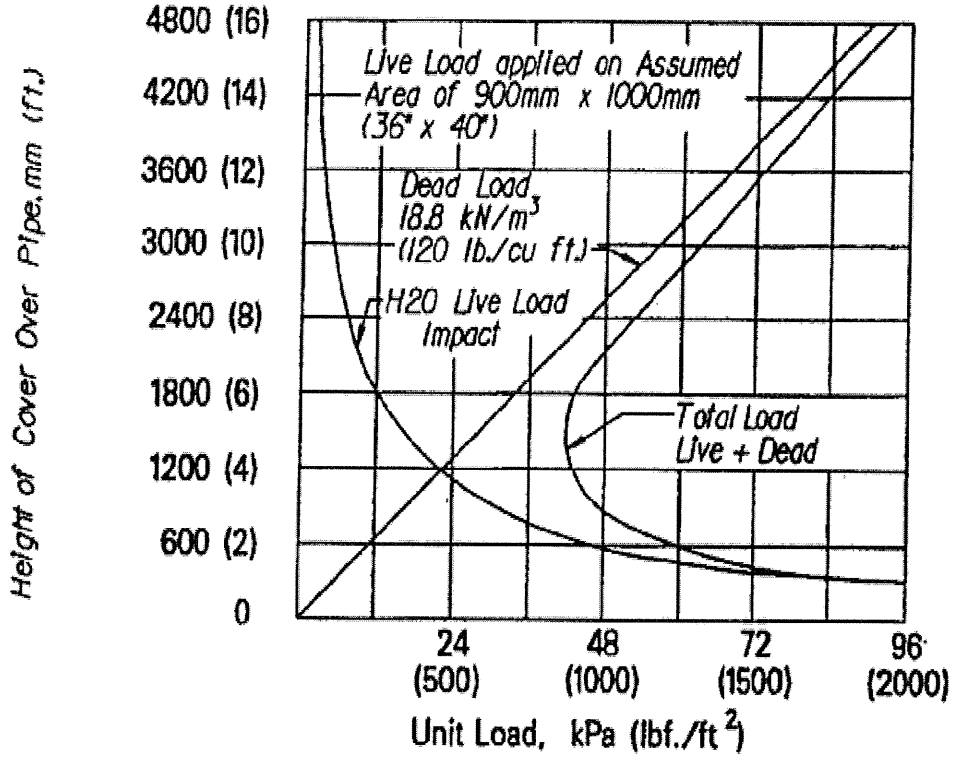
q = Surcharge load (psf) usually taken as 500 psf

γ = Submerged density of soils (pcf) = use 60 pcf

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

EARTH PRESSURE DIAGRAM	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA	WBS NO. S-00035-0192-4
	PROJECT NO. : G13-196 / FIGURE 5c

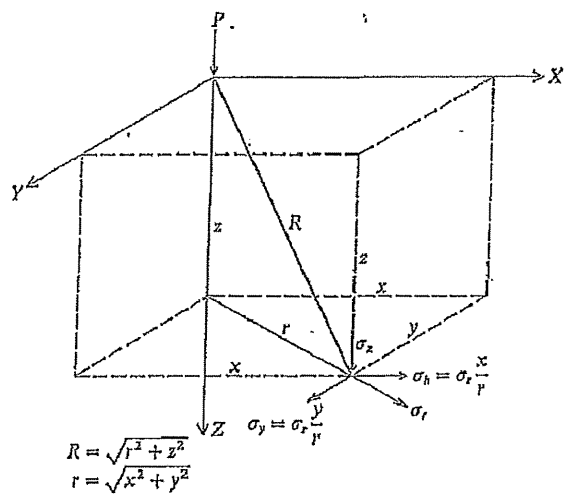
PST 8/28/12



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	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA	WBS NO. S-00035-0192-4
	PROJECT NO. : G13-196 — FIGURE 6

PST 8/28/12



Later Pressure, σ_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, σ_z :

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

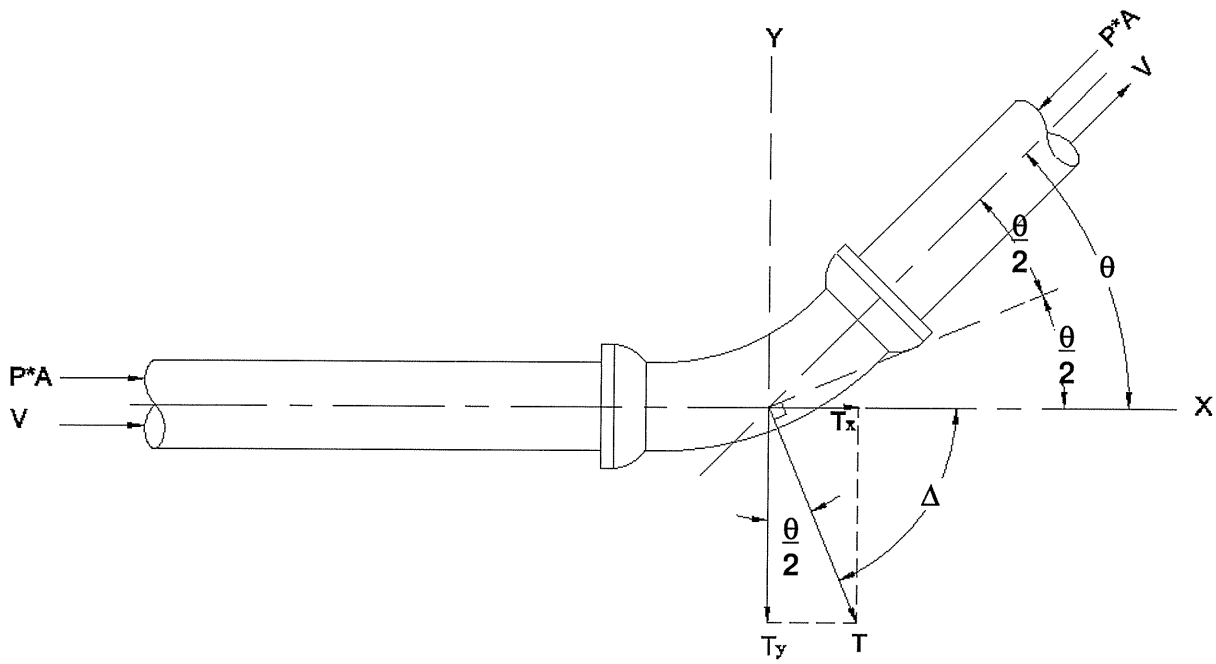
P = Point load surcharge

μ = 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	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748	
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA	WBS NO. S-00035-0192-4	
	PROJECT NO. : G13-196	FIGURE 7

PST 8/28/12



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

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

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

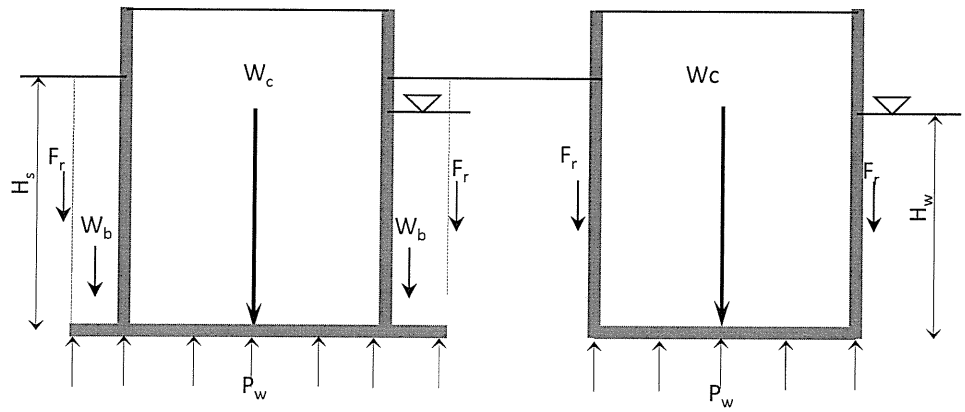
Where:

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
θ	=	Angle of the pipe bend, degrees
Δ	=	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	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748	
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA	WBS NO. S-00035-0192-4	
	PROJECT NO. : G13-196	FIGURE 8

PST 8/28/12



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

$P_w = H_w\gamma_w$
$F_u = A_bP_w$
$W_c/S_{fa}+W_b/S_{fb}+ F_r/S_{fc} \geq F_u$
(S_{fa} = 1.1; S_{fb} = 1.5; S_{fc} = 3.0)

Dead Weight of Structure + Frictional Resistance

$P_w = H_w\gamma_w$
$F_u = A_bP_w$
$W_c/S_{fa}+F_r/S_{fc} \geq F_u$
(S_{fa} = 1.1; S_{fc} = 3.0)

For cohesive soils:
$F_r = \alpha c_nA_n$

For cohesionless soils,
$Fr = p_nK\tan\delta_nA_n$

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 x Hw, psf
F_u	=	Total uplift force exerted on base of structure = Pw x 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.
α	=	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
δ_n	=	Average frictional angle between cohesionless soil layer "n" and the walls of the structure, use 0.75 of the angle of internal friction (ϕ) of the cohesionless soil. A ϕ 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	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA	WBS NO. S-00035-0192-4
	PROJECT NO. : G13-196 / FIGURE 9

PST 8/28/12

LIST OF TABLES

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TABLE 1

SUMMARY OF PAVEMENT MEASUREMENTS
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
CITY OF HOUSTON,TEXAS
WBS NO. S-000035-0192-4
ATL PROJECT NO. G13-196

Boring Number	Boring Depth (ft)	Piezometer		Asphalt Paving (inch)	Concrete Paving (inch)	Base Material (inch)
		No.	Depth (ft)			
B-1 (PZ-1)	15	PZ-1	15	1.5	5.5	--
B-2	15.5	--	--	1	6	--
B-3	13	--	--	4	4	--
B-4	13	--	--	4	5	--
B-5	10	--	--	3	5	--
B-6	10	--	--	2	6	--
B-7	10	--	--	2.5	4	--
B-8	10	--	--	2	5	--
B-9	10	--	--	2	5	--
B-10 (PZ-2)	25	PZ-2	25	2	8	--
B-11	25	--	--	2	--	7.5" Cement stabilized shell
B-12	13	--	--	3.5	--	6" Cement stabilized shell
B-13	15	--	--	4	--	5" Cement stabilized shell
B-14	13	--	--	1	5.5	--
B-15	10	--	--	2	3	4" Sand
B-16	13	--	--	2	5	--
B-17	13	--	--	1	5	--
B-18	10	--	--	2	4	--
B-19	10	--	--	3	5	--
B-20	10	--	--	3	4	--
B-21	20	--	--	1	--	7" Crushed stone
B-22	20	--	--	3	5.5	--
B-23 (PZ-3)	20	PZ-3	20	2	7	--
B-24	25	--	--	2.5	5.5	--
B-25	12	--	--	5	--	13" Crushed limestone
B-26	10	--	--	4	4	--
B-27	10	--	--	3	4	--
B-28	13	--	--	3	--	5" Cement stabilized shell
B-29	12	--	--	--	--	--
B-30	10	--	--	4	--	5" Shell
B-31	10	--	--	2	5	--
B-32	17	--	--	3	--	4.5" Shell
B-33	10	--	--	2	4	--
B-34	10	--	--	1.5	5	--
B-35	10	--	--	2	5	--
B-36	10	--	--	2	5	--
B-37	10	--	--	1.5	4	--
B-38	20	--	--	1	6	--
B-39	20	--	--	2.5	4	--
B-40	20	--	--	3	4	--

TABLE 1

SUMMARY OF PAVEMENT MEASUREMENTS
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
CITY OF HOUSTON,TEXAS
WBS NO. S-000035-0192-4
ATL PROJECT NO. G13-196

Boring Number	Boring Depth (ft)	Piezometer		Asphalt Paving (inch)	Concrete Paving (inch)	Base Material (inch)
		No.	Depth (ft)			
B-41 (PZ-4)	20	PZ-4	20	2	--	5.5" Cement stabilized shell
B-42	10	--	--	1.5	5	--
B-43	10	--	--	1.5	5	--
B-44	10	--	--	2	3	--
B-45	10	--	--	1.5	5	--
B-46	10	--	--	5	--	5" Cement stabilized shell
B-47	10	--	--	2	4	--
B-48	10	--	--	1.5	5	--
B-49	13	--	--	4	5	--
B-50	13	--	--	2	5	--
B-51	13	--	--	--	--	--

TABLE 2

SUMMARY OF GROUNDWATER MEASUREMENTS
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
CITY OF HOUSTON,TEXAS
WBS NO. S-000035-0192-4
ATL PROJECT NO. G13-196

Boring Number	Location	Ground Water in Boreholes		Ground Water in Piezometers		
		During Drilling	At Completion	After 24 Hours	After 7 Days	After 30 Days
B-1 (PZ-1)	Stonecrest Dr.	Dry	Dry	(10/02/2013) 13.5'	(10/08/2013) 14'	(10/30/2013) 13'
B-2	Stonecrest Dr.	14'	N/A	--	--	--
B-3	W. 31st St.	Dry	Dry	--	--	--
B-4	W. 31st St.	Dry	Dry	--	--	--
B-5	W. 31st St.	Dry	Dry	--	--	--
B-6	Stonecrest Dr.	Dry	Dry	--	--	--
B-7	Stonecrest Dr.	Dry	Dry	--	--	--
B-8	W. 30th St.	Dry	Dry	--	--	--
B-9	W. 30th St.	Dry	Dry	--	--	--
B-10 (PZ-2)	Alba Rd.	Dry	Dry	(10/02/2013) Dry	(10/08/2013) Dry	(10/30/2013) 18'
B-11	Alba Rd.	Dry	Dry	--	--	--
B-12	Alba Rd.	Dry	Dry	--	--	--
B-13	Alba Rd.	Dry	Dry	--	--	--
B-14	W. 30th St.	Dry	Dry	--	--	--
B-15	Stonecrest Dr.	Dry	Dry	--	--	--
B-16	W. 30th St.	Dry	Dry	--	--	--
B-17	Stonecrest Dr.	10.5	12.5	--	--	--
B-18	W. 31st St.	Dry	Dry	--	--	--
B-19	W. 30th St.	Dry	Dry	--	--	--
B-20	Stonecrest Dr.	Dry	Dry	--	--	--
B-21	W. 31st St.	14.5'	14'	--	--	--
B-22	W. 31st St.	14'	N/A	--	--	--
B-23 (PZ-3)	W. 30th St.	12'	N/A	(10/02/2013) 11'	(10/08/2013) 12'	(10/30/2013) 12'
B-24	W. 30th St.	18'	14'	--	--	--
B-25	Randall St.	Dry	Dry	--	--	--
B-26	Randall St.	Dry	Dry	--	--	--
B-27	W. 30th St.	Dry	Dry	--	--	--
B-28	W. 30th St.	10'	11'	--	--	--
B-29	W. 34th St.	Dry	Dry	--	--	--

TABLE 2

SUMMARY OF GROUNDWATER MEASUREMENTS
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
CITY OF HOUSTON,TEXAS
WBS NO. S-000035-0192-4
ATL PROJECT NO. G13-196

Boring Number	Location	Ground Water in Boreholes		Ground Water in Piezometers		
		During Drilling	At Completion	After 24 Hours	After 7 Days	After 30 Days
B-30	Lawrence St.	Dry	Dry	--	--	--
B-31	Lawrence St	Dry	Dry	--	--	--
B-32	W. 30th St.	14	16.5	--	--	--
B-33	W. 34th St.	Dry	Dry	--	--	--
B-34	W. 32ND	Dry	Dry	--	--	--
B-35	W. 30th St.	Dry	Dry	--	--	--
B-36	W. 34th St.	Dry	Dry	--	--	--
B-37	W. 32ND	Dry	Dry	--	--	--
B-38	W. 34th St.	18	13.5	--	--	--
B-39	Ashland St.	Dry	Dry	--	--	--
B-40	Ashland St.	Dry	Dry	--	--	--
B-41 (PZ-4)	W. 30th St.	Dry	Dry	(10/02/2013) 11.5'	(10/08/2013) 12'	(10/30/2013) 11'
B-42	W. 34th St.	Dry	Dry	--	--	--
B-43	W. 32ND	Dry	Dry	--	--	--
B-44	W. 33rd St.	Dry	Dry	--	--	--
B-45	W. 32ND	Dry	Dry	--	--	--
B-46	W. 30th St.	Dry	Dry	--	--	--
B-47	W. 34th St.	Dry	Dry	--	--	--
B-48	W. 33rd St.	Dry	Dry	--	--	--
B-49	W. 34th St.	Dry	Dry	--	--	--
B-50	W. 32ND	Dry	Dry	--	--	--
B-51	W. 30th St.	Dry	Dry	--	--	--

TABLE 3

ASSOCIATED TESTING LABORATORIES, INC.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UNDRAINED SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE) (TSF)	UNDRAINED SHEAR STRENGTH (TSF) TORVANE	UNDRAINED SHEAR STRENGTH (TSF) POCKET PENETRO-METER	TYPE OF MATERIAL
B-1	1	0-2	UD		15		37	17	20	53				3.50	Sandy Lean Clay (CL)
	2	2-4	UD		14									2.00	Sandy Lean Clay (CL)
	3	4-6	UD		17	113					0.40			1.50	Sandy Lean Clay (CL)
	4	6-8	UD		19									1.00	Sandy Lean Clay (CL)
	5	8-10	UD		20									2.00	Sandy Lean Clay (CL)
	6	10-12	UD		24									2.00	Sandy Lean Clay (CL)
	7	12-14	UD		18		24	15	9	52				1.50	Sandy Lean Clay (CL)
	8	14-15	UD		20									2.00	Sandy Lean Clay (CL)
B-2	1	0-2	UD		18		65	21	44	66				3.50	Sandy Fat Clay (CH)
	2	2-4	UD		19									4.00	Sandy Fat Clay (CH)
	3	4-6	UD		15									3.50	Sandy Fat Clay (CH)
	4	6-8	UD		14	115					1.75			4.00	Sandy Lean Clay (CL)
	5	8-10	UD		12		37	17	20					4.50	Sandy Lean Clay (CL)
	6	10-12	UD		15	112						1.12 (0.58)		3.50	Sandy Lean Clay (CL)
	7	12-14	SS	25	19					46					Silty Sand (SM)
	8	14-15.5	SS	22	17										Silty Sand (SM)
B-3	1	0-2	UD		10		30	16	14	58				4.50	Sandy Lean Clay (CL)
	2	2-4	UD		9									4.50	Sandy Lean Clay (CL)
	3	4-6	UD		10									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		14									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		15	114					0.90			2.50	Sandy Lean Clay (CL)
	6	10-12	UD		15		28	15	13					3.00	Sandy Lean Clay (CL)
	7	12-13	UD		14									3.00	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 (contin'd)

ASSOCIATED TESTING LABORATORIES, INC.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	TYPE OF MATERIAL
B-4	1	0-2	UD		23									1.50	Sandy Fat Clay (CH)
	2	2-4	UD		19		55	20	35	51				2.00	Sandy Fat Clay (CH)
	3	4-6	UD		17									2.00	Sandy Lean Clay (CL)
	4	6-8	UD		15									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		15									4.50	Sandy Lean Clay (CL)
	6	10-12	UD		17	114	44	18	26			2.30 (0.58)		4.50	Sandy Lean Clay (CL)
	7	12-13	UD		19	112					2.15			4.50	Sandy Lean Clay (CL)
B-5	1	0-2	UD		21									4.50	Sandy Lean Clay (CL)
	2	2-4	UD		15									3.75	Sandy Lean Clay (CL)
	3	4-6	UD		15		40	17	23	54				3.50	Sandy Lean Clay (CL)
	4	6-8	UD		15									2.75	Sandy Lean Clay (CL)
	5	8-10	UD		15	115					0.65			2.00	Sandy Lean Clay (CL)
B-6	1	0-2	UD		16									4.00	Sandy Fat Clay (CH)
	2	2-4	UD		17		52	19	33	55				4.50	Sandy Fat Clay (CH)
	3	4-6	UD		16									4.50	Sandy Fat Clay (CH)
	4	6-8	UD		10									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		13	115					1.60			4.00	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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME: WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

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		27		70	22	48	70				1.75	Fat Clay with Sand (CH)
	2	2-4	UD		23									2.50	Fat Clay with Sand (CH)
	3	4-6	UD		19									4.50	Fat Clay with Sand (CH)
	4	6-8	UD		17	114					1.65			4.00	Sandy Lean Clay (CL)
	5	8-10	UD		17									3.50	Sandy Lean Clay (CL)
B-8	1	0-2	UD		34									0.50	Sandy Fat Clay (CH)
	2	2-4	UD		16		54	19	35	51				4.50	Sandy Fat Clay (CH)
	3	4-6	UD		15									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		14									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		14	119					2.10			4.50	Sandy Lean Clay (CL)
B-9	1	0-2	UD		28									1.00	Sandy Fat Clay (CH)
	2	2-4	UD		15									3.50	Sandy Fat Clay (CH)
	3	4-6	UD		21		56	20	36	62				3.75	Sandy Fat Clay (CH)
	4	6-8	UD		23	105					0.50			2.00	Sandy Fat Clay (CH)
	5	8-10	UD		15									4.00	Sandy Fat Clay (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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UNDRAINED SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE) (TSF)	UNDRAINED SHEAR STRENGTH (TSF) TORVANE	UNDRAINED SHEAR STRENGTH (TSF) POCKET PENETRO-METER	TYPE OF MATERIAL
B-10	1	0-2	AU		13										Silty-Clayey Sand (SC-SM)
	2	2-4	SS	11	12		18	14	4	33					Silty-Clayey Sand (SC-SM)
	3	4-6	UD		18									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		13									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		15									4.50	Sandy Lean Clay (CL)
	6	10-12	UD		16		35	16	19					4.50	Sandy Lean Clay (CL)
	7	12-14	UD		15	114						2.00(0.65)		4.50	Sandy Lean Clay (CL)
	8	14-16	SS	27	14										Clayey Sand (SC)
	9	16-18	SS	22	16					39					Clayey Sand (SC)
	10	18-20	SS	25	16										Clayey Sand (SC)
	11	23-25	UD		17	110	41	17	24		2.25			4.50	Sandy Lean Clay (CL)
B-11	1	0-2	UD		14									1.75	Sandy Lean Clay (CL)
	2	2-4	SS	16	21										Silty Sand (SM)
	3	4-6	UD		21		64	21	43	60				2.50	Sandy Fat Clay (CH)
	4	6-8	UD		15									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		15									4.50	Sandy Lean Clay (CL)
	6	10-12	UD		15									4.50	Sandy Lean Clay (CL)
	7	12-14	UD		15									4.50	Sandy Lean Clay (CL)
	8	14-16	UD		17	112					0.80			2.00	Sandy Lean Clay (CL)
	9	16-18	UD		16									4.00	Sandy Lean Clay (CL)
	10	18-20	UD		15									4.00	Sandy Lean Clay (CL)
	11	23-25	UD		16		46	18	28					4.50	Sandy Lean Clay (CL)
B-12	1	0-2	UD		24		63	21	42	69				4.50	Sandy Fat Clay (CH)
	2	2-4	UD		13									4.50	Sandy Fat Clay (CH)
	3	4-6	UD		11									4.50	Sandy Fat Clay (CH)
	4	6-8	UD		11									3.00	Sandy Lean Clay (CL)
	5	8-10	UD		13	116					0.85			2.00	Sandy Lean Clay (CL)
	6	10-12	UD		16		41	17	24	65				3.50	Sandy Lean Clay (CL)
	7	12-13	UD		16									4.00	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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UNDRAINED SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE) (TSF)	UNDRAINED SHEAR STRENGTH (TSF) TORVANE	UNDRAINED SHEAR STRENGTH (TSF) POCKET PENETRO-METER	TYPE OF MATERIAL
B-13	1	0-2	AU		20										Sandy Lean Clay (CL)
	2	2-4	UD		12		47	18	29	53				4.50	Sandy Lean Clay (CL)
	3	4-6	UD		8									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		8									4.00	Sandy Lean Clay (CL)
	5	8-10	UD		9		26	15	11					4.50	Sandy Lean Clay (CL)
	6	10-12	SS	31	9					22					Silty Sand (SM)
	7	12-14	UD		10									4.00	Sandy Lean Clay (CL)
	8	14-15	UD		12	120					2.25			4.50	Sandy Lean Clay (CL)
B-14	1	0-2	AU		10		16	13	3	47					Silty Sand (SM)
	2	2-4	UD		19									2.75	Sandy Lean Clay (CL)
	3	4-6	UD		17									3.25	Sandy Lean Clay (CL)
	4	6-8	UD		17	111					0.75			2.00	Sandy Lean Clay (CL)
	5	8-10	UD		15		27	15	12					2.75	Sandy Lean Clay (CL)
	6	10-12	UD		26									2.50	Fat Clay with Sand (CH)
	7	12-13	UD		18	108						0.66(0.65)		2.75	Fat Clay with Sand (CH)
B-15	1	0-2	UD		24									4.50	Sandy Lean Clay (CL)
	2	2-4	UD		12									4.50	Sandy Lean Clay (CL)
	3	4-6	UD		13		46	18	28	64				4.50	Sandy Lean Clay (CL)
	4	6-8	UD		11									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		17	113					2.15			4.50	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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	TYPE OF MATERIAL
B-16	1	0-2	AU		22										Sandy Lean Clay (CL)
	2	2-4	UD		16		45	18	27	56				3.50	Sandy Lean Clay (CL)
	3	4-6	UD		16									3.75	Sandy Lean Clay (CL)
	4	6-8	UD		14									2.50	Sandy Lean Clay (CL)
	5	8-10	UD		16									0.50	Sandy Lean Clay (CL)
	6	10-12	UD		18		30	16	14					2.00	Sandy Lean Clay (CL)
	7	12-13	UD		16	114					1.30			3.50	Sandy Lean Clay (CL)
B-17	1	0-2	UD		25		66	21	45	67				2.50	Sandy Fat Clay (CH)
	2	2-4	UD		22									2.50	Sandy Fat Clay (CH)
	3	4-6	UD		20									2.50	Sandy Fat Clay (CH)
	4	6-8	UD		18									3.00	Sandy Fat Clay (CH)
	5	8-10	UD		17		39	17	22	53				1.50	Sandy Lean Clay (CL)
	6	10-12	UD		24	104					0.40			1.50	Sandy Lean Clay (CL)
	7	12-13	UD		17									2.75	Sandy Lean Clay (CL)
B-18	1	0-2	UD		23									2.50	Sandy Lean Clay (CL)
	2	2-4	UD		15									3.00	Sandy Lean Clay (CL)
	3	4-6	UD		14		43	18	25	56				3.50	Sandy Lean Clay (CL)
	4	6-8	UD		14									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		15	113					0.80			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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	
B-19	1	0-2	AU		12										Sandy Lean Clay (CL)
	2	2-4	UD		10		34	16	18	62				4.50	Sandy Lean Clay (CL)
	3	4-6	UD		15									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		15	111					0.70			2.00	Sandy Lean Clay (CL)
	5	8-10	UD		15									1.00	Sandy Lean Clay (CL)
B-20	1	0-2	UD		18									1.50	Sandy Lean Clay (CL)
	2	2-4	UD		15		44	18	26	60				3.00	Sandy Lean Clay (CL)
	3	4-6	UD		14									4.00	Sandy Lean Clay (CL)
	4	6-8	UD		13									3.50	Sandy Lean Clay (CL)
	5	8-10	UD		17	115					1.10			3.50	Sandy Lean Clay (CL)
B-21	1	0-2	UD		20									4.50	Sandy Fat Clay (CH)
	2	2-4	UD		15		66	21	45	61				4.50	Sandy Fat Clay (CH)
	3	4-6	UD		11									4.50	Sandy Fat Clay (CH)
	4	6-8	UD		11									4.50	Sandy Fat Clay (CH)
	5	8-10	UD		13	118					1.65			4.00	Sandy Fat Clay (CH)
	6	10-12	UD		14	117						1.91 (0.58)		4.50	Sandy Fat Clay (CH)
	7	12-14	SS	20	13					28					Silty Sand (SM)
	8	14-16	UD		26		51	19	32					1.50	Sandy Fat Clay (CH)
	9	16-18	UD		19									0.50	Sandy Fat Clay (CH)
	10	18-20	UD		17									2.00	Sandy Fat Clay (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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	TYPE OF MATERIAL
B-22	1	0-2	AU		10										Silty Sand (SM)
	2	2-4	UD		16		69	22	47	66				4.50	Sandy Fat Clay (CH)
	3	4-6	UD		12									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		13									3.75	Sandy Lean Clay (CL)
	5	8-10	UD		15		43	18	25					2.75	Sandy Lean Clay (CL)
	6	10-12	UD		16	112					0.60			2.00	Sandy Lean Clay (CL)
	7	12-14	SS	17	14										Silty Sand (SM)
	8	14-16	SS	28	19										Silty Sand (SM)
	9	16-18	SS	39	20					15					Silty Sand (SM)
	10	18-20	UD		16	115						1.28(0.94)		2.50	Sandy Lean Clay (CL)
B-23	1	0-2	UD		16		53	19	34	59				4.50	Sandy Fat Clay (CH)
	2	2-4	UD		18									4.50	Sandy Fat Clay (CH)
	3	4-6	UD		12		35	16	19					4.50	Sandy Lean Clay (CL)
	4	6-8	UD		15	110					1.20			3.50	Sandy Lean Clay (CL)
	5	8-10	SS	26	16										Silty Sand (SM)
	6	10-12	SS	20	17										Silty Sand (SM)
	7	12-14	SS	22	20					15					Silty Sand (SM)
	8	14-16	SS	20	19										Silty Sand (SM)
	9	16-18	SS	33	20										Silty Sand (SM)
	10	18-20	SS	31	25					17					Silty Sand (SM)
B-24	1	0-2	UD		16									2.00	Sandy Lean Clay (CL)
	2	2-4	UD		14		42	18	24	51				4.50	Sandy Lean Clay (CL)
	3	4-6	UD		15									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		15									2.00	Sandy Lean Clay (CL)
	5	8-10	UD		16									2.00	Sandy Lean Clay (CL)
	6	10-12	SS	22	20										Silty Sand (SM)
	7	12-14	SS	37	20										Silty Sand (SM)
	8	14-16	SS	32	22					17					Silty Sand (SM)
	9	16-18	SS	23	20										Silty Sand (SM)
	10	18-20	UD		16	118	48	18	30		2.25			4.50	Sandy Lean Clay (CL)
	11	23-25	UD		19									3.50	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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	TYPE OF MATERIAL
B-25	1	0-2	AU		19										
	2	2-4	UD		20		63	21	42	66				2.50	Sandy Fat Clay (CH) (fill)
	3	4-6	UD		16									3.50	Sandy Fat Clay (CH) (fill)
	4	6-8	UD		16									3.75	Sandy Lean Clay (CL)
	5	8-10	UD		15									3.00	Sandy Lean Clay (CL)
	6	10-12	UD		16	118					1.90			4.25	Sandy Lean Clay (CL)
B-26	1	0-2	UD		28									1.00	Sandy Lean Clay (CL)
	2	2-4	UD		16									2.00	Sandy Lean Clay (CL)
	3	4-6	UD		15		38	17	21	56				3.00	Sandy Lean Clay (CL)
	4	6-8	UD		14									4.00	Sandy Lean Clay (CL)
	5	8-10	UD		15	114					1.05			3.50	Sandy Lean Clay (CL)
B-27	1	0-2	AU		13										Silty Sand (SM)
	2	2-4	UD		17		33	16	17	54				1.50	Sandy Lean Clay (CL)
	3	4-6	UD		21									1.50	Sandy Lean Clay (CL)
	4	6-8	UD		14									2.50	Sandy Lean Clay (CL)
	5	8-10	UD		14	121					1.25			3.50	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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	TYPE OF MATERIAL
B-28	1	0-2	UD		14									2.00	Sandy Lean Clay (CL)
	2	2-4	UD		10		35	16	19	68				4.50	Sandy Lean Clay (CL)
	3	4-6	UD		11									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		17									3.50	Sandy Lean Clay (CL)
	5	8-10	UD		17	109					0.75			2.00	Sandy Lean Clay (CL)
	6	10-12	UD		15		27	15	12					2.00	Sandy Lean Clay (CL)
	7	12-13	UD		16									1.50	Sandy Lean Clay (CL)
B-29	1	0-2	AU		12					41					Silty Sand (SM)
	2	2-4	UD		10		46	18	28	56				2.75	Sandy Lean Clay (CL)
	3	4-6	UD		10									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		14									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		13	115					1.10			3.50	Sandy Lean Clay (CL)
	6	10-12	UD		15									3.00	Sandy Lean Clay (CL)
B-30	1	0-2	UD		8									0.50	Sandy Lean Clay (CL)
	2	2-4	UD		5		25	15	10	63				1.50	Sandy Lean Clay (CL)
	3	4-6	UD		9									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		11									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		13	115					2.25			4.50	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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UNDRAINED SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE) (TSF)	UNDRAINED SHEAR STRENGTH (TSF) TORVANE	UNDRAINED SHEAR STRENGTH (TSF) POCKET PENETRO-METER	TYPE OF MATERIAL
B-31	1	0-2	AU		9										Silty Sand (SM)
	2	2-4	UD		9									4.50	Sandy Lean Clay (CL)
	3	4-6	UD		12		37	17	20	66				4.50	Sandy Lean Clay (CL)
	4	6-8	UD		19									3.50	Sandy Lean Clay (CL)
	5	8-10	UD		18	109					0.75			2.00	Sandy Lean Clay (CL)
B-32	1	0-2	AU		10										Silty Sand (SM)
	2	2-4	UD		10		38	17	21	67				4.50	Sandy Lean Clay (CL)
	3	4-6	UD		9									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		9									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		16	113						3.19 (0.43)		4.50	Sandy Lean Clay (CL)
	6	10-12	UD		14	119					0.55			2.00	Sandy Lean Clay (CL)
	7	12-14	UD		16		39	17	22	63				2.50	Sandy Lean Clay (CL)
	8	14-16	UD		16									3.00	Sandy Lean Clay (CL)
	9	16-17	UD		15									3.25	Sandy Lean Clay (CL)
B-33	1	0-2	UD		17		41	17	24	54				1.00	Sandy Lean Clay (CL)
	2	2-4	UD		18									4.00	Sandy Lean Clay (CL)
	3	4-6	UD		16	112					1.30			3.50	Sandy Lean Clay (CL)
	4	6-8	UD		17		42	18	24					3.00	Sandy Lean Clay (CL)
	5	8-10	UD		21									3.50	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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

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-34	1	0-2	UD		13		24	15	9	61				3.00	Sandy Lean Clay (CL)
	2	2-4	UD		13									4.50	Sandy Lean Clay (CL)
	3	4-6	UD		13									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		15									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		18	110					1.05			3.50	Sandy Lean Clay (CL)
B-35	1	0-2	UD		16									1.00	Sandy Lean Clay (CL)
	2	2-4	UD		21									3.50	Sandy Lean Clay (CL)
	3	4-6	UD		16		43	18	25	70				2.50	Sandy Lean Clay (CL)
	4	6-8	UD		18									3.50	Sandy Lean Clay (CL)
	5	8-10	UD		18	110					0.85			2.00	Sandy Lean Clay (CL)
B-36	1	0-2	UD		14									2.00	Sandy Lean Clay (CL)
	2	2-4	UD		14		24	15	9	68				2.50	Sandy Lean Clay (CL)
	3	4-6	UD		14									2.50	Sandy Lean Clay (CL)
	4	6-8	UD		18									3.50	Sandy Lean Clay (CL)
	5	8-10	UD		19	107					0.80			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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UNDRAINED SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE) (TSF)	UNDRAINED SHEAR STRENGTH (TSF) TORVANE	UNDRAINED SHEAR STRENGTH (TSF) POCKET PENETRO-METER	TYPE OF MATERIAL
B-37	1	0-2	UD		11		24	15	9	62				3.00	Sandy Lean Clay (CL)
	2	2-4	UD		17									4.50	Sandy Lean Clay (CL)
	3	4-6	UD		18									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		19	108					1.85			4.00	Sandy Lean Clay (CL)
	5	8-10	UD		17									4.50	Sandy Lean Clay (CL)
B-38	1	0-2	UD		16									3.00	Sandy Lean Clay (CL)
	2	2-4	UD		23		35	16	19	68				1.00	Sandy Lean Clay (CL)
	3	4-6	UD		16									3.75	Sandy Lean Clay (CL)
	4	6-8	UD		17									2.00	Sandy Lean Clay (CL)
	5	8-10	UD		23									1.50	Sandy Lean Clay (CL)
	6	10-12	UD		21	108					0.65			2.00	Sandy Lean Clay (CL)
	7	12-14	UD		22									1.00	Sandy Lean Clay (CL)
	8	14-16	UD		18		31	16	15	70				1.75	Sandy Lean Clay (CL)
	9	16018	UD		16	117						1.80 (0.79)		3.75	Sandy Lean Clay (CL)
	10	18-20	UD		17									4.50	Sandy Lean Clay (CL)
B-39	1	0-2	UD		8									3.00	Sandy Lean Clay (CL)
	2	2-4	UD		12		30	16	14	65				3.50	Sandy Lean Clay (CL)
	3	4-6	UD		14									3.50	Sandy Lean Clay (CL)
	4	6-8	UD		20									2.50	Sandy Lean Clay (CL)
	5	8-10	UD		19									2.00	Sandy Lean Clay (CL)
	6	10-12	UD		27	98					0.40			1.50	Sandy Lean Clay (CL)
	7	12-14	UD		19									4.00	Sandy Lean Clay (CL)
	8	14-16	UD		18		50	19	31	87				3.50	Fat Clay (CH)
	9	16-18	UD		18	114						1.01 (0.79)		3.00	Fat Clay (CH)
	10	18-20	UD		18									1.50	Fat Clay (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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	TYPE OF MATERIAL
B-40	1	0-2	UD		14									4.50	Lean Clay with Sand (CL)
	2	2-4	UD		15									3.75	Lean Clay with Sand (CL)
	3	4-6	UD		15		43	18	25	77				3.75	Lean Clay with Sand (CL)
	4	6-8	UD		16									2.50	Lean Clay with Sand (CL)
	5	8-10	UD		19									2.00	Lean Clay with Sand (CL)
	6	10-12	UD		19									3.50	Lean Clay with Sand (CL)
	7	12-14	UD		18		37	17	20					2.75	Lean Clay with Sand (CL)
	8	14-16	UD		19	112						0.91 (0.72)		1.50	Lean Clay with Sand (CL)
	9	16-18	UD		20									3.25	Lean Clay with Sand (CL)
	10	18-20	UD		20	109					1.70			4.00	Lean Clay with Sand (CL)
B-41	1	0-2	UD		20									1.50	Lean Clay with Sand (CL)
	2	2-4	UD		21									1.50	Lean Clay with Sand (CL)
	3	4-6	UD		16		45	18	27	74				3.50	Lean Clay with Sand (CL)
	4	6-8	UD		19									3.00	Lean Clay with Sand (CL)
	5	8-10	UD		19									3.00	Lean Clay with Sand (CL)
	6	10-12	UD		19									3.50	Lean Clay with Sand (CL)
	7	12-14	UD		17		49	19	30	80				4.00	Lean Clay with Sand (CL)
	8	14-16	UD		18	112						1.47(0.72)		3.75	Lean Clay with Sand (CL)
	9	16-18	UD		23									3.00	Lean Clay with Sand (CL)
	10	18-20	UD		19	109					1.45			3.50	Lean Clay with Sand (CL)
B-42	1	0-2	UD		15		24	15	9	62				1.00	Sandy Lean Clay(CL)
	2	2-4	UD		18									1.75	Sandy Lean Clay(CL)
	3	4-6	UD		18									1.50	Sandy Lean Clay(CL)
	4	6-8	UD		14									4.50	Sandy Lean Clay(CL)
	5	8-10	UD		16	113					1.20			3.50	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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UNDRAINED SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE) (TSF)	UNDRAINED SHEAR STRENGTH (TSF) TORVANE	UNDRAINED SHEAR STRENGTH (TSF) POCKET PENETRO-METER	TYPE OF MATERIAL
B-43	1	0-2	UD		16									1.00	Fat Clay with Sand (CH)
	2	2-4	UD		15		53	19	34	80				4.50	Fat Clay with Sand (CH)
	3	4-6	UD		16									4.50	Fat Clay with Sand (CH)
	4	6-8	UD		30	103					2.20			4.50	Fat Clay with Sand (CH)
	5	8-10	UD		18									4.50	Fat Clay with Sand (CH)
B-44	1	0-2	UD		15									2.00	Sandy Lean Clay (CL)
	2	2-4	UD		19		39	17	22	70				1.50	Sandy Lean Clay (CL)
	3	4-6	UD		16									2.50	Sandy Lean Clay (CL)
	4	6-8	UD		15									4.00	Sandy Lean Clay (CL)
	5	8-10	UD		14	116					1.65			4.00	Sandy Lean Clay (CL)
B-45	1	0-2	UD		12		24	15	9	65				3.00	Sandy Lean Clay(CL)
	2	2-4	UD		13									3.00	Sandy Lean Clay(CL)
	3	4-6	UD		13									4.00	Sandy Lean Clay(CL)
	4	6-8	UD		13	118					1.30			3.50	Sandy Lean Clay(CL)
	5	8-10	UD		10									2.75	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.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

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-46	1	0-2	UD		15									2.50	Lean Clay with Sand (CL)
	2	2-4	UD		17		38	17	21	75				2.75	Lean Clay with Sand (CL)
	3	4-6	UD		17									3.50	Lean Clay with Sand (CL)
	4	6-8	UD		15	118					2.00			4.50	Lean Clay with Sand (CL)
	5	8-10	UD		18									3.00	Lean Clay with Sand (CL)
B-47	1	0-2	UD		14									3.50	Sandy Lean Clay (CL)
	2	2-4	UD		14		28	15	13	62				3.50	Sandy Lean Clay (CL)
	3	4-6	UD		15									4.00	Sandy Lean Clay (CL)
	4	6-8	UD		20	108	45	18	27		0.60			2.00	Sandy Lean Clay (CL)
	5	8-10	UD		19									2.00	Sandy Lean Clay (CL)
B-48	1	0-2	UD		19									2.50	Lean Clay with Sand (CL)
	2	2-4	UD		22		45	18	27	74				2.75	Lean Clay with Sand (CL)
	3	4-6	UD		17									3.00	Lean Clay with Sand (CL)
	4	6-8	UD		16									4.00	Lean Clay with Sand (CL)
	5	8-10	UD		17	113					1.65			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 3 (cont'd)

ASSOCIATED TESTING LABORATORIES, INC.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
COH WBS NO: S-000035-0192-4
CONSULTANT PROJECT NUMBER: G13-196

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UNDRAINED SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE) (TSF)	UNDRAINED SHEAR STRENGTH (TSF) TORVANE	UNDRAINED SHEAR STRENGTH (TSF) POCKET PENETRO-METER	TYPE OF MATERIAL
B-49	1	0-2	UD		17		41	17	24	68				1.75	Sandy Lean Clay (CL)
	2	2-4	UD		13									2.00	Sandy Lean Clay (CL)
	3	4-6	UD		18									1.50	Sandy Lean Clay (CL)
	4	6-8	UD		21	106					0.45			1.25	Sandy Lean Clay (CL)
	5	8-10	UD		28	98						0.52(0.43)		1.75	Fat Clay (CH)
	6	10-12	UD		25		84	24	60	97				2.00	Fat Clay (CH)
	7	12-13	UD		31									1.75	Fat Clay (CH)
B-50	1	0-2	UD		17		29	15	14	74				1.00	Lean Clay with Sand (CL)
	2	2-4	UD		17									2.00	Lean Clay with Sand (CL)
	3	4-6	UD		17									3.25	Lean Clay with Sand (CL)
	4	6-8	UD		16									2.75	Lean Clay with Sand (CL)
	5	8-10	UD		20		49	19	30	83				2.00	Lean Clay with Sand (CL)
	6	10-12	UD		17	114					1.15			3.50	Lean Clay with Sand (CL)
	7	12-13	UD		19									2.00	Lean Clay with Sand (CL)
B-51	1	0-2	UD		14		30	16	14	70				4.50	Sandy Lean Clay (CL)
	2	2-4	UD		15									4.50	Sandy Lean Clay (CL)
	3	4-6	UD		12									3.00	Sandy Lean Clay (CL)
	4	6-8	UD		19									1.50	Sandy Lean Clay (CL)
	5	8-10	UD		21		44	18	26	70				1.00	Sandy Lean Clay (CL)
	6	10-12	UD		18	104					0.95			2.50	Sandy Lean Clay (CL)
	7	12-13	UD		16	115						1.24 (0.65)		3.00	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

APPENDIX 1

PHOTOGRAPHS OF THE PROJECT SITE

PHOTOGRAPHS OF THE PROJECT SITE
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
WBS NO.: S-000035-0192-4
ATL PROJECT NO. G13-196

Looking NE. along W. 31th St., from S. of Stonecrest Dr.

Looking S. along Alba Rd., from S. of Sara Rose St.

PHOTOGRAPHS OF THE PROJECT SITE
WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA
WBS NO.: S-000035-0192-4
ATL PROJECT NO. G13-196

Looking N. along Lawrence St., from S. of W. 32nd St.

Looking W. along W. 30th St., from Yale St.

APPENDIX 2

PIEZOMETER INSTALLATION REPORTS

PIEZOMETER INSTALLATION REPORT

PROJECT NAME: WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA WBS No.: S-000035-0192-4	PIEZOMETER NO.: B-1 (PZ-1)

GEOTECHNICAL CONSULTANT ASSOCIATED TESTING LABORATORIES, INC.	DESIGN CONSULTANT ISANI CONSULTANTS, L.P.	CITY OF HOUSTON

COMPLETION DATE: 10-1-13

DRY AUGERED 0 TO 15 FT

WASH BORED _____ TO _____ FT

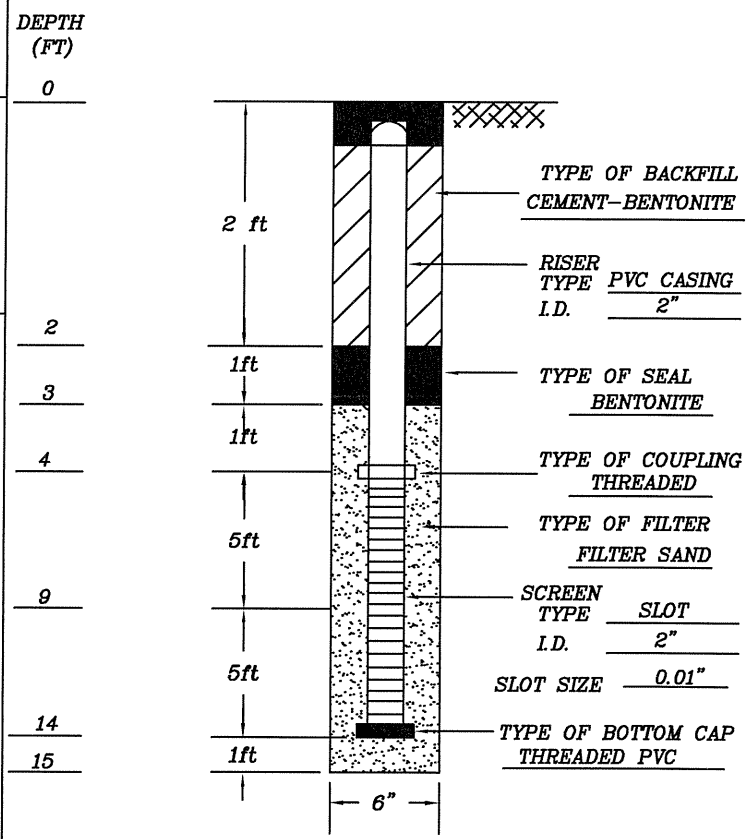
DRILING FLUID: _____

DEVELOPMENT DATE: 10-1-13

METHOD OF DEVELOPMENT: BAILING

WATER LEVEL READING:

DATE	READING
10-2-13	13.5'
10-8-13	14'
10-30-13	13'



(NOT TO SCALE)

REMARKS:

NOTES:

DRILLED BY: VAN & SON	STARTED: 10-1-13	ATL job No. G13-196
LOGGED BY: PV	COMPLETED: 10-1-13	
CHECKED BY: JITU	APPROVED BY: PST	SHEET 1 OF 4

ASSOCIATED TESTING LABORATORIES, INC.

PIEZOMETER INSTALLATION REPORT

PROJECT NAME: WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA WBS No.: S-000035-0192-4	PIEZOMETER NO.: B-10 (PZ-2)

GEOTECHNICAL CONSULTANT ASSOCIATED TESTING LABORATORIES, INC.	DESIGN CONSULTANT ISANI CONSULTANTS, L.P.	CITY OF HOUSTON

COMPLETION DATE: 10-1-13

DRY AUGERED 0 TO 25 FT

WASH BORED _____ TO _____ FT

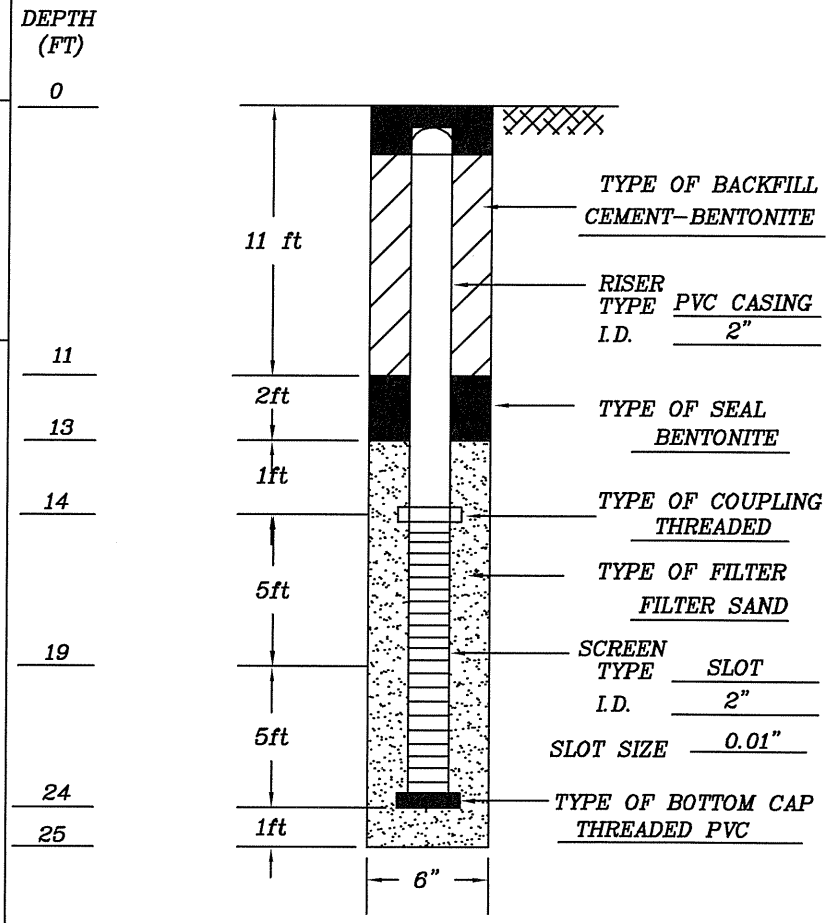
DRILING FLUID: _____

DEVELOPMENT DATE: 10-1-13

METHOD OF DEVELOPMENT: BAILING

WATER LEVEL READING:

DATE	READING
10-2-13	Dry
10-8-13	Dry
10-30-13	18'



(NOT TO SCALE)

REMARKS:

NOTES:

DRILLED BY: VAN & SON	STARTED: 10-1-13	ATL job No. G13-196
LOGGED BY: PV	COMPLETED: 10-1-13	
CHECKED BY: JITU	APPROVED BY: PST	SHEET 2 OF 4

ASSOCIATED TESTING LABORATORIES, INC.

PIEZOMETER INSTALLATION REPORT

PROJECT NAME: WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA WBS No.: S-000035-0192-4	PIEZOMETER NO.: B-23 (PZ-3)

GEOTECHNICAL CONSULTANT ASSOCIATED TESTING LABORATORIES, INC.	DESIGN CONSULTANT ISANI CONSULTANTS, L.P.	CITY OF HOUSTON

COMPLETION DATE: 10-1-13

DRY AUGERED 0 TO 20 FT

WASH BORED _____ TO _____ FT

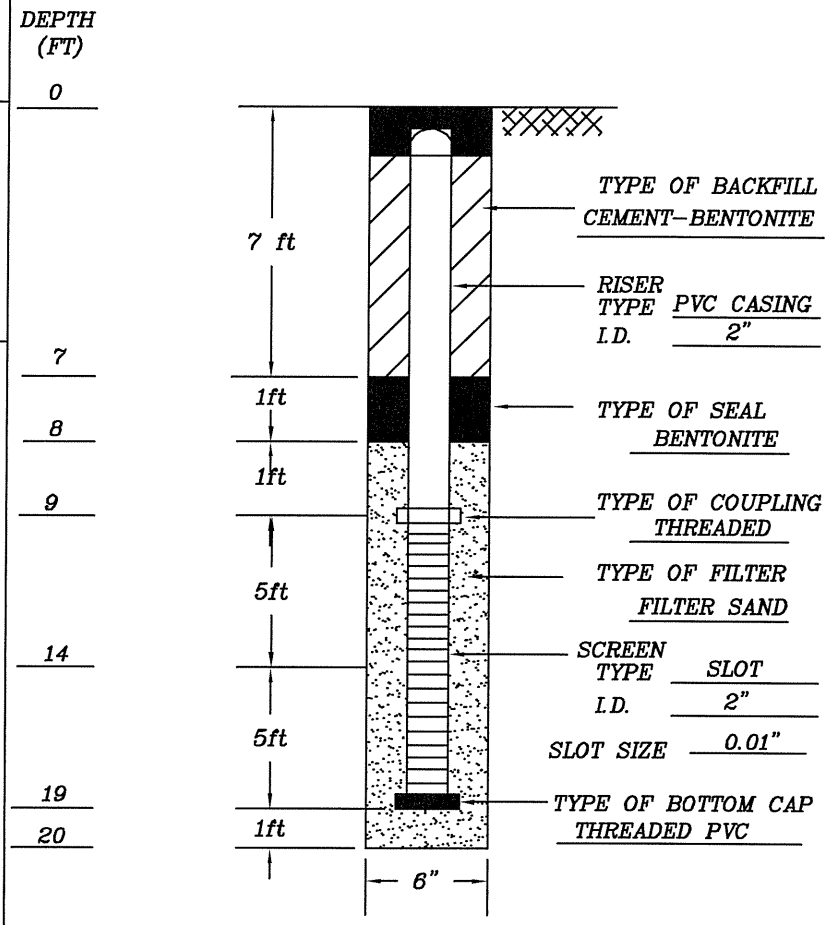
DRILING FLUID: _____

DEVELOPMENT DATE: 10-1-13

METHOD OF DEVELOPMENT: BAILING

WATER LEVEL READING:

DATE	READING
10-2-13	11'
10-8-13	12'
10-30-13	12'



(NOT TO SCALE)

REMARKS:

NOTES:

DRILLED BY: VAN & SON	STARTED: 10-1-13	ATL job No. G13-196
LOGGED BY: PV	COMPLETED: 10-1-13	
CHECKED BY: JITU	APPROVED BY: PST	SHEET 3 OF 4

PIEZOMETER INSTALLATION REPORT

PROJECT NAME: WATER LINE REPLACEMENT IN SHEPHERD FOREST II AREA WBS No.: S-000035-0192-4	PIEZOMETER NO.: B-41 (PZ-4)

GEOTECHNICAL CONSULTANT ASSOCIATED TESTING LABORATORIES, INC.	DESIGN CONSULTANT ISANI CONSULTANTS, L.P.	CITY OF HOUSTON

COMPLETION DATE: 10-1-13

DRY AUGERED 0 TO 20 FT

WASH BORED _____ TO _____ FT

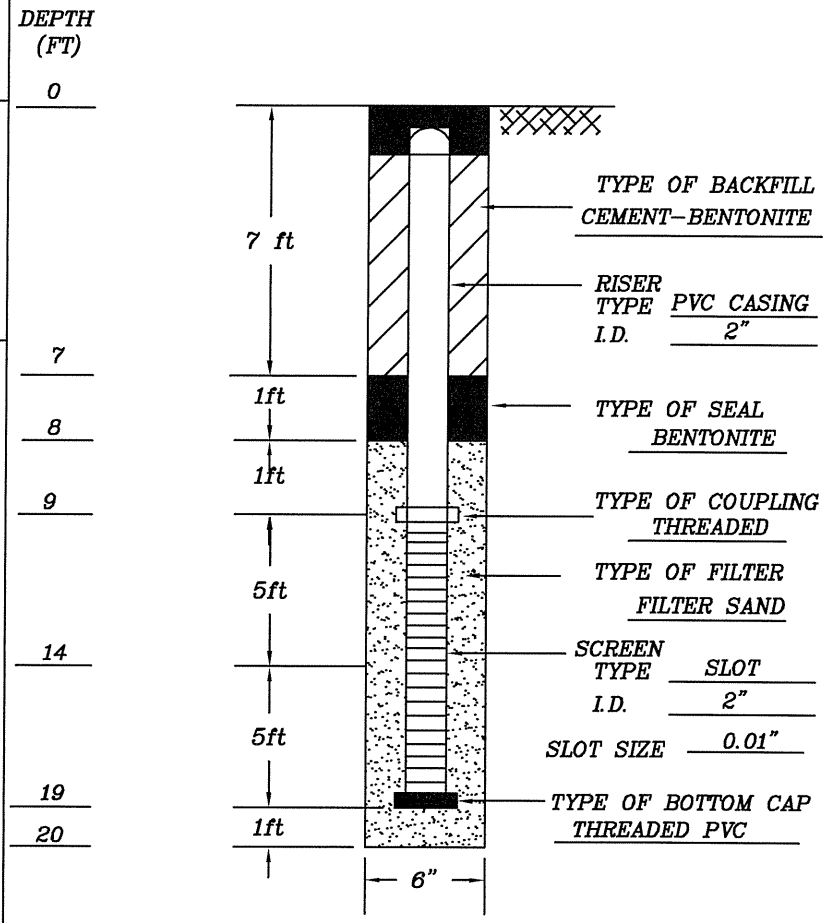
DRILING FLUID: _____

DEVELOPMENT DATE: 10-1-13

METHOD OF DEVELOPMENT: BAILING

WATER LEVEL READING:

DATE	READING
10-2-13	11.5'
10-8-13	12'
10-30-13	11'



(NOT TO SCALE)

REMARKS:

NOTES:

DRILLED BY: VAN & SON	STARTED: 10-1-13	ATL job No. G13-196
LOGGED BY: PV	COMPLETED: 10-1-13	
CHECKED BY: JITU	APPROVED BY: PST	SHEET 4 OF 4

ASSOCIATED TESTING LABORATORIES, INC.

G13-196

STATE OF TEXAS WELL REPORT for Tracking #349506

Owner:	City of Houston Geotechnical Dept	Owner Well #:	PZ-1
Address:	611 Walker Floor 14 Houston , TX 77002	Grid #:	65-13-5
Well Location:	Spring Rock Row at HCFC Ditch Houston , TX 77018	Latitude:	29° 48' 54" N
Well County:	Harris	Longitude:	095° 25' 32" W
Elevation:	No Data	GPS Brand Used:	No Data
Type of Work:	New Well	Proposed Use:	Monitor

Drilling Date:	Started: 10/10/2013 Completed: 10/10/2013
Diameter of Hole:	Diameter: 4 in From Surface To 15 ft
Drilling Method:	Other: flight auger
Borehole Completion:	Other: (No Data)
Annular Seal Data:	1st Interval: From 0 ft to 6 ft with .5 cement (#sacks and material) 2nd Interval: From 6 ft to 8 ft with .5 bentonite (#sacks and material) 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 Slab Installed
Water Level:	Static level: dry ft. below land surface on 10/10/2013 Artesian flow: No Data
Packers:	20/40 8-15
Plugging Info:	Casing left in well: Cement/Bentonite left in well: From (ft) To (ft) From (ft) To (ft) Cem/Bent Sacks Used 0-15 plugged with 1 sack cement via tremmie method on 12/17/2013
Type Of Pump:	No Data
Well Tests:	No Data
Water Quality:	Type of Water: No Data Depth of Strata: No Data Chemical Analysis Made: No 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:	Van and Sons Drilling Service 319 John Alber Houston , TX 77076

Driller License Number:	3003
Licensed Well Driller Signature:	Edward Van Antwerp
Registered Driller Apprentice Signature:	Elliot Van Antwerp
Apprentice Registration Number:	No Data
Comments:	Elliot Van Antwerp set and plugged this well under Edward's supervision

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 #349506) 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	15	SaCl

CASING, BLANK PIPE & WELL SCREEN DATA

Dia.	New/Used	Type	Setting From/To
2	n	Sch 40 PVC Riser	0-10
2	n	Sch 40 PVC Screen	10-15 .010

STATE OF TEXAS WELL REPORT for Tracking #349513

Owner:	City of Houston Geotechnical Dept	Owner Well #:	pz-2
Address:	611 Walker Floor 14 Houston , TX 77002	Grid #:	65-13-5
Well Location:	Alba at RR Tracks Houston , TX 77018	Latitude:	29° 49' 09" N
Well County:	Harris	Longitude:	095° 25' 13" W
Elevation:	No Data	GPS Brand Used:	No Data
Type of Work:	New Well	Proposed Use:	Monitor

Drilling Date:	Started: 10/1/2013 Completed: 10/1/2013
Diameter of Hole:	Diameter: 4 in From Surface To 25 ft
Drilling Method:	Mud Rotary
Borehole Completion:	Other: (No Data)
Annular Seal Data:	1st Interval: From 0 ft to 11 ft with 1 cement (#sacks and material) 2nd Interval: From 11 ft to 13 ft with .5 bentonite (#sacks and material) 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 Slab Installed
Water Level:	Static level: dry ft. below land surface on 10/1/2013 Artesian flow: No Data
Packers:	20/40 13-25
Plugging Info:	Casing left in well: Cement/Bentonite left in well: From (ft) To (ft) From (ft) To (ft) Cem/Bent Sacks Used 0-25 grouted in place via tremmie method using 1.5 sacks of cement on 12/17/2013
Type Of Pump:	No Data
Well Tests:	No Data
Water Quality:	Type of Water: No Data Depth of Strata: No Data Chemical Analysis Made: No 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:	

Van and Sons Drilling Service
319 John Alber
Houston , TX 77076

Driller License Number:	3003
Licensed Well Driller Signature:	Edward Van Antwerp
Registered Driller Apprentice Signature:	Elliot Van Antwerp
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 #349513) 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	4	ClSa
4	14	SaCl
14	16	ClSa
16	20	SaCl
20	25	Cl

CASING, BLANK PIPE & WELL SCREEN DATA

Dia.	New/Used	Type	Setting From/To
2 n	Sch 40	PVC Riser	0-15
2 n	Sch 40	PVC Screen	15-25 .010

STATE OF TEXAS WELL REPORT for Tracking #349519

Owner:	City of Houston Geotechnical Dept	Owner Well #:	pz-3
Address:	611 Walker Floor 14 Houston , TX 77002	Grid #:	65-13-6
Well Location:	30th St at HCFC Ditch Houston , TX 77018	Latitude:	29° 48' 50" N
Well County:	Harris	Longitude:	095° 24' 48" W
Elevation:	No Data	GPS Brand Used:	No Data
Type of Work:	New Well	Proposed Use:	Monitor

Drilling Date:	Started: 10/1/2013 Completed: 10/1/2013
Diameter of Hole:	Diameter: 4 in From Surface To 20 ft
Drilling Method:	Mud Rotary
Borehole Completion:	No Data
Annular Seal Data:	1st Interval: From 0 ft to 6 ft with .5 cement (#sacks and material) 2nd Interval: From 6 ft to 8 ft with .5 bentonite (#sacks and material) 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 Slab Installed
Water Level:	Static level: 12 ft. below land surface on 10/1/2013 Artesian flow: No Data
Packers:	20/40 8-20
Plugging Info:	Casing left in well: Cement/Bentonite left in well: From (ft) To (ft) From (ft) To (ft) Cem/Bent Sacks Used 0-20 grouted in place using 1.5 sacks of cement via tremmie method on 12/17/2013
Type Of Pump:	No Data
Well Tests:	No Data
Water Quality:	Type of Water: No Data Depth of Strata: No Data Chemical Analysis Made: No 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:	

	Van and Sons Drilling Service 319 John Alber Houston , TX 77076
Driller License Number:	3003
Licensed Well Driller Signature:	Edward Van Antwerp
Registered Driller Apprentice Signature:	Elliot Van Antwerp
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 #349519) 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	8	SaCl
8	10	ClSa
10	20	Sa

CASING, BLANK PIPE & WELL SCREEN DATA

Dia.	New/Used	Type	Setting From/To
2	n	Sch 40 PVC Riser	0-10
2	n	Sch 40 PVC Screen	10-20 .010

STATE OF TEXAS WELL REPORT for Tracking #349523

Owner:	City of Houston Geotechnical Dept	Owner Well #:	pz-4
Address:	611 Walker Floor 14 Houston , TX 77002	Grid #:	65-13-6
Well Location:	W. 30th St Houston , TX 77018	Latitude:	29° 48' 50" N
Well County:	Harris	Longitude:	095° 24' 48" W
Elevation:	No Data	GPS Brand Used:	No Data
Type of Work:	New Well	Proposed Use:	Monitor

Drilling Date:	Started: 10/1/2013 Completed: 10/1/2013
Diameter of Hole:	Diameter: 4 in From Surface To 20 ft
Drilling Method:	Mud Rotary
Borehole Completion:	Other: (No Data)
Annular Seal Data:	1st Interval: From 0 ft to 6 ft with .5 cement (#sacks and material) 2nd Interval: From 6 ft to 8 ft with .5 bentonite (#sacks and material) 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 Slab Installed
Water Level:	Static level: dry ft. below land surface on 10/1/2013 Artesian flow: No Data
Packers:	20/40 8-20
Plugging Info:	Casing left in well: Cement/Bentonite left in well: From (ft) To (ft) From (ft) To (ft) Cem/Bent Sacks Used 0-20 grouted in place using 1.5 sacks cement via tremmie method on 12/17/2013
Type Of Pump:	No Data
Well Tests:	No Data
Water Quality:	Type of Water: No Data Depth of Strata: No Data Chemical Analysis Made: No 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:	

APPENDIX 3

BORING LOGS AND KEY TO LOG TERMS AND SYMBOLS

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

LOG OF BORING B-1 (PZ-1)

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

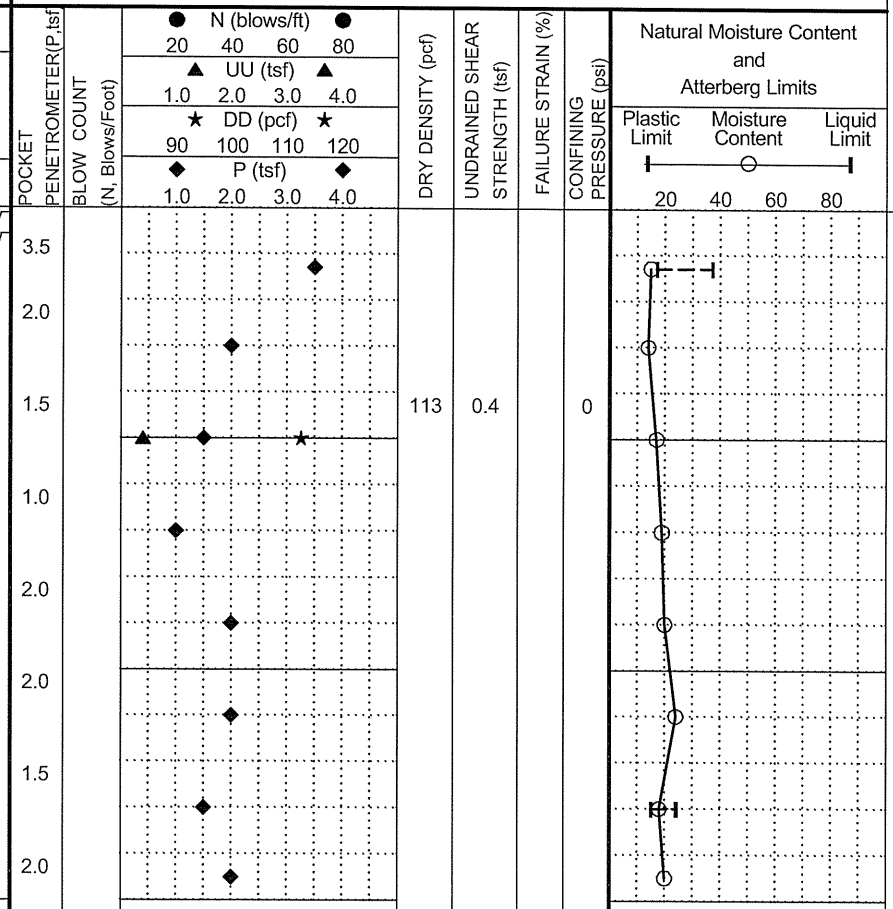
PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 10-1-13

SURFACE ELEVATION: 61.41

LOCATION
Stonecrest
Northing: 13862515.952
Easting: 3102215.782

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				1.5" Asphalt												
				5.5" Concrete												
				Sandy Lean Clay (CL), very stiff, medium plasticity, light gray & tan	3.5						15	37	17	20	53	
				.. stiff, with ferrous nodules below 2'	2.0						14					
				.. firm below 4'	1.5		113	0.4		0	17					
5				.. with sand seams below 6'	1.0						19					
		CL		.. stiff below 6'	2.0						20					
10					2.0						24					
				.. slight plasticity below 12'	1.5						18	24	15	9	52	
					2.0						20					
15																



Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 15'; PZ water level: 13.5' (10-2-2013); PZ water level: 14' (10-8-2013); PZ water level: 13' (10-30-2013);Drilled By: Van & Sons, Logged BY: PV, Checked By: Jitu/pankaj QC/QA By: PST

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

LOG OF BORING B-2

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-19-13

SURFACE ELEVATION: 61.35

LOCATION

Stonecrest
Northing: 13862479.225
Easting: 3102316.914

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		1" Asphalt												
		6" Concrete												
	CH	Sandy Fat Clay (CH), very stiff, very high plasticity, light gray & tan	3.5						18	65	21	44	66	
			4.0						19					
			3.5						15					
5														
	CL	Sandy Lean Clay (CL), very stiff, medium plasticity, light gray & tan with sand seams	4.0		115	1.75		0	14					
		.. hard below 8'	4.5						12	37	17	20		
10		.. very stiff below 10'	3.5		112	1.12		8	15					
	SM	Silty Sand (SM), medium dense, non plastic, light gray & tan		25					19				46	
		.. wet below 14'		22					17					
15														

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: 14', After Drilling: N/A

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 15.5' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-3

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-25-13

SURFACE ELEVATION: 60.61

LOCATION

W. 31st
Northing: 13862095.818
Easting: 3102246.295

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	N (blows/ft) 20 40 60 80 / UU (tsf) 1.0 2.0 3.0 4.0 / DD (pcf) 90 100 110 120 / P (tsf) 1.0 2.0 3.0 4.0	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits (Plastic Limit – Moisture Content – Liquid Limit; 20 40 60 80)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				4" Asphalt														
				4" Concrete														
				Sandy Lean Clay (CL), very stiff, high plasticity, light gray & tan	4.5								10	30	16	14	58	
					4.5								9					
				.. with ferrous nodules below 4'	4.5								10					
5																		
		CL			4.5								14					
				.. stiff below 8'	2.5			114	0.9		0		15					
10				.. very stiff below 10'	3.0								15	28	15	13		
					3.0								14					

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ▨ Shelby Tube ▤ Disturbed

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

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-4

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-25-13

SURFACE ELEVATION: 63.81

LOCATION
W. 31st
Northing: 13862691.012
Easting: 3102874.47

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				4" Asphalt												
				5" Concrete												
		CH		Sandy Fat Clay (CH), stiff, high plasticity, light gray & tan	1.5						23	55	20	35	51	
					2.0						19					
				Sandy Lean Clay (CL), stiff, high plasticity, light gray & tan	2.0						17					
5				.. hard below 6'	4.5						15					
		CL			4.5						15					
10				.. with ferrous nodules below 10'	4.5		114	2.3		8	17	44	18	26		
					4.5		112	2.15		0	19					

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-5

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE 9-25-13

SURFACE ELEVATION 70.14

LOCATION

W. 31st
Northing: 13862713.983
Easting: 3103483.233

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				3" Asphalt												
				5" Concrete												
				Sandy Lean Clay (CL), hard, high plasticity, light gray & tan	4.5						21					
				.. very stiff, with sand seams below 2'	3.75						15					
				.. reddish brown below 4'	3.5						15	40	17	23	54	
5		CL		.. light gray & tan below 6'	2.75						15					
				.. stiff below 8'	2.0		115	0.65		0	15					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-6

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-19-13

SURFACE ELEVATION: 64.57

LOCATION

Stonecrest
Northing: 13862414.876
Easting: 3103110.198

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				2" Asphalt												
				6" Concrete												
		CH		Sandy Fat Clay (CH), very stiff, high plasticity, light gray & tan	4.0						16					
				.. hard below 2'	4.5						17	52	19	33	55	
					4.5						16					
5																
		CL		Sandy Lean Clay (CL), hard, high plasticity, light gray & tan	4.5						10					
				.. very stiff below 8'	4.0		115	1.6		0	13					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-7

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-19-13

SURFACE ELEVATION: 69.09

LOCATION

Stonecrest
Northing: 13862439.777
Easting: 3103740.518

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				2.5" Asphalt												
				4" Concrete												
		CH		Fat Clay With Sand (CH), stiff, very high plasticity, light gray & tan	1.75						27	70	22	48	70	
				.. very stiff, with ferrous nodules below 2'	2.5						23					
				.. hard below 4'	4.5						19					
5				Sandy Lean Clay (CL), very stiff, high plasticity, light gray & tan	4.0		114	1.65		0	17					
		CL			3.5						17					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20, 40, 60, 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-8

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

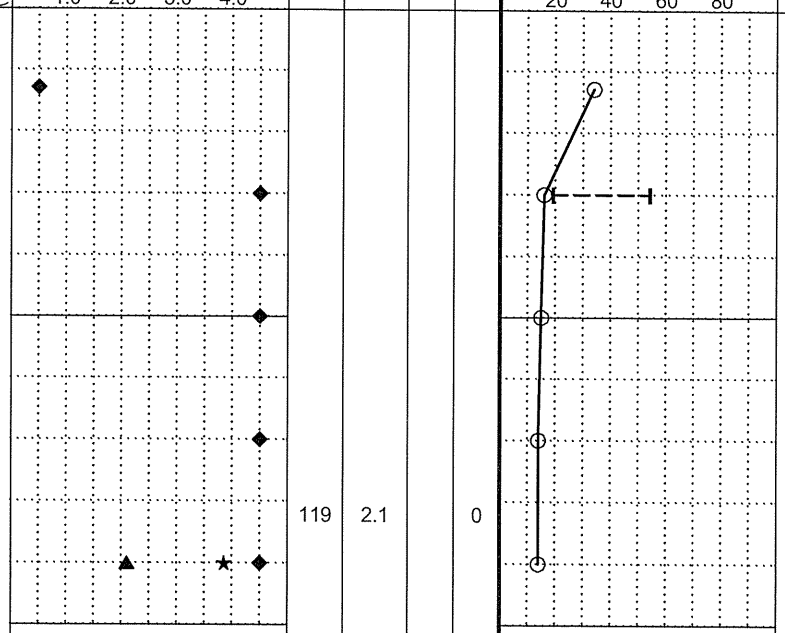
PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-25-13

SURFACE ELEVATION: 63.54

LOCATION
W. 30th
Northing: 13862113.915
Easting: 3102623.625

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				2" Asphalt												
				5" Concrete												
		CH		Sandy Fat Clay (CH), soft, high plasticity, light gray & tan	0.5						34					
				.. hard below 2'	4.5						16	54	19	35	51	
				Sandy Lean Clay (CL), hard, high plasticity, light gray & tan	4.5						15					
5																
		CL			4.5						14					
				.. with ferrous nodules below 8'	4.5		119	2.1		0	14					
10																



Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-9

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-25-13

SURFACE ELEVATION: 66.45

LOCATION

W. 30th
Northing: 13862139.723
Easting: 3103318.005

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				2" Asphalt												
				5" Concrete												
				Sandy Fat Clay (CH), soft, high plasticity, light gray & tan	1.0						28					
				.. very stiff below 2'	3.5						15					
				.. stiff below 6'	3.75						21	56	20	36	62	
5		CH			2.0		105	0.5		0	23					
				.. very stiff below 8'	4.0						15					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: After Drilling: 24 Hrs:
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-10 (PZ-2)

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 10-1-13

SURFACE ELEVATION: 75.02

LOCATION

Alba
Northing: 13864230.23
Easting: 3103318.005

MATERIAL DESCRIPTION

Depth (ft.)	USC	Material Description
0		2" Asphalt
		8" Concrete
	SC SM	Silty Clayey Sand (SC-SM), slight plasticity, light gray & tan
		.. medium dense below 2'
5		Sandy Lean Clay (CL), hard, medium plasticity, light gray & tan
		.. with ferrous nodules below 6'
10	CL	
15		Clayey Sand (SC), medium dense, non plastic, light gray & tan, moist
20	SC	
25	CL	Sandy Lean Clay (CL), hard, high plasticity, light gray & tan

Depth (ft.)	Pocket Penetrometer (P, tsf)	Blow Count (N, Blows/Foot)	Dry Density (pcf)	Undrained Shear Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Passing #200 Sieve (%)
0							13				
		11					12	18	14	4	33
	4.5						18				
	4.5						13				
	4.5						15				
10	4.5						16	35	16	19	
	4.5		114	2.0		9	15				
15		27					14				
		22					16				39
20		25					16				
25	4.5		110	2.25		0	17	41	17	24	

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level: Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 25' ; PZ water level: Dry (10-2-2013); PZ water level: Dry (10-8-2013); PZ water level: 18' (10-30-2013); Drilled By: Van & Sons, Logged BY: PV, Checked By: Jitu/pankaj QC/QA By: PST

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

LOG OF BORING B-11

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 10-2-13

SURFACE ELEVATION: 73.90

LOCATION

Alba
Northing: 13864118.18
Easting: 3103769.69

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				2" Asphalt												
		CL		7.5" Cement stabilized shell base	1.75						14					
		SM		Sandy Lean Clay (CL), stiff, medium plasticity, light gray & tan		16					21					
5		CH		Silty Sand (SM), medium dense, non plastic, light gray & tan	2.5						21	64	21	43	60	
				Sandy Fat Clay (CH), very stiff, high plasticity, light gray & tan	4.5						15					
				Sandy Lean Clay (CL), hard, high plasticity, light gray & tan	4.5						15					
10					4.5						15					
				.. with ferrous nodules below 12'	4.5						15					
15				.. stiff below 14'	2.0		112	0.8		0	17					
		CL		.. very stiff below 16'	4.0						16					
					4.0						15					
20																
				.. hard below 23'	4.5						16	46	18	28		
25																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20, 40, 60, 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 25' & Hole Grouted after Drilling. Drilled By: Van & sons, Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-12

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-30-13

SURFACE ELEVATION: 70.89

LOCATION

Alba
Northing: 13863770.54
Easting: 3103780.55

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				3.5" Asphalt												
				6" Cement stabilized shell base												
		CH		Sandy Fat Clay (CH), hard, high plasticity, light gray & tan	4.5						24	63	21	42	69	
					4.5						13					
					4.5						11					
5																
				Sandy Lean Clay (CL), very stiff, high plasticity, light gray & tan	3.0						11					
				.. stiff below 8'	2.0		116	0.85		0	13					
10		CL		.. very stiff below 10'	3.5						16	41	17	24	65	
					4.0						16					

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20, 40, 60, 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-13

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE 9-25-13

SURFACE ELEVATION 71.50

LOCATION

Alba
Northing: 13863084.87
Easting: 3103776.407

MATERIAL DESCRIPTION

Depth (ft.)	USC	Material Description	Pocket Penetrometer (P, tsf)	Blow Count (N, Blows/Foot)	Dry Density (pcf)	Undrained Shear Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Passing #200 Sieve (%)	Estimated Angle of Internal Friction (°), Other Tests & Remarks
0		4" Asphalt												
		5" Cement stabilized shell base												
	CL	Sandy Lean Clay (CL), high plasticity, light gray & tan .. hard, with calcareous nodules below 2'	4.5						20					
									12	47	18	29	53	
			4.5						8					
5		.. very stiff below 6'	4.0						8					
		.. hard, medium plasticity, below 8'	4.5						9	26	15	11		
10	SM	Silty Sand (SM), non plastic, dense, light gray & tan		31					9				22	
	CL	Sandy Lean Clay (CL), very stiff, high plasticity, light gray & tan							10					
15		.. hard below 14'			120	2.25		0	12					

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20, 40, 60, 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-14

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-25-13

SURFACE ELEVATION: 64.33

LOCATION

W. 30th
Northing: 13862159.367
Easting: 3103886.221

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		1" Asphalt											
		5.5" Concrete											
	SM	Silty Sand (SM) , Non plastic, light gray & tan						10	16	13	3	47	
		Sandy Lean Clay (CL), very stiff, medium plasticity, light gray & tan	2.75					19					
		.. with sand seams below 4'	3.25					17					
5	CL	.. stiff below 6'	2.0	111	0.75		0	17					
		.. very stiff below 8'	2.75					15	27	15	12		
10	CH	Fat Clay With Sand (CH), very stiff, high plasticity, light gray & tan (Slickensided)	2.5					26					
		.. stiff, with ferrous nodules below 12'	2.75	108	0.66		9	18					

SAMPLES | WATER LEVEL

BLOW COUNT (N, Blows/Foot): ● N (blows/ft) ● 20 40 60 80; ▲ UU (tsf) ▲ 1.0 2.0 3.0 4.0; ★ DD (pcf) ★ 90 100 110 120; ◆ P (tsf) ◆ 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; 20 40 60 80

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ▨ Disturbed

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

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-15

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-19-13

SURFACE ELEVATION: 66.19

LOCATION

Stonecrest
Northing: 13862456.678
Easting: 3104189.437

MATERIAL DESCRIPTION

2" Asphalt
3" Concrete
Sandy Lean Clay (CL), hard, high plasticity, light gray & tan
.. with ferrous nodules below 2'

DEPTH (ft.)	USC	POCKET PENETROMETER (P, tsf)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)
0		4.5				24				
		4.5				12				
		4.5				13	46	18	28	64
5	CL	4.5				11				
		4.5	113	2.15	0	17				
10										

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20, 40, 60, 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-16

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE 9-25-13

SURFACE ELEVATION 64.65

LOCATION

W. 30th
Northing: 13862182.825
Easting: 3104511.789

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)
0		2" Asphalt										
		5" Concrete										
		Sandy Lean Clay (CL), hard, high plasticity, light gray & tan						22				
		.. very stiff below 2'	3.5					16	45	18	27	56
			3.75					16				
5	CL	.. with sand seams below 6'	2.5					14				
		.. firm, with sand pockets below 8'	0.5					16				
10		.. stiff, medium plasticity below 10'	2.0					18	30	16	14	
		.. very stiff below 12'	3.5	114	1.3		0	16				

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-17

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-19-13

SURFACE ELEVATION: 64.93

LOCATION

Stonecrest
Northing: 13862477.595
Easting: 3104754.581

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				1" Asphalt												
				5" Concrete												
		CH		Sandy Fat Clay (CH), very stiff, high plasticity, light gray & tan	2.5						25	66	21	45	67	
				.. with sand seams below 2'	2.5						22					
5				.. with ferrous nodules below 4'	2.5						20					
					3.0						18					
				Sandy Lean Clay (CL), firm, high plasticity, light gray & tan	1.5						17	39	17	22	53	
10		CL	▽	.. wet sand layer 10'-10.5'	1.5		104	0.4		0	24					
			▼	.. very stiff below 12'	2.75						17					

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: 10.5', After Drilling: 12.5'

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-18

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-25-13

SURFACE ELEVATION: 67.20

LOCATION

W. 31st
Northing: 13862767.228
Easting: 3104945.559

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		2" Asphalt												
		4" Concrete												
		Sandy Lean Clay (CL), very stiff, high plasticity, light gray & tan	2.5						23					
			3.0						15					
		.. with ferrous nodules below 4'	3.5						14	43	18	25	56	
5	CL													
		.. hard below 6'	4.5						14					
		.. stiff below 8'	2.0		113	0.8		0	15					
10														

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-19

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

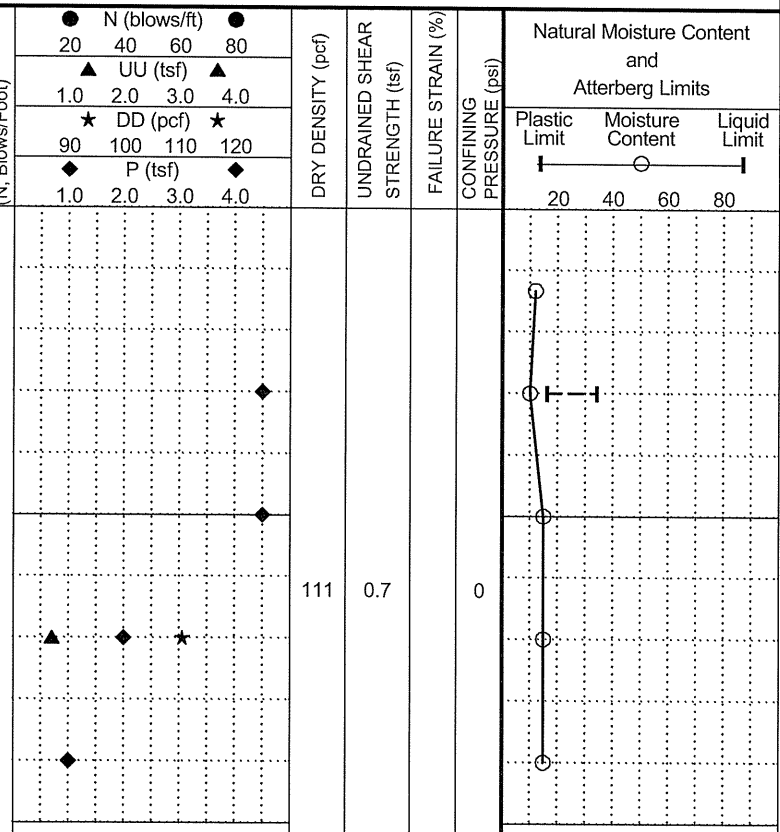
PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-25-13

SURFACE ELEVATION: 65.60

LOCATION
W. 30th
Northing: 13862203.68
Easting: 3105075.59

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				3" Asphalt												
				5" Concrete												
				Sandy Lean Clay (CL), medium plasticity, light gray & tan							12					
				.. hard below 2'	4.5						10	34	16	18	62	
				.. with calcareous nodules below 4'	4.5						15					
5		CL		.. stiff below 6'	2.0		111	0.7		0	15					
				.. firm below 8'	1.0						15					
10																



Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ▨ Shelby Tube ▤ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-20

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-19-13

SURFACE ELEVATION: 64.77

LOCATION

Stonecrest
Northing: 13862495.661
Easting: 3105258.086

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)
0		3" Asphalt									
		4" Concrete									
		Sandy Lean Clay (CL), stiff, high plasticity, light gray & tan	1.5				18				
		.. very stiff below 2'	3.0				15	44	18	26	60
			4.0				14				
5	CL										
		.. with ferrous nodules below 6'	3.5				13				
			3.5	115	1.1	0	17				
10											

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20, 40, 60, 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-21

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-25-13

SURFACE ELEVATION: 66.84

LOCATION

W. 31st
Northing: 13862766.48
Easting: 3105630.02

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION
0		1" Asphalt
		7" Base
	CH	Fat Clay (CH), hard, high plasticity light gray & tan
		.. with ferrous nodules below 4'
5		
		.. very stiff below 8'
10		.. hard below 10'
	SM	Silty Sand (SM) , medium dense, non plastic, light gray & tan
15	CH	Sandy Fat Clay (CH), stiff, high plasticity, light gray & tan
		.. with sand pockets from 16' to 18'
20		

POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
4.5						20					
4.5						15	66	21	45	61	
4.5						11					
4.5						11					
4.0		118	1.65		0	13					
4.5		117	1.91		8	14					
	20					13				28	
1.5						26	51	19	32		
0.5						19					
2.0						17					

Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▽
Water Observations: Initial Water Level: 14.5', After Drilling: 14'. Caved in at 15.5'

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 20' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-22

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 10-2-13

SURFACE ELEVATION: 67.28

LOCATION

W. 31st
Northing: 13862765.703
Easting: 3105713.004

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		3" Asphalt												
		5.5" Concrete												
	SM	Silty Sand (SM), non plastic, light gray & tan							10					
	CH	Sandy Fat Clay (CH), hard, very high plasticity, light gray & tan	4.5						16	69	22	47	66	
5		Sandy Lean Clay (CL), hard, high plasticity, light gray & tan	4.5						12					
		.. very stiff below 6'	3.75						13					
	CL	.. with ferrous nodules below 8'	2.75						15	43	18	25		
10		.. stiff below 10'	2.0		112	0.6		0	16					
		Silty Sand (SM), medium dense, non plastic, light gray & tan		17					14					
		.. wet below 14'		28					19					
15	SM			39					20				15	
	CL	Sandy Lean Clay (CL), very stiff, medium plasticity, light gray & tan			115	1.28		13	16					
20														

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: 14', After Drilling: N/A

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 20' & Hole Grouted after Drilling. Drilled By: Van & Sons, Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-23 (PZ-3)

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

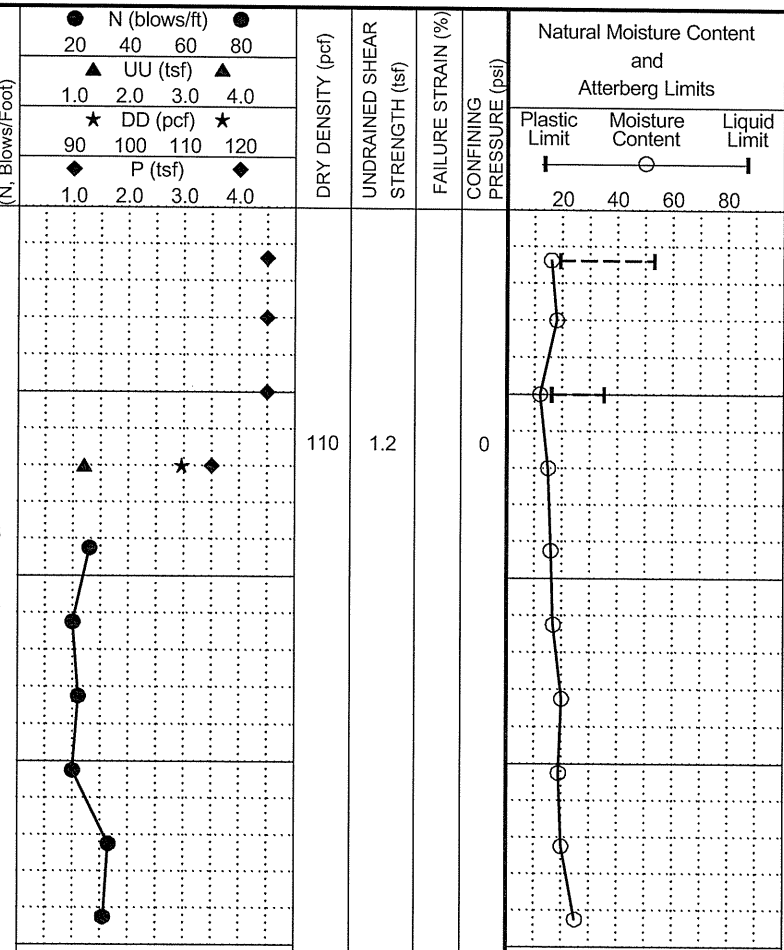
DATE: 10-1-13

SURFACE ELEVATION: 65.56

LOCATION

W. 30th
Northing: 13862282.308
Easting: 3105682.366

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		2" Asphalt												
		7" Concrete												
	CH	Sandy Fat Clay (CH), hard, high plasticity, light gray & tan	4.5						16	53	19	34	59	
			4.5						18					
5		Sandy Lean Clay (CL), hard, medium plasticity, light gray & tan	4.5						12	35	16	19		
	CL	.. very stiff, with sand seams below 6'	3.5		110	1.2		0	15					
		Silty Sand (SM), medium dense, non plastic, light gray & tan with clayey sand seams 8'-10'		26					16					
10				20					17					
		.. wet below 12'		22					20				15	
	SM			20					19					
15		.. dense below 16' (wet)		33					20					
				31					25				17	
20														



Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: 12', After Drilling: N/A

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 12' ; PZ water level: 11' (10-2-2013); PZ water level: 12' (10-8-2013); PZ water level: 12' (10-30-2013); Drilled By: Van & Sons, Logged BY: PV, Checked By: Jitu/pankaj QC/QA By: PST

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

LOG OF BORING B-24

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 10-2-13

SURFACE ELEVATION: 65.70

LOCATION

W. 30th
Northing: 13862297.035
Easting: 3105725.31

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		2.5" Asphalt												
		5.5" Concrete												
	CL	Sandy Lean Clay (CL), stiff, high plasticity, light gray & tan	2.0						16					
		.. hard below 2'	4.5						14	42	18	24	51	
5			4.5						15					
		.. stiff, with sand seams below 6'	2.0						15					
			2.0						16					
10	SM	Silty Sand (SM), medium dense, non plastic, light gray & tan, wet		22					20					
		.. dense below 12'		37					20					
15				32					22				17	
		.. medium dense below 16'		23					20					
	CL	Sandy Lean Clay (CL), hard, high plasticity, light gray & tan	4.5		118	2.25		0	16	48	18	30		
20														
		.. very stiff, with ferrous nodules below 23'	3.5						19					
25														

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20, 40, 60, 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: 18', After Drilling: 14'

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 18' & Hole Grouted after Drilling. Drilled By: Van & Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-25

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-25-13

SURFACE ELEVATION: 67.03

LOCATION

Randall
Northing: 13863490.917
Easting: 3106471.275

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				13" Crushed limestone												
		CH		Fill: Sandy Fat Clay (CH), high plasticity, light gray & tan .. very stiff below 2'	2.5						20	63	21	42	66	
5				Sandy Lean Clay (CL), very stiff, high plasticity, light gray & tan	3.5						16					
				.. with ferrous nodules below 6'	3.75						16					
		CL			3.0						15					
10				.. reddish brown below 10'	4.25		118	1.9		0	16					

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 12' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-26

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE 9-25-13

SURFACE ELEVATION 65.83

LOCATION
Randall
Northing: 13862887.917
Easting: 3106505.292

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				4" Asphalt												
				4" Concrete												
				Sandy Lean Clay (CL), firm, high plasticity, light gray & tan	1.0						28					
				.. stiff, with sand seams below 2'	2.0						16					
				.. very stiff below 4'	3.0						15	38	17	21	56	
5		CL														
				.. with ferrous nodules below 6'	4.0						14					
					3.5		114	1.05		0	15					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▽
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-27

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-25-13

SURFACE ELEVATION: 65.17

LOCATION

W. 30th
Northing: 13862327.509
Easting: 3106468.706

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				3" Asphalt												
				4" Concrete												
		SM		Silty Sand (SM), non plastic, light gray & tan							13					
				Sandy Lean Clay (CL), stiff, medium plasticity, light gray & tan	1.5						17	33	16	17	54	
				.. with sand pockets below 4'	1.5						21					
5		CL		.. very stiff below 6'	2.5						14					
					3.5		121	1.25		0	14					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Water Level Intial: After Drilling: 24 Hrs:
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-28

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-25-13

SURFACE ELEVATION: 63.53

LOCATION

W. 30th
Northing: 13862358.623
Easting: 3107146.053

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	N (blows/ft) 20 40 60 80 / UU (tsf) 1.0 2.0 3.0 4.0 / DD (pcf) 90 100 110 120 / P (tsf) 1.0 2.0 3.0 4.0	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				3" Asphalt														
				5" Cement stabilized shell														
				Sandy Lean Clay (CL), stiff, medium plasticity, light gray & tan	2.0								14					
				.. hard below 2'	4.5								10	35	16	19	68	
				.. with ferrous nodules below 4'	4.5								11					
5																		
		CL		.. very stiff below 6'	3.5								17					
				.. stiff below 8'	2.0			109	0.75		0		17					
10					2.0								15	27	15	12		
					1.5								16					

Water Level Intial: After Drilling: 24 Hrs:
Water Observations: Initial Water Level: 10', After Drilling: 11'

Sample Key: SPT Shelby Tube Disturbed

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

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-29

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-24-13

SURFACE ELEVATION: 65.54

LOCATION

W. 34th
Northing: 13863636.419
Easting: 3107113.474

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		SM		Silty Sand (SM) , non plastic, light gray & tan							12				41	
		CL		Sandy Lean Clay (CL), very stiff, high plasticity, light gray & tan	2.75						10	46	18	28	56	
				.. hard below 4'	4.5						10					
5				.. with ferrous nodules below 6'	4.5						14					
				.. very stiff below 8'	3.5		115	1.1		0	13					
10					3.0						15					

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed

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

Notes:
Augered dry to 12' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-30

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-24-13

SURFACE ELEVATION: 63.88

LOCATION

Lawrence
Northing: 13863201.661
Easting: 3107367.906

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				4" Asphalt												
				5" Shell base												
				Sandy Lean Clay (CL), medium plasticity, light gray & tan	0.5						8					
				.. firm, with clayey sand seams to 2'	1.5						5	25	15	10	63	
				.. stiff below 2'												
				.. hard below 4'	4.5						9					
5		CL														
					4.5						11					
					4.5		115	2.25		0	13					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ▨ Shelby Tube ▤ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-31

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-24-13

SURFACE ELEVATION: 63.75

LOCATION

Lawrence
Northing: 13862748.516
Easting: 3107394.191

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		2" Asphalt												
		5" Concrete												
	SM	Silty Sand (SM) , non plastic, light gray & tan							9					
		Sandy Lean Clay (CL), hard, high plasticity, light gray & tan	4.5						9					
			4.5						12	37	17	20	66	
5	CL	.. very stiff, with ferrous nodules below 6'	3.5						19					
		.. stiff below 8'	2.0		109	0.75		0	18					
10														

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-32

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE 9-25-13

SURFACE ELEVATION 63.05

LOCATION

W. 30th
Northing: 13862369.741
Easting: 3107726.967

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		3" Asphalt												
		4.5" Shell base												
	SM	Silty Sand (SM), non plastic, dark gray							10					
		Sandy Lean Clay (CL), hard, high plasticity, light gray & tan	4.5						10	38	17	21	67	
5			4.5						9					
			4.5						9					
		.. with ferrous nodules below 8'	4.5		113	3.19		6	16					
10	CL	.. stiff below 10'	2.0		119	0.55		0	14					
		.. very stiff, with sand seams below 12'	2.5						16	39	17	22	63	
15			3.0						16					
			3.25						15					

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▽
Water Observations: Initial Water Level: 14', After Drilling: 16.5'

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed

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

Notes:
Augered dry to 17' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-33

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-17-13

SURFACE ELEVATION: 64.25

LOCATION

W. 34th
Northing: 13863862.58
Easting: 3107673.87

MATERIAL DESCRIPTION

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				2" Asphalt												
				4" Concrete												
				Sandy Lean Clay (CL), firm, high plasticity, light gray & tan	1.0						17	41	17	24	54	
				.. very stiff, with sand seams below 2'	4.0						18					
				.. with ferrous nodules below 4'	3.5		112	1.3		0	16					
5		CL			3.0						17	42	18	24		
					3.5						21					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20, 40, 60, 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-34

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-24-13

SURFACE ELEVATION: 63.34

LOCATION

W. 32nd
Northing: 13863130.33
Easting: 3108054.16

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		1.5" Asphalt												
		5" Concrete												
		Sandy Lean Clay (CL), very stiff, slight plasticity, light gray & tan	3.0						13	24	15	9	61	
		.. hard below 2'	4.5						13					
		.. with ferrous nodules below 4'	4.5						13					
5	CL													
			4.5						15					
		.. very stiff below 8'	3.5		110	1.05		0	18					
10														

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-35

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-24-13

SURFACE ELEVATION: 62.83

LOCATION

W. 30th
Northing: 13862354.939
Easting: 3108344.547

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		2" Asphalt												
		5" Concrete												
	CL	Sandy Lean Clay (CL), firm, high plasticity, light gray & tan	1.0						16					
		.. very stiff, with ferrous nodules below 2'	3.5						21					
			2.5						16	43	18	25	70	
5														
			3.5						18					
		.. stiff below 10'	2.0		110	0.85		0	18					
10														

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20, 40, 60, 80)

N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-36

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-24-13

SURFACE ELEVATION: 63.65

LOCATION

W. 34th
Northing: 13863993.68
Easting: 3108167.45

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				2" Asphalt												
				5" Concrete												
				Sandy Lean Clay (CL), stiff, slight plasticity, light gray & tan	2.0						14					
				.. very stiff, with ferrous nodules below 2'	2.5						14	24	15	9	68	
				.. with sand seams below 4'	2.5						14					
5		CL														
					3.5						18					
				.. stiff below 8'	2.0		107	0.8		0	19					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-37

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-24-13

SURFACE ELEVATION: 63.20

LOCATION

W. 32nd
Northing: 13863208.48
Easting: 3108619.81

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				1.5" Asphalt												
				4" Concrete												
				Sandy Lean Clay (CL), stiff, slight plasticity, light gray & tan	3.0						11	24	15	9	62	
				.. hard below 2'	4.5						17					
					4.5						18					
5		CL														
				.. very stiff below 6'	4.0		108	1.85		0	19					
				.. hard, with ferrous nodules below 8'	4.5						17					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▽
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-38

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 10-1-13

SURFACE ELEVATION: 63.03

LOCATION

W. 34th
Northing: 13864025.41
Easting: 3108682.514

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)
0		1" Asphalt									
		6" Concrete									
	CL	Sandy Lean Clay (CL), very stiff, medium plasticity, light gray & tan	3.0				16				
		.. firm, with sand seams below 2'	1.0				23	35	16	19	68
5		.. very stiff below 4'	3.75				16				
		.. stiff below 6'	2.0				17				
		.. with ferrous nodules below 8'	1.5				23				
10			2.0	108	0.65	0	21				
			1.0				22				
15		.. stiff below 14'	1.75				18	31	16	15	70
		.. very stiff below 16'	3.75	117	1.8	11	16				
20		.. hard below 18'	4.5				17				

SAMPLES | WATER LEVEL | BLOW COUNT (N, Blows/Foot) | FAILURE STRAIN (%) | ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▽
Water Observations: Initial Water Level: 18', After Drilling: 13.5'

Sample Key: ☒ SPT ⧄ Shelby Tube ▤ Disturbed

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

Notes:
Augered dry to 20' & Hole Grouted after Drilling. Drilled By: Van & Sons, Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-39

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 10-1-13

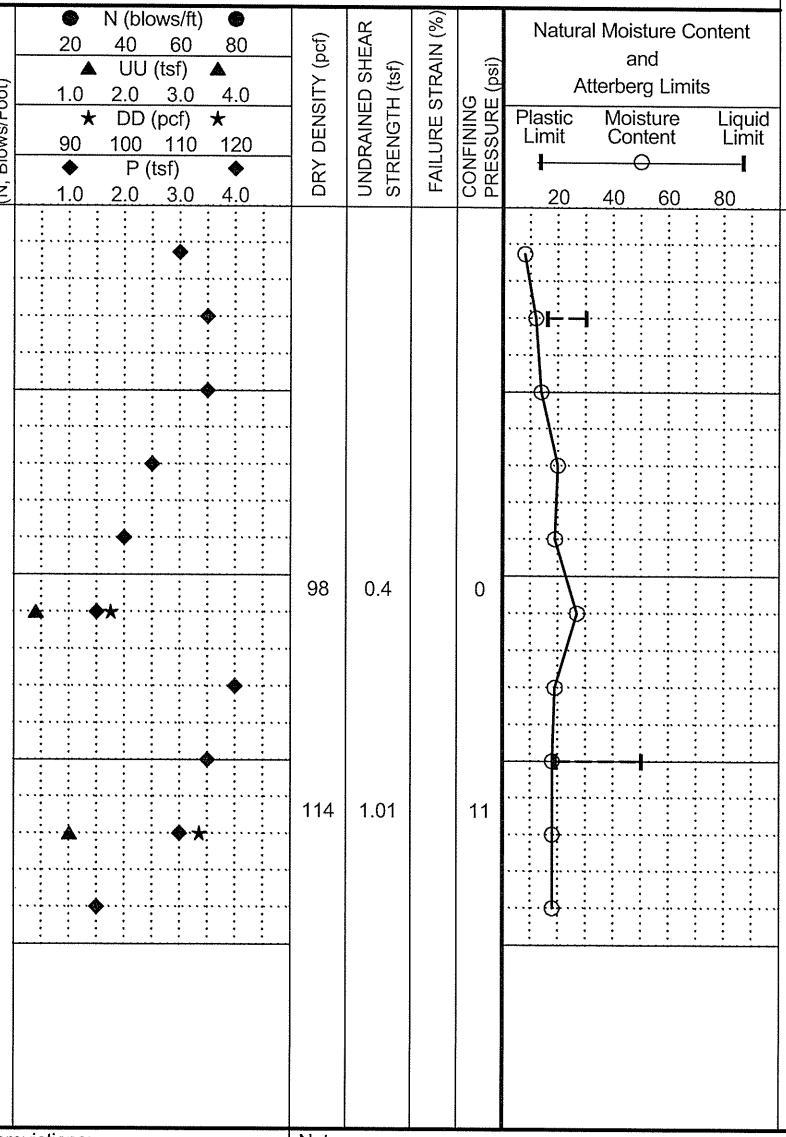
SURFACE ELEVATION: 63.52

LOCATION

Ashland
Northing: 13863503.561
Easting: 3108880.039

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		2.5" Asphalt											
		4" Concrete											
		Sandy Lean Clay (CL), very stiff, medium plasticity, light gray & tan	3.0					8					
		.. with calcareous nodules below 2'	3.5					12	30	16	14	65	
		.. with ferrous nodules below 4'	3.5					14					
5	CL		2.5					20					
		.. stiff below 8'	2.0					19					
10		.. firm below 10'	1.5	98	0.4		0	27					
		.. very stiff below 12'	4.0					19					
15		Fat Clay (CH), very stiff, high plasticity, light gray & tan	3.5					18	50	19	31	87	
	CH	.. with ferrous nodules below 16'	3.0	114	1.01		11	18					
20		.. stiff below 18'	1.5					18					



Water Level Intial: After Drilling: 24 Hrs:
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

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

Notes:
Augered dry to 20' & Hole Grouted after Drilling. Drilled By: Van & Sons, Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-40

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 10-1-13

SURFACE ELEVATION: 63.35

LOCATION

Ashland
Northing: 13862911.635
Easting: 3108937.95

MATERIAL DESCRIPTION

Depth (ft.)	USC	Material Description	Pocket Penetrometer (P, tsf)	Dry Density (pcf)	Undrained Shear Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Passing #200 Sieve (%)
0		3" Asphalt										
		4" Concrete										
		Lean Clay With Sand (CL), hard, high plasticity, light gray & tan	4.5					14				
		.. very stiff below 2'	3.75					15				
5		.. with calcareous nodules below 4'	3.75					15	43	18	25	77
		.. with ferrous nodules below 6'	2.5					16				
		.. stiff below 8'	2.0					19				
10	CL	.. very stiff below 10'	3.5					19				
			2.75					18	37	17	20	
15		.. stiff below 14'	1.5	112	0.91		10	19				
		.. very stiff below 16'	3.25					20				
20			4.0	109	1.7		0	20				

Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▽
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed

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

Notes:
Augered dry to 20' & Hole Grouted after Drilling. Drilled By: Van & Sons, Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-41 (PZ-4)

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE 10-1-13

SURFACE ELEVATION 62.40

LOCATION

W. 30th
Northing: 13862396.66
Easting: 3109110.7

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION
0		2" Asphalt
		5.5" Cement stabilized shell base
	CL	Lean Clay With sand (CL), stiff, high plasticity, light gray & tan
		.. very stiff, with ferrous nodules below 4'
5		.. with calcareous nodules below 6'
10		
15		
		.. tan & light gray below 18'
20		

POCKET PENETROMETER(P,tsf	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
1.5						20					
1.5						21					
3.5						16	45	18	27	74	
3.0						19					
3.0						19					
3.5						19					
4.0						17	49	19	30	80	
3.75		112	1.47		10	18					
3.0						23					
3.5		109	1.45		0	19					

Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▽
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 20' ; PZ water level: 11.5' (10-2-2013); PZ water level: 12' (10-8-2013); PZ water level: 11' (10-30-2013); Drilled By: Van & Sons, Logged BY: PV, Checked By: Jitu/pankaj QC/QA By: PST

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

LOG OF BORING B-42

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-24-13

SURFACE ELEVATION: 63.10

LOCATION

W. 34th
Northing: 13864024.39
Easting: 3109118.86

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				1.5" Asphalt												
				5" Concrete												
				Sandy Lean Clay (CL), firm, slight plasticity, light gray & tan	1.0						15	24	15	9	62	
				.. stiff below 2'	1.75						18					
				.. with sand seams below 4'	1.5						18					
5		CL														
				.. hard, with ferrous nodules below 6'	4.5						14					
				.. very stiff below 8'	3.5		113	1.2		0	16					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-43

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-23-13

SURFACE ELEVATION: 63.34

LOCATION
W. 32nd
Northing: 13863233.083
Easting: 3109144.121

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				1.5" Asphalt												
				5" Concrete												
				Fat Clay With Sand (CH), firm, high plasticity, light gray & tan	1.0						16					
				.. hard below 2'	4.5						15	53	19	34	80	
				.. with ferrous nodules below 4'	4.5						16					
5		CH			4.5		103	2.2		0	30					
				.. with calcareous nodules below 8'	4.5						18					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-44

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-24-13

SURFACE ELEVATION: 62.70

LOCATION

W. 33rd
Northing: 13863619.81
Easting: 3109345.3

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				2" Asphalt												
				3" Concrete												
				Sandy Lean Clay (CL), stiff, high plasticity, light gray & tan	2.0						15					
				.. with sand seams below 2'	1.5						19	39	17	22	70	
				.. very stiff below 4'	2.5						16					
5		CL														
					4.0						15					
				.. with ferrous nodules below 8'	4.0		116	1.65		0	14					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-45

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-23-13

SURFACE ELEVATION: 62.79

LOCATION

W. 32nd
Northing: 13863239.135
Easting: 3109703.107

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P,tsf)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		1.5" Asphalt											
		5" Concrete											
	CL	Sandy Lean Clay (CL), very stiff, slight plasticity, light gray & tan	3.0					12	24	15	9	65	
		.. with ferrous nodules below 2'	3.0					13					
		.. with calcareous nodules below 4'	4.0					13					
5			3.5	118	1.3		0	13					
			2.75					10					
10													

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-46

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-24-13

SURFACE ELEVATION: 62.66

LOCATION

W. 30th
Northing: 13862422.863
Easting: 3109625.829

MATERIAL DESCRIPTION

Depth (ft.)	Samples	USC	Water Level	Material Description	Pocket Penetrometer (P, tsf)	Blow Count (N, Blows/Foot)	Dry Density (pcf)	Undrained Shear Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Passing #200 Sieve (%)	Estimated Angle of Internal Friction (°), Other Tests & Remarks
0				5" Asphalt												
				5" Cement stabilized shell base												
				Lean Clay With Sand (CL), very stiff, high plasticity, light gray & tan	2.5						15					
					2.75						17	38	17	21	75	
				.. with sand seams below 4'	3.5						17					
5		CL		.. hard,with ferrous nodules below 6'	4.5		118	2.0		0	15					
				.. very stiff below 8'	3.0						18					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-47

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE 9-17-13

SURFACE ELEVATION 62.38

LOCATION

W. 34th
Northing: 13864040.205
Easting: 3109706.359

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				2" Asphalt												
				4" Concrete												
				Sandy Lean Clay (CL), very stiff, medium plasticity, light gray & tan	3.5						14					
				.. with ferrous nodules below 2'	3.5						14	28	15	13	62	
				.. with calcareous nodules below 4'	4.0						15					
5		CL		.. stiff, with sand seams below 6'	2.0		108	0.6		0	20	45	18	27		
					2.0						19					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▽
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-48

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-24-13

SURFACE ELEVATION: 61.35

LOCATION

W. 33rd
Northing: 13863647.992
Easting: 3110143.82

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				1.5" Asphalt												
				5" Concrete												
				Lean Clay With Sand (CL), very stiff, high plasticity, light gray & tan	2.5						19					
					2.75						22	45	18	27	74	
				.. with sand seams below 4'	3.0						17					
5		CL														
				.. with ferrous nodules below 6'	4.0						16					
					4.0		113	1.65		0	17					
10																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▽
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 10' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-49

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-17-13

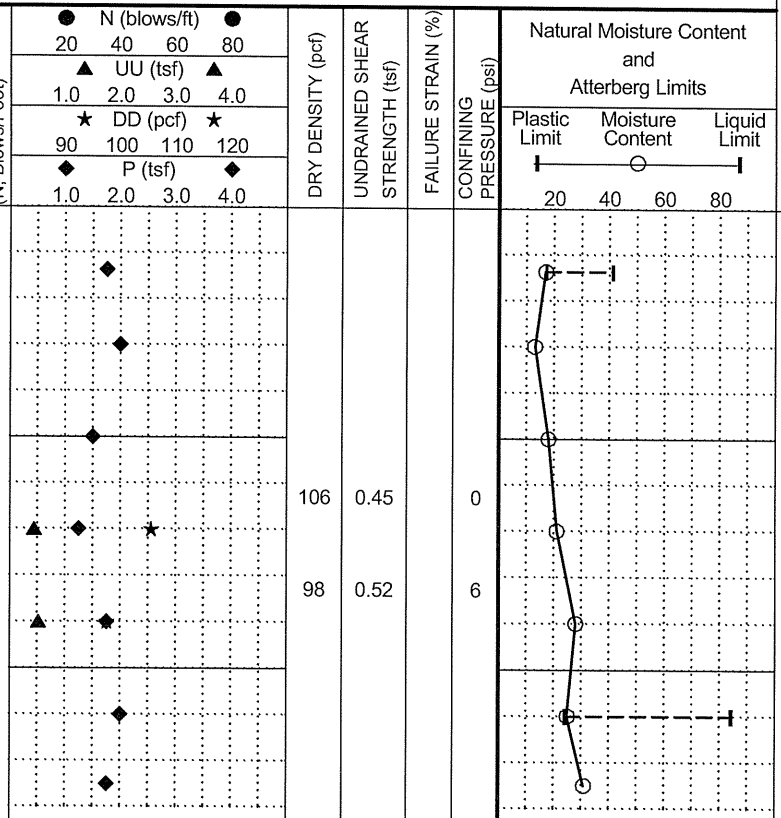
SURFACE ELEVATION: 61.39

LOCATION

W. 34th
Northing: 13864073.179
Easting: 3110232.91

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)
0		4" Asphalt									
		5" Concrete									
	CL	Sandy Lean Clay (CL), stiff, high plasticity, light gray & tan	1.75				17	41	17	24	68
		.. with calcareous nodules below 2'	2.0				13				
5		.. with ferrous nodules below 4'	1.5				18				
		..firm, with sand seams below 6'	1.25	106	0.45	0	21				
	CH	Fat Clay (CH), stiff, high plasticity, light gray & tan	1.75	98	0.52	6	28				
10		.. reddish brown, with calcareous nodules below 10'	2.0				25	84	24	60	97
		.. with ferrous nodules below 12'	1.75				31				

SAMPLES | WATER LEVEL | BLOW COUNT (N, Blows/Foot) | FAILURE STRAIN (%) | ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS



Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed

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

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-50

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-23-13

SURFACE ELEVATION: 61.70

LOCATION

W. 32nd
Northing: 13863238.62
Easting: 3110264.43

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				2" Asphalt												
				5" Concrete												
		CL		Lean Clay With Sand (CL), firm, medium high plasticity, light gray & tan .. stiff below 2'	1.0						17					
					2.0						17	29	15	14	74	
				.. very stiff below 4'	3.25						17					
5				.. with ferrous nodules below 6'	2.75						16					
				.. stiff below 8'	2.0						20	49	19	30	83	
10				.. very stiff below 10'	3.5		114	1.15		0	17					
				.. stiff below 12'	2.0						19					

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed

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

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

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

LOG OF BORING B-51

PROJECT: Water Line Replacement in Shepherd Forest II Area
WBS No.: S-000035-0192-4

PROJECT NO.: G13-196 BORING TYPE: Auger

DATE: 9-24-13

SURFACE ELEVATION: 61.88

LOCATION

W. 30th
Northing: 13862429.747
Easting: 3110293.626

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				Sandy Lean Clay (CL), hard, medium plasticity, light gray & tan	4.5						14	30	16	14	70	
				.. with calcareous nodules below 2'	4.5						15					
				.. very stiff, with ferrous nodules below 4'	3.0						12					
5		CL		.. stiff below 6'	1.5						19					
				..firm, with sand seams below 8'	1.0						21	44	18	26	70	
10				.. stiff below 10'	2.5		104	0.95		0	18					
				.. very stiff below 12'	3.0		115	1.24		9	16					

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

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

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

KEY TO LOG TERMS AND SYMBOLS

SOIL TYPE

ROCK | GRAVEL | SAND | SILT | CLAY | PEAT

SAMPLER TYPE

NO SAMPLE | AUGER SAMPLE | SHELBY TUBE | SPLIT SPOON

MODIFIER

STONE | GRAVELY | SANDY | SILTY | CLAYEY | FILL

NO RECOVERY | ROCK CORE | 2" SHELBY TUBE | TXDOT CONE

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
			GP	POORLY GRADED GRAVELS,GRAVEL SAND MIXTURES WITH LITTLE OR NO FINES
		W/ APPRECIATEBLE FINES	GM	SILTY GRAVELS,GRAVEL SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS,GRAVEL SAND-CLAY MIXTURES
	SANDS MORE THAN 50% PASSING No.4 SIEVE	CLEAN SANDS LITTLE FINES	SW	WELL GRADED SAND,GRAVELY SAND (LITTLE FINES)
			SP	POORLY GRADED SANDS,GRAVELY SAND(L. FINES)
		SANDS WITH APPREA. FINES	SM	SILTY SANDS,SAND-SILT MIXTURES
			SC	CLAYEY SANDS,SAND-CLAY MIXTURES
FINE GRAINED SOILS LESS THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		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
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PI
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		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