AVILES
ENGINEERING CORP.

GEOTECHNICAL INVESTIGATION

CITY OF HOUSTON
SOUTHPARK AND SOUTHCREST AREA
DRAINAGE AND PAVING IMPROVEMENTS
COH WBS NO. M-000277-0001-3
HOUSTON, TEXAS

Reported To:
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by

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EXECUTIVE SUMMARY

The report submitted herein presents the results of Aviles Engineering Corporation's (AEC) geotechnical investigation for the City of Houston's (COH) proposed drainage and paving improvements for the Southpark and Southcrest areas, in Houston, Texas (Houston Key Map 534P and T). Based on information provided by IDS Engineering Group (IDS), the proposed improvements include installation of storm sewers, sanitary sewers, and waterlines, as well as reconstruction of residential streets. The invert depths of the underground utilities range from 4.5 to 13 feet below grade and will be installed primarily by open cut method. Plan and profile drawings of the proposed underground utilities were not available at the time this report was prepared.

1. Subsurface Soil Conditions: A generalized subsurface profile along the underground utility alignments is presented on Plates B-1 through B-13, in Appendix B.

   Southcrest Area: Based on Borings B-1 through B-9, the subsurface conditions in the Southcrest area generally consists of firm to hard lean/fat clay (CL/CH) from the ground surface to the boring termination depths of 15 to 20 feet below existing grade. Approximately 6 feet of stiff to very stiff fat clay (CH) fill was encountered at the ground surface in Borings B-1 and B-2. Approximately 2 feet of silt (ML) was encountered at a depth of 18 feet in Boring B-4 and approximately 4 feet of medium dense poorly graded sand/clayey sand (SP-SM/SC) was encountered at a depth of 12 feet in Boring B-9.

   Southpark Area: Based on Borings B-10 through B-26, the subsurface conditions in the Southpark area generally consists of firm to hard lean/fat clay (CL/CH) from the ground surface to the boring termination depths of 5 to 30 feet below existing grade. Approximately 2 feet of stabilized clay fill was encountered at the ground surface of Borings B-20 through B-23, B-25, and B-26. Approximately 2 feet of medium dense poorly graded sand with silt (SP-SM) was encountered at a depth of 14 feet in Boring B-11 and approximately 10 feet of medium dense poorly graded sand/clayey sand (SP-SM/SC) was encountered at a depth of 10 feet in Boring B-12.

2. Subsurface Soil Properties: The subsurface clayey soils have moderate to very high plasticity, with liquid limits (LL) ranging from 32 to 92, and plasticity indices (PI) ranging from 15 to 68. High plasticity clays can undergo significant volume changes due to seasonal changes in moisture contents. The cohesive soils encountered are classified as "CL" and "CH" type soils and granular soils were classified as "SC", "SP-SM", and "ML" in accordance with ASTM D 2487.

3. Groundwater Conditions: Groundwater was encountered at a depth of 12 to 19 feet below grade during drilling in Borings B-4, B-9, and B-12. Ground water was not encountered in the remaining borings during drilling. After completion of drilling, Borings B-4, B-8, B-14, and B-24 were converted to piezometers.

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EXECUTIVE SUMMARY (cont.)

4. Geologic Hazards: AEC's staff geologist performed a preliminary fault investigation that included a review of available literature, aerial photographs, public maps and limited field observations. According to the published map "Principal Surface Faults of the Houston Central Metropolitan Area (after O'Neill and Van Siclen, with addition by C. Norman, 2004)", there do not appear to be any mapped surface faults at the Southpark/Southcrest Drainage Improvement area (project area).

   Limited field observations were made at the project site and surrounding area by AEC's Senior Geologist for evidence of faulting. Most of the pavement damage in the project area does not appear to be related to faulting, however, two features observed on Southbank Street may be related to faulting. One feature is a linear break in the road on Southbank Street just north of its intersection with Southgood Street. A second linear rupture which may be related to faulting was observed crossing Southbank Street between Southville Street and Southlark Street. Whether these two rupture features crossing Southbank are due to faulting or some other process is difficult to determine given the general condition of the road and lack of continuation of the ruptures much beyond the road pavement. If the features are due to faulting, it appears based on the observations that they are fairly limited in extent.

   No evidences of faulting were observed throughout the remaining portion of the project area and surrounding area.

5. Hazardous Materials: No signs of visual staining or odors were encountered during field drilling or during processing of the soil samples in the laboratory.

6. Design parameters and recommendations for installation of underground utilities by open cut method are presented in Sections 5.1 and 5.2 of this report.

7. Design parameters and recommendations for concrete pavement reconstruction are presented in Section 5.3 of this report.

This Executive Summary is intended as a summary of the investigation and should not be used without the full text of this report.

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GEOTECHNICAL INVESTIGATION

CITY OF HOUSTON
SOUTHPARK AND SOUTHCREST AREA
DRAINAGE AND PAVING IMPROVEMENTS
COH WBS NO. M-000277-0001-3
HOUSTON, TEXAS

1.0 INTRODUCTION

1.1 General

The report submitted herein presents the results of Aviles Engineering Corporation's (AEC) geotechnical investigation for the City of Houston's (COH) proposed drainage and paving improvements for the Southpark and Southcrest areas, in Houston, Texas (Houston Key Map 534P and T). A vicinity map is presented on Plate A-1, in Appendix A. Based on information provided by IDS Engineering Group (IDS), the proposed improvements include installation of storm sewers, sanitary sewers, and waterlines, as well as reconstruction of residential streets. The invert depths of the underground utilities range from 4.5 to 13 feet below grade and will be installed primarily by open cut method. Plan and profile drawings of the proposed underground utilities were not available at the time this report was prepared.

1.2 Authorization

The geotechnical investigation was authorized on May 14, 2012 by IDS Engineering Group, Inc. (formerly Pate Engineers) via Professional Services Agreement, based on AEC's proposal G2011-03-05R2, dated March 23, 2012.

1.3 Purpose and Scope

The purpose of this geotechnical investigation is to evaluate the subsurface soil conditions along the alignment and develop geotechnical engineering recommendations for design and construction of underground utilities by open cut method, as well as concrete pavement residential street reconstruction. The scope of this geotechnical investigation is summarized below:

1. Drilling and sampling 26 geotechnical borings, ranging from 5 to 30 feet below existing grade;
2. Soil laboratory testing on selected soil samples;
3. Engineering analyses and recommendations for the installation of underground utilities by open cut method, including loadings on pipes, bedding, lateral earth pressure parameters, trench stability, and backfill requirements;
4. Engineering analyses and recommendations for the design of rigid pavement, including pavement thickness and subgrade preparation;
5. Construction recommendations for installation of underground utilities by open cut methods, as well as rigid pavements.

2.0 SUBSURFACE EXPLORATION

2.1 Soil Borings

The subsurface exploration consisted of drilling and sampling a total of 26 soil borings ranging from 5 to 30 feet below existing grade. The boring locations are shown on the Boring Location Plan on Plates A-2a and A-2b, in Appendix A. The total drilling footage is 420 feet. Boring survey data was provided by IDS and is presented on the boring logs. Plan and profile drawings of the underground utilities were not available at the time this report was prepared. The boring designations and depths and proposed underground utility invert depths are presented in Table 1 below. AEC notes that the invert depths provided by IDS are approximate and may be subject to change once plan and profile drawings are available.

Table 1. Boring Number and Depth

Boring No.	Street	Boring Depth (ft)	Proposed Invert Depth(1) near Boring (ft)	Piezometer Depth (ft)
B-1	Southcrest	15	5.1	--
B-2	Southcrest	15	7.1	--
B-3	Southcrest	20	9.0	--
B-4 (PZ-1)	Southridge	20	8.5	20
B-5	Southridge	20	8.5	--
B-6	Southridge	15	6.4	--
B-7	Southridge	15	6.4	--
B-8 (PZ-2)	Crestville	15	6.9	15
B-9	Southlea	16	6.6	--
B-10	Cresthill	10	5.7	--

Boring No.	Street	Boring Depth (ft)	Proposed Invert Depth(1) near Boring (ft)	Piezometer Depth (ft)
B-11	Southmund	16	7.5	--
B-12	Southmund	20	9.3	--
B-13	Southmund	25	11.2	--
B-14 (PZ-3)	Cherbourg	30	13	25
B-15	Southville	25	10.4	--
B-16	Southville	20	8.8	--
B-17	Southbank	15	8.5	--
B-18	Southville	15	7.2	--
B-19	Southville	10	5.6	--
B-20	Southington	15	8.4	--
B-21	Southington	15	5.9	--
B-22	Southgood	5	--	--
B-23	Southgood	15	7.4	--
B-24(PZ-4)	Southbank	15	8.4	15
B-25	Southford	15	7.2	--
B-26	Southford	5	--	--

Note: (1) Plan and profile drawings are not available, the proposed invert depths provided are approximate.

Existing concrete pavement at Borings B-9 through B-26 was first cut with a core barrel prior to field drilling. The field drilling was performed with a truck-mounted drilling rig primarily using dry auger method, and then using wet rotary method once water-bearing granular soils were encountered or the borings began to cave in. Undisturbed samples of cohesive soils were obtained from the borings by pushing 3-inch diameter thin-wall, seamless steel Shelby tube samplers in general accordance with ASTM D 1587. Granular soils were sampled with a 2-inch split-barrel sampler in accordance with ASTM D 1586. Standard Penetration Test resistance (N) values were recorded for the granular soils as "Blows per Foot" and are shown on the boring logs. Strength of the cohesive soils was estimated in the field using a hand penetrometer. The undisturbed samples of cohesive soils were extruded mechanically from the core barrels in the field and wrapped in aluminum foil; all samples were sealed in plastic bags to reduce moisture loss and disturbance. The samples were then placed in core boxes and transported to the AEC laboratory for testing and further study. Bore holes were grouted with cement-bentonite upon completion of drilling

except for Borings B-1, B-8, B-14, and B-24 which were converted to piezometers. Existing pavement was patched with non-shrink grout.

3.0 LABORATORY TESTING PROGRAM

Soil laboratory testing was performed by AEC personnel. Samples from the borings were examined and classified in the laboratory by a technician under the supervision of a geotechnical engineer. Laboratory tests were performed on selected soil samples in order to evaluate the engineering properties of the foundation soils in accordance with applicable ASTM Standards. Atterberg limits, moisture contents, percent passing a No. 200 sieve, and dry unit weight tests were performed on typical samples to establish the index properties and confirm field classification of the subsurface soils. Strength properties of cohesive soils were determined by means of unconfined compression (UC) and undrained-unconsolidated (UU) triaxial tests performed on undisturbed samples. The test results are presented on the boring logs. Details of the soils encountered in the borings are presented on Plates A-3 through A-28, in Appendix A. A key to the boring logs, classification of soils for engineering purposes, terms used on boring logs, and reference ASTM Standards for laboratory testing are presented on Plates A-29 through A-32, in Appendix A.

4.0 SITE CONDITIONS

Based on our site visit, the Southpark and Southcrest areas are residential neighborhoods; the roads of the Southcrest area are primarily asphalt and the roads of the Southpark area are primarily concrete (with asphalt overlay on some streets). In general, existing pavement is in poor condition, except for some roadways (along Southington, Southgood, and Southford Street) that have recently been repaved. A summary of existing pavement sections encountered in our borings is presented in Table 2 below.

Table 2. Existing Pavement Encountered at Pavement Borings

Boring No.	Street	Pavement Section
B-1	Southcrest	7” asphalt, 17” shell, sand, and gravel base
B-2	Southcrest	7” asphalt, 17” stabilized shell, sand, and gravel base
B-3	Southcrest	8” asphalt, 16” stabilized shell, sand, and gravel base
B-4	Southridge	9” asphalt, 14” stabilized shell, sand, and gravel base
B-5	Southridge	8” asphalt, 14” stabilized shell, sand, and gravel base

Boring No.	Street	Pavement Section
B-6	Southridge	9” asphalt, 15” stabilized shell, sand, and gravel base
B-7	Southridge	9” asphalt, 15” stabilized shell, sand, and gravel base
B-8	Crestville	7” asphalt, 17” stabilized shell, sand, and gravel base
B-9	Southlea	6.25” concrete
B-10	Cresthill	2” asphalt, 5.5” concrete
B-11	Southmund	1.5” asphalt, 5.5” concrete
B-12	Southmund	2” asphalt, 5.25” concrete
B-13	Southmund	2” asphalt, 5.25” concrete
B-14	Cherbourg	2” asphalt, 4.5” concrete
B-15	Southville	1.25” asphalt, 5” concrete
B-16	Southville	2.25” asphalt, 8” concrete
B-17	Southbank	2” asphalt, 6” concrete
B-18	Southville	2” asphalt, 7” concrete
B-19	Southville	2.5” asphalt, 4” concrete
B-20	Southington	8.75” concrete
B-21	Southington	9” concrete
B-22	Southgood	6.75” concrete
B-23	Southgood	6.5” concrete
B-24	Southbank	0.5” asphalt, 5.75” concrete
B-25	Southford	6.5” concrete
B-26	Southford	6.5” concrete

4.1 Subsurface Conditions

A generalized subsurface profile along the utility alignments is presented on Plates B-1 through B-13, in Appendix B. Pipe inverts are not included on the soil profiles since profile drawings of the proposed underground utilities were not available at the time this report was prepared.

Southcrest Area: Based on Borings B-1 through B-9, the subsurface conditions in the Southcrest area generally consists of firm to hard lean/fat clay (CL/CH) from the ground surface to the boring termination depths of 15 to 20 feet below existing grade. Approximately 6 feet of stiff to very stiff fat clay (CH) fill was encountered at the ground surface in Borings B-1 and B-2. Approximately 2 feet of silt (ML) was

encountered at a depth of 18 feet in Boring B-4 and approximately 4 feet of medium dense poorly graded sand/clayey sand (SP-SM/SC) was encountered at a depth of 12 feet in Boring B-9.

Southpark Area: Based on Borings B-10 through B-26, the subsurface conditions in the Southpark area generally consists of firm to hard lean/fat clay (CL/CH) from the ground surface to the boring termination depths of 5 to 30 feet below existing grade. Approximately 2 feet of stabilized clay fill was encountered at the ground surface of Borings B-20 through B-23, B-25, and B-26. Approximately 2 feet of medium dense poorly graded sand with silt (SP-SM) was encountered at a depth of 14 feet in Boring B-11 and approximately 10 feet of medium dense poorly graded sand/clayey sand (SP-SM/SC) was encountered at a depth of 10 feet in Boring B-12.

Subsurface Soil Properties: The subsurface clayey soils have moderate to very high plasticity, with liquid limits (LL) ranging from 32 to 92, and plasticity indices (PI) ranging from 15 to 68. High plasticity clays can undergo significant volume changes due to seasonal changes in moisture contents. The cohesive soils encountered are classified as "CL" and "CH" type soils and granular soils were classified as "SC", "SP-SM", and "ML" in accordance with ASTM D 2487. "CH" soils undergo significant volume changes due to seasonal changes in soil moisture contents. "CL" type soils with lower LL (less than 40) and PI (less than 20) generally do not undergo significant volume changes with changes in moisture content. However, "CL" soils with LL approaching 50 and PI greater than 20 essentially behave as "CH" soils and could undergo significant volume changes. Slickensides were encountered in the fat clays.

Groundwater Conditions: Groundwater was encountered at a depth of 12 to 19 feet below grade during drilling in Borings B-4, B-9, and B-12. Ground water was not encountered in the remaining borings during drilling. After completion of drilling, Borings B-4, B-8, B-14, and B-24 were converted to piezometers. Piezometer details are presented on Plates B-14 through B-17, in Appendix B. Detailed groundwater levels are summarized in Table 3. Piezometer installation and plugging reports are presented in Appendix E.

Table 3. Groundwater Depths below Existing Ground Surface

Boring No.	Date Drilled	Boring Depth (ft)	Groundwater Depth Encountered during Drilling (ft)	Groundwater Depth 15 min. after Initial Encounter (ft)	Groundwater Depth in Piezometer (ft)
B-1	6/18/12	15	Dry	Dry	--

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Boring No.	Date Drilled	Boring Depth (ft)	Groundwater Depth Encountered during Drilling (ft)	Groundwater Depth 15 min. after Initial Encounter (ft)	Groundwater Depth in Piezometer (ft)
B-2	6/25/12	15	Dry	Dry	--
B-3	6/18/12	20	Dry	Dry	--
B-4 (PZ-1)	6/18/12	20	19	Dry	17.6 (6/29/12) 15.8 (7/27/12)
B-5	6/18/12	20	Dry	Dry	--
B-6	6/18/12	15	Dry	Dry	--
B-7	6/18/12	15	Dry	Dry	--
B-8 (PZ-2)	6/25/12	15	Dry	Dry	Dry (6/29/12) 10.2 (7/27/12)
B-9	6/25/12	16	12	7.4	--
B-10	6/25/12	10	Dry	Dry	--
B-11	6/25/12	16	Dry	Dry	--
B-12	6/25/12	20	17	--	--
B-13	6/25/12	25	Dry	Dry	--
B-14 (PZ-3)	6/26/12	30	Dry	Dry	Dry (6/29/12) 12.3 (7/27/12)
B-15	6/26/12	25	Dry	Dry	--
B-16	6/26/12	20	Dry	Dry	--
B-17	6/26/12	15	Dry	Dry	--
B-18	6/27/12	15	Dry	Dry	--
B-19	6/26/12	10	Dry	Dry	--
B-20	6/26/12	15	Dry	Dry	--
B-21	6/26/12	15	Dry	Dry	--
B-22	6/27/12	5	Dry	Dry	--
B-23	6/27/12	15	Dry	Dry	--
B-24 (PZ-4)	6/27/12	15	Dry	Dry	Dry (6/29/12) 12.3 (7/27/12)
B-25	6/27/12	15	Dry	Dry	--
B-26	6/27/12	15	Dry	Dry	--

The information in this report summarizes conditions found on the dates the borings were drilled. It should be noted that our groundwater observations are short-term; groundwater depths and subsurface soil moisture contents will vary with environmental variations such as frequency and magnitude of rainfall and the time of year when construction is in progress.

4.2 Geologic Faults

AEC's staff geologist performed a preliminary fault investigation that included a review of available literature, aerial photographs, public maps and limited field observations. According to the published map "Principal Surface Faults of the Houston Central Metropolitan Area (after O'Neill and Van Siclen, with addition by C. Norman, 2004)", there do not appear to be any mapped surface faults at the Southpark/Southcrest Drainage Improvement area (project area). The closest fault to the project area is an unnamed fault associated with the Mykawa Salt Dome and the fault is located approximately 3 miles south-southeast of the southernmost street (Southford Street) of the project area.

Limited field observations were made at the project site and surrounding area by AEC's Senior Geologist for evidence of faulting. The pavement of the streets in the project area are commonly fractured including open fractures or shattered. The most severe damage appears to be to the pavement of Southbank Street between Southgood and Southmund Streets. Most of the pavement damage in the project area does not appear to be related to faulting, however, two features observed on Southbank Street may be related to faulting. One feature is a linear break in the road on Southbank Street just north of its intersection with Southgood Street. The feature crosses Southbank Street at an angle and there is about a 4 to 5 inch difference in elevation across the rupture in the road. The lower elevation is on the south side of the rupture. There are also large pavement fractures extending outward north-south from the rupture and paralleling the length of the road. The rupture feature extends eastward from the road about 20 feet through a driveway to a garage but cannot be observed west of the road. A portion of the driveway has been recently replaced but is developing a crack in line with the rupture in the road. A swell in the pavement in the driveway is also visible in line with the road rupture and the garage has a slight tilt to the south.

A second linear rupture which may be related to faulting was observed crossing Southbank Street between Southville Street and Southlark Street. The elevation change across the rupture is about 4 inches with the lower side on the north side of the rupture. This feature was not observed extending either east or west of the road.

Whether these two rupture features crossing Southbank are due to faulting or some other process is difficult to determine given the general condition of the road and lack of continuation of the ruptures much beyond

the road pavement. If the features are due to faulting, it appears based on the observations that they are fairly limited in extent.

No evidences of faulting were observed throughout the remaining portion of the project area and surrounding area.

Limitations: The preliminary fault investigation provided in this report is limited to a review of literature, aerial photographs and maps and our limited field observations, and distances are scaled from maps. Faults may exist in the project site or surrounding area which are not identified in this preliminary fault investigation due to the following reasons: not observed during the reconnaissance due to limitations of the scope of work and cost; the presence of obscuring vegetation and environmental features; modification of the land surface by human activities; and lack of documentation in the literature. Subsurface faults may also be present which do not currently have surface expressions. Identification of these faults is beyond the scope of work for this project.

4.3 Hazardous Materials

No signs of visual staining or odors were encountered during field drilling or during processing of the soil samples in the laboratory.

4.4 Subsurface Variations

It should be emphasized that: (i) at any given time, groundwater depths can vary from location to location, and (ii) at any given location, groundwater depths can change with time. Groundwater depths will vary with seasonal rainfall and other climatic/environmental events. Subsurface conditions may vary away from and between the boring locations.

Clay soils in the Houston area typically have secondary features such as slickensides and contain sand/silt seams/lenses/layers/pockets. It should be noted that the information in the boring logs is based on 3-inch diameter soil samples which were obtained continuously at intervals of 2 feet in the top 20 feet of the borings, then at intervals of 5 feet thereafter to the boring termination depths. A detailed description of the soil secondary features may not have been obtained due to the small sample size and sampling interval

between the samples. Therefore, while a boring log shows some soil secondary features, it should not be assumed that the features are absent where not indicated on the boring logs.

5.0 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

Based on information provided by IDS, the proposed improvements include installation of storm sewers, sanitary sewers, and waterlines, as well as reconstruction of residential streets. The invert depths of the underground utilities range from 4.5 to 13 feet below grade and will be installed primarily by open cut method. Plan and profile drawings of the proposed underground utilities were not available at the time this report was prepared.

5.1 Geotechnical Parameters for Underground Utilities

Recommended geotechnical parameters for the subsurface soils along the alignment to be used for design of underground utilities are presented on Plates C-1a through C-1c, in Appendix C. The design values are based on the results of field and laboratory test data on individual boring logs as well as our experience. It should be noted that because of the variable nature of soil stratigraphy, soil types and properties along the alignment or at locations away from a particular boring may vary substantially.

5.2 Installation of Underground Utilities by Open-Cut Method

Underground utilities installed by open-cut methods should be installed in accordance with Section 02317 of the 2011 City of Houston Standard Construction Specifications (COHSCS).

5.2.1 Loadings on Pipes

Underground utilities support the weight of the soil and water above the crown, as well as roadway traffic and any structures that exist above the utilities.

Earth Loads: For underground utilities to be installed using open cut methods, the vertical soil load W_e can be calculated as the larger of the two values from Equations (1) and (3):

$$W_e = C_d \gamma B_d^2 \quad \text{.....Equation (1)}$$

$$C_d = [1 - e^{-2K\mu'(H/B_d)}]/(2K\mu') \quad \text{.....Equation (2)}$$

$$W_e = \gamma B_c H \quad \text{.....Equation (3)}$$

where:
- W_e = trench fill load, in pounds per linear foot (lb/ft);
- C_d = trench load coefficient, see Plate C-2, in Appendix C;
- γ = effective unit weight of soil over the conduit, in pounds per cubic foot (pcf);
- B_d = trench width at top of the conduit < 1.5 B_c (ft);
- B_c = outside diameter of the conduit (ft);
- H = variable height of fill (ft);
  when the height of fill above the top of the conduit H_c >2 B_d, $H = H_h$ (height of fill above the middle of the conduit). When H_c < 2 B_d, H varies over the height of the conduit; and
- $K\mu'$ = 0.1650 maximum for sand and gravel,
  0.1500 maximum for saturated top soil,
  0.1300 maximum for ordinary clay,
  0.1100 maximum for saturated clay.

When underground conduits are located below groundwater, the total vertical dead loads should include the weight of the projected volume of water above the conduits.

Traffic Loads: The vertical stress on top of an underground conduit, p_L (psf), resulting from traffic loads (from a H-20 or HS-20 truck) can be obtained from Plate C-3, in Appendix C. The live load on top of the underground conduit can be calculated from Equation (4):

$$W_L = p_L B_c \quad \text{.....Equation (4)}$$

where:
- W_L = live load on the top of the conduit (lb/ft);
- p_L = vertical stress (on the top of the conduit) resulting from traffic loads (psf);
- B_c = outside diameter of the conduit, (ft);

Lateral Loads: The lateral soil pressure p_l can be calculated from Equation (5); hydrostatic pressure should be added, if applicable.

$$p_l = 0.5\,(\gamma H_h + p_s) \quad \text{.....Equation (5)}$$

where:
- H_h = height of fill above the center of the conduit (ft);
- γ = effective unit weight of soil over the conduit (pcf);
- p_s = vertical pressure on conduit resulting from traffic and/or construction equipment (psf).

5.2.2 Trench Stability

Cohesive soils in the Houston area contain many secondary features which affect trench stability, including sand seams and slickensides. Slickensides are shiny weak failure planes which are commonly present in fat clays; such clays often fail along these weak planes when they are not laterally supported, such as in an open excavation. The Contractor should not assume that slickensides and sand seams/layers/pockets are absent where not indicated on the logs.

The Contractor should be responsible for designing, constructing and maintaining safe excavations. The excavations should not cause any distress to existing structures.

Trenches 20 feet and Deeper: OSHA requires that shoring or bracing for trenches 20 feet and deeper be specifically designed by a licensed professional engineer.

Trenches Less than 20 Feet Deep: Trench excavations that are less than 20 feet deep may be shored, sheeted and braced, or laid back to a stable slope for the safety of workers, the general public, and adjacent structures, except for excavations which are less than 5 feet deep and verified by a competent person to have no cave-in potential. The excavation and trenching should be in accordance with Occupational Safety and Health Administration (OSHA), Safety and Health Regulations, 29 CFR, Part 1926. Recommended OSHA soil types for trench design for existing soils can be found on Plates C-1a through C-1c, in Appendix C. Fill soils are considered OSHA Class 'C'; submerged cohesive soils should also be considered OSHA Class 'C', unless they are dewatered first.

Critical Height is defined as the height a slope will stand unsupported for a short time; in cohesive soils, it is used to estimate the maximum depth of open-cuts at given side slopes. Critical Height may be calculated based on the soil cohesion. Values for various slopes and cohesion are shown on Plate D-1, in Appendix D. Cautions listed below should be exercised in use of Critical Height applications:

1. No more than 50 percent of the Critical Height computed should be used for vertical slopes. Unsupported vertical slopes are not recommended where granular soils or soils that will slough when not laterally supported are encountered within the excavation depth.

2. If the soil at the surface is dry to the point where tension cracks occur, any water in the crack will increase the lateral pressure considerably. In addition, if tension cracks occur, no cohesion should

be assumed for the soils within the depth of the crack. The depth of the first waler should not exceed the depth of the potential tension crack. Struts should be installed before lateral displacement occurs.

3. Shoring should be provided for excavations where limited space precludes adequate side slopes, e.g., where granular soils will not stand on stable slopes and/or for deep open cuts.

4. All excavation, trenching and shoring should be designed and constructed by qualified professionals in accordance with OSHA requirements.

The maximum (steepest) allowable slopes for OSHA Soil Types for excavations less than 20 feet are presented on Plate D-2, in Appendix D.

If limited space is available for the required open trench side slopes, the space required for the slope can be reduced by using a combination of bracing and open cut as illustrated on Plate D-3, in Appendix D. Guidelines for bracing and calculating bracing stress are presented below.

<u>Computation of Bracing Pressures:</u> The following method can be used for calculating earth pressure against bracing for open cuts. Lateral pressure resulting from construction equipment, traffic loads, or other surcharge should be taken into account by adding the equivalent uniformly distributed surcharge to the design lateral pressure. Hydrostatic pressure, if any, should also be considered. The active earth pressure at depth z can be determined by Equation (6). The design soil parameters for trench bracing design are presented on Plates C-1a through C-1c, in Appendix C.

$$p_a = (q_s + \gamma h_1 + \gamma' h_2)K_a - 2c\sqrt{K_a} + \gamma_w h_2 \qquad \text{.....Equation (6)}$$

where:
- p_a = active earth pressure (psf);
- q_s = uniform surcharge pressure (psf);
- γ, γ' = wet unit weight and buoyant unit weight of soil (pcf);
- h_1 = depth from ground surface to groundwater table (ft);
- h_2 = $z-h_1$, depth from groundwater table to the point under consideration (ft);
- z = depth below ground surface for the point under consideration (ft);
- K_a = coefficient of active earth pressure;
- c = cohesion of clayey soils (psf); c can be omitted conservatively;
- γ_w = unit weight of water, 62.4 pcf.

Pressure distribution for the practical design of struts in open cuts for clays and sands are illustrated on Plates D-4 through D-6, in Appendix D.

Bottom Stability: In open-cuts, it is necessary to consider the possibility of the bottom failing by heaving, due to the removal of the weight of excavated soil. Heaving typically occurs in soft plastic clays when the excavation depth is sufficiently deep enough to cause the surrounding soil to displace vertically due to bearing capacity failure of the soil beneath the excavation bottom, with a corresponding upward movement of the soils in the bottom of the excavation. In fat and lean clays, heave normally does not occur unless the ratio of Critical Height to Depth of Cut approaches one. In very sandy and silty lean clays and granular soils, heave can occur if an artificially large head of water is created due to installation of impervious sheeting while bracing the cut. This can be mitigated if groundwater is lowered below the excavation by dewatering the area. Guidelines for evaluating bottom stability in clay soils are presented on Plate D-7, in Appendix D.

Based on the invert depths provided in Table 1 of Section 2.1 and Table 3 of Section 4.1 of this report, open cut excavations could encounter ground water within the pipe bedding zone in the vicinity of Boring B-9. If the excavation extends below groundwater and the soils at or near the bottom of the excavation are mainly sands or silts, the bottom can fail by blow-out (boiling) when a sufficient hydraulic head exists. The potential for boiling or in-flow of granular soils increases where the groundwater is pressurized. To reduce the potential for boiling of excavations terminating in granular soils below pressurized groundwater, the groundwater table should be lowered at least 3 feet below the excavation

Calcareous nodules, silt/sand seams, and fat clays with slickensides were encountered in some of the borings. These secondary structures may become sources of localized instability when they are exposed during excavation, especially when they become saturated. Such soils have a tendency to slough or cave in when not laterally confined, such as in trench excavations. The Contractor should be aware of the potential for cave-in of the soils. Low plasticity soils (silts and clayey silts) will lose strength and may behave like granular soils when saturated.

5.2.3 Thrust Force Design Recommendations

Thrust forces are generated in pressure pipes, typically as a result of changes in pipe diameter, pipe direction or at the termination point of the pipes. The pipes could disengage at the joints if the forces are

not balanced and if the pipe restraint is not adequate. Various methods of thrust restraint are used including thrust blocks, restrained joints, encasement and tie-rods.

Thrust restraint design procedure based on the 2008 American Water Works Association (AWWA) Manual "Concrete Pressure Pipe (M9)" is discussed below. Plate D-8, in Appendix D shows the force diagram generated by flow in a bend in a pipe and also gives the equation for computing the thrust force. An example computation of a thrust force for a given surge pressure and a bend angle is presented on Plate D-9, in Appendix D.

Frictional Resistance: The unbalanced force due to changes in grade and alignment can be resisted by frictional force F_R, between the pipe and the surrounding soil. The resisting frictional force per linear foot of pipe against soil can be calculated from Equation (7):

$$F_R = f\,(2W_e + W_w + W_p) \qquad \text{.....Equation (7)}$$

where: f = Coefficient of friction between pipe and soil;
W_e = Weight of soil over pipe (lb/ft);
W_w = Weight of water inside the pipe (lb/ft);
W_p = Weight of pipe (lb/ft).

The value of the frictional resistance depends on the material in contact with the backfill and the soil used in the backfill. For a ductile iron pipe or PVC pipe with crushed stone or compacted sand backfill, an allowable coefficient of friction of 0.3 can be used. To account for submerged conditions, a soil unit weight of 60 pcf should be used to compute the weight of compacted backfill on the pipe.

Thrust Blocks: Thrust blocks utilize passive earth pressures to resist forces generated by changes in direction or diameter of pressurized pipes. Passive earth pressure can be calculated using Equation (8); we recommend that a factor safety of 2.0 be used when using passive earth pressure for design of thrust blocks. The design soil parameters for thrust block design are presented on Plates C-1a through C-1c, in Appendix C. Design parameters for bearing thrust blocks are presented on Plate D-10, in Appendix D.

$$p_p = \gamma z K_p + 2c(K_p)^{1/2} \qquad \text{.....Equation (8)}$$

where, p_p = passive earth pressure (psf);
γ = wet unit weight of soil (pcf);
z = depth below ground surface for the point under consideration (ft);
K_p = coefficient of passive earth pressure;
c = cohesion of clayey soils (psf).

5.2.4 Bedding and Backfill

Trench excavation, pipe embedment material, and backfill for the proposed underground utilities should be in general accordance with Section 02317 of the 2011 COHSCS. Backfill should be placed in loose lifts not exceeding 8 inches and compacted to 95 percent of its ASTM D-698 (Standard Proctor) maximum dry density at a moisture content ranging between optimum and 3 percent above optimum.

5.3 Pavement Reconstruction

AEC understands that the existing pavement along the proposed utility alignments will be replaced with new concrete pavement. Plan and profile drawings were not available at the time this report was prepared. In addition, traffic design information such as traffic volume, types of vehicles, percentage of heavy trucks, traffic volume growth rate, and design life for the pavement was not available when this report was prepared. AEC should be notified once this information becomes available so that our recommendations can be revised as necessary.

Based on our site visits the majority of the streets are residential, with the exception of the portion of Crestmont Street, between Southcrest and Southridge, which has light to moderate traffic volume. According to the document "Average Daily Traffic" (last updated April 4, 2011), available from the City of Houston's Public Works and Engineering Division website, the 2009 average daily traffic (ADT) of Crestmont Street between South Loop (i.e. IH-610 S) and Bellfort Boulevard was 4,925 vehicles per day (vpd). According to Chapter 10 - Appendix 2, of the 2011 City of Houston Infrastructure Design Manual, Crestmont Street is classified as an Urban Street, based on ADT and assumed ROW width (60 feet).

According to Section 10.05 of the 2011 Infrastructure Design Manual, residential roadways with concrete pavement width less than 27 feet from curb to curb must have a minimum concrete thickness of 6 inches and a minimum stabilized subgrade thickness of 6 inches, while residential roadways with concrete pavement width greater than 27 feet from curb to curb must have a minimum thickness of 7 inches and a

minimum stabilized subgrade thickness of 6 inches. Major thoroughfares must have a minimum thickness of 8 inches and a minimum stabilized subgrade thickness of 8 inches. AEC also assumes that the new pavement will be placed at or near existing grade.

The pavement design recommendations developed below are in accordance with the "AASHTO Guide for Design of Pavement Structures," 1993 edition.

5.3.1 Rigid Pavement

Rigid pavement design is based on the anticipated design number of 18-kip ESALs the pavement is subjected to during its design life. The parameters that were used in computing the rigid pavement section are as follows:

Overall Standard Deviation (S_0)	0.34
Initial Serviceability (P_0)	4.5
Terminal Serviceability (P_t)	2.0
Reliability Level (R)	95%
Overall Drainage Coefficient (C_d)	1.0
Load Transfer Coefficient (J)	3.2
Loss of Support Category (LS)	1.0
Roadbed Soil Resilient Modulus (M_R)	4,500 psi
Elastic Modulus (E_{sb}) of Stabilized Soils	20,000 psi
Composite Effective Modulus of Subgrade Reaction (k)	86 to 91 pci
Mean Concrete Modulus of Rupture (S'_c)	600 psi (at 28 days)
Concrete Elastic Modulus (E_c)	3.37×10^6 psi

Table 4. Recommended Rigid Pavement Sections

Pavement Layer	Thickness (in)		
	Curb-to-Curb Width Less Than or Equal to 27'	Curb-to-Curb Width Greater Than 27'	Crestmont Street
Portland Cement Concrete	6	7	8
Lime-stabilized Subgrade	6	6	8

Given the above design parameters, AEC selected the required minimum pavement section for pavement reconstruction as presented in Table 4. The 6-, 7- and 8 inch thick concrete pavement sections should sustain 231,355, 571,960, and 1,301,375 repetitions of 18-kip ESALs, respectively. The design engineer

should verify whether the proposed pavement section will provide enough ESALs for the anticipated amount of site traffic. AEC should be notified if different standards or constants are required for pavement design at the site, so that our recommendations can be updated accordingly.

Concrete Pavement: Portland Cement Concrete (PCC) pavement should be constructed in accordance with Section 02751 of the 2011 COHSCS. According to Section 02751, concrete mix design has a required flexural strength of 600 psi at 28 days and field testing shall confirm a minimum concrete compressive strength of 3,500 psi at 28 days. *The Contractor shall be responsible for ensuring that a concrete mix design based on concrete compressive strength of 3,500 psi at 28 days also meets a minimum concrete flexural strength of 500 psi at 7 days and 600 psi at 28 days.*

5.3.2 Reinforcing Steel

Reinforcing steel should be in accordance with Section 02751 of the 2011 COHSCS. Reinforcing steel is required to control pavement cracks, deflections across pavement joints and resist warping stresses in rigid pavements. The cross-sectional area of steel (A_s) required per foot of slab width can be calculated as follows (for both longitudinal and transverse steel).

$$A_s = FLW/(2f_s) \qquad \text{.....Equation (9)}$$

where:
- A_s = Required cross-sectional area of reinforcing steel per foot width of pavement, in^2
- F = Coefficient of resistance between slab and subgrade, F = 1.8 for stabilized soil
- L = Distance between free transverse joints or between free longitudinal edges, ft.
- W = Weight of pavement slab per foot of width, lbs/ft
- f_s = Allowable working stress in steel, 0.75 x (yield strength), psi
  i.e. f_s = 45,000 psi for Grade 60 steel.

5.3.3 Pavement Subgrade Preparation

Roadway grading and fill should be performed in general accordance with Section 02315 of the 2011 COHSCS. Existing pavement should be demolished in accordance with Section 02221 of the 2011 COHSCS. Subgrade preparation should extend a minimum of 2 feet beyond the paved area perimeters. After demolition of pavement, a minimum of 6 inches of surface soils, existing vegetation, trees, roots, and other deleterious materials be removed and wasted. The excavation depth should be increased when inspection indicates the presence of organics and deleterious materials to greater depths. The exposed soils

should be proof-rolled in accordance with Item 216 of the 2004 Texas Department of Transportation (TxDOT) Standard Specifications for the Construction and Maintenance of Highways, Streets, and Bridges to identify and remove any weak, compressible, or other unsuitable materials; such materials should be replaced with compacted fill.

Scarify the top 6 to 8 inches of the exposed subgrade (See Table 4 in Section 5.4.1 of this report to determine depth of stabilization) and stabilize the underlying soils with a minimum of 7 percent hydrated lime by dry soil weight. Lime stabilization shall be performed in accordance with Section 02336 of the 2011 COHSCS. The percentage of lime required for stabilization are preliminary estimates for planning purposes only; laboratory testing should be performed to determine optimum contents for stabilization prior to construction. The stabilized soils should be compacted to 95 percent of their ASTM D 698 (Standard Proctor) dry density at a moisture content ranging from optimum to 3 percent above optimum.

5.4 Select Fill

Select fill should consist of uniform, non-active inorganic lean clays with a PI between 10 and 20 percent, and more than 50 percent passing a No. 200 sieve. Excavated material delivered to the site for use as select fill shall not have clay clods with PI greater than 20, clay clods greater than 2 inches in diameter, or contain sands/silts with PI less than 10. Prior to construction, the Contractor should determine if he or she can obtain qualified select fill meeting the above select fill criteria.

As an alternative to imported fill, on-site soils excavated during construction can be stabilized with hydrated lime. Excavated clay soils should be stabilized with at least 7 percent hydrated lime by dry soil weight. Lime stabilization shall be performed in accordance with Section 02336 of the 2011 COHSCS. The percentage of lime required for stabilization is a preliminary estimate for planning purposes only; laboratory testing should be performed to determine optimum contents for stabilization prior to construction. AEC prefers using stabilized on-site clay as select fill since compacted lime-stabilized clay generally has high shear strength, low compressibility, and relatively low permeability. Blended or mixed soils (sand and clay) should not be used as select fill.

All material intended for use as select fill should be tested prior to use to confirm that it meets select fill criteria. The fill should be placed in loose lifts not exceeding 8 inches in thickness. Backfill within 3 feet of walls or columns should be placed in loose lifts no more than 4-inches thick and compacted using hand

tampers, or small self-propelled compactors. The lime-stabilized onsite soils or select fill should be compacted to a minimum of 95 percent of the ASTM D 698 (Standard Proctor) maximum dry unit weight at a moisture content ranging between optimum and 3 percent above optimum.

If imported select fill will be used, at least one Atterberg Limits and one percent passing a No. 200 sieve test shall be performed for each 5,000 square feet (sf) of placed fill, per lift (with a minimum of one set of tests per lift), to determine whether it meets select fill requirements. Prior to placement of pavement, the moisture contents of the top 2 lifts of compacted select fill shall be re-tested (if there is an extended period of time between fill placement and pavement construction) to determine if the in-place moisture content of the lifts have been maintained at the required moisture requirements.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Site Preparation

To mitigate site problems that may develop following prolonged periods of rainfall, it is essential to have adequate drainage to maintain a relatively dry and firm surface prior to starting any work at the site. Adequate drainage should be maintained throughout the construction period. Methods for controlling surface runoff and ponding include proper site grading, berm construction around exposed areas, and installation of sump pits with pumps.

6.2 Groundwater Control

The need for groundwater control will depend on the depth of excavation relative to the groundwater depth at the time of construction. In the event that there is heavy rain prior to or during construction, the groundwater table may be higher than indicated in this report; higher seepage is also likely and may require a more extensive groundwater control program. In addition, groundwater may be pressurized in certain areas of the alignment, requiring further evaluation and consideration of the excess hydrostatic pressures.

The Contractor should be responsible for selecting, designing, constructing, maintaining and monitoring a groundwater control system and adapt his operations to ensure the stability of the excavations. Groundwater information presented in Section 4.1 and elsewhere in this report, along with consideration for

potential environmental and site variation between the time of our field exploration and construction, should be incorporated in evaluating groundwater depths. The following recommendations are intended to guide the Contractor during design and construction of the dewatering system.

In cohesive soils seepage rates are lower than in granular soils and groundwater is usually collected in sumps and channeled by gravity flow to storm sewers. If cohesive soils contain significant secondary features, seepage rates will be higher. This may require larger sumps and drainage channels, or if significant granular layers are interbedded within the cohesive soils, methods used for granular soils may be required. Where it is present, pressurized groundwater will also yield higher seepage rates.

Groundwater for excavations within saturated sands can be controlled by the installation of wellpoints. The practical maximum dewatering depth for well points is about 15 feet. When groundwater control is required below 15 feet, multiple staged wellpoint or deep wells with submersible pumps have generally proved successful. Generally, the groundwater depth should be lowered at least 3 feet below the excavation bottom.

Extended and/or excessive dewatering can result in settlement of existing structures in the vicinity; the Contractor should take the necessary precautions to minimize the effect on existing structures in the vicinity of the dewatering operation. We recommend that the Contractor verify the groundwater depths and seepage rates prior to and during construction and retain the services of a dewatering expert (if necessary) to assist him in identifying, implementing, and monitoring the most suitable and cost-effective method of controlling groundwater.

For open cut construction in cohesive soils, the possibility of bottom heave must be considered due to the removal of the weight of excavated soil. In lean and fat clays, heave normally does not occur unless the ratio of Critical Height to Depth of Cut approaches one. In silty clays, heave does not typically occur unless an artificially large head of water is created through the use of impervious sheeting in bracing the cut. Guidelines for evaluating bottom stability are presented in Section 5.2.2 of this report.

6.3 Construction Monitoring

Pavement construction and subgrade preparation, as well as excavation, bedding, and backfilling of underground utilities should be monitored by qualified geotechnical professionals to check for compliance with project documents and changed conditions, if encountered. AEC should be allowed to review the design and construction plans and specifications prior to release to check that the geotechnical recommendations and design criteria presented herein are properly interpreted.

6.4 Monitoring of Existing Structures

Existing structures in the vicinity of the proposed alignment should be closely monitored prior to, during, and for a period after excavation. Several factors (including soil type and stratification, construction methods, weather conditions, other construction in the vicinity, construction personnel experience and supervision) may impact ground movement in the vicinity of the alignment. We therefore recommend that the Contractor be required to survey and adequately document the condition of existing structures in the vicinity of the proposed alignments.

7.0 LIMITATIONS

The information contained in this report summarizes conditions found on the dates the borings were drilled. The attached boring logs are true representations of the soils encountered at the specific boring locations on the dates of drilling. Reasonable variations from the subsurface information presented in this report should be anticipated. If conditions encountered during construction are significantly different from those presented in this report; AEC should be notified immediately.

This investigation was performed using the standard level of care and diligence normally practiced by recognized geotechnical engineering firms in this area, presently performing similar services under similar circumstances. This report is intended to be used in its entirety. The report has been prepared exclusively for the project and location described in this report. If pertinent project details change or otherwise differ from those described herein, AEC should be notified immediately and retained to evaluate the effect of the changes on the recommendations presented in this report, and revise the recommendations if necessary. The recommendations presented in this report should not be used for other structures located along these

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alignments or similar structures located elsewhere, without additional evaluation and/or investigation.

8.0 CLOSING REMARKS

AEC appreciates the opportunity to be of service on this project and looks forward to our continuing association during the construction phase of this project and on future projects.

AVILES ENGINEERING CORPORATION
(TBPE Firm Registration No. F-42)

9/14/2012

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September 14, 2012

Copies Submitted:	3	IDS Engineering Group, Inc.
	1	file

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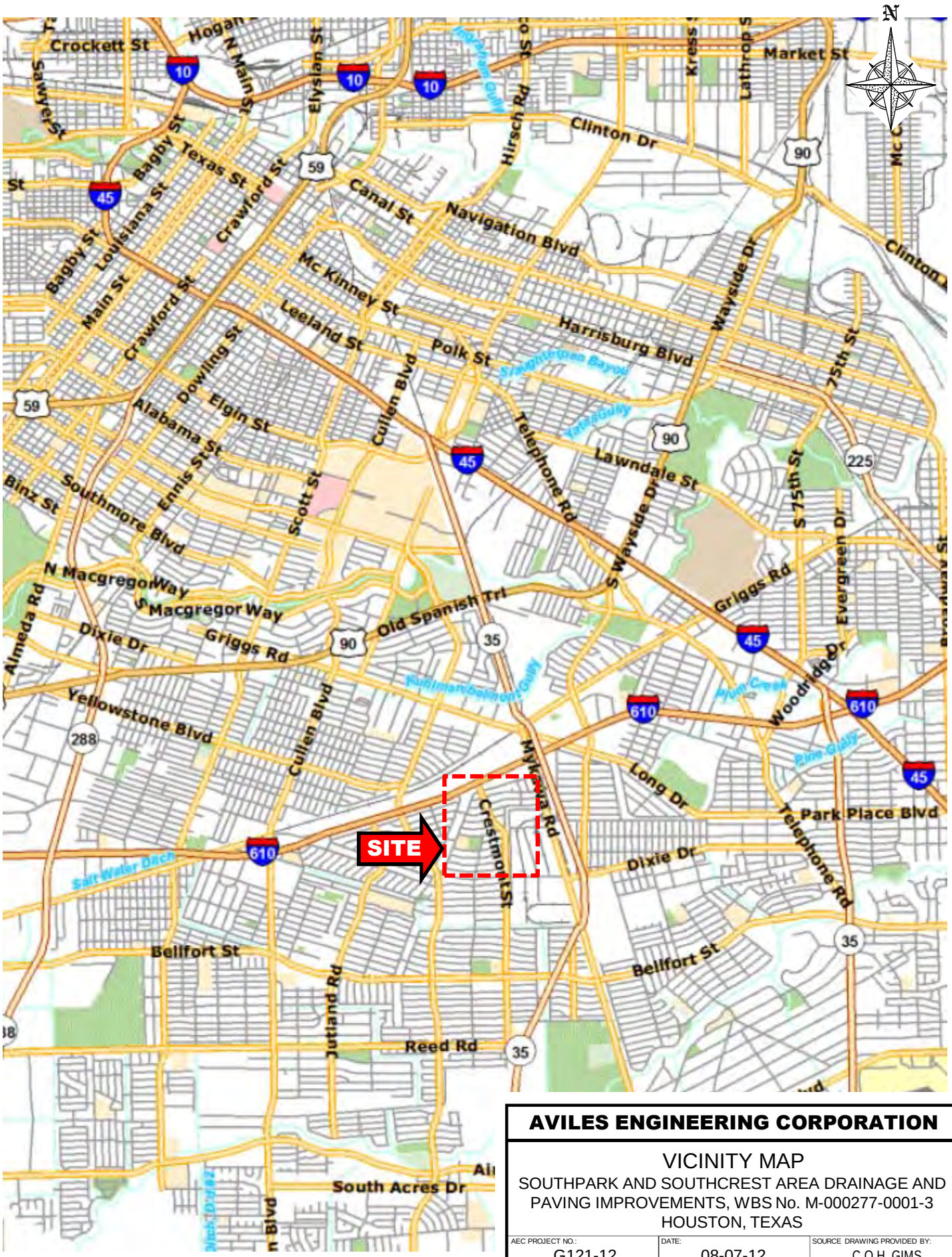
APPENDIX A

Plate A-1	Vicinity Map
Plates A-2a and A-2b	Boring Location Plan
Plates A-3 to A-28	Boring Logs
Plate A-29	Key to Symbols
Plate A-30	Classification of Soils for Engineering Purposes
Plate A-31	Terms Used on Boring Logs
Plate A-32	ASTM & TXDOT Designation for Soil Laboratory Tests



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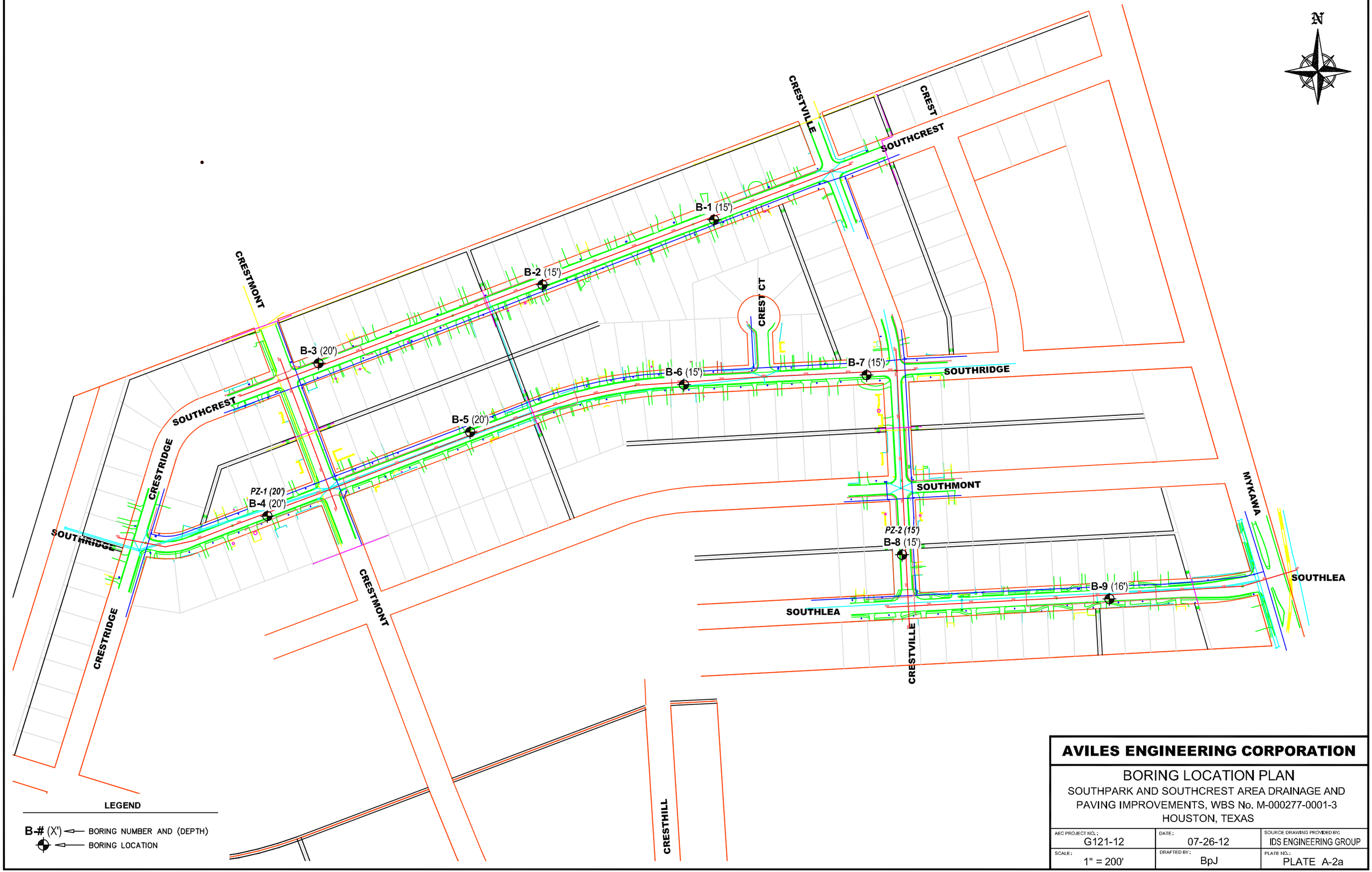
VICINITY MAP

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3
HOUSTON, TEXAS

AEC PROJECT NO.:	DATE:	SOURCE DRAWING PROVIDED BY:
G121-12	08-07-12	C.O.H. GIMS
APPROX. SCALE:	DRAFTED BY:	PLATE NO.:
N.T.S.	BpJ	PLATE A-1



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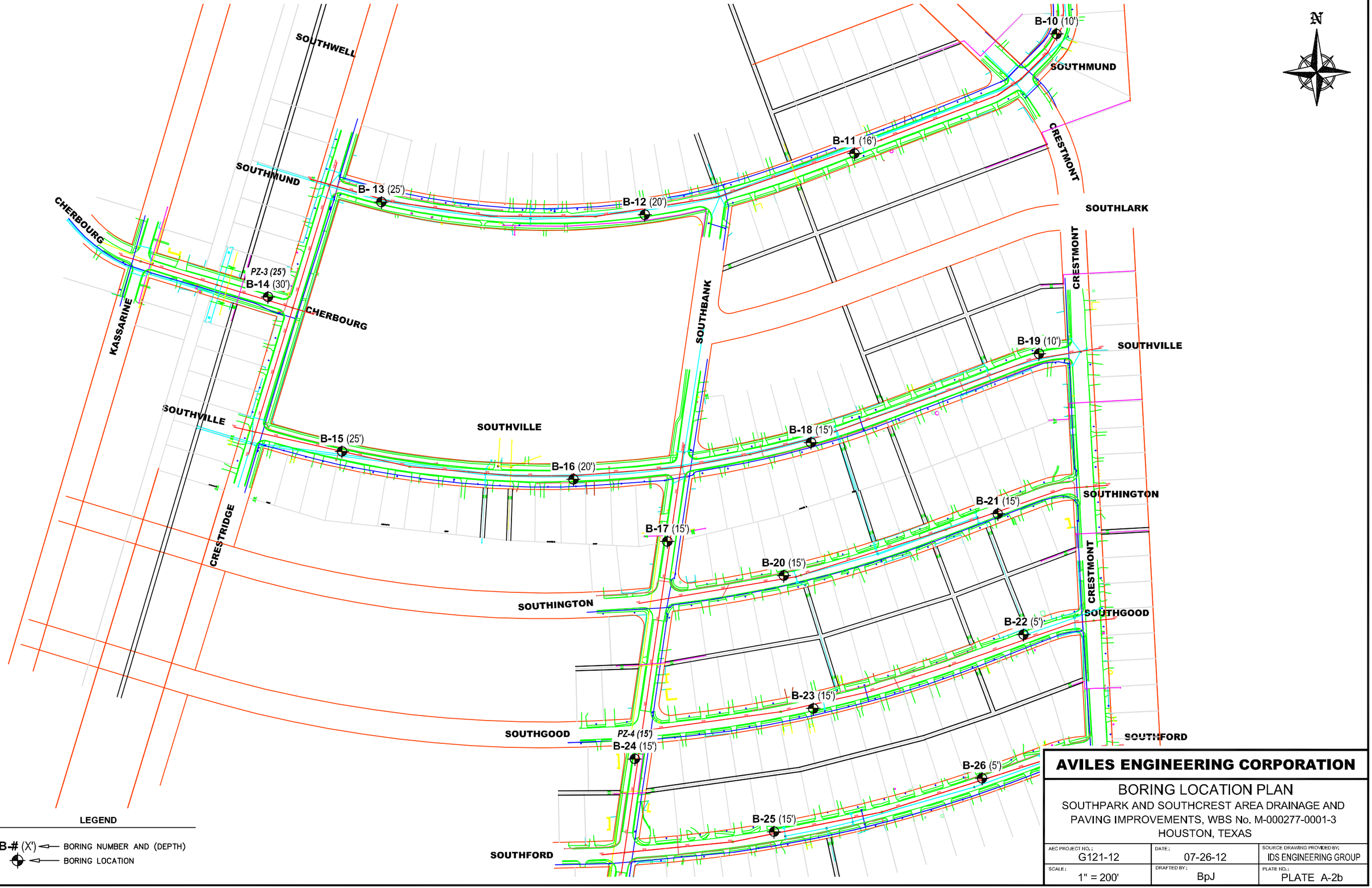
BORING LOCATION PLAN

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3
HOUSTON, TEXAS

AEC PROJECT NO.:	DATE:	SOURCE DRAWING PROVIDED BY:
G121-12	07-26-12	IDS ENGINEERING GROUP
SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE A-2a



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BORING LOCATION PLAN

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

HOUSTON, TEXAS

AEC PROJECT NO.:	DATE:	SOURCE DRAWING PROVIDED BY:
G121-12	07-26-12	IDS ENGINEERING GROUP
SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE A-2b

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

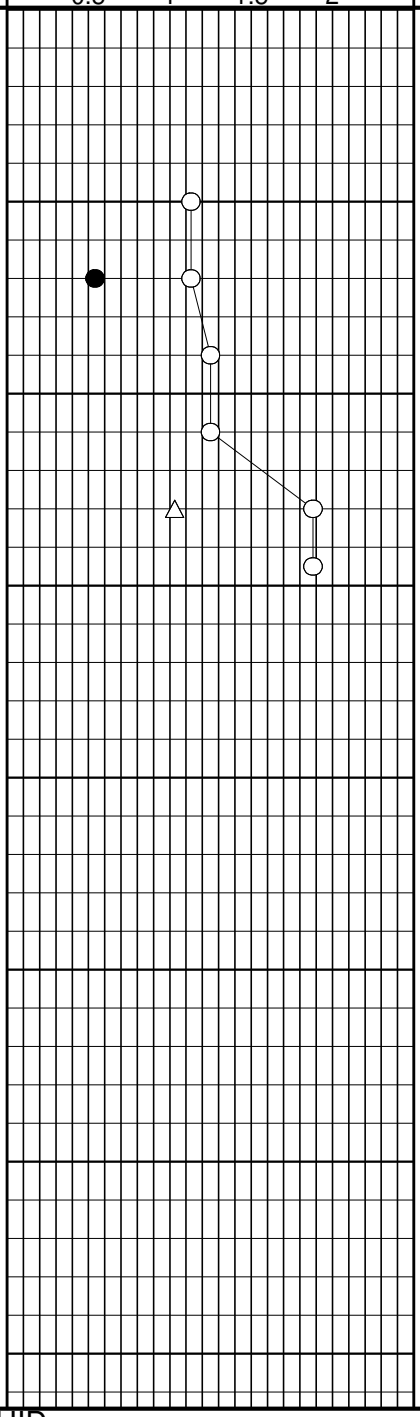
PROJECT: **Southpark and Southcrest Drainage** BORING **B-1**

DATE **6/18/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			*Survey Coordinates (ft):* *Easting: 3134421.91* *Northing: 13817936.91* *Elevation: 35.72*							
			Pavement: 7" asphalt							
			Base: 17" crushed shell, silty sand, and gravel		4					
			Fill: very stiff, gray and tan Fat Clay w/ Sand (CH)		29		80	46	15	31
5			-with stabilized shell and silty sand 4'-6'		32					
			Stiff to very stiff, olive Fat Clay (CH), with slickensides		32	89				
			-with ferrous nodules and stains 6'-8' -tan 8'-10'		32					
10			-reddish tan and gray 10'-12'		29		99	73	22	51
			-reddish tan 12'-15'		29	96				
					31					
15			Termination Depth = 15 Feet							
20										
25										
30										
35										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING

WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**

DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

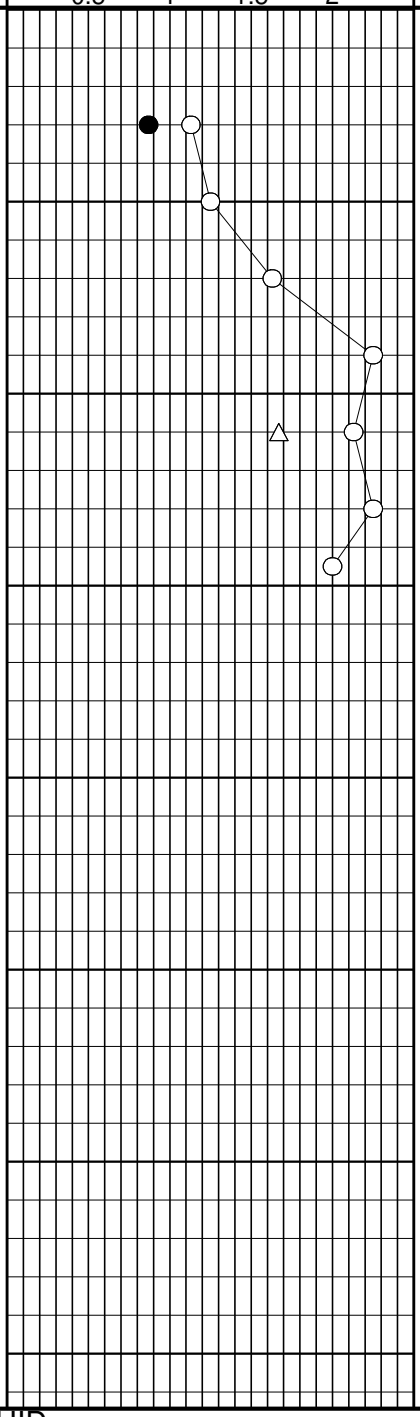
AVILES ENGINEERING CORP.
GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-2**

DATE **6/25/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3134015.42
Northing: 13817783.06
Elevation: 34.88

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 7" asphalt						
	Base: 17" stabilized sand, shell, and gravel	31					
	Fill: stiff, olive and tan Fat Clay (CH)	31	92				
5	-olive and dark gray, with ferrous nodules 4'-6'	32		96	88	23	65
	Very stiff to hard, reddish tan Fat Clay (CH), with slickensides and ferrous stains	28					
	-gray and tan 8'-10'	18					
10	Very stiff to hard, light gray Lean Clay (CL)	21	106				
	-gray and tan 12'-15', with ferrous nodules 12'-14'	19		91	47	16	31
	-with abundant silt seams 14'-15'	17					
15	Termination Depth = 15 Feet						
20							
25							
30							
35							



BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-3**

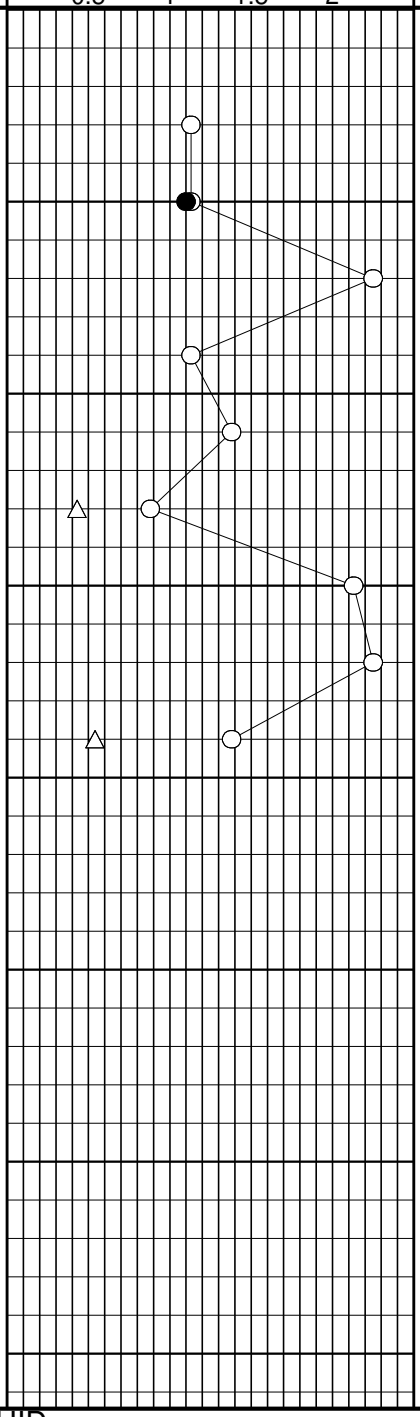
DATE **6/18/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3133484.75
Northing: 13817597.09
Elevation: 36.45

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 8" asphalt							
	Base: 16" stabilized sand, crushed shell, and gravel		9					
	Very stiff to hard, dark gray Fat Clay (CH), with slickensides		25		90	62	17	45
5	-gray and tan, with calcareous nodules 6'-10'		26	99				
	-with voids and ferrous nodules 8'-10'		18					
			24					
10	Firm to very stiff, gray and tan Lean Clay (CL), with silt seams and fat clay pockets -with calcareous nodules 10'-12'		20		92	32	17	15
			22	102				
15	Stiff to hard, reddish tan Fat Clay (CH), with slickensides and calcareous nodules		21					
	-reddish tan and gray 16'-20'		25		99	61	21	40
	-with silty clay layers 18'-20'		21	105				
20	Termination Depth = 20 Feet							
25								
30								
35								

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **20** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

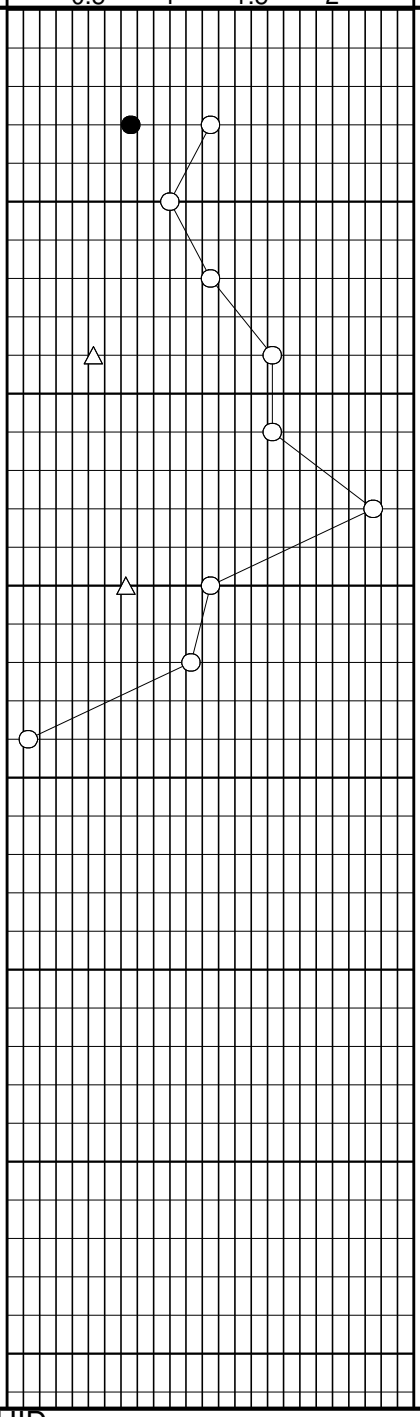
PROJECT: **Southpark and Southcrest Drainage** BORING **B-4**

DATE **6/18/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3133363.41
Northing: 13817235.13
Elevation: 36.18

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 9" asphalt						
	Base: 14" stabilized sand, crushed shell, and gravel	6					
	Stiff to hard, dark gray Fat Clay (CH), with slickensides	27	96				
5	-light brown 4'-6', with ferrous and calcareous nodules 4'- 8'	29		93	73	21	52
	-reddish tan and brown 6'-8'	29					
	-gray and tan, with ferrous stains 8'-10'	26	97				
10	-light tan, with ferrous nodules 10'-12'	27		94	64	21	43
	-tan and gray 12'-14', with abundant calcareous nodules 12'-16'	20					
	-reddish tan, with silty clay layers 14'-16'						
15		20	108				
	-reddish tan and gray 16'-18'	24		92	58	17	41
	Light tan Silt (ML)	14					
20	Termination Depth = 20 Feet						
25							
30							
35							

SHEAR STRENGTH, TSF



BORING DRILLED TO **20** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **19** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

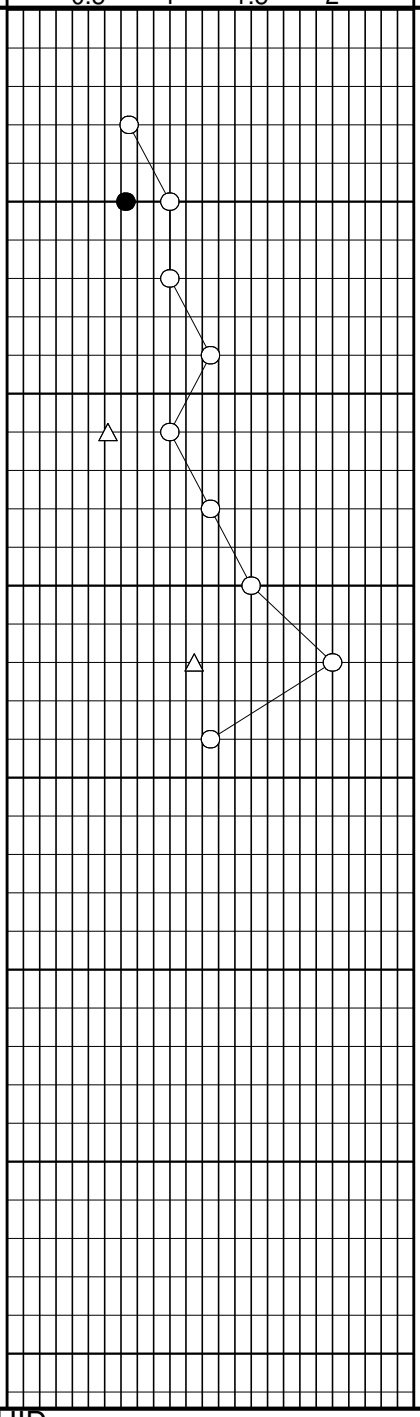
PROJECT: **Southpark and Southcrest Drainage** BORING **B-5**

DATE **6/18/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3133844.11
Northing: 13817434.14
Elevation: 36.40

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 8" asphalt						
	Base: 14" stabilized sand, crushed shell, and gravel	6					
	Stiff to very stiff, dark brown Fat Clay (CH), with slickensides	30		95	61	22	39
	-with ferrous nodules 2'-4'	32	91				
5	-light gray and tan 6'-12', with voids and ferrous nodules 6'-8'	27					
		26		94	66	22	44
10	-with voids 10'-12'	26	95				
	-tan and gray 12'-16'	21					
	-with chalk and calcareous nodules 14'-16'	27		92	61	23	38
15	-reddish tan, with silt partings 16'-20'	25	101				
		26					
20	Termination Depth = 20 Feet						
25							
30							
35							

SHEAR STRENGTH, TSF



BORING DRILLED TO **20** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-6**

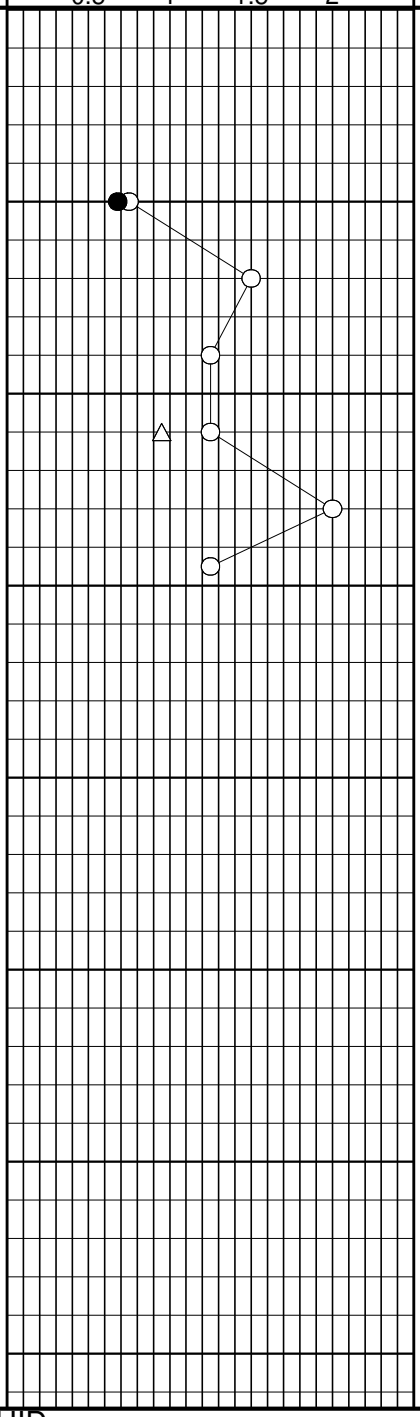
DATE **6/18/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 9" asphalt							
			Base: 15" stabilized sand, crushed shell, and gravel		10					
			Stiff to very stiff, dark brown Fat Clay (CH), with slickensides		32		94	92	24	68
5			-light brown 4'-6'		32	91				
			-tan, with calcareous nodules and ferrous stains 6'-8', and voids 6'-15'		30					
			-reddish brown 8'-10'		30		100	76	28	48
10			-reddish brown and tan 10'-12'		28	96				
			-reddish brown and gray 12'-14'		31					
			-dark tan and gray 14'-15'		34		98	85	32	53
15			Termination Depth = 15 Feet							
20										
25										
30										
35										

Survey Coordinates (ft):
Easting: 3134350.58
Northing: 13817546.50
Elevation: 35.03

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-7**

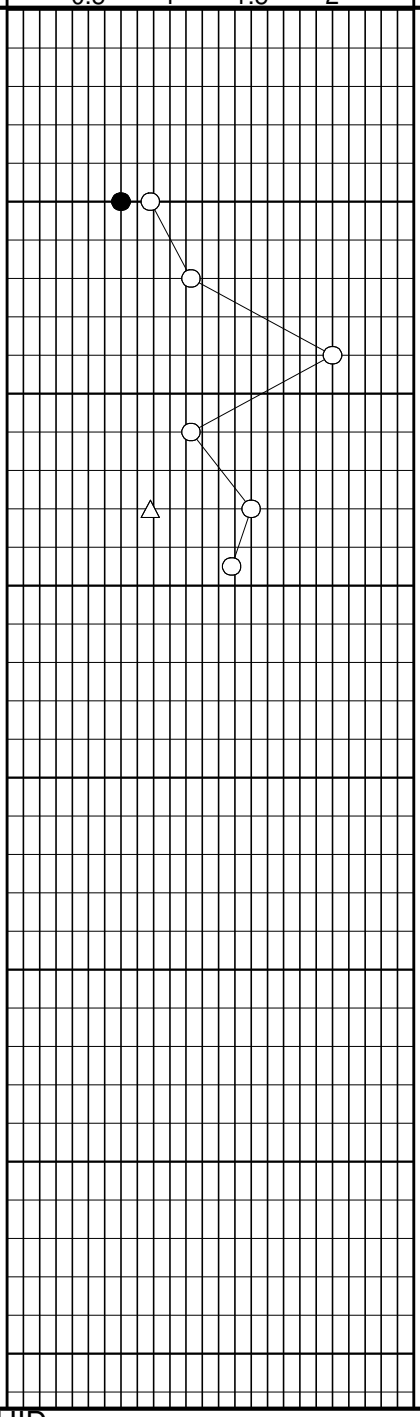
DATE **6/18/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3134783.37
Northing: 13817569.21
Elevation: 35.18

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 9" asphalt							
			Base: 15" stabilized sand, crushed shell, and gravel		11					
			Stiff to very stiff, dark gray Fat Clay (CH), with slickensides		28		91	78	19	59
5			-with ferrous nodules 4'-8'		30	92				
			-gray and tan, with claystone fragments 6'-8'		29					
			-reddish tan and gray 8'-10'		23					
10			-reddish brown 10'-12'		29		98	70	20	50
			-reddish tan 12'-14'		32	92				
			-tan, with voids 14'-15'		34					
15			Termination Depth = 15 Feet							
20										
25										
30										
35										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-8**

DATE **6/25/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3134867.73
Northing: 13817143.49
Elevation: 36.36

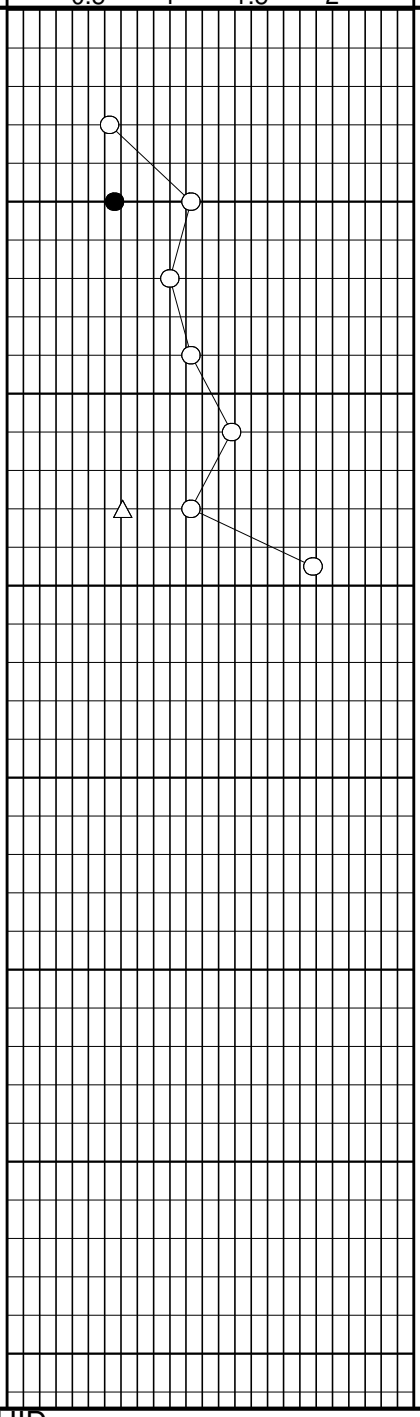
DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 7" asphalt						
	Base: 17" stabilized sand, crushed shell, and gravel	13					
	Stiff to very stiff, dark gray Fat Clay w/Sand (CH), with slickensides	27		83	63	19	44
5	-with ferrous nodules 4'-6'	28	94				
	Stiff to very stiff, light gray and tan Fat Clay (CH), with slickensides	28					
	-with calcareous nodules 6'-8' and ferrous nodules 6'-12'	26					
10	-gray and tan 8'-14'						
	-with ferrous stains 10'-12' and calcareous nodules 10'-15'	26		89	62	17	45
		26	97				
	-reddish tan and gray 14'-15'	19					
15	Termination Depth = 15 Feet						
20							
25							
30							
35							

SYMBOL

SAMPLE INTERVAL

S.P.T. BLOWS / FT.

SHEAR STRENGTH, TSF



△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane

BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-9**

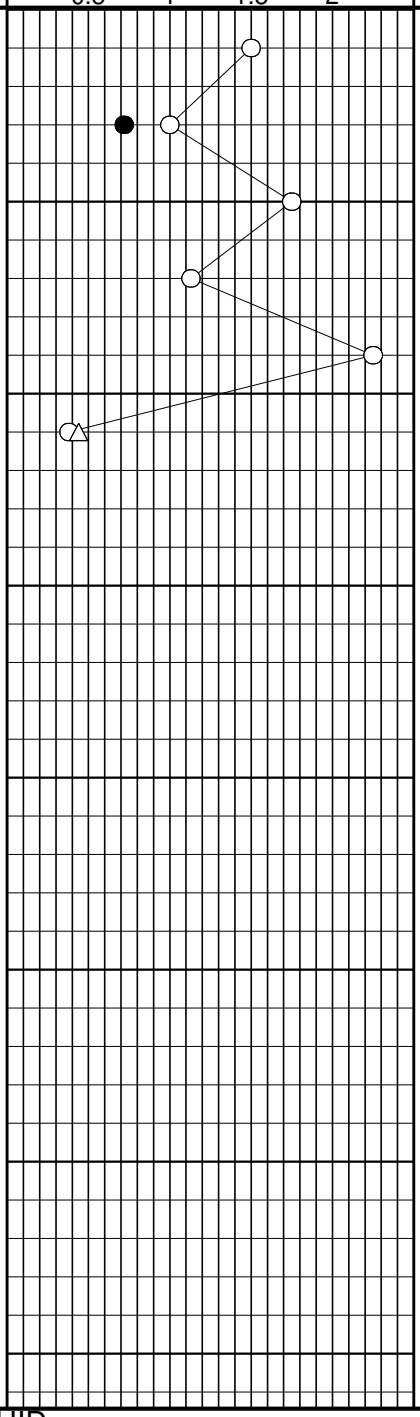
DATE **6/25/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3135359.10
Northing: 13817038.90
Elevation: 35.36

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 6.25" concrete							
	Stiff to hard, dark gray Sandy Fat Clay (CH), with ferrous nodules		26		64	79	28	51
	-gray and tan 2'-8'		22	102				
5			16					
			20					
	-tan, with abundant calcareous nodules 8'-10'		21		66	56	18	38
10	Firm, tan and brown Sandy Lean Clay (CL), with ferrous nodules and abundant calcareous nodules		21	113				
	Medium dense, tan and gray Poorly Graded Sand w/Silt (SP-SM)	20	20		11			
	-wet at 12'							
15	Medium dense, tan Clayey Sand (SC), with silt partings	18	24					
	Termination Depth = 16 Feet							
20								
25								
30								
35								

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **12** FEET WHILE DRILLING
WATER LEVEL AT **7.4** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-10**

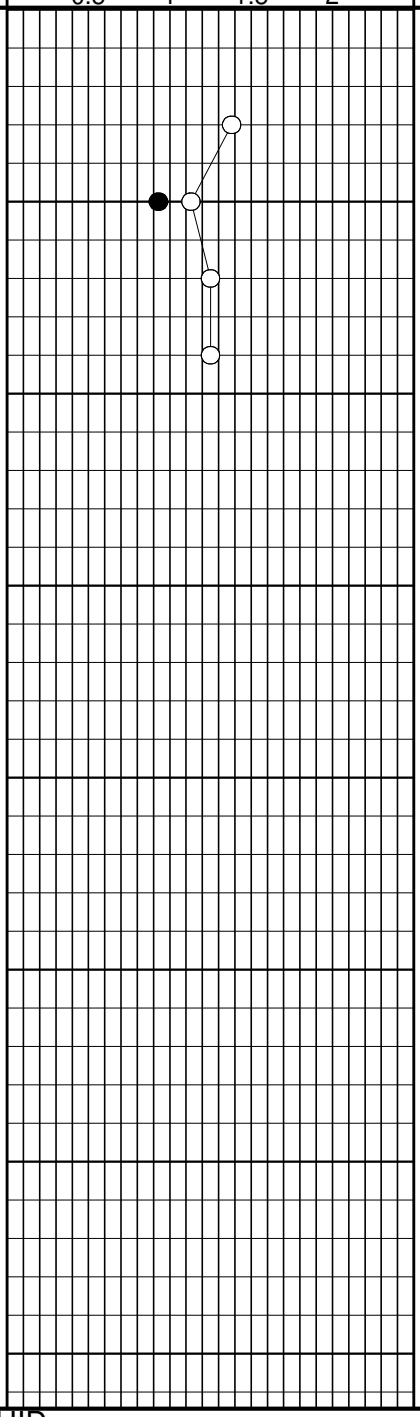
DATE **6/25/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3134312.44
Northing: 13816090.16
Elevation: 36.51

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 2" asphalt						
	Pavement: 5.5" concrete	22					
	Very stiff, dark olive Sandy Lean Clay (CL)	24		60	42	19	23
5	Very stiff, dark brown Sandy Fat Clay (CH)	27	95				
	-dark olive 6'-8'	25					
	-gray and tan, with calcareous nodules 8'-10'	22		66	61	19	42
10	Termination Depth = 10 Feet						
15							
20							
25							
30							
35							

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **10** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

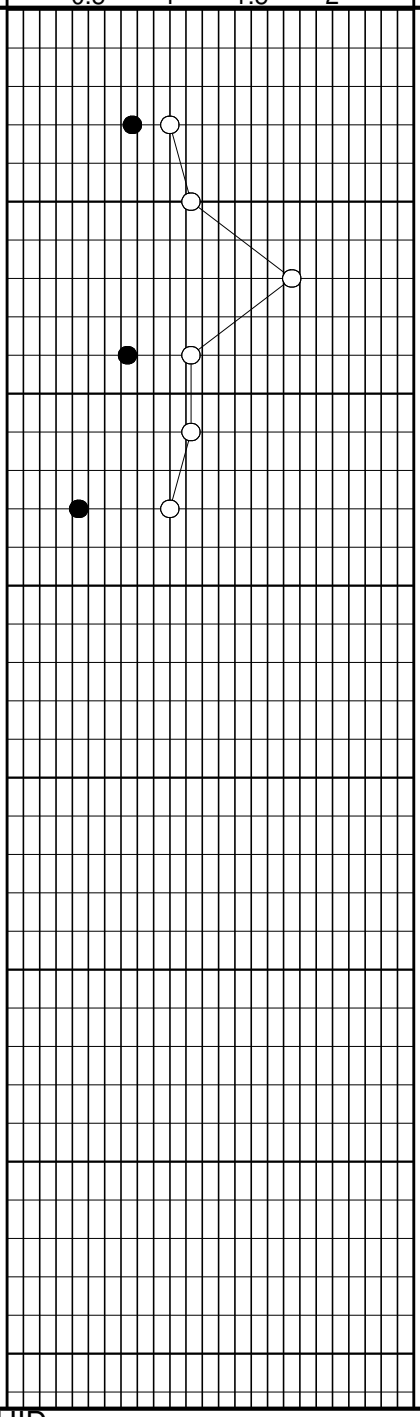
PROJECT: **Southpark and Southcrest Drainage** BORING **B-11**

DATE **6/25/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3133842.62
Northing: 13815812.28
Elevation: 36.42

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 1.5" asphalt							
	Pavement: 5.5" concrete		20					
	Stiff to very stiff, dark gray Sandy Fat Clay (CH)		24	98				
	-with silty sand pockets 2'-6'				68	66	19	47
5			25					
	Firm to very stiff, gray and tan Sandy Lean Clay (CL)		16					
	-tan and brown 8'-10'		20	106				
10	-with silty sand seams 10'-12'		18		53	38	14	24
	-gray, with ferrous stains 12'-14'		14	111				
15	Medium dense, gray Poorly Graded Sand w/ Silt (SP-SM)	30	19		10			
	Termination Depth = 16 Feet							
20								
25								
30								
35								

SHEAR STRENGTH, TSF



BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

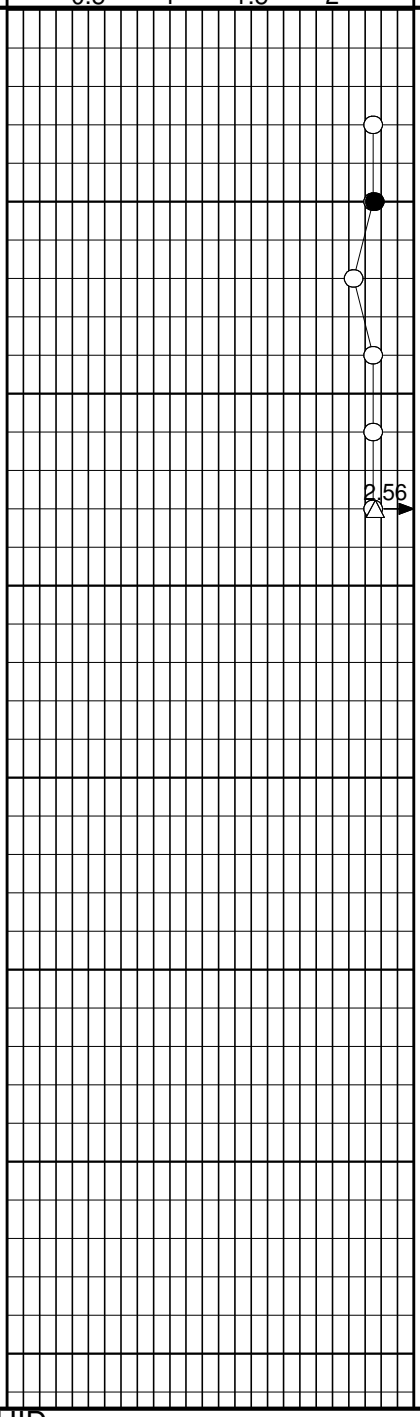
PROJECT: **Southpark and Southcrest Drainage** BORING **B-12**

DATE **6/25/12** TYPE **4" Dry Auger/Wet Rotary** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3133355.00
Northing: 13815670.17
Elevation: 36.82

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 2" asphalt							
	Pavement: 5.25" concrete		22					
	Hard, dark brown Fat Clay w/Sand (CH)		25		73	77	24	53
5	-gray and tan 6'-8'		21	105				
			21					
	Hard, gray and tan Lean Clay (CL), with ferrous and calcareous nodules		15					
10	Gray and tan Clayey Sand (SC)		11		45	39	14	25
			12	114				
15	Medium dense, tan Poorly Graded Sand w/ Silt (SP-SM) -boring caved at 15.3'	28	22					
		17	20		11			
		23	21					
20	Termination Depth = 20 Feet							
25								
30								
35								



BORING DRILLED TO **17** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **17** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-13**

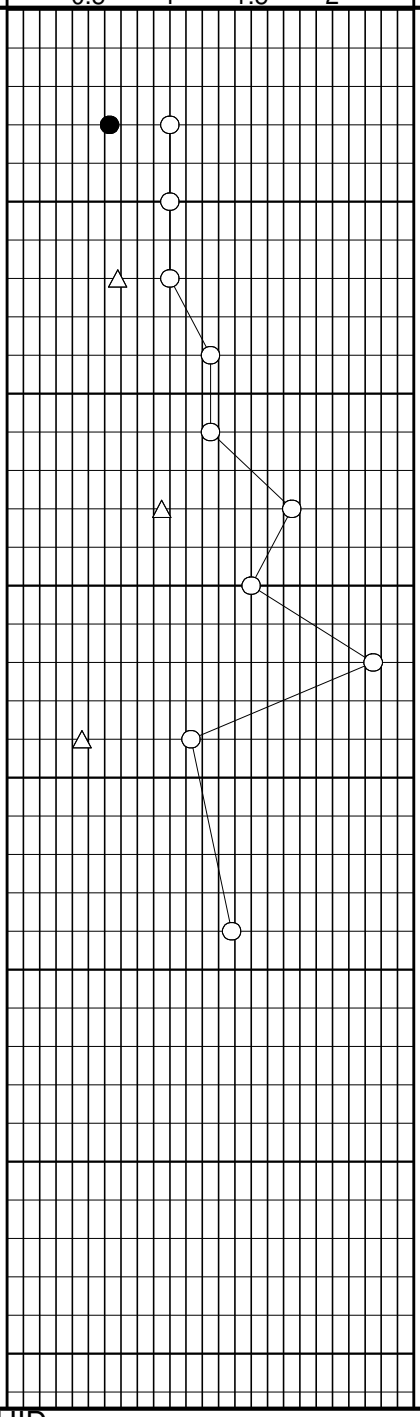
DATE **6/25/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3132742.86
Northing: 13815699.48
Elevation: 37.29

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 2" asphalt						
	Pavement: 5.25" concrete						
	Firm to hard, dark gray Fat Clay (CH), with slickensides	30					
		29	92				
5		28		89	72	26	46
	-gray and tan 6'-12', with calcareous nodules 6'-8'	28	94				
	-with ferrous nodules 8'-10'	26					
10		27		90	71	27	44
	-reddish tan, with abundant calcareous nodules 12'-14'	22	109				
	-reddish brown and gray 14'-16'	32					
15	-tan and gray 16'-18'	29		99	88	31	57
	-tan 18'-25', with ferrous nodules 18'-20'	35	87				
20							
		30					
25	Termination Depth = 25 Feet						
30							
35							

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **25** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-14**

DATE **6/26/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3132479.18
Northing: 13815478.80
Elevation: 37.83

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 2" asphalt						
	Pavement: 4.5" concrete	33					
	Firm to very stiff, dark gray Fat Clay (CH), with slickensides	28	95				
5		27		88	74	24	50
	-gray and tan, with calcareous and ferrous nodules 6'-12'	28					
		24	100				
10		29		91	66	22	44
	-reddish tan 12'-18'	26					
15		30					
		31	92				
	-tan and gray 18'-25', with ferrous nodules 18'-20'	31		98	78	28	50
20							
	-with calcareous nodules 23'-25'	32	91				
25							
	-tan 28'-30'	34		97	92	31	61
30	Termination Depth = 30 Feet						
35							

BORING DRILLED TO **30** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-15**

DATE **6/26/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3132651.21
Northing: 13815119.67
Elevation: 37.70

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 1.25" asphalt						
	Pavement: 5" concrete						
	Stiff to hard, dark olive Fat Clay w/Sand (CH), with slickensides	25					
	-dark brown, with silty sand pockets 2'-4' and ferrous nodules 2'-6'	27		80	81	25	56
5	-dark gray, with voids 4'-6'	24	100				
	-gray and tan 6'-12'	27					
	-with ferrous nodules 8'-12'	28		80	64	23	41
10		19	104				
	-reddish tan and gray, with ferrous stains and calcareous nodules 12'-14'	18					
15	Stiff to very stiff, reddish tan and gray Fat Clay (CH), with slickensides	23		99	62	21	41
	-with calcareous nodules and voids 14'-16'						
	-tan and gray 16'-25'	33	90				
	-with voids 18'-20'	32					
20							
	-with ferrous nodules 23'-25'	33	88	95	79	31	48
25	Termination Depth = 25 Feet						
30							
35							

BORING DRILLED TO **25** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

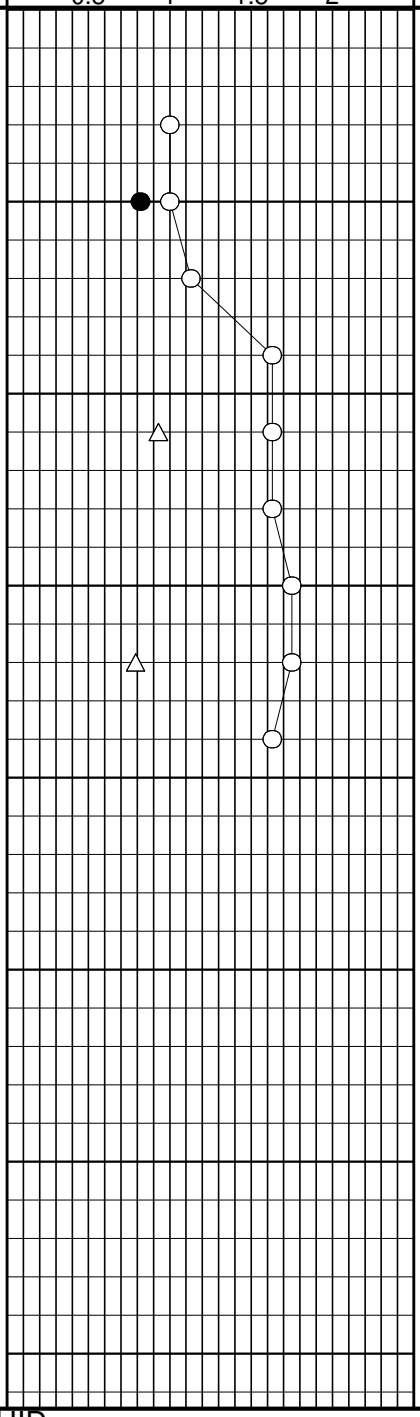
PROJECT: **Southpark and Southcrest Drainage** BORING **B-16**

DATE **6/26/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 2.25" asphalt							
			Pavement: 8" concrete		26					
			Stiff to very stiff, dark gray Fat Clay (CH), with slickensides		29		91	70	23	47
			-with calcareous nodules 1'-2'							
			-dark olive 4'-6'		27	97				
5			-gray and tan 6'-8'		27					
			tan 8'-10', with calcareous nodules 8'-14' and ferrous stains 8'-12'		26		88	70	22	48
10			-gray and tan 10'-12'		20	105				
			-reddish tan and gray 12'-16'		23					
15					28		99	72	23	49
			-reddish brown, with abundant calcareous nodules 16'-18'		30	94				
			-red 18'-20'		31					
20			Termination Depth = 20 Feet							
25										
30										
35										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



Survey Coordinates (ft):
Easting: 3133189.33
Northing: 13815054.83
Elevation: 37.46

BORING DRILLED TO **20** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-17**

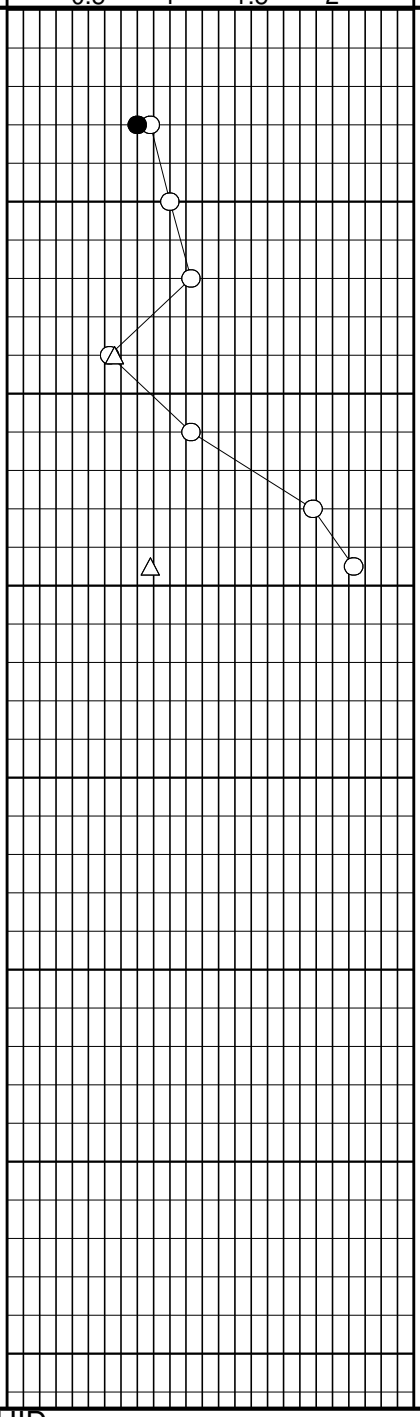
DATE **6/26/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3133407.56
Northing: 13814910.37
Elevation: 37.61

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 2" asphalt							
	Pavement: 6" concrete		29					
	Stiff to hard, olive gray Fat Clay (CH), with slickensides		32	92				
	-with ferrous nodules 2'-4'				90	78	23	55
5			30					
	-gray and tan 6'-8'		30					
	-tan and dark gray 8'-10', with calcareous nodules 8'-15'		28	94				
10	-reddish tan and gray 10'-12'		21					
	-reddish tan 12'-14'		24		96	66	20	46
	-reddish brown, with calcareous nodules 14'-15'		22	103				
15	Termination Depth = 15 Feet							
20								
25								
30								
35								

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-18**

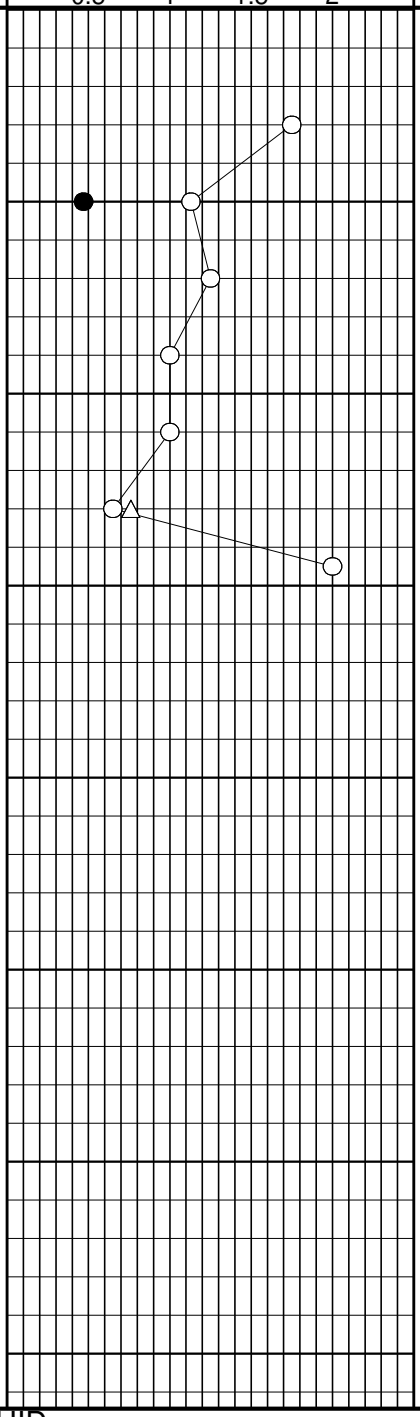
DATE **6/27/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3133741.39
Northing: 13815140.30
Elevation: 36.13

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 2" asphalt							
	Pavement: 7" concrete							
	Firm to very stiff, olive Fat Clay w/Sand (CH), with slickensides		22					
	-olive gray 2'-4'		22		80	70	22	48
5	-gray and tan 4'-14', with ferrous nodules 4'-12'		28	95				
			27					
			29					
10			28		84	68	25	43
	-with sand partings 12'-14'		17	115				
15	-reddish tan and gray, with calcareous nodules 14'-15'		18					
	Termination Depth = 15 Feet							
20								
25								
30								
35								

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-19**

DATE **6/26/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	SHEAR STRENGTH, TSF (△ Confined Compression, ● Unconfined Compression, ○ Pocket Penetrometer, □ Torvane; 0.5, 1, 1.5, 2)	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
			Survey Coordinates (ft): *Easting: 3134271.69* *Northing: 13815346.81* *Elevation: 36.36*								
0			Pavement: 2.5" asphalt								
			Pavement: 4" concrete		19						
			Very stiff to hard, dark brown Fat Clay w/ Sand (CH), with slickensides		21			85	74	23	51
			-dark gray, with silty sand pockets 2'-4'								
			-olive gray 4'-6'								
5					21	104					
			-tan and gray, with ferrous nodules 6'-10' and calcareous nodules 6'-8'		23						
					22						
10			Termination Depth = 10 Feet								
15											
20											
25											
30											
35											

BORING DRILLED TO **10** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING

WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**

DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

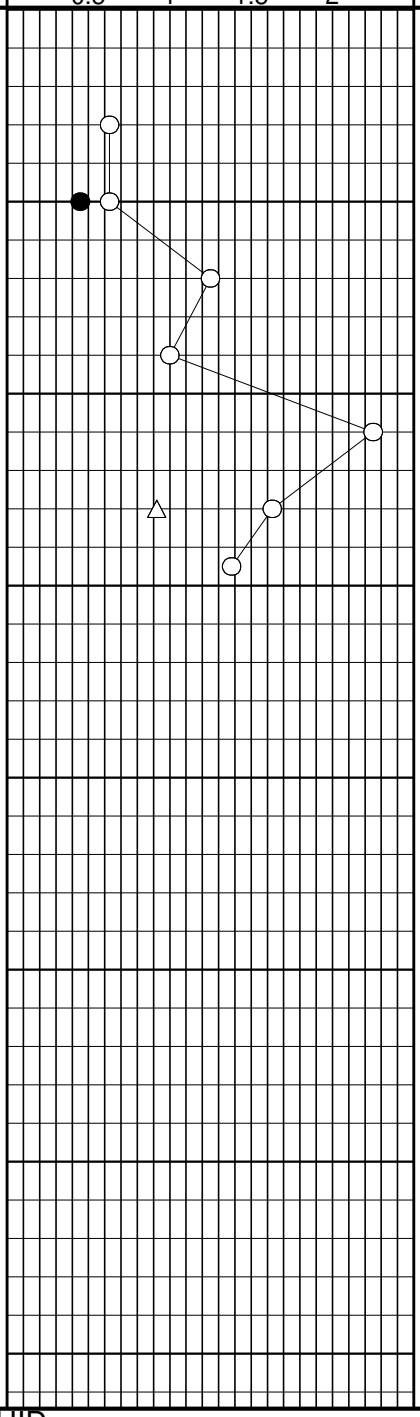
PROJECT: **Southpark and Southcrest Drainage** BORING **B-20**

DATE **6/26/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
			Survey Coordinates (ft): *Easting: 3133680.65* *Northing: 13814831.07* *Elevation: 36.71*							
0			Pavement: 8.75" concrete							
			Fill: stabilized gray clay, with silty sand pockets		28					
			Firm to hard, dark gray and olive gray Fat Clay (CH), with slickensides		30		91	74	24	50
5			-olive gray 4'-6', with ferrous nodules 4'-8'		30	93				
			-tan 6'-8'		29					
			-reddish tan and gray 8'-10', with calcareous nodules 8'-12'		29					
10			-reddish brown and gray 10'-12'		22		99	64	22	42
			-reddish brown 12'-14'		28	96				
			-reddish tan and gray 14'-15'		28					
15			Termination Depth = 15 Feet							
20										
25										
30										
35										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING

WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**

DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

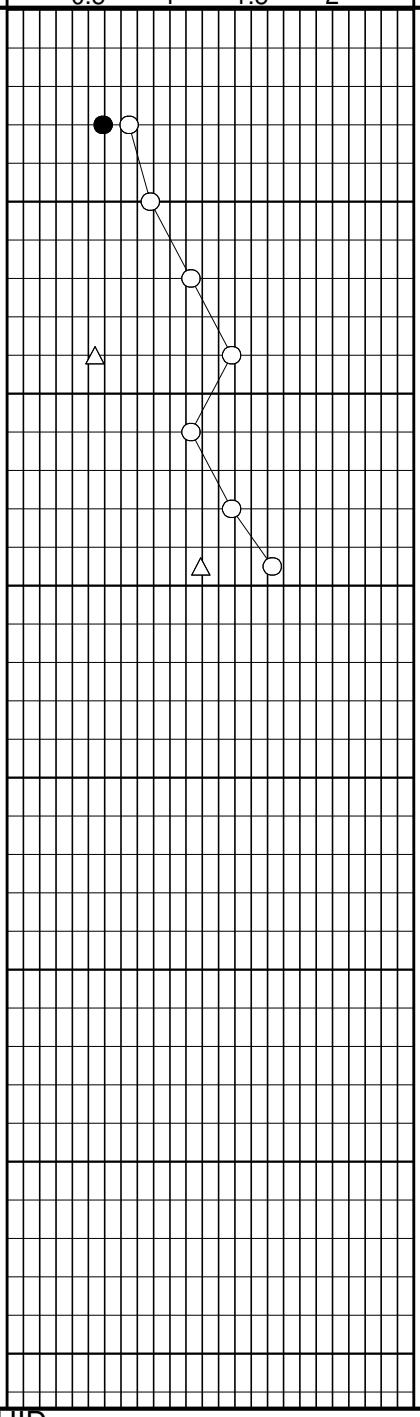
PROJECT: **Southpark and Southcrest Drainage** BORING **B-21**

DATE **6/26/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 9" concrete							
			Fill: stabilized gray clay		42					
			Stiff to very stiff, olive gray Fat Clay w/ Sand (CH), with slickensides		33	90				
			-tan and gray 4'-6', with ferrous nodules 4'-10'				84	77	24	53
5					32					
			-tan 6'-8'		30					
			-gray and tan 8'-10'		27	95				
10			Very stiff, reddish brown and gray Fat Clay (CH), with slickensides		25					
			-with ferrous and calcareous nodules 10'-12'				97	75	23	52
			-reddish tan 12'-14'		28					
			-red 14'-15'		28	97				
15			Termination Depth = 15 Feet							
20										
25										
30										
35										

Survey Coordinates (ft):
Easting: 3134175.74
Northing: 13814974.68
Elevation: 36.33

SHEAR STRENGTH, TSF



△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane

BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-22**

DATE **6/27/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3134235.70
Northing: 13814693.95
Elevation: 36.25

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane (0.5, 1, 1.5, 2)

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 6.75" concrete							
			Fill: stabilized brown clay		35					
			Firm to stiff, dark gray Fat Clay (CH), with slickensides		34		94	84	26	58
			-with ferrous nodules 4'-5'		32	89				
5			Termination Depth = 5 Feet							
10										
15										
20										
25										
30										
35										

BORING DRILLED TO **5** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

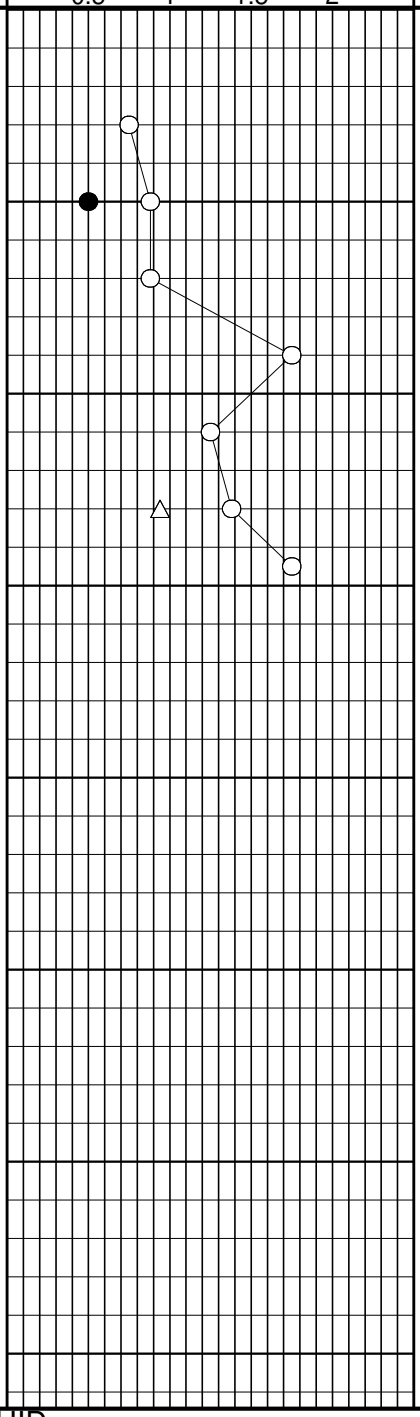
PROJECT: **Southpark and Southcrest Drainage** BORING **B-23**

DATE **6/27/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3133746.85
Northing: 13814522.15
Elevation: 35.64

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 6.5" concrete							
	Fill: stabilized gray clay		29					
	Stiff to very stiff, gray Fat Clay (CH), with slickensides		34		93	88	27	61
	-tan 4'-6', with ferrous nodules 4'-8'							
5			32	90				
	-gray and tan 6'-8'		31					
	-reddish tan and gray 8'-14', with ferrous stains 8'-10' and calcareous nodules 8'-12'		22					
10					98	75	28	47
			29					
			26	97				
	-reddish brown 14'-15'		29					
15	Termination Depth = 15 Feet							
20								
25								
30								
35								

SHEAR STRENGTH, TSF



BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-24**

DATE **6/27/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3133331.99
Northing: 13814404.85
Elevation: 37.77

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane (0.5, 1, 1.5, 2)

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 0.5" asphalt							
	Pavement: 5.75" concrete							
	Stiff to hard, dark gray Fat Clay (CH), with slickensides		30					
			29		94	76	23	53
	-olive brown 4'-6', with ferrous nodules 4'- 14'							
5			28	93				
	gray and tan 6'-12'							
			30					
			27		93	69	22	47
10								
			26	100				
	-reddish tan and gray, with calcareous nodules 12'-15' and silty clay pockets 12'-14'		20					
			24		99	62	23	39
15	Termination Depth = 15 Feet							
20								
25								
30								
35								

BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-25**

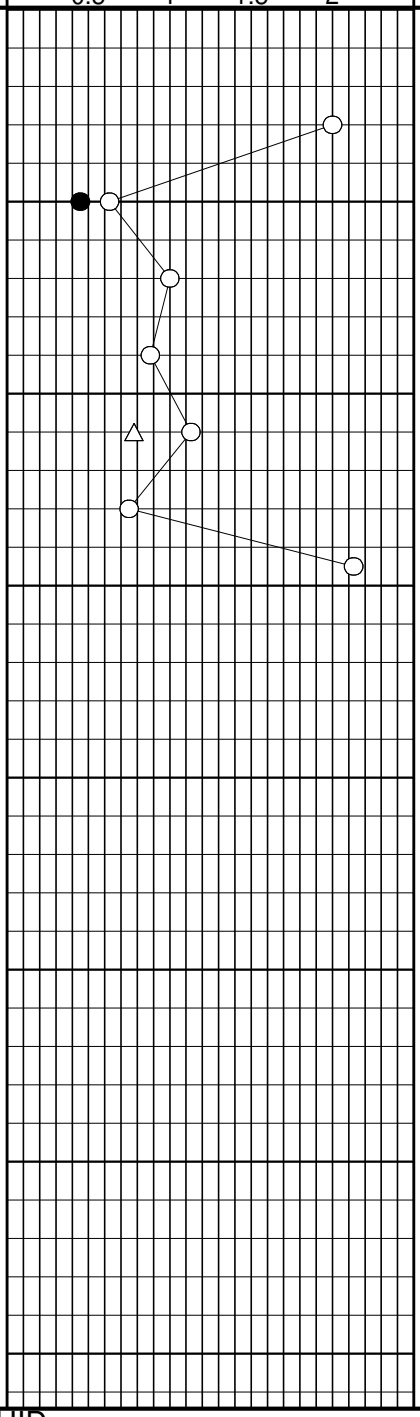
DATE **6/27/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3133655.76
Northing: 13814235.54
Elevation: 36.68

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 6.5" concrete							
			Fill: stabilized gray clay, with fat clay pockets		32					
					33					
5			Firm to hard, gray Fat Clay (CH), with slickensides		28	96	94	74	24	50
			-tan and gray 6'-10', with ferrous nodules 6'-8'		29					
					29					
10			-reddish tan and tan, with calcareous nodules 10'-12'		29	101				
			-reddish tan and gray 12'-14'		30		98	69	25	44
			-reddish tan 14'-15'		25					
15			Termination Depth = 15 Feet							
20										
25										
30										
35										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **15** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **Southpark and Southcrest Drainage** BORING **B-26**

DATE **6/27/12** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

Survey Coordinates (ft):
Easting: 3134139.16
Northing: 13814359.90
Elevation: 36.56

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 6.5" concrete							
			Fill: stabilized gray clay		30					
			-with fat clay pockets 1'-2'				95	83	25	58
			Firm to very stiff, olive gray Fat Clay (CH), with ferrous nodules		33					
			-gray and tan 4'-5'		29	92				
5			Termination Depth = 5 Feet							
10										
15										
20										
25										
30										
35										

BORING DRILLED TO **5** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **n/a** FEET WHILE DRILLING
WATER LEVEL AT **n/a** FEET AFTER **1/4 HR**
DRILLED BY **Van & Sons** CHECKED BY **WW** LOGGED BY **CB**

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
	Paving
	Fill
	High plasticity clay
	Low plasticity clay
	Silt
	Poorly graded sand with silt
	Clayey sand
Misc. Symbols	
○	Pocket Penetrometer
●	Unconfined Compression
△	Confined Compression
	Water table depth during drilling
	Subsequent water table depth
Soil Samplers	
	Auger
	Undisturbed thin wall Shelby tube
	Standard penetration test

AYLES ENGINEERING CORP.

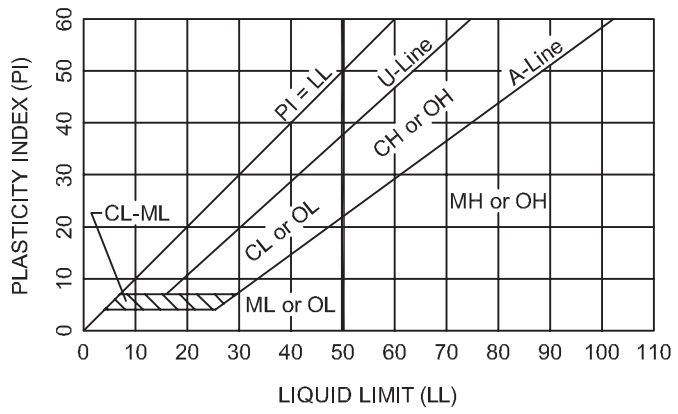
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation D-2487

MAJOR DIVISIONS				GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (Less than 50% of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)		GW	Well-graded gravel, well-graded gravel with sand
				GP	Poorly-graded gravel, poorly-graded gravel with sand
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart	GM	Silty gravel, silty gravel with sand
			Limits plot above "A" line & hatched zone on plasticity chart	GC	Clayey gravel, clayey gravel with sand
	SANDS (50% or more of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)		SW	Well-graded sand, well-graded sand with gravel
				SP	Poorly-graded sand, poorly-graded sand with gravel
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart	SM	Silty sand, silty sand with gravel
			Limits plot above "A" line & hatched zone on plasticity chart	SC	Clayey sand, clayey sand with gravel
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)		SILTS AND CLAYS (Liquid Limit Less Than 50%)		ML	Silt, silt with sand, silt with gravel, sandy silt, gravelly silt
				CL	Lean clay, lean clay with sand, lean clay with gravel, sandy lean clay, gravelly lean clay
				OL	Organic clay, organic clay with sand, sandy organic clay, organic silt, sandy organic silt
		SILTS AND CLAYS (Liquid Limit 50% or More)		MH	Elastic silt, elastic silt with sand, sandy elastic silt, gravelly elastic silt
				CH	Fat clay, fat clay with sand, fat clay with gravel, sandy fat clay, gravelly fat clay
				OH	Organic clay, organic clay with sand, sandy organic clay, organic silt, sandy organic silt

NOTE: Coarse soils between 5% and 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone of the plasticity chart are to have dual symbols.

PLASTICITY CHART



Equation of A-Line: Horizontal at PI=4 to LL=25.5, then PI=0.73(LL-20)

Equation of U-Line: Vertical at LL=16 to PI=7, then PI=0.9(LL-8)

DEGREE OF PLASTICITY OF COHESIVE SOILS

Degree of Plasticity	Plasticity Index
None	0 - 4
Slight	5 - 10
Medium	11 - 20
High	21 - 40
Very High	>40

SOIL SYMBOLS

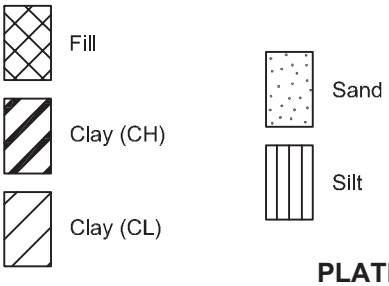


PLATE A-30

AYLES ENGINEERING CORP.

TERMS USED ON BORING LOGS

SOIL GRAIN SIZE

U.S. STANDARD SIEVE

6"	3"	3/4"	#4	#10	#40	#200	
BOULDERS	COBBLES	GRAVEL		SAND		SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	
152	76.2	19.1	4.76	2.00	0.420	0.074	0.002

SOIL GRAIN SIZE IN MILLIMETERS

STRENGTH OF COHESIVE SOILS

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

RELATIVE DENSITY OF COHESIONLESS SOILS FROM STANDARD PENETRATION TEST

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

SPLIT-BARREL SAMPLER DRIVING RECORD

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

NOTE: To avoid change to sampling tools, driving is limited to 50 blows during or after seating interval.

DRY STRENGTH ASTM D2488

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

MOISTURE CONDITION ASTM D2488

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy. The degree of slickensidedness depends upon the spacing of slickensides and the easiness of breaking along these planes.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil types.
Interlayered	Soil sample composed of alternating layers of different soil types.
Intermixed	Soil sample composed of pockets of different soil types and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of calcium material.

ASTM & TXDOT DESIGNATION FOR SOIL LABORATORY TESTS

NAME OF TEST	ASTM TEST DESIGNATION	TXDOT TEST DESIGNATION
Moisture Content	D 2216	Tex-103-E
Specific Gravity	D 854	Tex-108-E
Sieve Analysis	D 421 D 422	Tex-110-E (Part 1)
Hydrometer Analysis	D 422	Tex-110-E (Part 2)
Minus No. 200 Sieve	D 1140	Tex-111-E
Liquid Limit	D 4318	Tex-104-E
Plastic Limit	D 4318	Tex-105-E
Shrinkage Limit	D 427	Tex-107-E
Standard Proctor Compaction	D 698	Tex-114-E
Modified Proctor Compaction	D 1557	Tex-113-E
Permeability (constant head)	D 2434	-
Consolidation	D 2435	-
Direct Shear	D 3080	-
Unconfined Compression	D 2166	-
Unconsolidated-Undrained Triaxial	D 2850	Tex-118-E
Consolidated-Undrained Triaxial	D 4767	Tex-131-E
Pinhole Test	D 4647	-
California Bearing Ratio	D 1883	-
Unified Soil Classification System	D 2487	Tex-142-E

AVILES ENGINEERING CORP.

APPENDIX B

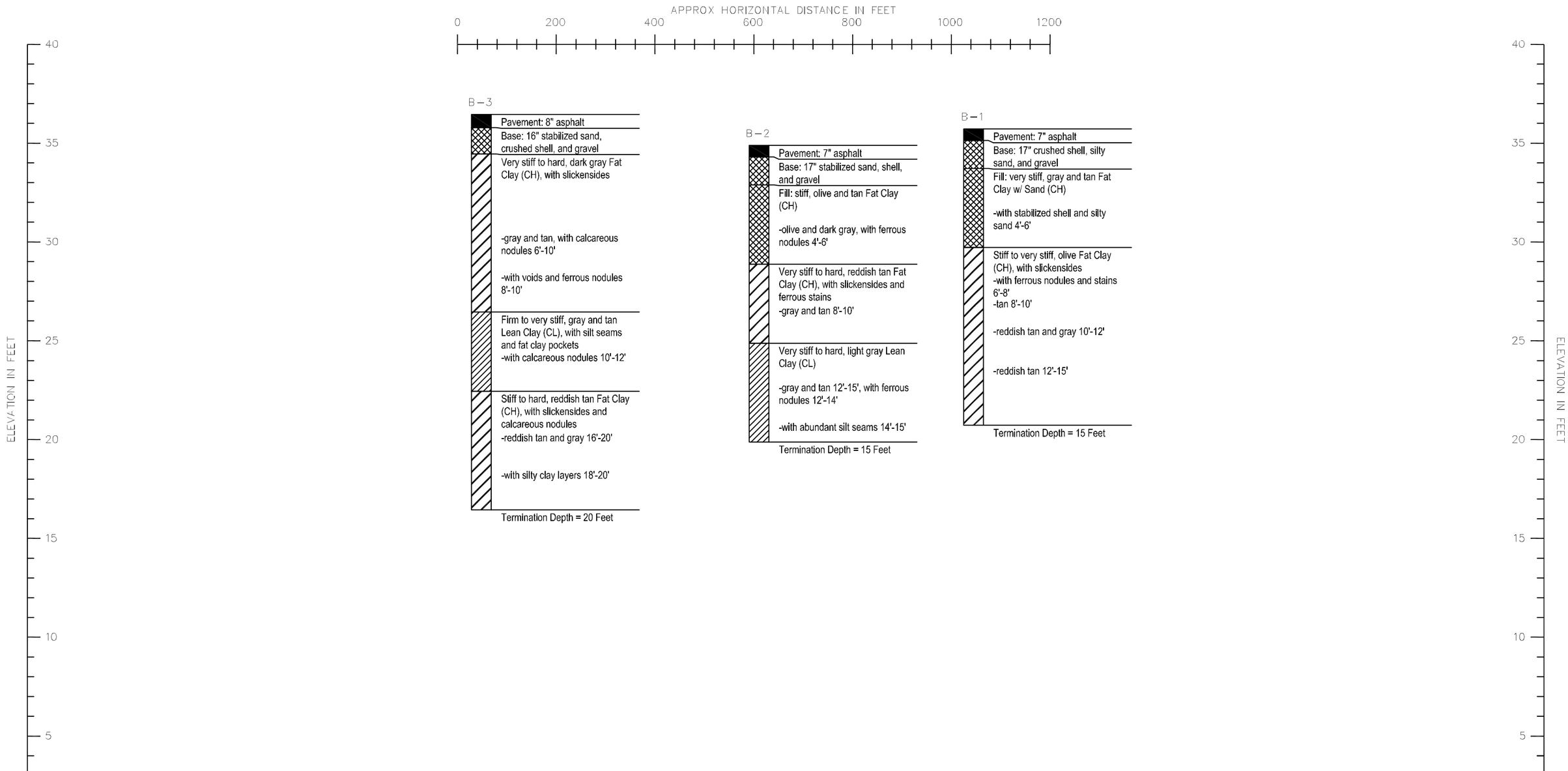
Plates B-1 to B-13	Generalized Soil Profile
Plates B-14 to B-17	Piezometer Details

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG SOUTHCREST

WEST

EAST



NOTES:

1. *SOIL STRATIGRAPHY AND SECONDARY SOIL STRUCTURE (SUCH AS SEAMS, LAYERS, OR POCKETS OF SANDS, SILTS, SLICKENSIDES, AND FISSURES) THAT ARE DIFFERENT FROM WHAT WERE IDENTIFIED IN THE ACTUAL BORINGS MAY EXIST AWAY FROM THESE BORINGS.*

AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

HOUSTON, TEXAS

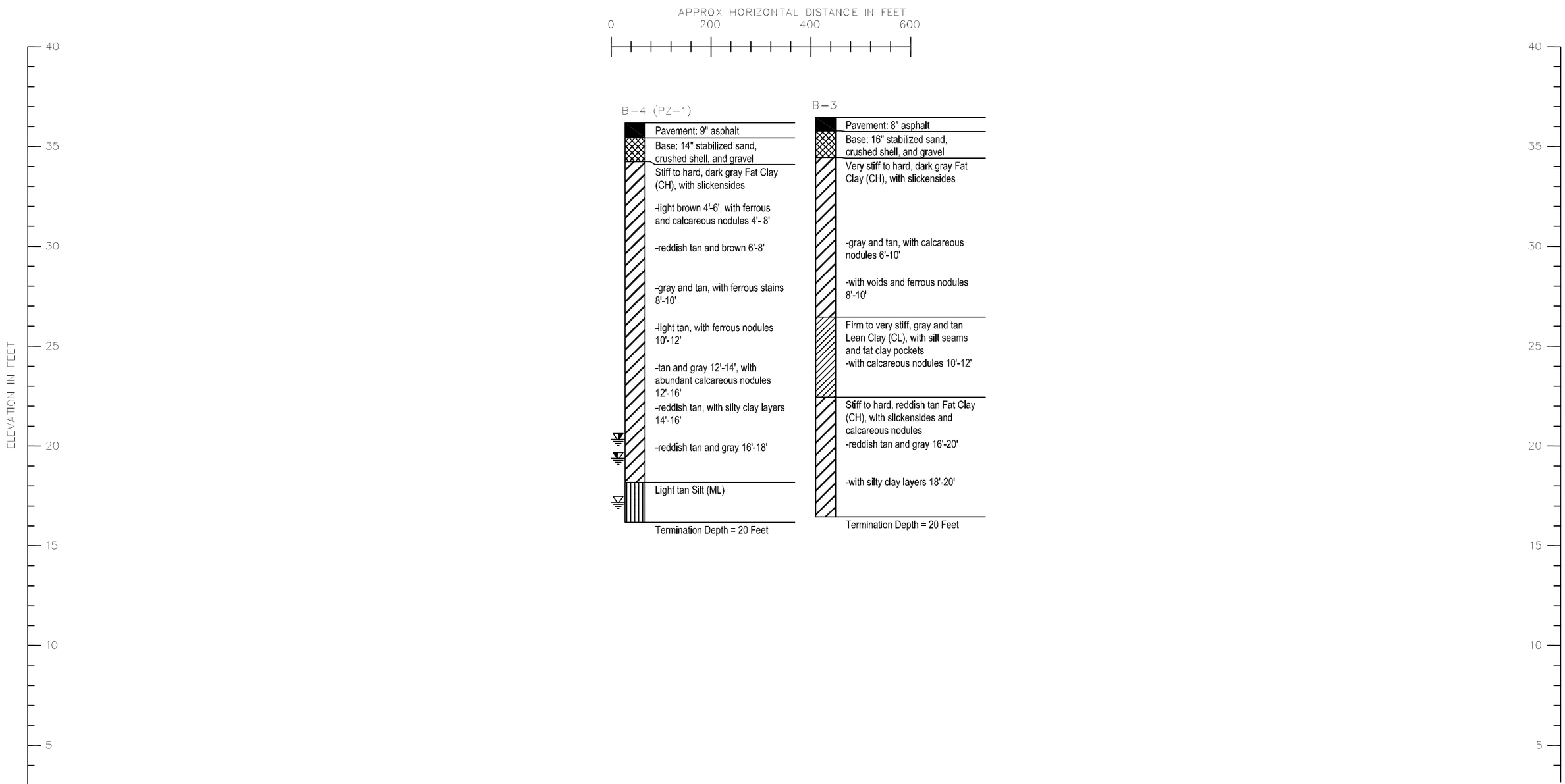
AEC PROJECT NO.: G121-12	DATE: 07-31-12	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-1

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG CRESTMONT

SOUTH

NORTH



LEGEND:

- Paving
- Fill
- Low plasticity clay
- High plasticity clay
- Clayey sand
- Silt
- Poorly graded sand with silt
- Depth of groundwater encountered during drilling
- Depth of groundwater ~15 min after initial encounter
- Depth of groundwater measured on 6/29/12 in piezometer
- Depth of groundwater measured on 7/27/12 in piezometer

NOTES:

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AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

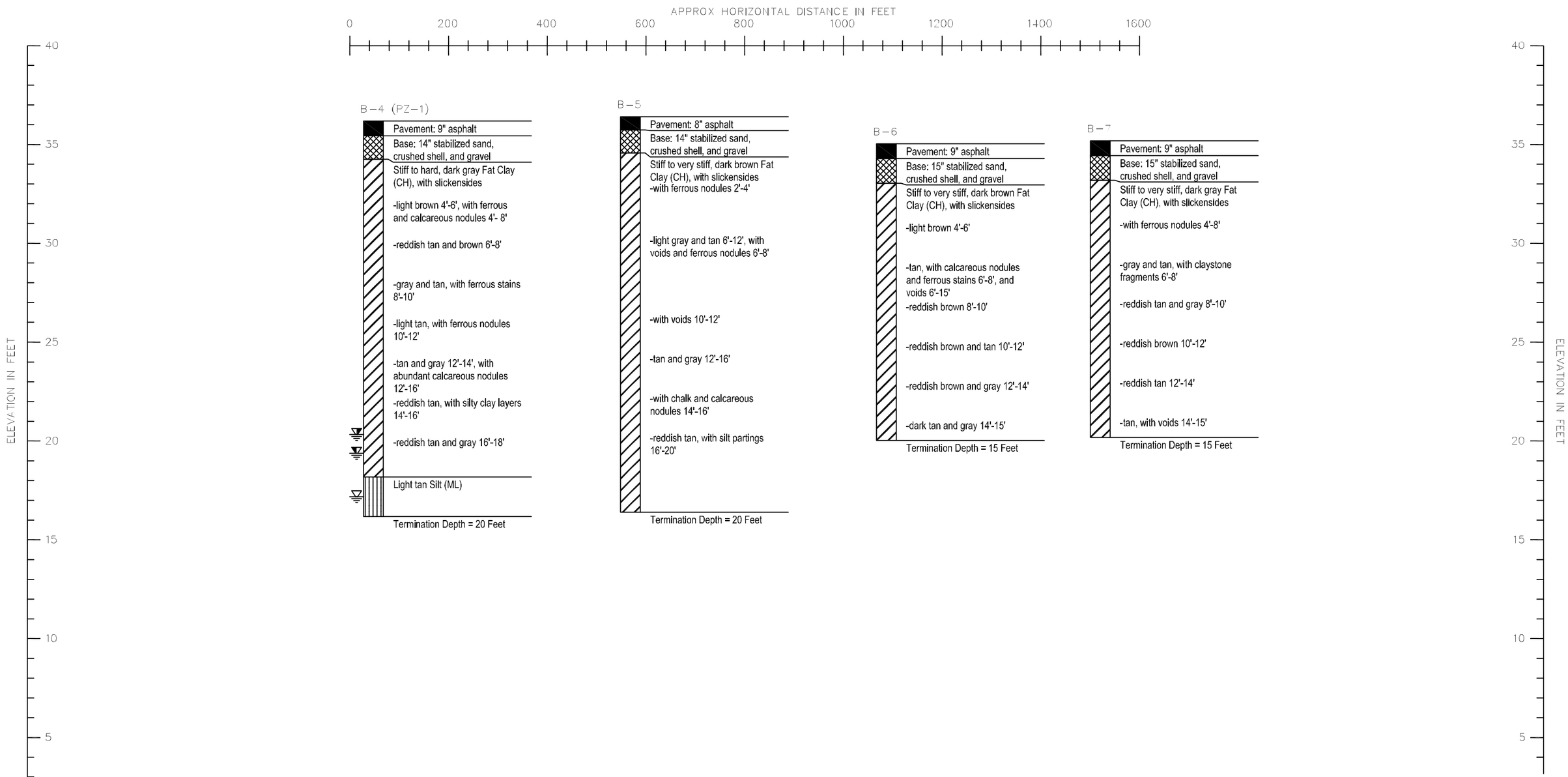
HOUSTON, TEXAS

AEC PROJECT NO.: G121-12	DATE: 07-31-12	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-2

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG SOUTHRIDGE

WEST — EAST



LEGEND:

- Paving
- Fill
- Low plasticity clay
- High plasticity clay
- Clayey sand
- Silt
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AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

HOUSTON, TEXAS

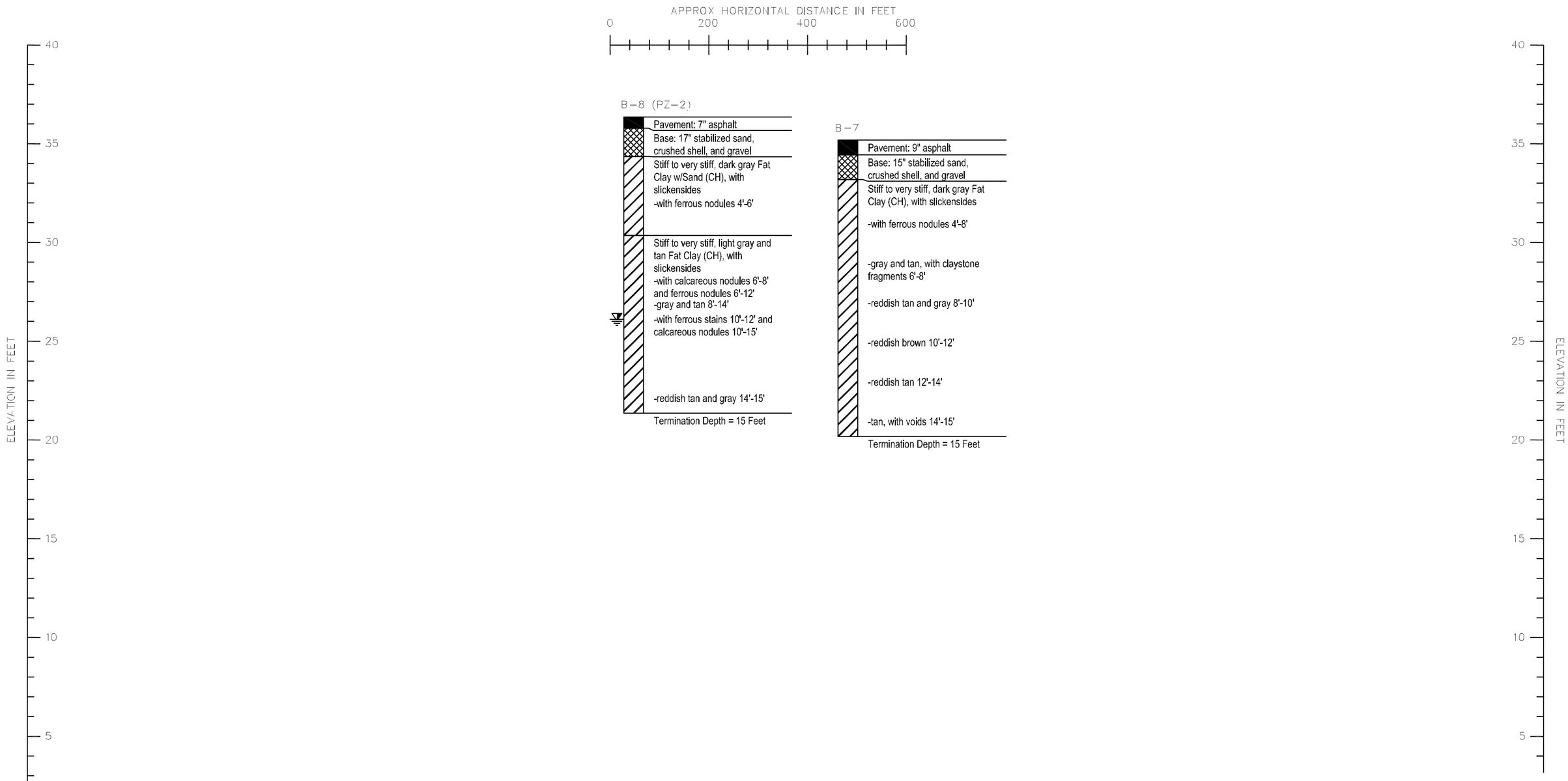
AEC PROJECT NO.:	DATE:	SOURCE DRAWING PROVIDED BY:
G121-12	07-31-12	AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 5' / HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-3

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG CRESTVILLE

SOUTH

NORTH



LEGEND:

- Paving
- Fill
- Low plasticity clay
- High plasticity clay
- Clayey sand
- Silt
- Poorly graded sand with silt
- Depth of groundwater encountered during drilling
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- Depth of groundwater measured on 7/27/12 in piezometer

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AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

HOUSTON, TEXAS

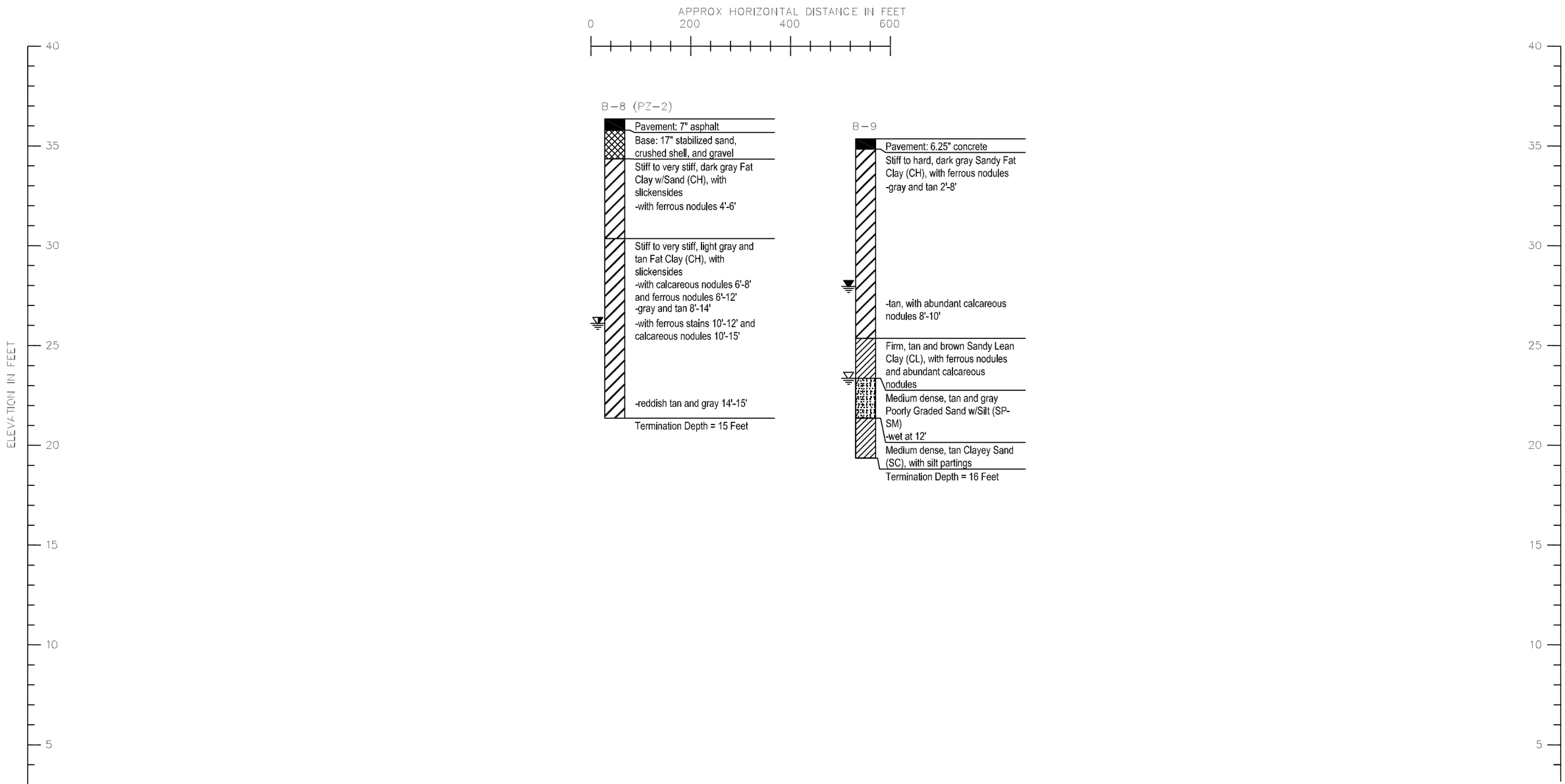
AEC PROJECT NO.: G121-12	DATE: 07-31-12	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-4

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG SOUTHLEA

WEST

EAST



LEGEND:

- Paving
- Fill
- Low plasticity clay
- High plasticity clay
- Clayey sand
- Silt
- Poorly graded sand with silt
- Depth of groundwater encountered during drilling
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- Depth of groundwater measured on 6/29/12 in piezometer
- Depth of groundwater measured on 7/27/12 in piezometer

NOTES:

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AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

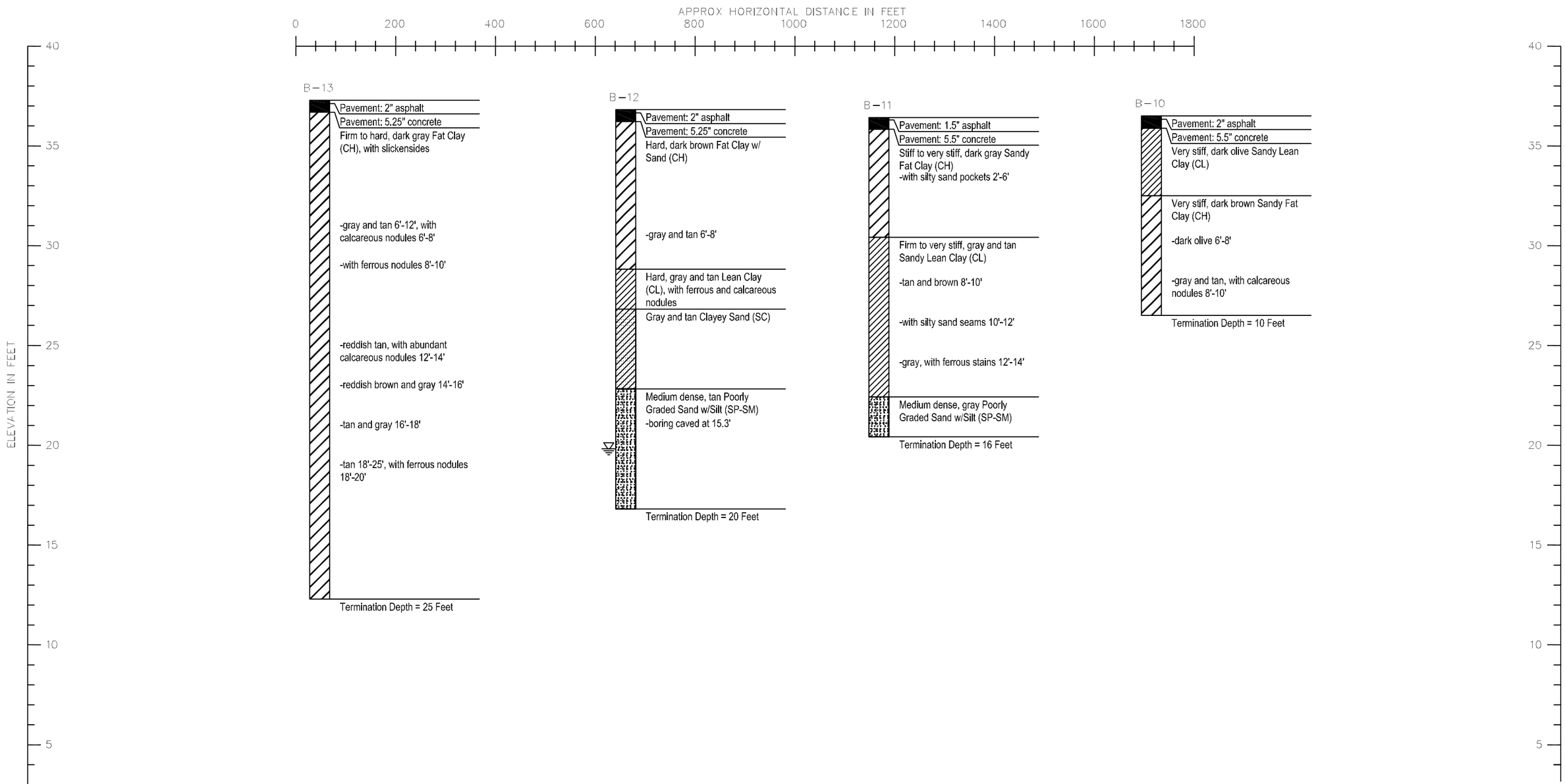
HOUSTON, TEXAS

AEC PROJECT NO.: G121-12	DATE: 07-31-12	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-5

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG SOUTHMUND

WEST — EAST



LEGEND:

- Paving
- Fill
- Low plasticity clay
- High plasticity clay
- Clayey sand
- Silt
- Poorly graded sand with silt
- Depth of groundwater encountered during drilling
- Depth of groundwater ~15 min after initial encounter
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- Depth of groundwater measured on 7/27/12 in piezometer

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AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

HOUSTON, TEXAS

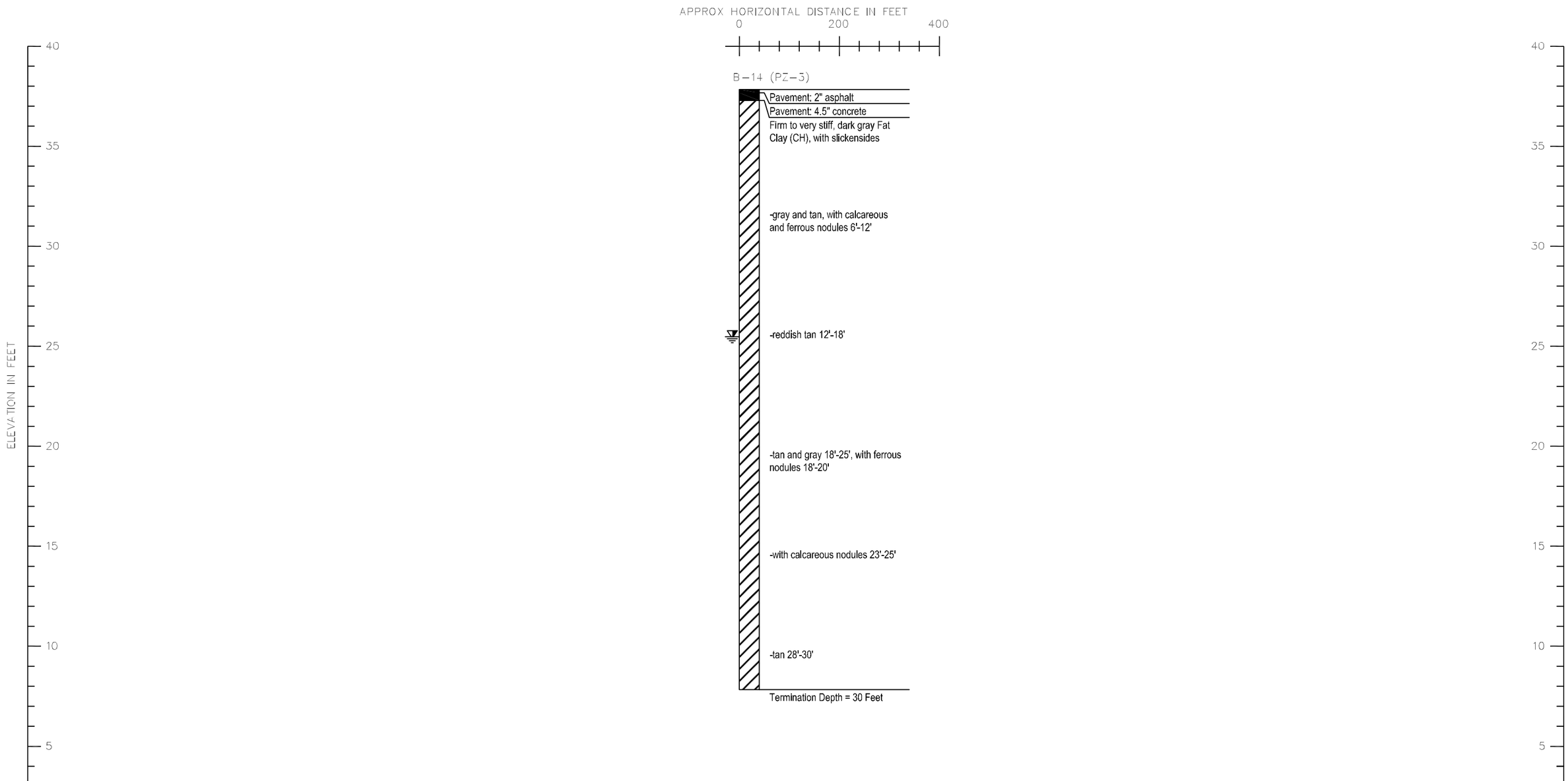
AEC PROJECT NO.: G121-12	DATE: 07-31-12	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-6

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG CHERBOURG

WEST

EAST



LEGEND:

- Paving
- Fill
- Low plasticity clay
- High plasticity clay
- Clayey sand
- Silt
- Poorly graded sand with silt
- Depth of groundwater encountered during drilling
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AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

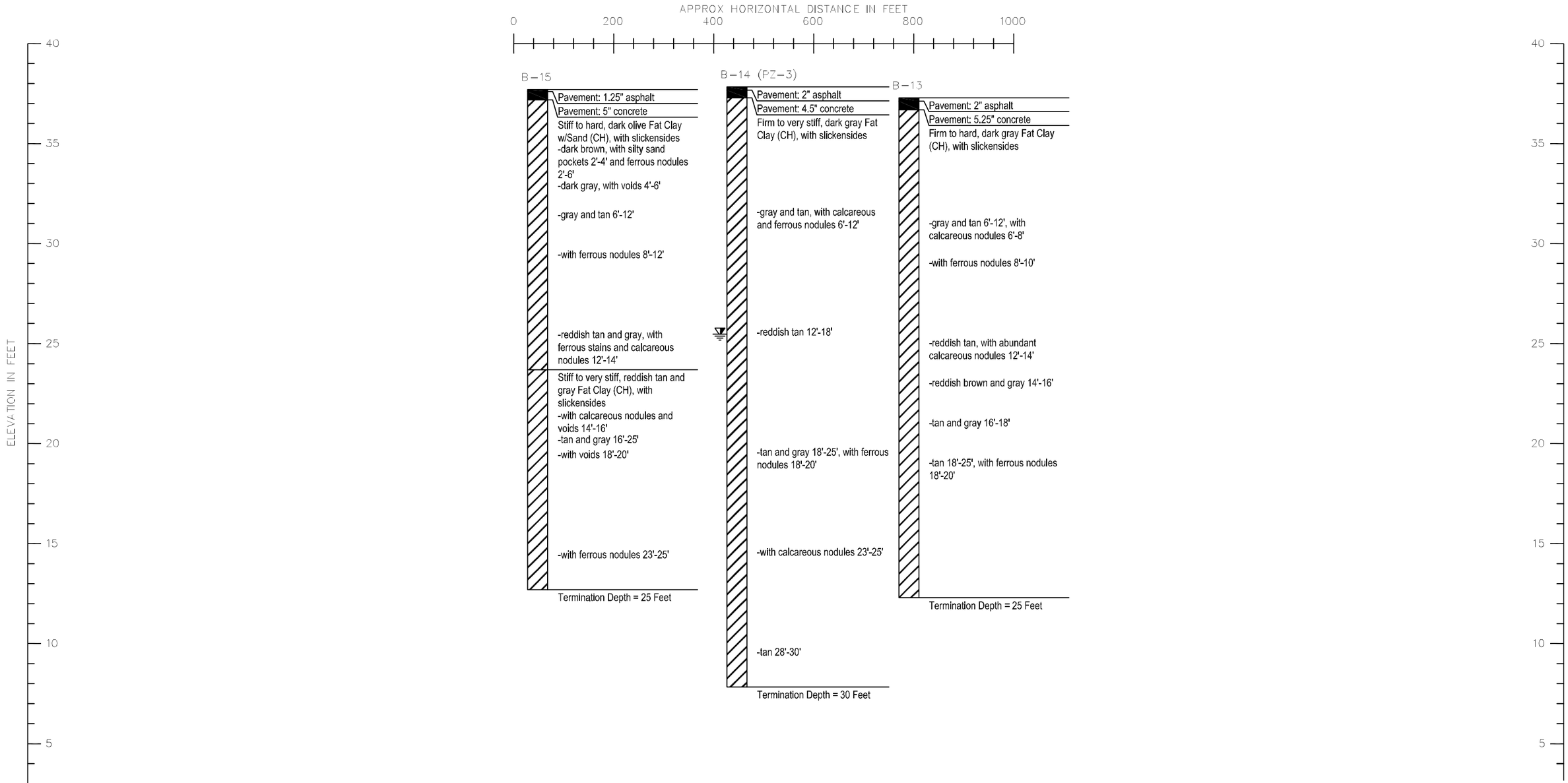
HOUSTON, TEXAS

AEC PROJECT NO.: G121-12	DATE: 07-31-12	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-7

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG CRESTRIDGE

SOUTH — NORTH



LEGEND:

- Paving
- Fill
- Low plasticity clay
- High plasticity clay
- Clayey sand
- Silt
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- Depth of groundwater measured on 7/27/12 in piezometer

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AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

HOUSTON, TEXAS

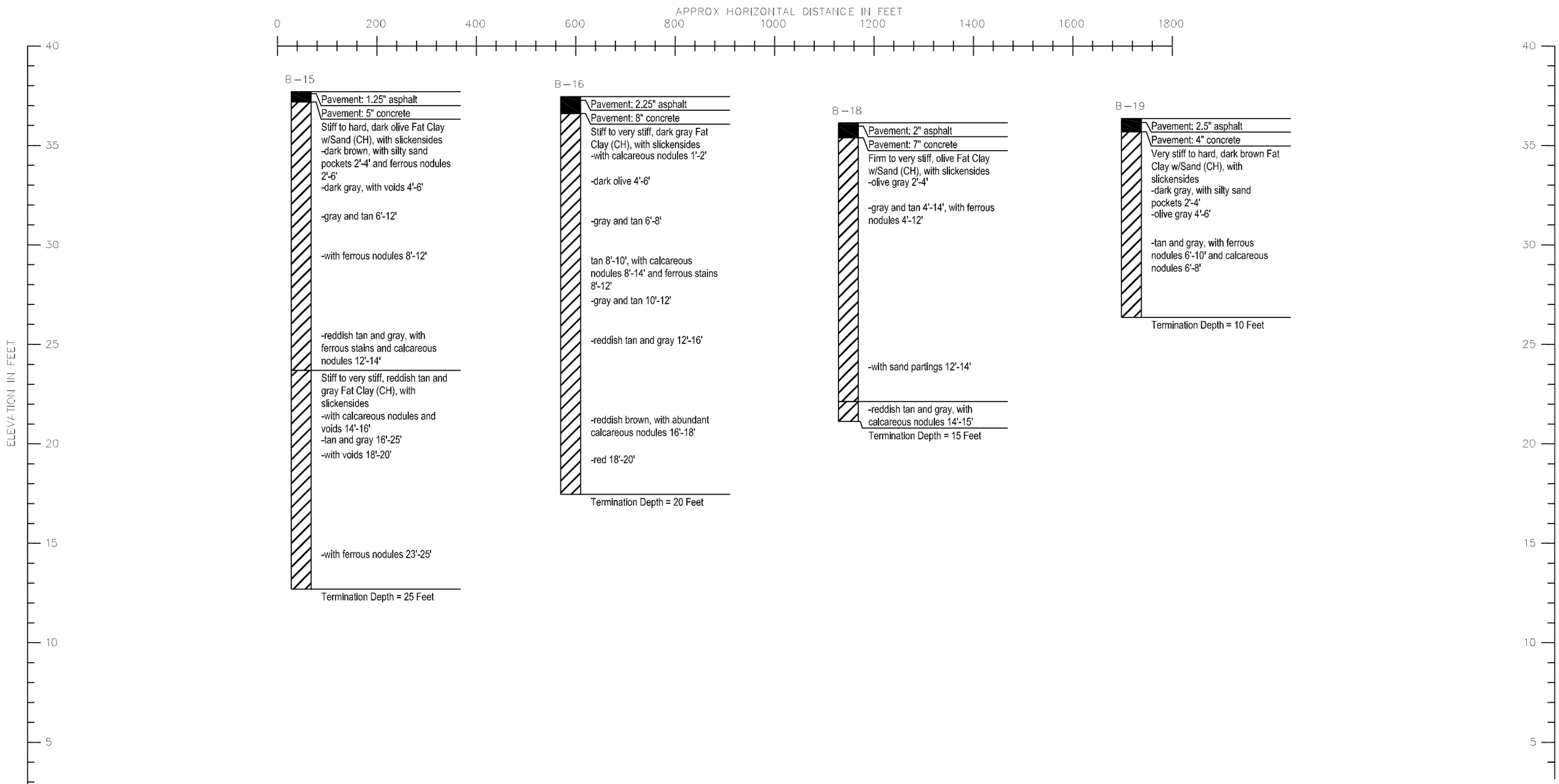
AEC PROJECT NO.:	DATE:	SOURCE DRAWING PROVIDED BY:
G121-12	07-31-12	AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-8

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG SOUTHVILLE

WEST

EAST



LEGEND:

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- Fill
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- High plasticity clay
- Clayey sand
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- Poorly graded sand with silt
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AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

HOUSTON, TEXAS

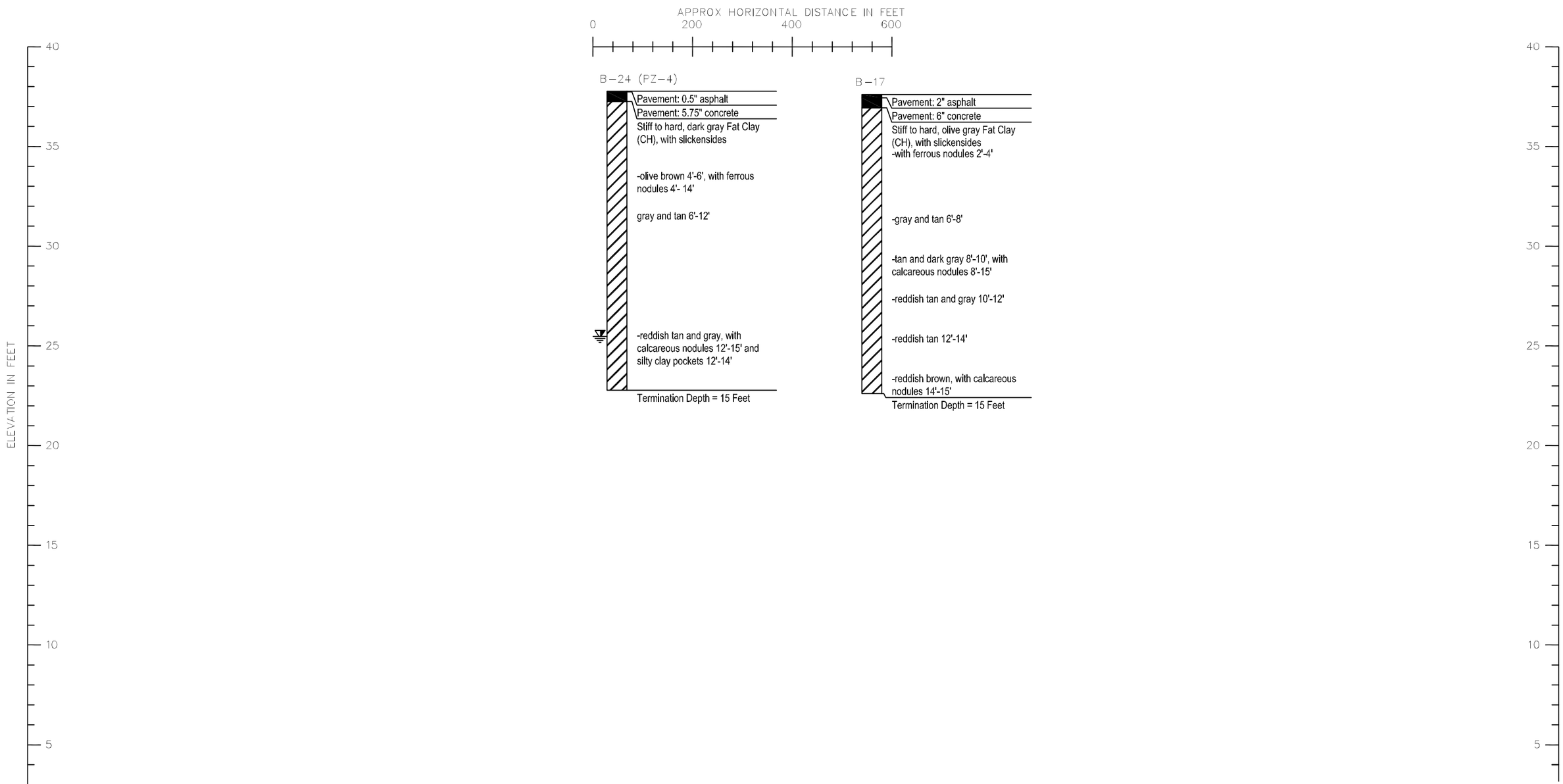
AEC PROJECT NO.: G121-12	DATE: 07-31-12	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-9

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG SOUTHBANK

SOUTH

NORTH



LEGEND:

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- Fill
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- Silt
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AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

HOUSTON, TEXAS

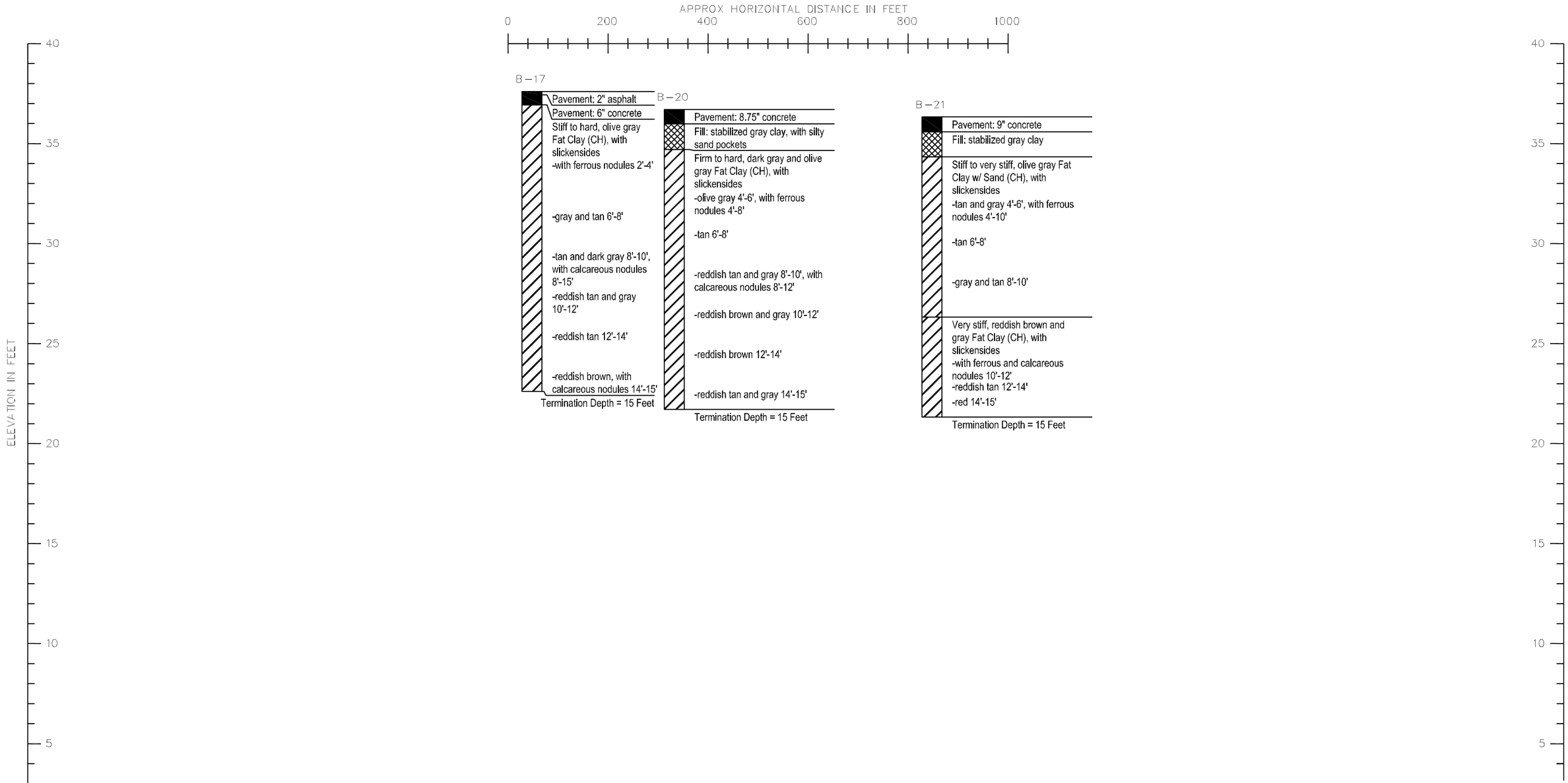
AEC PROJECT NO.:	DATE:	SOURCE DRAWING PROVIDED BY:
G121-12	07-31-12	AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-10

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG SOUTHINGTON

WEST

EAST



LEGEND:

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- Fill
- Low plasticity clay
- High plasticity clay
- Clayey sand
- Silt
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AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

HOUSTON, TEXAS

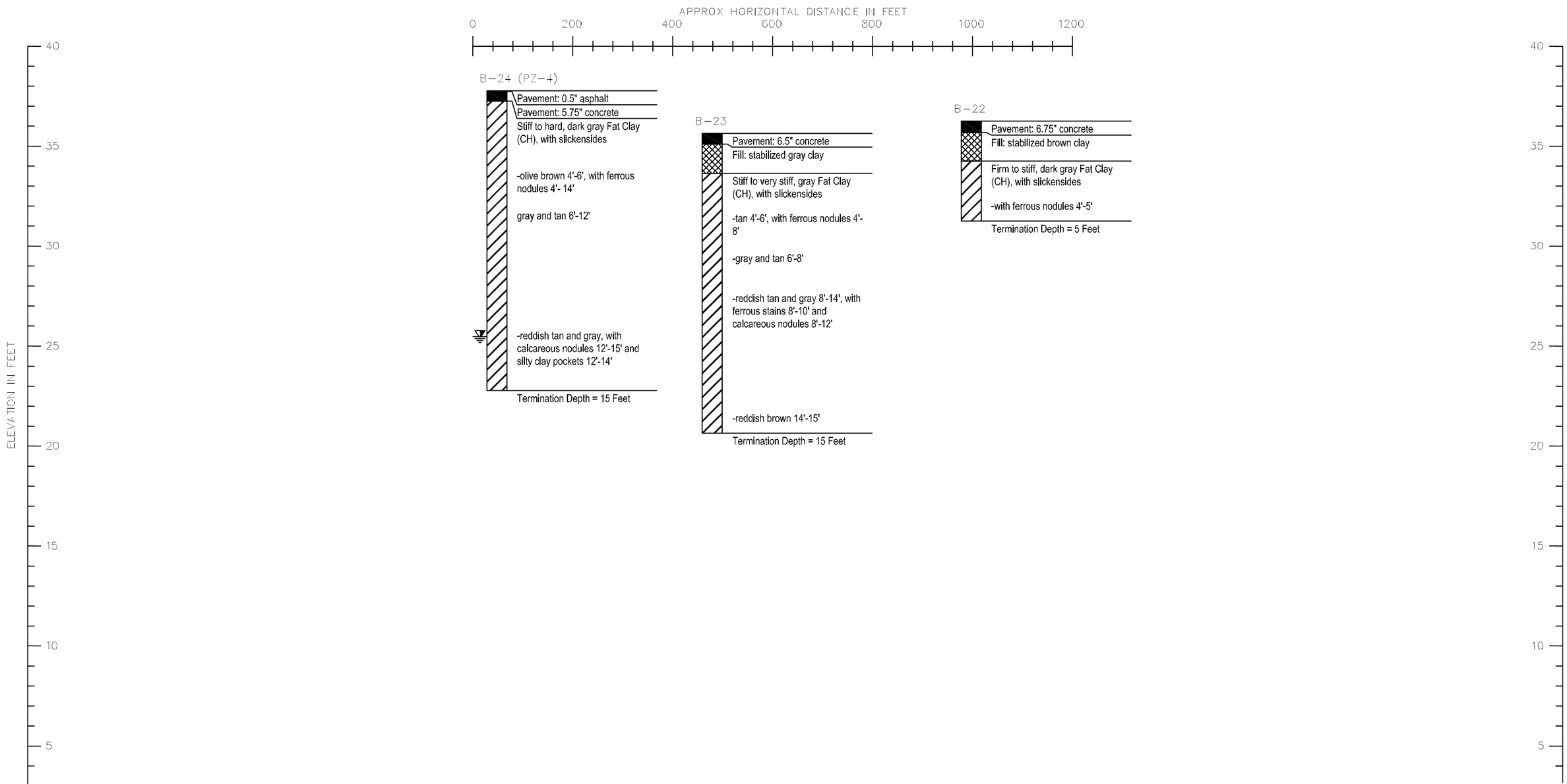
AEC PROJECT NO.:	DATE:	SOURCE DRAWING PROVIDED BY:
G121-12	07-31-12	AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-11

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG SOUTHGOOD

WEST

EAST



LEGEND:

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- Fill
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AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

HOUSTON, TEXAS

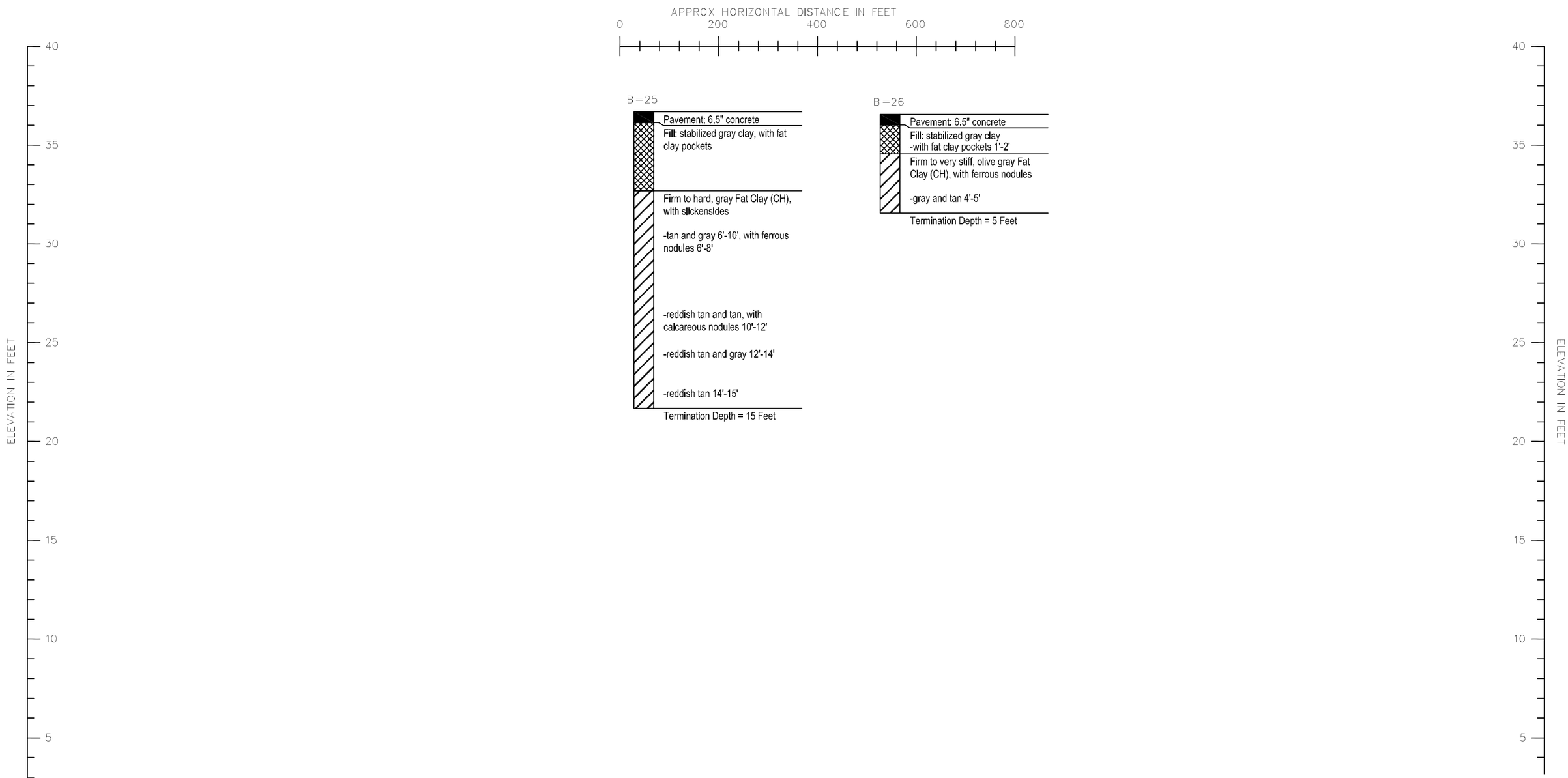
AEC PROJECT NO.: G121-12	DATE: 07-31-12	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-12

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG SOUTHFORD

WEST

EAST



LEGEND:

- Paving
- Fill
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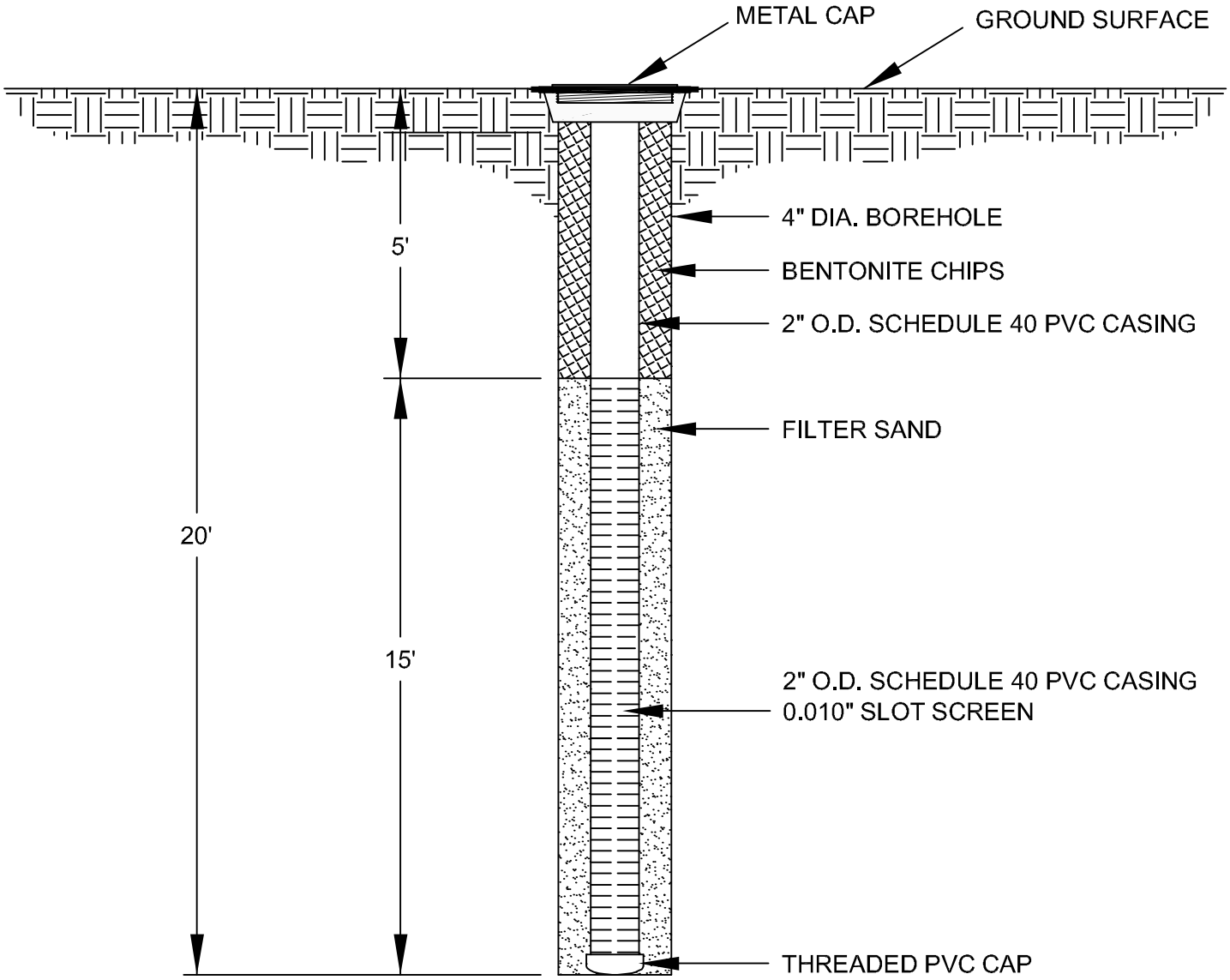
AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3

HOUSTON, TEXAS

AEC PROJECT NO.:	DATE:	SOURCE DRAWING PROVIDED BY:
G121-12	07-31-12	AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-13



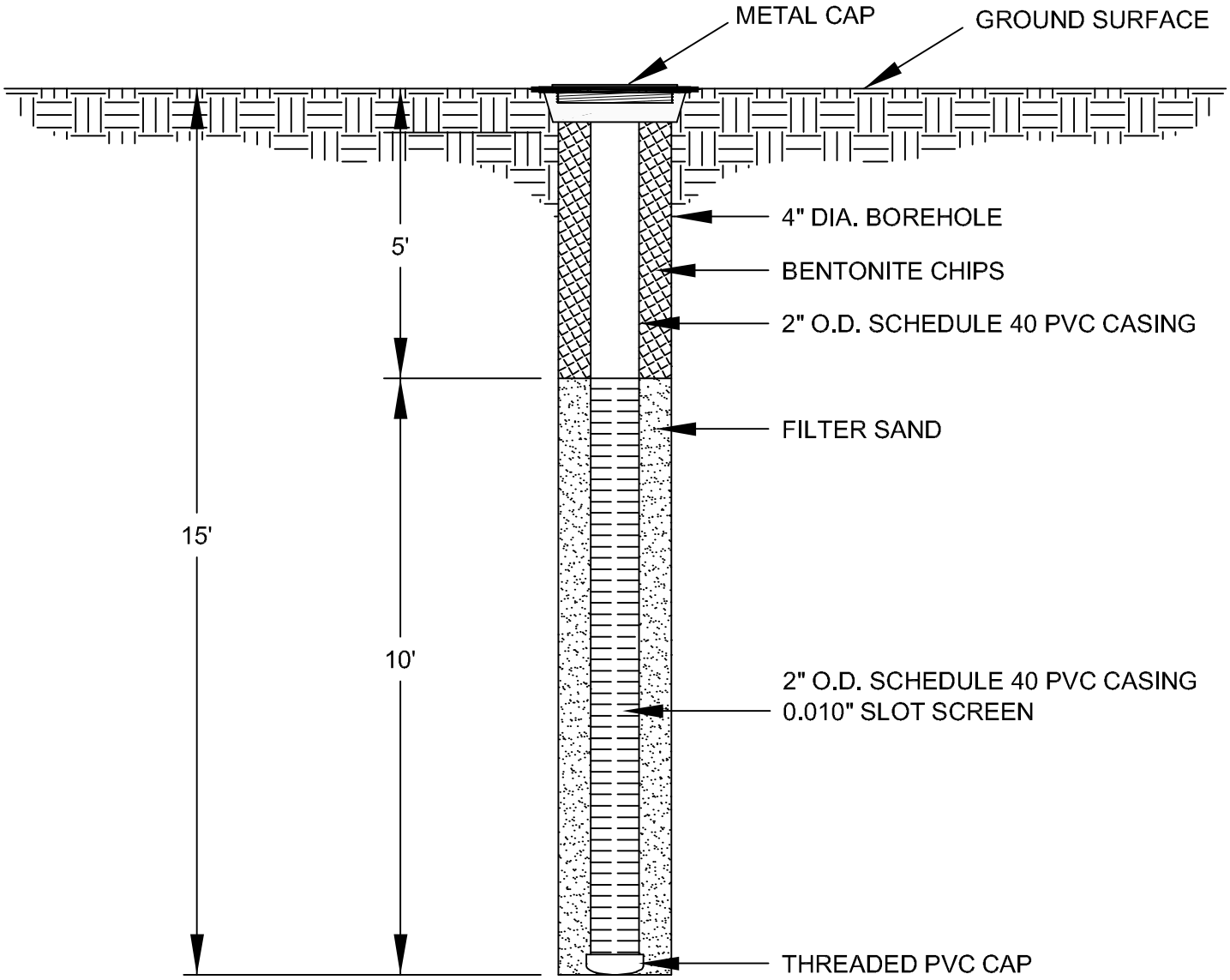
GROUNDWATER DEPTH FROM SURFACE:	DATE MEASURED:
17.6 ft.	6/29/12
15.8 ft.	7/27/12

AVILES ENGINEERING CORPORATION

PIEZOMETER INSTALLATION DETAILS
BORING B-4 (PZ-1)

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3
HOUSTON, TEXAS

AEC PROJECT NO.:	DATE:	SOURCE DWG. BY:
G121-12	08-07-12	AVILES ENGINEERING CORP.
SCALE: N.T.S.	DRAWN BY: BpJ	PLATE NO.: PLATE B-14



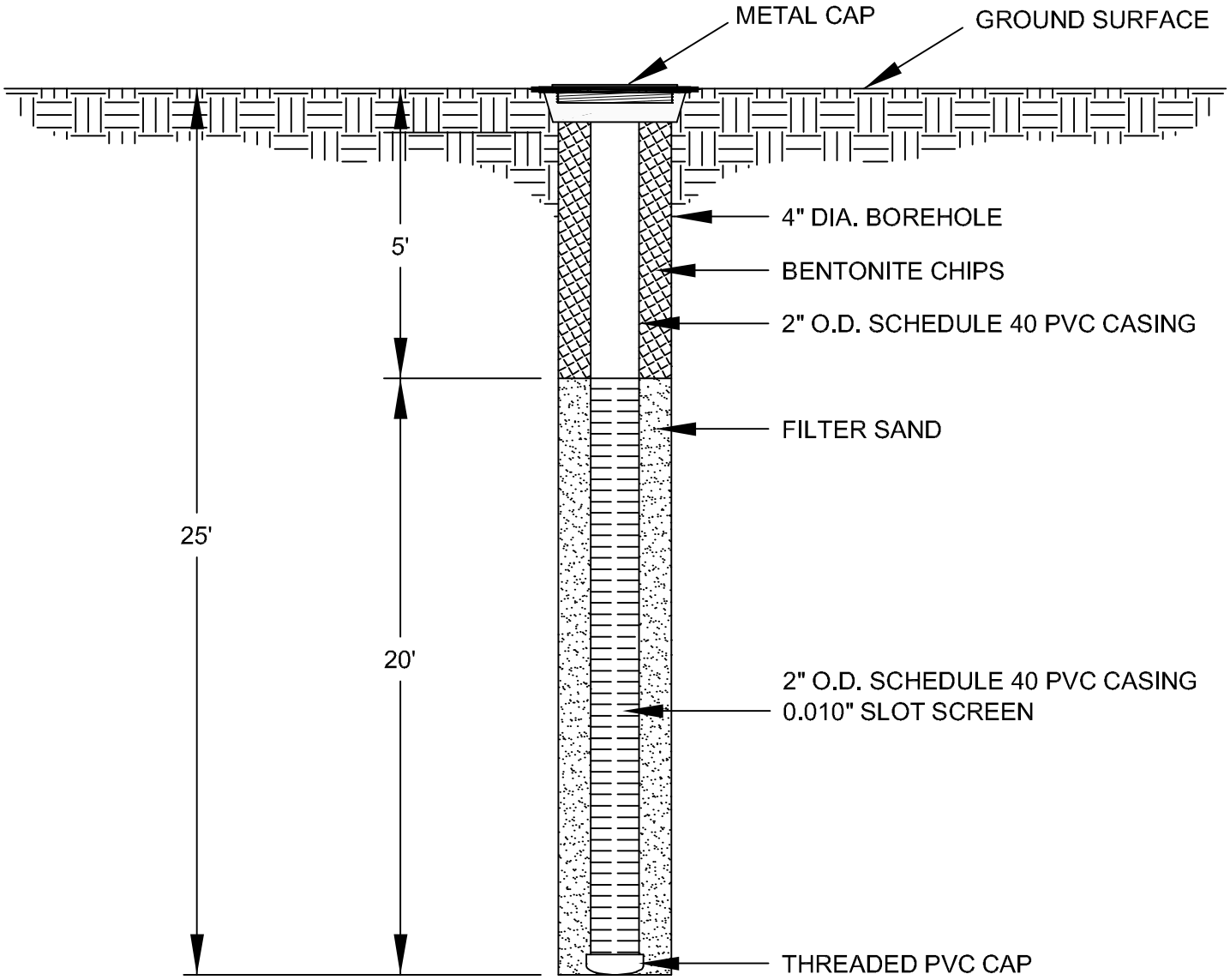
GROUNDWATER DEPTH FROM SURFACE:	DATE MEASURED:
DRY	6/29/12
10.2 ft.	7/27/12

AVILES ENGINEERING CORPORATION

PIEZOMETER INSTALLATION DETAILS
BORING B-8 (PZ-2)

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3
HOUSTON, TEXAS

AEC PROJECT NO.:	DATE:	SOURCE DWG. BY:
G121-12	08-07-12	AVILES ENGINEERING CORP.
SCALE: N.T.S.	DRAWN BY: BpJ	PLATE NO.: PLATE B-15



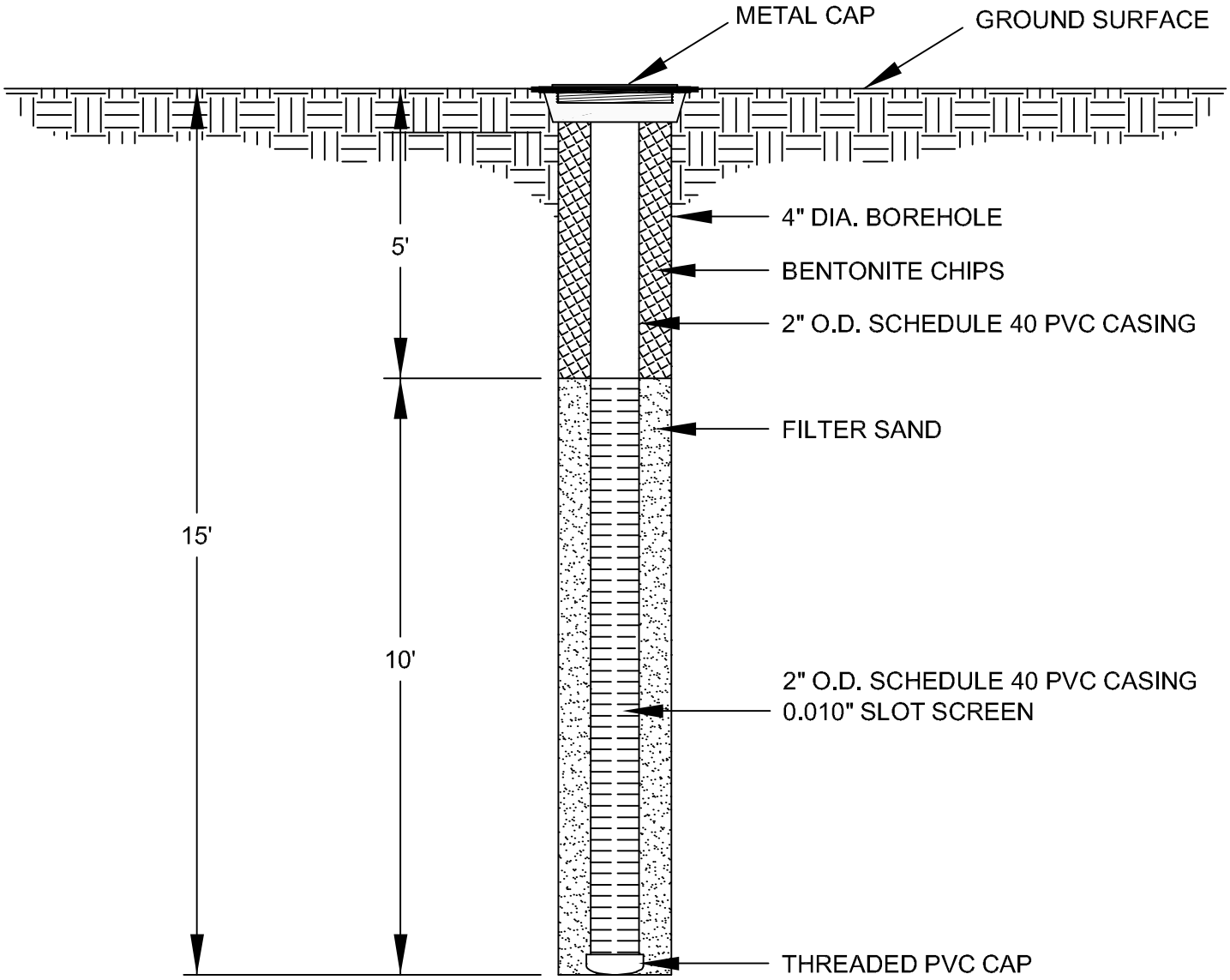
GROUNDWATER DEPTH FROM SURFACE:	DATE MEASURED:
DRY	6/29/12
12.3 ft.	7/27/12

AVILES ENGINEERING CORPORATION

PIEZOMETER INSTALLATION DETAILS
BORING B-14 (PZ-3)

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3
HOUSTON, TEXAS

AEC PROJECT NO.:	DATE:	SOURCE DWG. BY:
G121-12	08-07-12	AVILES ENGINEERING CORP.
SCALE: N.T.S.	DRAWN BY: BpJ	PLATE NO.: PLATE B-16



GROUNDWATER DEPTH FROM SURFACE:	DATE MEASURED:
DRY	6/29/12
12.3 ft.	7/27/12

AVILES ENGINEERING CORPORATION

PIEZOMETER INSTALLATION DETAILS
BORING B-24 (PZ-4)

SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS, WBS No. M-000277-0001-3
HOUSTON, TEXAS

AEC PROJECT NO.:	DATE:	SOURCE DWG. BY:
G121-12	08-07-12	AVILES ENGINEERING CORP.
SCALE: N.T.S.	DRAWN BY: BpJ	PLATE NO.: PLATE B-17

AVILES ENGINEERING CORP.

APPENDIX C

Plates C-1a thru C-1c	Recommended Geotechnical Design Parameters
Plate C-2	Load Coefficients for Pipe Loading
Plate C-3	Live Loads on Pipe Crossing Under Roadway

G121-12 COH SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS
DESIGN SOIL PARAMETERS FOR UNDERGROUND UTILITIES

Location	Depth (ft)	Soil Type	γ (pcf)	γ' (pcf)	E'n (psi)	OSHA Type	Short-Term					Long-Term				
							C_u (psf)	φ_u (deg)	K_a	K_0	K_p	C' (psf)	φ' (deg)	K_a	K_0	K_p
B-1	0-2	Base: sand and shell	120	58	300	C	0	0	1.00	1.00	1.00	0	30	0.33	0.50	3.00
	2-6	Fill: very stiff CH	120	58	300	C	1100	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
	6-12	Stiff to very stiff CH	117	55	600	B	1000	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
	12-15	Very stiff CH	124	62	600	B	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
B-2	0-2	Base: sand and shell	120	58	300	C	0	30	0.33	0.50	3.00	0	30	0.33	0.50	3.00
	2-6	Fill: stiff CH	121	59	600	C	1700	0	1.00	1.00	1.00	150	16	0.57	0.72	1.76
	6-10	Very stiff to hard CH	120	58	600	B	1500	0	1.00	1.00	1.00	150	16	0.57	0.72	1.76
	10-15	Very stiff to hard CL	128	66	1000	B	3300	0	1.00	1.00	1.00	300	18	0.53	0.69	1.89
B-3	0-2	Base: sand and shell	120	58	300	C	0	30	0.33	0.50	3.00	0	30	0.33	0.50	3.00
	2-10	Very stiff to hard CH	125	63	1000	B	2200	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
	10-20	Firm to hard CL/CH	127	65	300	B	800	0	1.00	1.00	1.00	75	16	0.57	0.72	1.76
B-4	0-2	Base: sand and shell	120	58	300	C	0	30	0.33	0.50	3.00	0	30	0.33	0.50	3.00
	2-6	Stiff to very stiff CH	122	60	600	B	1500	0	1.00	1.00	1.00	150	16	0.57	0.72	1.76
	6-13	Stiff to hard CH	122	60	600	B	1000	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
	13-18	Stiff to very stiff CH	130	68	600	B	1400	0	1.00	1.00	1.00	125	16	0.57	0.72	1.76
	18-20	ML	120	58	300	C	0	26	0.39	0.56	2.56	0	26	0.39	0.56	2.56
B-5	0-2	Base: sand and shell	120	58	300	C	0	30	0.33	0.50	3.00	0	30	0.33	0.50	3.00
	2-15	Stiff to very stiff CH	120	58	600	B	1200	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
	15-20	Very stiff CH	126	64	1000	B	2300	0	1.00	1.00	1.00	225	16	0.57	0.72	1.76
B-6	0-2	Base: sand and shell	120	58	300	C	0	30	0.33	0.50	3.00	0	30	0.33	0.50	3.00
	2-8	Stiff to very stiff CH	120	58	600	B	1400	0	1.00	1.00	1.00	125	16	0.57	0.72	1.76
	8-15	Stiff to very stiff CH	123	61	600	B	1900	0	1.00	1.00	1.00	175	16	0.57	0.72	1.76
B-7	0-2	Base: sand and shell	120	58	300	C	0	30	0.33	0.50	3.00	0	30	0.33	0.50	3.00
	2-15	Stiff to very stiff CH	121	59	600	B	1400	0	1.00	1.00	1.00	125	16	0.57	0.72	1.76
B-8	0-2	Base: sand and shell	120	58	300	C	0	30	0.33	0.50	3.00	0	30	0.33	0.50	3.00
	2-15	Stiff to very stiff CH	122	60	600	B	1300	0	1.00	1.00	1.00	125	16	0.57	0.72	1.76
B-9	0-8	Stiff to very stiff CH	124	62	600	B	1400	0	1.00	1.00	1.00	125	16	0.57	0.72	1.76
	8-10	Very stiff to hard CH	124	62	600	C*	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
	10-12	Firm CL	137	75	300	C*	800	0	1.00	1.00	1.00	75	18	0.53	0.69	1.89
	12-16	Medium dense SP-SM/SC	120	58	1000	C	0	30	0.33	0.50	3.00	0	30	0.33	0.50	3.00

G121-12 COH SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS
DESIGN SOIL PARAMETERS FOR UNDERGROUND UTILITIES

Location	Depth (ft)	Soil Type	γ (pcf)	γ' (pcf)	E'n (psi)	OSHA Type	Short-Term					Long-Term				
							C_u (psf)	φ_u (deg)	K_a	K_0	K_p	C' (psf)	φ' (deg)	K_a	K_0	K_p
B-10	0-10	Very stiff CL/CH	121	59	600	B	1800	0	1.00	1.00	1.00	175	16	0.57	0.72	1.76
B-11	0-10	Stiff to very stiff CH/CL	127	65	600	B	1500	0	1.00	1.00	1.00	150	16	0.57	0.72	1.76
	10-14	Firm to stiff CL	127	65	300	B	800	0	1.00	1.00	1.00	75	18	0.53	0.69	1.89
	14-16	Medium dense SP-SM	125	63	1000	C	0	32	0.31	0.47	3.25	0	32	0.31	0.47	3.25
B-12	0-10	Hard CH/CL	127	65	2000	B	3600	0	1.00	1.00	1.00	300	16	0.57	0.72	1.76
	10-20	Medium dense SC/SP-SM	128	66	1000	C	0	30	0.33	0.50	3.00	0	30	0.33	0.50	3.00
B-13	0-8	Stiff to very stiff CH	120	58	600	B	1200	0	1.00	1.00	1.00	125	16	0.57	0.72	1.76
	8-18	Stiff to hard CH	133	71	600	B	1900	0	1.00	1.00	1.00	175	16	0.57	0.72	1.76
	18-25	Firm to very stiff CH	117	55	300	B (18-20)	900	0	1.00	1.00	1.00	75	16	0.57	0.72	1.76
B-14	0-8	Stiff to very stiff CH	122	60	600	B	1400	0	1.00	1.00	1.00	125	16	0.57	0.72	1.76
	8-30	Firm to very stiff CH	124	62	300	B (8-20)	1000	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
B-15	0-10	Stiff to very stiff CH	124	62	1000	B	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
	10-16	Stiff to hard CH	124	62	600	B	1200	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
	16-20	Very stiff CH	120	58	1000	B	2300	0	1.00	1.00	1.00	225	16	0.57	0.72	1.76
	20-25	Stiff to very stiff CH	117	55	600	N/A	1200	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
B-16	0-20	Stiff to very stiff CH	126	64	600	B	1600	0	1.00	1.00	1.00	150	16	0.57	0.72	1.76
B-17	0-15	Stiff to hard CH	126	64	600	B	1400	0	1.00	1.00	1.00	125	16	0.57	0.72	1.76
B-18	0-12	Firm to very stiff CH	122	60	300	B	900	0	1.00	1.00	1.00	75	16	0.57	0.72	1.76
	12-15	Stiff to very stiff CH	135	73	600	B	1500	0	1.00	1.00	1.00	150	16	0.57	0.72	1.76
B-19	0-10	Very stiff to hard CH	126	64	1000	B	3600	0	1.00	1.00	1.00	300	16	0.57	0.72	1.76
B-20	0-2	Fill: stabilized clay	120	58	300	C	1000	0	1.00	1.00	1.00	100	18	0.53	0.69	1.89
	2-10	Firm to very stiff CH	121	59	300	B	900	0	1.00	1.00	1.00	75	16	0.57	0.72	1.76
	10-15	Stiff to hard CH	123	61	600	B	1800	0	1.00	1.00	1.00	175	16	0.57	0.72	1.76
B-21	0-2	Fill: stabilized clay	120	58	300	C	1000	0	1.00	1.00	1.00	100	18	0.53	0.69	1.89
	2-10	Stiff to very stiff CH	121	59	600	B	1100	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
	10-15	Very stiff CH	124	62	1000	B	2400	0	1.00	1.00	1.00	225	16	0.57	0.72	1.76
B-22	0-2	Fill: stabilized clay	120	58	300	C	1000	0	1.00	1.00	1.00	100	18	0.53	0.69	1.89
	2-5	Firm to stiff CH	117	55	300	B	800	0	1.00	1.00	1.00	75	16	0.57	0.72	1.76

G121-12 COH SOUTHPARK AND SOUTHCREST AREA DRAINAGE AND PAVING IMPROVEMENTS
DESIGN SOIL PARAMETERS FOR UNDERGROUND UTILITIES

Location	Depth (ft)	Soil Type	γ (pcf)	γ' (pcf)	E'n (psi)	OSHA Type	Short-Term					Long-Term				
							C_u (psf)	φ_u (deg)	K_a	K_0	K_p	C' (psf)	φ' (deg)	K_a	K_0	K_p
B-23	0-2	Fill: stabilized clay	120	58	300	C	1000	0	1.00	1.00	1.00	100	18	0.53	0.69	1.89
	2-8	Stiff CH	119	57	300	B	1000	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
	8-15	Stiff to very stiff CH	122	60	600	B	1800	0	1.00	1.00	1.00	175	16	0.57	0.72	1.76
B-24	0-15	Stiff to hard CH	126	64	600	B	1300	0	1.00	1.00	1.00	125	16	0.57	0.72	1.76
B-25	0-4	Fill: stabilized clay	120	58	300	C	1500	0	1.00	1.00	1.00	150	18	0.53	0.69	1.89
	4-10	Firm to stiff CH	123	61	300	B	900	0	1.00	1.00	1.00	75	16	0.57	0.72	1.76
	10-15	Stiff to hard CH	130	68	600	B	1600	0	1.00	1.00	1.00	150	16	0.57	0.72	1.76
B-26	0-2	Fill: stabilized clay	120	58	300	C	1000	0	1.00	1.00	1.00	100	18	0.53	0.69	1.89
	2-5	Firm to very stiff CH	119	57	300	B	1000	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76

Notes: (1) γ = Unit weight for soil above water level, γ' = Buoyant unit weight for soil below water level.

(2) Cu = Short term soil ultimate cohesion (upper limit of 3,600 psf for design purposes), φu = Short term soil friction angle.

(3) C' = Long term soil ultimate cohesion (upper limit of 350 psf for design purposes),φ' = Long term soil friction angle.

(4) E'n = Effective modulus of soil reaction for flexible pipe deflection.

(5) K_a = Coefficient of active earth pressure, K_0 = Coefficient of at-rest earth pressure, K_p = Coefficient of passive earth pressure, for level backfill.

(6) CL = Lean Clay, CH = Fat Clay, SC = Clayey Sand, ML = Silt; SP-SM = Poorly Graded Sand with Silt.

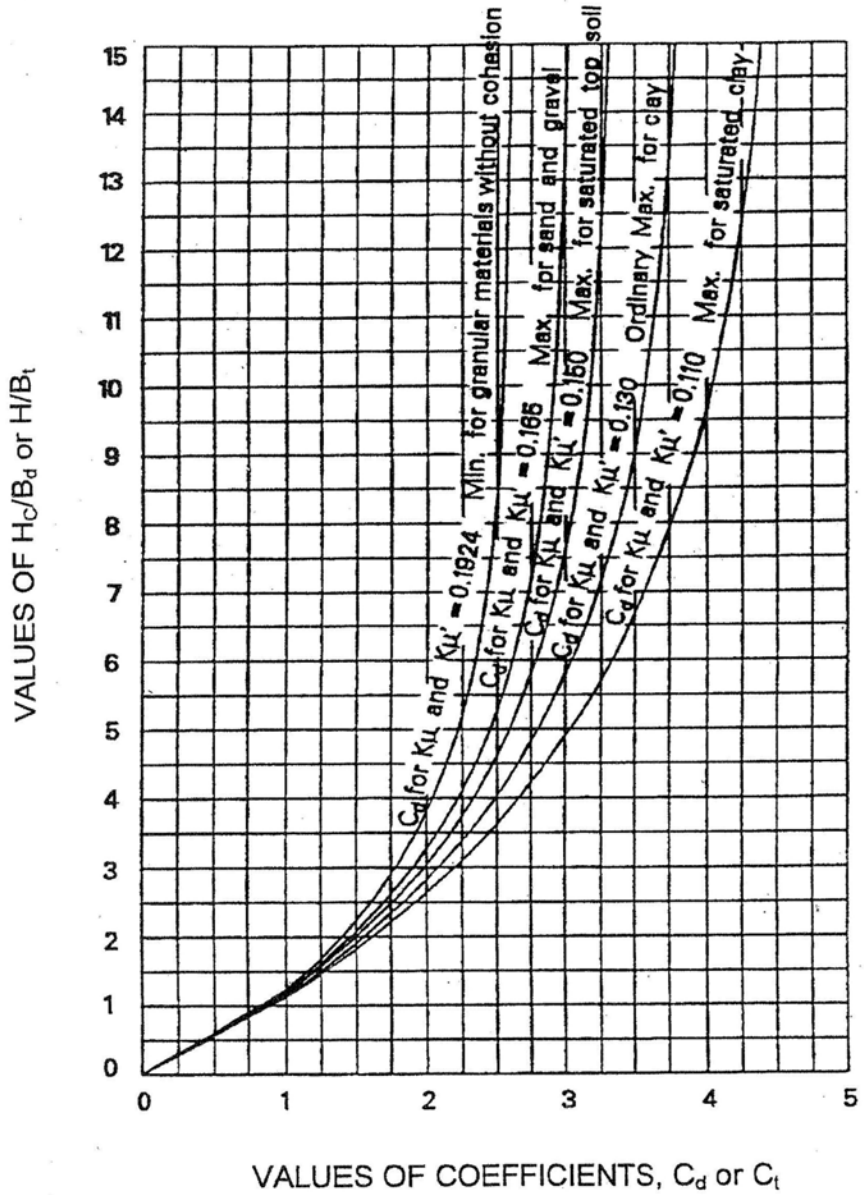
(7) OSHA Soil Types for soils in the top 20 feet below grade:

A: cohesive soils with qu = 1.5 tsf or greater (qu = Unconfined Compressive Strength of the Soil)

B: cohesive soils with qu = 0.5 tsf or greater

C: cohesive soils with qu = less than 0.5 tsf, fill materials, or granular soil

C*: The above OSHA Soil Types were recommended on assumption that the excavations are dewatered; if the site is not dewatered, all submerged soils should be classified as OSHA Type C.



Reference: US Army Corps of Engineers Engineering Manual, EM 1110-2-2909, Oct. 31, 1997, Figure 2-5.

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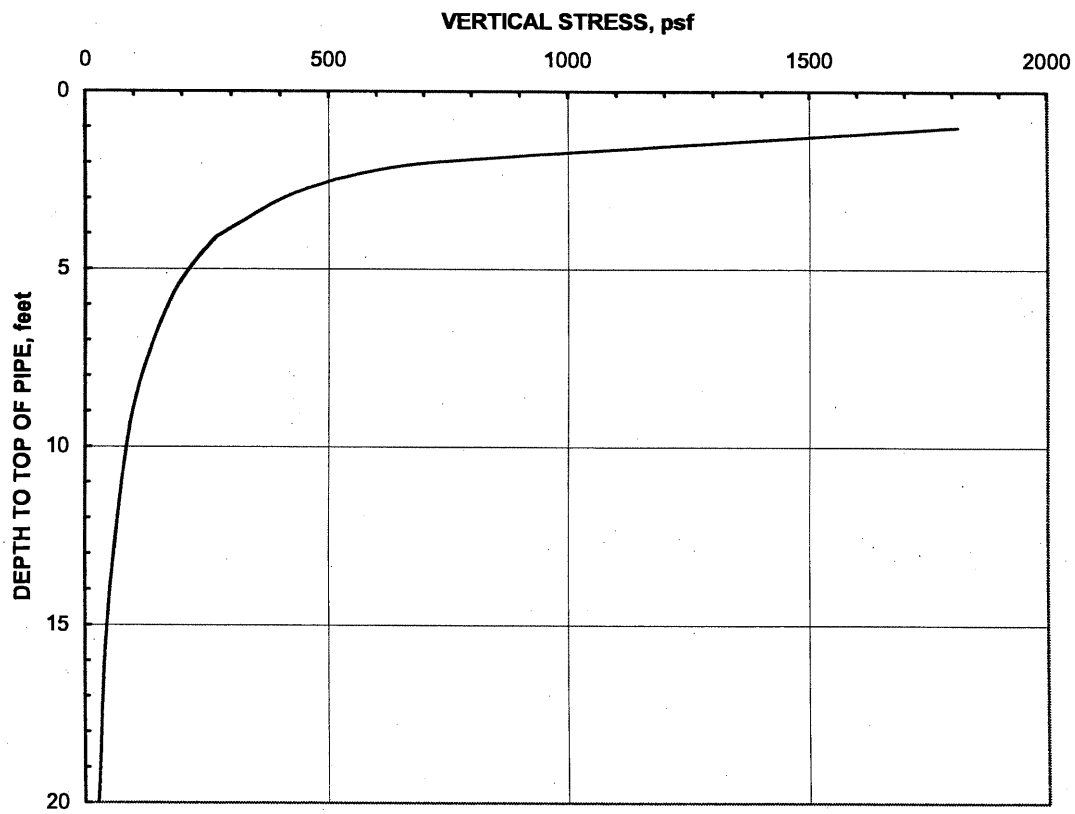

LIVE LOADS ON PIPE CROSSING UNDER ROADWAY

Note: 1. The vertical stress was estimated using AASHTO HS20 truck axle loadings on paved surfaces (Reference: ASCE 15-98, "Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standandard Installations").
2. Single truck passing.

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APPENDIX D

Plate D-1	Critical Heights of Cuts in Nonfissured Clays
Plate D-2	Maximum Allowable Slopes
Plate D-3	A Combination of Bracing and Open Cuts
Plate D-4	Lateral Pressure Diagrams for Open Cuts in Cohesive Soil-Long Term Conditions
Plate D-5	Lateral Pressure Diagrams for Open Cuts in Cohesive Soil-Short Term Conditions
Plate D-6	Lateral Pressure Diagrams for Open Cuts in Sand
Plate D-7	Bottom Stability for Braced Excavation in Clay
Plate D-8	Thrust Force Calculation
Plate D-9	Thrust Force Example Calculation
Plate D-10	Design Parameters for Bearing Thrust Block

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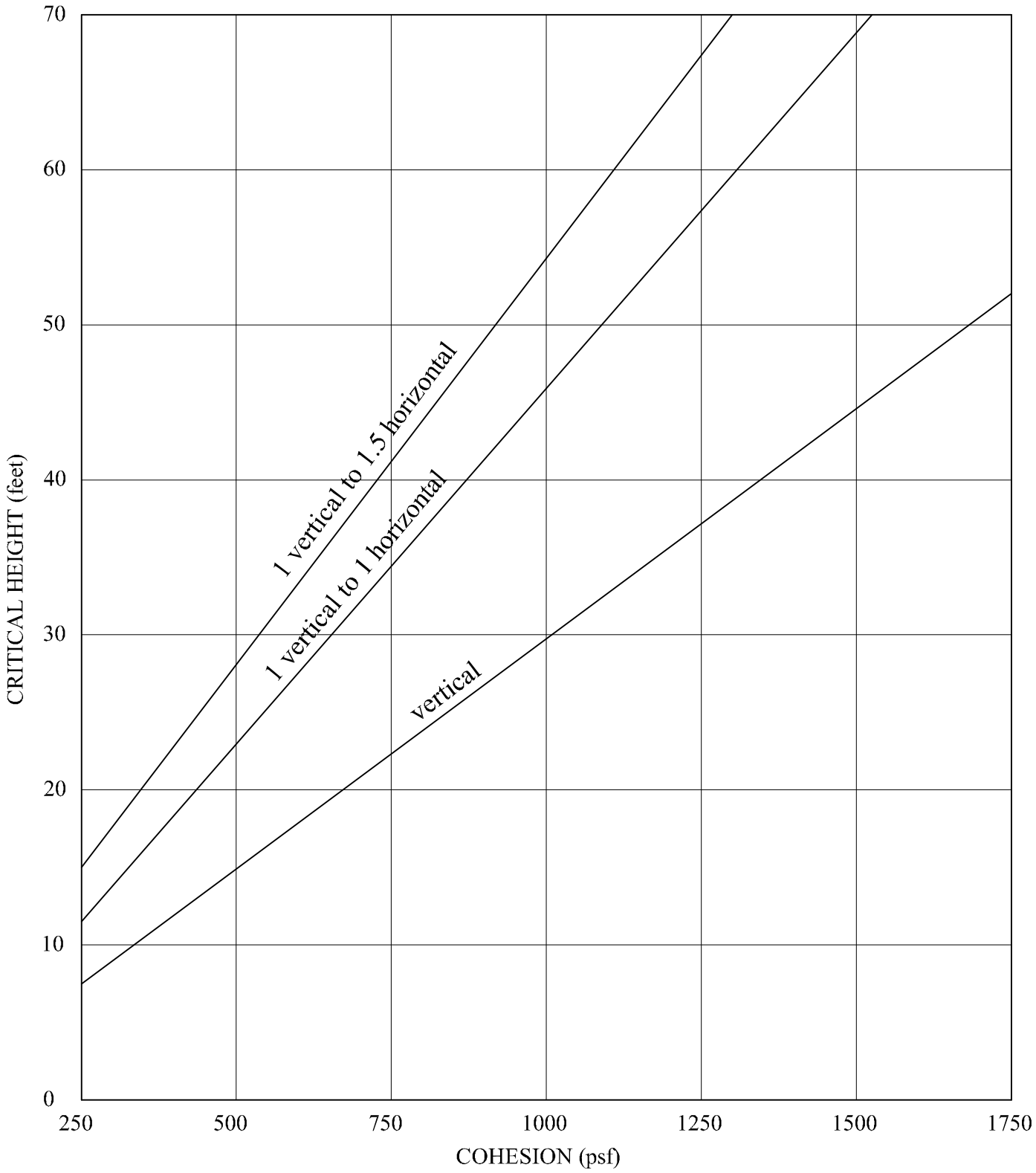
Critical Heights of Cut Slopes in Nonfissured Clays



Note: The charts are calculated based on NAVFAC DM7.1, Page 7.1-319, assuming the critical circles are toe circles, and wet unit weight of soils = 125pcf.

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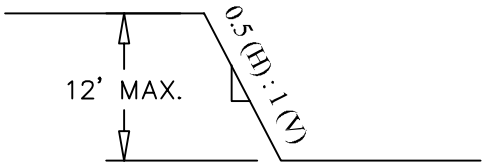
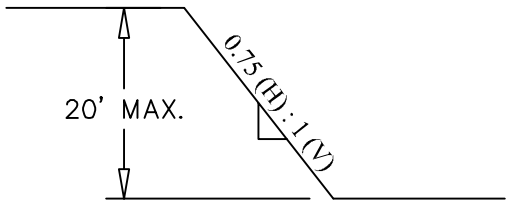
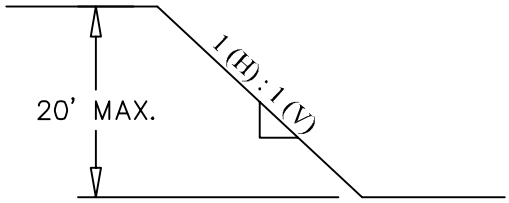
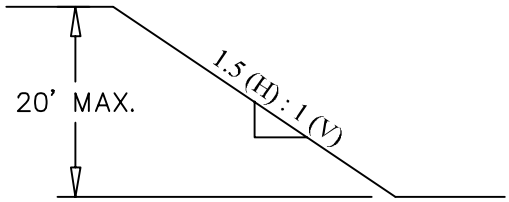
MAXIMUM ALLOWABLE SLOPES

	SHORT TERM	LONG TERM
TYPE A SOILS		
TYPE B SOILS	N/A	
TYPE C SOILS	N/A	

NOTES:

(1) For Type A soils, a short term maximum allowable slope of 0.5 (H) : 1 (V) is allowed in excavations that are 12 feet or less in depth; short term (24 hours or less) maximum allowable slopes for excavations greater than 12 feet in depth shall be 0.75 (H) : 1 (V).

(2) Maximum depth for above slopes is 20 feet. For slopes deeper than 20 feet, trench protection should be designed by the Contractor's professional engineer.

Reference: OSHA, Safety and Health Regulations for Construction, 1926 Subpart P.

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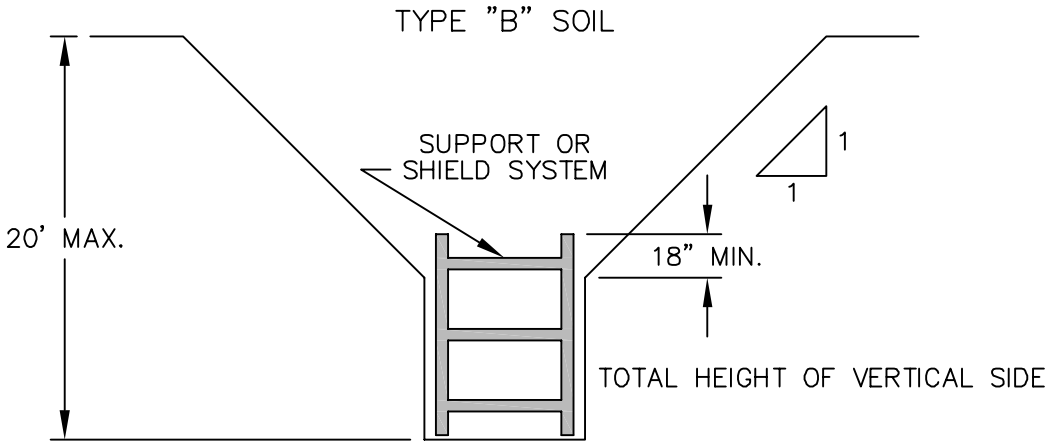
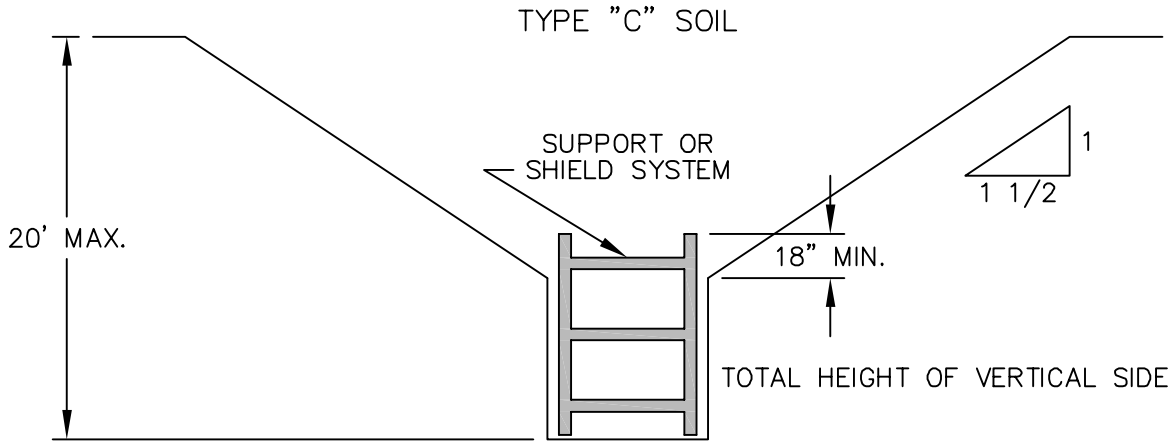
A COMBINATION OF BRACING AND OPEN CUTS





Reference: OSHA, Safety and Health Regulations for Construction, 1926 Subpart P.

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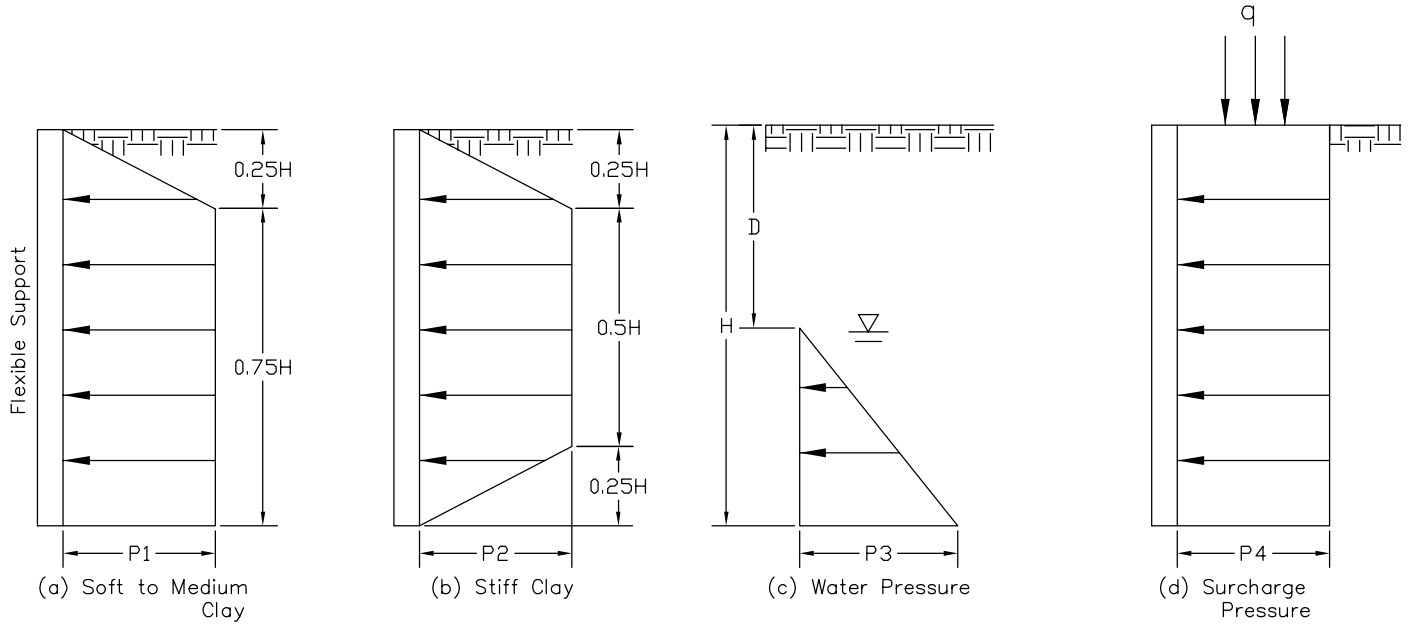
LATERAL PRESSURE DIAGRAMS
FOR OPEN CUTS IN COHESIVE SOIL - LONG TERM CONDITIONS



Empirical Pressure Distributions

Where:
H = Total excavation depth, feet
D = Depth to water table, feet
P1 = Lateral earth pressure = γH-4C, psf
P2 = Lateral earth pressure = 0.4γH, psf
P3 = Water pressure = γ_w (H-D), psf
P4 = Lateral earth pressure caused by surcharge = qK_a, psf
γ = Effective unit weight of soil, pcf
γ_w = Unit weight of water, pcf
C = Drained shear strength or cohesion, psf
K_a = Coefficient of active earth pressure

Notes:
1. All pressures are additive.
2. No safety factors are included.
3. For use only during long term construction.
4. If γH/C < 4, use section (b),
   If 4 < γH/C < 6, use larger of section (a) or (b),
   If γH/C > 6, use section (a).

Reference: Peck, R.B. (1969), "Deep Excavation and Tunneling in soft Ground", 7th ICSMFE, State of art volume, pp. 225-290.

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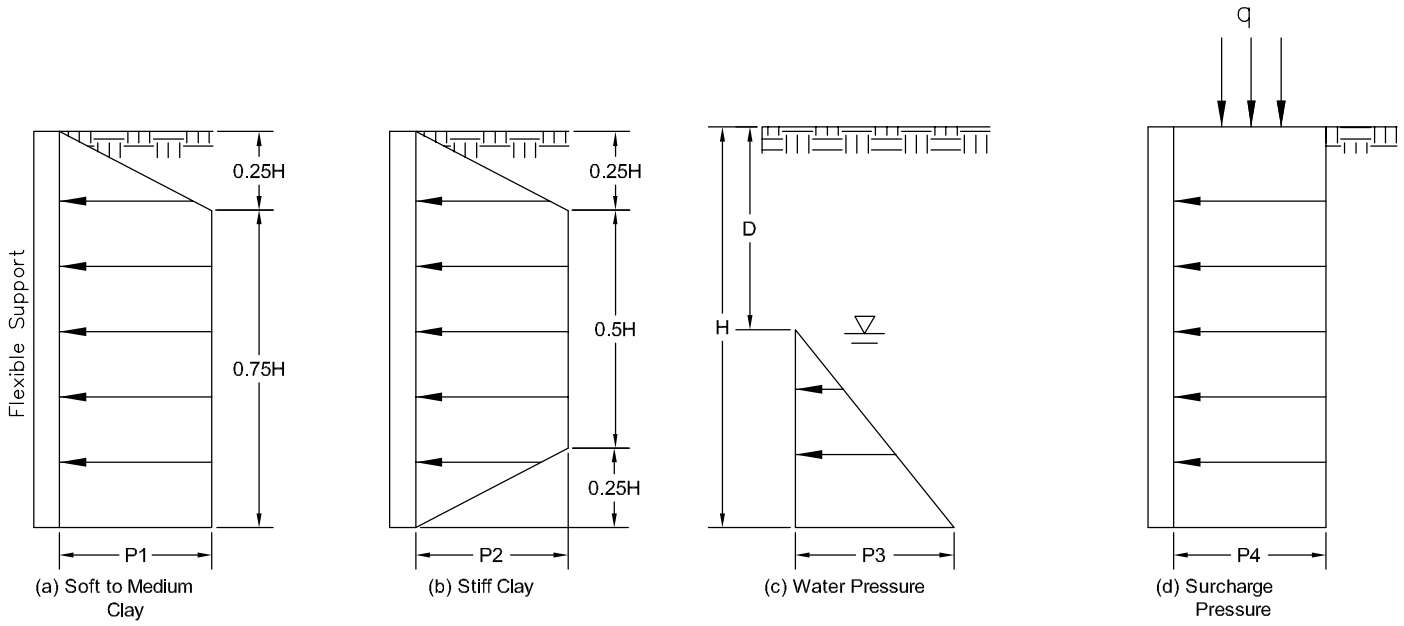
LATERAL PRESSURE DIAGRAMS
FOR OPEN CUTS IN COHESIVE SOIL - SHORT TERM CONDITIONS



Empirical Pressure Distributions

Where:
H = Total excavation depth, feet
D = Depth to water table, feet
P1 = Lateral earth pressure = $\gamma H - 4S_u$, psf
P2 = Lateral earth pressure = $0.2\gamma H$, psf
P3 = Water pressure = γ_w (H-D), psf
P4 = Lateral earth pressure caused by surcharge = qK_a, psf
γ = Effective unit weight of soil, pcf
γ_w = Unit weight of water, pcf
S_u = Undrained shear strength = $q_u/2$, psf
q_u = Unconfined compressive strength, psf
K_a = Coefficient of active earth pressure

Notes:
1. All pressures are additive.
2. No safety factors are included.
3. For use only during short term construction.
4. If $\gamma H/S_u < 4$, use section (b),
   If $4 < \gamma H/S_u < 6$, use larger of section (a) or (b),
   If $\gamma H/S_u > 6$, use section (a).

Reference: Peck, R.B. (1969), "Deep Excavation and Tunneling in soft Ground", 7th ICSMFE, State of art volume, pp. 225-290.

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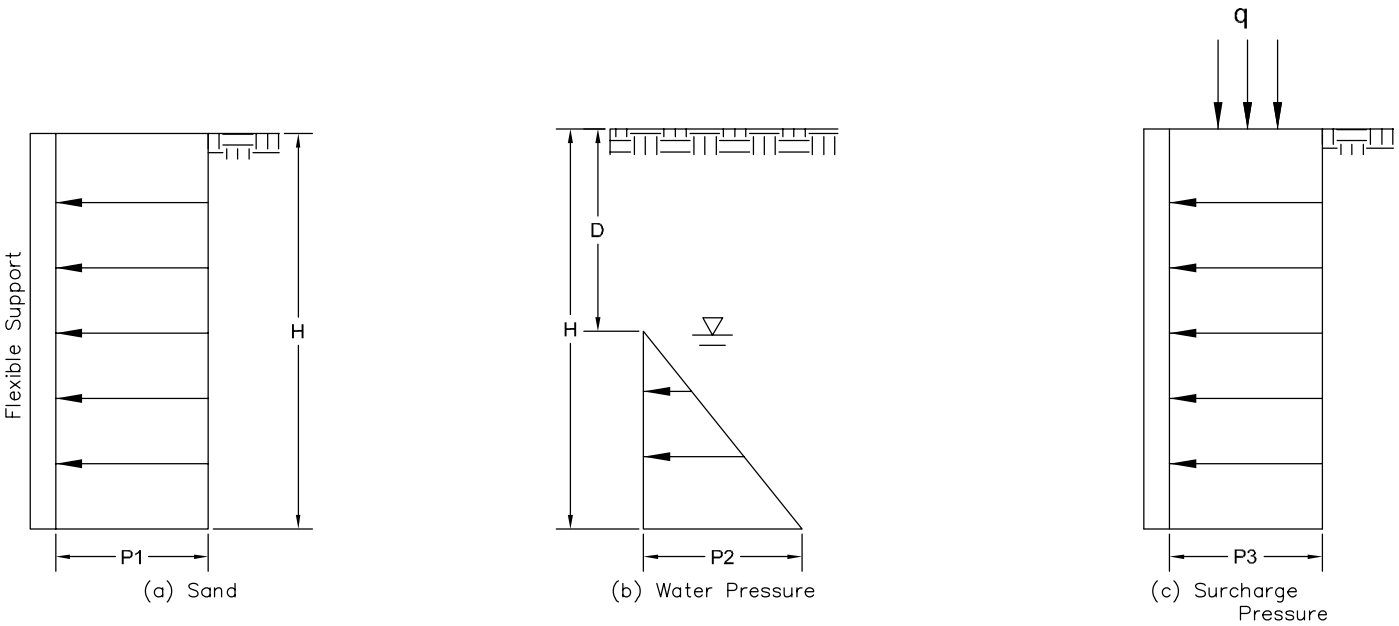
LATERAL PRESSURE DIAGRAMS
FOR OPEN CUTS IN SAND



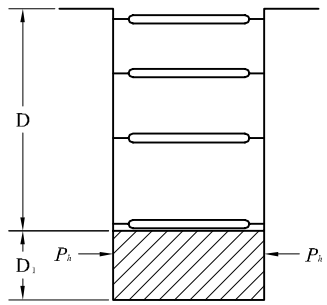
Empirical Pressure Distributions

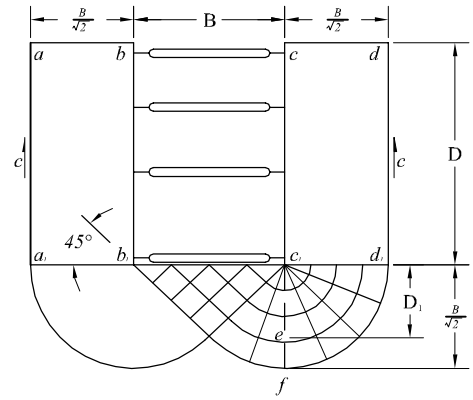
Where:
H = Total excavation depth, feet
D = Depth to water table, feet
P1 = Lateral earth pressure = $0.65*\gamma HK_a$, psf
P2 = Water pressure = γ_w (H-D), psf
P3 = Lateral earth pressure caused by surcharge = qK_a, psf
γ = Effective unit weight of soil, pcf
γ_w = Unit weight of water, pcf
K_a = Coefficient of active earth pressure = $(1-\sin\varphi)/(1+\sin\varphi)$
φ = Drained friction angle

Notes:
1. All pressures are additive.
2. No safety factors are included.

Reference: Peck, R.B. (1969), "Deep Excavation and Tunneling in soft Ground", 7th ICSMFE, State of art volume, pp. 225-290.

BOTTOM STABILITY FOR BRACED EXCAVATION IN CLAY





Factor of Safety against bottom of heave,

$$F.S = \frac{NcC}{(\gamma D + q)}$$

where, Nc = Coefficient depending on the dimension of the excavation (see Figure at the bottom)
C = Undrained shear strength of soil in zone immediately around the bottom of the excavation,
γ = Unit weight of soil,
D = Depth of excavation,
q = Surface surcharge.

If F.S < 1.5, sheeting should be extended further down to achieve stability

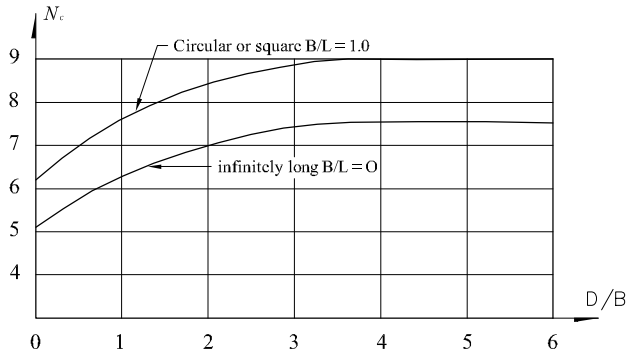
$$\text{Depth of Buried Length, } (D_1) = \frac{1.5(\gamma D + q) - NcC}{(C/B) - 0.5\gamma} \; ; D_1 \geq 5 \text{ ft.}$$

Pressure on buried length, P_h:

For $D_1 < 0.47B$; $P_h = 1.5\, D_1(\gamma D - 1.4\, CD/B - 3.14C)$

For $D_1 > 0.47B$; $P_h = 0.7\, (\gamma DB - 1.4\, CD - 3.14CB)$

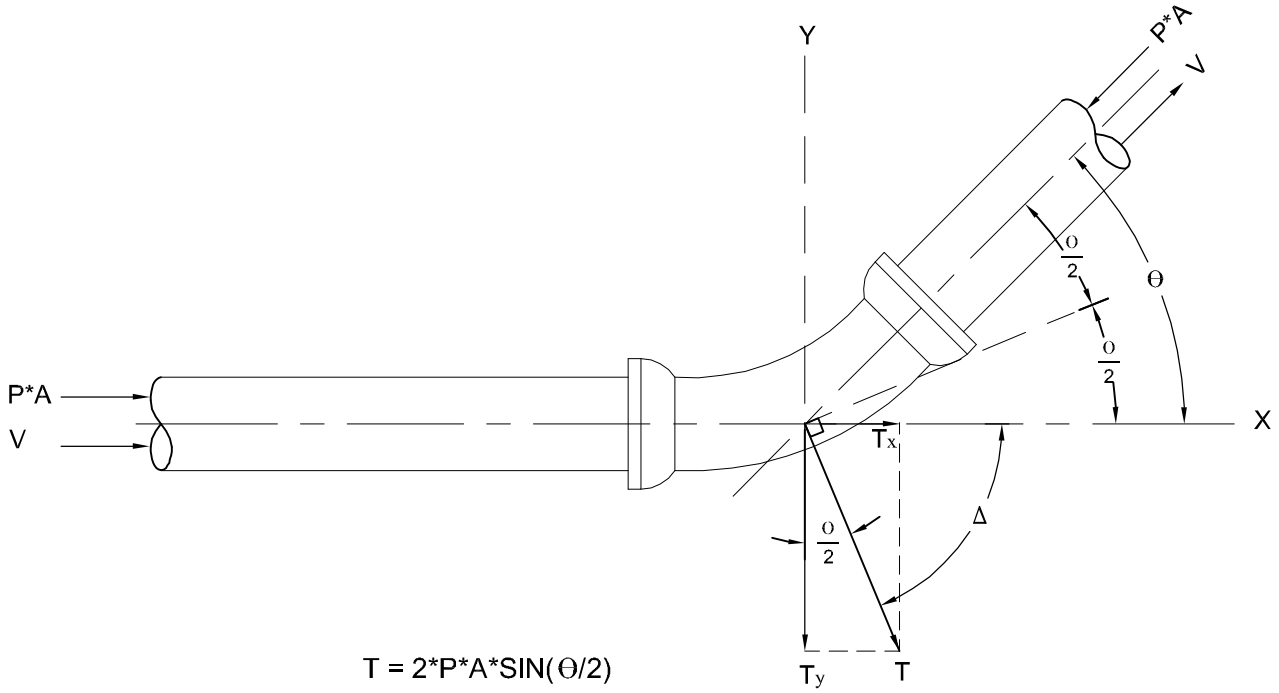
where; B = width of excavation



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

Reference: Bjerrum, L. and Eide, O., Stability of Strutted Excavations in Clay, Geotechnique, 6, 32-47 (1956).

THRUST FORCE CALCULATION



$T = 2*P*A*SIN(\Theta/2)$

$T_x = P*A*(1-COS\Theta)$

$T_y = P*A*SIN\Theta$

$\Delta = (90-\Theta/2)$

Where:

T = resultant thrust force

T_x= thrust force component along the X axis

T_y= thrust force component along the Y axis

P = maximum sustained pressure

A = cross-sectional area of pipe = $(\pi/4)*(D)^2$

D = inside diameter conduit

Θ = angle of bend

Δ = angle between X axis and T

V = fluid velocity

Reference: American Water Works Association, Manual MA, "Concrete Pressure Pipe".

THRUST FORCE EXAMPLE CALCULATION

Trust Force Example Calculation

$T = 2*P*A*SIN(\Theta/2)$

$T_x = P*A*SIN(1-COS\,\Theta)$

$T_y = P*A*SIN\,\Theta$

Where:

T = resultant thrust force

T_x = thrust force component along the X axis

T_y = thrust force component along the Y axis

P = maximum sustained pressure

A = cross-section area of pipe = $(\pi/4)*(D)^2$

D = inside diameter of conduit

U = angle of bend

Given: D = 24", P = 200 psi, $\Theta = 60°$

Find: T, T_x and T_y

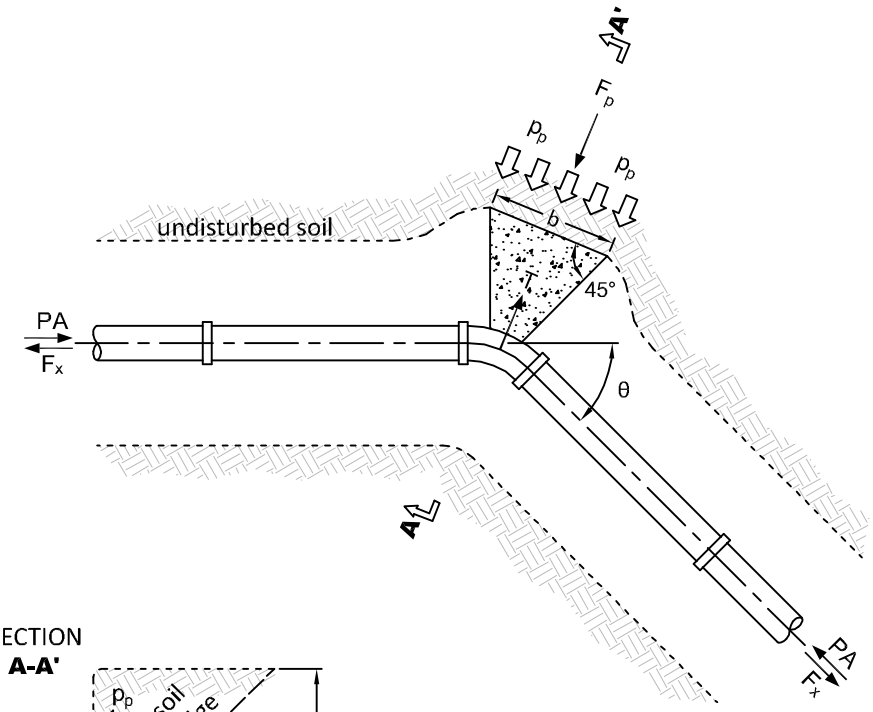
$A = (\pi/4)*(24)^2 = 452.39\ in^2$

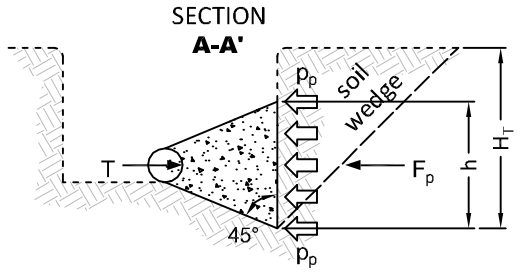
T = 2*200*452.39*SIN(60/2) = 90,478 lb

T_x = 200*452.39*(1-COS60) = 45,239 lb

T_y = 200*452.39*SIN60 = 78,356 lb

DESIGN PARAMETERS FOR BEARING THRUST BLOCK





Where:

T = resultant thrust force on the bend

F_p = resistance force developed by passive soil pressure

A_b = minimum bearing area of block base

h = height of thrust block

b = width of thrust block

A = pipe cross-sectional area

θ = bend deflection angle

p_p = passive soil pressure

H_T = depth to bottom of block

ϒ = soil unit weight

K_p = coefficient of passive earth pressure

Ø = soil internal friction angle

C = soil cohesion

F_s = factor of safety (usually 1.5)

H_c = mean depth from ground surface to the plane of resistance (center of bearing area of a thrust block)

p = maximum sustained pressure

F_x = conduit frictional resistance per unit length

Required Bearing Area:

$$A_b = hb = \frac{F_s\ 2PA\ \mathrm{Sin}\ \frac{\theta}{2}}{p_p}$$

Required Block Width:

$$b = \frac{2F_s\ PA\ \mathrm{Sin}\ \frac{\theta}{2}}{h\ p_p}$$

Where:

$$p_p = \Upsilon H_c K_p + 2C\sqrt{K_p}$$

$$K_p = \mathrm{Tan}^2\left(45° + \frac{Ø}{2}\right)$$

AVILES ENGINEERING CORP.

APPENDIX E

Piezometer Installation and Plugging Reports

Attention Owner: Confidentiality Privilege Notice on reverse side of owner's copy.

Texas Department of Licensing and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512) 463-7880 FAX (512) 463-8616
Toll free (800) 803-9202
Email address: water.well@license.state.tx.us

This form must be completed and filed with the department and owner within 60 days upon completion of the well.

WELL REPORT

1) OWNER — **2) WELL IDENTIFICATION AND LOCATION DATA**

Name	Address	City	State	Zip
City of Houston Geotech Dept	611 Walker, Floor 14	Houston	Tx	77002

2) WELL LOCATION

County	Physical Address	City	State	Zip
Harris	Crestridge at Southridge(pz-1)	Houston	Tx	77033

3) Type of Work ☒ New Well ☐ Reconditioning ☐ Replacement ☐ Deepening

Lat. ° ' " Long. ° ' " Grid # 66-22-4

4) Proposed Use (check) ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell ☐ Rig Supply ☐ Stock or Livestock If Public Supply, were plans approved? ☐ Yes ☐ No

5) N↑

6) Drilling Date
Started 7/18/2012
Completed 7/18/2012

Diameter of Hole

Dia. (in)	From (ft)	To (ft)
4	Surface 0	20

7) Drilling Method (check) ☐ Driven ☐ Air Rotary ☒ Mud Rotary ☐ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Hollow Stem Auger ☐ Reverse Circulation ☐ Other

From (ft)	To (ft)	Description and color of formation material
0	6	CL SiSa
6	14	Cl
14	20	SaCl

(Use reverse side if more space is necessary)

8) Borehole Completion ☐ Open Hole ☐ Straight Wall ☐ Under-reamed ☐ Gravel Packed ☐ Other
Gravel Packed interval from ft. to ft. Size

Casing, Blank Pipe and Well Screen Data

Dia. (in.)	New Or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft) From	Setting (ft) To	Gage Casing Screen
2	N	Sch 40 PVC Riser	0	10	
2	N	Sch 40 PVC Screen	10	20	.010

9) Annular Seal Data: i.e. *(from 0 ft to 100 ft #sacks & material 13 cement)*
from 0 ft. to 8 ft. #sacks & material 1 holeplug
from ft. to ft. #sacks & material
from ft. to ft. #sacks & material
Method Used manually done
Distance to septic field or other concentrated contamination ft.
Distance to Property Line ft Method
Verified:

10) Surface Completion (If steel cased, leave blank)
☐ Surface Slab Installed ☐ Surface Sleeve Installed ☐ Pitless Adapter Used ☒ Alternative Procedure Used

11) Water Level
Static level 19 ft. Date 7/18/2012
Artesian Flow gpm

12) Packers

Type	Depth	Type	Depth
20/40	8		
	20		

13) Plugged ☐ Well plugged within 48 hours
Casing left in well: na Cement/Bentonite placed in well:

From (ft)	To (ft)	From (ft)	To (ft)	Material Used or Size

14) Type Pump ☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other na
Depth to pump bowls, cylinder, jet, etc.. ft.

15) Water Test
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: na gpm with ft. drawdown after hrs.

16) Water Quality
Type of water: Depth of Strata: Was a chemical analysis made? ☐ Yes ☒ No
Did you knowingly penetrate a strata which contains undesirable constituents? ☐ Yes ☒ No If yes, Continue:
Check One: ☐ Naturally poor-quality groundwater – type ☐ Hydrocarbons (i.e. gas, oil, etc.)
☐ Hazardous material/waste contamination encountered ☐ Other (describe)

☐ *I certify that while drilling, deepening, or otherwise altering the above described well, undesirable water or constituents was encountered and the landowner was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.*

Company or Individual's Name (type or print) Van and Sons Drilling Service, Inc Lic. No. 2903M
Address 319 John Alber City Houston State Tx Zip 77076
Signature 9/12/2012 Signature / /
Licensed Driller/Pump Installer Date Owner Date

TDLR FORM 001WWD / 9-03 Copies to TDLR - Owner - Driller/Pump Installer Form provided by Forms On-A-Disk - (214) 340-9429 - FormsOnADisk.com

Texas Department of License and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512)463-7880 FAX (512)463-8616
Email address: water.well@license.state.tx.us

This form must be completed and filed with the department within 30 days following the plugging of the well.

PLUGGING REPORT

A. WELL IDENTIFICATION AND LOCATION DATA

1) OWNER

Name	Address	City	State	Zip
City of Houston Geo Dept	611 Walker, Floor 14	Houston	Tx	77002

2) WELL LOCATION

County	Physical Address	City	State	Zip
Harris	Crestridge at Southridge	Houston	Tx	77033

3) Owner's Well No. 1 | Long. ° ' " | Lat. ° ' " | Grid # 66-22-4

4) Type of Well ☐ Water ☒ Monitor ☐ Injection ☐ De-Watering

5) N↑

Drill, Pump Installer, or Landowner performing the plugging operations must locate and identify the location of the well within a specific grid on a full scale gridded map available from Texas Natural Resource Information Service. The location of the well should be denoted within the grid by placing a corresponding dot in the square to the right. The legal description is optional.

B) HISTORICAL DATA ON WELL TO BE PLUGGED (if available)

6) Driller: Eddie Van Antwerp | License No. 2903M

7) Drilled 07/18/2012 | 8) Diameter of hole 4 inches | 9) Total depth of well 20 feet.

C. CURRENT PLUGGING DATA

10) Date well plugged: 9/8/2012

12) Name of Driller/Pump Installer or Well Owner performing the plugging: Eddie Van Antwerp

License No. 2903M

13) CASING AND CEMENTING DATA RELATIVE TO THE PLUGGING OPERATIONS.

CASING LEFT IN WELL

DIAMETER (inches)	FROM (feet)	TO (feet)
2	0	20

CEMENT/BENTONITE PLUG(S) PLACED IN WELL

FROM (feet)	TO (feet)	SACKS
0	20	2

11) REMOVE ALL REMOVEABLE CASING

Please check box beside the method of plugging used

- ☐ Tremmie pipe cement from bottom to top.
- ☐ Tremmie pipe bentonite from bottom to 2 feet from surface, cement top 2 feet.
- ☒ Pour in 3/8 bentonite chips when standing water in well is less than 100 feet in depth, cement top 2 feet.
- ☐ Large diameter well filled with clay material from top to bottom.

COMMENTS

1) attempted to pull the well
2) backfilled annular space with bentonite chips

D. VALIDATION OF INFORMATION INCLUDED IN FORM

I certify that I plugged this well (or the well was plugged under my supervision) and that all of the statements herein are true and correct. I understand that failure to complete items 1 through 13 will result in the report(s) being returned for completion and resubmitted.

Company or Individual's Name (type or print): Van and Sons Drilling Service, Inc.

Address: 319 John Alber | City: Houston | State: Tx | Zip: 77076

Signature		Signature	
Licensed Driller/Pump Installer	9/12/2012 Date	Apprentice	/ / Date

Attention Owner:
Confidentiality Privilege Notice on reverse side of owner's copy.

Texas Department of Licensing and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512) 463-7880 FAX (512) 463-8616
Toll free (800) 803-9202
Email address: water.well@license.state.tx.us

This form must be completed and filed with the department and owner within 60 days upon completion of the well.

WELL REPORT

1) OWNER — **2) WELL LOCATION**

Name	Address	City	State	Zip
City of Houston Geotech Dept	611 Walker, Floor 14	Houston	Tx	77002

County	Physical Address	City	State	Zip
Harris	Crestville at Southmont (pz-2)	Houston	Tx	77033

3) Type of Work
☒ New Well ☐ Reconditioning
☐ Replacement ☐ Deepening

Lat. ° ' " Long. ° ' " Grid # 66-22-4

4) Proposed Use (check) ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic
☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
☐ Rig Supply ☐ Stock or Livestock If Public Supply, were plans approved? ☐ Yes ☐ No

5) N↑

6) Drilling Date
Started 7/18/2012
Completed 7/18/2012

Diameter of Hole

Dia. (in)	From (ft)	To (ft)
4	Surface 0	20

7) Drilling Method (check)
☐ Driven ☐ Air Rotary ☒ Mud Rotary
☐ Bored ☐ Air Hammer ☐ Cable Tool
☐ Jetted ☐ Hollow Stem Auger
☐ Reverse Circulation
☐ Other

8) Borehole Completion ☐ Open Hole ☐ Straight Wall
☐ Under-reamed ☐ Gravel Packed ☐ Other
Gravel Packed interval from ft. to ft. Size:

From (ft)	To (ft)	Description and color of formation material
0	6	CL SiSa
6	14	Cl
14	20	SaCl

(Use reverse side of Well Owner's copy if necessary)

Casing, Blank Pipe and Well Screen Data

Dia. (in.)	New Or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft) From	Setting (ft) To	Gage Casing Screen
2	N	Sch 40 PVC Riser	0	10	
2	N	Sch 40 PVC Screen	10	20	.010

9) Annular Seal Data: i.e. *(from 0 ft to 100 ft #sacks & material 13 cement)*
from 0 ft. to 8 ft. #sacks & material 1 holeplug
from ft. to ft. #sacks & material
from ft. to ft. #sacks & material
Method Used manually done
Distance to septic field or other concentrated contamination ft.
Distance to Property Line ft Method
Verified:

13) Plugged ☐ Well plugged within 48 hours
Casing left in well: na Cement/Bentonite placed in well:

From (ft)	To (ft)	From (ft)	To (ft)	Material and Size of Stem

10) Surface Completion (If steel cased, leave blank)
☐ Surface Slab Installed ☐ Surface Sleeve Installed
☐ Pitless Adapter Used ☒ Alternative Procedure Used

14) Type Pump
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other na
Depth to pump bowls, cylinder, jet, etc.. ft.

11) Water Level
Static level dry ft. Date 7/18/2012
Artesian Flow gpm

15) Water Test
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: na gpm with ft. drawdown after hrs.

12) Packers

Type	Depth	Type	Depth
20/40	8		
	20		

16) Water Quality
Type of water: Depth of Strata: Was a chemical analysis made? ☐ Yes ☒ No
Did you knowingly penetrate a strata which contains undesirable constituents? ☐ Yes ☒ No If yes, Continue:
Check One: ☐ Naturally poor-quality groundwater – type ☐ Hydrocarbons (i.e. gas, oil, etc.)
☐ Hazardous material/waste contamination encountered ☐ Other (describe)

☐ *I certify that while drilling, deepening, or otherwise altering the above described well, undesirable water or constituents was encountered and the landowner was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.*

Company or Individual's Name (type or print) Van and Sons Drilling Service, Inc Lic. No. 2903M
Address 319 John Alber City Houston State Tx Zip 77076
Signature 9/12/2012 Signature / /
Licensed Driller/Pump Installer Date Owner/Agent Date

TDLR FORM 001WWD / 9-03 Copies to TDLR - Owner - Driller/Pump Installer Form provided by Forms On-A-Disk - (214) 340-9429 - FormsOnADisk.com

Texas Department of License and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512)463-7880 FAX (512)463-8616
Email address: water.well@license.state.tx.us

This form must be completed and filed with the department within 30 days following the plugging of the well.

PLUGGING REPORT

A. WELL IDENTIFICATION AND LOCATION DATA

1) OWNER

Name	Address	City	State	Zip
City of Houston Geo Dept	611 Walker, Floor 14	Houston	Tx	77002

2) WELL LOCATION

County	Physical Address	City	State	Zip
Harris	Crestville at Southmont	Houston	Tx	77033

3) Owner's Well No. 2 | Long. ° ' " | Lat. ° ' " | Grid # 66-22-4

4) Type of Well ☐ Water ☒ Monitor ☐ Injection ☐ De-Watering

5) N↑

Drill, Pump Installer, or Landowner performing the plugging operations must locate and identify the location of the well within a specific grid on a full scale gridded map available from Texas Natural Resource Information Service. The location of the well should be denoted within the grid by placing a corresponding dot in the square to the right. The legal description is optional.

B) HISTORICAL DATA ON WELL TO BE PLUGGED (if available)

6) Driller: Eddie Van Antwerp | License No. 2903M

7) Drilled 07/18/2012 | 8) Diameter of hole 4 inches | 9) Total depth of well 20 feet.

C. CURRENT PLUGGING DATA

10) Date well plugged: 9/8/2012

12) Name of Driller/Pump Installer or Well Owner performing the plugging: Eddie Van Antwerp

License No. 2903M

13) CASING AND CEMENTING DATA RELATIVE TO THE PLUGGING OPERATIONS.

CASING LEFT IN WELL

DIAMETER (inches)	FROM (feet)	TO (feet)
2	0	20

CEMENT/BENTONITE PLUG(S) PLACED IN WELL

FROM (feet)	TO (feet)	SACKS
0	20	2

11) **REMOVE ALL REMOVEABLE CASING**

Please check box beside the method of plugging used

- ☐ Tremmie pipe cement from bottom to top.
- ☐ Tremmie pipe bentonite from bottom to 2 feet from surface, cement top 2 feet.
- ☒ Pour in 3/8 bentonite chips when standing water in well is less than 100 feet in depth, cement top 2 feet.
- ☐ Large diameter well filled with clay material from top to bottom.

COMMENTS

1) attempted to pull the well
2) backfilled annular space with bentonite chips

D. VALIDATION OF INFORMATION INCLUDED IN FORM

I certify that I plugged this well (or the well was plugged under my supervision) and that all of the statements herein are true and correct. I understand that failure to complete items 1 through 13 will result in the report(s) being returned for completion and resubmitted.

Company or Individual's Name (type or print): Van and Sons Drilling Service, Inc.

Address: 319 John Alber | City: Houston | State: Tx | Zip: 77076

Signature: E. J. Van Antwerp	9/12/2012	Signature:	/ /
Licensed Driller/Pump Installer	Date	Apprentice	Date

Attention Owner: Confidentiality Privilege Notice on reverse side of owner's copy.

Texas Department of Licensing and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512) 463-7880 FAX (512) 463-8616
Toll free (800) 803-9202
Email address: water.well@license.state.tx.us

This form must be completed and filed with the department and owner within 60 days upon completion of the well.

WELL REPORT

1) OWNER — **A. WELL IDENTIFICATION AND LOCATION DATA**

Name	Address	City	State	Zip
City of Houston Geotech Dept	611 Walker, Floor 14	Houston	Tx	77002

2) WELL LOCATION

County	Physical Address	City	State	Zip
Harris	6900 Crestridge (pz-3)	Houston	Tx	77033

Lat. ° ' " Long. ° ' " Grid # 66-22-4

3) Type of Work
☒ New Well ☐ Reconditioning
☐ Replacement ☐ Deepening

4) Proposed Use (check) ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic
☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
☐ Rig Supply ☐ Stock or Livestock If Public Supply, were plans approved? ☐ Yes ☐ No

5) N↑ °

6) Drilling Date
Started 7/26/2012
Completed 7/26/2012

Diameter of Hole

Dia. (in)	From (ft)	To (ft)
4	Surface 0	25

7) Drilling Method (check)
☐ Driven ☐ Air Rotary ☒ Mud Rotary
☐ Bored ☐ Air Hammer ☐ Cable Tool
☐ Jetted ☐ Hollow Stem Auger
☐ Reverse Circulation
☐ Other

From (ft)	To (ft)	Description and color of formation material
0	30	Cl

8) Borehole Completion ☐ Open Hole ☐ Straight Wall
☐ Under-reamed ☐ Gravel Packed ☐ Other
Gravel Packed interval from ft. to ft. Size

Casing, Blank Pipe, and Well Screen Data

Dia. (in.)	New Or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft) From	Setting (ft) To	Gage Casing Screen
2	N	Sch 40 PVC Riser	0	15	
2	N	Sch 40 PVC Screen	15	25	.010

9) Annular Seal Data: i.e. *(from 0 ft to 100 ft #sacks & material 13 cement)*
from 0 ft. to 13 ft. #sacks & material 1.5 holeplug
from ft. to ft. #sacks & material
from ft. to ft. #sacks & material
Method Used manually done
Distance to septic field or other concentrated contamination ft.
Distance to Property Line ft Method
Verified:

(Use reverse side of Well Owner's copy if necessary)

13) Plugged ☐ Well plugged within 48 hours
Casing left in well: na Cement/Bentonite placed in well:

From (ft)	To (ft)	From (ft)	To (ft)	Material and # Sacks

10) Surface Completion (If steel cased, leave blank)
☐ Surface Slab Installed ☐ Surface Sleeve Installed
☐ Pitless Adapter Used ☒ Alternative Procedure Used

14) Type Pump
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other na
Depth to pump bowls, cylinder, jet, etc., ft.

11) Water Level
Static level dry ft. Date 7/26/2012
Artesian Flow gpm

15) Water Test
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: na gpm with ft. drawdown after hrs.

12) Packers

Type	Depth	Type	Depth
20/40	13		
	25		

16) Water Quality
Type of water: Depth of Strata: Was a chemical analysis made? ☐ Yes ☒ No
Did you knowingly penetrate a strata which contains undesirable constituents? ☐ Yes ☒ No If yes, Continue:
Check One: ☐ Naturally poor-quality groundwater – type ☐ Hydrocarbons (i.e. gas, oil, etc.)
☐ Hazardous material/waste contamination encountered ☐ Other (describe)

☐ *I certify that while drilling, deepening, or otherwise altering the above described well, undesirable water or constituents was encountered and the landowner was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.*

Company or Individual's Name (type or print) Van and Sons Drilling Service, Inc Lic. No. 2903M
Address 3319 John Alberti City Houston State Tx Zip 77076
Signature 9/12/2012 Signature / /
Licensed Driller/Pump Installer Date Apprentice Date

TDLR FORM 001WWD / 9-03 Copies to TDLR - Owner - Driller/Pump Installer Form provided by Forms On-A-Disk · (214) 340-8428 · FormsOnADisk.com

Texas Department of License and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512)463-7880 FAX (512)463-8616
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This form must be completed and filed with the department within 30 days following the plugging of the well.

PLUGGING REPORT

A. WELL IDENTIFICATION AND LOCATION DATA

1) OWNER

Name	Address	City	State	Zip
City of Houston Geo Dept	611 Walker, Floor 14	Houston	Tx	77002

2) WELL LOCATION

County	Physical Address	City	State	Zip
Harris	6900 Crestridge	Houston	Tx	77033

3) Owner's Well No. 3 | Long. ° ' " | Lat. ° ' " | Grid # 66-22-4

4) Type of Well ☐ Water ☒ Monitor ☐ Injection ☐ De-Watering

5) N↑

Drill, Pump Installer, or Landowner performing the plugging operations must locate and identify the location of the well within a specific grid on a full scale gridded map available from Texas Natural Resource Information Service. The location of the well should be denoted within the grid by placing a corresponding dot in the square to the right. The legal description is optional.

B) HISTORICAL DATA ON WELL TO BE PLUGGED (if available)

6) Driller	License No.
Eddie Van Antwerp	2903M

7) Drilled 07/26/2012 | 8) Diameter of hole 4 inches | 9) Total depth of well 25 feet.

C. CURRENT PLUGGING DATA

10) Date well plugged 9/8/2012

12) Name of Driller/Pump Installer or Well Owner performing the plugging
Eddie Van Antwerp

License No. 2903M

13) CASING AND CEMENTING DATA RELATIVE TO THE PLUGGING OPERATIONS.

CASING LEFT IN WELL

DIAMETER (inches)	FROM (feet)	TO (feet)
2	0	25

CEMENT/BENTONITE PLUG(S) PLACED IN WELL

FROM (feet)	TO (feet)	SACKS
0	25	2

11) REMOVE ALL REMOVEABLE CASING
Please check box beside the method of plugging used

- ☐ Tremmie pipe cement from bottom to top.
- ☐ Tremmie pipe bentonite from bottom to 2 feet from surface, cement top 2 feet.
- ☒ Pour in 3/8 bentonite chips when standing water in well is less than 100 feet in depth, cement top 2 feet.
- ☐ Large diameter well filled with clay material from top to bottom.

COMMENTS

1) attempted to pull the well
2) backfilled annular space with bentonite chips

D. VALIDATION OF INFORMATION INCLUDED IN FORM

I certify that I plugged this well (or the well was plugged under my supervision) and that all of the statements herein are true and correct. I understand that failure to complete items 1 through 13 will result in the report(s) being returned for completion and resubmitted.

Company or Individual's Name (type or print) Van and Sons Drilling Service, Inc.

Address 319 John Alber | City Houston | State Tx | Zip 77076

Signature		Signature	
Licensed Driller/Pump Installer	Date 9/12/2012	Apprentice	Date / /

Attention Owner:
Confidentiality Privilege Notice on reverse side of owner's copy.

Texas Department of Licensing and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512) 463-7880 FAX (512) 463-8616
Toll free (800) 803-9202
Email address: water.well@license.state.tx.us

This form must be completed and filed with the department and owner within 60 days upon completion of the well.

WELL REPORT

1) OWNER — **2) WELL IDENTIFICATION AND LOCATION DATA**

Name	Address	City	State	Zip
City of Houston Geotech Dept	611 Walker, Floor 14	Houston	Tx	77002

2) WELL LOCATION

County	Physical Address	City	State	Zip
Harris	S. Good at S. Bank (pz-4)	Houston	Tx	77033

Lat. ° ' " Long. ° ' " Grid # 66-22-4

3) Type of Work
☒ New Well ☐ Reconditioning
☐ Replacement ☐ Deepening

4) Proposed Use (check) ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic
☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
☐ Rig Supply ☐ Stock or Livestock If Public Supply, were plans approved? ☐ Yes ☐ No

5) N↑

6) Drilling Date
Started 7/27/2012
Completed 7/27/2012

Diameter of Hole

Dia. (in)	From (ft)	To (ft)
4	Surface 0	15

7) Drilling Method (check)
☐ Driven ☐ Air Rotary ☒ Mud Rotary
☐ Bored ☐ Air Hammer ☐ Cable Tool
☐ Jetted ☐ Hollow Stem Auger
☐ Reverse Circulation
☐ Other

From (ft)	To (ft)	Description and color of formation material
0	15	Cl

(Use reverse side of Well Owner's Copy if necessary)

8) Borehole Completion ☐ Open Hole ☐ Straight Wall
☐ Under-reamed ☐ Gravel Packed ☐ Other
Gravel Packed interval from ft. to ft. Size:

Casing, Blank Pipe and Well Screen Data

Dia. (in.)	New Or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft) From	Setting (ft) To	Gage Casing Screen
2	N	Sch 40 PVC Riser	0	10	
2	N	Sch 40 PVC Screen	10	15	.010

9) Annular Seal Data: i.e. *(from 0 ft to 100 ft #sacks & material 13 cement)*
from 0 ft. to 8 ft. #sacks & material 1 holeplug
from ft. to ft. #sacks & material
from ft. to ft. #sacks & material
Method Used manually done
Distance to septic field or other concentrated contamination ft.
Distance to Property Line ft Method
Verified:

13) Plugged ☐ Well plugged within 48 hours
Casing left in well: na Cement/Bentonite placed in well:

From (ft)	To (ft)	From (ft)	To (ft)	Material Used & # Sacks

10) Surface Completion (If steel cased, leave blank)
☐ Surface Slab Installed ☐ Surface Sleeve Installed
☐ Pitless Adapter Used ☒ Alternative Procedure Used

14) Type Pump
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other na
Depth to pump bowls, cylinder, jet, etc., ft.

11) Water Level
Static level dry ft. Date 7/27/2012
Artesian Flow gpm

15) Water Test
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: na gpm with ft. drawdown after hrs.

12) Packers

Type	Depth	Type	Depth
20/40	8		
	15		

16) Water Quality
Type of water: Depth of Strata: Was a chemical analysis made? ☐ Yes ☒ No
Did you knowingly penetrate a strata which contains undesirable constituents? ☐ Yes ☒ No If yes, Continue:
Check One: ☐ Naturally poor-quality groundwater – type ☐ Hydrocarbons (i.e. gas, oil, etc.)
☐ Hazardous material/waste contamination encountered ☐ Other (describe)

☐ *I certify that while drilling, deepening, or otherwise altering the above described well, undesirable water or constituents was encountered and the landowner was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.*

Company or Individual's Name (type or print) Van and Sons Drilling Service, Inc Lic. No. 2903M
Address 3[illegible] John Alber City Houston State Tx Zip 77076
Signature 9/12/2012 Signature / /
Licensed Driller/Pump Installer Date Apprentice Date

Texas Department of License and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512)463-7880 FAX (512)463-8616
Email address: water.well@license.state.tx.us

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1) OWNER

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2) WELL LOCATION

County	Physical Address	City	State	Zip
Harris	S. Good at S. Bank	Houston	Tx	77033

3) Owner's Well No. 4 | Long. ° ' " | Lat. ° ' " | Grid # 66-22-4

4) Type of Well ☐ Water ☒ Monitor ☐ Injection ☐ De-Watering

5) N↑

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B) HISTORICAL DATA ON WELL TO BE PLUGGED (if available)

6) Driller	License No.
Eddie Van Antwerp	2903M

7) Drilled 07/27/2012 | 8) Diameter of hole 4 inches | 9) Total depth of well 15 feet.

C. CURRENT PLUGGING DATA

10) Date well plugged 9/8/2012

12) Name of Driller/Pump Installer or Well Owner performing the plugging
Eddie Van Antwerp

License No. 2903M

13) CASING AND CEMENTING DATA RELATIVE TO THE PLUGGING OPERATIONS.

CASING LEFT IN WELL

DIAMETER (inches)	FROM (feet)	TO (feet)
2	0	15

CEMENT/BENTONITE PLUG(S) PLACED IN WELL

FROM (feet)	TO (feet)	SACKS
0	15	1

11) REMOVE ALL REMOVEABLE CASING

Please check box beside the method of plugging used

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Company or Individual's Name (type or print) Van and Sons Drilling Service, Inc.

Address 819 John Alber | City Houston | State Tx | Zip 77076

Signature		Signature	
E. Van Antwerp	9/12/2012		/ /
Licensed Driller/Pump Installer	Date	Apprentice	Date