GEOTECHNICAL INVESTIGATION
PINEMONT STREET RECONSTRUCTION
WBS NO. N-000475-0002-3
HOUSTON, TEXAS

SUBMITTED TO
IDC, INC.
11111 WILCREST GREEN
HOUSTON, TEXAS 77042

BY
HVJ ASSOCIATES, INC.
HOUSTON, TEXAS
MAY 14, 2013

REPORT NO. HG1018721
KEY MAP NOS. 452 F & G

HVJ ASSOCIATES

Houston
Austin
Dallas
San Antonio

6120 S. Dairy Ashford Rd.
Houston, TX 77072-1010
281.933.7388 Ph
281.933.7293 Fax
www.hvj.com

May 14, 2013

Mr. Larry Janak, PE
IDC, Inc.
11111 Wilcrest Green
Houston, Texas 77042

Re: Geotechnical Investigation
Pinemont Drive Street Reconstruction: From 300 feet west of Ella to N. Shepherd
Owner: City of Houston
WBS No. N-000475-0002-3
HVJ Report No. HG1018721

Dear Mr. Janak:

Submitted herein is the final report of our geotechnical investigation for the above referenced project. The study was conducted in general accordance with our proposal number HG1018721 dated November 15, 2010 (revised on August 28, 2012) and is subject to the limitations presented in this report.

We appreciate the opportunity of working with you on this project. Please read the entire report and notify us if there are questions concerning this report or if we may be of further assistance.

Sincerely,

HVJ ASSOCIATES, INC.
Texas Firm Registration No. F-000646

Ziad AlAawar, PE
Project Manager

STATE OF TEXAS
5-14-2013
ZIAD R. ALAAWAR
107115
LICENSED
PROFESSIONAL ENGINEER

Gina M. Ellison, PE
Project Engineer

STATE OF TEXAS
GINA M. ELLISON
109846
LICENSED
PROFESSIONAL ENGINEER

MM/ZA/GE/ar

Copies submitted: 2

The seals appearing on this document were authorized by Ziad AlAawar, PE 107115 and Gina M. Ellison, P.E., 109846 on May 14, 2013. The geotechnical investigations presented in Sections 2, thru 7, 9 and 10 were completed under the direction of Mr. Mustafa; the pavement recommendations presented in Section 8 was developed by Ms. Ellison. Alteration of a sealed document without proper notification to the responsible engineer is an offense under the Texas Engineering Practice Act.

The following lists the pages which complete this report:

- Main Text – 21 pages
- Plates – 9 pages
- Appendix A – 13 pages
- Appendix B – 6 pages
- Appendix C – 7 pages
- Appendix D – 2 pages
- Appendix E – 2 pages
- Appendix F – 5 pages

CONTENTS

Page

1 EXECUTIVE SUMMARY i

2 INTRODUCTION 1
2.1 Project Description 1
2.2 Geotechnical Investigation Program 1

3 FIELD INVESTIGATION 1
3.1 Geotechnical Borings 1
3.2 Survey Data 2
3.3 Sampling Methods 2
3.4 Water Level Measurements 2

4 LABORATORY TESTING 3

5 SITE CHARACTERIZATION 3
5.1 General Geology 3
5.2 Geologic Faulting 4
5.3 Soil Stratigraphy 4
5.4 Groundwater Conditions 4

6 STORM SEWER DESIGN CRITERIA AND RECOMMENDATIONS 5
6.1 General 5
6.2 Geotechnical Parameters 5
6.3 Utilities Installed by Trenchless Technique 6

7 UTILITY CONSTRUCTION CONSIDERATIONS 7
7.1 General 7
7.2 Excavation Considerations 8
7.3 Auger Construction Considerations 9
7.4 Auger Pit Construction Considerations 9
7.5 Select Fill and General Earthwork Recommendations 10
7.6 Groundwater Control 10

8 PAVEMENT DESIGN RECOMMENDATIONS 11
8.1 General 11
8.2 Existing Pavement Thickness 11
8.3 Rigid Pavement Design Recommendations 11
8.4 Preparation of Subgrade 14

9 MONITORING 14
9.1 Excavation Safety 14
9.2 Preconstruction Survey 14
9.3 Construction Monitoring - Tunneling 15
9.4 Construction Materials Testing 15

10 FOUNDATION RECOMMENDATIONS FOR TRAFFIC SIGNAL LIGHTS 15

11 DESIGN REVIEW 15

12 LIMITATIONS 16

PLATES

Plate

SITE VICINITY MAP 1

PLAN OF BORINGS 2

RIGID PIPE AND TUNNEL LINER LOADS 3

BRACED EXCAVATION LATERAL EARTH PRESSURE DIAGRAM 4

APPENDICES

Appendix

BORING LOGS AND KEY TO TERMS & SYMBOLS ..... A

SUMMARY OF LABORATORY TEST RESULTS ..... B

PIEZOMETER INSTALLATION RECORDS C

SOIL PROFILE ..... D

DARWIN PAVEMENT ANALYSIS OUTPUT ..... E

DRILLED SHAFT CAPACITY CURVES ..... F

1 EXECUTIVE SUMMARY

HVJ Associates, Inc. was retained by IDC, Inc. to provide geotechnical services for the proposed Pinemont Drive street reconstruction from 300 feet west of Ella Boulevard to North Shepherd Drive in Houston, Texas. The project also includes replacement of storm sewers and construction signal lights. The signal lights will be constructed at the intersection of Pinemont Drive with Ella Boulevard and Brinkman Drive. Based on the information provided to us by IDC, Inc., we understand that the invert depth of the proposed storm sewers ranges between 5 and 7.2 feet below the existing grade. The project also includes construction of a 4.5-acres detention pond and the depth of the pond will be about 6 feet below the existing grade. A site vicinity map showing the approximate project location is presented on Plate 1 of the report.

The purpose of this study is to provide design and construction recommendations for the proposed pavement reconstruction, utilities, signal lights and detention pond. However, no geotechnical services were provided for the proposed detention pond in this report due to the site entry issues to perform drilling at the proposed detention pond. Geotechnical services for the detention pond will be provided as an addendum once the right-of-entry is granted to complete the work. The geotechnical investigation, laboratory testing and report preparation was performed in accordance with Chapter 11 of the City of Houston Department of Public Works and Engineering Infrastructure Design Manual, July 2012.

Based on the subsurface conditions revealed by the soil borings, the findings and recommendations of this report are summarized below:

1. Borings B-1 through B-11: The subsurface soils at the site generally comprise of sandy lean clays, silty sands and fat clays at most of the boring locations. At boring B-1, clayey sand was observed at the top 2 feet underlain by sandy lean clay to the depth of 10 feet and silty sand was encountered in between 10 and 16 feet followed by fat clay with sand to the termination depth of the boring. At boring B-2, sandy lean clay was observed at the top 12 feet underlain by silty sand to the depth of 16 feet and the boring was terminated by fat clay. Sandy lean clay was encountered at the top 12 feet followed by fat clay to the termination depth at borings B-3, B-4 and B-5. Sandy lean clay was observed at top 10 feet followed by fat clay to the termination depth of boring B-6. At boring B-7, clayey sand was encountered at the top 2 feet underlain by sandy lean clay to the depth of 10 feet and lean clay was observed from 10 to 14 feet followed by silty sand to the depth of 16 feet, fat clay was observed from 16 to 18 feet and the boring was terminated by sandy lean clay. Sandy lean clay was encountered over the entire depth of boring B-8 with layers of lean clay with sand and silty sand between 10 to 14 feet and 14 to 16 feet respectively. At boring B-9, sandy lean clay was observed at the top 14 feet underlain by sand with silt and the boring was terminated by fat clay. At boring B-10, clayey sand was observed at the top 2 feet followed by sandy lean clay to the depth of 12 feet and lean clay was observed from 12 feet to the termination depth. Clayey sand was observed at the top 2 feet at boring B-11 followed by sandy lean clay to the depth of 14 feet and lean clay was observed from 14 feet to the termination depth.

2. Groundwater was encountered at boring locations B-1, B-6 and B-8 during the drilling operations. Two piezometers were installed at boring locations B-1 (PZ-1) and B-8 (PZ-2). The 24-hour water level readings at borings B-1 and B-8 were 9.25 and 11.0 feet respectively. Piezometer installation records and groundwater level data are provided in Appendix C.

3. A literature review of surface faults was made from published reports. The primary objective of this review was to evaluate available information from published reports and

open file reports. Based on our review, Eureka Heights fault is located at about 1.5 miles south of the project site. We believe that faulting should not impact the project site; however, it should be noted that unmapped faults that could impact the project site might exist within the project area. A detailed fault study was not within the scope of this study.

4. Recommendations for pavement reconstruction and installation of storm sewers using both open cut and trenchless techniques are presented in this report. Trenchless operations should generally be in accordance with City of Houston Standard Specification, 02447.

5. The existing pavements were cored at all the boring locations prior to drilling and the core data revealed that the existing pavement consists of 6 to 9 inches of concrete over 2.25 to 3.5 inches of asphalt. Details of existing pavement thickness at each boring location are presented in the report.

Please note that this executive summary does not fully relate our findings and opinions. Those findings and opinions are only presented through our full report.

2 INTRODUCTION

2.1 Project Description

HVJ Associates, Inc. was retained by IDC, Inc. to provide geotechnical services for the proposed Pinemont Drive street reconstruction from 300 feet west of Ella Boulevard to North Shepherd Drive in Houston, Texas. The project also includes replacement of storm sewers and construction of signal lights. The signal lights will be constructed at the intersection of Pinemont Drive with Ella Boulevard and Brinkman Drive. Based on the information provided to us by IDC, Inc., we understand that the invert depth of the proposed storm sewers ranges between 5 and 7.2 feet below the existing grade. The project also includes construction of a 4.5-acres detention pond and the depth of the pond will be about 6 feet below the existing grade. A site vicinity map showing the approximate project location is presented on Plate 1 of the report.

The purpose of this study is to provide design and construction recommendations for the proposed pavement reconstruction, utilities, signal lights and detention pond. However, no geotechnical services were provided for the proposed detention pond in this report due to the site entry issues to perform drilling at the proposed detention pond. The geotechnical investigation, laboratory testing and report preparation was performed in accordance with Chapter 11 of the City of Houston Department of Public Works and Engineering Infrastructure Design Manual, July 2012.

2.2 Geotechnical Investigation Program

The primary objectives of this study were to gather information on subsurface conditions at the site and to provide recommendations for the proposed pavement reconstruction, signal lights and storm sewer lines. The objectives were accomplished by:

1. Drilling eleven soil borings to depths ranging between 15 to 25 feet below the existing subgrade to determine soil stratigraphy and to obtain samples for laboratory testing;

2. Installing two piezometers at boring locations B-1 (PZ-1) and B-8 (PZ-2) to gain an understanding of the groundwater conditions at the site and to evaluate the potential need for dewatering during construction;

3. Performing laboratory tests to determine physical and engineering characteristics of the soils; and

4. Performing engineering analyses to develop design guidelines and recommendations for the proposed pavement, signal lights and storm sewer lines construction.

Subsequent sections of this report contain descriptions of the field exploration, laboratory-testing program, general subsurface conditions, design recommendations, and construction considerations.

3 FIELD INVESTIGATION

3.1 Geotechnical Borings

The field exploration program undertaken at the project site was performed on December 11, 2012. Subsurface conditions were investigated by drilling eleven soil borings to depths ranging from 15 to 25 feet below the existing grade. The pavement was cored at all eleven boring locations and pavement thickness information was obtained. All boreholes were backfilled with cement grout by tremie method in accordance with the City guidelines and patched at the surface, where applicable.

3.2 Survey Data

Based on the survey information provided to us by IDC, Inc. the station number, offset distance, ground surface elevation and termination depth for all the borings is presented below.

Boring No.	Approximate Location	Northing	Easting	Ground Surface Elevation (ft)	Station	Offset	Depth of Boring (ft)
B-1	Pinemont Dr/ N Ella Blvd	13872017.2	3100709.7	78.71	14+33.05	23.47LT	25
B-2	Pinemont Dr	13871958.4	3101262.2	79.02	19+89.75	5.56RT	20
B-3	Pinemont Dr/ Golf Dr	13871996.5	3101834.7	78.81	25+63.38	6.69LT	15
B-4	Pinemont Dr	13872005.3	3102316.7	78.82	30+45.34	6.21RT	15
B-5	Pinemont Dr	13872043.6	3102858.8	78.25	35+88.62	7.64LT	15
B-6	Pinemont Dr/ Alba Rd	13872052.5	3103380.5	77.54	41+10.16	6.94RT	20
B-7	Pinemont Dr/ Sue Marie Ln	13872102.9	3104180.6	76.34	49+11.68	7.45LT	20
B-8	Pinemont Dr/ Brinkman St	13872115.4	3104761.1	75.52	54+92.24	6.24RT	25
B-9	Pinemont Dr	13872142.5	3105084.6	75.23	58+16.63	6.27LT	20
B-10	Pinemont Dr	13872146.1	3105448.3	74.65	61+80.10	6.50RT	15
B-11	Pinemont Dr / N Shepherd Dr	13872217.5	3106380.8	72.85	71+14.89	22.86LT	15

3.3 Sampling Methods

Soil samples were obtained continuously to a depth of 20 feet or to the termination depth whichever is earlier and then at 5-foot intervals. Cohesive soil samples were obtained with a three-inch thin-walled (Shelby) tube sampler in general accordance with ASTM D-1587 standard. Each sample was removed from the sampler in the field, carefully examined and then classified. The shear strength of the cohesive soils was estimated by a hand penetrometer in the field. Cohesionless soils were sampled with the split spoon sampler in accordance with ASTM D 1586 standard. Suitable portions of each sample were sealed and packaged for transportation to our laboratory.

Detailed descriptions of the soils encountered in the borings are given on the boring logs presented in Appendix A. A key to the soils classification and symbols used in the boring logs is also presented in Appendix A.

3.4 Water Level Measurements

Groundwater readings were measured during and after the drilling operations. Two piezometers were installed at boring locations B-1 (PZ-1) and B-8 (PZ-2) to record long term water level

readings. Water level readings in the piezometers were measured after 24 hours and 30 days of installation. Piezometer installation and Plugging records are provided in Appendix C.

4 LABORATORY TESTING

Selected soil samples were tested in the laboratory to determine applicable physical and engineering properties. All tests except pocket penetrometer were performed according to the relevant ASTM Standards. These tests consisted of moisture content measurements, Percent Passing No. 200 Sieve, Atterberg Limits, unconsolidated undrained compression and unit dry weight tests.

The Atterberg limits and percent passing number 200 sieve tests were utilized to verify field classification by the ASTM version of the Unified Soils Classification System, and the unconsolidated undrained tests were performed to obtain the undrained shear strength of the soil. The type and number of tests performed for this investigation are summarized below:

Type of Test	Number of Tests
Moisture Content (ASTM D2216)	84
Atterberg Limits (ASTM D4318)	25
Percent Passing No. 200 Sieve (ASTM D1140 & ASTM 2487)	31
Pocket Penetrometer	72
Unconsolidated Undrained Compression (UU) (ASTM D 2850)	25
Unit Dry Weight (ASTM D 2166/2850)	25

The laboratory test results are presented on the boring logs in Appendix A. A summary of laboratory test results are provided in Appendix B.

5 SITE CHARACTERIZATION

5.1 General Geology

There are two major surface geological formations that exist in the Houston area: the Beaumont formation and the Lissie formation. The Beaumont formation is a relatively younger formation generally found to the southeast of the Lissie formation. The Beaumont formation dips southeastward and extends beneath beach sand and waters of the Gulf of Mexico as far as the continental shelf. The project site is located in an area where the Lissie formation is typically encountered.

The upper Lissie formation is sometimes denoted as the Montgomery formation. The upper Lissie formation is heterogeneous, containing interbedded layers of clay, sand and silt. It was deposited in mid-Pleistocene times in shallow coastal river channels and flood plains.

The clay present in the formation has been preconsolidated by a process of desiccation. Numerous wetting and drying cycles have produced a network of randomly oriented and closely spaced joints, which are sometimes slickensided, that is, have a shiny appearance when exposed. The joint pattern strongly influences the engineering behavior of the soil.

The sand layers vary in compactness from loose to very dense, and in thickness from a fraction of an inch to many feet due to an irregular depositional environment. Sands are generally subrounded to subangular and vary from coarse to very fine, are poorly graded, and often contain significant amounts of silt-sized particles in the sand matrix. The coastal plain in this region has a complex tectonic geology, several major features of which are: Gulf Coastal geosyncline, salt domes, major sea level fluctuations during the glacial stages, subsidence and faulting activities. Most of these faulting activities have ceased for millions of years, but some are still active.

5.2 Geologic Faulting

The tectonic history of the Texas Gulf Coast includes a relatively stable depositional cycle since the Cretaceous Period (about 65 million years). During this period the area has been subjected to deposition of clays, silts, and sands resulting in over 30 thousand feet of sedimentary rocks. Underlying this clastic sequence are salt formations, which have migrated upwards to produce the typical salt dome features associated with the Texas Gulf Coast. In conjunction with salt movement, dewatering and compaction of some of the deeper sediments in the basin have resulted in the development of growth faults.

A literature review of surface faults was made from published reports. The primary objective of this review was to evaluate available information from published reports and open file reports. Based on our review, Eureka Heights fault is located at about 1.5 miles south of the project site. We believe that faulting should not impact the project site; however, it should be noted that unmapped faults that could impact the project site might exist within the project area. A detailed fault study was not within the scope of this study.

5.3 Soil Stratigraphy

Our interpretation of soil and groundwater conditions at the project site is based on information obtained at the boring locations only. This information has been used as the basis for our conclusions and recommendations. Significant variations at areas not explored by the project boring may require reevaluation of our findings and conclusions. Soil stratigraphy encountered at different borings and at different depths is detailed below.

Borings B-1 through B-11: The subsurface soil consists of sandy lean clays, silty sands and fat clays at most of the boring locations. At boring B-1, clayey sand was observed at the top 2 feet underlain by sandy lean clay to the depth of 10 feet and silty sand was encountered in between 10 and 16 feet followed by fat clay with sand to the termination depth of the boring. At boring B-2, sandy lean clay was observed at the top 12 feet underlain by silty sand to the depth of 16 feet and the boring was terminated by fat clay. Sandy lean clay was encountered at the top 12 feet followed by fat clay to the termination depth at borings B-3, B-4 and B-5. Sandy lean clay was observed at top 10 feet followed by fat clay to the termination depth of boring B-6. At boring B-7, clayey sand was encountered at the top 2 feet underlain by sandy lean clay to the depth of 10 feet and lean clay was observed from 10 to 14 feet followed by silty sand to the depth of 16 feet, fat clay was observed from 16 to 18 feet and the boring was terminated by sandy lean clay. Sandy lean clay was encountered over the entire depth of boring B-8 with layers of lean clay with sand and silty sand between 10 to 14 feet and 14 to 16 feet respectively. At boring B-9, sandy lean clay was observed at the top 14 feet underlain by sand with silt and the boring was terminated by fat clay. At boring B-10, clayey sand was observed at the top 2 feet followed by sandy lean clay to the depth of 12 feet and lean clay was observed from 12 feet to the termination depth. Clayey sand was observed at the top 2 feet at boring B-11 followed by sandy lean clay to the depth of 14 feet and lean clay was observed from 14 feet to the termination depth.

Details of the subsurface stratigraphy encountered in the borings are shown on the boring logs presented in Appendix A.

5.4 Groundwater Conditions

Groundwater was encountered at boring locations B-1, B-6 and B-8 during the drilling operations. Two piezometers were installed at boring locations B-1 (PZ-1) and B-8 (PZ-2). The 24-hour water level readings at borings B-1 and B-8 were 9.25 and 11.0 feet respectively. Piezometer installation records and groundwater level data are provided in Appendix C. Plugging reports will be provided in the final report.

It should be noted that groundwater levels determined during drilling may not accurately reflect the true groundwater conditions, and therefore should only be considered as approximate. Groundwater levels measured in open standpipe piezometers are, on the other hand, more accurate; however, these readings will fluctuate seasonally and in response to rainfall. Other factors that might impact piezometric groundwater levels include leakage from existing sewers and/or sanitary sewers.

6 STORM SEWER DESIGN CRITERIA AND RECOMMENDATIONS

6.1 General

The project involves the replacement of storm sewers along Pinemont Drive from 300 feet west of Ella Boulevard to North Shepherd Drive in Houston. Based on the information provided to us by IDC, Inc., we understand that the invert depth of the proposed storm sewers ranges between 5 and 7.2 feet below the existing grade. Our Analyses and recommendations for the installation of utilities using both augering and open cut techniques are presented below.

6.2 Geotechnical Parameters

Geotechnical design parameters are presented in the following table. Design parameters given in the table are based on field and laboratory test data obtained at boring locations only and at the approximate invert depth. It must be noted that because of the nature of the soil stratigraphy at this site, parameters at locations away from the borings may vary substantially from values reported in the table.

Boring No.	Street Name	Actual Invert Depth (ft)	Soil Description at Invert Depth	Total Unit Weight (pcf)	Undrained Shear Strength (psf)	Allowable Bearing Pressure (psf)	E'n, Long Term (psi)
B-2	Pinemont Drive	7.0	Stiff Sandy Lean Clay	134	2000	3300	600
B-3	Pinemont Drive	6.0	Stiff Sandy Lean Clay	134	1300	2100	600
B-4	Pinemont Drive	7.0	Stiff Lean Clay w/ Sand	132	1500	2500	600
B-5	Pinemont Drive	7.3	Stiff Sandy Lean Clay	126	1100	1800	600
B-6	Pinemont Drive	6.5	Soft Sandy Lean Clay	127	500	1000	200
B-7	Pinemont Drive	6.0	Stiff Sandy Lean Clay	129	1400	2400	600
B-9	Pinemont Drive	5.0	Stiff Sandy Lean Clay	138	1500	2500	600
B-10	Pinemont Drive	6.0	Very stiff Sandy Lean Clay	124	2600	4300	1000
B-11	Pinemont Drive	5.3	Stiff Sandy Lean Clay	121	1700	2900	600

The values shown in the above table represent our interpretation of the soil properties based on the available laboratory and field test data. Use of the soil properties shown above may or may not be appropriate for a particular analysis, since choice of design parameters often depends on whether total or effective stress analysis is used, rate of loading, duration of loading, geometry of loaded area, and other factors. The total unit weight values shown above represent our interpretation of soil unit weight at natural moisture content. The undrained shear strength and allowable bearing pressure values represent our interpretation of the shear strength in clay soils based primarily on the results of unconsolidated undrained compression tests and hand penetrometer tests. The allowable bearing pressures include a factor of safety of three.

Pipe Design. The loads imposed on underground pipes depend principally upon the method of installation, the weight of overburden soils, roadway traffic load, and loads due to existing surface structures. For design of rigid pipes installed using open-cut excavation methods, loads due to overburden and traffic can be determined from Plate 3.

The traffic load applied to the pipe can be calculated using 85% of wheel load with an impact factor of 1.5 for one foot of soil cover, 50% of wheel load with an impact factor of 1.35 for 2 feet of cover, and 30% of wheel load with an impact factor of 1.15 for 3 feet of cover. This results in a total design traffic load on the pipe or box culvert of about 1.28, 0.68 and 0.35 times the wheel load for 1, 2 and 3 feet of cover, respectively. For pipes or box culverts with four or more feet of cover, the traffic loads may be taken as a surcharge equivalent to 250 psf.

The design of flexible pipes requires the modulus of soil reaction of the native soil (E_n') in the trench wall as input. The E_n' values are based on empirical relationships to the soil consistency as defined by unconsolidated undrained compression tests for cohesive soils. E_n' values for the native soils are presented in the above table.

The E_n' values for short-term conditions in cohesive soils may be assumed to be 1.5 times the long-term values. These values are based on the soil data obtained at the boring locations only and may be used for the noted invert depth zone.

Pipe Bedding. The storm sewer may be installed using City of Houston standard bedding details as outlined on Standard Drawing Nos. 02317-02 and 02317-03. If needed, we recommend groundwater control in accordance with Section 01578 of City of Houston Standard Specifications be implemented to achieve stable trench conditions and satisfactory foundation base.

The excavations should be performed with equipment capable of providing a relatively clean bearing area. Stable soils are essential to provide a strong base during construction. In addition, stable soils enhance trench bottom stability, support for bedding compaction, and minimize possible pipe settlement. Whenever soft foundation soils are encountered such as those encountered in borings B-6 (soft 4 to 8 feet) during trench excavation, we recommend over excavating 3 to 5 feet below the base of the foundation and replacing with on-site soils compacted to at least 95% of maximum dry density in loose lifts not exceeding 8 inches.

Trench Backfill. Trench backfill for storm sewer should be in accordance with Section 02317, Excavation and Backfill for Utilities, of the City of Houston Standard Specifications, October 2002. Backfill around the storm sewers, including manholes and other underground structures, should be in accordance with the provisions that are explained in the City of Houston Standard Details on Drawing Nos. 02317-02 and 02317-03.

6.3 Utilities Installed by Trenchless Technique

We understand that trenchless construction methods may be used to install storm sewers at some locations along the alignment. The results of our soil borings indicate that cohesive soils will be encountered at the pipe invert depth. It should be noted that due to variability in soil deposits any tunneling operations along the projected alignments could result in varying degrees of mixed face tunneling conditions where several types of soil material may be encountered at the tunneling face.

Although the clays are typically stable, face stability problems can occur when soft soils are encountered such as those encountered in boring B-6 (soft sandy lean clay). Even with dewatering systems operating, unstable flowing situation may occur.

Geotechnical Properties. Recommended ranges of engineering design soil parameters for the cohesive soils that may be encountered in the pipe zone are summarized below.

For cohesive soils:

Total Unit Weight	121 to 134 pcf
Coefficient of Earth Pressure, K_o	1.0
Undrained Shear Strength	500 to 2600 psf
Average Undrained Shear Strength	1600 psf
Poisson's Ratio	0.45
Young's Modulus	3000 to 14000 psi

Pipe Design. For pipes to be installed by tunneling techniques, whereby sections of pipe are jacked forward against the surrounding soil, pipes should be designed to resist significant bending moments, along with the jacking forces exerted on the pipe during installation. These loads generally exceed the overburden pressures that are typically determined based on the prism earth load to the ground surface, plus hydrostatic pressure and surcharge loads as shown on Plates 4A and 4B. Therefore, pipes designed to resist construction loads during tunneling operations should have adequate strength for most long-term overburden and traffic loads.

During design, allowance should be made for any external loads, other than soil loads, which may be exerted on the pipe. These include loads from foundations for structures located near the water line and any possible future excavation to be performed near the pipelines.

Influence of Tunneling on Adjacent or Overlying Structures. The construction of every tunnel in soils is associated with a change in the state of stress in the ground and with the corresponding strains and displacement. In particular, some degree of settlement of the overlying ground surface is always induced. If such settlement, referred to as subsidence, is excessive, it may cause damage to structures, roads and services located above the tunnel.

It should be noted that the existing foundation of the nearby structures and buried portion of existing pipelines within the zone of influence of the tunnel might be subject to possible distress due to tunnel-induced settlement. While the recommendations we are providing intend to reduce the settlement and distress to these structures and pipelines within the zone of influence, they still should be monitored before and for a period after tunneling operations are completed. Generally, settlements due to tunneling are not anticipated after the tunneling operations are completed.

In order to minimize settlement due to tunneling operations the contractor should use well-established techniques and provide temporary support, by advancing the primary liner continuously, as tunneling progresses. No voids should be allowed between any temporary support and the surrounding soils, and with that purpose the injection of cement grout should be considered if it is deemed necessary to fill the voids.

7 UTILITY CONSTRUCTION CONSIDERATIONS

7.1 General

This section is intended to address issues that might arise during construction. Our recommendations are intended for use as guidelines in dealing with particular soil conditions. The topics addressed in this section include trench excavation stability, groundwater control, open-cut construction and augering technique construction considerations.

The recommendations contained herein are not intended to dictate construction methods or sequences. Instead they are provided solely to assist designers in identifying potential construction problems related to excavation, based upon findings derived from sampling. Depending upon the final design chosen for the project, the recommendations may also be useful to personnel who observe construction activity.

Prospective contractors for the project must evaluate potential construction problems on the basis of their review of the contract documents, their own knowledge of and experience in the local area, and on the basis of similar projects in other localities, taking into account their own proposed methods and procedures.

7.2 Excavation Considerations

Excavations should satisfy two requirements. First, the soils above final grade must be removed without disturbing the soil below excavation grade, which will support constructed facilities. Second, the sides of the excavation must be stable to prevent damage to adjacent streets and facilities as a result of either vertical or lateral movements of the soil. In addition, a satisfactory excavation procedure must include an adequate construction dewatering system to lower and maintain the water level at least a few feet below the lowest excavation grade.

Excavation Stability. Excavations shall be shored, laid back to a stable slope or some other equivalent means may be used to provide safety for workers and adjacent structures. Earth pressures for braced excavations are presented on Plates 4A and 4B. Assessment of the need for excavation sloping, use of trench boxes or other measures required to provide a stable excavation, and the use of appropriate construction practices and/or equipment is the contractor's responsibility.

The following comments are intended to represent common solutions to stability problems encountered in similar soil conditions in the Houston area, and may not be construed as excavation system design recommendations. The excavation operations shall be performed in accordance with 29 CFR Part 1926 subpart P, as amended, including rules published in the Federal Register, Vol. 54, No. 209, dated October 31, 1989, as a minimum. In addition, the provisions of legislation enacted by the Texas Legislature and City of Houston should be satisfied.

Boring No.	Street Name	OSHA Soil Type			
		Depth of Trench (feet)			
		0-2	2-5	5 – 10	10-14
B-1	Pinemont Drive	C	B	B	C
B-2	Pinemont Drive	B	B	B	C
B-3	Pinemont Drive	B	B	B	B
B-4	Pinemont Drive	B	B	B	B
B-5	Pinemont Drive	B	B	B	B
B-6	Pinemont Drive	B	C	C	B
B-7	Pinemont Drive	C	B	B	B
B-8	Pinemont Drive	B	B	B	B
B-9	Pinemont Drive	B	B	C	C
B-10	Pinemont Drive	B	B	B	B
B-11	Pinemont Drive	C	B	C	B

In general, it is our opinion that the pressure distribution (for braced walls) should be used for design of sheeting or trench boxes. To reduce the potential for ground movement adjacent to the top of the excavation, the bracing should be preloaded in stages as the excavation is deepened. The detailed earth pressure diagrams are presented on Plates 4A and 4B.

The planned construction will be performed along alignments near existing utility installations (either crossing or paralleling the new alignments). The contractors should be aware of potential excavation stability problems while working in the vicinity of old trenches and the excavation system should be designed to accommodate this weak material (trench backfill).

The vertical walls of excavations should be located a safe distance from existing utilities in order to prevent movement in the soil mass behind the excavation that may adversely affect the utilities. We recommend that the horizontal distance should be 4 feet for excavation depths of up to 10 feet.

7.3 Auger Construction Considerations

In augering, a launch pit is excavated and a horizontal boring rig is used to excavate an unsupported bore distance of up to 300 to 400 feet to a receive pit. Once the bore is excavated, dragging a tool through the bore cleans it, and then the pipe is dragged through the bore. This technique is commonly used in the Houston area for installation of small diameter pipes at depths above the groundwater table. Augering operations should generally be in accordance with City of Houston Standard Specification, 02447.

Bore Stability. In auger construction, where the bore must stand open unsupported for a period of several hours, the structure of the soil is very important. Augering operations have encountered difficulties such as slowed production rates, ground surface settlement above the bore, and bore collapse in some soil conditions in the Houston area. We do not recommend augering in unstable soils or in soils below the water table without providing casing to prevent running ground condition. Firm to very stiff clay soils are generally suitable for augering, however, the secondary structure of the soil is an important consideration. Where a blocky, slickensided, or fissured condition is noted on the boring logs, the clay soil may slough excessively from the bore walls. This will lead to an excessive number of cleaning passes to allow passage of the pipe, and it will result in formations of large voids around the pipe. Collapse of these voids after pipe placement commonly results in noticeable settlement of the ground surface above the bore.

Loss of Ground. A properly designed and controlled augering operation can eliminate or reduce immediate soil movement and subsidence to a tolerable level. Nevertheless, some ground loss should be expected during any tunnel construction operation. With good construction techniques, ground loss can be held to acceptable levels. Generally, tunnels constructed beneath pavement and buried utilities can be expected to create a loosened subgrade or bedding condition which may lead to subsequent deformations.

Large ground loss can result from uncontrolled flowing ground. The potential for such ground loss exists wherever water-bearing sands or silts are encountered along the alignment. Careful dewatering of such layers will reduce the potential for development of flowing conditions, but local experience shows that complete dewatering is difficult to achieve as discussed in a later section.

Ground Control and Improvement. We recommend that tunnels be constructed using techniques that provide positive support to the soil during augering operations. Several measures are available to overcome adverse ground conditions including groundwater lowering and grouting. We expect that groundwater will be encountered in tunnels that are excavated below 9 feet. Groundwater control and dewatering recommendations are provided in Section 7.6 of this report.

7.4 Auger Pit Construction Considerations

It is our understanding that auger pits constructed for augering operations will vary in size depending on whether the pit is a drive or receive pit, the size of machine, and the length of auger pit. Pit construction should be in accordance with City of Houston Standard Specification 02447. Pit should be backfilled in accordance with City of Houston Standard Specification 02317.

Pit Excavation Stability. Pit excavations shall be shored or some other equivalent means may be used to provide safety for workers and adjacent structures. Assessment of the need for excavation shoring or other measures required to provide a stable excavation, and the use of appropriate construction practices and/or equipment is the contractor's responsibility. The lateral earth pressures recommended for short-term design are generally lower than the long-term pressures as the state of stress in the soil changes from "at rest" to "active" conditions immediately after excavation. In calculating the "design" lateral earth pressures, a combination of lateral soil pressures; hydrostatic water pressures; and surcharge loads need to be considered. We recommend that pressure distribution as shown on Plates 4A and 4B be used, and that the hydrostatic water pressure be computed by assuming the groundwater table to coincide with the ground surface. Calculation of these pressure components is explained on Plates 4A and 4B.

Pit Bottom Stability. Bottom instability results from inadequate shear strength in clay soils to resist stress relief at the base of the excavation, or from piping of water bearing granular soil. This mode of failure results in loss of ground at the ground surface outside the pit and heave of the excavation base inside the pit. Pits for augering operations are typically excavated approximately 4 feet below pipe invert depth. Whenever soft foundation soils are encountered during trench excavation such as those encountered in boring B-6, we recommend over excavating 3 to 5 feet below the base of the foundation and replacing with on-site soils compacted to at least 95% of maximum dry density in loose lifts not exceeding 8 inches.

Loss of Ground. Installation of pits may experience some loss of ground around the outside of the excavation due to sloughing of material into the excavation. If proper construction procedures are followed, little or no loss of ground should occur. If loss of ground is excessive, it may cause damage to structures, pavement and services located near the excavation. If loss of ground does occur, soft disturbed soils may develop beneath existing pavement and utilities located close to the excavation location.

Corrective measures to address loss of ground problems often include improved dewatering and/or grouting around the pit from the ground surface or within the pit. Repairs associated with loss of ground often include replacement of paving near the top of the pit, and making up for ground loss through placement of cement stabilized sand fill.

7.5 Select Fill and General Earthwork Recommendations

Select fill required to raise the grade or backfill should consist of lean sandy clay with a liquid limit less than 40 and a plasticity index between 8 and 20. Fill material that is used should be placed in loose lifts not exceeding eight inches and should be compacted to 95 percent of standard Proctor maximum dry density as determined by ASTM D698.

7.6 Groundwater Control

Groundwater seepage may be expected during excavation depending upon the groundwater conditions at the time of construction. It should be noted that groundwater levels determined during drilling may not accurately reflect the true groundwater conditions, and therefore should only be considered as approximate. Assessment of the need for groundwater control and installation of appropriate dewatering equipment is the contractor's responsibility. The following comments are intended to represent common solutions to groundwater control problems encountered in similar soil conditions in the Houston area, and may not be construed as dewatering system design recommendations.

A conventional pump and sump arrangement may be adequate if water bearing cohesive soils are encountered during trench excavations. Well points are generally not effective below about 15 feet beneath the top of the well point, and deeper dewatering requires deep wells with submersible

pumps and eductors. Based on the subsurface soils encountered, we anticipate groundwater to be controlled using a pump and sump arrangement. In any case, the groundwater control system used must provide a relatively dry, stable base for construction. However, it should be noted that groundwater conditions will change due to rainfall and seasonal changes.

Control of groundwater should be accomplished in a manner that will preserve the strength of the foundation soils; will not cause instability of the excavation; and will not result in damage to existing structures. Where necessary to this purpose, the water will be lowered at least 3 feet in advance of excavation by pump and sump arrangement, wells, well points, or similar methods. Open pumping should not be permitted if it results in boils, loss of fines, softening of the subgrade, or excavation instability. Discharge should be arranged to facilitate sampling by the owner's representative or engineer.

8 PAVEMENT DESIGN RECOMMENDATIONS

8.1 General

HVJ understands that the project includes reconstruction of Pinemont Drive from 300 feet west of Ella Boulevard to North Shepherd Drive in Houston, Texas.

8.2 Existing Pavement Thickness

The existing pavement within the project area was cored prior to drilling at all the boring locations. The existing pavement structure and thickness are presented in the following table:

Boring No.	Asphalt Thickness (inch)	Concrete Thickness (inch)	Base Thickness and Description	Total Thickness (inch)
B-1	-	6.5	-	6.5
B-2	-	9	8" Shells	9
B-3	3	6.5	-	9.5
B-4	3	7	-	10
B-5	3	6	-	9
B-6	2.5	6	-	8.5
B-7	3	6	-	9
B-8	2.25	6	-	8.25
B-9	3	6	-	9
B-10	2.5	6.5	-	9
B-11	3.5	6.5	-	10

The existing pavements were cored at all the boring locations prior to drilling and the core data revealed that the existing pavement consists of 2.25 to 3.5 inches of asphalt over 6 to 9 inches of concrete.

8.3 Rigid Pavement Design Recommendations

The recommendations presented in this report for the pavement design were developed using the pavement design and analysis system DARWin in accordance with the "AASHTO Guide for Design of Pavement Structures", 1993 Edition. The design procedure for determining concrete slab

thickness for rigid pavements is based on an extension of the algorithms that were originally developed from the AASHTO Road Test. The categories required for the design of pavement includes: (a) design variables, (b) performance criteria, (c) pavement structural characteristics, (d) material properties for structural design, and (e) reinforcement variables. Parameters relative to these categories are discussed below with the DARWin output given in Appendix E.

8.3.1 Design Inputs

Traffic. Based on the 24 hour traffic count provided, HVJ has estimated a 2013 2-way ADT of 10,489 resulting in a traffic loading of 1,379,888, 18-Kip equivalent single axle load (ESAL) for a 20 year design period utilizing a 4% growth factor and 5% trucks based on thoroughfare street classification.

Reliability Level and Overall Standard Deviation. A reliability (R) of 95 percent was selected for the pavement design performance. A mean value of the overall standard deviation (S_o) was selected to be 0.39 for Portland cement concrete pavement.

Serviceability. The serviceability of a pavement is defined as its ability to serve the type of traffic that uses the facility. The condition of the pavement after the performance period is characterized by a Terminal Serviceability Index (P_t), which is a function of the pavement structure. HVJ recommends a Terminal Serviceability Index of 2.5 be used for all pavements. Since the time at which a given pavement structure reaches its terminal serviceability depends on traffic volume and the original or initial serviceability (P_o), some consideration also must be given to the selection of P_o. As obtained at the AASHO Road Test, a P_o value of 4.5 was selected.

Drainage. The consideration of the expected level of drainage for a rigid pavement is through the use of a drainage coefficient, C_d. A C_d value of 1.2 was selected for good quality of drainage.

Load Transfer. The load transfer coefficient, J, is a factor used in rigid pavement design to account for the ability of a concrete pavement structure to transfer load across discontinuities, such as joints. Based on the values developed by AASHTO, a mean value of the load transfer coefficient (J) of 3.2 was selected for the design of jointed reinforced concrete pavement with tied curbs.

Loss of Support. This factor, LS, was included in the design of rigid pavement to account for the potential loss of support arising from subbase erosion and/or differential vertical soil movement. An LS value of 1.0 was selected according to the AASHTO suggestion for the condition of lime stabilized soils beneath the pavement.

Effective Modulus of Subgrade Reaction. Based on the laboratory test results, a subgrade resilient modulus has been estimated as 6,900 psi. AASHTO recommends that the composite K-value be adjusted to account for the potential loss of support arising from subbase erosion. Based on the loss of support factor (LS) described previously (LS=1.0), an effective modulus of subgrade reaction (k) was found to be 132 pci.

Concrete Elastic Modulus and Modulus of Rupture. Based on the City of Houston Standard Specification 02751, a mean value of 600 psi for S'c is considered appropriate for the design. A value of 3.37 x 10^6 psi was used for the modulus of elasticity of the concrete (E_c) using the correlation recommended by the American Concrete Institute shown below.

$$E_c = 57{,}000(f'c)^{0.5}$$

Where,
E_c = elastic modulus of concrete in psi and,
f'c = compressive strength of concrete in psi; a value of 3,500 psi is used here.

8.3.2 Rigid Pavement Design Input Summary

The estimated and/or assumed values for the parameters relative to these categories are summarized in the following table.

Parameter	Value
Traffic, ESALs	1,379,888
Percent Growth Rate	4%
Percent Trucks	5%
Subgrade Resilient Modulus, M_R	6,900 psi
Lime Stabilized Subbase Thickness, D_{sb}	6 inches
Compressive Strength of Concrete f'c	3,500 psi
Lime Stabilized Subbase Elastic Modulus, E_{sb}	50,000 psi
Effective Modulus of Subgrade Reaction, k	132 psi
Loss of Support Factor, LS	1.0
Concrete Elastic Modulus, E_c	3.37×10^6 psi
Mean Concrete Modulus of Rupture, S'_c	600 psi
Load Transfer Coefficient, J	3.2
Drainage Coefficient, C_d	1.2
Design Serviceability Loss, $(P_o - P_t)$	2.0
Reliability, R	95%
Overall Standard Deviation, S_o	0.39
Minimum PCC Thickness	8"

8.3.3 Rigid Pavement Thickness and Load Capacity

Based on the previous input factors including design and performance constraints, traffic, and subgrade soils, DARWin was used to check compliance with the City of Houston minimum cross section for concrete pavement widths less than or equal to 27 feet face of curb to face of curb. Based on the design inputs the calculated pavement section exceeds the minimum pavement section required. Therefore, the calculated pavement section of 7.5 inches of concrete pavement over 6 inches lime stabilized subgrade shall be used for reconstruction of Pinemont Drive for a 20-year design life period. For all soils to be lime treated, it is recommended that the existing subgrade soils be tested prior to lime treatment to confirm the sulfate level. The amount of lime to be added should also be determined by a lime-series test on the subgrade soils encountered. For estimating purposes, 6% lime per dry unit weight of soil may be assumed.

8.3.4 Reinforcing Steel Requirement

Longitudinal and transverse reinforcing steel is required to resist warping stresses in the pavement section and to hold pavement cracks that develop tightly closed. In addition, reinforcement is required at pavement joints in order to prevent deflections across the joint.

Steel reinforcement is recommended for concrete pavement including the bar size and spacing in accordance to City of Houston standard drawing 02751-01.

8.4 Preparation of Subgrade

The surficial soils mostly consist of clayey sands and sandy lean clays. HVJ recommends stabilizing the top six inches of the subgrade soil beneath the proposed concrete pavement with lime. Stabilization of the subgrade will increase the modulus of subgrade reaction and provide subgrade stability for construction during inclement weather.

Subgrade stabilization will enhance long-term pavement performance by reducing the tendency of the soil to displace from beneath pavement by pumping. HVJ recommends the following procedures for subgrade preparation.

Excavate existing pavement to the required depth.

1. Surfaces exposed after excavation should be proof-rolled in accordance with TxDOT Standard Specification Item 216 or equivalent City of Houston specification. If rutting develops, tire pressures should be reduced. The purpose of the proof-rolling operation is to identify any underlying zones or pockets of soft soils and to remove such weak materials.

2. In areas where soft, compressible or loose soils are encountered, additional excavation may be required.

3. Before stabilizing the subgrade, scarify the upper eight inches of exposed surface as required, mix with lime and compact it to 95 percent of standard proctor maximum dry density (ASTM D698). For estimating purposes, 6% lime per dry unit of soil may be assumed.

Construction of lime stabilized subgrade should conform to City of Houston Section 02336. The actual amount of lime should be determined for subgrade soils by conducting laboratory tests on the exposed subgrade material during construction.

9 MONITORING

9.1 Excavation Safety

As required under OSHA regulations, the contractor should provide a "competent person" to inspect trench excavations daily before the start of work, as needed during the shift, and after every rainstorm or other hazard increasing occurrence. When the competent person finds evidence of a hazardous condition, exposed workers should be removed from the hazardous area until the necessary precautions have been taken to ensure their safety. A competent person means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to workers, and who has authorization to take prompt corrective measures to eliminate them.

9.2 Preconstruction Survey

We recommend that a preconstruction survey be performed prior to any tunneling operations. As part of the survey, a complete visual record should be made of all structures along the tunnel alignment. This survey should be comprised of a combined photographic and video taped

documentation of the condition of the surrounding structures. Settlement sensitive structures and structures with pre-existing damage should be of particular concern during the visual record process.

In addition to the visual record, a review of the operating conditions of facilities located within a horizontal distance equal to approximately twice the invert depth from the centerline of the tunnel is recommended. Particular attention should be paid to the conditions of existing utilities near the tunnel bore. Existing leaking utilities need to be identified and repaired prior to tunneling to prevent tunneling difficulties due to infiltration of water or sewage into the bore. The location of settlement sensitive utilities should be established and a monitoring program implemented to determine whether tunneling operations are proceeding without loss of ground prior to the tunnel being driven near the utility.

9.3 Construction Monitoring - Tunneling

We recommend that surface elevations along the tunnel alignment be monitored prior to, at intervals during, and after construction.

Ground surface settlements can be measured by taking precise leveling measurements, by standard surveying methods, on settlement monuments installed in the ground along the centerline of the tunnel. The monuments should be suitably protected against vandalism and accidental damage. Survey benchmarks should be established in close proximity to the alignment but outside the influence of any settlement trough.

9.4 Construction Materials Testing

We recommend that backfill be monitored by an accredited testing laboratory to verify that construction is performed in conformance with project specifications. HVJ Associates routinely provides these services and would be pleased to do so for this project.

10 FOUNDATION RECOMMENDATIONS FOR TRAFFIC SIGNAL LIGHTS

We understand that the project involves the construction of signal light poles, one at Pinemont Drive and Ella Blvd. intersection and the second one will be at the intersection of Pinemont Drive and Brinkman Street. We recommend drilled shaft foundations for the proposed signal lights. Drilled shaft capacity curves were generated based on borings B-1 and B-8 and are presented in Appendix F. We recommend using the total allowable capacity curves presented in appendix F (F-1 and F-2) to calculate the allowable bearing capacity. These curves include a factor of safety of 3. We also recommend using the ultimate skin friction curves presented in Appendix F (F-3 and F-4) to determine the uplift potential in the top 10 feet. These curves do not include a factor of safety. The allowable capacity is calculated as the total allowable capacity from F-1 and F-2 minus the uplift potential from F-3 and F-4 within the top 10 feet. The construction should be in accordance with City of Houston Specification Section 02465, "Drilled Shaft Foundations". The presence of silty sands between the depth of 10 to 16 feet at B-1, and between 14 feet and 16 feet in B-8 may require the use of temporary steel casing or drilling slurry.

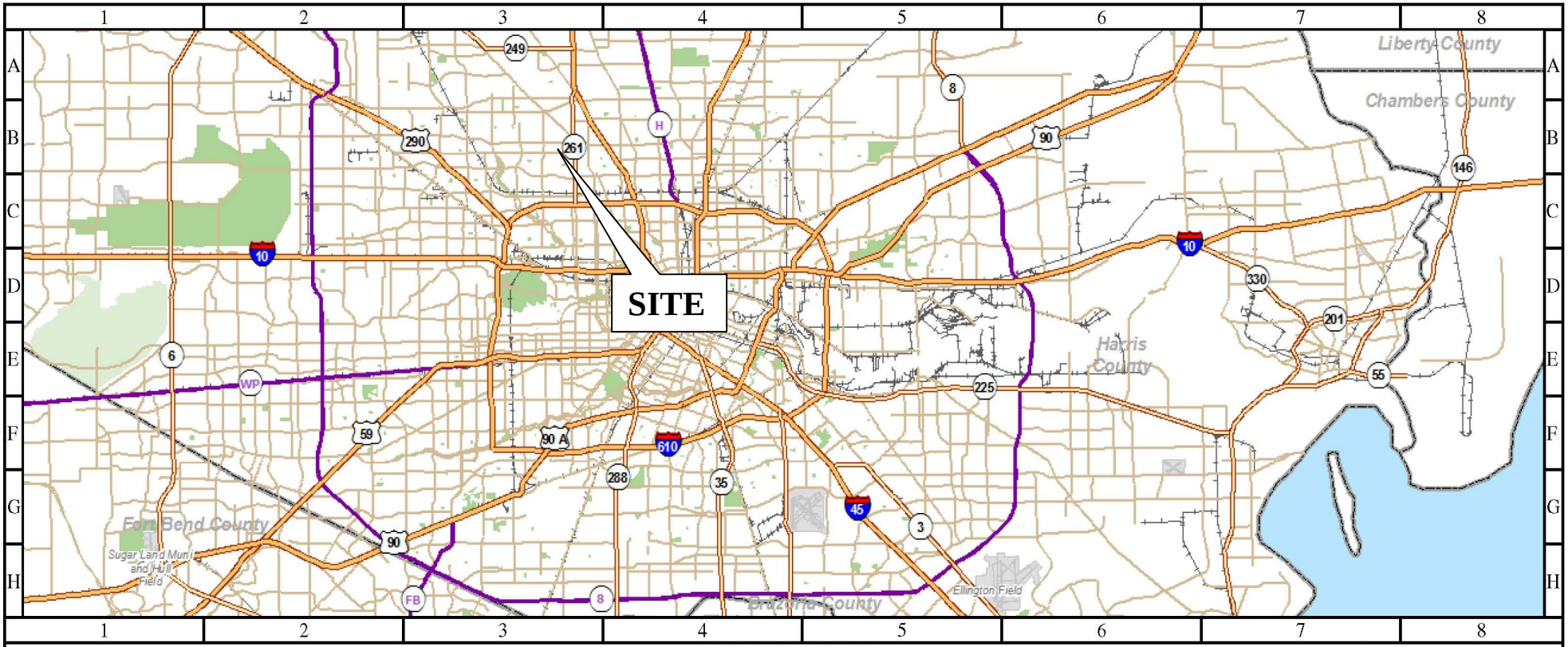
11 DESIGN REVIEW

HVJ Associates should be retained to review the final design plans and specifications for this project. During all excavation, grading and construction phases of this project, HVJ should provide the materials testing verification and observation services so our geotechnical recommendations may be interpreted and implemented correctly.

12 LIMITATIONS

This investigation was performed for the exclusive use of IDC, Inc. and the City of Houston for the proposed Pinemont Drive street reconstruction from 300 feet west of Ella to N. Shepherd in Houston, Texas. HVJ Associates, Inc. has endeavored to comply with generally accepted geotechnical engineering practice common in the local area. HVJ Associates, Inc. makes no warranty, express or implied. The analyses and recommendations contained in this report are based on data obtained from subsurface exploration, laboratory testing, the project information provided to us and our experience with similar soils and site conditions. The methods used indicate subsurface conditions only at the specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Samples cannot be relied on to accurately reflect the strata variations that usually exist between sampling locations. Should any subsurface conditions other than those described in our boring logs be encountered, HVJ Associates, Inc. should be immediately notified so that further investigation and supplemental recommendations can be provided.

PLATES



CITY OF HOUSTON
Department of Public Works and Engineering
Geographic Information & Management System (GIMS)

N W E S

1 inch = 23146 feet

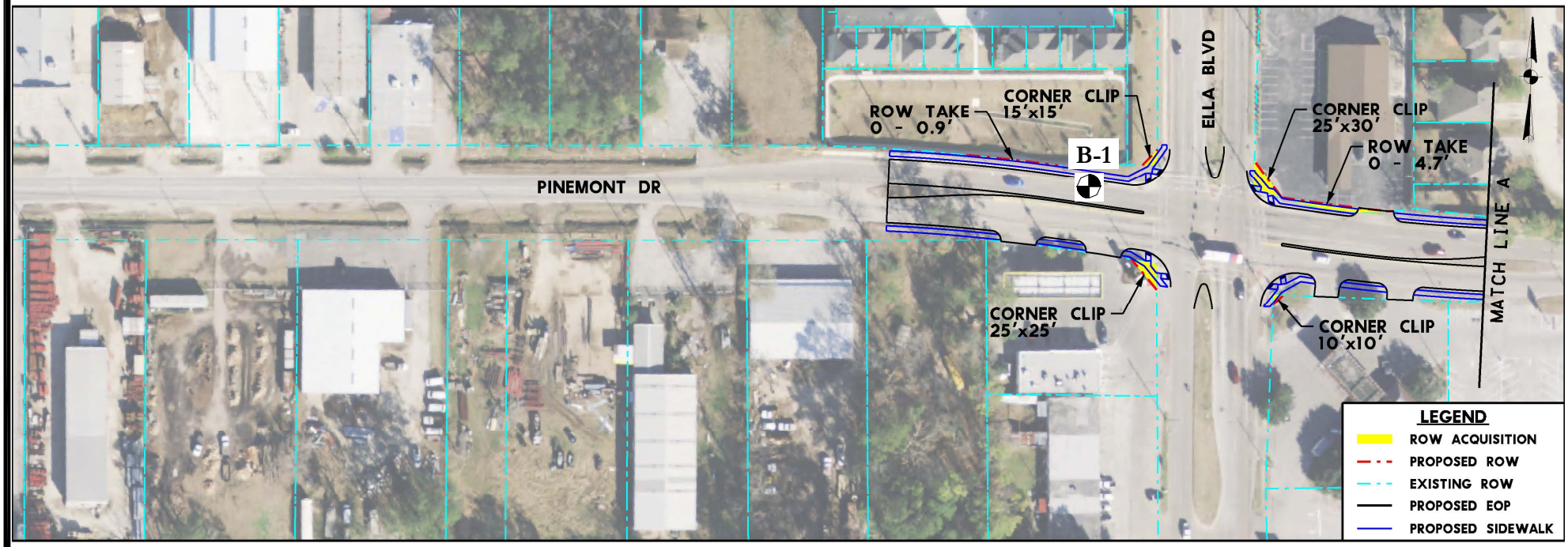
DISCLAIMER: THIS MAP REPRESENTS THE BEST INFORMATION AVAILABLE TO THE CITY.
THE CITY DOES NOT WARRANT ITS ACCURACY OR COMPLETENESS.
FIELD VERIFICATIONS SHOULD BE DONE AS NECESSARY.

HVJ ASSOCIATES
6120 S. Dairy Ashford Road
Houston, Texas 77072-1010
281.933.7388 Ph
281.933.7293 Fax

DATE: 01/24/2013	APPROVED BY: ZA	PREPARED BY: AR

SITE VICINITY MAP
PINEMONT STREET RECONSTRUCTION FROM ELLA TO N SHEPHERD STREET

PROJECT NO.: HG1018721	DRAWING NO.: PLATE 1



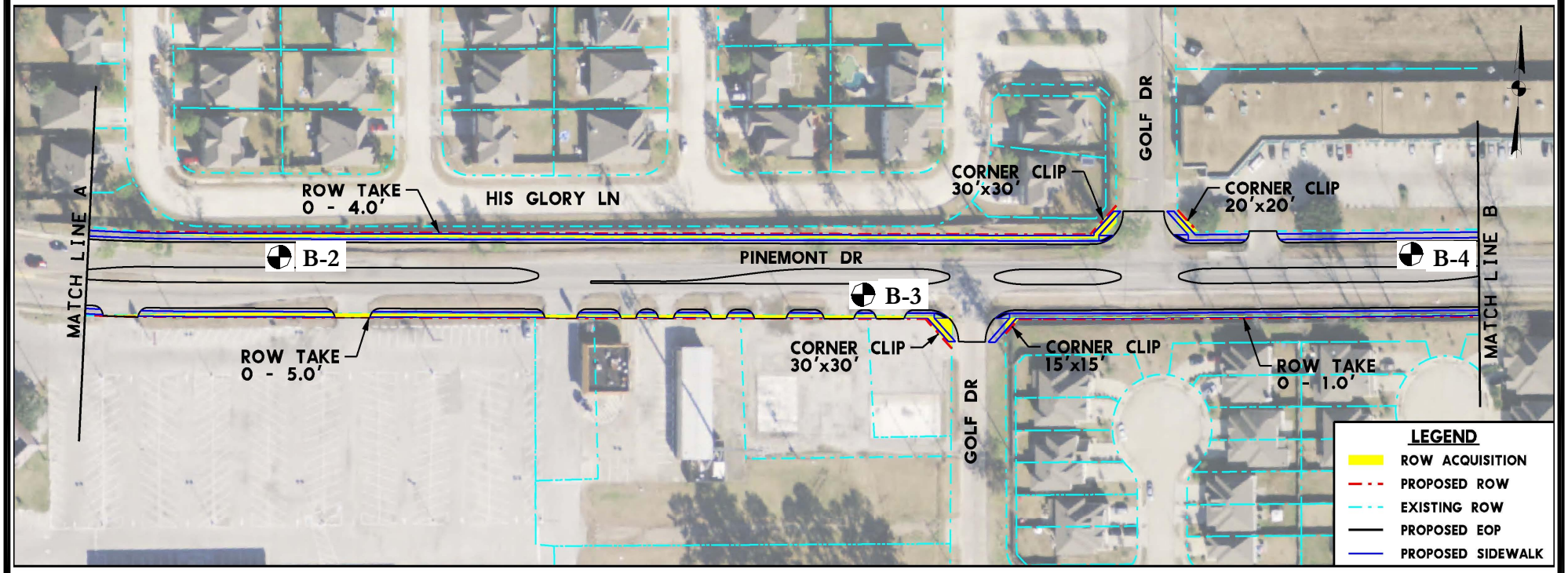
APPROXIMATE BORING LOCATIONS

HVJ ASSOCIATES
6120 S. Dairy Ashford Road
Houston, Texas 77072-1010
281.933.7388 Ph
281.933.7293 Fax

DATE: 4/26/2012	APPROVED BY: SV	PREPARED BY: NL

PLAN OF BORINGS
PINEMONT STREET RECONSTRUCTION: ELLA TO N. SHEPHERD

PROJECT NO.: HG1018721	DRAWING NO.: PLATE 2A



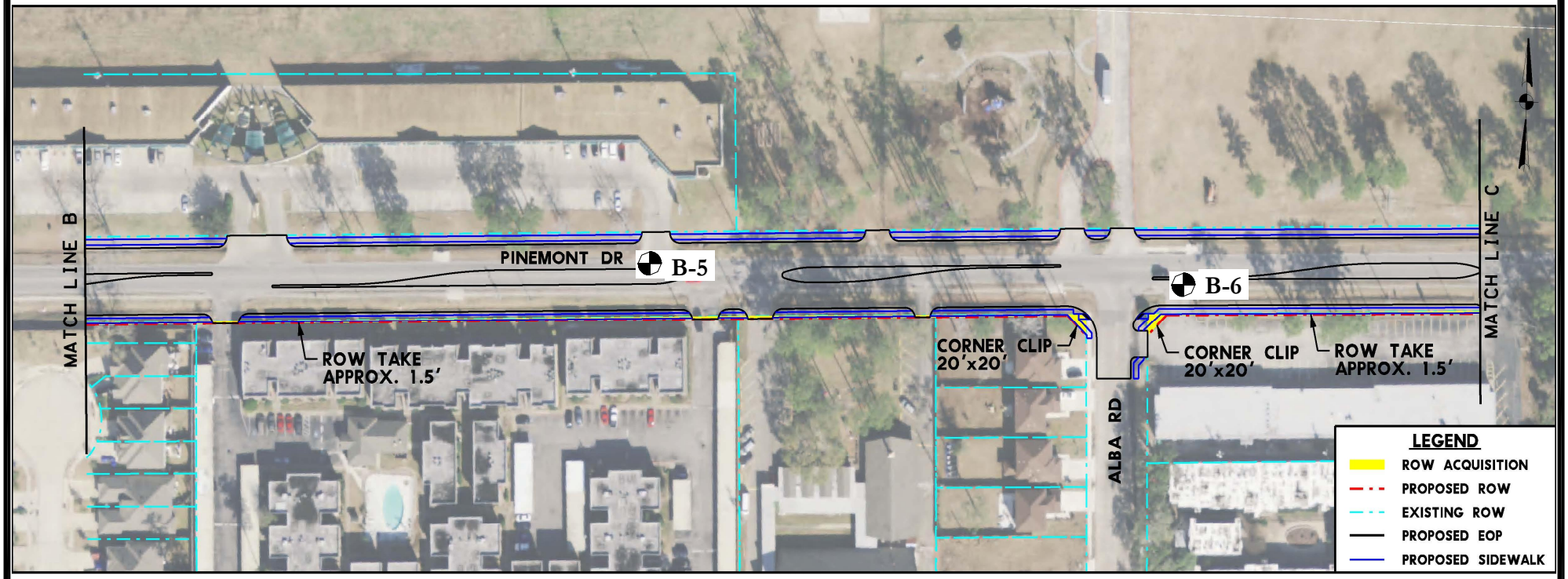
APPROXIMATE BORING LOCATIONS

HVJ ASSOCIATES
6120 S. Dairy Ashford Road
Houston, Texas 77072-1010
281.933.7388 Ph
281.933.7293 Fax

DATE: 4/26/2012	APPROVED BY: SV	PREPARED BY: NL

PLAN OF BORINGS
PINEMONT STREET RECONSTRUCTION: ELLA TO N. SHEPHERD

PROJECT NO.: HG1018721	DRAWING NO.: PLATE 2B



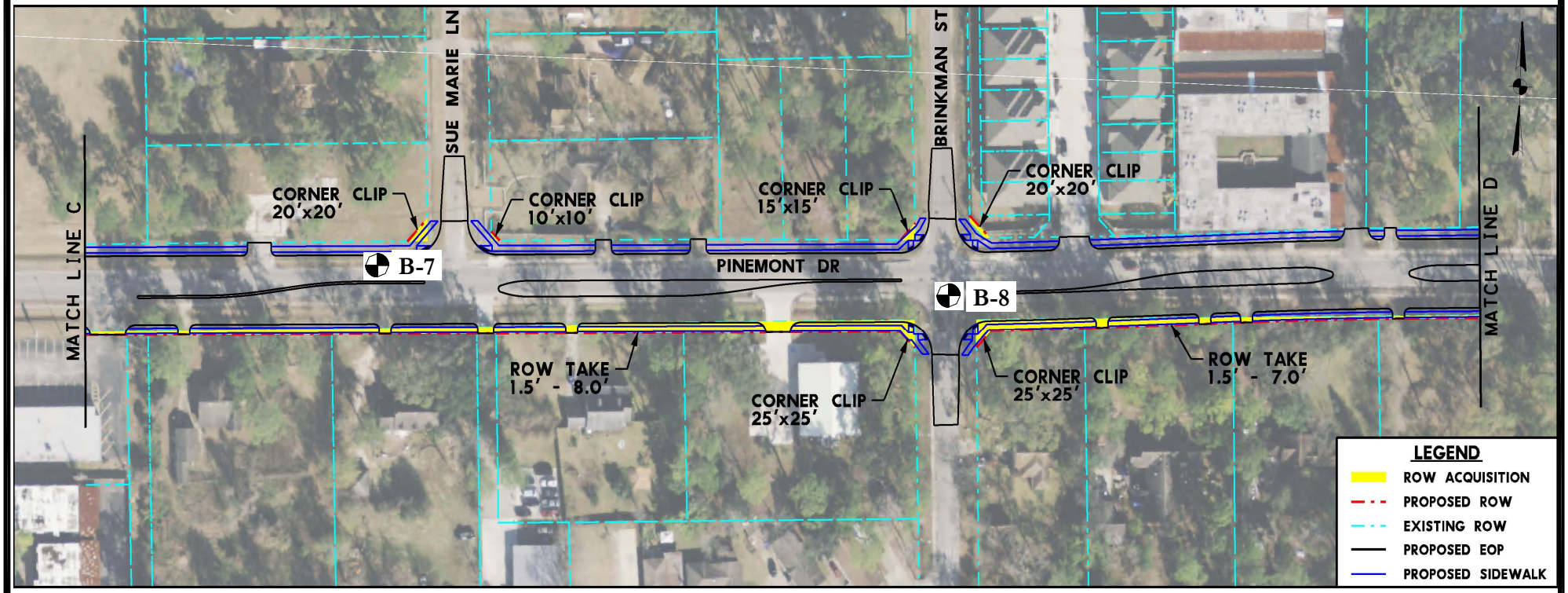
APPROXIMATE BORING LOCATIONS

HVJ ASSOCIATES
6120 S. Dairy Ashford Road
Houston, Texas 77072-1010
281.933.7388 Ph
281.933.7293 Fax

DATE: 4/26/2012	APPROVED BY: SV	PREPARED BY: NL

PLAN OF BORINGS
PINEMONT STREET RECONSTRUCTION: ELLA TO N. SHEPHERD

PROJECT NO.: HG1018721	DRAWING NO.: PLATE 2C



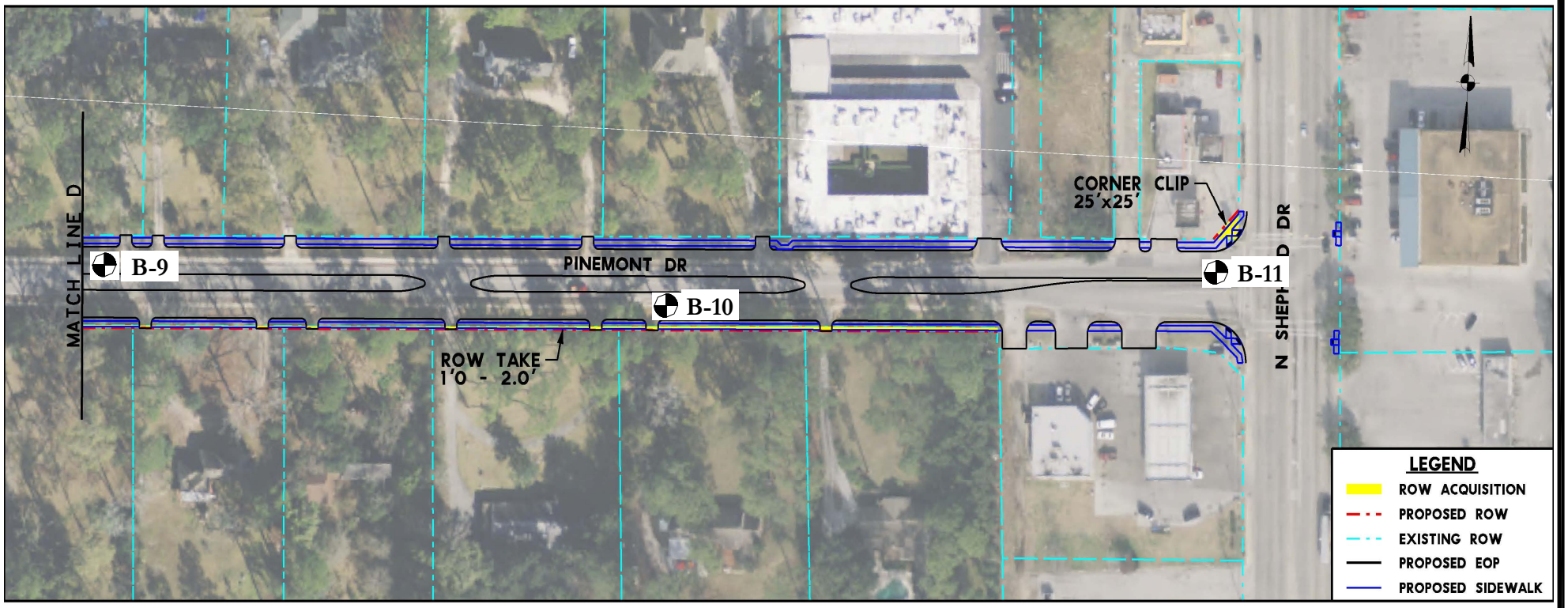
⊕ **APPROXIMATE BORING LOCATIONS**

HVJ ASSOCIATES
6120 S. Dairy Ashford Road
Houston, Texas 77072-1010
281.933.7388 Ph
281.933.7293 Fax

DATE: 4/26/2012	APPROVED BY: SV	PREPARED BY: NL

PLAN OF BORINGS
PINEMONT STREET RECONSTRUCTION: ELLA TO N. SHEPHERD

PROJECT NO.: HG1018721	DRAWING NO.: PLATE 2D



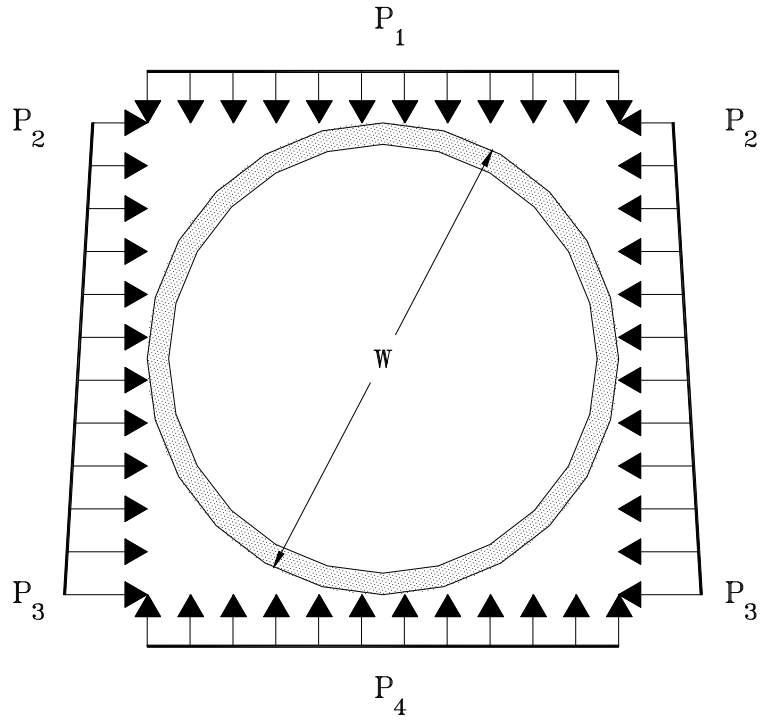
APPROXIMATE BORING LOCATIONS

HVJ ASSOCIATES
6120 S. Dairy Ashford Road
Houston, Texas 77072-1010
281.933.7388 Ph
281.933.7293 Fax

DATE: 4/26/2012	APPROVED BY: SV	PREPARED BY: NL

PLAN OF BORINGS
PINEMONT STREET RECONSTRUCTION: ELLA TO N. SHEPHERD

PROJECT NO.: HG1018721	DRAWING NO.: PLATE 2E



For

$D_w \leq H$

$P_1 = \gamma D_w + (H - D_w)(\gamma - \gamma_w) + P_s + (H - D_w)\gamma_w$

$P_2 \equiv [\gamma D_w + (H - D_w)(\gamma - \gamma_w) + P_s]K_o + (H - D_w)\gamma_w$

$P_3 = [\gamma D_w + (H + W - D_w)(\gamma - \gamma_w) + P_s]K_o + (H + W - D_w)\gamma_w$

$P_4 = \gamma D_w + (H + W - D_w)(\gamma - \gamma_w) + P_s + (H + W - D_w)\gamma_w$

For

$H < D_w < H + W$

$P_1 \equiv H\gamma + P_s$

$P_2 = (\gamma H + P_s)K_o$

$P_3 = [\gamma D_w + (H + W - D_w)(\gamma - \gamma_w) + P_s]K_o + (H + W - D_w)\gamma_w$

$P_4 = \gamma D_w + (H + W - D_w)(\gamma - \gamma_w) + P_s + (H + W - D_w)\gamma_w$

For

$D_w \geq (H + W)$

$P_1 \equiv H\gamma + P_s$

$P_2 = (\gamma H + P_s)K_o$

$P_3 = [(H + W)\gamma + P_s]K_o$

$P_4 = (H + W)\gamma + P_s$

Where

P_1, P_2, P_3 = Pressure imposed on pipe, psf

D_w = Depth of groundwater, feet

H = Depth of top of pipe from ground surface, feet

W = Diameter of pipe, feet

γ = Total Unit weight of soil, pcf

γ_w = Unit weight of water, pcf

P_s = Surcharge load, psf

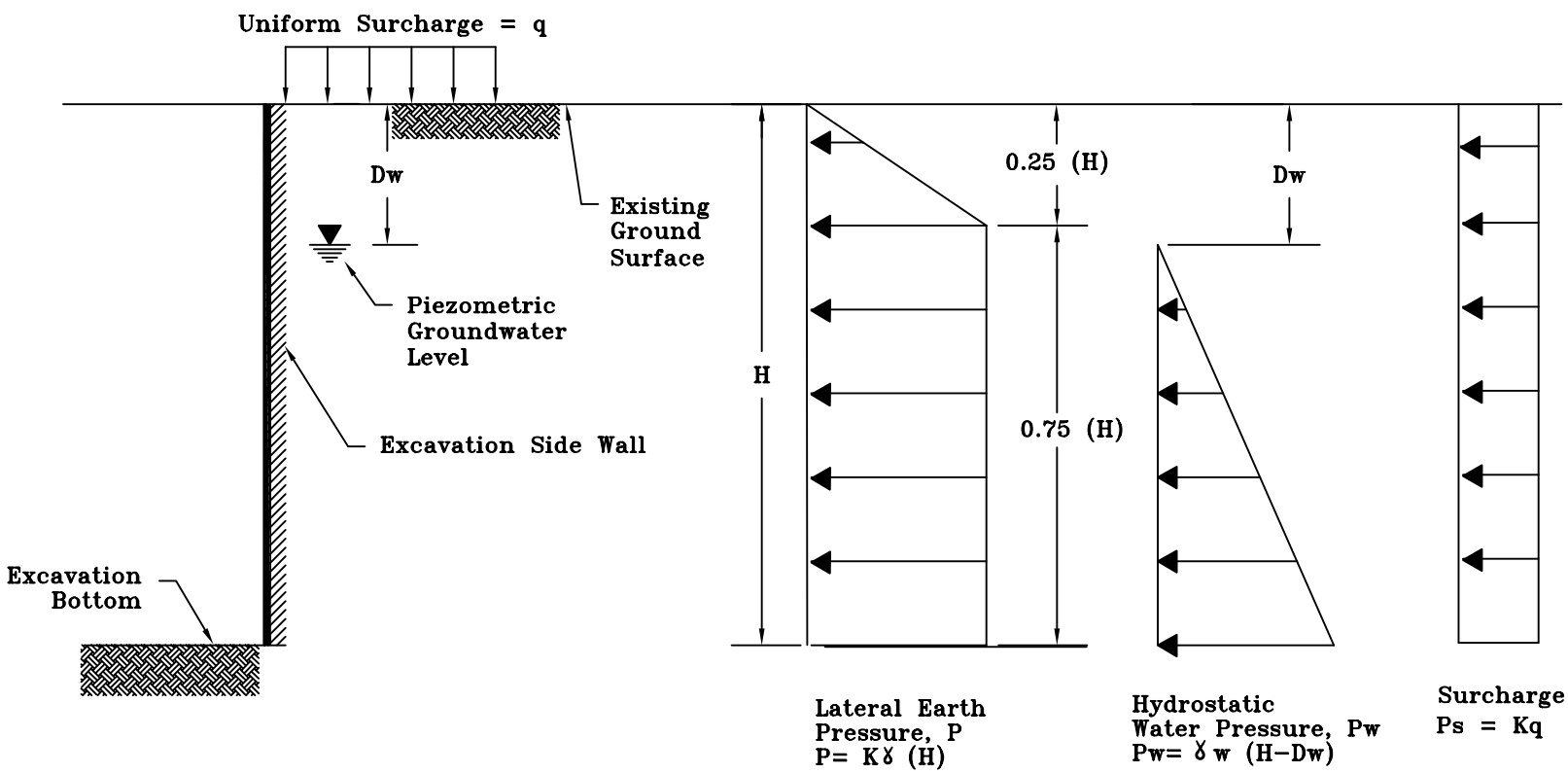
K_o = Coefficient of earth pressure, (1.0 for clays and 0.5 for sands)

HVJ ASSOCIATES
6120 S. Dairy Ashford Road
Houston, Texas 77072-1010
281.933.7388 Ph
281.933.7293 Fax

DATE: 01/24/2013	APPROVED BY: ZA	PREPARED BY: AR

RIGID PIPE AND TUNNEL LINER LOADS

PROJECT NO.: HG1018721	DRAWING NO.: PLATE 3



H, (ft) = Depth to Excavation Bottom

Ps, (psf) = Surcharge loading adjacent to Excavation wall

Dw, (ft) = Depth to groundwater below Existing grade

= Zero for temporary excavation

K = Lateral Earth Pressure coefficient

= Ka "active" for short-term conditions (use 0.50)

= Ko "at rest" for long-term conditions (use 1.0)

γ, (pcf) = Total unit weight above water table or submerged unit weight below groundwater level

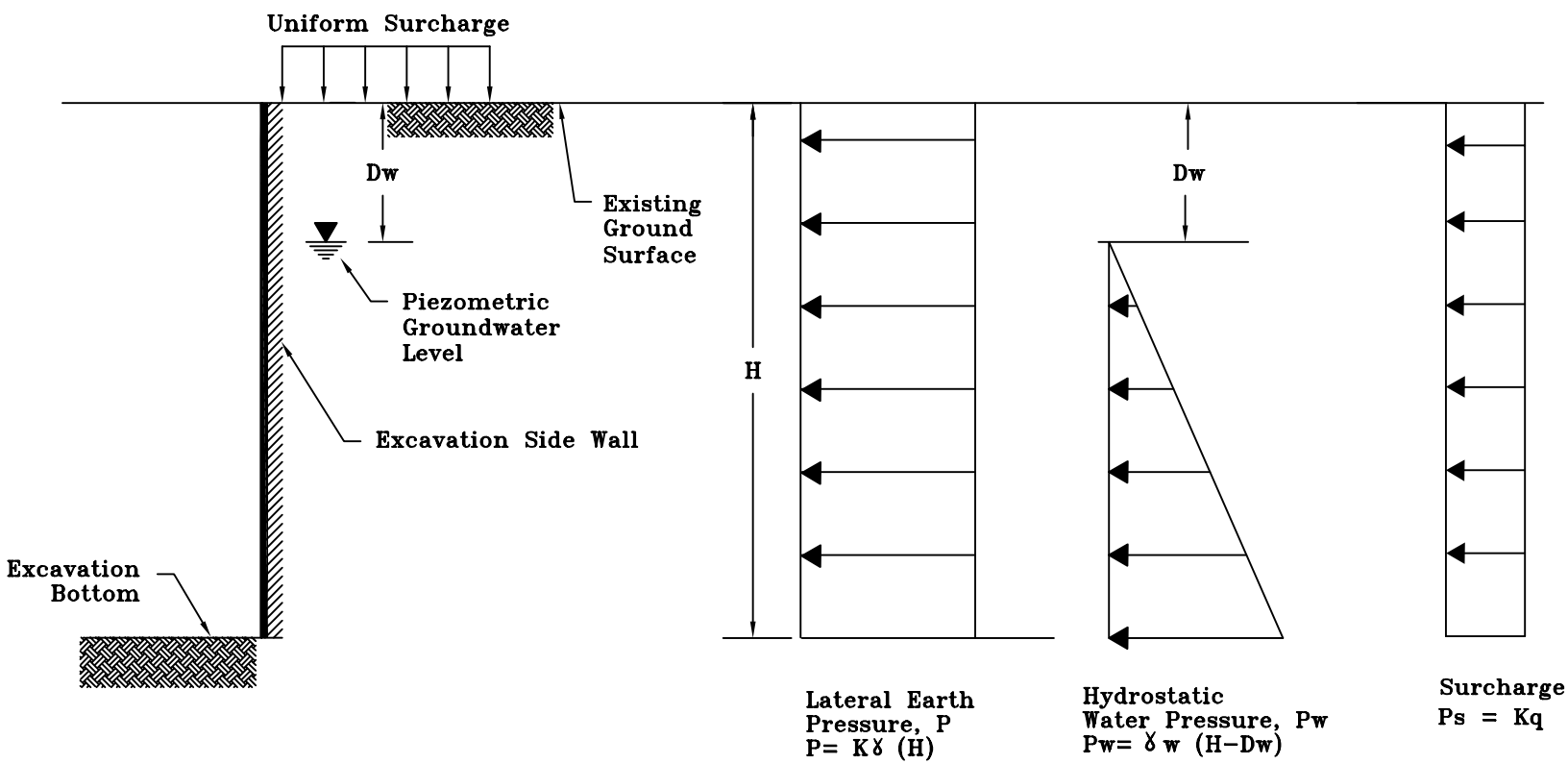
γw, (pcf) = Unit weight of water = 62.4 pcf

Note: The pressure diagram shown is not appropriate for design of cantilever walls.

HVJ ASSOCIATES
6120 S. Dairy Ashford Road
Houston, Texas 77072-1010
281.933.7388 Ph
281.933.7293 Fax

BRACED EXCAVATION
LATERAL EARTH PRESSURE DIAGRAM (CLAY)

PROJECT NO.:	DRAWING NO.:
HG1018721	PLATE 4A



H, (ft) = Depth to Excavation Bottom

Ps, (psf) = Surcharge loading adjacent to Excavation wall

Dw, (ft) = Depth to groundwater below Existing grade

= Zero for temporary excavation

K = Lateral Earth Pressure coefficient

= Ka "active" for short-term conditions (use 0.35)

= Ko "at rest" for long-term conditions (use 0.50)

γ, (pcf) = Total unit weight above water table or submerged unit weight below groundwater level

γw, (pcf) = Unit weight of water = 62.4 pcf

Note: The pressure diagram shown is not appropriate for design of cantilever walls.

HVJ ASSOCIATES
6120 S. Dairy Ashford Road
Houston, Texas 77072-1010
281.933.7388 Ph
281.933.7293 Fax

BRACED EXCAVATION
LATERAL EARTH PRESSURE DIAGRAM(SAND/SILT)

PROJECT NO.:	DRAWING NO.:
HG1018721	PLATE 4B

APPENDIX A

BORING LOGS AND KEY TO TERMS & SYMBOLS

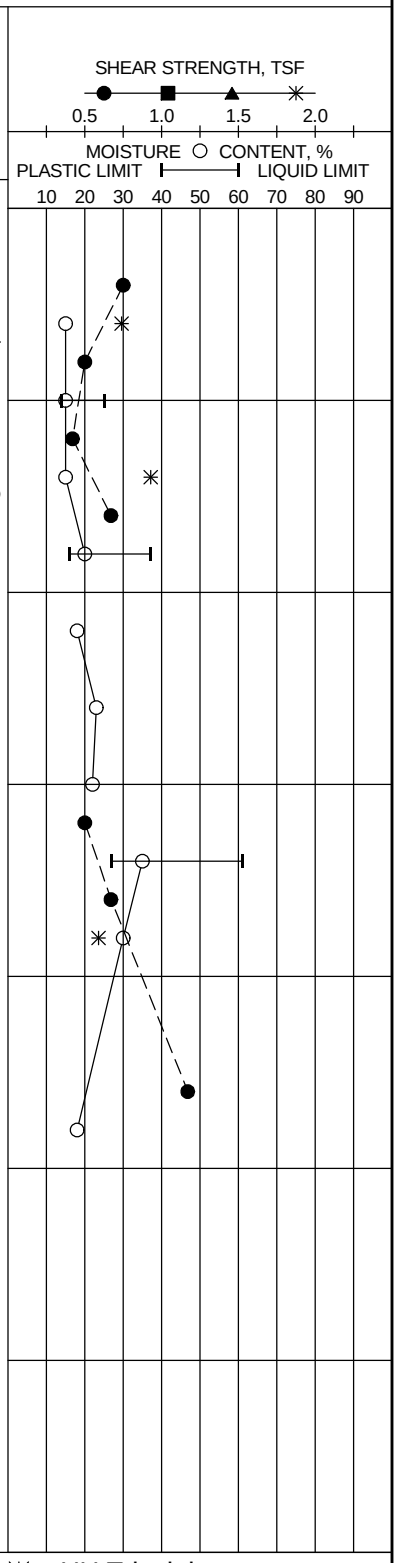
LOG OF BORING

Project: Pinemont Street Reconstruction
Boring No.: B-1 (PZ-1)
Groundwater during drilling: 14 feet
Groundwater after drilling: 9.3 feet

WBS No.: N-000475-0002-3
Date: 12/11/2012
Northing: 13,872,017.2
Easting: 3,100,709.7

Project No.: HG1018721
Elevation: 78.71 feet
Station: 14+33.05
Offset: -23.472'

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0		Pavement: 6.5" Concrete		
		Brown CLAYEY SAND (SC)	37	
		Firm to stiff brown SANDY LEAN CLAY (CL)		114
75 / 5			58	
				115
70 / 10		Loose light brown SILTY SAND (SM)		
	5-5-5		41	
65 / 15	2-2-5		26	
		Stiff to very stiff brown and gray FAT CLAY WITH SAND (CH)	77	
60 / 20				88
55 / 25				
50 / 30				
45 / 35				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 2 for boring location.

PLATE A-1

HVJ ASSOCIATES

LOG OF SOIL BORING HG-10-18721.GPJ HVJ.GDT 1/28/13

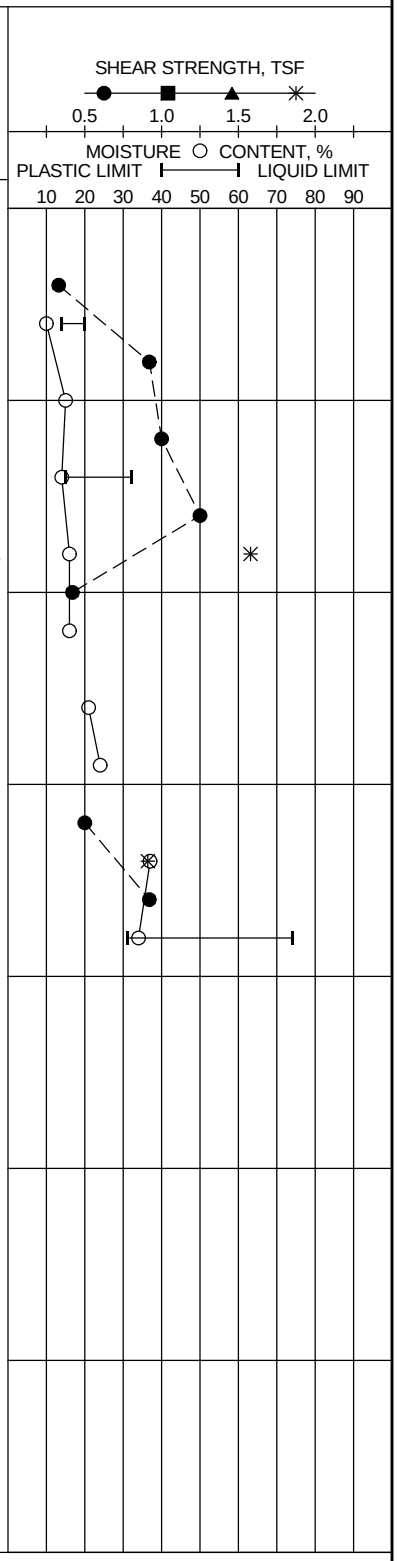
LOG OF BORING

Project: Pinemont Street Reconstruction
Boring No.: B-2
Groundwater during drilling: ---
Groundwater after drilling: ---

WBS No.: N-000475-0002-3
Date: 12/11/2012
Northing: 13,871,958.4
Easting: 3,101,262.2

Project No.: HG1018721
Elevation: 79.02 feet
Station: 19+89.75
Offset: 5.558'

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0		Pavement: 9" Concrete, 8" Shells		
		Firm to very stiff brown and gray SANDY LEAN CLAY (CL)	53	
			70	117
	4-5-7	Medium dense brown SILTY SAND (SM)	16	
	3-5-9			
		Stiff reddish brown FAT CLAY (CH)		86
		-w/ calcareous nodules 18'-20'		
		***Boring was moved 40' north due to unknown pavement after 5ft.		



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 2 for boring location.

PLATE A-2

HVJ ASSOCIATES

LOG OF SOIL BORING HG-10-18721.GPJ HVJ.GDT 1/28/13

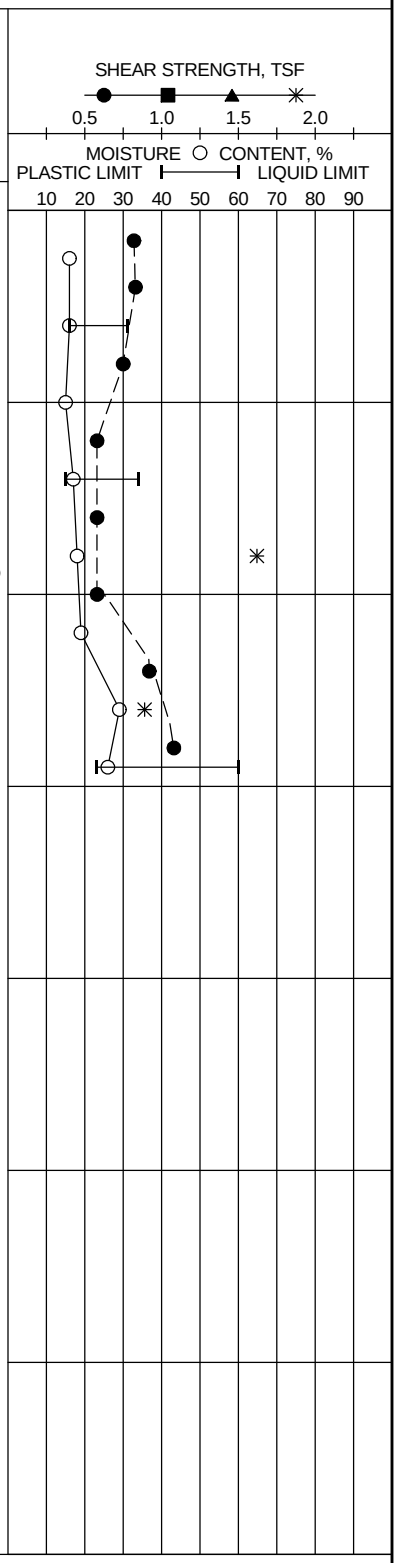
LOG OF BORING

Project: Pinemont Street Reconstruction
Boring No.: B-3
Groundwater during drilling: ---
Groundwater after drilling: ---

WBS No.: N-000475-0002-3
Date: 12/11/2012
Northing: 13,871,996.5
Easting: 3,101,834.7

Project No.: HG1018721
Elevation: 78.81 feet
Station: 25+63.38
Offset: -6.689'

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0		Pavement: 3" Asphalt, 6.5" Concrete		
		Stiff to very stiff brown and gray SANDY LEAN CLAY (CL)		
75 / 5			59	
70 / 10				115
			61	
		Stiff to very stiff reddish brown FAT CLAY (CH)		
65 / 15		-w/ calcareous nodules 14'-15'		96
60 / 20				
55 / 25				
50 / 30				
45 / 35				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 2 for boring location.

PLATE A-3

HVJ ASSOCIATES

LOG OF SOIL BORING HG-10-18721.GPJ HVJ.GDT 1/28/13

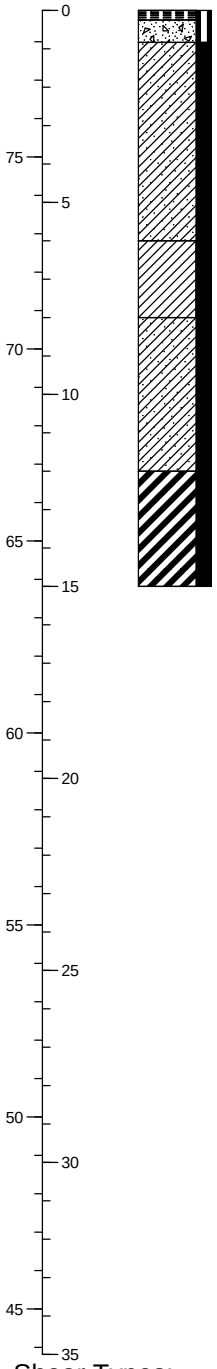
LOG OF BORING

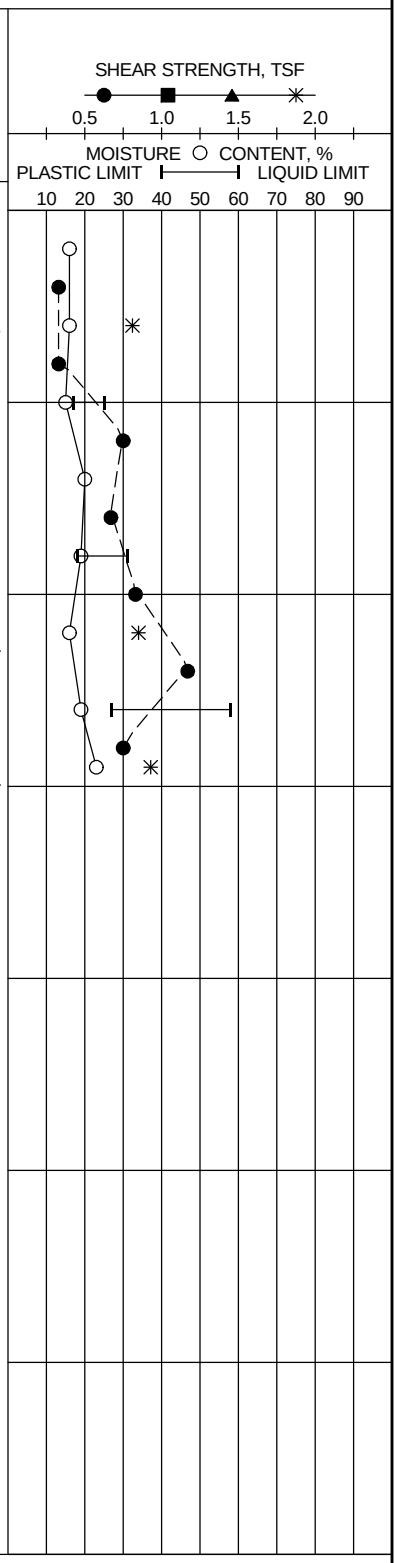
Project: Pinemont Street Reconstruction
Boring No.: B-4
Groundwater during drilling: ---
Groundwater after drilling: ---

WBS No.: N-000475-0002-3
Date: 12/10/2012
Northing: 13,872,005.3
Easting: 3,102,316.7

Project No.: HG1018721
Elevation: 78.82 feet
Station: 30+45.34
Offset: 6.214'

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
		Pavement: 3" Asphalt, 7" Concrete		
		Firm to stiff brown and gray SANDY LEAN CLAY (CL)	67	117
		Stiff brown and gray LEAN CLAY WITH SAND (CL) -w/ calcareous nodules	75	
		Stiff to brown and gray SANDY LEAN CLAY (CL) -w/ calcareous nodules 8'-12'		114
		Stiff to very stiff brown and gray FAT CLAY (CH) -w/ calcareous nodules 12'-15'	93	104





Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 2 for boring location.

PLATE A-4

HVJ ASSOCIATES

LOG OF SOIL BORING HG-10-18721.GPJ HVJ.GDT 1/28/13

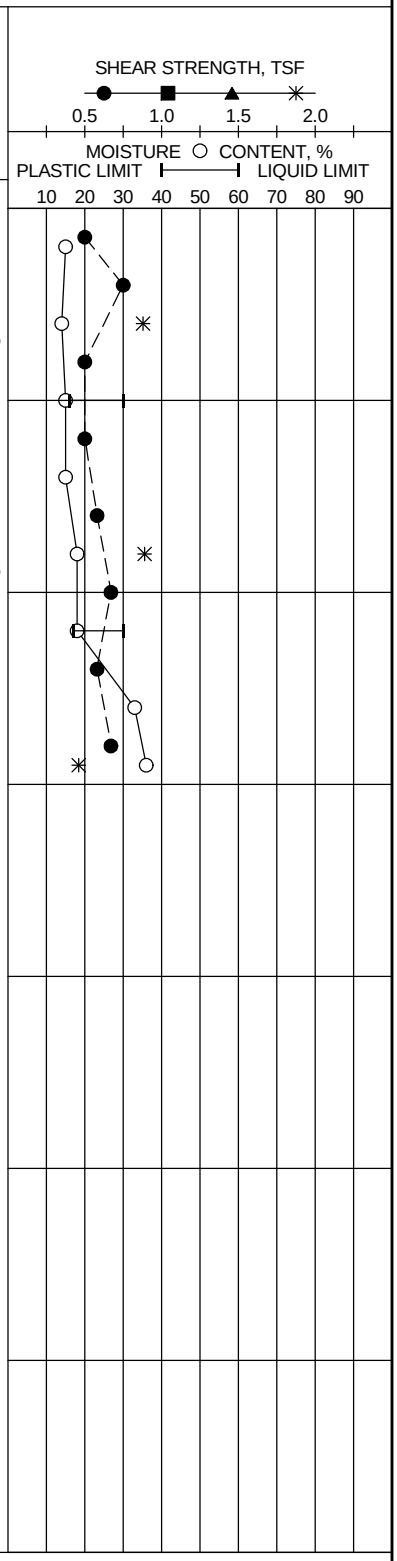
LOG OF BORING

Project: Pinemont Street Reconstruction
Boring No.: B-5
Groundwater during drilling: ---
Groundwater after drilling: ---

WBS No.: N-000475-0002-3
Date: 12/11/2012
Northing: 13,872,043.6
Easting: 3,102,858.8

Project No.: HG1018721
Elevation: 78.25 feet
Station: 35+88.62
Offset: -7.64'

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0		Pavement: 3" Asphalt, 6" Concrete		
		Stiff brown and gray SANDY LEAN CLAY (CL)	60	115
5			62	
10				108
15		Firm to stiff reddish brown FAT CLAY (CH)	93	88
20				
25				
30				
35				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 2 for boring location.

PLATE A-5

HVJ ASSOCIATES

LOG OF SOIL BORING HG-10-18721.GPJ HVJ.GDT 1/28/13

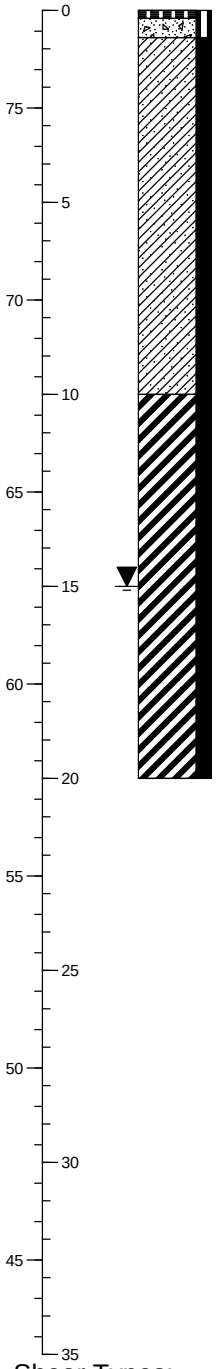
LOG OF BORING

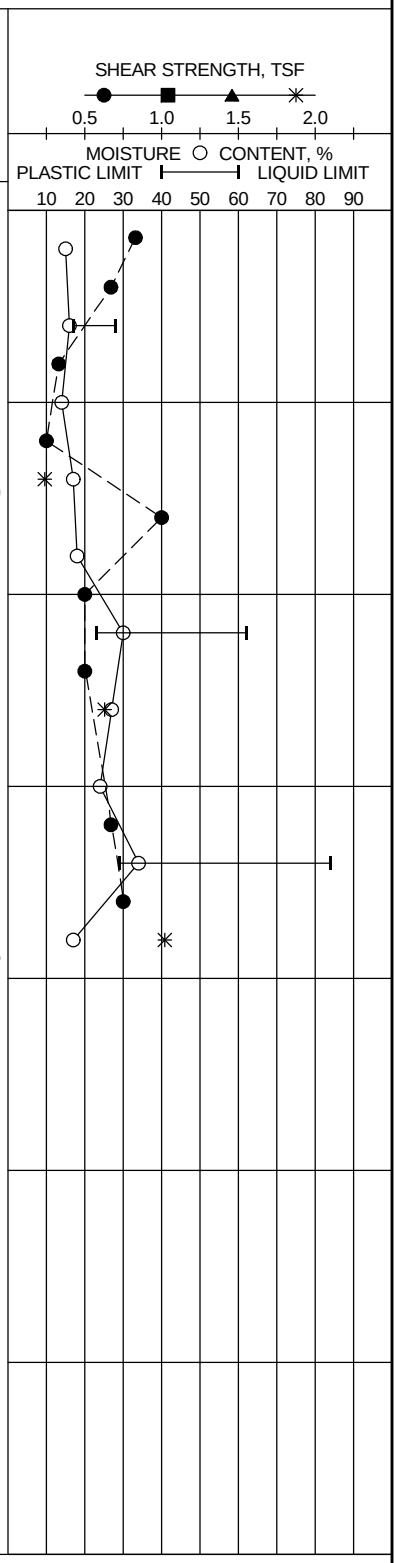
Project: Pinemont Street Reconstruction
Boring No.: B-6
Groundwater during drilling: 15 feet
Groundwater after drilling: ---

WBS No.: N-000475-0002-3
Date: 12/10/2012
Northing: 13,872,052.5
Easting: 3,103,380.5

Project No.: HG1018721
Elevation: 77.54 feet
Station: 41+10.16
Offset: 6.936

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
		Pavement: 2.5" Asphalt, 6" Concrete		
		Soft to stiff brown SANDY LEAN CLAY (CL)	67	
			63	109
		Stiff to very stiff reddish brown FAT CLAY (CH)	94	
		-w/ sand seams 14'-16'	75	97
		-w/ calcareous nodules 18'-20'		103





Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 2 for boring location.

PLATE A-6

HVJ ASSOCIATES

LOG OF SOIL BORING HG-10-18721.GPJ HVJ.GDT 1/28/13

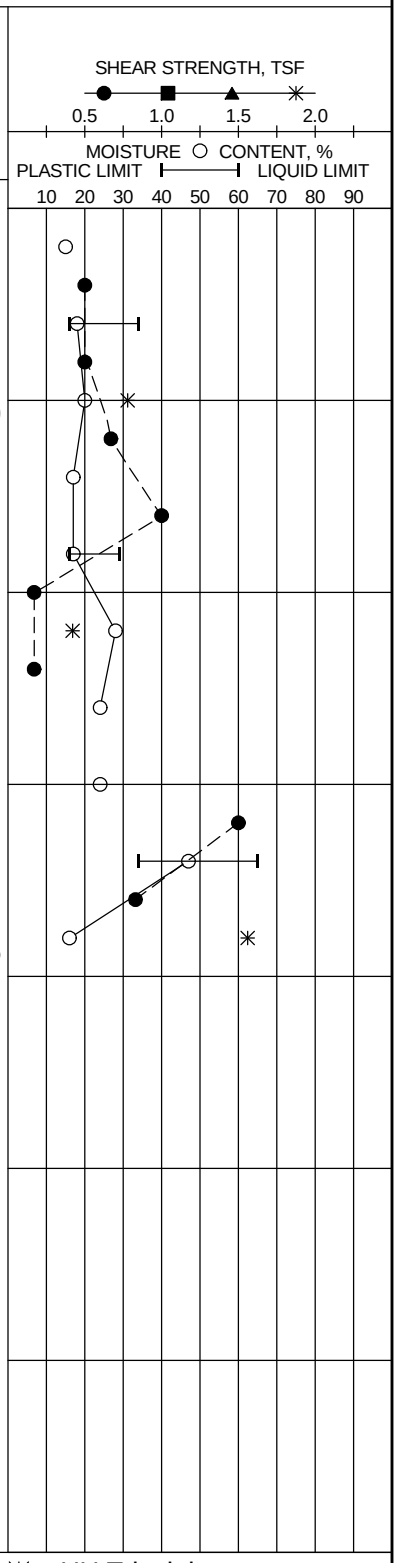
LOG OF BORING

Project: Pinemont Street Reconstruction
Boring No.: B-7
Groundwater during drilling: 15 feet
Groundwater after drilling: ---

WBS No.: N-000475-0002-3
Date: 12/11/2012
Northing: 13,872,102.9
Easting: 3,104,180.6

Project No.: HG1018721
Elevation: 76.34 feet
Station: 49+11.68
Offset: -7.447'

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0		Pavement: 3" Asphalt, 6" Concrete		
75		Dark brown CLAYEY SAND (SC)	47	
		Stiff brown and gray SANDY LEAN CLAY (CL)		
5				109
70				
			67	
10		Soft to firm brown and gray LEAN CLAY (CL)		
65				99
	5-5-6	Medium dense reddish brown SILTY SAND (SM)		
15			46	
60		Very stiff reddish brown FAT CLAY (CH) -w/ calcareous nodules		
		Stiff to very stiff gray SANDY LEAN CLAY (CL)		
20				116
55				
25				
50				
30				
45				
35				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 2 for boring location.

PLATE A-7

HVJ ASSOCIATES

LOG OF SOIL BORING HG-10-18721.GPJ HVJ.GDT 1/28/13

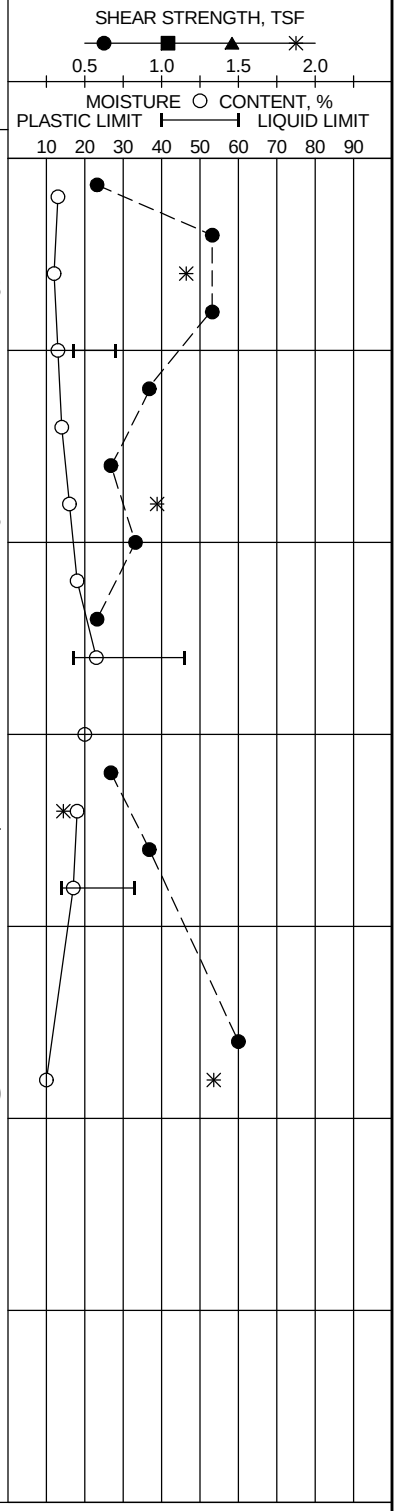
LOG OF BORING

Project: Pinemont Street Reconstruction
Boring No.: B-8 (PZ-2)
Groundwater during drilling: 15 feet
Groundwater after drilling: 11 feet

WBS No.: N-000475-0002-3
Date: 12/11/2012
Northing: 13,872,115.4
Easting: 3,104,761.1

Project No.: HG1018721
Elevation: 75.52 feet
Station: 54+92.24
Offset: 6.245'

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
75 / 0		Pavement: 2.25" Asphalt, 6" Concrete		
		Stiff to very stiff brown and gray SANDY LEAN CLAY (CL)	61	118
70 / 5			65	113
65 / 10		Stiff gray LEAN CLAY WITH SAND (CL)	77	
			84	
60 / 15	5-6-8	Medium dense light brown SILTY SAND (SM)	29	
		Firm to very stiff brown and gray SANDY LEAN CLAY (CL)		114
55 / 20				
50 / 25				120
45 / 30				
35				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 2 for boring location.

PLATE A-8

HVJ ASSOCIATES

LOG OF SOIL BORING HG-10-18721.GPJ HVJ.GDT 1/28/13

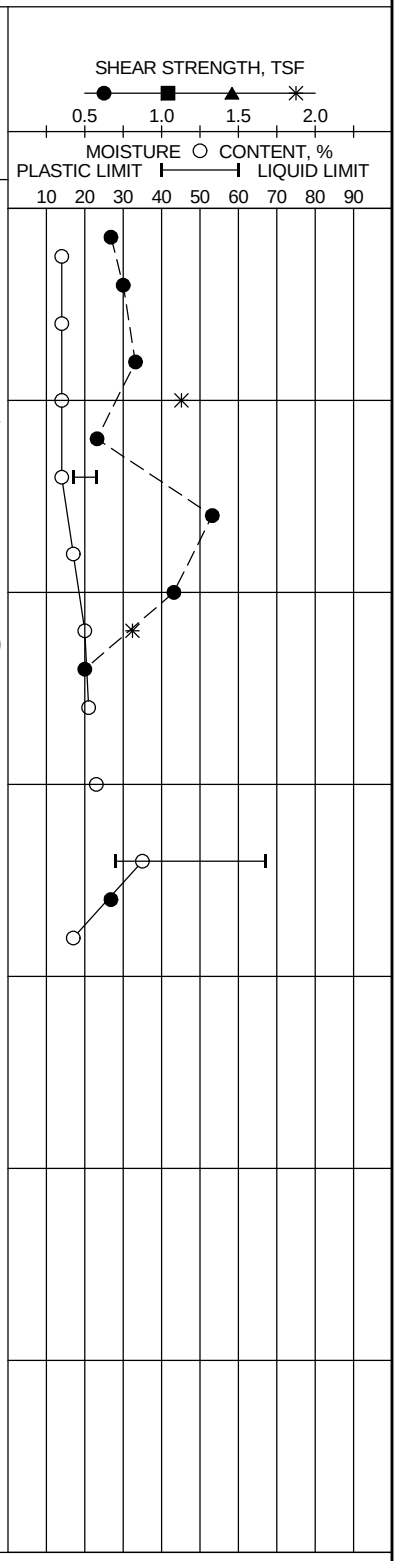
LOG OF BORING

Project: Pinemont Street Reconstruction
Boring No.: B-9
Groundwater during drilling: ---
Groundwater after drilling: ---

WBS No.: N-000475-0002-3
Date: 12/11/2012
Northing: 13,872,142.5
Easting: 3,105,084.6

Project No.: HG1018721
Elevation: 75.23 feet
Station: 58+16.63
Offset: -6.269'

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
75 / 0		Pavement: 3" Asphalt, 6" Concrete		
		Stiff to very stiff brown and gray SANDY LEAN CLAY (CL)	56	
70 / 5				121
			69	
65 / 10				110
		Brown SAND WITH SILT (SP-SM)		
60 / 15			12	
	5-4-7	Stiff brown and gray FAT CLAY (CH)		
55 / 20				
50 / 25				
45 / 30				
35				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 2 for boring location.

PLATE A-9

HVJ ASSOCIATES

LOG OF SOIL BORING HG-10-18721.GPJ HVJ.GDT 1/28/13

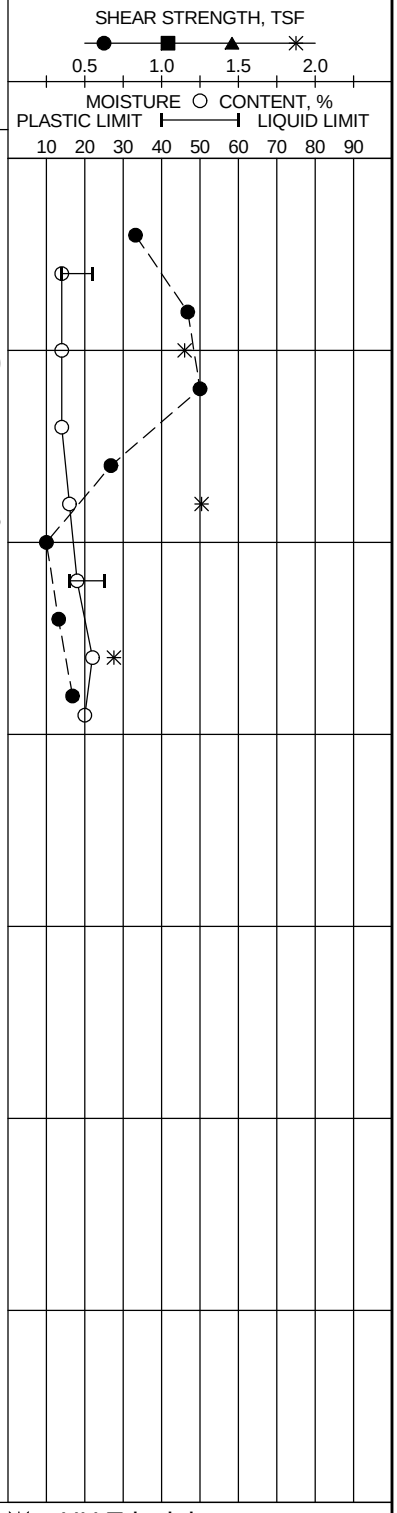
LOG OF BORING

Project: Pinemont Street Reconstruction
Boring No.: B-10
Groundwater during drilling: ---
Groundwater after drilling: ---

WBS No.: N-000475-0002-3
Date: 12/10/2012
Northing: 13,872,146.1
Easting: 3,105,448.3

Project No.: HG1018721
Elevation: 74.65 feet
Station: 61+80.10
Offset: 6.502'

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0		Pavement: 2.5" Asphalt, 6.5" Concrete		
		Brown CLAYEY SAND (SC)	49	
		Firm to very stiff brown and gray SANDY LEAN CLAY (CL)		
70 / 5				109
			62	
65 / 10				118
		Firm to stiff brown and gray LEAN CLAY (CL)		
		-w/ sand 14'-15'	71	97
60 / 15				
55 / 20				
50 / 25				
45 / 30				
40 / 35				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 2 for boring location.

PLATE A-10

HVJ ASSOCIATES

LOG OF SOIL BORING HG-10-18721.GPJ HVJ.GDT 1/28/13

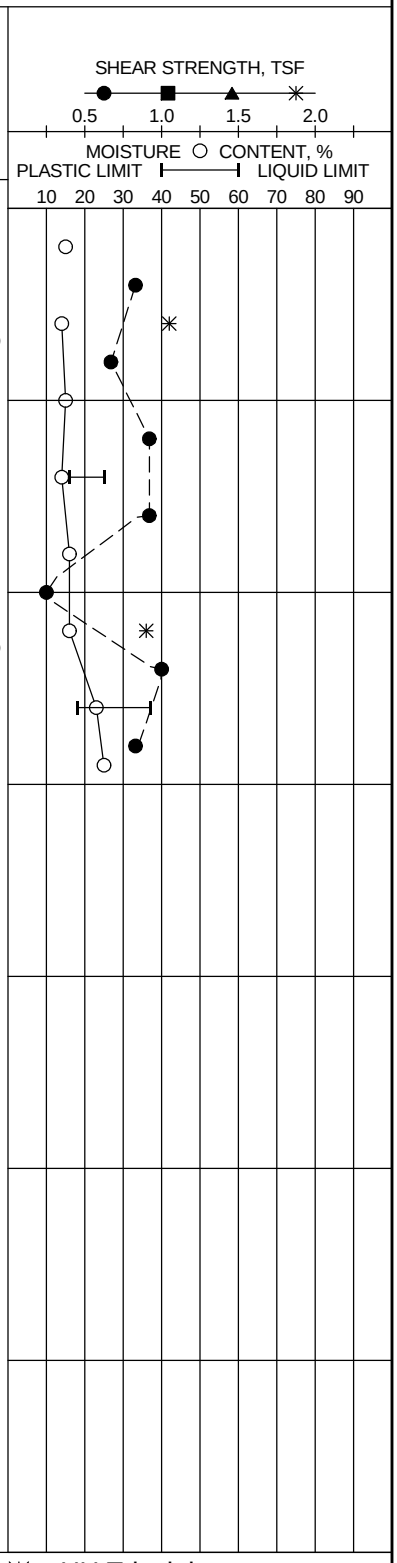
LOG OF BORING

Project: Pinemont Street Reconstruction
Boring No.: B-11
Groundwater during drilling: ---
Groundwater after drilling: ---

WBS No.: N-000475-0002-3
Date: 12/11/2012
Northing: 13,872,217.5
Easting: 3,106,380.8

Project No.: HG1018721
Elevation: 72.85 feet
Station: 71+14.89
Offset: -22.858'

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0		Pavement: 3.5" Asphalt, 6.5" Concrete		
		Dark gray CLAYEY SAND (SC)	42	
70		Firm to very stiff brown and gray SANDY LEAN CLAY (CL)		106
5				
65			57	
10				
60				106
		Stiff gray LEAN CLAY (CL)	91	
15				
55				
20				
50				
25				
45				
30				
40				
35				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

See Plate 2 for boring location.

PLATE A-11

HVJ ASSOCIATES

LOG OF SOIL BORING HG-10-18721.GPJ HVJ.GDT 1/28/13

SOIL SYMBOLS

Soil Types

Clay | Silt | Sand | Gravel

Modifiers

Clayey | Silty | Sandy | Cemented

Construction Materials

Asphaltic Concrete | Stabilized Base | Fill or Debris | Portland Cement Concrete

SAMPLER TYPES

- Thin Walled Shelby Tube
- No Recovery
- Split Barrel
- Core
- Liner Tube
- Jar Sample

WATER LEVEL SYMBOLS

- Groundwater level after drilling in open borehole or piezometer
- Groundwater level determined during drilling operations

SOIL GRAIN SIZE

Classification	Particle Size	Particle Size or Sieve No. (U.S. Standard)
Clay	< 0.002 mm	< 0.002 mm
Silt	0.002 - 0.075 mm	0.002 mm - #200 sieve
Sand	0.075 - 4.75 mm	#200 sieve - #4 sieve
Gravel	4.75 - 75 mm	#4 sieve - 3 in.
Cobble	75 - 200 mm	3 in. - 8 in.
Boulder	> 200 mm	> 8 in.

DENSITY OF COHESIONLESS SOILS

Descriptive Term	Penetration Resistance "N" * Blows/Foot
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	> 50

CONSISTENCY OF COHESIVE SOILS

Consistency	Undrained Shear Strength (tsf)	Penetration Resistance "N" * Blows/Foot
Very Soft	0 - 0.125	0 - 2
Soft	0.125 - 0.25	2 - 4
Firm	0.25 - 0.5	4 - 8
Stiff	0.5 - 1.0	8 - 16
Very Stiff	1.0 - 2.0	16 - 32
Hard	> 2.0	> 32

PENETRATION RESISTANCE

3/6	Blows required to penetrate each of three consecutive 6-inch increments per ASTM D-1586 *
50/4"	If more than 50 blows are required, driving is discontinued and penetration at 50 blows is noted
0/18"	Sampler penetrated full depth under weight of drill rods and hammer

* The N value is taken as the blows required to penetrate the final 12 inches

TERMS DESCRIBING SOIL STRUCTURE

Slickensided	Fracture planes appear polished or glossy, sometimes striated
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Inclusion	Small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Parting	Inclusion less than 1/4 inch thick extending through the sample
Seam	Inclusion 1/4 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 of different soil type
Stratified	Soil sample composed of alternating seams or layers of different soil type
Intermixed	Soil sample composed of pockets of different soil type and laminated or stratified structure is not evident
Calcareous	Having appreciable quantities of calcium carbonate
Ferrous	Having appreciable quantities of iron
Nodule	A small mass of irregular shape

HVJ ASSOCIATES
6120 S. Dairy Ashford Road
Houston, Texas 77072-1010
281.933.7388 Ph
281.933.7293 Fax

KEY TO TERMS AND SYMBOLS USED ON BORING LOGS

PROJECT NO.: HG1018721

DRAWING NO.: PLATE A-12

APPENDIX B

SUMMARY OF LABORATORY TEST RESULTS

Project: Pinemont Street Reconstruction
Location: Houston, Texas
Number: HG1018721

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	% Pass #200 Sieve	Moisture Content (%)	Unit Density (pcf)	Shear Strength (UU) (tsf)	Shear Strength (Pocket Pen) (tsf)
B-1	1				37				
B-1	2								0.75
B-1	3					14.6	130.1	0.74	
B-1	4								0.5
B-1	5	25	14	11	58	14.7			
B-1	6								0.42
B-1	7					15.1	132.2	0.93	
B-1	8								0.67
B-1	9	37	16	21		20			
B-1	11				41	18.1			
B-1	13				26	22.5			
B-1	15					21.7			
B-1	16								0.5
B-1	17	61	27	34	77	34.9			
B-1	18								0.67
B-1	19					30.3	115.2	0.59	
B-1	23								1.17
B-1	24					17.7			
B-2	2								0.33
B-2	3	20	14	6	53	9.7			
B-2	4								0.92
B-2	5					14.7			
B-2	6								1
B-2	7	32	15	17	70	14.4			
B-2	8								1.25
B-2	9					16.2	136	1.58	
B-2	10								0.42
B-2	11					15.9			
B-2	13				16	20.6			
B-2	14.5					24.4			
B-2	16								0.5
B-2	17					36.5	117.8	0.91	
B-2	18								0.92
B-2	19	74	31	43		33.9			
B-3	0.8								0.82
B-3	1.3					16.4			
B-3	2								0.83
B-3	3	31	16	15		16.2			
B-3	4								0.75
B-3	5				59	15.4			

B-3	6								0.58
B-3	7	34	15	19		16.9			
B-3	8								0.58
B-3	9					18	135.6	1.62	
B-3	10								0.58
B-3	11				61	18.9			
B-3	12								0.92
B-3	13					28.6	124.1	0.89	
B-3	14								1.08
B-3	14.5	60	23	37		25.6			
B-4	1				67	15.6			
B-4	2								0.33
B-4	3					15.6	135.1	0.81	
B-4	4								0.33
B-4	5	25	17	8		15.4			
B-4	6								0.75
B-4	7				75	19.9			
B-4	8								0.67
B-4	9	31	18	13		19.4			
B-4	10								0.83
B-4	11					16.5	132.4	0.85	
B-4	12								1.17
B-4	13	58	27	31	93	19.3			
B-4	14								0.75
B-4	14.5					22.7	127.7	0.93	
B-5	0.8								0.5
B-5	1				60	15.4			
B-5	2								0.75
B-5	3					14.3	131.5	0.88	
B-5	4								0.5
B-5	5	30	16	14	62	15.3			
B-5	6								0.5
B-5	7					15.2			
B-5	8								0.58
B-5	9					18.3	128	0.89	
B-5	10								0.67
B-5	11	30	17	13		18.5			
B-5	12								0.58
B-5	13				93	33.2			
B-5	14								0.67
B-5	14.5					35.7	119.4	0.46	
B-6	0.7								0.83
B-6	1				67	14.7			
B-6	2								0.67
B-6	3	28	17	11		15.7			
B-6	4								0.33
B-6	5				63	14.4			

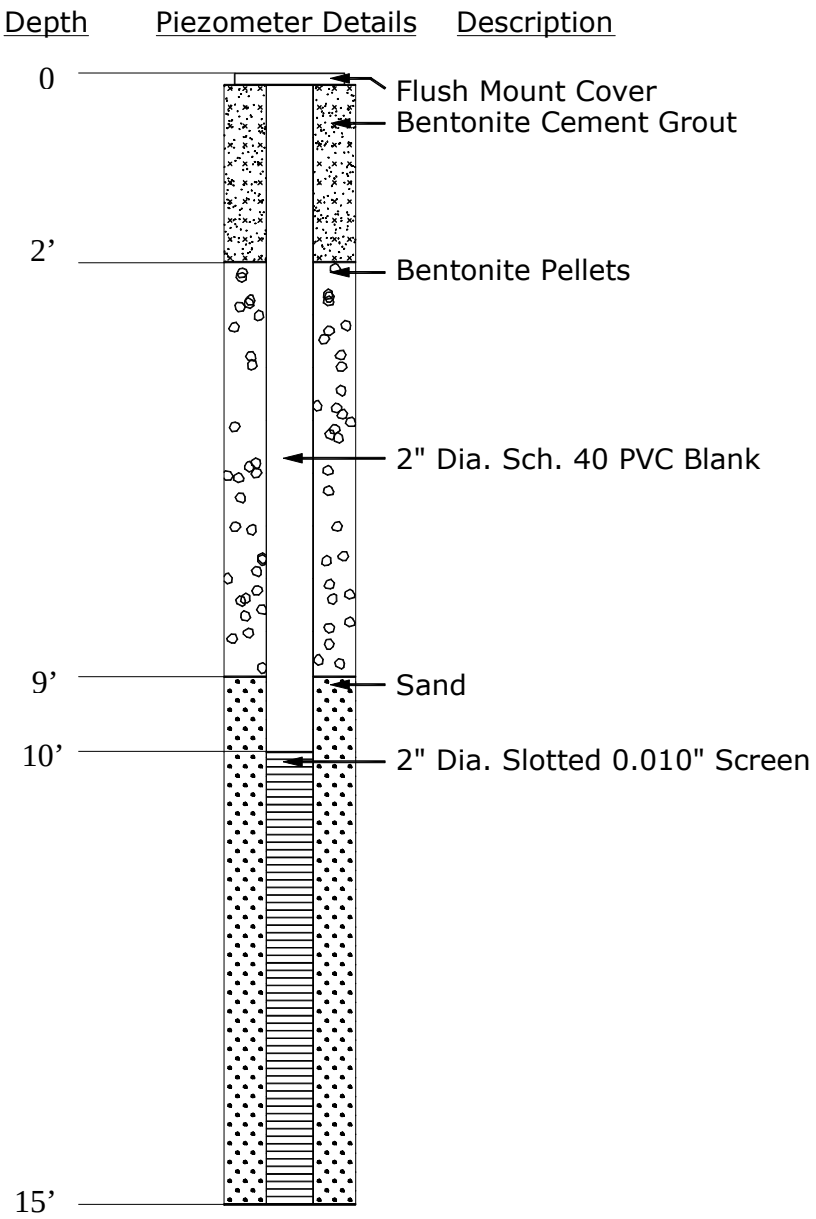
B-6	6								0.25
B-6	7					17.4	127.7	0.24	
B-6	8								1
B-6	9					17.7			
B-6	10								0.5
B-6	11	62	23	39	94	30			
B-6	12								0.5
B-6	13					27	122.9	0.63	
B-6	15				75	24.5			
B-6	16								0.67
B-6	17	84	29	55		33.5			
B-6	18								0.75
B-6	19					17	120.6	1.02	
B-7	1				47	15.5			
B-7	2								0.5
B-7	3	34	16	18		18.1			
B-7	4								0.5
B-7	5					19.7	130.3	0.78	
B-7	6								0.67
B-7	7					17.4			
B-7	8								1
B-7	9	29	16	13	67	16.7			
B-7	10								0.17
B-7	11					28.2	127.3	0.42	
B-7	12								0.17
B-7	13					23.7			
B-7	15				46	23.6			
B-7	16								1.5
B-7	17	65	34	31		46.7			
B-7	18								0.83
B-7	19					15.7	133.7	1.56	
B-8	0.7								0.58
B-8	1				61	13			
B-8	2								1.33
B-8	3					12.4	132.5	1.16	
B-8	4								1.33
B-8	5	28	17	11		13.3			
B-8	6								0.92
B-8	7				65	14.2			
B-8	8								0.67
B-8	9					16.2	131.8	0.97	
B-8	10								0.83
B-8	11				77	18.5			
B-8	12								0.58
B-8	13	46	17	29	84	22.6			
B-8	15				29	20.2			
B-8	16								0.67

B-8	17					18.4	134.5	0.36	
B-8	18								0.92
B-8	19	33	14	19		17.3			
B-8	23								1.5
B-8	24					10.5	132.6	1.34	
B-9	0.8								0.67
B-9	1.3				56	14.4			
B-9	2								0.75
B-9	3					14.2			
B-9	4								0.83
B-9	5					13.6	137.8	1.13	
B-9	6								0.58
B-9	7	23	17	6		14			
B-9	8								1.33
B-9	9				69	16.7			
B-9	10								1.08
B-9	11					20.4	132.5	0.81	
B-9	12								0.5
B-9	13					21.4			
B-9	15				12	22.6			
B-9	17	67	28	39		35.3			
B-9	18								0.67
B-9	19					17.1			
B-10	1				49				
B-10	2								0.83
B-10	3	22	14	8		13.6			
B-10	4								1.17
B-10	5					13.5	124.1	1.15	
B-10	6								1.25
B-10	7				62	14.1			
B-10	8								0.67
B-10	9					15.7	137	1.26	
B-10	10								0.25
B-10	11	25	16	9		17.7			
B-10	12								0.33
B-10	13					22.2	118.1	0.69	
B-10	14								0.42
B-10	14.5				71	20.2			
B-11	1				42	15.4			
B-11	2								0.83
B-11	3					13.6	120.6	1.05	
B-11	4								0.67
B-11	5					14.9			
B-11	6								0.92
B-11	7	25	16	9	57	13.9			
B-11	8								0.92
B-11	9					16.1			

B-11	10								0.25
B-11	11					16.2	123.2	0.9	
B-11	12								1
B-11	13	37	18	19		23.1			
B-11	14								0.83
B-11	14.5				91	24.7			
Total		**25**	**25**	**25**	**31**	**84**	**25**	**25**	**72**

APPENDIX C

PIEZOMETER INSTALLATION RECORDS



Water Level Readings

Date	Depth (ft.)	Elev. (ft.)
12/24/12	9.25	69.46
01/22/13	7.50	71.21

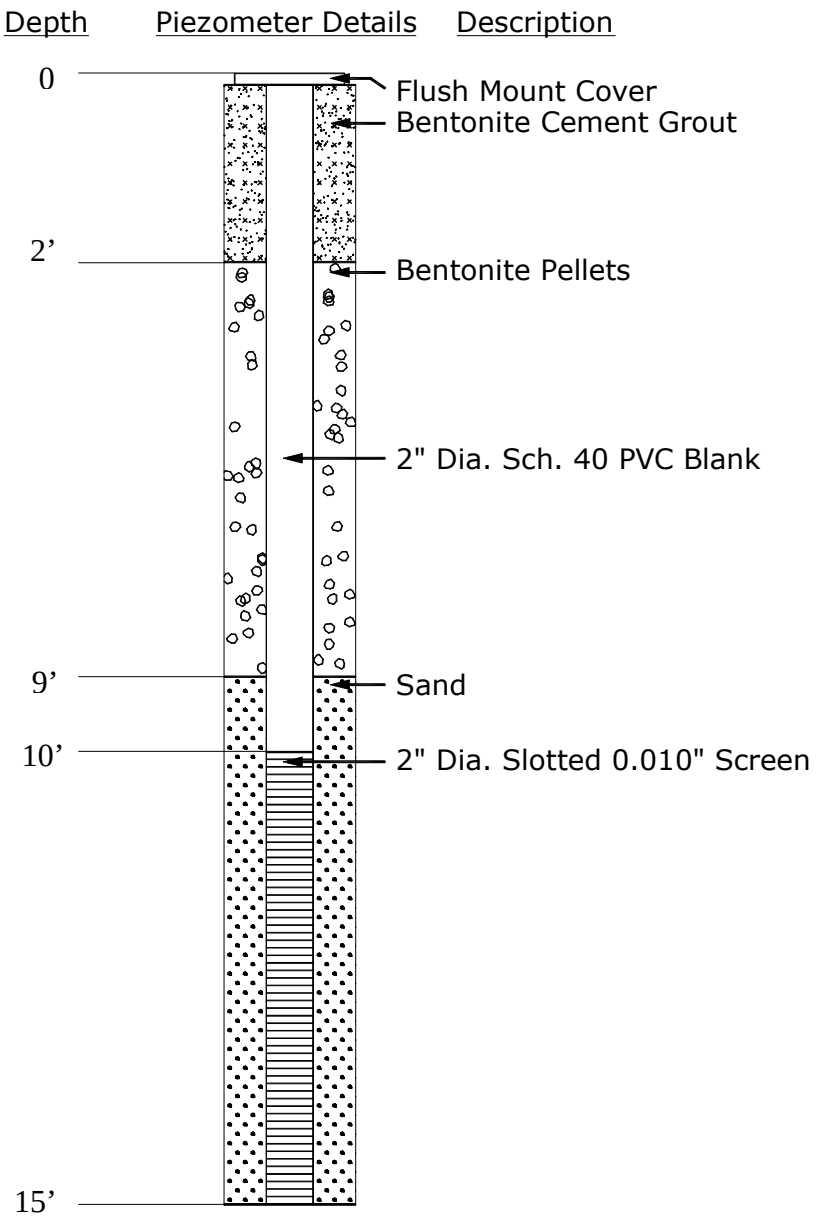
NOTES:

- Piezometer was installed on 12/22/12.
- See Plate 2 for boring location; see Plate A-1 for boring log.

HVJ ASSOCIATES
6120 S. Dairy Ashford Road
Houston, Texas 77072-1010
281.933.7388 Ph
281.933.7293 Fax

PIEZOMETER INSTALLATION REPORT
PIEZOMETER NO. PZ-1 (B-1)

PROJECT NO.:	DRAWING NO.:
HG1018721	PLATE C-1



Water Level Readings

Date	Depth (ft.)	Elev. (ft.)
12/24/12	11.0	64.52
01/22/13	9.75	65.77

NOTES:

- Piezometer was installed on 12/22/12.
- See Plate 2 for boring location; see Plate A-8 for boring log.

HVJ ASSOCIATES
6120 S. Dairy Ashford Road
Houston, Texas 77072-1010
281.933.7388 Ph
281.933.7293 Fax

PIEZOMETER INSTALLATION REPORT
PIEZOMETER NO. PZ-2 (B-8)

PROJECT NO.:	DRAWING NO.:
HG1018721	PLATE C-2

Van n Sons Copy

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	Pinemont at Ella Blvd (pz-1)	Houston	Tx	7018

Lat. ° ' " Long. ° ' " Grid # 65-13-2

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 12/26/2013
Completed 12/26/2013

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	10	SaCl
10	15	SiSa
15	25	Ch

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

8) Borehole Completion ☐ Open Hole ☐ Straight Wall ☐ Under-reamed ☐ Gravel Packed ☒ Other 9 &12
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 11 ft. #sacks & material 1 cement
from 13 ft. to 13 ft. #sacks & material .5 bentonite
from ft. to ft. #sacks & material
Method Used tremmie
Distance to septic field or other concentrated contamination na ft.
Distance to Property Line na ft Method
Verified: na

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 14 ft. Date 12/26/2012
Artesian Flow gpm

12) Packers

Type	Depth	Type	Depth
20/40	13-25		

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

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) ____

RECEIVED FEB 02 2013 ASSOCIATES, INC

☐ *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 Driling Service, Inc — Lic. No. 3003M
Address 319 John Alber — City Houston — State Tx — Zip 77076

Signature (Licensed Driller/Pump Installer)	Date	Signature (Apprentice)	Date
	1/28/2013		/ /

...ion Owner:
...nfidentiality Privilege Notice
...n 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	Pinemont at Brinkman (pz-2)	Houston	Tx	7018

Lat. ° ' " Long. ° ' " Grid # 65-13-2

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 12/26/2013
Completed 12/26/2013

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	10	SaCl
10	14	Cl
14	25	SaCl

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

8) Borehole Completion ☐ Open Hole ☐ Straight Wall
☐ Under-reamed ☐ Gravel Packed ☒ Other 9 &12
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 11 ft. #sacks & material 1 cement
from 13 ft. to 13 ft. #sacks & material .5 bentonite
from ____ ft. to ____ ft. #sacks & material ____
Method Used tremmie
Distance to septic field or other concentrated contamination na ft.
Distance to Property Line na ft Method ____
Verified: na

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 14 ft. Date 12/26/2012
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 Driling Service, Inc Lic. No. 3003M
Address 319 John Alber City Houston State Tx Zip 77076

Signature	1/28/2013	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

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	**Pinemont at Ella**	**Houston**	**Tx**	**77018**

3) Owner's Well No. 1 | **Long.** ° ' " | **Lat.** ° ' " | **Grid # 65-13-2**

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 **Edward Van Antwerp** | License No. **3003M**

7) Drilled **12/26/2012** | 8) Diameter of hole **4** inches | 9) Total depth of well **25** feet.

C. CURRENT PLUGGING DATA

10) Date well plugged **01/18/2013**

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

License No. **3003M**

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) removed surface sleeve
2) tried to pull pvc well material
3) top section of pvc broke
4) grouted well material in place

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	1/28/2013 **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

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	Pinemont at Brinkman	Houston	Tx	77018

3) Owner's Well No. 2 | Long. ° ' " | Lat. ° ' " | Grid # 65-13-2

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: Edward Van Antwerp | License No. 3003M

7) Drilled 12/26/2012 | 8) Diameter of hole 4 inches | 9) Total depth of well 25 feet.

C. CURRENT PLUGGING DATA

10) Date well plugged 01/18/2013

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

License No. 3003M

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) removed surface sleeve
2) tried to pull pvc well material
3) top section of pvc broke
4) grouted well material in place

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

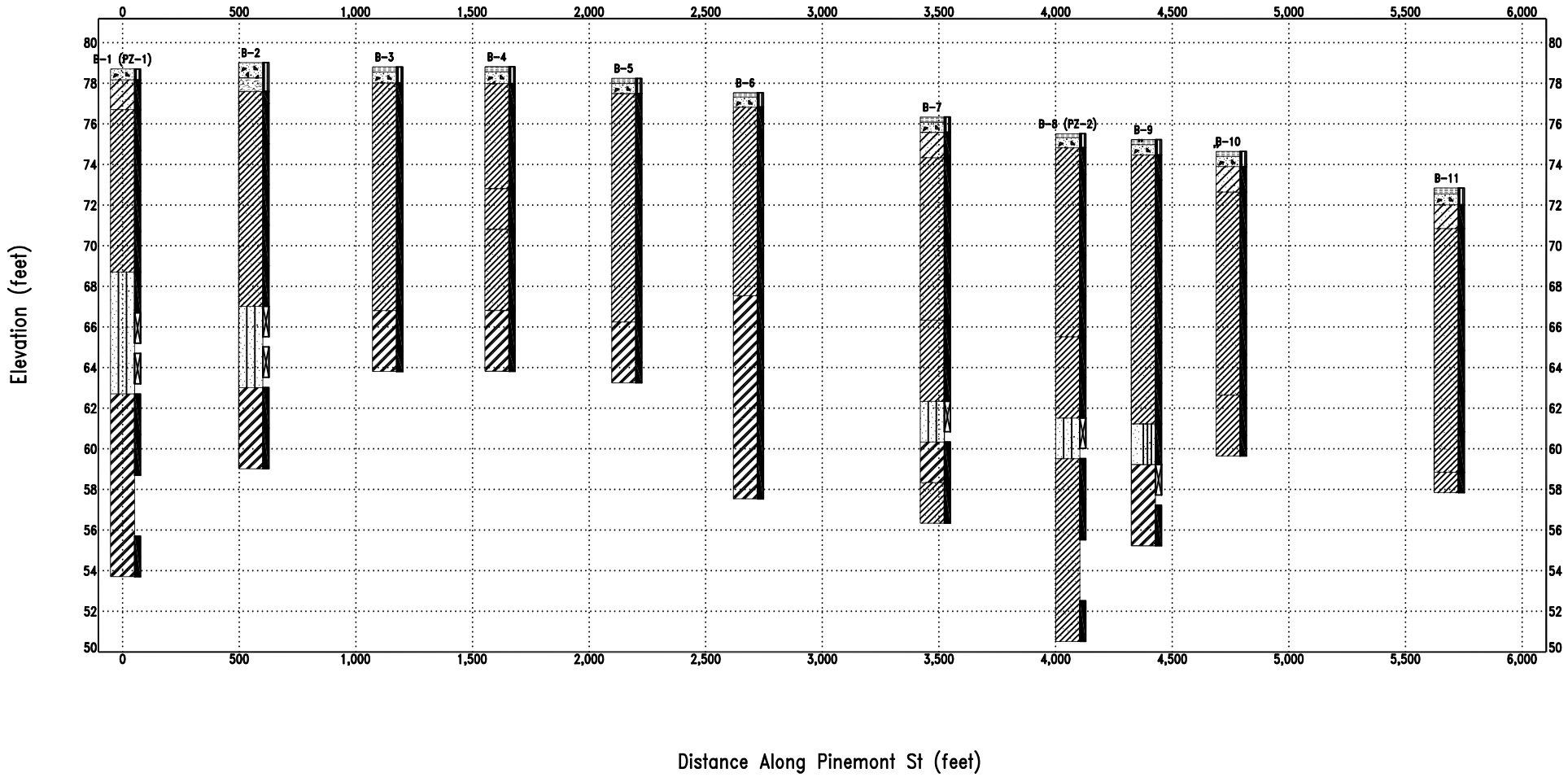
Address: 319 John Alber | City: Houston | State: Tx | Zip: 77076

Signature		Signature	
Licensed Driller/Pump Installer	1/28/2013 Date	Apprentice	/ / Date

Form provided by Forms On-A-Disk, Inc. · Dallas, Texas · (214) 340-9429

APPENDIX D

SOIL PROFILE



LEGEND:

- Concrete
- Fill (made ground)
- Sandy Clay
- Silt
- Asphaltic Concrete
- Fat Clay
- Base
- Clayey Sand
- Sand

Note:
Data concerning subsurface conditions obtained at boring locations only.

HVJ ASSOCIATES	01/25/2013	
	APPROVED BY: ZA	PREPARED BY: KL
BORING LOG PROFILE PINEMONT STREET RECONSTRUCTION		
PROJECT NO.: HG1018721	DRAWING NO.: PLATE D-1	

APPENDIX E

DARWIN PAVEMENT ANALYSIS OUTPUT

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Rigid Structural Design Module

Pinemont St. HG-10-18721

Rigid Structural Design

Pavement Type	JRCP
18-kip ESALs Over Initial Performance Period	736,043
Initial Serviceability	4.5
Terminal Serviceability	2.5
28-day Mean PCC Modulus of Rupture	600 psi
28-day Mean Elastic Modulus of Slab	3,370,000 psi
Mean Effective k-value	132 psi/in
Reliability Level	95 %
Overall Standard Deviation	0.39
Load Transfer Coefficient, J	3.2
Overall Drainage Coefficient, Cd	1.2
Calculated Design Thickness	6.52 in

Effective Modulus of Subgrade Reaction

Period	Description	Roadbed Soil Resilient Modulus (psi)	Base Elastic Modulus (psi)
1	-	6,900	50,000

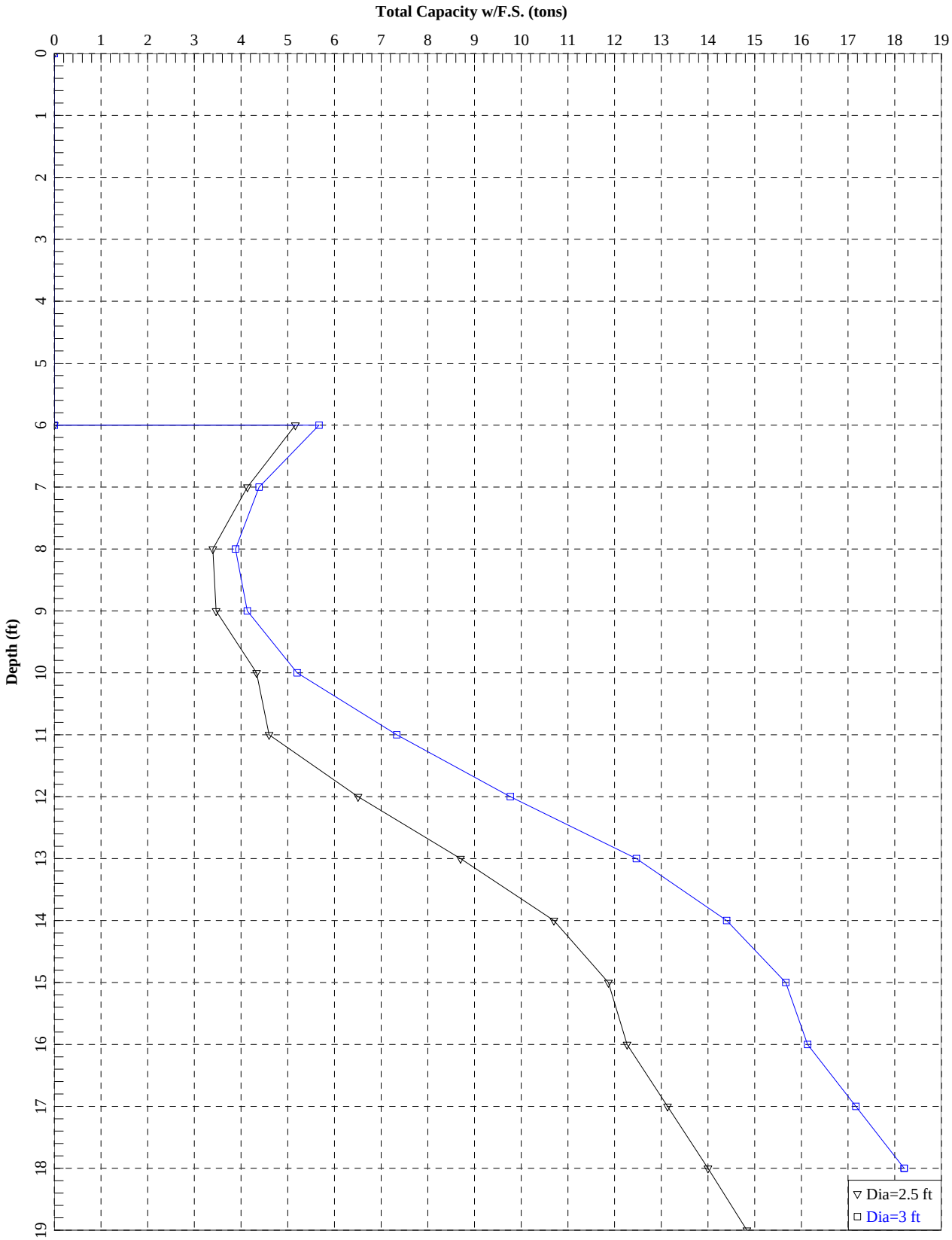
Base Type	Lime Stabilized
Base Thickness	6 in
Depth to Bedrock	100 ft
Projected Slab Thickness	8 in
Loss of Support Category	1
Effective Modulus of Subgrade Reaction	132 psi/in

Simple ESAL Calculation

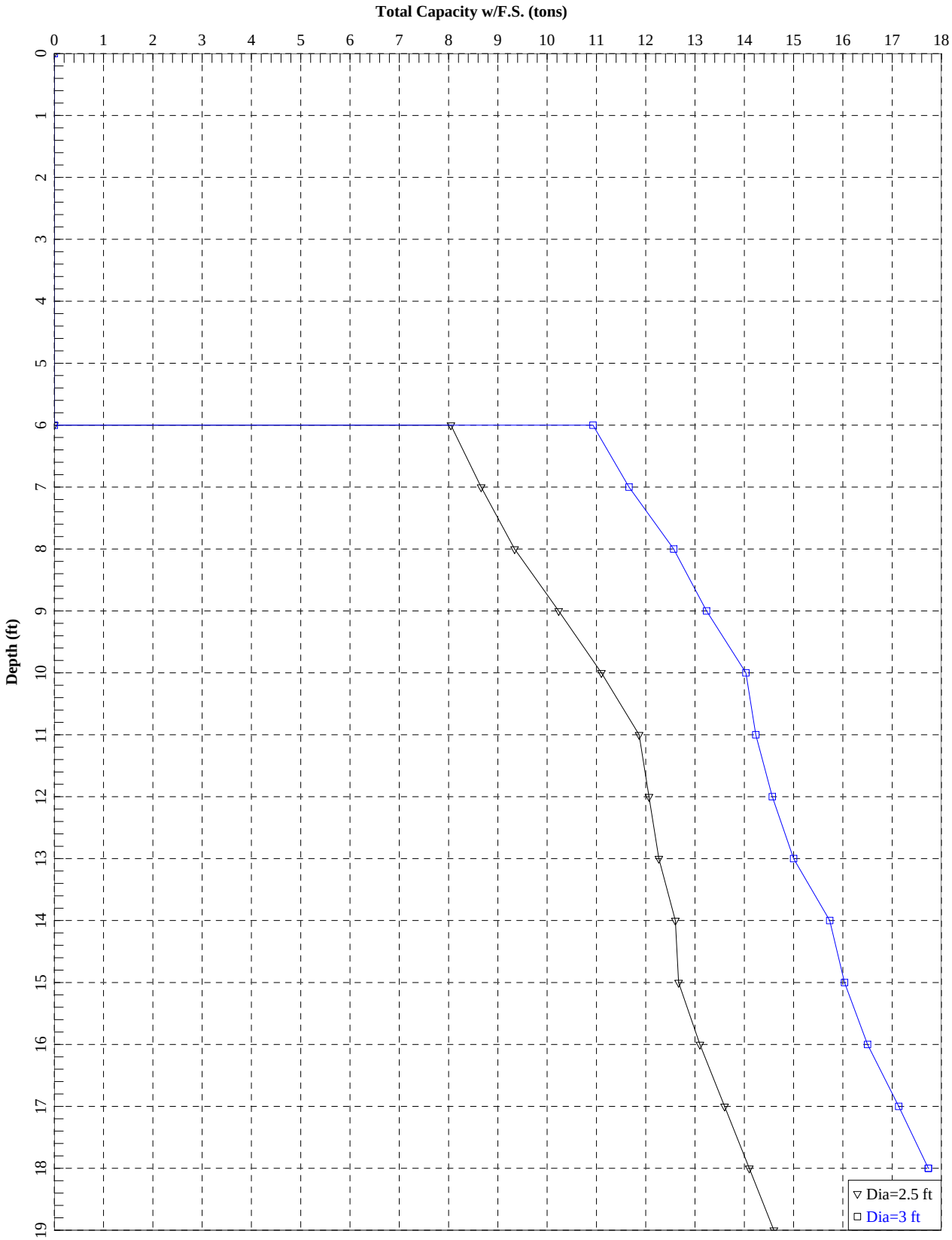
Performance Period (years)	20
Two-Way Traffic (ADT)	13,500
Number of Lanes in Design Direction	2
Percent of All Trucks in Design Lane	90 %
Percent Trucks in Design Direction	50 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	2 %
Average Initial Truck Factor (ESALs/truck)	0.66
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	2.7 %
Growth	Simple
Total Calculated Cumulative ESALs	736,043

APPENDIX F

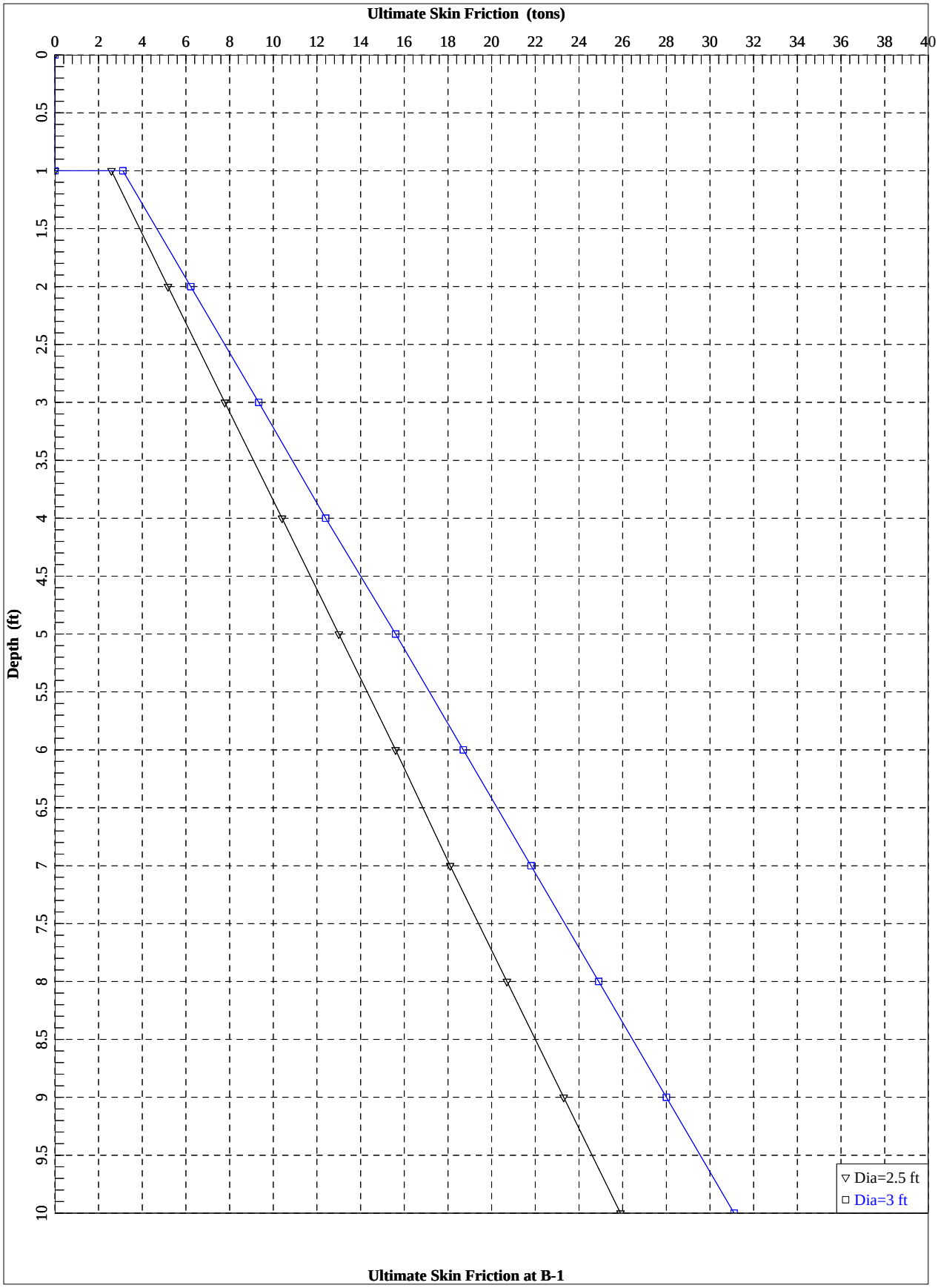
DRILLED SHAFT CAPACITY CURVES

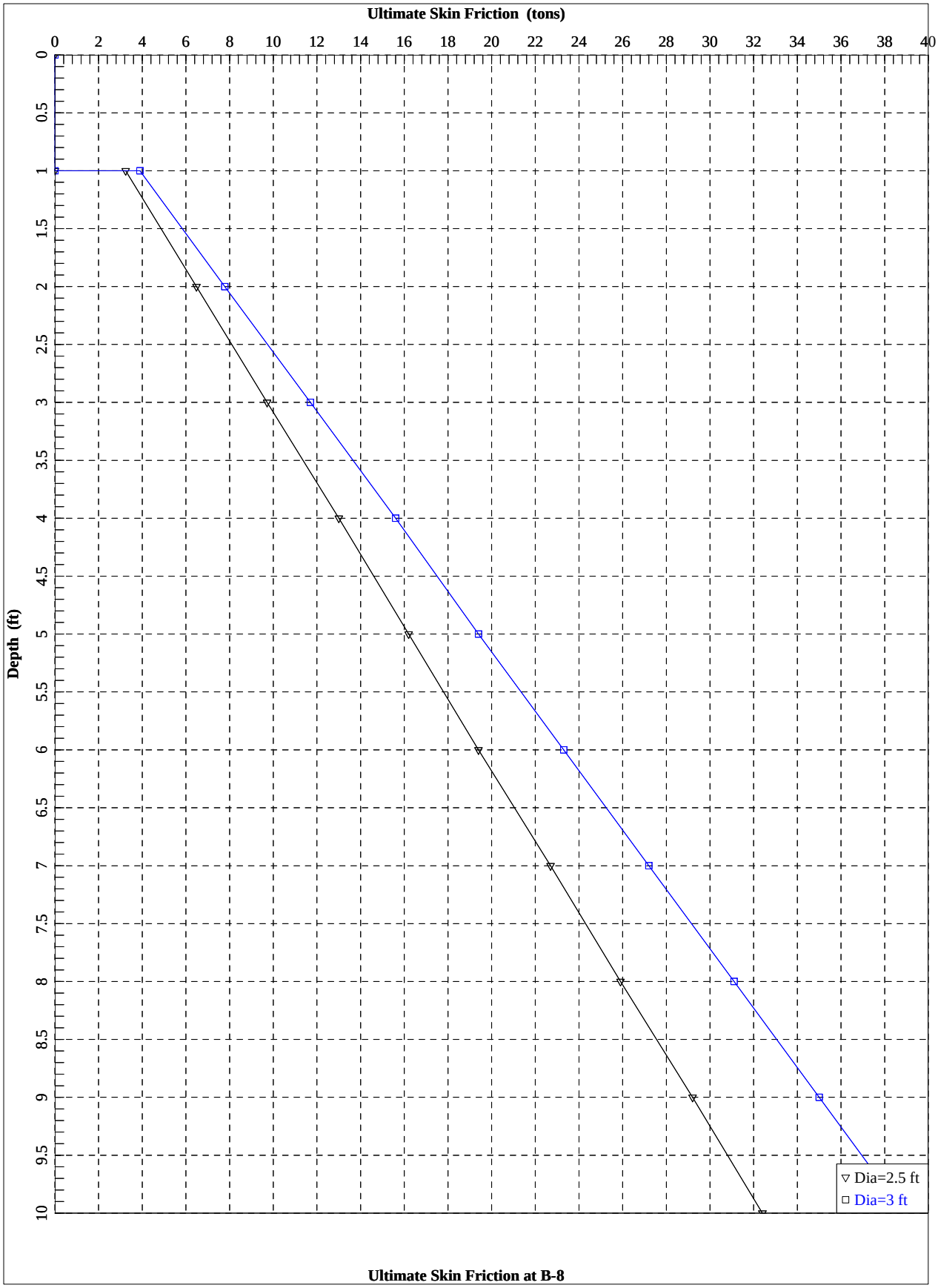


Total Allowable Capacity at Boring B-1



Total Allowable Capacity at Boring B-8


Ultimate Skin Friction (tons)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
Depth (ft)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
Dia=2.5 ft
Dia=3 ft
Ultimate Skin Friction at B-1


Ultimate Skin Friction (tons)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
Depth (ft)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
Dia=2.5 ft
Dia=3 ft
Ultimate Skin Friction at B-8