REPORT

OF

PRELIMINARY GEOTECHNICAL EXPLORATION

FOR

PROPOSED SOUTH INNERBELT TRENCH RETAINING WALLS

PROJECT FRA-70-8.93 (PID No. 77369)

FRANKLIN COUNTY, OHIO

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DLZ Job. No. 0221-1004.01

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EXECUTIVE SUMMARY

As part of the FRA-70-8.93 South Innerbelt project in Columbus, Ohio, a preliminary geotechnical exploration was performed for the proposed retaining walls in the I-70/I-71 South Innerbelt Trench area, which is essentially between Short Street and the east interchange. This exploration was performed to (1) determine the subsurface conditions, (2) determine the characteristics of the subsurface materials, and (3) provide information to assist in developing the construction cost estimate and preliminary design of the retaining walls.

The subsurface conditions were determined by drilling fourteen borings to depths of 111.0 to 136.5 feet. Four adjacent roadway borings were also considered for the development of the retaining wall recommendations. Samples of the subsurface materials were obtained for classification and general index tests. In addition, in-situ pressuremeter testing was performed at selected depths in two of the borings.

Walls 6W1 through 6W5 along the south side of I-70/I-71 and walls 7W1 through 7W5 along the north side of I-70/I-71 were evaluated. All calculations were performed in accordance with AASHTO LRFD Specifications.

In areas where the walls will be constructed primarily in cut sections, walls utilizing top-down construction were evaluated, including soldier pile and lagging walls with anchors and drilled shaft retaining walls. In areas where the walls will be constructed primarily with new fill, cast-in-place semi-gravity walls were evaluated. MSE walls could also be utilized in areas of new fill but were not evaluated in this report. Cast-in-place and MSE walls could also be constructed in cut sections, provided there is sufficient right-of-way to excavate behind the proposed retaining wall and install temporary shoring.

Due the presence of boulders, driven piles were not considered a viable option to support the retaining walls. Driving piles on boulders would likely damage the piles. In addition, the induced vibrations could damage nearby structures.

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1.0 INTRODUCTION

This project is located in downtown Columbus, Ohio. In general, the FRA-70-8.93 project consists of a reconfiguration of the mainline freeway, major interchanges, and ramps along the I-70, I-71, I-670, and SR 315 corridors. In conjunction with the scope on this project, DLZ has prepared recommendations for the retaining walls in an area referred to as the south trench, essentially along I-70 between Short Street and the I-70/I-71 (east) interchange. These recommendations are based in part on the results of DLZ's drilling and testing program for the project.

The purpose of this exploration was to 1) determine the subsurface conditions to the depths of the borings, 2) evaluate the engineering characteristics of the subsurface materials, and 3) provide information to assist in the design of the retaining walls and bridge foundations (abutments only). Recommendations for the bridge piers are presented under separate cover.

Under DLZ's scope of work, the executed drilling program is preliminary in nature. According to ODOT's Specifications for Geotechnical Explorations (SGE), the boring spacing of approximately 500 feet used in this subsurface exploration is not sufficient to develop final recommendations. As per the SGE, the maximum spacing for retaining wall borings should be 150 feet. Therefore, the recommendations presented herein should not solely be used for final design. It is the intension of this document to provide information regarding the approximate size and spacing of retaining wall elements, as well as to identify potential concerns regarding constructibility. This information should be sufficient to develop cost estimates and to facilitate discussions regarding a preferred retaining wall type in this area. It is understood that the borings presented in this report will be supplemented with additional borings in the future followed by updated recommendations for use during final design of the proposed retaining walls.

The geotechnical engineer has planned and supervised the performance of the geotechnical engineering services, has considered the findings, and has prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranties, either expressed or implied, are made as to the professional advice included in this report.

2.0 GENERAL PROJECT INFORMATION

Although retaining walls are planned in several different areas of the project, this report focuses on the retaining walls proposed for either side of the I-70/I-71 alignment from essentially Short Street to the east interchange, in an area referred to as the south trench.

In the south trench area, much of the alignment is situated in a soil cut. The depth of the proposed cut relative to the adjacent grade level varies up to approximately 45 feet. In general, the tallest retaining walls are in the vicinity of Front and High Streets, near station 740+50 on the north side of the roadway. However, a majority of the proposed retaining walls in the south trench will have retained heights of approximate 25 feet.

The urban setting of this portion of the project presents unique challenges in terms of spatial constraints. Interference with utilities, existing interstate travel lanes, and existing side streets should be considered when selecting a preferred retaining wall type. Different types of retaining walls require various construction techniques. Some wall types (bottom-up construction) require extensive excavation behind the proposed wall, while other wall types (top-down construction) do not require such excavations. Therefore, the retaining walls have been grouped together in terms of bottom-up or top-down construction.

The analysis and recommendations presented in this report have been made on the basis of the foregoing information. If the proposed locations or structural concept is changed or differs from that assumed, DLZ should be informed of the changes so that recommendations and conclusions presented in this report may be revised as necessary.

3.0 FIELD EXPLORATION

The subsurface exploration consisted of drilling 14 borings for the proposed trench retaining walls. Four of the adjacent roadway borings were also considered for the development of the retaining wall recommendations and are included in this report. Other roadway borings were also drilled in the south trench area, but the results of these borings can be found in reports for the roadway, which will be produced by others. In general, the retaining wall borings were spaced at approximately 500-foot intervals along the proposed alignment. Retaining wall borings were advanced 6.0 to 20.6 feet into bedrock to total depths ranging from 111.0 to 136.5 feet. Additional information regarding the drilling procedures is presented in Appendix A.

Historic borings drilled for the original construction of the freeway were also initially considered for this report but did they did not provide sufficient information to be included and did not extend to bedrock. These historic borings were obtained from the foundation exploration reports for the bridges over I-70 between Front Street and Grant Avenue. A complete list of historic reports evaluated for the project is presented in the Red Flag Summary report, dated April 11, 2008.

The boring locations for the current retaining wall exploration were located and marked in the field by representatives of DLZ. Representatives of ms consultants, inc. surveyed the as-drilled boring locations. Boring logs are presented in Appendix A. The boring locations are shown on the boring logs and on the Plan and Profile drawing presented in Appendix B.

4.0 FINDINGS

4.1 Field Reconnaissance

A field reconnaissance for the FRA-70-8.93 project was performed in 2008. Findings of the field reconnaissance as well as other information obtained on the project area are presented in the Red Flag Summary report, dated April 11, 2008.

4.2 Geology of the Site

General geological references report that the site was covered by both the Wisconsin and Illinoian glaciers. The project area is divided by the Scioto River, which lies to the west of the south trench area.

The predominant glacial deposits in Franklin County consist of glacial till, which is a heterogeneous mixture of clay, silt, sand, gravel, cobbles, and boulders. Most of the project alignment extends through glacial outwash deposits that fill the preglacial valley in which the Scioto River flows. Fine-grained fill and quaternary (recent) alluvial deposits cover the glacial outwash materials and are present along the length of the project area. The thickness of the glacial deposits in the south trench area generally varies between 80 and 120 feet.

Bedrock along the alignment lies on the eastern margin of the Cincinnati Arch and is inclined at approximately 10 feet per mile to the southeast towards the Appalachian Basin. Bedrock units as well as contacts between units display a pronounced north-south orientation or strike. Three different rock formations lie immediately below the soils along the alignment. These include from youngest to oldest: the Olentangy Shale, the Delaware Limestone, and the Columbus Limestone, all of Devonian Age.

Information regarding the thickness of the glacial deposits was obtained from general geologic references. A complete list of the geologic references used for the project is presented in the Red Flag Summary report, dated April 11, 2008.

4.3 Subsurface Conditions

The following sections present the generalized subsurface conditions encountered by the borings. For more detailed information, refer to the Boring Logs presented in Appendix A. Grain-size test results and unconfined (rock) test results are shown on the Boring Logs. Unconfined (rock) test results are also presented in Appendix C.

4.3.1 Soil Conditions

At the ground surface, the borings encountered between 3 and 8 inches of topsoil or between 13 and 27 inches of pavement. The pavement materials consisted of 2 to 11 inches of asphalt concrete over 3 to 11 inches of Portland cement concrete and 3 to 11 inches of aggregate base. Borings B-025, B-030, and B-041 encountered pavement material but did not encounter the Portland cement

concrete. Boring B-24 did not encounter any topsoil or pavement material at the ground surface.

Below the topsoil and pavement material, 1.2 to 18.2 feet of fill or possible fill was encountered in eight of the borings: B-025, B-029, B-031, B-032, B-034, B-040, B-044, and B-046. The fill or possible fill consisted of medium stiff to hard sandy silt (A-4a), silt and clay (A-6a) and silty clay (A-6b) and loose to medium dense coarse and fine sand (A-3a) and gravel with sand (A-1-b). Layers of brick fragments were also encountered in Boring B-034 as deep as 11.0 feet.

Below the topsoil, pavement, fill, and possible fill, the natural soils consisted of alternating layers of primarily very stiff to hard cohesive materials and dense to very dense granular materials. The cohesive soils consisted primarily of sandy silt (A-4a) and silt and clay (A-6a) with lesser amounts of silty clay (A-6b) and clay (A-7-6). The granular soils consisted primarily of gravel (A-1-a), gravel with sand (A-1-b), and coarse and fine sand (A-3a) with lesser amounts of fine sand (A-3), gravel with sand and silt (A-2-4), gravel with sand, silt, and clay (A-2-6) and silt (A-4b).

In Borings B-024, B-025, B-026, B-032, B-037, B-039, B-041 and B-043, the top 25 to 50 feet consisted primarily of cohesive soil. Below of depth of 50 to 84 feet, most of the borings encountered primarily granular soil. Borings B-035, and B-036 encountered only granular soils. Heaving sands were encountered occasionally in the wet granular soils, primarily below depths of 30.0 feet.

Cobbles and boulders or difficult drilling conditions, indicating possible cobbles and boulders, were encountered in all the retaining wall borings drilled in the south trench area. The cobbles and boulder zones were encountered primarily below depths of 30.0 feet but occasionally as shallow as 11.0 feet.

4.3.2 Bedrock Conditions

Below the soil, a layer of severely weathered shale was encountered above the more competent bedrock in most of the retaining wall borings, ranging in thickness between 0.5 and 3.0 feet.

The top of more competent bedrock was encountered at depths between 90.0 and 120.5 feet. The type and condition of bedrock was confirmed in all the retaining wall borings by coring 6.0 to 20.6 feet into bedrock. The bedrock consisted primarily of a very weak to weak blue-gray to dark gray shale with 0 to 10 percent limestone interbedding. The RQD values ranged from 0 to 100 percent with an average RQD of 68 percent.

A moderately strong to strong brownish gray to light gray limestone was also encountered in Boring B-029 between 120.6 and 136.5 feet. The RQD values ranged from 76 to 88 percent with an average RQD of 83 percent.

4.3.3 Groundwater Conditions

The borings first encountered seepage between depths of 9.2 and 41.0 feet. Groundwater levels prior to the addition of drilling water were observed in Borings B-024, B-025, B-035 and B-037 at depths ranging from 6.5 to 39.0 feet below the ground surface. At the completion of drilling, final water levels were observed at depths ranging from 4.6 to 51.6 feet below the ground surface. These final water levels all included drilling water.

4.4 In-situ Pressuremeter Testing

4.4.1 Field Work

In accordance with the scope of work on this project, DLZ conducted eight successful pressuremeter tests in two borings (B-026 and B-046) in the south trench area. In general, the test borings were drilled approximately 5 feet from the parent boring.

In general, the pressuremeter test is an in-situ stress-strain test consisting of lowering a cylindrical probe into a prepared borehole and inflating the probe such that the probe presses against the borehole sidewall. The measurement of the volume versus pressure relationship is useful in refining soil-structure interaction models, foundation design, and settlement analyses among other things. Testing was conducted essentially in accordance with ASTM 4719 – Method A. Testing was conducted using the G-AM pressuremeter model from Roctest with the N-sized (70 mm) probe. The G-AM model is a Menard-type, tri-cell pressuremeter. Calibration of the probes was conducted in order to ascertain the membrane resistance (low pressure) and system compressibility (high pressure). The field test results were then corrected using the calibration data. The calibration reports are presented in Appendix C.

Borings were advanced using 4 1/4-inch hollow stem augers to a depth which was approximately 3 feet above the test elevation. Below the hollow stem augers, the test cavity was prepared using a 2 7/8-inch tricone bit while circulating water or prepared drilling fluid. No boring logs were created for the test borings. For additional information regarding soil type and consistency, refer to the boring logs generated for the parent borings presented in Appendix A.

4.4.2 Reduction and Use of Data

Corrections to the pressuremeter data were performed which include adjustments for pressure losses (low pressure – membrane resistance) and volume losses (high pressure – system compressibility). The corrected pressuremeter data is presented in Appendix C. Data in both SI and Imperial units have been provided for convenience.

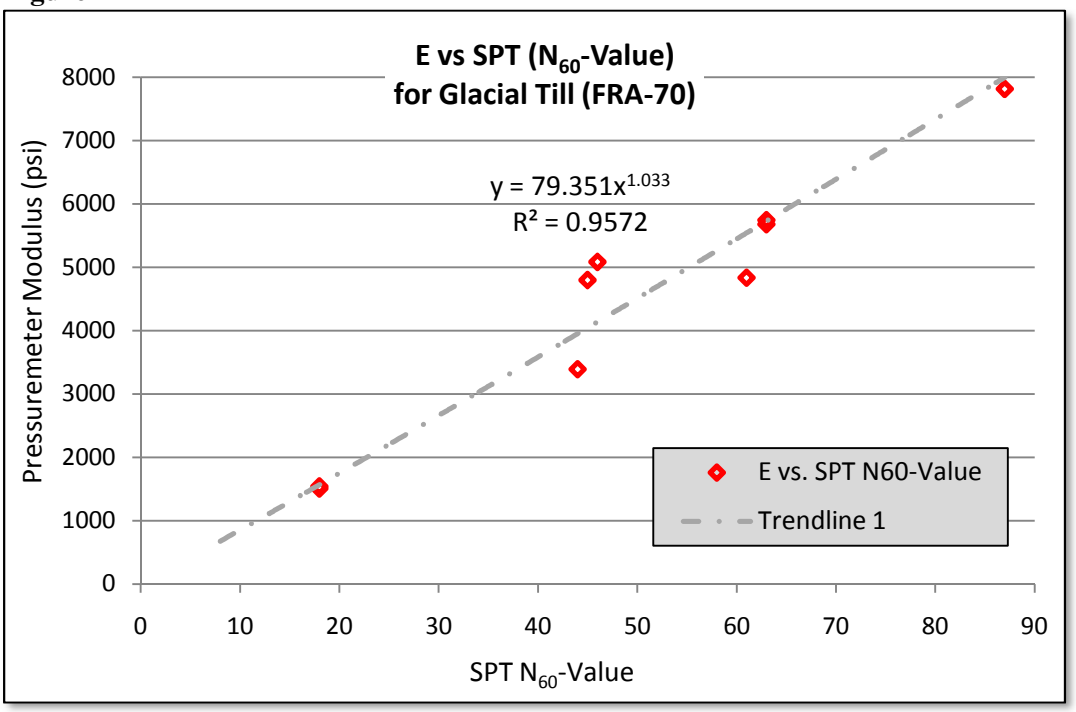
Data from the pressuremeter curves was used to create families of p-y curves for use in lateral analyses of the retaining walls. The p-y curves were developed

using methods by Robertson et al (1985) and applied to the two soil profiles, Profile A and Profile B, which were used in the lateral analyses. For Profile B, the direct test results obtained in Boring B-046 were used to create p-y curves that were used in the LPILE model of the retaining walls. For Profile A, p-y curves were generated based upon correlations with tests conducted in similar soils. The following paragraphs discuss this procedure.

It should be noted that in an effort to apply the test results in a broader sense to similar soils within the project area, a brief study was conducted to ascertain the presence, if any, of correlations between standard soil parameters and pressuremeter parameters. The data indicates that a strong correlation exists between the SPT N_{60}-value and the pressuremeter modulus. After plotting the data a near-linear relationship was evident. Figure 1 shows this relationship.

In general, the pressuremeter modulus controls the initial slope of the p-y curve, prior to reaching the yield pressure. Because deflections of the retaining walls should be limited to approximately one percent of the retained height (as per OSE) it is unlikely that the portions of the p-y curves much beyond the yield pressure will be engaged by these walls. Therefore, it can be assumed that in the case of these walls, the soil reaction is in large part controlled by the pressuremeter modulus and not the yield pressure of the soil. It is important to note this because no correlation was found between the yield pressure and any available soil parameters. The yield and limit pressures are difficult to approximate with a great degree of certainty. However, in order to model the effect of the yield pressure threshold on the p-v curves, an effort was made to shape the curves generated by the SPT N_{60}-value correlation to match those from the direct tests. In order to accomplish this, a series of fit factors were developed in order to match the general shape of the curves. By qualitatively matching the shape of the p-v curves, DLZ was able to develop families of curves and apply the resulting p-y curve data with a reasonable degree of confidence.

Figure 1



While the dataset which DLZ has obtained is small, it is believed that this correlation can be applied to similar soils with some degree of confidence. The soil tested was very stiff to hard gray glacial till, which was classified into two categories; Sandy Silt (A-4a) and Silt and Clay (A-6a). It should be noted that the plasticity index of the soil ranged only from 10 to 12 percent, with water content values ranging from 9 to 12 percent. Similarly, the percent passing the #200 sieve ranged from 48 to 64 percent. The range of soils tested was characterized by only small variations in the above-referenced soil parameters. Therefore, it is recommended that this correlation only be applied to materials which have characteristics similar to those tested.

During the next phase of work, it is suggested that additional pressuremeter testing be performed. By expanding the existing dataset, it may be possible to refine this correlation further, providing a greater degree of confidence in the application of this data in the lateral analyses.

5.0 LABORATORY TESTING PROGRAM

The laboratory testing program consisted of visual classifications and general index tests of the soil samples. The general index tests consisted of grain-size analyses and moisture content and plasticity determinations. In addition, unconfined compression tests were performed on selected rock core samples. The results of the classifications, grain-size analyses, moisture content and plasticity determinations, and unconfined compression tests are shown on the boring logs in Appendix A. The results of the unconfined compression tests are also shown in tabular form in Appendix C.

6.0 CONCLUSIONS AND RECOMMENDATIONS

As discussed in Section 2.0, the types of retaining wall considered on this portion of the project were divided into two general categories based on construction type: top-down construction and bottom-up construction. The following sections discuss the general features associated with each wall type, details and procedures associated with the analyses, and the results of the analyses.

It is understood that according to ODOT's Office of Structural Engineering (OSE), a deflection limit of approximately one percent of the retained height should be used.

Based on the soils encountered in the borings drilled for this project, the south trench area was divided into two profiles. Information regarding the assumed soil profiles is discussed in Section 6.2. In general, the retained height of the proposed walls ranges from several feet to just over 45 feet. However, along most of the alignment, the maximum retaining wall height is approximately 25 feet. Therefore, the analyses assumed retaining wall heights of 25, 35, and 45 feet in order to provide a sufficiently wide range of retaining wall sizes for cost estimating purposes.

Calculations and analyses performed for the purposes of investigating the proposed retaining walls were conducted according the AASHTO's LRFD Bridge Design Specifications, Fourth Edition 2007, with 2008 Interim Revisions.

6.1 Loading

6.1.1 General

The proposed retaining walls will be subject to loading from several sources. Loading sources include horizontal earth pressure, live load surcharge, anchor loads (soldier piles with ground anchors only), and vertical structural loads.

Many bridges are planned to span the distance between the proposed retaining walls along the I-70/I-71 alignment. The method of supporting the bridge abutments is still under development. It is anticipated that the proposed bridges/caps may bear on the top of the proposed retaining walls. Consequently, analyses were performed which include the vertical load from the proposed structures/cap. The larger value between the vertical bridge load and the cap load was used to evaluate the affect on the proposed retaining walls. The vertical load from the proposed structures was estimated to be approximately 23 kips per linear foot (along wall face) for the SERVICE-I load case. Because the configuration (width, lane use, et cetera) of the proposed bridges/caps is still under development, it was decided that the load factor for the STRENGTH-I case be taken conservatively as 1.75.

6.1.2 Application of Vertical Load from Structure (Bridge/Cap)

Because the cantilevered drilled shaft walls may move a modest amount prior to construction of any proposed structures, a sensitivity analysis regarding the location of the axial load was conducted. In the LPILE analyses it was assumed that an eccentricity equal to one percent of the retained height would be used. The eccentricity represents any difference from the planned centerline of bearing for the structure and the centerline of the drilled shafts resulting from any deviation between the estimated and actual deflection of the retaining walls which are supporting structures. The resulting moment was applied such a way that it held the same sign convention as the moment generated from the lateral earth pressures, in other words, it was assumed that the eccentricity was in the roadside direction.

It was assumed that this eccentricity only needed to be accounted for in the drilled shaft wall analysis. The cantilevered nature of this wall lends it to be most susceptible to deflections relative to other wall types, such as those that are tied back using ground anchors.

6.2 Soil Profiles

Based upon the soils encountered in the project borings, two subsurface profiles were established which are considered representative of their respective portions of the trench alignment. Profile A, based upon Boring B-029 is considered representative of subsurface conditions essentially between Front Street and Fifth Street. Similarly, Profile B, based upon Boring B-046 is considered to be representative of subsurface conditions on either side of the Profile A area. For additional information, refer to the boring logs in Appendix A and the plan and profile drawing in Appendix B.

6.3 Top-Down Construction

Based on the currently available plans, it is understood that I-70/I-71 is to be widened and realigned within the south trench area. Based upon the consistency of soils encountered in the project borings, it is believed that temporary shoring such as sheet piling could not be installed in the dense near-surface soils, which would facilitate excavation and bottom-up construction of permanent retaining walls. Consequently, in these areas, it is believed that top-down construction of the proposed retaining walls will be necessary in order to limit the impact of construction activities adjacent city streets, nearby buildings and utilities.

In addition to the dense near-surface soils, boulders or difficult drilling, indicating possible boulders were also encountered during the execution of the drilling program. Due to the presence of boulders, it is recommended that driven piling not be considered on this portion of the project. The depths where boulders or difficult drilling were encountered are indicated on the plan and profile drawing in Appendix B.

6.3.1 Drilled Shaft Retaining Walls

In areas where top-down construction of the proposed retaining walls is necessary, the use of drilled shaft (bored pile) retaining walls could be considered. DLZ has performed analyses in order to determine the approximate size and spacing of the shafts for this type of wall. Drilled shaft size and spacing was determined based upon a deflection criterion of approximately one percent of the retained height or less. Furthermore, the estimated embedment depth of the drilled shaft walls was estimated using the STRENGTH-I loading case.

LPILE Plus 5.0 was used to model the soil-structure interaction using the non-linear pile stiffness to compute the pile response (Type 3 analysis). A summary of the recommended shaft sizes and spacing options is presented below for both soil profiles.

Table 1: Profile A (Front Street to Fifth Street)

Retained Height (ft)	Drilled Shaft Dia. (in)	c-c Spacing (in)	δmax (in) no axial load	δmax (in) with axial load	Embedment D (ft)
25	48	120	2.76	2.67	50
35	60	84	3.90	3.82	60
45	86	120	4.95	4.91	69

Table 2: Profile B (East and West of Profile A)

Retained Height (ft)	Drilled Shaft Dia. (in)	c-c Spacing (in)	δmax (in) no axial load	δmax (in) with axial load	Embedment D (ft)
25	48	78	2.87	2.82	45
35	60	84	3.71	3.63	55

It should be noted that the analyses which include the axial load show deflections that are smaller than those performed without the axial load. The application of the axial load to the pile slightly changes the bending behavior of the pile. The analyses make use of the non-linear bending stiffness (EI) of the pile. Because the pile is subjected to an axial load, the cracked moment of inertia (for reinforced concrete sections) is developed under a higher bending moment relative to the case with no axial load. With the addition of this axial load, the pile behaves in a stiffer manner. This effect is analogous to the bending behavior of a pre-stressed member.

The required embedment depths are based upon the required geotechnical resistance against lateral loading. The axial resistance of the pile was evaluated and was found to be more than adequate to support the factored axial loads from the proposed structures.

6.3.2 Soldier Pile and Lagging Retaining Wall using Permanent Ground Anchors

In addition to drilled shafts, a soldier piles and lagging retaining wall could also be considered in areas where top-down construction is required. Many of the proposed retaining walls will have retained heights of 25 feet or more. In order to provide an efficient design, it is recommended that permanent ground anchors be used to limit the lateral forces and bending moments that would have to be resisted by the embedded piles. The ground anchors would also limit deflections of the proposed wall while using a smaller steel section. Because the soils are typically hard/dense, it is anticipated that the piles will have to be prebored with structural concrete filling the annular space around the pile below the bottom of the proposed excavation.

DLZ has performed analyses to determine the approximate size and spacing of the piles and soil anchors for this type of wall. It was assumed that deflections should be limited to approximately 1 to 2 inches. It was also assumed that two rows of soil anchors would be used. For taller walls, it may be beneficial to add additional rows of anchors. However, details regarding optimization of the proposed design can be addressed during final design. Preliminary analyses indicate that 2-C15x50 sections on 9-foot center-to-center spacing would adequately support walls having retained heights up to 35 feet. Similarly, analyses indicate that 2-C12x30 sections on 8-foot center-to-center spacing would adequately support walls having retained heights up to 25 feet. Wall heights above 35 feet generally occur in one portion of the project, on the north side of the I-70 alignment between Front and High Streets. In this area, sufficient right of way does not exist to permit the installation of ground anchors without encroaching upon private property, where buildings are reported to be on deep foundations. For this reason, soldier pile walls up to 45 feet were not considered.

Table 3: Profile A and B

Retained Height (ft)	Section	c-c Spacing (ft)	Anchor Load, R1 (kips)	Anchor Load, R2 (kips)	Embedment D (ft)
25	2C12x30	8	98.64	98.42	44
35	2C15x50	9	225.60	201.31	54

It is assumed that a 36-inch diameter shaft would be used below the bottom of the excavation (embedded length). Unlike the drilled shaft wall, the soldier pile embedded length is affected by the application of the axial load. The embedded piles length required for only lateral geotechnical resistance is not adequate to resist the applied axial loads from the proposed structure. Therefore, the embedment lengths cited in Table 3 include the additional lengths required in order to develop the factored nominal resistance to axial loading.

Spreadsheet calculations were used to analyze the development of shear and bending moments in the piles above the bottom of the excavation using factored

and unfactored loads. LPILE Plus 5.0 was used to model the soil-structure interaction using a constant pile stiffness (EI) to compute the response of the discrete embedded piles.

6.4 Bottom-up Construction

In areas where ample right-of-way exists, and construction activities would not impede traffic on side roads, bottom-up construction of the retaining walls would be possible. The use of reinforced concrete cantilever semi-gravity walls could be considered in areas where bottom-up construction is possible. Counterforts may be considered to help control deflections of the proposed retaining walls. As an alternative to the cantilevered semi-gravity walls, the use of internally stabilized retaining walls should also be considered. Mechanically stabilized earth (MSE) walls are well suited for this application.

Most of the existing retaining walls in the project area are supported by shallow footings founded on dense glacial till or alluvium deposits. Based on the performance of the existing structures and a review of soils encountered in the project borings, the subsurface conditions are well suited for retaining walls founded on shallow footings.

It should also be noted that while it may not appear to be cost effective, the use of temporary shoring to support excavations for construction of retaining walls utilizing bottom-up construction could be considered. Temporary shoring could be provided by soldier pile walls using lagging and ground anchors or drilled shaft walls.

6.4.1 Nominal Bearing Resistance

It is anticipated that concrete gravity-type retaining walls supported on spread footing foundations will most likely be used in areas where the walls will be less than 15 feet high, such as between Stations 729+60 and 734+50, or where predominantly new fill will be placed behind the walls, such as along the south wall between Stations 746+00 and 762+50. Separate recommendations for bearing resistance were developed for gravity-type walls bearing on granular-type soils and cohesive-type soils. It is anticipated that predominantly granular-type soils will be encountered at the bearing elevation west of Station 734+50 and along the south wall between Stations 759+00 and 762+50. It is anticipated that cohesive-type soils will be encountered at the bearing elevation along the south wall between Stations 746+00 and 759+00.

The nominal bearing resistance (q_n) for spread footing foundations on cohesive soil is 15.9 kips per square foot (ksf), assuming a minimum 4-foot embedment and a 10-foot wide footing. If a different width footing is used, the nominal bearing resistance will need to be adjusted. Refer to the table below for nominal bearing resistances for other footing widths. The recommended bearing resistance

factor (ϕ_r) is 1.0 for service and extreme limit states and 0.5 for strength limit states.

Table 4: Nominal Bearing Resistance Values (q_n) for Spread Footings on Cohesive Soil

Effective Footing Width, B' (ft)	Nominal Bearing Resistance, q_n (ksf)
5.0	14.6
6.0	15.1
7.0	15.6
8.0 and greater	15.9*

*- maximum value of q_n

The recommended value of nominal sliding resistance on cohesive soils is 3000 pounds per square foot (psf). The recommended sliding resistance factor (ϕ_τ) is 0.85 for the strength limit state.

The nominal bearing resistance (q_n) for spread footing foundations on granular soil is 20.0 ksf, assuming a minimum 4-foot embedment and a 10-foot wide footing. If a different width footing is used, the nominal bearing resistance will need to be adjusted. Refer to the table below for nominal bearing resistances for other footing widths. The recommended bearing resistance factor (ϕ_r) is 1.0 for service and extreme limit states and 0.45 for strength limit states.

Table 5: Nominal Bearing Resistance Values (q_n) for Spread Footings on Granular Soil

Effective Footing Width, B' (ft)	Nominal Bearing Resistance, q_n (ksf)
5.0	17.1
6.0	17.7
7.0	18.3
8.0	18.8
9.0	19.4
10.0	20.0
11.0	20.6
12.0	21.2
13.0	21.8
14.0	22.4
15.0	23.0

The recommended value of tan δ to determine nominal sliding resistance on granular soils is 0.67. The recommended sliding resistance factor (ϕ_τ) is 0.8 for the strength limit state.

6.4.2 Settlement Analysis

A settlement analysis was performed on a typical 25 to 30-foot high wall along the south side of the south trench between Stations 746+00 and 762+50, based on the soils encountered in Borings B-034 and B-035. Results of the analysis indicate that approximately 0.75 inches will occur at the face of the wall. Due to the predominantly granular nature of the underlying soils, it is anticipated that most of this settlement will occur during construction.

6.5 Construction Considerations

6.5.1 Driven Piles

As outlined in Section 6.3, it is recommended that driven piles not be used on this portion of the project. The presence of boulders would likely damage piles, possibly reducing their load carrying capacity or rendering them useless. In addition to drivability concerns, the vibrations induced by the hammering of the piles could cause damage to nearby structures. Along most of the alignment, construction activities will occur in very close proximity to residential and commercial buildings. It is understood that ms consultants has retained the services of a firm which specializes in construction vibrations. Further discussion of this topic would be warranted after this firm has had an opportunity to assess any potential concerns on this project.

6.5.2 Special Considerations - Deflection

Excessive amounts of deflection could occur at the top of the proposed retaining walls. This deflection will need to be considered, particularly where the walls will support bridge or cap abutments. The cantilevered drilled shaft retaining walls are the most critical wall type with respect to this issue. Section 6.1.2 discussed the eccentricity that was assumed in the analysis. The analyses were done in this manner to show that a certain amount of uncertainty with respect to the deflection should not preclude this wall type from being used in such an application. In the analyses, the worst case scenario for the application of the load was assumed while limiting eccentricity to one percent. The analyses indicate that the most critical drilled shafts (smallest diameter on largest spacing) could withstand eccentricities of up to 12 inches prior to exceeding strength and service limits. Interaction diagrams have been prepared which illustrate the effect of the application of the axial load and bending moment couple (from eccentricity) on the drilled shafts. These diagrams can be provided upon request.

Deflections of the proposed retaining walls should be monitored in order to estimate when the wall movement has ceased and to gauge the magnitude of said movement. Retaining walls constructed in a bottom-up fashion will deflect when backfill is placed to grade behind the wall. Conversely, drilled shaft walls will deflect as the material in front of the walls is excavated. In order to allow the drilled shaft retaining walls to deflect prior to construction bridges or caps, it is recommended that the material in front of the wall be excavated to proposed

this process could take up to several months. Other sequencing schemes could be considered in the future as additional design details are developed.

7.0 CLOSING REMARKS

We appreciate having the opportunity to be of service to you on this project. Please do not hesitate to call if you have any questions concerning our report.

Respectfully submitted,

DLZ OHIO, INC.

Steven J. Riedy
Geotechnical Engineer

Dorothy A. Adams, P.E.
Senior Geotechnical Engineer

cc: file

sjr

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APPENDIX A

General Information – Drilling Procedures and Logs of Borings
Legend – Boring Log Terminology
Boring Logs – Eighteen (18) Borings

GENERAL INFORMATION
DRILLING PROCEDURES AND LOGS OF BORINGS

Drilling and sampling were conducted in accordance with procedures generally recognized and accepted as standardized methods of investigation of subsurface conditions concerning geotechnical engineering considerations. Borings were drilled with either a truck-mounted or ATV-mounted drill rig.

Drive split-barrel sampling was performed in 1.5 foot increments at intervals not exceeding 5 feet. In the event the sampler encountered resistance to penetration of 6 inches or less after 50 blows of the drop hammer, the sampling increment was discontinued. Standard penetration data were recorded and one or more representative samples were preserved from each sampling increment.

In borings where rock was cored, NXM or NQ size diamond coring tools were used.

In the laboratory all samples were visually classified by a geotechnical engineer. Moisture contents of representative fine-grained soil samples were determined. A limited number of samples, considered representative of foundation materials present, were selected for performance of grain-size analyses and plasticity characteristics tests. The results of these tests are shown on the boring logs.

The boring logs included in the Appendix have been prepared on the basis of the field record of drilling and sampling, and the results of the laboratory examination and testing of samples. Stratification lines on the boring logs indicating changes in soil stratigraphy represent depths of changes approximated by the driller, by sampling effort and recovery, and by laboratory test results. Actual depths to changes may differ somewhat from the estimated depths, or transitions may occur gradually and not be sharply defined. The boring logs presented in this report therefore contain both factual and interpretative information and are not an exact copy of the field log.

Although it is considered that the borings have disclosed information generally representative of site conditions, it should be expected that between borings conditions may occur which are not precisely represented by any one of the borings. Soil deposition processes and natural geologic forces are such that soil and rock types and conditions may change in short vertical intervals and horizontal distances.

Soil/rock samples will be stored at our laboratory for a period of six months. After this period of time, they will be discarded, unless notified to the contrary by the client.

LEGEND – BORING LOG TERMINOLOGY

Explanation of each column, progressing from left to right

1. Depth (in feet) – refers to distance below the ground surface.

2. Elevation (in feet) – is referenced to mean sea level, unless otherwise noted.

3. Standard Penetration (N) – the number of blows required to drive a 2-inch O.D., 1-3/8 inch I.D., split-barrel sampler, using a 140-pound hammer with a 30-inch free fall. The blows are recorded in 6-inch drive increments. Standard penetration resistance is determined from the total number of blows required for one foot of penetration by summing the second and third 6-inch increments of an 18-inch drive.

   50/n – indicates number of blows (50) to drive a split-barrel sampler a certain number of inches (n) other than the normal 6-inch increment.

4. The length of the sampler drive is indicated graphically by horizontal lines across the "Standard Penetration" and "Recovery" columns.

5. Sample recovery from each drive is indicated numerically in the column headed "Recovery".

6. The drive sample location is designated by the heavy vertical bar in the "Sample No., Drive" column.

7. The length of hydraulically pressed "Undisturbed" samples is indicated graphically by horizontal lines across the "Press" column.

8. Sample numbers are designated consecutively, increasing in depth.

9. Soil Description

   a. The following terms are used to describe the relative compactness and consistency of soils:

   Granular Soils – Compactness

Term	Blows/Foot Standard Penetration
Very Loose	0 – 4
Loose	4 – 10
Medium Dense	10 – 30
Dense	30 – 50
Very Dense	over 50

   Cohesive Soils – Consistency

Term	Unconfined Compression tons/sq.ft.	Blows/Foot Standard Penetration	Hand Manipulation
Very Soft	less than 0.25	below 2	Easily penetrated by fist
Soft	0.25 – 0.50	2 – 4	Easily penetrated by thumb
Medium Stiff	0.50 – 1.0	4 – 8	Penetrated by thumb with moderate pressure
Stiff	1.0 – 2.0	8 – 15	Readily indented by thumb but not penetrated
Very Stiff	2.0 – 4.0	15 – 30	Readily indented by thumb nail
Hard	over 4.0	over 30	Indented with difficulty by thumb nail

   b. Color – If a soil is a uniform color throughout, the term is single, modified by such adjective as light and dark. If the predominant color is shaded by a secondary color, the secondary color precedes the primary color. If two major and distinct colors are swirled throughout the soil, the colors are modified by the term "mottled".

   c. Texture is based on the Ohio Department of Transportation Classification System. Soil particle size definitions are as follows:

Description		Size	Description		Size
Boulders		Larger than 8"	Sand	– Coarse	2.0 mm to 0.42 mm
Cobbles		8" to 3"		– Fine	0.42 mm to 0.074 mm
Gravel	– Coarse	3" to ¾"	Silt		0.074 mm to 0.005 mm
	– Fine	¾" to 2.0 mm	Clay		smaller than 0.005 mm

d. The main soil component is listed first. The minor components are listed in order of decreasing percentage of particle size.

e. Modifiers to main soil descriptions are indicated as a percentage by weight of particle sizes.

trace	0 to 10%
little	10 to 20%
some	20 to 35%
"and"	35 to 50%

f. Moisture content of **cohesionless soils** (sands and gravels) is described as follows:

Term	Relative Moisture or Appearance
Dry	No moisture present
Damp	Internal moisture, but none to little surface moisture
Moist	Free water on surface
Wet	Voids filled with free water

g. The moisture content of **cohesive soils** (silts and clays) is expressed relative to plastic properties.

Term	Relative Moisture or Appearance
Dry	Powdery
Damp	Moisture content slightly below plastic limit
Moist	Moisture content above plastic limit but below liquid limit
Wet	Moisture content above liquid limit

10. Rock Hardness and Rock Quality Designation

a. The following terms are used to describe the relative hardness of the **bedrock**.

Term	Description
Very Soft	Permits denting by moderate pressure of the fingers. Resembles hard soil but has rock structure. (Crushes under pressure of fingers and/or thumb)
Soft	Resists denting by fingers, but can be abraded and pierced to shallow depth by a pencil point. (Crushes under pressure of pressed hammer)
Medium Hard	Resists pencil point, but can be scratched with a knife blade. (Breaks easily under single hammer blow, but with crumbly edges.)
Hard	Can be deformed or broken by light to moderate hammer blows. (Breaks under one or two strong hammer blow, but with resistant sharp edges.)
Very Hard	Can be broken only by heavy and in some rocks repeated hammer blows.

b. Rock Quality Designation, RQD – This value is expressed in percent and is an indirect measure of rock soundness. It is obtained by summing the total length of all core pieces which are at least four inches long, and then dividing this sum by the total length of the core run.

11. Gradation – when tests are performed, the percentage of each particle size is listed in the appropriate column (defined in Item 9c).

12. When a test is performed to determine the natural moisture content, liquid limit moisture content, or plastic limit moisture content, the moisture content is indicated graphically.

13. The standard penetration (N) value in blows per foot is indicated graphically.

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

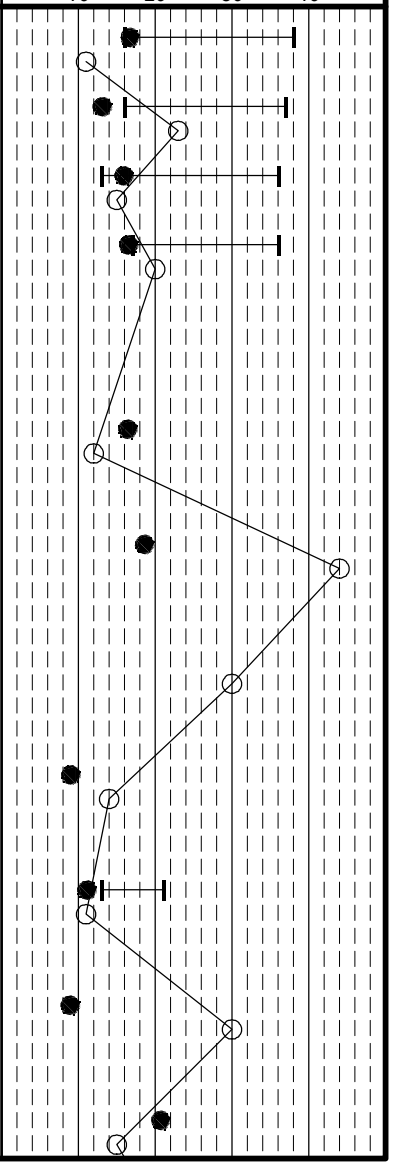
LOG OF: Boring B-024 | *Location:* Sta. 730+58.01, 93.53 ft Rt. of I-70 CL | *Date Drilled:* 7/1/2008 to 7/2/2008

WATER OBSERVATIONS:
Water seepage at: 28.5'-80.0'
Water level at completion: 16.5' (prior to coring)
10.7' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	743.4	3 4 7	11	1		--	Stiff to very stiff brown SILTY CLAY (A-6b), trace to little fine to coarse sand, little gravel; damp to moist. @ 0.0 - 3.0', contains roots.		11	9	---	11	32	37
		7 12 11	12	2		4.5+	@ 1.5', hard.		15	8	---	10	32	35
		5 7 8	16	3		4.0	@ 3.0', very stiff to hard.		11	8	---	12	33	36
5		4 6 14	13	4		3.75			12	10	---	13	31	34
		4 4 8	15	5		4.5								
10		14 21 22	9	6		--	@ 11.0', encountered rock fragments.							
		17 14 15	1	7		--								
15.5	727.9						Very stiff brownish gray SANDY SILT (A-4a), little to some fine to coarse sand, trace gravel; damp to moist.							
		4 7 7	18	8		3.5								
20		2 4 7	18	9		3.0			9	15	---	19	35	22
		7 13 16	12	10		--	@ 21.5', encountered possible large rock fragments, cobbles.							
		3 7 8	18	11		3.25								
25	718.4													

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-024 | *Location:* Sta. 730+58.01, 93.53 ft Rt. of I-70 CL | *Date Drilled:* 7/1/2008 to 7/2/2008

WATER OBSERVATIONS:
Water seepage at: 28.5'-80.0'
Water level at completion: 16.5' (prior to coring), 10.7' (includes drilling water)

FIELD NOTES: *Advanced boring using 3.25" diameter hollowstem augers.*

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	718.4														
		8 10 14	18	12		--	Very stiff brownish gray SANDY SILT (A-4a), little to some fine to coarse sand, trace gravel; damp to moist.								
28.0	715.4														
30		3 12 15	16	13			Medium dense brownish gray SILT (A-4b), little fine sand; wet.		0	0	---	17	--83--		NP
32.0	711.4														
35		7 18 18	11	14			Dense brown GRAVEL (A-1-a), some fine to coarse sand, trace to little silty clay; wet.		60	22	---	8	--10--		NP
37.0	706.4														
40		13 26 45	15	15		--	Hard brownish gray SANDY SILT (A-4a), little gravel, trace clay; damp.		12	14	---	27	33	14	72
42.0	701.4														
45		17 26 45	18	16			Very dense brownish gray FINE SAND (A-3), trace silty clay; wet. @ 43.5', 2.0 feet sand heave.		16	25	---	47	--12--		NP 72
47.0	696.4														
50	693.4	26 30 27	13	17			Very dense brownish gray SANDY SILT (A-4a), little gravel; wet.								58

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-024 | *Location:* Sta. 730+58.01, 93.53 ft Rt. of I-70 CL | *Date Drilled:* 7/1/2008 to 7/2/2008

WATER OBSERVATIONS:
Water seepage at: 28.5'-80.0'
Water level at completion: 16.5' (prior to coring)
10.7' (includes drilling water)

FIELD NOTES: *Advanced boring using 3.25" diameter hollowstem augers.*

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / Atterberg
	693.4						Very dense brownish gray SANDY SILT (A-4a), little gravel; wet.								
55		15 40 50/4	13	18			@ 50.0'-60.0', difficulty advancing boring due to obstruction inside augers blocking rods; possible boulder zone.		30	31	---	16	15	8	50+
57.0	686.4														
							Very dense brownish gray SANDY SILT (A-4a), some gravel, some fine to coarse sand; damp.								
60		37 21 50	13	19					30	19	---	10	28	13	72
62.0	681.4														
							Very dense brown and gray GRAVEL (A-1-a), some fine to coarse sand, trace silt; wet.								
		11 50/4	10	20			@ 63.5', one foot sand heave; encountered black shale fragments.		73	17	---	5	--5--		NP 50+
65															
		50/3	0	21			@ 68.5', possible cobbles or boulders.								50+
70															
		50 50/3	6	22			@ 73.5', 6.0 feet sand heave; washed out with tricone.								50+
75	668.4														

STANDARD PENETRATION (N60) / Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

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LOG OF: Boring B-024 | *Location:* Sta. 730+58.01, 93.53 ft Rt. of I-70 CL | *Date Drilled:* 7/1/2008 to 7/2/2008

WATER OBSERVATIONS:
Water seepage at: 28.5'-80.0'
Water level at completion: 16.5' (prior to coring)
10.7' (includes drilling water)

FIELD NOTES: *Advanced boring using 3.25" diameter hollowstem augers.*

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - ○ / Non-Plastic - NP
	668.4						Very dense brown and gray GRAVEL (A-1-a), some fine to coarse sand, trace silt; wet.								
		39 50/3	9	23			@ 78.5', 3.0 feet sand heave.		55	36	---	5	--4--		NP ● 50+ ○
80							@ 80.0'-90.0', difficult drilling; possible cobbles.								
		50/0	0	24											50+ ○
85															
		50/0	0	25			@ 88.5', 1.0 foot sand heave.								50+ ○
90							@ 90.0' - 91.5', core loss.								
		Core 18"	Rec 0"	RQD 0%	R1		@ 91.5' - 91.8', encountered igneous-plutonic cobble/boulder; likely peridotite or gabbro.								
91.8	651.6														
							Interbedded Shale (90%) and Limestone (10%) RQD 60%, LOSS 26%; Shale, blue-gray, highly weathered, weak, laminated, slightly calcareous, contains abundant pyritic inclusions, moderately to highly fractured; Limestone, light gray, moderately weathered, moderately strong to strong, fractured.								
95															
		Core 120"	Rec 116"	RQD 81%	R2		@ 97.7' - 98.1', qu = 1650 psi								
100	643.4														

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LOG OF: Boring B-024 | *Location:* Sta. 730+58.01, 93.53 ft Rt. of I-70 CL | *Date Drilled:* 7/1/2008 to 7/2/2008

WATER OBSERVATIONS:
Water seepage at: 28.5'-80.0'
Water level at completion: 16.5' (prior to coring)
10.7' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	643.4						Interbedded Shale (90%) and Limestone (10%) RQD 60%, LOSS 26%; Shale, blue-gray, highly weathered, weak, laminated, slightly calcareous, contains abundant pyritic inclusions, moderately to highly fractured; Limestone, light gray, moderately weathered, moderately strong to strong, fractured.								
105		Core 120"	Rec 76"	RQD 48%	R3		@ 101.2', dark gray (shale).								
110							@ 107.8' - 111.5', core loss due to pyritic inclusion lodged in core barrel.								
111.5	631.9						Bottom of Boring - 111.5'								
115															
120															
125															

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

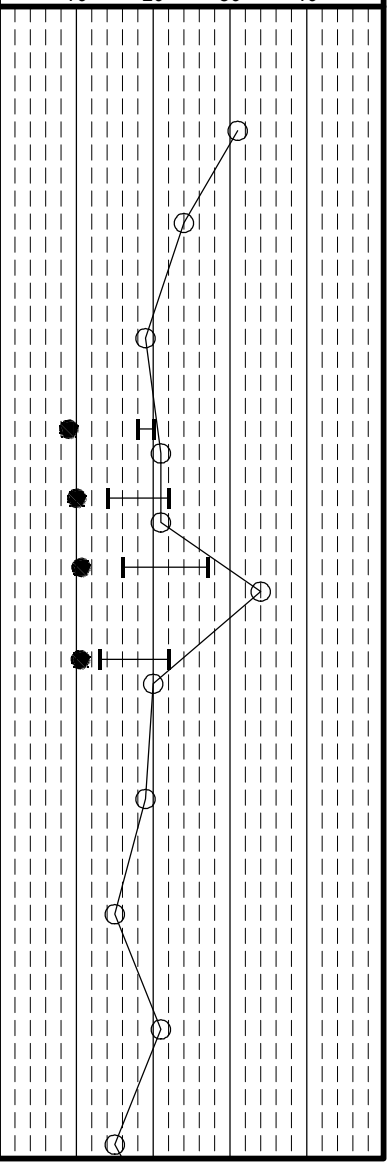
LOG OF: Boring B-025 | *Location:* Sta. 732+65.07, 88.70 ft Lt. of I-70 CL | *Date Drilled:* 7/24/2008

WATER OBSERVATIONS:
Water seepage at: 26.0'
Water level at completion: 39.0'

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	740.4													
1.2	739.2						Asphalt Concrete - 7" Aggregate Base - 7"							
		14 13 17	15	1		4.5+	FILL: Hard brown SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; contains few brick fragments; damp.							
3.5	736.9													
5		11 10 14	14	2		4.5+	Hard gray SANDY SILT (A-4a), some to "and" fine to coarse sand, trace to little gravel; damp.							
		6 8 11	14	3		4.5+								
10		7 10 11	18	4		4.5+			18	12	---	16	32	22
		6 10 11	18	5		4.5+			8	15	---	20	36	21
11.5	728.9													
		14 16 17	4	6		4.5+	Hard gray SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; damp to moist.		12	16	---	18	34	20
13.5	726.9													
15		5 8 12	18	7		4.5+	Very stiff to hard gray SANDY SILT (A-4a), some to "and" fine to coarse sand, trace to little gravel; damp.							
		5 7 12	18	8		4.5+								
20		4 6 9	18	9		2.75								
		5 9 12	18	10		4.5								
		5 6 9	18	11		2.5								
25	715.4													

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL ⊢——⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-025 | *Location:* Sta. 732+65.07, 88.70 ft Lt. of I-70 CL | *Date Drilled:* 7/24/2008

WATER OBSERVATIONS:
Water seepage at: 26.0'
Water level at completion: 39.0'

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / Blows per foot - / Non-Plastic - NP
	715.4														PL — LL; 10 20 30 40
		3 6 17	13	12		3.5	Very stiff gray SILTY CLAY (A-6b), little fine sand; moist.								
28.5	711.9														
		17 29 37	10	13			Very dense brown GRAVEL WITH SAND (A-1-b), some fine to coarse sand, little silty clay; wet. @ 30.0'-38.5', encountered cobbles while augering.								67
30															
		29 50/5	6	14					50	21	---	10	14	5	NP; 50+
35															
38.5	701.9														
		23 50/6	10	15		4.5+	Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace gravel; damp.								50+
40															
43.5	696.9														
		9 30 37	12	16			Very dense gray GRAVEL WITH SAND (A-1-b), "and" fine to coarse sand, little silt; wet.								68
45															
		22 39 30	15	17					39	26	---	22	--13--		NP; 70
50	690.4														

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LOG OF: Boring B-025 | *Location:* Sta. 732+65.07, 88.70 ft Lt. of I-70 CL | *Date Drilled:* 7/24/2008

WATER OBSERVATIONS:
Water seepage at: 26.0'
Water level at completion: 39.0'

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	690.4						Very stiff gray SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; moist.								
55		22 33 26	13	18		2.5									60 ○
57.0	683.4														
							Very dense brown COARSE AND FINE SAND (A-3a), some silt, little gravel; wet.								
59.3	681.1	48 50/3	9	19											50+ ○
60							Bottom of Boring - 59.3'								
65															
70															
75															

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

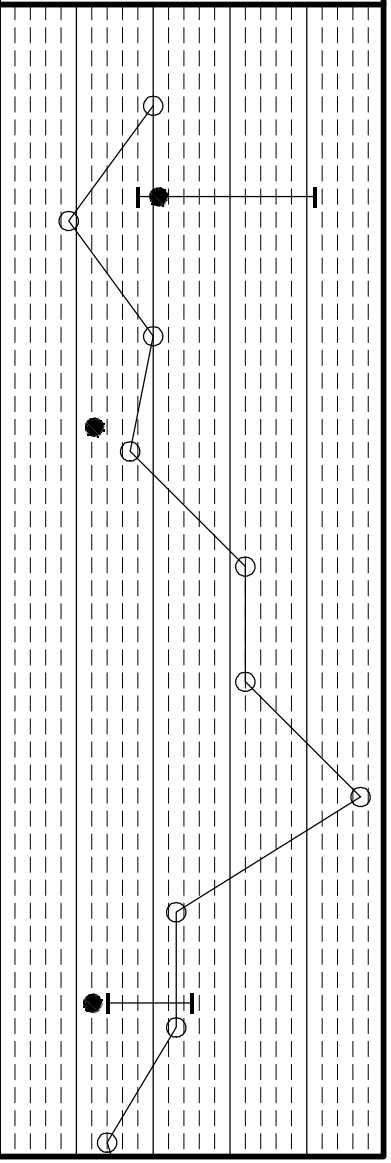
LOG OF: Boring B-026 | *Location:* Sta. 732+50.74, 140.07 ft Lt. of I-70 CL | *Date Drilled:* 8/1/2008 to 8/6/2008

WATER OBSERVATIONS:
Water seepage at: 41.0', 58.0', 77.0'
Water level at completion: 29.1' (beginning of shift, 8/5/08)
30.7' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	754.0													
0.3	753.7						Topsoil - 4"							
2.0	752.0	8 11 8	18	1A 1B		1.5 0.5	Stiff brown SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; moist.							
3.5	750.5						Soft brown SANDY SILT (A-4a), some fine to coarse sand, little gravel; wet.							
5		5 4 5	18	2		2.75	Very stiff to hard brown CLAY (A-7-6), little to some fine to coarse sand, trace to little gravel; moist.		5	6	---	13	37	39
		5 8 11	18	3		4.25								
10		11 8 8	18	4		0.5	@ 8.5'-10.0', soft, wet.							
		8 10 20	4	5		2.5								
15		5 10 20	2	6		1.5	@ 13.5', becomes gray. @ 13.5'-15.0', stiff.							
		19 23 22	0	7		--								
18.5	735.5													
20		11 8 14	18	8		3.0	Very stiff to hard gray SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; damp to moist.							
		11 12 10	18	9		2.5			9	14	---	16	35	26
25	729.0	7 5 8	18	10		4.5+								

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-026 | *Location:* Sta. 732+50.74, 140.07 ft Lt. of I-70 CL | *Date Drilled:* 8/1/2008 to 8/6/2008

WATER OBSERVATIONS:
Water seepage at: 41.0', 58.0', 77.0'
Water level at completion: 29.1' (beginning of shift, 8/5/08)
30.7' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	729.0													
		9 10 8	18	11		3.5	Very stiff gray SILT AND CLAY (A-6a), little to some fine to coarse sand, trace gravel; moist.							
		8 12 10	10	12		2.25								
30														
31.0	723.0													
		21 21 23	18	13		1.5	Stiff to very stiff gray SANDY SILT (A-4a), little to some fine to coarse sand, trace to little gravel; damp to moist.							
		4 8 11	18	14		3.0			10	13	---	18	36	23
35														
		12 8 7	18	15		3.25								
38.5	715.5													
		6 9 18	16	16		1.75	Stiff gray SILTY CLAY (A-6b), trace fine sand; damp.		0	0	---	1	39	60
40														
42.0	712.0													
		29 34 32	18	17			Very dense gray GRAVEL WITH SAND AND SILT (A-2-4), some fine to coarse sand, some silty clay; wet.							
45														
		19 35 32	18	18										
50	704.0													

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

69
70

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

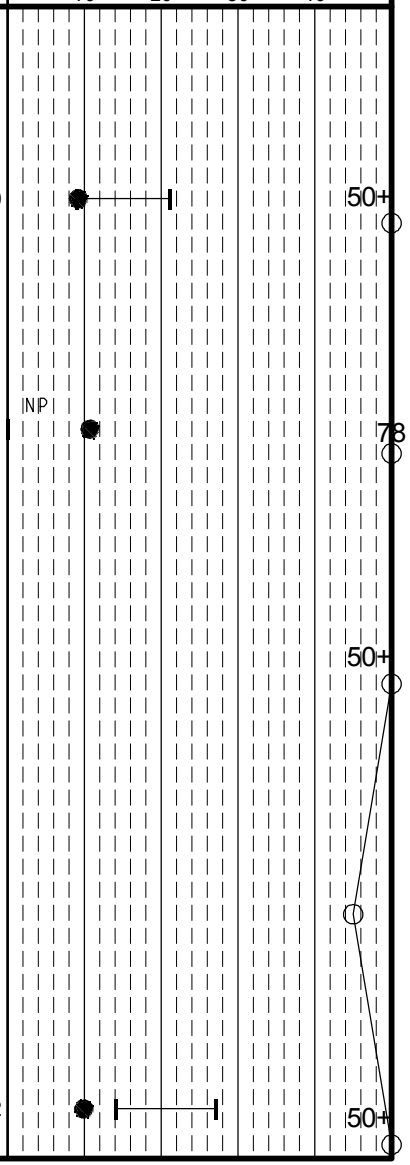
LOG OF: Boring B-026 | *Location:* Sta. 732+50.74, 140.07 ft Lt. of I-70 CL | *Date Drilled:* 8/1/2008 to 8/6/2008

WATER OBSERVATIONS:
Water seepage at: 41.0', 58.0', 77.0'
Water level at completion: 29.1' (beginning of shift, 8/5/08)
30.7' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	704.0													
		21 23 50/5	17	19		4.5+	Hard gray SILT AND CLAY (A-6a), some fine to coarse sand, trace to little gravel; contains sand seams; damp.		10	13	---	22	35	20
55														
57.0	697.0													
		19 30 44	18	20			Very dense gray GRAVEL WITH SAND (A-1-b), trace to little silt; wet.		30	41	---	21	--8--	
60														
		29 50/4	2	21										
65														
67.0	687.0													
		8 20 23	2	22		4.5	Hard gray SILT AND CLAY (A-6a), some fine to coarse sand, trace to little gravel; damp to moist.							
70														
		13 50/5	10	23		4.5+			9	10	---	19	40	22
75	679.0													

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL ⊢——⊣ *LL*
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-026 | *Location:* Sta. 732+50.74, 140.07 ft Lt. of I-70 CL | *Date Drilled:* 8/1/2008 to 8/6/2008

WATER OBSERVATIONS:
Water seepage at: 41.0', 58.0', 77.0'
Water level at completion: 29.1' (beginning of shift, 8/5/08)
30.7' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	679.0						Very dense gray GRAVEL (A-1-a); possible cobbles and boulders; wet.							
		50/5	2	24										
80														
82.0	672.0													
							Stiff gray SANDY SILT (A-4a), "and" fine to coarse sand, trace gravel; damp.							
		35 50/5	7	25		1.75			9	13	---	27	33	18
85														
87.0	667.0													
							Stiff gray CLAY (A-7-6), trace fine to coarse sand, trace gravel; moist.							
		13 19 33	7	26		1.5			6	3	---	2	30	59
90.0 90	664.0													
		Core 60"	Rec 5"	RQD 0%	R1		Claystone, brown, severely weathered, very weak, fractured, RQD 14%, Loss 67%. @ 90.0'-97.8' lost recovery.							
95														
97.8	656.2	Core 60"	Rec 60"	RQD 80%	R2									
							Shale, blue-gray, highly weathered, weak, laminated, friable, fissile, jointed, fractured to moderately fractured, tight, slightly rough, RQD 87%, Loss 0%.							
100	654.0													

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL ⊢——⊣ *LL*
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

50+ (○)
50+ (○)
55 (○)

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-026 | *Location:* Sta. 732+50.74, 140.07 ft Lt. of I-70 CL | *Date Drilled:* 8/1/2008 to 8/6/2008

WATER OBSERVATIONS:
Water seepage at: 41.0', 58.0', 77.0'
Water level at completion: 29.1' (beginning of shift, 8/5/08)
30.7' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	654.0														
		Core 60"	Rec 60"	RQD 85%	R3		Shale, blue-gray, highly weathered, weak, laminated, friable, fissile, jointed, fractured to moderately fractured, tight, slightly rough, RQD 87%, Loss 0%. Contains dark gray, well cemented shale zones [thin, dark bands]. Dark shale zones are typically 1-2 inches thick, spaced at intervals of 12 to 18 inches.									
105															
		Core 60"	Rec 60"	RQD 90%	R4		@ 100.5' - 101.0', qu = 2391 psi								
108.9	645.1														
110							Interbedded Shale (90%) and Limestone (10%), RQD 88%, Loss 0%; Shale, dark gray, moderately weathered, weak, thinly laminated, calcareous, fissile, pyritic, jointed, moderately fractured, tight, slightly rough; Limestone, light gray, slightly weathered, strong, thinly bedded, pyritic.									
		Core 60"	Rec 60"	RQD 83%	R5		@ 110.2'-110.5', 113.9'-114.2', high angle fractures.								
115.0 115	639.0														
							Bottom of Boring - 115.0'								
120															
125															

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

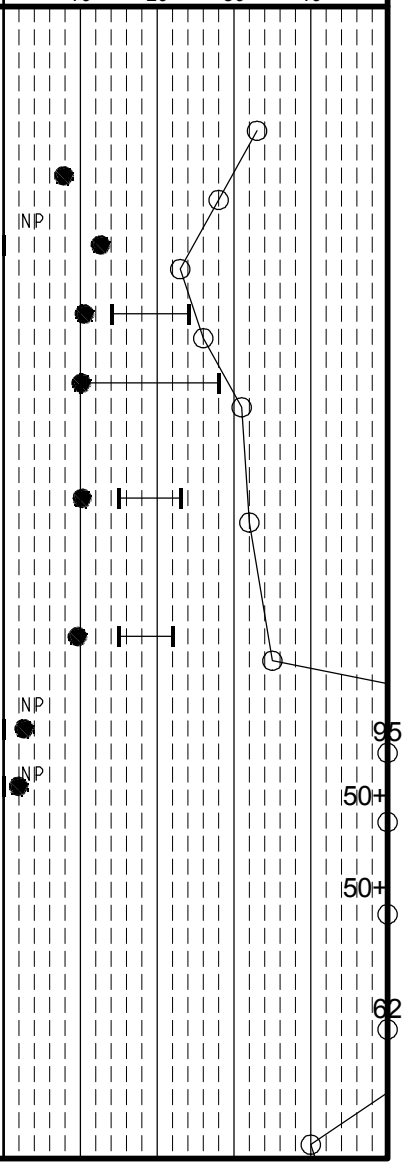
LOG OF: Boring B-029 | *Location:* Sta. 740+41.62, 85.96 ft Rt. of I-70 CL | *Date Drilled:* 7/9/2008 to 7/14/2008

WATER OBSERVATIONS:
Water seepage at: 21.0'-25.0',30.0'-32.0',40.0'-110.0'
Water level at completion: 29.4' (beginning of shift, 7/10/08)
20.5' (includes drilling water)

FIELD NOTES: Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	742.3						Asphalt Concrete Pavement - 7" Portland Cement Concrete - 9" Aggregate Base - 11"							
2.3	740.0	5 15 17	7	1										
		13 15 12	10	2			POSSIBLE FILL: Medium dense to dense brown GRAVEL WITH SAND (A-1-b), little to some silt; damp.							
5		11 13 10	6	3					55	17	---	9	--19--	
6.0	736.3	4 10 15	14	4		4.5	Hard gray SANDY SILT (A-4a), some fine to coarse sand, little gravel; damp.		12	11	---	16	35	26
7.5	734.8	12 15 15	12	5		4.5	Hard gray SILTY CLAY (A-6b), some fine to coarse sand, trace gravel; damp to moist.		9	9	---	15	41	26
10.0	732.3	10 14 17	18	6		4.5	Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace gravel; damp. @ 11.5'-21.0', difficult drilling.		8	8	---	15	40	29
15.0	727.3	8 15 19	18	7		4.5								
		15 48 45	12	8			Very dense gray GRAVEL (A-1-a), some fine to coarse sand, trace to little silt; damp.		55	24	---	10	--11--	
		29 50/3	8	9					61	16	---	12	--11--	
		50/5	1	10			@ 18.5'-18.9', rock fragments; possible cobble blocking shoe.							
20 21.0	721.3													
		21 28 33	6	11			Very dense gray GRAVEL WITH SAND AND SILT (A-2-4), some silt; wet.							
23.5	718.8	11 18 21	16	12			Dense gray SILT (A-4b), little fine sand; contains interbedded sand seams; wet.							
25	717.3													

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-029 | *Location:* Sta. 740+41.62, 85.96 ft Rt. of I-70 CL | *Date Drilled:* 7/9/2008 to 7/14/2008

WATER OBSERVATIONS:
Water seepage at: 21.0'-25.0',30.0'-32.0',40.0'-110.0'
Water level at completion: 29.4' (beginning of shift, 7/10/08)
20.5' (includes drilling water)

FIELD NOTES: *Advanced boring using 3.25" diameter hollowstem augers.*

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % -
	717.3														PL — LL; Blows per foot - ○ / Non-Plastic - NP; 10 20 30 40
		10 19 25	15	13		4.5+	Hard gray SANDY SILT (A-4a), "and" fine to coarse sand, trace gravel; contains interbedded sand seams; damp.		9	8	---	33	34	16	NP
28.5	713.8															
30		13 23 31	13	14			Dense to very dense gray COARSE AND FINE SAND (A-3a), some silt; moist.									55
31.8	710.5	3 6		15A												
		29	14	15B		4.5+	Hard gray SANDY SILT (A-4a), some gravel, little to some fine to coarse sand; damp.									
							@ 31.0'-43.5', difficult drilling.									
35		13 26 31	9	16		--	@ 33.5', 5 inches sand heave.									58
40		14 23 33	14	17		4.5+			28	15	---	19	25	13		57
42.0	700.3															
							Dense gray COARSE AND FINE SAND (A-3a), little silt; contains silty clay seams; wet.									
44.2	698.1	10 20		18A												
45		29	18	18B			Dense gray SANDY SILT (A-4a), some fine to coarse sand, trace gravel; moist.									
47.0	695.3															
							Very dense gray GRAVEL WITH SAND (A-1-b), trace silt; wet.									
		19 37 50/3	15	19			@ 48.5', 6 inches sand heave.		21	48	---	27	--4--		NP	50+
50	692.3															

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-029 | *Location:* Sta. 740+41.62, 85.96 ft Rt. of I-70 CL | *Date Drilled:* 7/9/2008 to 7/14/2008

WATER OBSERVATIONS:
Water seepage at: 21.0'-25.0',30.0'-32.0',40.0'-110.0'
Water level at completion: 29.4' (beginning of shift, 7/10/08) 20.5' (includes drilling water)

FIELD NOTES: *Advanced boring using 3.25" diameter hollowstem augers.*

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - PL — LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	692.3						Very dense gray GRAVEL WITH SAND (A-1-b), trace silt; wet.								
55		10 16 50/5	13	20			@ 53.5', 1.7 feet sand heave; washed out.								50+
57.0	685.3														
							Very dense gray COARSE AND FINE SAND (A-3a), little to some silt, trace to little gravel; wet.								
60		31 50/5	11	21			@ 58.5'-68.5', three to six inches sand heave.								50+
65		21 50/5	11	22					18	13	---	52	--17--		NP 50+
70		13 29 41	14	23											71
73.8	668.5	25		24A		3.75									
75	667.3	38 50/6	18	24B			Very stiff gray SILT (A-4b), little fine sand; moist.								50+

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-029 | *Location:* Sta. 740+41.62, 85.96 ft Rt. of I-70 CL | *Date Drilled:* 7/9/2008 to 7/14/2008

WATER OBSERVATIONS:
Water seepage at: 21.0'-25.0',30.0'-32.0',40.0'-110.0'
Water level at completion: 29.4' (beginning of shift, 7/10/08)
20.5' (includes drilling water)

FIELD NOTES: *Advanced boring using 3.25" diameter hollowstem augers.*

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	667.3						Stiff gray SILT AND CLAY (A-6a), some to "and" fine to coarse sand, trace to little gravel; damp to moist.								
		50/4	4	25		1.5			25	20	---	18	26	11	50+
80															
84.0	658.3	31		26A											
		31 50/3	15	26B		4.5+	Very dense gray GRAVEL WITH SAND (A-1-b), trace silt; wet.								50+
85															
		15 50/4	10	27											50+
90															
		13 26 30	18	28					31	48	---	18	--2--		NP 57
95															
		41 50/2	8	29			@ 98.5', 1.2 feet sand heave.								50+
100	642.3														

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-029 | *Location:* Sta. 740+41.62, 85.96 ft Rt. of I-70 CL | *Date Drilled:* 7/9/2008 to 7/14/2008

WATER OBSERVATIONS:
Water seepage at: 21.0'-25.0',30.0'-32.0',40.0'-110.0'
Water level at completion: 29.4' (beginning of shift, 7/10/08)
20.5' (includes drilling water)

FIELD NOTES: Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	642.3						Very dense gray FINE SAND (A-3), little coarse sand, trace gravel; wet.								
105		2 12 49	18	30			@ 103.5', 2.3 feet sand heave.		3	13	---	76	--8--		NP ● 62 ○
110		41 50/0	6	31			@ 113.5', 22 feet sand heave; washed out.								50+ ○
113.5	628.8														
115		50/2	2	32			Severely weathered gray SHALE.								50+ ○
116.5	625.8														
120		Core 42"	Rec 38"	RQD 0%	R-1		Shale, dark gray, moderately to highly weathered, weak, thinly laminated, calcareous, pyritic, fissile, friable, jointed, fractured, tight, slightly rough; RQD 0%, Loss 10%.								
120.6	621.7														
125	617.3	Core 60"	Rec 60"	RQD 88%	R-2		Limestone, brownish-gray, moderately weathered, moderately strong to strong, very thinly bedded, pyritic, cherty, moderately fractured, tight, slightly rough, RQD 86%, Loss 0%. [Delaware Limestone] @ 121.2' - 121.5', qu = 14,137 psi								

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-029 | *Location:* Sta. 740+41.62, 85.96 ft Rt. of I-70 CL | *Date Drilled:* 7/9/2008 to 7/14/2008

WATER OBSERVATIONS:
Water seepage at: 21.0'-25.0',30.0'-32.0',40.0'-110.0'
Water level at completion: 29.4' (beginning of shift, 7/10/08) 20.5' (includes drilling water)

FIELD NOTES: *Advanced boring using 3.25" diameter hollowstem augers.*

Depth (ft)	Elev. (ft) 617.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
		Core 60"	Rec 60"	RQD 85%	R-3		Limestone, brownish-gray, moderately weathered, moderately strong to strong, very thinly bedded, pyritic, cherty, moderately fractured, tight, slightly rough, RQD 86%, Loss 0%. [Delaware Limestone]								
130.2	612.1														
		Core 60"	Rec 54"	RQD 76%	R-4		Limestone, light gray, slightly weathered, strong, thinly bedded, slightly fossiliferous, stylolitic, slightly fractured, tight to narrow, slightly rough, RQD 82%, Loss 8%. [Columbus Limestone]								
135															
		Core 18"	Rec 18"	RQD 100%	R-5										
136.5	605.8						Bottom of Boring - 136.5'								
140															
145															
150															

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

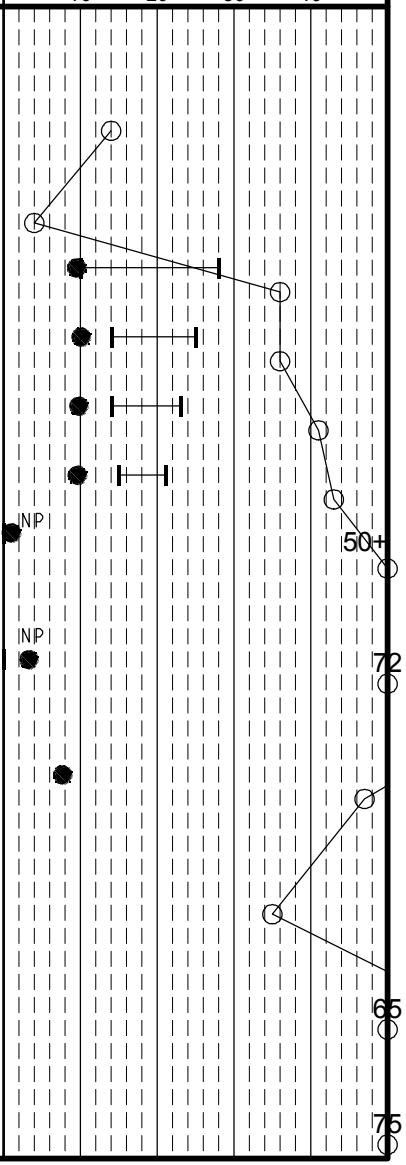
LOG OF: Boring B-030 | *Location:* Sta. 743+00.05, 64.213 ft Lt. of I-70 CL | *Date Drilled:* 7/20/2008 to 7/23/2008

WATER OBSERVATIONS:
Water seepage at: 16.0'
Water level at completion: 13.6' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	736.7													
1.4	735.3						Asphalt Concrete - 11" Aggregate Base - 6"							
		4 6 8	11	1		--	Loose to medium dense brown GRAVEL WITH SAND (A-1-b), some fine to coarse sand, little silt; damp.							
5.0	731.7	3 3 1	8	2		--								
6.5	730.2	4 14 21	18	3		4.5+	Hard gray SILTY CLAY (A-6b), some fine to coarse sand, trace to little gravel; contains few rock fragments; damp to moist.		9	9	---	14	40	28
8.0	728.7	10 16 19	18	4		4.5+	Hard gray SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; damp.		6	10	---	14	40	29
		13 19 21	18	5		4.5+	Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace gravel; damp.		5	11	---	18	41	25
11.0	725.7	11 15 27	18	6		4.5+								
		16 50/5	8	7			Dense to very dense gray GRAVEL (A-1-a), little to some fine to coarse sand, trace to little silty clay; damp.		71	12	---	5	--12--	
		11 33 38	13	8					59	21	---	8	--12--	
		18 23 23	13	9			@ 16.0', becomes wet.		61	20	---	8	--11--	
		12 13 21	12	10										
		13 28 36	12	11										
23.5	713.2													
	711.7	17 34 40	14	12			Very dense gray FINE SAND (A-3), some silty clay, trace coarse sand; wet.							

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-030 | *Location:* Sta. 743+00.05, 64.213 ft Lt. of I-70 CL | *Date Drilled:* 7/20/2008 to 7/23/2008

WATER OBSERVATIONS:
Water seepage at: 16.0'
Water level at completion: 13.6' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	711.7														
		23 45 50/4	15	13			Very dense gray FINE SAND (A-3), some silty clay, trace coarse sand; wet.								50+
							@ 26.0', 0.4 feet sand heave.								
		9 21 31	16	14											53
30															
		14 30 45	16	15					0	8	---	69	--23--		77
35															
		50/4	4	16			@ 38.5'-38.8', contains sandy silt seams.								50+
40							@ 38.5'-43.5', difficult drilling.								
		11 32 50/5	17	17			@ 43.5', 1.9 feet sand heave.								50+
45															
47.0	689.7														
		12 50/5	10	18			Very dense gray COARSE AND FINE SAND (A-3a), little gravel, trace silty clay; wet.		15	54	---	23	--8--		50+
50	686.7														

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-030 | *Location:* Sta. 743+00.05, 64.213 ft Lt. of I-70 CL | *Date Drilled:* 7/20/2008 to 7/23/2008

WATER OBSERVATIONS:
Water seepage at: 16.0'
Water level at completion: 13.6' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	686.7						Very dense gray COARSE AND FINE SAND (A-3a), little gravel, little to some silty clay; wet.								
55		41 50/6	10	19			@ 53.5', 0.7 feet sand heave.								50+
60		24 39 45	13	20											86
62.0	674.7														
							Very dense gray FINE SAND (A-3), trace silt, trace gravel; wet.								
65		16 31 41	15	21											73
67.0	669.7														
							Very dense gray GRAVEL WITH SAND (A-1-b), trace to little silty clay; wet.		49	29	---	13	--9--		
70		33 50/5	9	22											50+
75	661.7	43 50/3	9	23											50+

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-030 | *Location:* Sta. 743+00.05, 64.213 ft Lt. of I-70 CL | *Date Drilled:* 7/20/2008 to 7/23/2008

WATER OBSERVATIONS:
Water seepage at: 16.0'
Water level at completion: 13.6' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	661.7						Very dense gray GRAVEL WITH SAND (A-1-b), trace to little silty clay; wet.								
80		35 50/5	10	24			@ 78.5', 1.0 foot sand heave.								50+
85		21 47 47	13	25			@ 83.5', 4.6 feet sand heave.		15	39	---	33	--13--		96
90		15 23 46	9	26											70
95		37 50/3	9	27											50+
100	636.7	38 50/5	7	28											50+

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-030 | *Location:* Sta. 743+00.05, 64.213 ft Lt. of I-70 CL | *Date Drilled:* 7/20/2008 to 7/23/2008

WATER OBSERVATIONS:
Water seepage at: 16.0'
Water level at completion: 13.6' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	636.7														
103.5	633.2						Very dense gray GRAVEL WITH SAND (A-1-b), trace to little silty clay; wet. @ 100.0'-103.5', 25.0 to 27.3 feet sand heave; washed out twice.								
		50/3	3	29			Severely weathered gray SHALE.								50+
105.0 105	631.7														
		Core 60"	Rec 57"	RQD 37%	R1		Shale, dark gray, highly weathered, weak, laminated, slightly calcareous, contains abundant pyritic inclusions, fissile, laminated, fractured to highly fractured, RQD 38%, Loss 4%. @ 107.7'-107.8', encounterd large pyritic inclusion. @ 108.1'-109.1', moderately weathered, moderately strong.								
110															
111.0	625.7	Core 12"	Rec 12"	RQD 42%	R2		@ 111.0', core steel damaged. Abandoned boring at 111.0'.								
							Bottom of Boring - 111.0'								
115															
120															
125															

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

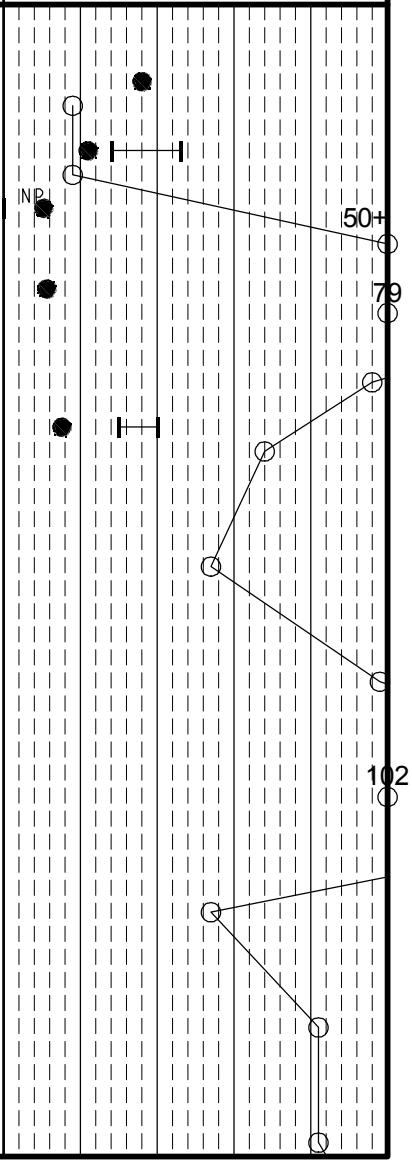
LOG OF: Boring B-031 | *Location:* Sta. 745+02.00, 72.77 ft Rt. of I-70 CL | *Date Drilled:* 7/7/2008 to 7/8/2008

WATER OBSERVATIONS:
Water seepage at: 9.5'
Water level at completion: 8.3' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.7	734.9						Topsoil - 8"							
		2 4 5	18	1		3.75	FILL: Very stiff to hard brown SANDY SILT (A-4a), little fine to coarse sand, trace to little gravel; contains few brick and coal fragments; damp.							
4.0	731.6	3 4 5	18	2		4.5+			12	5	---	6	52	25
5		16 50/5	5	3			Dense to very dense brownish gray GRAVEL WITH SAND (A-1-b), little silt; damp.		50	20	---	13	--17--	
		42 44 31	1	4			@ 5.0', encountered refusal; offset boring approx. three feet west.							
8.5	727.1	18 21 25	1	5			@ 5.5'-8.5', rock fragments; possible cobble blocking shoe.							
9.5	726.1	9 15 17	18	6A		4.5	Hard gray SANDY SILT (A-4a), trace to little gravel; damp.		15	12	---	25	32	16
10				6B			Medium dense to dense gray SILT (A-4b), some fine sand; wet.							
		4 12 14	18	7										
13.5	722.1													
15		18 22 25	12	8		4.5+	Very stiff to hard gray SANDY SILT (A-4a), some fine to coarse sand, little gravel; damp.							
		14 48 49	18	9		3.5								
18.5	717.1													
20		11 13 13	18	10			Medium dense gray SILT (A-4b), trace fine sand; moist.							
21.0	714.6													
		7 18 21	18	11			Dense gray COARSE AND FINE SAND (A-3a), some silt; wet.							
23.5	712.1													
25	710.6	12 18 21	18	12		4.5+	Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace gravel; damp.							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢——⊣ *LL*
Blows per foot - ○ / *Non-Plastic -* NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-031 | *Location:* Sta. 745+02.00, 72.77 ft Rt. of I-70 CL | *Date Drilled:* 7/7/2008 to 7/8/2008

WATER OBSERVATIONS:
Water seepage at: 9.5'
Water level at completion: 8.3' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % -
	710.6														PL — LL; Blows per foot - ○ / Non-Plastic - NP; 10 20 30 40
		20 50/5	10	13		4.5+	Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace to little gravel; damp.								50+
28.0	707.6														
		50/5	5	14			Very dense gray SANDY SILT (A-4a), some fine to coarse sand, trace to little gravel; wet.								50+
30															
							@ 28.5'-38.9', possible cobbles.								
		24 49 48	18	15											102
35															
		50/5	5	16											50+
40															
42.0	693.6														
		11 13 18	18	17			Dense gray FINE SAND (A-3), trace silt; wet.								
45															
47.0	688.6														
		16 33 41	18	18			Very dense gray COARSE AND FINE SAND (A-3a), little silt, little gravel; wet. @ 48.5', ten feet sand heave; triconed and washed out.								78
50	685.6														

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-031 | *Location:* Sta. 745+02.00, 72.77 ft Rt. of I-70 CL | *Date Drilled:* 7/7/2008 to 7/8/2008

WATER OBSERVATIONS:
Water seepage at: 9.5'
Water level at completion: 8.3' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	685.6						Very dense gray COARSE AND FINE SAND (A-3a), trace to little gravel, trace silt; wet.								
55		25 33 40	18	19											77 ○
60.0 60	675.6	38 42 49	18	20											96 ○
							Bottom of Boring - 60.0'								
65															
70															
75															

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

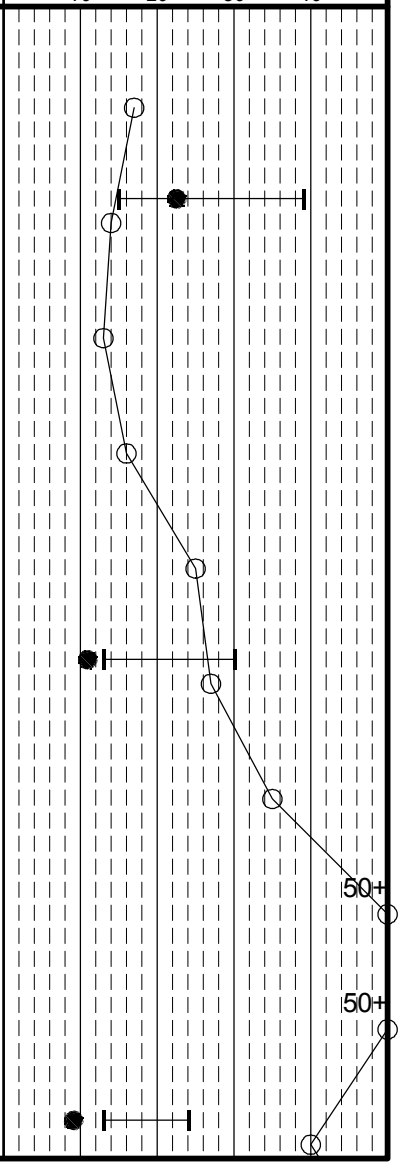
LOG OF: Boring B-032 | *Location:* Sta. 745+06.78, 119.69 ft Rt. of I-70 CL | *Date Drilled:* 7/8/2008 to 7/15/2008

WATER OBSERVATIONS:
Water seepage at: 47.0'
Water level at completion: 25.7' (includes drilling water)

FIELD NOTES:
3.25" diameter hollowstem augers to 120.5';
4.0" diameter flush joint casing from 120.5' to 128.5'.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	751.4													
1.1	750.3						Asphalt Concrete - 5" Portland Cement Concrete - 3"							
2.0	749.4	5 10 6	9	1		4.5+	Aggregate Base - 5"							
							FILL: Medium dense brown COARSE AND FINE SAND (A-3a), little silt, little gravel; moist.							
5		5 7 6	18	2		2.0	FILL: Very stiff to hard brown SILTY CLAY (A-6b), little to some fine to coarse sand, trace gravel; contains few brick fragments; damp to moist.		8	7	---	13	29	43
6.0	745.4													
		3 4 8	3	3		2.5	Very stiff brown SILT AND CLAY (A-6a), little fine to coarse sand, trace gravel; moist.							
8.5	742.9													
10		4 7 8	3	4			Medium dense gray COARSE AND FINE SAND (A-3a), little silt, little gravel; damp. (POSSIBLE FOUNDRY SAND)							
11.0	740.4													
		5 8 16	18	5		4.5+	Hard gray SILTY CLAY (A-6b), little to some fine to coarse sand, trace to little gravel; damp. @ 11.0'-12.5', brown and gray.							
15		12 12 14	18	6		4.5+			12	8	---	15	38	27
							@ 13.0'-35.0', difficult drilling; possible cobbles and boulders.							
		5 16 17	1	7		--								
		50/1	0	8		--	@ 18.5'-20.0', only gravel recovered in auger cuttings sample.							
20														
		50/3	0	9		--								
23.5	727.9													
25	726.4	34 17 21	18	10		4.5+	Hard gray SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; damp.		7	14	---	20	37	22

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-032 | *Location:* Sta. 745+06.78, 119.69 ft Rt. of I-70 CL | *Date Drilled:* 7/8/2008 to 7/15/2008

WATER OBSERVATIONS:
Water seepage at: 47.0'
Water level at completion: 25.7' (includes drilling water)

FIELD NOTES:
3.25" diameter hollowstem augers to 120.5';
4.0" diameter flush joint casing from 120.5' to 128.5'.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	726.4														
		50/1	1	11		--	Hard gray SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; damp.								50+
		50/4	0	12		--									50+
30		50/1	0	13		--									50+
		50/3	1	14		--									50+
35															
36.0	715.4														
		10 24 45	18	15		4.5+	Hard gray SANDY SILT (A-4a), some to "and" fine to coarse sand, little gravel; damp.		16	20	---	23	26	15	73
		11 17 28	18	16		4.5+									
40															
		11 50/4	10	17		4.5+									50+
45															
		32 50/3	9	18		4.5+	@ 48.5'-49.3', contains occasional thin sand seams.								50+
50	701.4														

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-032 | *Location:* Sta. 745+06.78, 119.69 ft Rt. of I-70 CL | *Date Drilled:* 7/8/2008 to 7/15/2008

WATER OBSERVATIONS:
Water seepage at: 47.0'
Water level at completion: 25.7' (includes drilling water)

FIELD NOTES:
3.25" diameter hollowstem augers to 120.5';
4.0" diameter flush joint casing from 120.5' to 128.5'.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ ○ / Non-Plastic - NP ⊣ LL Blows per foot - 10 20 30 40
	701.4						Very dense gray FINE SAND (A-3); contains silty clay seams; wet.								
		26 50/3	9	19			@ 53.5', 1.5 feet sand heave; used tricone bit to wash out.								50+ ○
55															
57.0	694.4														
							Very dense gray GRAVEL WITH SAND (A-1-b), trace silt; contains silty clay seams; wet.								
		18 50/4	10	20					42	30	---	20	--9--		NP ● 50+ ○
60															
		28 50/3	9	21											50+ ○
65															
		16 42 50/3	15	22											50+ ○
70															
		33 50/5	11	23											50+ ○
75	676.4														

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-032 | *Location:* Sta. 745+06.78, 119.69 ft Rt. of I-70 CL | *Date Drilled:* 7/8/2008 to 7/15/2008

WATER OBSERVATIONS:
Water seepage at: 47.0'
Water level at completion: 25.7' (includes drilling water)

FIELD NOTES:
3.25" diameter hollowstem augers to 120.5';
4.0" diameter flush joint casing from 120.5' to 128.5'.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	676.4						Very dense gray COARSE AND FINE SAND (A-3a), trace to little silt, trace to little gravel; wet.								
		17 50/4	10	24											50+
80															
		17 41 49	18	25					10	15	---	62	--13--		NP 95
85															
		17 49 50/3	15	26			@ 88.5'-90.0', few limestone fragments.								50+
90															
		20 50/4	8	27											50+
95															
		17 50/4	10	28											50+
100	651.4														

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-032 | *Location:* Sta. 745+06.78, 119.69 ft Rt. of I-70 CL | *Date Drilled:* 7/8/2008 to 7/15/2008

WATER OBSERVATIONS:
Water seepage at: 47.0'
Water level at completion: 25.7' (includes drilling water)

FIELD NOTES:
3.25" diameter hollowstem augers to 120.5';
4.0" diameter flush joint casing from 120.5' to 128.5'.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - PL / LL, Blows per foot - / Non-Plastic - NP (10 20 30 40)
	651.4						Very dense gray GRAVEL WITH SAND (A-1-b), trace silt; wet.								
105		5 37 50/3	15	29											50+
		27 50/4	10	30					38	43	---	13	--6--		NP, 50+
110															
		50/5	5	31			@ 113.5'-113.9', possible cobbles.								50+
115															
117.0	634.4														
							Very dense gray GRAVEL (A-1-a), "and" fine to coarse sand, trace silt; wet.								
		22 50/4	10	32					55	24	---	14	--7--		NP, 50+
120.0 120	631.4														
120.5	630.9	50/3	3	33			Severely weathered gray SHALE.								50+
		Core 60"	Rec 22"	RQD 8%	R1		Shale, dark gray, highly to severely weathered, very weak to weak, laminated, calcareous, friable, fissile, pyritic, jointed, fractured to highly fractured, tight, slightly rough; RQD 5% Loss 53%.								
125	626.4														

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-032 | *Location:* Sta. 745+06.78, 119.69 ft Rt. of I-70 CL | *Date Drilled:* 7/8/2008 to 7/15/2008

WATER OBSERVATIONS:
Water seepage at: 47.0'
Water level at completion: 25.7' (includes drilling water)

FIELD NOTES:
3.25" diameter hollowstem augers to 120.5';
4.0" diameter flush joint casing from 120.5' to 128.5'.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	626.4														
		Core 36"	Rec 23"	RQD 0%	R2		Shale, dark gray, highly to severely weathered, very weak to weak, laminated, calcareous, friable, fissile, pyritic, jointed, fractured to highly fractured, tight, slightly rough; RQD 5% Loss 53%.								
128.5	622.9						@ 125.2' - 125.5', encountered thin limestone layer. @ 128.5', boring terminated due to difficult coring conditions (core steel broke off during both core runs).								
							Bottom of Boring - 128.5'								
130															
135															
140															
145															
150															

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-034 | *Location:* Sta. 752+71.04, 96.62 ft Lt. of I-70 CL | *Date Drilled:* 8/7/2008 to 8/14/2008

WATER OBSERVATIONS:
Water seepage at: 5.5', 10.5', 20.5', 25.5', 62.0'
Water level at completion: 43.3' (measured inside casing)
At beginning of shift: 8/8 28.5, BOH 45.0'
FIELD NOTES: Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft) 751.5	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - ●
0.3	751.2						Topsoil - 3"								
		19 35 14	8	1			Brick Fragments								52
3.5	748.0														
5		5 7 9	3	2		1.5	FILL: Stiff brown SANDY SILT (A-4a), little fine to coarse sand, little gravel; contains numerous 1/8"-1/4" size brick fragments; moist.								
6.0	745.5														
		2 5 6	16	3			FILL: Medium dense brown GRAVEL WITH SAND (A-1-b), little silt; contains numerous 1/8"-1/4" size brick fragments; wet.		41	32	---	12	--15--		NP ●
8.5	743.0														
10		2 4 WOH	8	4			Brick Fragments								
11.0	740.5														
		4 6 20	10	5		1.75	FILL: Stiff brown and gray SANDY SILT (A-4a), some fine to coarse sand, some gravel; contains brick and rock fragments; moist.								
15		15 25 27	18	6		--									55
16.0	735.5														
		6 2 4	6	7			FILL: Loose brown GRAVEL WITH SAND (A-1-b), little silt; contains few 1/8'-1/2' size brick fragments; wet.								
18.5	733.0														
20		11 13 16	13	8		4.5+	Hard gray SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; contains few 1/8'-1/2' size brick fragments; damp.								
21.0	730.5														
		28 45 50/5	2	9			Very dense gray GRAVEL WITH SAND (A-1-b), trace silt; possible cobbles; wet.								50+
23.5	728.0														
25	726.5	13 23 49	2	10		4.5+	Hard gray SANDY SILT (A-4a), some fine to coarse sand, little gravel; damp.								● 76

PL ⊢——⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-034 | *Location:* Sta. 752+71.04, 96.62 ft Lt. of I-70 CL | *Date Drilled:* 8/7/2008 to 8/14/2008

WATER OBSERVATIONS:
Water seepage at: 5.5', 10.5', 20.5', 25.5', 62.0'
Water level at completion: 43.3' (measured inside casing)
At beginning of shift: 8/8 28.5, BOH 45.0'

FIELD NOTES: *Advanced boring using 4.0" diameter flush joint casing.*

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	726.5														
		6 11 14	12	11			Medium dense gray GRAVEL (A-1-a), little to some fine to coarse sand, trace silt; contains few brick fragments (likely picked up at higher elevation); wet.		74	15	---	6	--5--		NP
28.5	723.0														
30		19 50/5	6	12			Very dense gray GRAVEL WITH SAND (A-1-b), little silt; wet.		36	34	---	15	--15--		NP 50+
31.0	720.5														
		6 4 4	18	13			Very loose to loose gray GRAVEL (A-1-a), little fine to coarse sand, trace silt; contains few brick fragments (likely picked up at higher elevation); wet.		81	12	---	4	--3--		NP
33.5	718.0														
35		19 30 26	18	14			Very dense gray GRAVEL WITH SAND (A-1-b), trace to little silt; wet.		33	30	---	21	--16--		NP 59
		8 11 26	14	15			@ 36.0'-37.5', contains 3/4"x1-1/2" steel fragment - possible conduit fragment (likely picked up at higher elevation); wet.								
38.5	713.0														
40		16 35 41	18	16			Very dense gray SILT (A-4b), trace silt, trace clay; contains occasional sand seams; wet.								80
41.0	710.5														
		8 8 9	18	17			Medium dense gray GRAVEL (A-1-a), little fine to coarse sand; wet.		87	9	---	3	--1--		NP
							@ 43.5'-44.0', fine sand seam.								
44.0	707.5	18													
45		25 30	18	18		<0.25	Very soft gray SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; wet.								58
47.0	704.5														
							Very dense gray GRAVEL (A-1-a), some fine to coarse sand; wet.								
		8 28 50/5	8	19											50+
50	701.5														

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-034 | *Location:* Sta. 752+71.04, 96.62 ft Lt. of I-70 CL | *Date Drilled:* 8/7/2008 to 8/14/2008

WATER OBSERVATIONS:
Water seepage at: 5.5', 10.5', 20.5', 25.5', 62.0'
Water level at completion: 43.3' (measured inside casing)
At beginning of shift: 8/8 28.5, BOH 45.0'
FIELD NOTES: Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	701.5						Very stiff to hard gray SANDY SILT (A-4a), some to "and" fine to coarse sand, trace gravel; damp.								
55		20 18 18	8	20		3.75			5	14	---	21	46	14	
		50/2	2	21		4.5+	@ 58.5'-62.0', possible cobbles.								50+
60															
62.0	689.5														
							Boulder/cobble fragments.								
		50/5	3	22											50+
65															
67.0	684.5														
							Very dense gray GRAVEL WITH SAND (A-1-b), some fine to coarse sand, little silt; possible cobbles; wet.								
		50/2	2	23											50+
70															
72.0	679.5														
							Very dense gray COARSE AND FINE SAND (A-3a), little gravel, trace silt; possible cobbles; wet.								
		37 50/5	9	24											50+
75	676.5														

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-034 | *Location:* Sta. 752+71.04, 96.62 ft Lt. of I-70 CL | *Date Drilled:* 8/7/2008 to 8/14/2008

WATER OBSERVATIONS:
Water seepage at: 5.5', 10.5', 20.5', 25.5', 62.0'
Water level at completion: 43.3' (measured inside casing)
At beginning of shift: 8/8 28.5, BOH 45.0'
FIELD NOTES: Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	676.5														
		25 38 50/5	15	25			Very dense gray GRAVEL WITH SAND (A-1-b), some silt; moist.		28	31	---	9	--32--		NP ● 50+ ○
80															
		21 32 47	18	26											83 ○
85															
87.0	664.5														
		22 35 50/5	17	27			Very dense gray SANDY SILT (A-4a), some gravel; moist.								50+ ○
90															
92.0	659.5														
		35 50/5	9	28			Very dense gray GRAVEL WITH SAND (A-1-b), "and" fine to coarse sand, little silt; wet.								50+ ○
95															
97.0	654.5														
		50/5	5	29		3.25	Very stiff gray SANDY SILT (A-4a), some fine to coarse sand, some gravel; possible cobbles; moist.								50+ ○
100	651.5														

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-034 | *Location:* Sta. 752+71.04, 96.62 ft Lt. of I-70 CL | *Date Drilled:* 8/7/2008 to 8/14/2008

WATER OBSERVATIONS:
Water seepage at: 5.5', 10.5', 20.5', 25.5', 62.0'
Water level at completion: 43.3' (measured inside casing)
At beginning of shift: 8/8 28.5, BOH 45.0'
FIELD NOTES: Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - ○ / Non-Plastic - NP
	651.5						Very dense gray GRAVEL WITH SAND (A-1-b), little to some silt; wet.								
							@ 100.0'-105.0', possible cobbles.								
105		37 50/5	6	30											50+
		30 33 33	18	31					25	47	---	16	--12--		NP 69
110															
		23 42 50/3	12	32											50+
115.0 115	636.5														
115.5	636.0	50/3	3	33			Severely weathered gray SHALE.								50+
		Core 60"	Rec 39"	RQD 55%	R-1		Shale, dark gray, highly to severely weathered, weak, thinly laminated, fissile, calcareous, pyritic, jointed, fractured, tight, slightly rough, RQD 69%, Loss 12%. Contains occasional large (up to 1" diameter) pyritic inclusion. @ 116.6'-117.0', encountered thin limestone bed. @ 117.5'-119.2', 121.1'-121.7', possible lost recovery.								
120															
		Core 60"	Rec 53"	RQD 77%	R-2		@ 121.7', moderately fractured, highly weathered.								
125	626.5														

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-034 | *Location:* Sta. 752+71.04, 96.62 ft Lt. of I-70 CL | *Date Drilled:* 8/7/2008 to 8/14/2008

WATER OBSERVATIONS:
Water seepage at: 5.5', 10.5', 20.5', 25.5', 62.0'
Water level at completion: 43.3' (measured inside casing)
At beginning of shift: 8/8 28.5, BOH 45.0'
FIELD NOTES: Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	626.5														
130		Core 60"	Rec 60"	RQD 57%	R-3		Shale, dark gray, highly to severely weathered, weak, thinly laminated, fissile, calcareous, pyritic, jointed, fractured, tight, slightly rough, RQD 69%, Loss 12%. Contains occasional large (up to 1" diameter) pyritic inclusion. @ 126.7'-127.2', 129.8'-130.4', 131.1'-131.5', high angle fractures. @ 130.0' -130.3', qu = 3978 psi								
135		Core 60"	Rec 60"	RQD 85%	R-4		@ 133.5'-133.7', encountered thin limestone bed.								
135.5	616.0						Bottom of Boring - 135.5'								
140															
145															
150															

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-035 | *Location:* Sta. 752+66.77, 72.74 ft Rt. of I-70 CL | *Date Drilled:* 7/7/2008

WATER OBSERVATIONS:
Water seepage at: 9.2'-15.0'
Water level at completion: 9.2'

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft) 732.3	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
							Asphalt Concrete Pavement - 8" Portland Cement Concrete - 10" Aggregate Base - 3"								
1.8	730.5	7 15 26	15	1			Dense brown FINE SAND (A-3), trace silt, trace gravel; contains silty clay seams; damp.								
3.0	729.3	9 25 26	15	2			Very dense brown GRAVEL WITH SAND (A-1-b), trace to little silt; damp.								53
5		10 25 27	15	3					37	36	---	17	--10--		NP 54
6.0	726.3	5 14 18	13	4			Dense to very dense brown FINE SAND (A-3), trace to little gravel; damp.		12	20	---	60	--8--		
7.5	724.8	10 24 27	13	5			Dense to very dense brown GRAVEL WITH SAND (A-1-b), trace to little silt; wet.		49	28	---	15	--9--		NP 53
10		11 22 25	13	6					34	36	---	20	--10--		NP
		12 23 27	15	7											52
15.0	717.3	10 22 34	13	8											58
20							Bottom of Boring - 15.0'								
25															

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-036 | *Location:* Sta. 755+56.04, 101.17 ft Rt. of I-70 CL | *Date Drilled:* 7/14/2008 to 7/16/2008

WATER OBSERVATIONS:
Water seepage at: 14.0'
Water level at completion: 11.8' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	734.7						Asphalt Concrete - 9.5" Portland Cement Concrete - 11" Aggregate Base - 4"								
2.0	732.7	16 22 27	13	1			Dense to very dense brown GRAVEL WITH SAND (A-1-b), trace to little silt; damp to moist.								
		20 24 25	13	2											
5		12 15 23	14	3					17	43	---	23	--17--		NP
		14 24 38	14	4					22	44	---	21	--12--		NP 63
		16 23 25	14	5					32	36	---	20	--12--		NP
10		19 32 34	15	6					36	34	---	17	--13--		NP 67
11.0	723.7	10 25 26	15	7			Very dense brown COARSE AND FINE SAND (A-3a), little silt, trace gravel; moist.		1	41	---	44	--14--		NP 52
12.5	722.2	17 29 31	16	8			Dense to very dense brown GRAVEL WITH SAND (A-1-b), little silt; moist to wet.								61
15		4 22 27	14	9			@ 14.0', becomes wet.								
		6 18 21	15	10											
		9 20 21	13	11											
		28 32 50/5	14	12					37	31	---	16	--16--		NP 50+
20															
		17 30 35	12	13											66
		18 28 29	13	14											58
25	709.7														

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-036 | *Location:* Sta. 755+56.04, 101.17 ft Rt. of I-70 CL | *Date Drilled:* 7/14/2008 to 7/16/2008

WATER OBSERVATIONS:
Water seepage at: 14.0'
Water level at completion: 11.8' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	709.7														
		19 32 33	18	15			Very dense brown COARSE AND FINE SAND (A-3a), little silt, trace to little gravel; wet.								66
28.5	706.2														
		14 30 41	14	16		2.5	Stiff to very stiff gray SANDY SILT (A-4a), some to "and" fine to coarse sand, trace to little gravel; moist.		5	12	---	38	42	3	NP 72
30							@ 29.0'-29.5', sandy silt seam.								
		24 42 50/5	14	17		--	@ 33.5'-34.9', contains sand seams.		10	23	---	25	35	7	NP 50+
35															
		29 50/4	10	18		1.0	@ 39.0'-39.3', silt seam.								50+
40															
42.0	692.7														
		17 49 39	14	19			Very dense gray GRAVEL WITH SAND (A-1-b), trace to little silt; wet.		43	33	---	14	--10--		NP 90
45							@ 45.0'-55.0', difficult drilling.								
		23 42 50/5	12	20			@ 48.5', 2.3 feet sand heave.								50+
50	684.7														

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-036 | *Location:* Sta. 755+56.04, 101.17 ft Rt. of I-70 CL | *Date Drilled:* 7/14/2008 to 7/16/2008

WATER OBSERVATIONS:
Water seepage at: 14.0'
Water level at completion: 11.8' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - PL / LL, Blows per foot - Non-Plastic - NP
	684.7						Very dense gray GRAVEL WITH SAND (A-1-b), trace to little silt; wet.								
		45 50/4	9	21			@ 53.5'-54.3', contains silty clay seams.								50+
55															
		19 35 45	12	22					30	38	---	21	--10--		NP 82
60															
		33 50/5	11	23			@ 63.5', 1.9 feet sand heave. @ 63.5'-64.4', brown.								50+
65															
		20 39 50/5	13	24											50+
70															
		35 46 50/6	13	25											50+
75	659.7														

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-036 | *Location:* Sta. 755+56.04, 101.17 ft Rt. of I-70 CL | *Date Drilled:* 7/14/2008 to 7/16/2008

WATER OBSERVATIONS:
Water seepage at: 14.0'
Water level at completion: 11.8' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	659.7						Very dense gray GRAVEL WITH SAND (A-1-b), trace to little silt; wet.								
		49 50/3	8	26			@ 78.5', 0.9 feet sand heave.								50+
80															
		28 46 48	11	27					42	35	---	11	--12--		NP ● 96
85															
		50/1	0	28			@ 88.5'-93.5', encountered boulders.								50+
90															
93.5	641.2														
		27 50/3	8	29			Severely weathered gray SHALE.								50+
94.9	639.8														
95															
96.6	638.1						Shale, blue-gray, highly weathered, very weak to weak, laminated, friable, fissile, pyritic, jointed, moderately fractured to fractured, tight, slightly rough, RQD 100%, Loss 0%. Contains dark gray, well cemented shale zones [thin, dark bands]. Dark shale zones are typically 1-2 inches thick, spaced at intervals of 12 to 18 inches.									
		Core 68"	Rec 68"	RQD 93%	R1										
100	634.7						Interbedded Shale (90%) and Limestone (10%)								

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-036 | *Location:* Sta. 755+56.04, 101.17 ft Rt. of I-70 CL | *Date Drilled:* 7/14/2008 to 7/16/2008

WATER OBSERVATIONS:
Water seepage at: 14.0'
Water level at completion: 11.8' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	634.7														
105		Core 60"	Rec 60"	RQD 83%	R2		Interbedded Shale (90%) and Limestone (10%) RQD 74% Loss 0%; Shale, dark gray, highly weathered, weak, laminated, friable, fissile, pyritic, jointed, moderately fractured to fractured, tight, slightly rough; Limestone, gray, moderately weathered, strong, thinly bedded, pyritic, slightly rough. @ 103.7' - 104.2', qu = 1442 psi								
110		Core 60"	Rec 60"	RQD 60%	R3										
115		Core 60"	Rec 60"	RQD 68%	R4										
115.6	619.1						Bottom of Boring - 115.6'								
120															
125															

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-037 | *Location:* Sta. 756+80.53, 69.18 ft Lt. of I-70 CL | *Date Drilled:* 7/21/2008 to 7/24/2008

WATER OBSERVATIONS:
Water seepage at: 21.0', 25.4', 33.0', 40.5'
Water level at completion: 25.6' (prior to coring), 51.6' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	749.1													
1.8	747.3	5 13 16	0	1		--	Asphalt Concrete - 6.5" Portland Cement Concrete - 9.5" Aggregate Base - 5" Stiff brown and gray SANDY SILT (A-4a), some fine to coarse sand, some gravel; increased moisture content due to pavement coring; moist to wet.							
		9 13 14	5	2		1.75			29	15	---	17	24	15
5														
		6 10 14	1	3		--								
8.5	740.6													
		3 8 12	2	4		--	Very stiff gray SILT AND CLAY (A-6a), little to some fine to coarse sand, little gravel; damp to moist.							
10														
		4 35 25	18	5		3.75								
13.5	735.6													
		10 16 16	2	6		4.25	Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace gravel; damp.							
15														
		10 11 12	1	7		--								
		7 12 21	18	8		4.5+			8	11	---	22	40	19
20.0	729.1	20												
		10 21 22	5	9		0.75	Hard gray SILT AND CLAY (A-6a), some fine to coarse sand, little gravel; damp. @ 20.0'-21.5', stiff, wet; possible sand and gravel seam.		18	14	---	20	32	16
		12 24 29	18	10		4.5+			13	12	---	21	36	18
23.0	726.1													
		19 48 50/5	2	11		4.5+	Hard gray SANDY SILT (A-4a), trace to little gravel; contains sand seams; damp.		10	15	---	28	32	15
25	724.1	16												

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

63
56
50+

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-037 | *Location:* Sta. 756+80.53, 69.18 ft Lt. of I-70 CL | *Date Drilled:* 7/21/2008 to 7/24/2008

WATER OBSERVATIONS:
Water seepage at: 21.0', 25.4', 33.0', 40.5'
Water level at completion: 25.6' (prior to coring), 51.6' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - ○ / Non-Plastic - NP
25.4	723.7	24 24	18	12A 12B		4.0	Hard gray SANDY SILT (A-4a), trace to little gravel; damp.								
		16 24 27	1	13			Very dense gray COARSE AND FINE SAND (A-3a), some silt, little gravel; wet.								54
28.5	720.6														
30		14 16 17	18	14		2.5	Very stiff gray SILT AND CLAY (A-6a), some fine to coarse sand, trace to little gravel; damp.								
		5 12 17	18	15		4.0			6	10	---	18	41	25	
33.5	715.6														
35		19 45 50/5	12	16			Very dense gray GRAVEL WITH SAND (A-1-b), little silt; wet.		36	36	---	12	--15--		NP 50+
		16 50/5	5	17			@ 36.0'-36.9', contains cobble fragments.								50+
38.5	710.6														
40		42 50/3	5	18		4.5+	Hard gray SANDY SILT (A-4a), some fine to coarse sand, little gravel; damp.								50+
41.0	708.1														
		31 50/4	10	19			Very dense gray COARSE AND FINE SAND (A-3a), trace to little silt; wet.								50+
45		42 50/5	10	20					0	8	---	75	--17--		NP 50+
		50/3	3	21			@ 48.5'-48.8', possible cobbles.								50+
50	699.1														

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-037 | *Location:* Sta. 756+80.53, 69.18 ft Lt. of I-70 CL | *Date Drilled:* 7/21/2008 to 7/24/2008

WATER OBSERVATIONS:
Water seepage at: 21.0', 25.4', 33.0', 40.5'
Water level at completion: 25.6' (prior to coring), 51.6' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - ○ / Non-Plastic - NP
	699.1						Hard gray SILT (A-4b), little fine to coarse sand, trace gravel; damp.								
		29 50/5	11	22		4.5+			3	3	---	10	63	21	50+
55															
57.0	692.1														
							Very dense gray GRAVEL WITH SAND (A-1-b), some fine to coarse sand, trace silt; wet.								
		25 50/3	3	23			@ 59.0'-75.0', encountered cobbles and boulders.								50+
60															
62.0	687.1														
							Very dense gray COARSE AND FINE SAND (A-3a), little to some silt, little gravel; wet.								
		45 50/5	4	24					17	24	---	39	--20--		NP 50+
65															
		50/3	3	25											50+
70															
		50/4	1	26			@ 73.5'-73.8', drove sampler on gravel; poor recovery.								50+
75	674.1														

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-037 | *Location:* Sta. 756+80.53, 69.18 ft Lt. of I-70 CL | *Date Drilled:* 7/21/2008 to 7/24/2008

WATER OBSERVATIONS:
Water seepage at: 21.0', 25.4', 33.0', 40.5'
Water level at completion: 25.6' (prior to coring), 51.6' (includes drilling water)

FIELD NOTES: *Advanced boring using 3.0" diameter flush joint casing.*

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - PL — LL; Blows per foot - ○ / Non-Plastic - NP
	674.1						Very dense gray COARSE AND FINE SAND (A-3a), little gravel, trace silt; wet.								
		47 50/4	5	27											50+
80							@ 75.0'-100.0', difficult advancement of casing due to gravel and boulders.								
		50/4	1	28											50+
85															
		27 50/5	5	29											50+
90															
92.0	657.1														
							Very dense gray GRAVEL (A-1-a); wet.								
		14 14 34	3	30											
95															50+
		50/4	1	31											
100	649.1														50+

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-037 | *Location:* Sta. 756+80.53, 69.18 ft Lt. of I-70 CL | *Date Drilled:* 7/21/2008 to 7/24/2008

WATER OBSERVATIONS:
Water seepage at: 21.0', 25.4', 33.0', 40.5'
Water level at completion: 25.6' (prior to coring), 51.6' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	649.1						Very stiff to hard gray SILTY CLAY (A-6b), trace fine to coarse sand; moist.							
105		23 32 35	18	32		2.75			0	1	---	3	49	47
108.5	640.6	50/5	5	33		4.5+	Severely weathered gray SHALE.							
110.0 110	639.1	Core 60"	Rec 60"	RQD 60%	R1		Interbedded Shale (92%) and Limestone (8%) RQD 76% LOSS 0%; Shale, dark gray, highly weathered, weak, laminated, calcareous, moderately fractured to fractured; Limestone, light gray, moderately weathered, moderately strong to strong, thinly bedded.							
115		Core 60"	Rec 60"	RQD 83%	R2		@ 110.8'-111.2', 111.7'-111.8', 113.2'-113.5', 119.6'-120.0', 122.9'-123.0', high angle fractures.							
120		Core 60"	Rec 60"	RQD 77%	R3		@ 121.2' - 121.7', qu = 1546 psi @ 122.1'-125.4', highly to severely weathered.							
125	624.1													

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40
70
50+

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-037 | *Location:* Sta. 756+80.53, 69.18 ft Lt. of I-70 CL | *Date Drilled:* 7/21/2008 to 7/24/2008

WATER OBSERVATIONS:
Water seepage at: 21.0', 25.4', 33.0', 40.5'
Water level at completion: 25.6' (prior to coring), 51.6' (includes drilling water)

FIELD NOTES: *Advanced boring using 3.0" diameter flush joint casing.*

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	624.1													
130.0 130	619.1	Core 60"	Rec 60"	RQD 82%	R4		Interbedded Shale (92%) and Limestone (8%) RQD 76% LOSS 0%; Shale, dark gray, highly weathered, weak, laminated, calcareous, moderately fractured to fractured; Limestone, light gray, moderately weathered, moderately strong to strong, thinly bedded. @ 125.9'-126.0', high angle fracture.							
							Bottom of Boring - 130.0'							
135														
140														
145														
150														

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

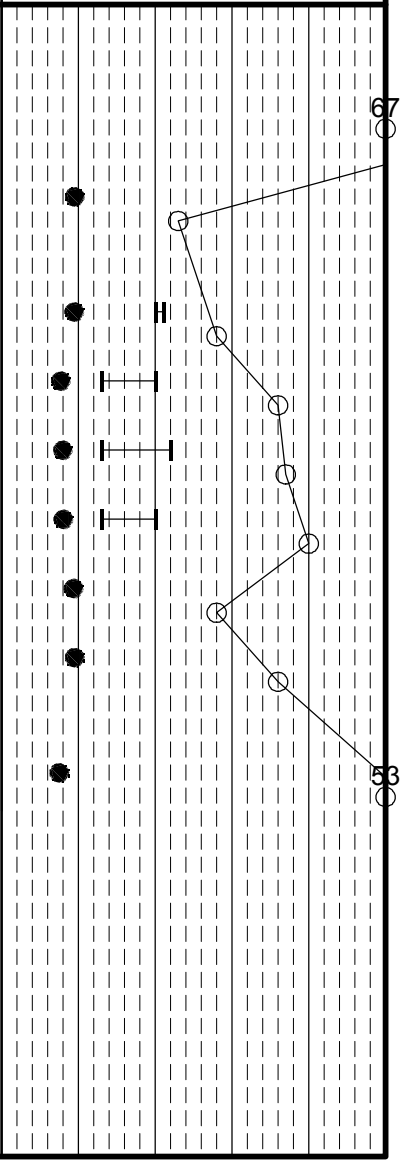
LOG OF: Boring B-039 | *Location:* Sta. 760+57.45, 102.65 ft Rt. of I-70 CL | *Date Drilled:* 7/17/2008

WATER OBSERVATIONS:
Water seepage at: None
Water level at completion: None

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft) 739.5	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
							Asphalt Concrete - 8" Portland Cement Concrete - 8" Aggregate Base - 5"							
1.8	737.7	7 36 30	13	1A 1B		4.5+ 4.5+	Hard gray SANDY SILT (A-4a), little gravel, trace clay; damp. @ 1.8'-3.0', contains concrete fragments.							
5		9 11 12	17	2		4.5+								
		3 12 15	15	3		4.5	@ 7.1', encountered 1-inch thick sand seam.		20	15	---	19	30	16
		11 16 19	18	4		4.5+			17	15	---	25	28	14
10		8 14 22	18	5		4.5+			14	15	---	25	31	15
12.0	727.5	12 18 21	18	6		4.5+			14	16	---	25	28	16
13.5	726.0	7 12 15	13	7A 7B			Medium dense gray COARSE AND FINE SAND (A-3a), some silt, trace gravel; moist.							
15		22 16 19	15	8		4.5+	Hard gray SANDY SILT (A-4a), some fine to coarse sand, little gravel; damp.							
17.5	722.0	7 19 33	16	9		4.5+								
20							Bottom of Boring - 17.5'							
25														

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL ——— LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

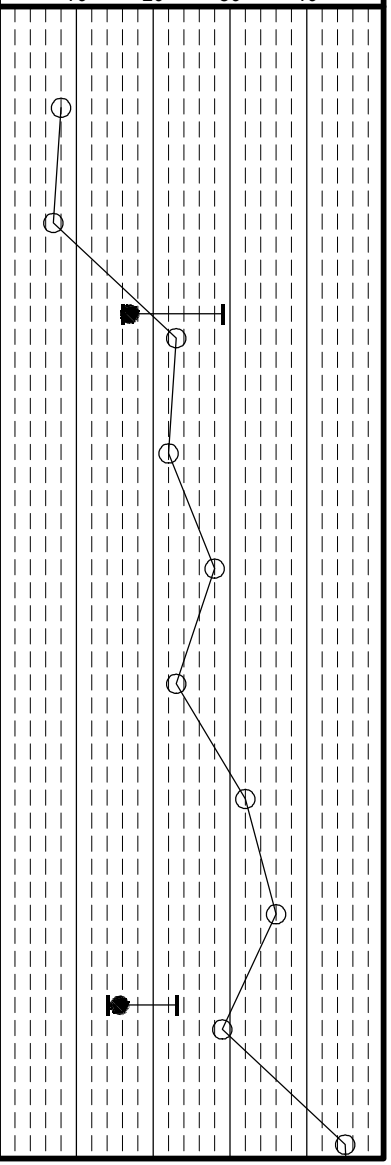
LOG OF: Boring B-040 | *Location:* Sta. 760+61.33, 137.60 ft Rt. of I-70 CL | *Date Drilled:* 8/15/2008 to 8/19/2008

WATER OBSERVATIONS:
Water seepage at: 10.5', 23.0', 47.0'
Water level at completion: 29.7' (beginning of shift, 8/18/08)
29.3' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	758.9													
		5 4 4	10	1		0.75	POSSIBLE FILL: Medium stiff brownish gray SILT AND CLAY (A-6a), little fine to coarse sand, trace gravel; brick fragments coating sample; moist.							
3.5	755.4													
5		4 3 4	1	2		--	Medium stiff brown SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; moist.							
		9 11 11	14	3		3.0	@ 6.0'-7.5', very stiff.		8	11	---	18	37	26
10		6 13 8	4	4		<0.25	@ 8.5'-10.0', very soft, some gravel.							
11.0	747.9													
		8 12 15	2	5			Medium dense gray GRAVEL (A-1-a); wet.							
13.5	745.4													
15		6 12 10	18	6		3.0	Very stiff gray SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; damp to moist. @ 13.5'-15.0', contains silt and sand seams.							
		8 12 18	18	7		4.0								
20		10 14 20	3	8		2.75								
21.0	737.9													
		12 14 14	15	9		2.0	Stiff to very stiff gray SANDY SILT (A-4a), some fine to coarse sand, little gravel; moist.		12	10	---	20	36	22
23.5	735.4													
25	733.9	14 18 25	2	10			Dense gray GRAVEL WITH SAND, SILT, AND CLAY (A-2-6); possible cobbles; wet.							

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-040 | *Location:* Sta. 760+61.33, 137.60 ft Rt. of I-70 CL | *Date Drilled:* 8/15/2008 to 8/19/2008

WATER OBSERVATIONS:
Water seepage at: 10.5', 23.0', 47.0'
Water level at completion: 29.7' (beginning of shift, 8/18/08)
29.3' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL / LL / Blows per foot - / Non-Plastic - NP
	733.9						Dense to very dense gray GRAVEL (A-1-a), some fine to coarse sand; possible cobbles; wet.								
		10 15 29	2	11											
		14 24 32	2	12			@ 28.5'-30.0', trace fine to coarse sand.								59
30															
31.0	727.9														
		11 17 22	18	13		4.5+	Hard gray SANDY SILT (A-4a), some to "and" fine to coarse sand, trace to little gravel; damp.		9	13	---	32	33	13	NP
							@ 32.0'-32.5', soft, wet (HP < 0.25).								
		29 31 34	18	14		4.5+	@ 33.5'-35.0', contains occasional silt seams								68
35															
		29 30 50/5	17	15		4.5+									50+
		18 50/3	2	16		4.5+	@ 38.5'-47.0', possible cobbles.								50+
40															
		16 50/5	5	17		4.5+									50+
		19 50/5	5	18		4.5+			6	9	---	29	37	19	NP
															50+
45															
47.0	711.9														
							Very dense gray COARSE AND FINE SAND (A-3a), some silt, little gravel; contains occasional silty clay seams, possible cobbles; wet.								
		50/4	4	19											50+
50	708.9														

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-040 | *Location:* Sta. 760+61.33, 137.60 ft Rt. of I-70 CL | *Date Drilled:* 8/15/2008 to 8/19/2008

WATER OBSERVATIONS:
Water seepage at: 10.5', 23.0', 47.0'
Water level at completion: 29.7' (beginning of shift, 8/18/08)
29.3' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	708.9						Very dense gray GRAVEL (A-1-a), trace silt; contains cobble fragments; wet.								
		50/5	3	20											50+
55															
57.0	701.9														
							Very dense gray COARSE AND FINE SAND (A-3a), little silt, trace to little gravel; wet.								
		45 50/5	11	21											50+
60															
		30 35 33	12	22					9	23	---	54	--14--		NP 72
65															
		50/3	0	23			@ 68.5'-72.0', possible cobbles.								50+
70															
		34 48 48	13	24											101
75	683.9														

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-040 | *Location:* Sta. 760+61.33, 137.60 ft Rt. of I-70 CL | *Date Drilled:* 8/15/2008 to 8/19/2008

WATER OBSERVATIONS:
Water seepage at: 10.5', 23.0', 47.0'
Water level at completion: 29.7' (beginning of shift, 8/18/08)
29.3' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % -
	683.9						Very dense gray GRAVEL WITH SAND (A-1-b), some to "and" coarse sand, little to some fine sand, little to some silt; wet.								PL — LL; Blows per foot - ○ / Non-Plastic - NP; 10 20 30 40
		45 50/4	10	25					48	25	---	12	--15--		NP ● 50+ ○
80															
		50/4	1	26			@ 83.5'-85.0', drove on cobble.								50+ ○
85															
		40 50/5	11	27											50+ ○
90															
		35 50/5	7	28											50+ ○
95															
		37 41 50/5	17	29					15	39	---	29	--17--		NP ● 50+ ○
100	658.9														

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-040 | *Location:* Sta. 760+61.33, 137.60 ft Rt. of I-70 CL | *Date Drilled:* 8/15/2008 to 8/19/2008

WATER OBSERVATIONS:
Water seepage at: 10.5', 23.0', 47.0'
Water level at completion: 29.7' (beginning of shift, 8/18/08)
29.3' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - ○ / Non-Plastic - NP
	658.9						Very dense gray COARSE AND FINE SAND (A-3a), some silt, little gravel; possible cobbles; wet.								
		40 50/5	4	30											50+
105															
107.0	651.9														
							Hard brown CLAY (A-7-6), some fine to coarse sand, trace gravel; contains rust stains; damp. (POSSIBLE DECOMPOSED SHALE)		1	18	---	10	29	42	
		50/5	5	31		4.5									50+
110															
113.5	645.4														
		38 42 50/5	7	32			Severely weathered brownish gray SHALE.								50+
115															
116.5	642.4						@ 116.1'-116.5', encountered granite cobble/boulder (cored through).								
		Core 60"	Rec 60"	RQD 73%	R1		Shale, blue-gray, highly weathered, weak, laminated, friable, fissile, jointed, fractured to moderately fractured, tight, slightly rough, RQD 77%, Loss 0%. Contains dark gray, well cemented shale zones [thin, dark bands]. Dark shale zones are typically 1-2 inches thick, spaced at intervals of 12 to 18 inches.								
120															
120.8	638.1						Interbedded Shale (92%) and Limestone (8%), RQD 86%, Loss 1%; Shale, dark gray, highly weathered, weak, thinly laminated, calcareous, fissile, pyritic, jointed, slightly rough, tight; Limestone, gray, moderately weathered, strong, thinly bedded.								
		Core 60"	Rec 58"	RQD 53%	R2										
125	633.9														

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-040 | *Location:* Sta. 760+61.33, 137.60 ft Rt. of I-70 CL | *Date Drilled:* 8/15/2008 to 8/19/2008

WATER OBSERVATIONS:
Water seepage at: 10.5', 23.0', 47.0'
Water level at completion: 29.7' (beginning of shift, 8/18/08)
29.3' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	633.9														
130		Core 60"	Rec 60"	RQD 90%	R3		Interbedded Shale (92%) and Limestone (8%), RQD 86%, Loss 1%; Shale, dark gray, highly weathered, weak, thinly laminated, calcareous, fissile, pyritic, jointed, slightly rough, tight; Limestone, gray, moderately weathered, strong, thinly bedded.								
		Core 60"	Rec 60"	RQD 100%	R4		@ 133.8' - 134.3', qu = 3589 psi								
135.0 135	623.9						Bottom of Boring - 135.0'								
140															
145															
150															

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-041 | *Location:* Sta. 762+58.90, 115.94 ft Lt. of I-70 CL | *Date Drilled:* 6/23/2008 to 6/25/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-15.5', 52.0'-92.0'
Water level at completion: 37.1' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	759.7													
1.5	758.2						Asphalt Concrete Pavement - 8" Aggregate Base - 5"							
		10 8 4	6	1			Medium dense brown GRAVEL (A-1-a), trace to little fine to coarse sand, trace to little silty clay; damp to moist.		71	11	---	7	--11--	
		1 4 14	2	2			@ 3.2', encountered large rock fragments.		98	1	---	1	--0--	
4.5	755.2													
5		5 7 8	18	3		3.0	Very stiff to hard brown SANDY SILT (A-4a), some fine to coarse sand, little gravel; damp.		13	14	---	16	31	26
		5 6 9	14	4		3.0								
		4 11 15	13	5		4.5+	@ 8.5', becomes gray.							
10														
		7 12 15	18	6		4.5+			12	11	---	20	37	20
13.0	746.7													
		17 38 31	18	7			Very dense brown and gray GRAVEL WITH SAND (A-1-b), some silt; wet.		21	32	---	23	--23--	
15														
15.5	744.2													
		7 10 16	18	8		4.5+	Hard gray SANDY SILT (A-4a), little gravel; damp to moist.							
		8 12 20	18	9		4.5+			12	13	---	22	33	20
20														
		9 15 23	18	10		4.5+								
		8 25 34	6	11		4.5+								
25	734.7													

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL ⊢—⊣ *LL*
Blows per foot - ○ / *Non-Plastic -* NP
10 20 30 40

NP
NP
NP
73
62

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-041 | *Location:* Sta. 762+58.90, 115.94 ft Lt. of I-70 CL | *Date Drilled:* 6/23/2008 to 6/25/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-15.5', 52.0'-92.0'
Water level at completion: 37.1' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP
	734.7						Hard gray SANDY SILT (A-4a), little gravel; damp to moist.								
		7 23 34	18	12		4.5+									● 60 ○
		15 34 42	18	13		4.5+									● 80 ○
30															
		10 22 30	18	14		4.5+			12	14	---	19	36	19	● ⊢ 55 ○
35															
		12 30 42	18	15		4.5+									● 76 ○
40															
		15 45 31	10	16		4.5+									● 80 ○
45															
		12 28 41	18	17		4.5+									● 73 ○
50	709.7														

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-041 | *Location:* Sta. 762+58.90, 115.94 ft Lt. of I-70 CL | *Date Drilled:* 6/23/2008 to 6/25/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-15.5', 52.0'-92.0'
Water level at completion: 37.1' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % -
	709.7						Hard gray SANDY SILT (A-4a), little gravel; damp to moist.								
52.0	707.7														
		18 30 49	18	18			Very dense brown and gray GRAVEL WITH SAND (A-1-b), little gravel, trace to little silty clay; wet. @ 52.0'-58.5', cobbles and boulders.		38	30	---	21	--11--		NP; 83
55															
		50/5	5	19											50+
60															
		6 30 38	18	20											72
65															
67.0	692.7						Very dense black, brown, and gray GRAVEL (A-1-a), little fine to coarse sand, trace silty clay; wet.								
		11 18 40	8	21					78	13	---	5	--4--		NP; 61
70															
		48 50/4	7	22											50+
75	684.7														

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-041 | *Location:* Sta. 762+58.90, 115.94 ft Lt. of I-70 CL | *Date Drilled:* 6/23/2008 to 6/25/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-15.5', 52.0'-92.0'
Water level at completion: 37.1' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - PL — LL; Blows per foot - ○ / Non-Plastic - NP
	684.7														
77.0	682.7						Very dense black, brown, and gray GRAVEL (A-1-a), little fine to coarse sand, trace silty clay; wet.								
		6 18 33	4	23			Very dense brown and gray GRAVEL WITH SAND AND SILT (A-2-4); wet.								54 ○
80															
82.0	677.7														
		50/5	3	24			Very dense gray COARSE AND FINE SAND (A-3a), some silty clay, trace gravel; possible cobbles; wet.								50+ ○
85															
		37 50/5	11	25					5	17	---	44	--34--		NP ● 50+ ○
90															
92.0	667.7														
		50/5	5	26			Very dense brownish gray SANDY SILT (A-4a), trace gravel; damp.								50+ ○
95															
		33 50/5	11	27					9	8	---	21	42	20	NP ● 50+ ○
100	659.7														

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-041 | *Location:* Sta. 762+58.90, 115.94 ft Lt. of I-70 CL | *Date Drilled:* 6/23/2008 to 6/25/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-15.5', 52.0'-92.0'
Water level at completion: 37.1' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - PL / LL, Blows per foot - / Non-Plastic - NP
	659.7						Very dense brownish gray SANDY SILT (A-4a), some gravel; damp.								
105		40 50/5	5	28											50+
110		50/5	5	29					21	17	---	21	27	14	NP 50+
112.0	647.7														
115.0	644.7	17 27 34	3	30			Stiff to very stiff brown and gray SILTY CLAY (A-6b), trace fine to coarse sand, trace gravel; moist.		2	3	---	2	55	38	64
120		Core 60"	Rec 60"	RQD 80%	R1		Shale, blue-gray, weak, highly weathered, thinly laminated, slightly calcareous, jointed, moderately to highly fractured, tight, with typical narrow fractures, slightly rough; RQD 42%, Loss 0%. Contains dark gray, well cemented shale zones [thin, dark bands]. Dark shale zones are typically 1-2 inches thick, spaced at intervals of 12 to 18 inches.								
125	634.7	Core 60"	Rec 60"	RQD 25%	R2										

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-041 | *Location:* Sta. 762+58.90, 115.94 ft Lt. of I-70 CL | *Date Drilled:* 6/23/2008 to 6/25/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-15.5', 52.0'-92.0'
Water level at completion: 37.1' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft) 634.7	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
127.5	632.2						Shale, blue-gray, weak, highly weathered, thinly laminated, slightly calcareous, jointed, moderately to highly fractured, tight, with typical narrow fractures, slightly rough; RQD 42%, Loss 0%. Contains dark gray, well cemented shale zones [thin, dark bands]. Dark shale zones are typically 1-2 inches thick, spaced at intervals of 12 to 18 inches.								
130		Core 120"	Rec 120"	RQD 58%	R3		Interbedded Shale [93%] and Limestone [7%], RQD 78%, Loss 0%; Shale, dark gray, weak, highly weathered, thinly laminated, calcareous, jointed, highly fractured with typical, tight, slightly rough shear fractures; Limestone, light gray, strong, slightly weathered, pyritic, unfractured. @ 133.5' - 134.0', qu = 1695 psi								
135.0 135	624.7						Bottom of Boring - 135.0'								
140															
145															
150															

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-043 | *Location:* Sta. 765+56.96, 96.30 ft Rt. of I-70 CL | *Date Drilled:* 7/16/2008 to 7/20/2008

WATER OBSERVATIONS:
Water seepage at: 37.0', 77.0'
Water level at completion: 14.4' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	743.1														
1.9	741.2	3 8 13	13	1			Asphalt Concrete - 9" Portland Cement Concrete - 9" Aggregate Base - 5"								
3.5	739.6						Medium dense brown GRAVEL WITH SAND, SILT, AND CLAY (A-2-6), some silty clay; damp.								
5		7 7 15	10	2		4.5+	Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace gravel; damp.								
6.0	737.1														
		7 25 30	18	3			Very dense grayish brown SANDY SILT (A-4a), some fine to coarse sand, trace gravel; moist.		13	13	---	26	38	10	NP ● 58
9.0	734.1	7 12 45	1	4			@ 7.5'-9.0', rock blocking sampler.								60
10		10 31 46	18	5		4.5+	Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace gravel; damp.		9	13	---	19	37	22	● 81
10.5	732.6	12 40 46	18	6		4.5+	Hard gray SILT AND CLAY (A-6a), some to "and" fine to coarse sand, trace to little gravel; damp.		7	21	---	19	33	20	● 90
		7 12 24	18	7		4.5+									●
15		12 28 49	10	8		4.5+	@ 13.5'-15.0', contains sand seams.								● 81
		7 19 39	18	9		4.5+									61
20		39 49 42	18	10		4.5+									96
		12 24 42	18	11		4.5+									69
25	718.1	17 42 42	18	12		4.5+			17	12	---	18	33	20	● 88

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-043 | *Location:* Sta. 765+56.96, 96.30 ft Rt. of I-70 CL | *Date Drilled:* 7/16/2008 to 7/20/2008

WATER OBSERVATIONS:
Water seepage at: 37.0', 77.0'
Water level at completion: 14.4' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	718.1	20 42 50/5	17	13		4.5+	Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace gravel; damp.								50+
30		24 34 45	18	14		4.5+									83
35		11 30 40	18	15		4.5+									74
40		13 28 45	10	16		--	@ 38.5', becomes wet.								77
42.0	701.1														
45		17 34 38	18	17			Very dense gray GRAVEL WITH SAND (A-1-b), trace silt; wet.		22	42	---	27	--9--		NP 76
50	693.1	13 31 39	18	18											74

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-043 | *Location:* Sta. 765+56.96, 96.30 ft Rt. of I-70 CL | *Date Drilled:* 7/16/2008 to 7/20/2008

WATER OBSERVATIONS:
Water seepage at: 37.0', 77.0'
Water level at completion: 14.4' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	693.1						Dense gray GRAVEL (A-1-a), some fine to coarse sand, trace silt; wet. (GEOLOGIST'S DESCRIPTION - sample lost)								
55		12 12 21	18	19			@ 50.0'-60.0', difficult drilling, possible boulders. @ 55.0'-60.0', encountered gas pockets.								
57.0	686.1														
							Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace gravel; damp.								
60		35 43 50/5	8	20		4.5+									50+
		50/1	1	21		--	@ 63.5', rock blocking sampler.								50+
65							@ 63.5'-70.0', possible cobbles.								
70		14 33 36	4	22		4.5+			17	19	---	26	28	10	NP 73
75	668.1	17 23 28	18	23		4.5									54

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-043 | *Location:* Sta. 765+56.96, 96.30 ft Rt. of I-70 CL | *Date Drilled:* 7/16/2008 to 7/20/2008

WATER OBSERVATIONS:
Water seepage at: 37.0', 77.0'
Water level at completion: 14.4' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	668.1						Very dense gray FINE SAND (A-3), trace gravel; wet.								
80		13 28 50/5	17	24			@ 78.5', 2.0 feet sand heave.								50+
82.0	661.1														
							Very dense gray GRAVEL WITH SAND (A-1-b), some fine to coarse sand, little silt; wet.								
85		40 42 42	18	25											88
90		34 42 48	10	26											95
93.5	649.6														
95.0	95 648.1	50/5	3	27			Severely weathered gray SHALE.								50+
100	643.1	Core 60"	Rec 60"	RQD 85%	R1		Shale, blue-gray, weak, highly weathered, thinly laminated, slightly calcareous, pyritic, jointed, moderately to fractured, tight, slightly rough; RQD 88%, Loss 0%. Contains dark gray, well cemented shale zones [thin, dark bands]. Dark shale zones are typically 1-2 inches thick, spaced at intervals of 12 to 18 inches.								

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-043 | *Location:* Sta. 765+56.96, 96.30 ft Rt. of I-70 CL | *Date Drilled:* 7/16/2008 to 7/20/2008

WATER OBSERVATIONS:
Water seepage at: 37.0', 77.0'
Water level at completion: 14.4' (includes drilling water)

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP
	643.1														10 20 30 40
105		Core 60"	Rec 60"	RQD 82%	R2		Shale, blue-gray, weak, highly weathered, thinly laminated, slightly calcareous, pyritic, jointed, moderately to fractured, tight, slightly rough; RQD 88%, Loss 0%. Contains dark gray, well cemented shale zones [thin, dark bands]. Dark shale zones are typically 1-2 inches thick, spaced at intervals of 12 to 18 inches.								
		Core 60"	Rec 60"	RQD 97%	R3		@ 104.3' - 104.7', qu = 1612 psi								
110.3 110	632.8														
		Core 60"	Rec 60"	RQD 87%	R4		Shale, dark gray, moderately to highly weathered, weak, thinly laminated, fissile, friable, pyritic, calcareous, jointed, fractured to moderately fractured, tight, slightly rough; RQD 87%, Loss 0%.								
115.0 115	628.1														
							Bottom of Boring - 115.0'								
120															
125															

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

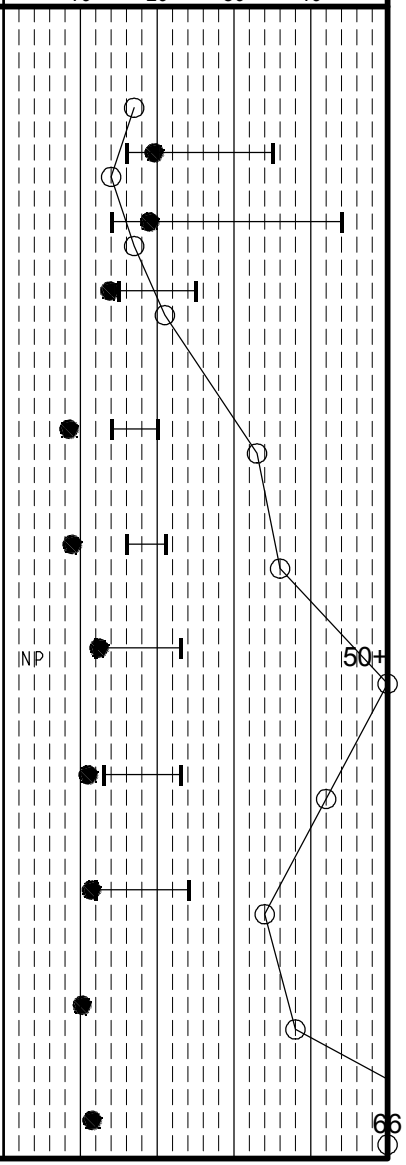
LOG OF: Boring B-044 | *Location:* Sta. 767+54.82, 120.59 ft Lt. of I-70 CL | *Date Drilled:* 6/16/2008 to 6/19/2008

WATER OBSERVATIONS:
Water seepage at: 13.5'-14.2', 23.5'-25.0'
Water level at completion: 19.1' (beginning of shift, 9/17/08)
20.8' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.25" diameter hollowstem augers to 47.0'; 4.0" casing from 47.0' to 115.5'.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	764.6													
1.3	763.3						Asphalt Concrete Pavement - 2" Portland Cement Concrete - 4"							
		10 9 7	8	1		--	Aggregate Base - 10"							
3.5	761.1	9 8 5	8	2		--	POSSIBLE FILL: Stiff to very stiff brown SILTY CLAY (A-6b), little to some fine to coarse sand, trace gravel; moist.		2	7	---	16	33	42
5		4 5 11	18	3		2.5	POSSIBLE FILL: Very stiff mottled olive-brown and gray CLAY (A-7-6), little fine to coarse sand, trace gravel; moist.		2	5	---	10	43	40
5.5	759.1													
		5 8 12	18	4		4.0	Very stiff brown SANDY SILT (A-4a), trace gravel, some clay; damp.		8	8	---	13	40	31
		7 15 16	18	5		2.0	@ 11.0'-16.0', encountered very difficult drilling, dense till, possible cobbles. Recovered rock fragments in split spoon.		1	5	---	10	--83--	
10														
11.0	753.6													
		12 13 21	17	6			Dense brown GRAVEL WITH SAND AND SILT (A-2-4); damp.		44	15	---	9	24	8
13.0	751.6													
14.0	750.6	18 50/2	8	7A 7B		--	Stiff gray SILT AND CLAY (A-6a), some fine to coarse sand, little to some gravel; damp to moist.		21	14	---	18	28	19
15.0	749.6						Very dense brown GRAVEL (A-1-a), little silty clay; moist to wet. @ 14.2', refusal of splitspoon.							
15														
		21 20 20	16	8		4.0	Very stiff to hard gray SANDY SILT (A-4a), little to some clay, trace to little gravel; damp.		10	11	---	20	38	21
18.0	746.6													
		9 14 18	16	9		3.5	Very stiff to hard gray SILT AND CLAY (A-6a), little to some clay, little gravel; damp to moist.		13	11	---	20	36	20
20														
		14 17 19	18	10		2.75	@ 20.5', moist to wet.							
		17 28 35	18	11		--								
25	739.6													

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL ⊢——⊣ *LL*
Blows per foot - ○ / *Non-Plastic -* NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-044 | *Location:* Sta. 767+54.82, 120.59 ft Lt. of I-70 CL | *Date Drilled:* 6/16/2008 to 6/19/2008

WATER OBSERVATIONS:
Water seepage at: 13.5'-14.2', 23.5'-25.0'
Water level at completion: 19.1' (beginning of shift, 9/17/08)
20.8' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.25" diameter hollowstem augers to 47.0'; 4.0" casing from 47.0' to 115.5'.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - ○ / Non-Plastic - NP
	739.6														10 20 30 40
		12 20 24	17	12		3.0	Very stiff to hard gray SILT AND CLAY (A-6a), little to some clay, little gravel; damp. @ 26.0', contains few thin (less than 1") fine to medium grained sand seams.								
28.0	736.6														
30		13 15 25	18	13		4.0	Very stiff to hard gray SANDY SILT (A-4a), little to some clay, little gravel; damp.		18	12	---	20	27	23	
35		35 34 32	4	14		--	@ 33.9', encountered possible cobble or boulder.								69
							@36.0', pulled augers to change lead. Lead auger bit destroyed. Could not advance further with 500-600 psi down pressure. Changed tools to drill with casing.								
39.6	725.0	14 37 48	18	15A		3.5									89
40				15B		--	Very dense gray COARSE AND FINE SAND (A-3a), little silty clay, trace gravel; wet.								
42.0	722.6														
45		21 42 50/5	17	16		4.5+	Hard gray SANDY SILT (A-4a), "and" fine to coarse sand, trace gravel; damp.		8	13	---	21	35	23	NP 50+
47.0	717.6														
50	714.6	10 20 42	6	17			Very dense gray GRAVEL WITH SAND (A-1-b), some silty clay; wet.		46	20	---	12	--23--		65

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LOG OF: Boring B-044 | *Location:* Sta. 767+54.82, 120.59 ft Lt. of I-70 CL | *Date Drilled:* 6/16/2008 to 6/19/2008

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FIELD NOTES:
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Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % -
	714.6														PL — LL; Blows per foot - ○ / Non-Plastic - NP; 10 20 30 40
52.0	712.6						Very dense gray GRAVEL WITH SAND (A-1-b), some silty clay; wet.								
							Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace to little gravel; damp.								
55		14 42 43	6	18		4.5+									○ 89
60		20 35 38	18	19		4.5+			10	12	---	22	32	24	○ 77
							@ 62.0 to 67.0', very stiff.								
65		14 22 31	18	20		2.5									○ 56
70		15 26 42	18	21		4.5+									○ 72
75	689.6	22 26 34	18	22		4.5+									○ 63

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-044 | *Location:* Sta. 767+54.82, 120.59 ft Lt. of I-70 CL | *Date Drilled:* 6/16/2008 to 6/19/2008

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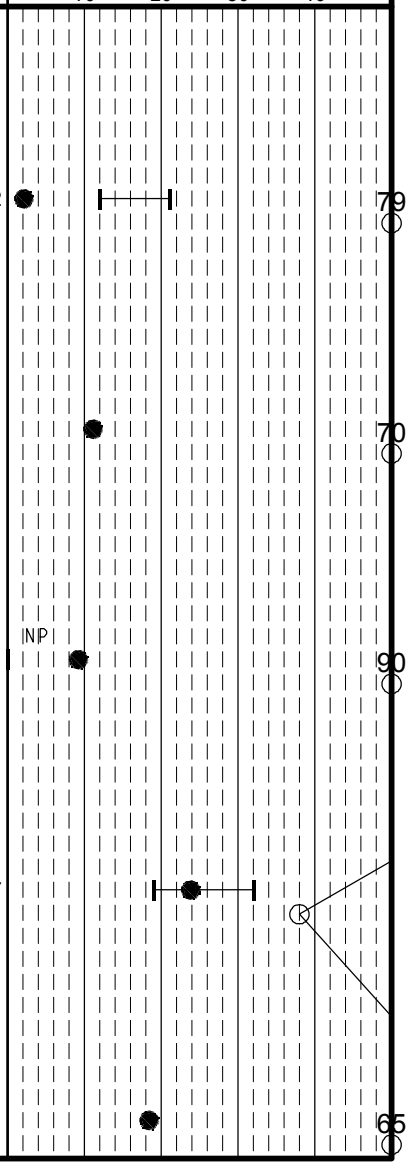
Advanced boring using 4.25" diameter hollowstem augers to 47.0'; 4.0" casing from 47.0' to 115.5'.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	689.6						Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace to little gravel; damp.							
80		19 33 42	18	23		4.5+			7	11	---	20	40	22
85		10 29 38	3	24		--	@ 84.0'-90.0', encountered possible cobbles.							
87.0	677.6													
							Very dense gray GRAVEL (A-1-a), some fine to coarse sand, little silty clay; wet.							
90		19 38 48	4	25					67	13	---	8	--12--	
92.0	672.6													
							Very stiff gray SILT AND CLAY (A-6a); moist.							
95		10 13 23	18	26		3.25			0	0	---	0	53	47
97.0	667.6													
							Hard gray SANDY SILT (A-4a), trace fine to coarse sand, trace gravel; moist.							
100	664.6	15 20 42	18	27		4.5+								

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL ⊢ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-044 | *Location:* Sta. 767+54.82, 120.59 ft Lt. of I-70 CL | *Date Drilled:* 6/16/2008 to 6/19/2008

WATER OBSERVATIONS:
Water seepage at: 13.5'-14.2', 23.5'-25.0'
Water level at completion: 19.1' (beginning of shift, 9/17/08) 20.8' (includes drilling water)

FIELD NOTES: *Advanced boring using 4.25" diameter hollowstem augers to 47.0'; 4.0" casing from 47.0' to 115.5'.*

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - PL / LL, Blows per foot - / Non-Plastic - NP
	664.6						Hard gray SILT (A-4b), trace fine to coarse sand, trace gravel; moist.								
105		13 14 14	18	28		2.5	@ 102', very stiff, grayish brown.		2	1	---	6	59	32	
107.0	657.6														
							Hard brown and gray CLAY (A-7-6), varved; damp.								
110.0 110	654.6	42 50/3	9	29		4.5+									50+
111.5	653.1	20 37 50/3		30			Shale, grayish brown, very weak, severely weathered, thinly laminated.								50+
114.9 115	649.7	Core 60"	Rec 60"	RQD 73%	R1		Shale [90%] interbedded and Siltstone [10%], RQD 76%, Loss 0%; Shale, blue-gray, very weak to weak, severely weathered, laminated, slightly calcareous, jointed, moderately fractured, tight, slightly rough, typical clay-filled fractures; Siltstone, gray to dark gray, strong, slightly weathered, laminated, argillaceous. @ 112.0', high angle fracture, clay filled with fine and coarse grained sand.								
120		Core 60"	Rec 60"	RQD 77%	R2		Shale, blue-gray, weak, moderately to highly weathered, laminated, slightly calcareous, jointed, slightly fractured, tight, slightly rough, clay filled fractures; RQD 77%, Loss 0%. Contains dark gray, well cemented shale zones [thin, dark bands]. Dark shale zones are typically 1-2 inches thick, spaced at intervals of 12 to 18 inches. @ 114.4', 115.3', 116.7', 118.4', and 119.4', high angle fractures. @ 117.6' - 118.0', qu = 1202 psi								
125	639.6														

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WATER OBSERVATIONS:
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Water level at completion: 19.1' (beginning of shift, 9/17/08)
20.8' (includes drilling water)

FIELD NOTES: Advanced boring using 4.25" diameter hollowstem augers to 47.0'; 4.0" casing from 47.0' to 115.5'.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	639.6														
		Core 120"	Rec 120"	RQD 79%	R3		Shale, blue-gray, weak, moderately to highly weathered, laminated, slightly calcareous, jointed, slightly fractured, tight, slightly rough, clay filled fractures; RQD 77%, Loss 0%. Contains dark gray, well cemented shale zones [thin, dark bands]. Dark shale zones are typically 1-2 inches thick, spaced at intervals of 12 to 18 inches.								
130															
131.5	633.1						Bottom of Boring - 131.5'								
135															
140															
145															
150															

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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

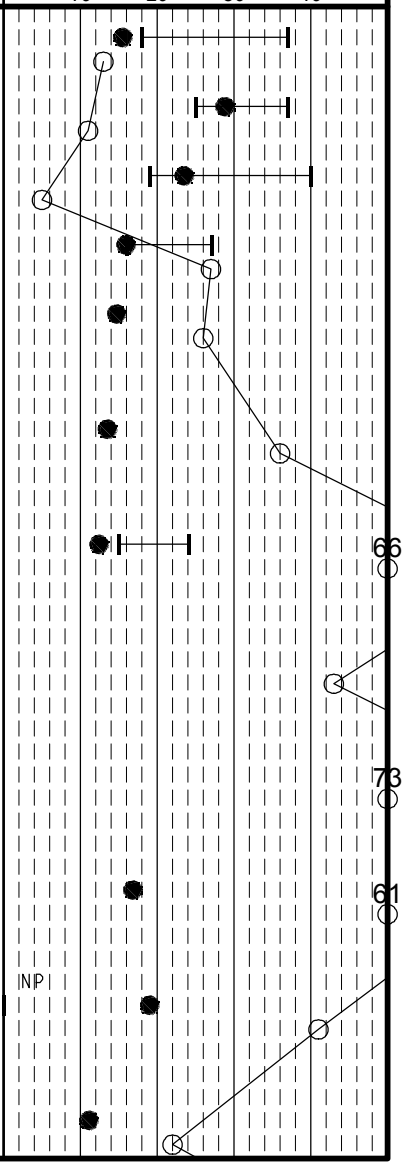
LOG OF: Boring B-046 | *Location:* Sta. 770+57.00, 173.88 ft Rt. of I-70 CL | *Date Drilled:* 6/26/2008 to 6/27/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-15.5', 18.0'-28.0', 52.0', 62.0'
Water level at completion: 32.1' (beginning of shift, 6/21/08)
4.6' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft) 770.1	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	769.8	3 4 8	18	1		--	Topsoil - 4"		10	9	---	16	35	30
1.5	768.6						POSSIBLE FILL: Stiff to very stiff mottled brown and gray SILTY CLAY (A-6b), some fine to coarse sand, trace gravel; trace organic debris (roots and wood chips); damp.							
3.0	767.1	4 5 5	18	2		--			7	13	---	16	42	22
		3 2 3	18	3		--	Stiff dark brown SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; contains roots; moist.		4	9	---	16	32	39
5 6.0	764.1	7 13 13	12	4		3.0	Very stiff brown SILTY CLAY (A-6b), some fine to coarse sand, trace gravel; moist.		8	13	---	17	36	26
		18 16 9	3	5		3.0	Very stiff brown SILT AND CLAY (A-6a), little to some fine to coarse sand, trace gravel; damp to moist.							
10 11.0	759.1	10 15 19	18	6		3.5	@ 8.0', little gravel.							
		15 23 40	18	7		4.0	Very stiff to hard brown SANDY SILT (A-4a), some fine to coarse sand, trace gravel; damp.		7	10	---	17	43	23
15 15.5	754.6	12 17 24	2	8		--	@ 13.5', encountered possible sandstone cobble / boulder, wet.							
		9 29 40	8	9		--	Hard gray SILT (A-4b), little fine to coarse sand, little clay, trace gravel; damp to moist.							
18.0	752.1													
20		18 26 32	18	10			Dense to very dense brown and gray COARSE AND FINE SAND (A-3a), little to some silty clay; wet.							
		9 19 20	16	11					3	6	---	64	--27--	
		8 9 12	18	12										
25	745.1													

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

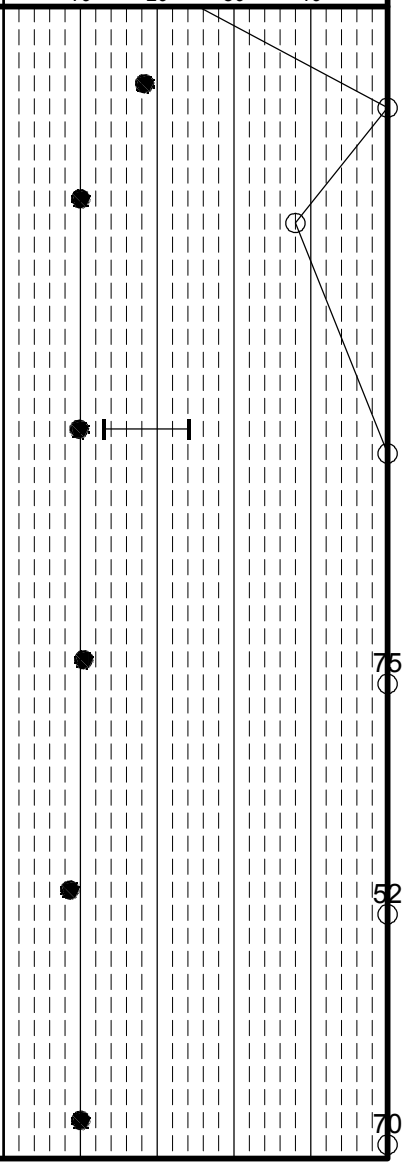
LOG OF: Boring B-046 | *Location:* Sta. 770+57.00, 173.88 ft Rt. of I-70 CL | *Date Drilled:* 6/26/2008 to 6/27/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-15.5', 18.0'-28.0', 52.0', 62.0'
Water level at completion: 32.1' (beginning of shift, 6/21/08)
4.6' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
25.5	744.6													
		14 21 27	12	13			Dense to very dense gray FINE SAND (A-3), trace to little silty clay; moist to wet.							
28.0	742.1													
		14 16 20	18	14		4.5+	Hard gray SILT AND CLAY (A-6a), some to "and" fine to coarse sand, little gravel; damp.							
30														
		10 21 27	18	15		4.5+			11	20	---	21	--48--	
35														
		10 33 38	18	16		4.5+								
40														
		14 20 29	18	17		4.5+								
45														
		19 26 41	18	18		4.5+								
50	720.1													

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL ⊢——⊣ *LL*
Blows per foot - ○ / *Non-Plastic -* NP
10 20 30 40



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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-046 | *Location:* Sta. 770+57.00, 173.88 ft Rt. of I-70 CL | *Date Drilled:* 6/26/2008 to 6/27/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-15.5', 18.0'-28.0', 52.0', 62.0'
Water level at completion: 32.1' (beginning of shift, 6/21/08)
4.6' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % -
	720.1														PL — LL; Blows per foot - ○ / Non-Plastic - NP; 10 20 30 40
52.0	718.1						Hard gray SILT AND CLAY (A-6a), little fine to coarse sand, little gravel; damp.								
55		27 42 49	1	19			Very dense brown and gray GRAVEL (A-1-a), trace fine to coarse sand, trace silty clay; possible cobbles; wet.								96
57.0	713.1														
60		11 17 26	18	20		4.5+	Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace gravel; damp.		7	11	---	18	40	24	
62.0	708.1														
65		15 13 9	18	21			Medium dense brown and gray GRAVEL (A-1-a), some fine to coarse sand, trace silty clay; wet.		76	16	---	5	--3--		
67.0	703.1														
70		21 35 41	16	22			Very dense gray COARSE AND FINE SAND (A-3a), some silty clay, little gravel; moist to wet.		15	17	---	35	26	7	NP 80
72.0	698.1														
75	695.1	35 50/5	8	23			Very dense brown and gray GRAVEL (A-1-a), some fine to coarse sand, trace silty clay; wet.		70	13	---	10	--7--		50+

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Water seepage at: 13.0'-15.5', 18.0'-28.0', 52.0', 62.0'
Water level at completion: 32.1' (beginning of shift, 6/21/08)
4.6' (includes drilling water)

FIELD NOTES: Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % -
	695.1						Very dense brown and gray GRAVEL (A-1-a), some fine to coarse sand, trace silty clay; wet.								
77.0	693.1						Hard brownish gray SANDY SILT (A-4a), some to "and" fine to coarse sand, trace gravel; damp.								
		16 42 50/3	8	24		4.5+	@ 73.5'-94.3', possible boulders.								50+
80															
		42 50/3	9	25		4.5+			8	12	---	27	39	14	50+
85															
		16 42 50/3	15	26		4.5+									50+
90															
		16 50/4	8	27		4.5+									50+
95															
97.0	673.1						Shale, gray and brownish gray, very weak, severely weathered to decomposed, thinly laminated.								
		10 21 38	18	28											
100	670.1														

PL ⊢ ○ / Non-Plastic - NP ⊣ LL
Blows per foot - 10 20 30 40

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LOG OF: Boring B-046 | *Location:* Sta. 770+57.00, 173.88 ft Rt. of I-70 CL | *Date Drilled:* 6/26/2008 to 6/27/2008

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Water level at completion: 32.1' (beginning of shift, 6/21/08)
4.6' (includes drilling water)

FIELD NOTES:
Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP
	670.1														
		50/5	2	29			Shale, gray and brownish gray, very weak, severely weathered to decomposed, thinly laminated.								50+
105.0	665.1														
		Core 60"	Rec 41"	RQD 10%	R1		Shale, brownish gray, weak to very weak, severely weathered, thinly laminated, jointed, highly fractured, tight, slighly rough shear fractures; RQD 0%, Loss 42%. @ 105.0' to 106.5', possible lost recovery [washed out].								
108.6	661.5														
110		Core 60"	Rec 60"	RQD 88%	R2		Shale, blue-gray, weak, moderately to highly weathered, thinly laminated, slightly calcareous, jointed, moderately fractured, tight, slighly rough fractures; RQD 79%, LOSS 0%. Contains dark gray, well cemented shale zones [thin, dark bands]. Dark shale zones are typically 1-4 inches thick, spaced at intervals of 4 to 12 inches. @ 108.6' - 109.1', qu = 1641 psi								
115															
120		Core 120"	Rec 120"	RQD 83%	R3		@ 121.8' to 123.0' calcareous.								
125.0	645.1						Bottom of Boring - 125.0'								

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LOG OF: Boring B-046 | *Location:* Sta. 770+57.00, 173.88 ft Rt. of I-70 CL | *Date Drilled:* 6/26/2008 to 6/27/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-15.5', 18.0'-28.0', 52.0', 62.0'
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4.6' (includes drilling water)

FIELD NOTES: Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP 10 20 30 40
	645.1														
130															
135															
140															
145															
150															

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-048 | *Location:* Sta. 775+44.31, 173.64 ft Rt. of I-70 CL | *Date Drilled:* 7/1/2008 to 7/2/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-20.5',32.0'-47.0',56.0'-102.0'
Water level at completion: 35.7' (beginning of shift, 7/2/08) 12.1' (includes drilling water)

FIELD NOTES: Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - / Non-Plastic - NP
0.3	774.4						Topsoil - 3"								
		2 3 3	3	1		--	Soft to medium stiff brown SILT AND CLAY (A-6a), little fine to coarse sand, trace to little gravel; moist.								
3.5	771.2														
5		2 2 2	10	2		1.0	Soft to medium stiff brown and gray SILTY CLAY (A-6b), some fine to coarse sand, trace gravel; moist.		4	9	---	16	33	38	
		woh 2 3	11	3		1.0									
10		3 2 2	6	4		1.0	@ 9.0', gray.								
		11 10 10	1	5		--									
13.0	761.7														
15		6 9 12	2	6			Medium dense to dense gray GRAVEL (A-1-a), some fine to coarse sand, trace silty clay; wet.								
		10 14 19	2	7			@ 12.5'-20.0', encountered cobbles and boulders.		66	14	---	9	--11--		NP
18.5	756.2														
20		8 8 15	1	8			Medium dense gray GRAVEL WITH SAND (A-1-b), some silt; used tricone bit to remove possible cobbles; wet.		34	28	---	17	--22--		NP
20.5	754.2														
		12 12 14	5	9		3.5	Very stiff to hard gray SANDY SILT (A-4a), little to some fine to coarse sand, trace gravel; damp.								
25	749.7	3 8 11	12	10		4.5+									

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

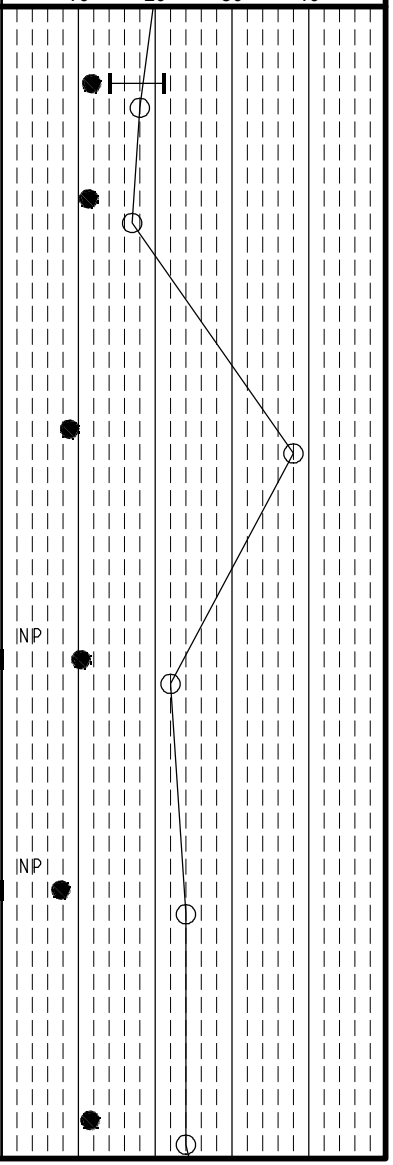
LOG OF: Boring B-048 | *Location:* Sta. 775+44.31, 173.64 ft Rt. of I-70 CL | *Date Drilled:* 7/1/2008 to 7/2/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-20.5',32.0'-47.0',56.0'-102.0'
Water level at completion: 35.7' (beginning of shift, 7/2/08)
12.1' (includes drilling water)

FIELD NOTES: Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	749.7						Very stiff to hard gray SANDY SILT (A-4a), little to some fine to coarse sand, trace gravel; damp.							
		6 7 10	15	11		4.5+			8	14	---	20	36	22
		4 6 10	14	12		2.0								
30														
32.0	742.7													
							Medium dense to dense brown, black, and gray GRAVEL (A-1-a), some fine to coarse sand, trace silty clay; wet.							
		14 12 24	5	13										
35														
		9 11 10	8	14					77	19	---	3	--1--	
40														
		9 13 10	6	15			@ 43.5'-45.0', trace fine to coarse sand.		90	6	---	3	--1--	
45														
47.0	727.7													
							Medium dense gray SANDY SILT (A-4a), trace clay, trace gravel; damp to moist.							
		8 9 14	16	16										
50	724.7													

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



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Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-048 | *Location:* Sta. 775+44.31, 173.64 ft Rt. of I-70 CL | *Date Drilled:* 7/1/2008 to 7/2/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-20.5',32.0'-47.0',56.0'-102.0'
Water level at completion: 35.7' (beginning of shift, 7/2/08) 12.1' (includes drilling water)

FIELD NOTES: *Advanced boring using 4.0" diameter flush joint casing.*

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	724.7													
		10 14 15	12	17		3.5	Very stiff gray SANDY SILT (A-4a), little clay, trace gravel; damp to moist.		8	10	---	19	44	19
55														
57.0	717.7													
		10 10 16	8	18			Medium dense brown, black, and gray GRAVEL (A-1-a), little fine to coarse sand; wet.		80	16	---	3	--1--	
60														
62.0	712.7													
		3 12 10	10	19			Medium dense brown and gray GRAVEL WITH SAND (A-1-b), little silty clay; wet.		15	52	---	18	--15--	
65														
67.0	707.7													
		10 11 14	18	20			Medium dense brown and gray FINE SAND (A-3), trace silty clay, trace gravel; wet.							
70														
72.0	702.7													
		11 24 16	1	21			Dense gray GRAVEL (A-1-a); possible cobbles; wet.							
75	699.7													

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ *LL*
Blows per foot - ○ / *Non-Plastic -* NP
10 20 30 40

NP
NP

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

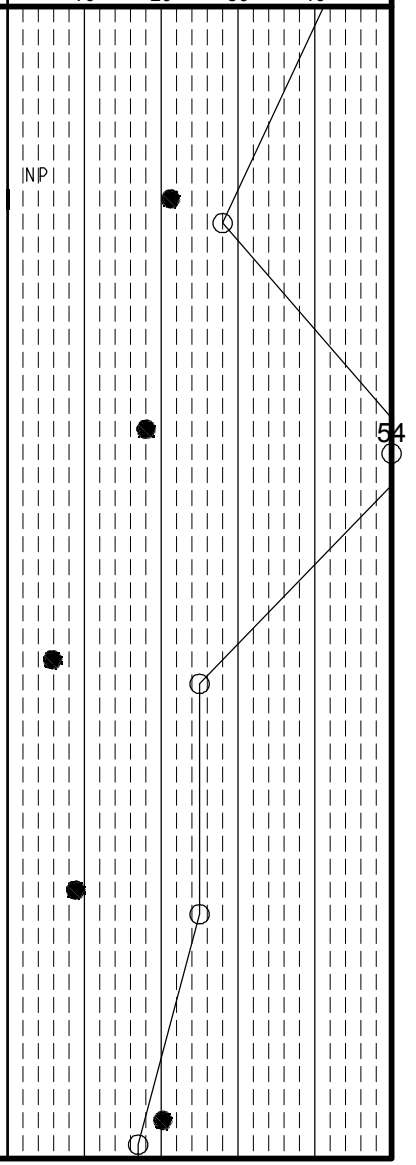
LOG OF: Boring B-048 | *Location:* Sta. 775+44.31, 173.64 ft Rt. of I-70 CL | *Date Drilled:* 7/1/2008 to 7/2/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-20.5',32.0'-47.0',56.0'-102.0'
Water level at completion: 35.7' (beginning of shift, 7/2/08)
12.1' (includes drilling water)

FIELD NOTES: Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	699.7													
77.0	697.7						Dense gray GRAVEL (A-1-a); possible cobbles; wet.							
80		9 10 17	18	22			Medium dense brownish gray COARSE AND FINE SAND (A-3a), some silty clay; moist to wet.		0	0	---	73	--27--	
85		6 25 26	18	23			@ 83.5'-85.0', very dense.							
87.0	687.7													
90		6 10 14	2	24			Medium dense brown and gray GRAVEL (A-1-a), trace fine sand; possible cobbles; wet.							
92.0	682.7						@ 90.0'-95.0', difficult advancement of casing; possible cobbles and boulders.							
95		9 10 14	5	25			Medium dense brown and gray GRAVEL WITH SAND (A-1-b), trace fine sand; possible cobbles; wet.		65	22	---	7	--6--	
97.0	677.7													
100	674.7	10 8 8	18	26			Medium dense brown FINE SAND (A-3), trace silty clay; wet.		6	60	---	27	--6--	

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-048 | *Location:* Sta. 775+44.31, 173.64 ft Rt. of I-70 CL | *Date Drilled:* 7/1/2008 to 7/2/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-20.5',32.0'-47.0',56.0'-102.0'
Water level at completion: 35.7' (beginning of shift, 7/2/08)
12.1' (includes drilling water)

FIELD NOTES: Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	674.7													
102.0	672.7						Medium dense brown FINE SAND (A-3), trace silty clay; wet.							
105		7 7 9	18	27			Medium stiff gray CLAY (A-7-6), little silt; varved; moist.		0	0	---	0	17	83
107.0	667.7						Shale, blue-gray, severely weathered, weak to very weak.							
110.0 110	664.7	38 46 36	7	28					10	9	---	18	44	19
115		Core 60"	Rec 49"	RQD 75%	R1		Shale, light gray to blue-gray, highly weathered, weak, thinly laminated, friable, fissile, pyritic, jointed, moderately fractured, tight, slightly rough; RQD 78%, Loss 5%.							
120		Core 60"	Rec 60"	RQD 77%	R2		@ 116.4', contains dark gray, well cemented shale zones [thin, dark bands]. Dark shale zones are typically 1-4 inches thick, spaced at intervals of 12 to 24 inches.							
125	649.7	Core	Rec	RQD										

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

86

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-048 | *Location:* Sta. 775+44.31, 173.64 ft Rt. of I-70 CL | *Date Drilled:* 7/1/2008 to 7/2/2008

WATER OBSERVATIONS:
Water seepage at: 13.0'-20.5',32.0'-47.0',56.0'-102.0'
Water level at completion: 35.7' (beginning of shift, 7/2/08)
12.1' (includes drilling water)

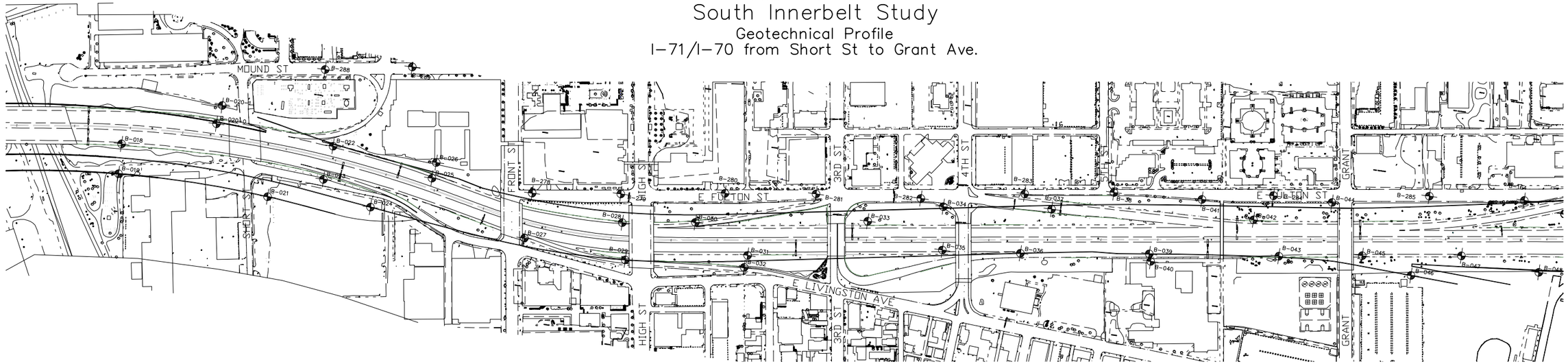
FIELD NOTES: Advanced boring using 4.0" diameter flush joint casing.

Depth (ft)	Elev. (ft) 649.7	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
		120"	120"	79%	R3		Shale, light gray to blue-gray, highly weathered, weak, thinly laminated, friable, fissile, pyritic, jointed, moderately fractured, tight, slightly rough; RQD 78%, Loss 5%. @ 126.4', 127.8', encountered thin (1") sandstone/siltstone beds.								
130.0 130	644.7						Bottom of Boring - 130.0'								
135															
140															
145															
150															

APPENDIX B

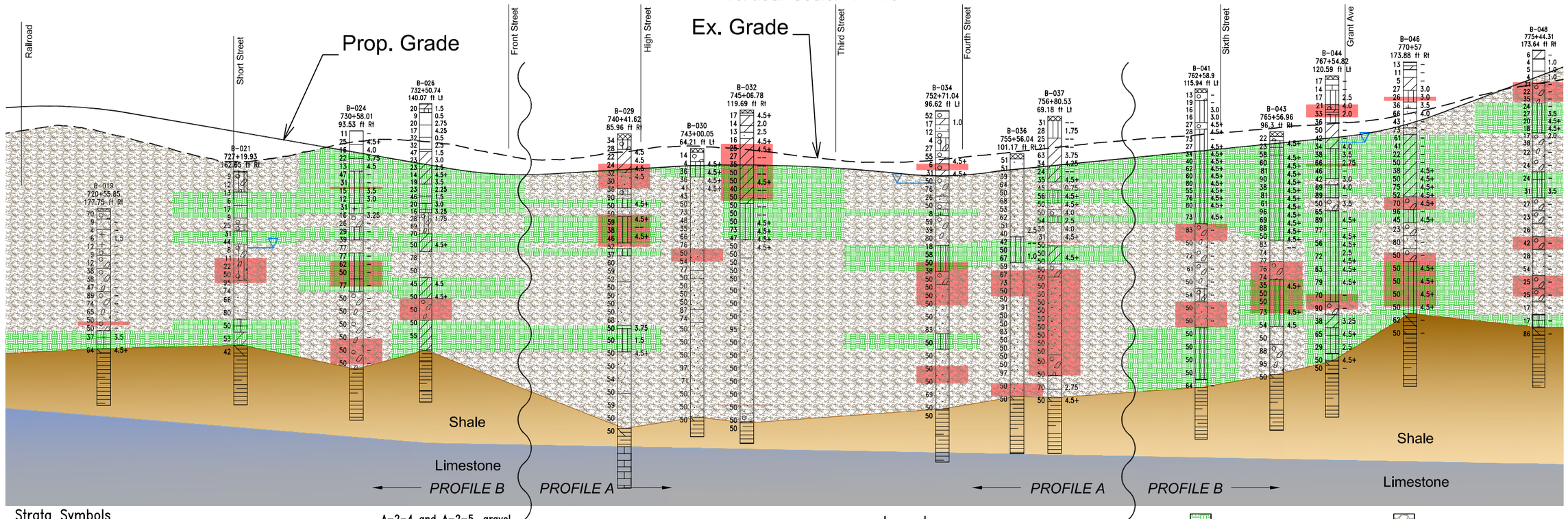
Plan and Profile Drawing
Typical Cross Section Drawings

FRA–70–8.93
South Innerbelt Study
Geotechnical Profile
I–71/I–70 from Short St to Grant Ave.



Horizontal Scale: 1"=400'

Vertical Scale: 1"=40'



Strata Symbols

- Asphalt Concrete (ODOT)
- Topsoil
- A–1–b, gravel and/or stone fragments with sand
- A–2–4 and A–2–5, gravel and/or stone fragments with sand and silt
- A–3a, coarse and fine sand
- A–4a, sandy silt
- A–4b, silt
- A–6a, silt and clay
- A–6b, silty clay
- A–7–6, clay
- Shale
- Limestone

Legend

SPT N Value 10 — 3.0 *Hand Penetrometer (tsf)*

- Fine–grained Soil
- Coarse–grained Soil
- Possible boulders/cobbles or difficult drilling conditions
- Water level as measured in piezometer installations

Profile as of 1-23-09

DLZ
Engineers • Architects • Scientists
Planners • Surveyors

DLZ Ohio, Inc.
6121 Huntley Road • Columbus, Ohio 43229-1003
Phone (614)888-0040 • Fax (614)848-6712
www.dlzcorp.com

HORIZONTAL SCALE IN FEET: 0, 100, 200, 400

PID No. 77369

DESIGNED SJR — DATE 03/30/09

GEOTECHNICAL PROFILE
SHORT ST TO GRANT AVE

FRA–70–8.93

1

SEEDING	
END WIDTH	SQ. YDS.

END AREA		VOLUME		CALCULATED	CHECKED
CUT	FILL	CUT	FILL		

$MESSAGE1$

$WDESC$ $PDESC$

1" 0.5" 0

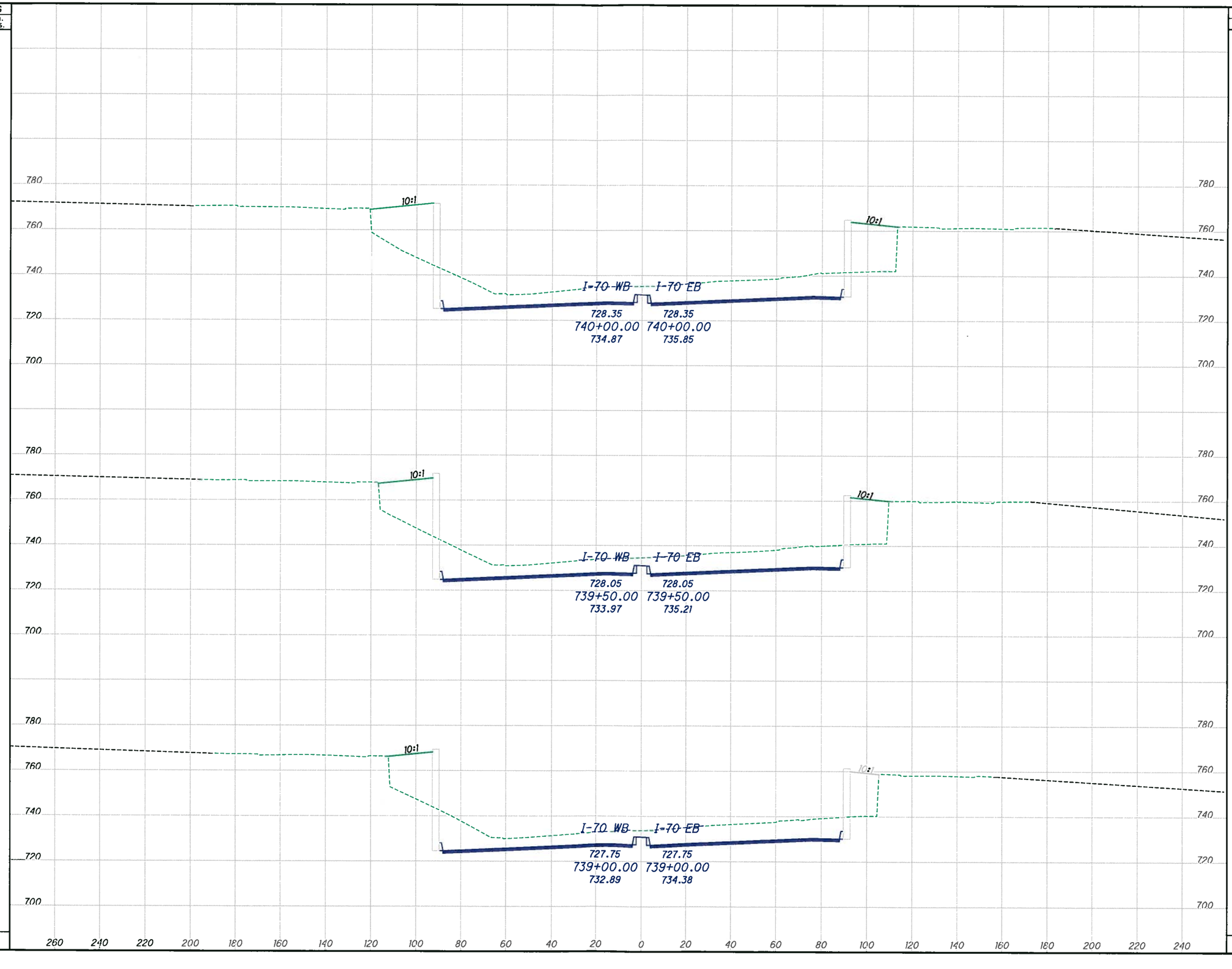
UC: UC
PC: PC

Batchplot Spec: $BATCH$
Pen Table: $PENTABLE$
Plot Driver: $PLOTDRIVER$

34" x 22"

View: $VIEW$
By: $USER$

Model: $MODEL$
Plotted: $DATE$ @ $TIME$
File: $FILE$



CROSS SECTIONS - I-70
STA. 739+00.00 TO STA. 740+00.00

FRA-70-8.93

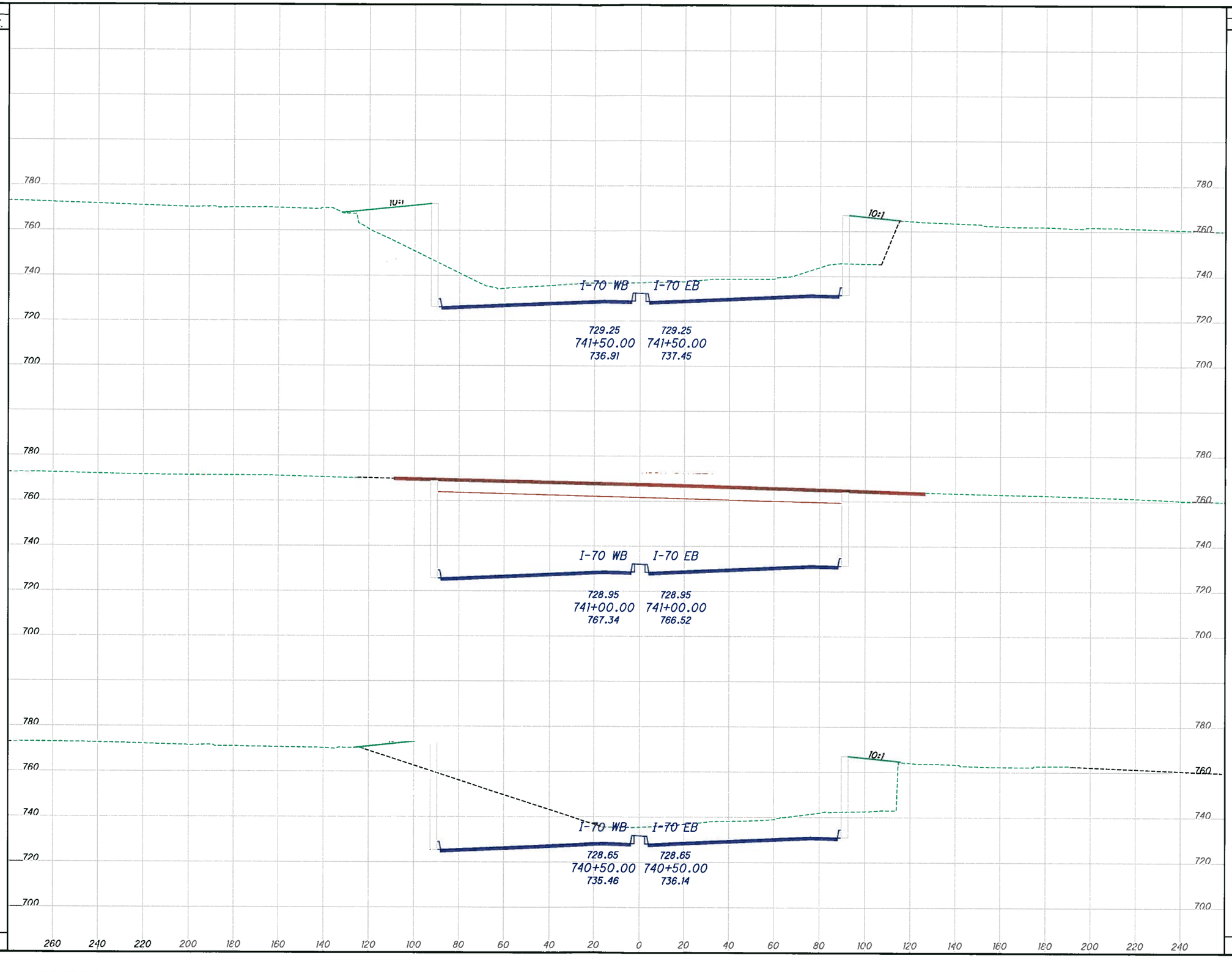
82
84

$MESSAGE2$

SEEDING	
END WIDTH	SQ. YDS.

END AREA		VOLUME	
CUT	FILL	CUT	FILL

CALCULATED | CHECKED



CROSS SECTIONS - I-70
STA. 740+50.00 TO STA. 741+50.00

FRA-70-8.93

83
84

$MESSAGE2$

$MESSAGE1$

$UCTDESC$
$PCTDESC$

UCF: UCF
PCF: PCF

Batchplot Spec: $BATCH$
Pen Table: $PENTABLE$
Plot Driver: $PLOTDRIVER$

Model: $MODEL$
Printed: $DATE$ @ $TIME$
File: $FILE$

View: $VIEW$
By: $USER$

34" x 22"

SEEDING	
END WIDTH	SQ. YDS.

END AREA		VOLUME	
CUT	FILL	CUT	FILL

CALCULATED

CHECKED

10/21/08 Submittal (Grant XS's)

I-70 CROSS SECTIONS (EAST INTERCHANGE)
STA. 767+00.00 TO STA. 769+00.00

FRA-70-8.93

3
21

$MESSAGE1$

$LOTHESS$ $POTHESS$

UOF: UOF
POF: POF

Batchplot Spec: $BATCH$
Pen Table: $PENTABLE$
Plot Driver: $PLOTDRIVER$

34" x 22"

View: $VIEW$
By: $USER$

Model: $MODEL$
Plotted: $DATE$
File: $FILE$

$MESSAGE2$

780 760 740 720 700

200 240 220 200 180 160 140 120 100 80 60 40 20 0 20 40 60 80 100 120 140 160 180 200 220 240

766.28
868+24.86
766.56

741.76
868+99.17
760.95

742.25
769+00.00
747.33

742.25
769+00.00
747.19

742.23
775+41.86
747.42

741.10
869+01.64
753.08

765.79
867+75.31
766.02

741.72
768+50.00
746.76

741.72
768+50.00
746.63

741.74
774+91.55
746.89

740.59
868+51.08
750.72

765.29
867+25.75
765.23

GRANT AVE

741.22
768+00.00
765.30

741.22
768+00.00
765.32

741.27
774+41.25
765.36

740.12
868+00.53
765.40

764.79
866+76.05
765.29

740.12
767+50.00
746.06

740.12
767+50.00
745.96

740.80
773+91.05
746.14

739.66
867+50.14
747.97

27'

764.29
866+26.04
764.86

740.22
767+00.00
745.58

740.22
767+00.00
745.50

740.33
773+41.02
745.63

739.20
867+00.08
745.59

SEEDING

END WIDTH	SQ. YDS.

END AREA		VOLUME	
CUT	FILL	CUT	FILL

CALCULATED

CHECKED

I-70 CROSS SECTIONS (EAST INTERCHANGE)
STA. 769+50.00 TO STA. 771+50.00

FRA-70-8.93

21

$MESSAGE1$

$NOTES$
$POTES$

$NOTES$
$POTES$

Batchplot Spec: $BATCH$
Pen Table: $PENTABLE$
Plot Driver: $PLOTDRIVER$

34" x 22"

Ver: NEW
By: $USER$

Model: $MODEL$
Plotted: $DATE$ @ $TIME$
File: $FILE$

$MESSAGE2$

780 760 740 720

770.48
870+80.89
750.82

746.48
871+47.38
765.69

747.07
771+50.00
751.83

747.07
771+50.00
752.13

746.85
777+93.73
752.17

745.65
871+55.08
765.41

769.11
870+26.87
758.00

745.24
870+97.74
763.19

745.81
771+00.00
750.71

745.81
771+00.00
750.96

745.63
777+43.31
751.04

744.25
871+04.17
761.50

768.06
869+74.89
765.21

744.15
870+48.10
763.03

744.69
770+50.00
749.75

744.69
770+50.00
749.80

744.57
776+92.91
749.91

743.29
870+53.45
759.48

767.31
869+24.26
767.25

743.20
869+98.46
762.56

743.73
770+00.00
748.93

743.73
770+00.00
748.80

743.64
776+42.54
748.95

742.53
870+02.82
756.28

766.78
868+74.42
766.99

742.40
869+48.82
761.73

742.91
769+50.00
747.95

742.91
769+50.00
747.80

742.86
775+92.19
748.00

741.74
869+52.22
754.88

2+00 2+40 2+20 2+00 1+60 1+40 1+20 1+00 80 60 40 20 0 20 40 60 80 1+00 1+20 1+40 1+60 1+80 2+00 2+20 2+40

APPENDIX C

Unconfined Compression Test Results: Rock
In-situ Test Results
Predicted p-y Curves

Unconfined Compression Test Results: Rock

Unconfined Compression of Rock Core Specimens

(ASTM D-2938)

DLZ Project No.: 022--1004.01 | **Client: ODOT**

Project Name: FRA-70-8.93 | **Date: 11/14/08**

Boring	Run	Depth (ft.)	D_1	D_2	D_3	$D_{(ave)}$	L_1	L_2	L_3	$L_{(ave)}$	L/D	Volume (ft^3)	Mass (Gram)	Unit Wt.(pcf)	Load (lbs)	Strength (psi)
B-021	3	82.8'-83.3'	1.979	1.805	1.981	1.956	4.131	4.068	4.016	4.072	2.082	0.007075	493.48	153.8	4610	**1,535**
			1.985	1.999	1.985											
B-024	2	97.7'-98.1'	1.957	1.950	1.953	1.955	4.336	4.351	4.448	4.378	2.239	0.007604	527.00	152.8	4950	**1,649**
			1.951	1.965	1.955											
B-026	3	100.5'-101.0'	1.985	1.972	1.990	1.981	4.341	4.337	4.354	4.344	2.193	0.007745	510.28	145.3	7369	**2,391**
			1.984	1.967	1.988											
B-029	2	11.2'-121.5'	1.989	1.988	1.996	1.991	4.321	4.287	4.241	4.283	2.151	0.007714	595.02	170.0	44000	**14,130**
			1.993	1.991	1.990											
B-034	4	130.0'-130.4'	1.974	1.988	1.994	1.981	3.847	3.886	3.831	3.855	1.946	0.00687	451.55	144.9	12,299	**3,978**
			1.984	1.975	1.969											
B-036	2	103.7'-104.2'	1.957	2.001	1.984	1.983	4.115	4.124	4.164	4.134	2.085	0.007386	457.57	136.6	4450	**1,441**
			1.995	1.974	1.987											
B-037	4	121.2'-121.7'	1.971	1.965	1.993	1.981	4.254	4.253	4.283	4.263	2.153	0.007597	506.48	147.0	4760	**1,545**
			1.994	1.962	1.998											

DLZ

Engineers * Architects * Scientists

6121 Huntley Road * Columbus, Ohio * 43229-1003 * Phone: (614) 888-0576 * Fax (614) 888-6415

Unconfined Compression of Rock Core Specimens

(ASTM D-2938)

DLZ Project No.: 022--1004.01 | **Client: ODOT**

Project Name: FRA-70-8.93 | **Date: 11/14/08**

Boring	Run	Depth (ft.)	D_1	D_2	D_3	$D_{(ave)}$	L_1	L_2	L_3	$L_{(ave)}$	L/D	Volume (ft^3)	Mass (Gram)	Unit Wt.(pcf)	Load (lbs)	Strength (psi)
B-040	4	133.8'-134.3'	1.988	1.985	1.960	1.974	3.921	3.900	3.883	3.901	1.977	0.006904	469.20	149.8	10,995	**3,589**
			1.983	1.995	1.931											
B-041	4	133.5'-134.0'	2.016	1.995	1.974	1.975	3.749	3.768	3.771	3.763	1.905	0.006669	452.30	149.5	5190	**1,684**
			1.965	1.948	1.953											
B-043	4	104.3'-104.7'	1.997	2.009	2.002	1.990	4.362	4.336	4.363	4.354	2.188	0.00783	526.67	148.3	5010	**1,611**
			1.999	1.950	1.981											
B-044	2	117.6'-118.0'	1.871	1.889	1.908	1.890	4.148	4.211	4.031	4.130	2.186	0.0067	438.65	144.3	3369	**1,201**
			1.881	1.875	1.914											
B-046	1	108.6'-109.1'	1.959	1.964	1.961	1.963	4.370	4.360	4.360	4.363	2.223	0.007634	529.56	152.9	4960	**1,640**
			1.958	1.971	1.962											

DLZ

Engineers * Architects * Scientists

6121 Huntley Road * Columbus, Ohio * 43229-1003 * Phone: (614) 888-0576 * Fax (614) 888-6415

In-situ Test Results

Pressuremeter Test Results

DLZ

SUBJECT FRA-70-8.93
Pressuremeter Data

JOB NUMBER 0221-1004.01
SHEET NO. OF
COMP. BY SJR DATE 3/20/09
CHECKED BY DAA DATE 3/20/09

PRESSUREMETER CALIBRATION

ASTM D 4719 - Method A

Project No.: 0221-1004.01
Test Date: 2/23/09
Testing By: SJR
Depth of Probe: 0 (ft)
0 (m)

Project Name: FRA-70-8.93
Probe Size: NX (2.76")
Height of Gage: 3 (ft)
Initial Water Level: 0 cc
Zero Level Volume: 158 cc

Probe No. 1

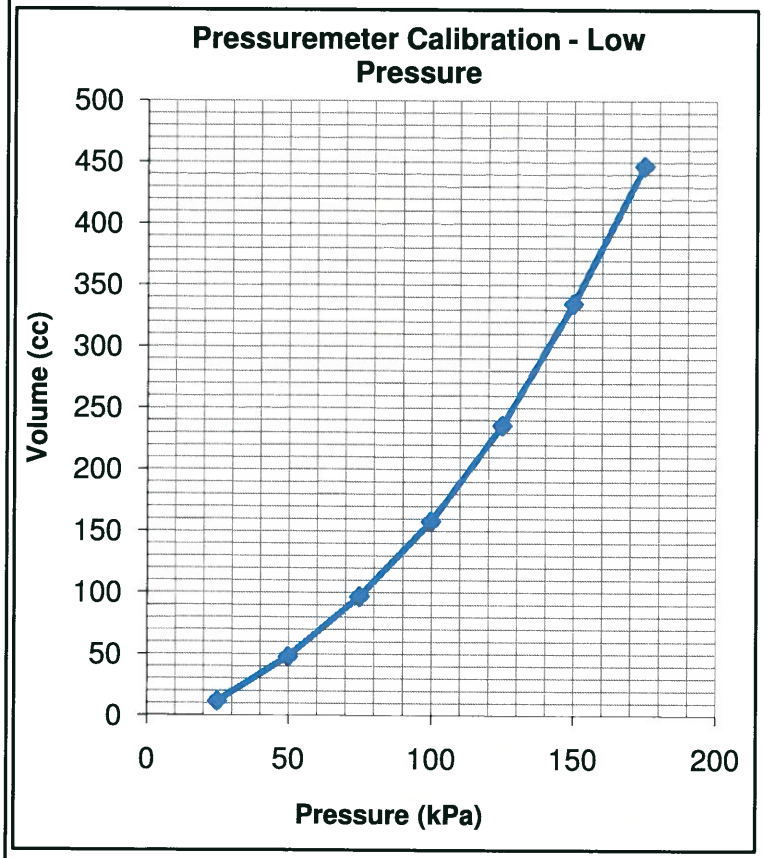
in 2.985" casing

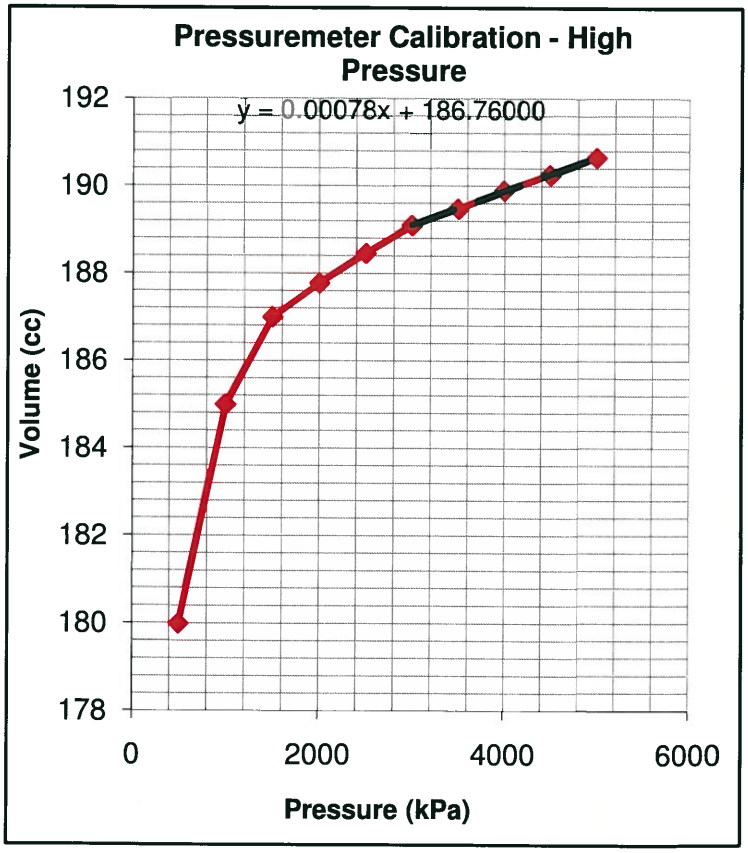
Low Pressure Calibration
CALIBRATION DATA

Pressure (kPa)	Vol (cc)
25	12.0
50	48.0
75	97.0
100	158.0
125	236.0
150	335.0
175	447.0

High Pressure Calibration
CALIBRATION DATA

(kPa)	Vol (cc)
500	180
1000	185
1500	187
2000	187.78
2500	188.46
3000	189.10
3500	189.48
4000	189.90
4500	190.26
5000	190.66





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SUBJECT FRA-70-8.93
Pressuremeter Data

JOB NUMBER 0221-1004.01
SHEET NO. OF
COMP. BY SJR DATE 3/20/09
CHECKED BY DAA DATE 3/20/09

PRESSUREMETER CALIBRATION

ASTM D 4719 - Method A

Project No.: 0221-1004.01
Test Date: 2/16/09
Testing By: SJR
Depth of Probe: 0 (ft)
0 (m)

Project Name: FRA-70-8.93
Probe Size: NX (2.76")
Height of Gage: 3 (ft)
Initial Water Level: 0 cc
Zero Level Volume: 158 cc

Probe No. 1A

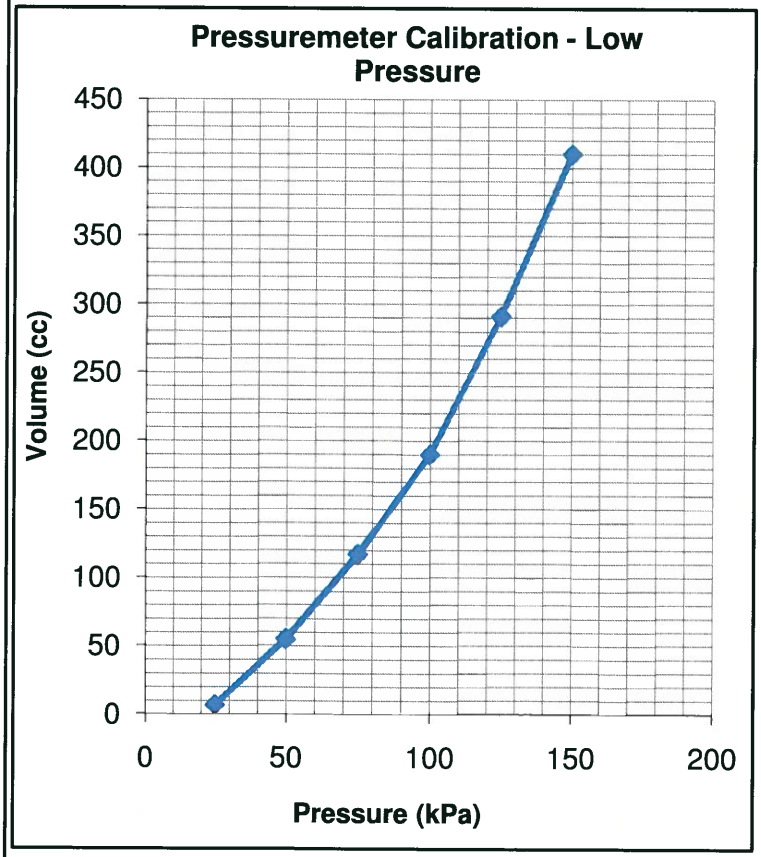
in 2.985" casing

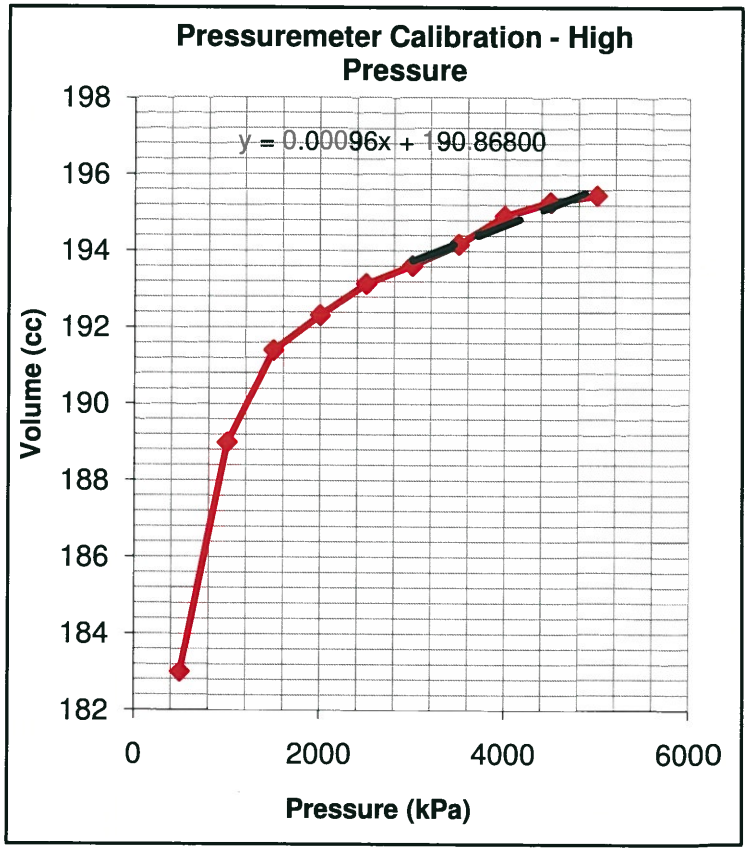
Low Pressure Calibration
CALIBRATION DATA

Pressure (kPa)	Vol (cc)
25	7.0
50	55.0
75	117.0
100	190.0
125	291.0
150	410.0

High Pressure Calibration
CALIBRATION DATA

(kPa)	Vol (cc)
500	183
1000	189
1500	191.4
2000	192.32
2500	193.14
3000	193.62
3500	194.18
4000	194.92
4500	195.28
5000	195.46





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SUBJECT FRA-70-8.93
Pressuremeter Data

JOB NUMBER 0221-1004.01
SHEET NO. OF
COMP. BY SJR DATE 3/20/09
CHECKED BY DAA DATE 3/20/09

PRESSUREMETER CALIBRATION

ASTM D 4719 - Method A

Project No.: 0221-1004.01
Test Date: 2/23/09
Testing By: SJR
Depth of Probe: 0 (ft)
0 (m)

Project Name: FRA-70-8.93
Probe Size: NX (2.76")
Height of Gage: 3 (ft)
Initial Water Level: 0 cc
Zero Level Volume: 158 cc

Probe No. 2

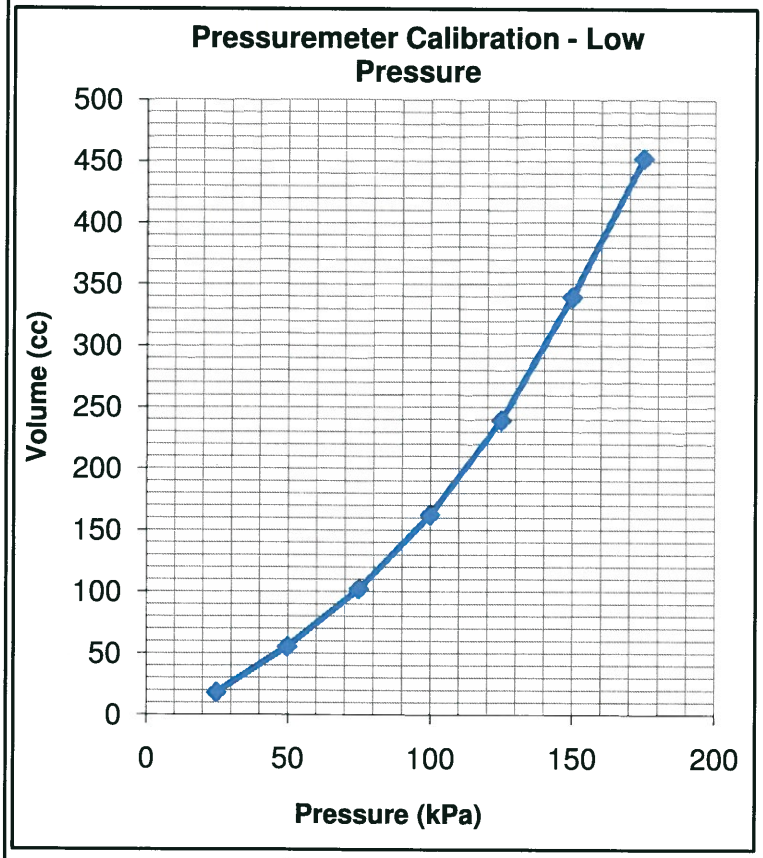
in 2.985" casing

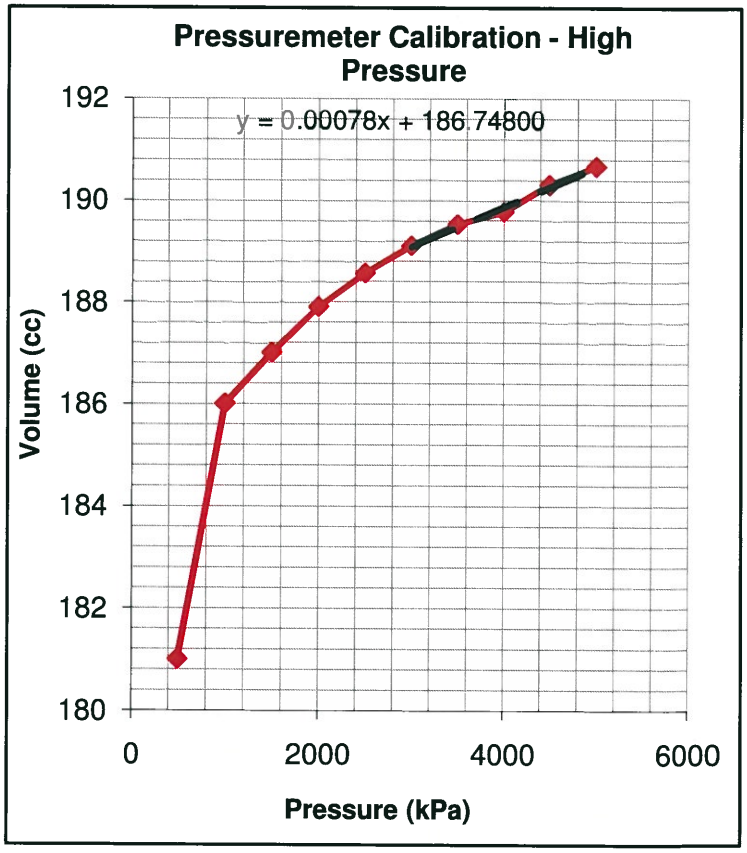
Low Pressure Calibration
CALIBRATION DATA

Pressure (kPa)	Vol (cc)
25	18.0
50	55.0
75	102.0
100	162.0
125	239.0
150	339.0
175	452.0

High Pressure Calibration
CALIBRATION DATA

(kPa)	Vol (cc)
500	181
1000	186
1500	187
2000	187.90
2500	188.56
3000	189.10
3500	189.52
4000	189.76
4500	190.30
5000	190.66





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SUBJECT FRA-70-8.93
Pressuremeter Data

JOB NUMBER 0221-1004.01
SHEET NO. OF
COMP. BY SJR DATE 3/20/09
CHECKED BY DAA DATE 3/20/09

FIELD PRESSUREMETER DATA

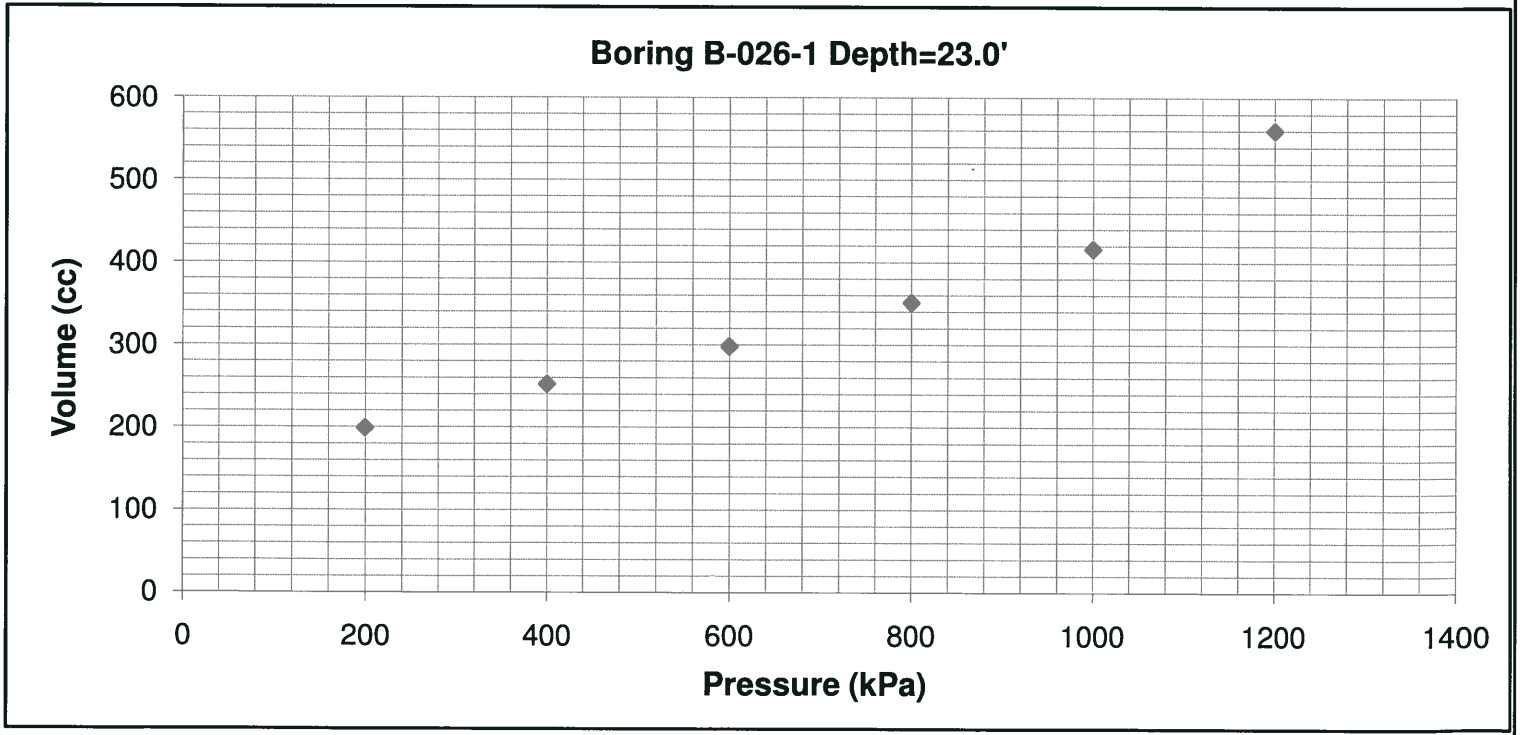
ASTM D 4719 - Method A

Project No.: 0221-1004.01
Test Date: 02/23/09
Boring Number: B-026-1
Operator: SJR
Driller: JP
Depth of Probe: 23.0 (ft)
Probe No. 1

Project Name: FRA-70
Probe Size: NX (2.76")
Height of Gage: 3.5 (ft)
Initial Water Level: 0 cc
Boring Method: Tricone with drilling fluid
Soil Description: Very stiff to hard Silt and Clay (A-6a)

FIELD DATA

Pressure (kPa)	Vol (cc) t=30 sec	Vol (cc) t=60 sec	Δ
200	138	199	
400	238	252	*53*
600	285	298	*46*
800	334	351	*53*
1000	391	416	*65*
1200	530	560	*144*
			Estimated



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-026-1	Test depth:	7.01 m
Test date: (dd/mm/yyyy)	23/02/2009	Manometer height above ground:	1.07 m
Test number:	1	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings			
Pressure kPa	Volume cm³	Pressure kPa	Volume cm³	$\Delta R/R_0$ %	
0	0.0	79	0.0	0.00	
200	199.0	166	198.9	11.94	◄
400	252.0	350	251.7	14.90	
600	298.0	539	297.6	17.41	
800	351.0	726	350.4	20.24	◄
1000	416.0	911	415.3	23.63	
1200	560.0	1081	559.2	30.82	

Test Results

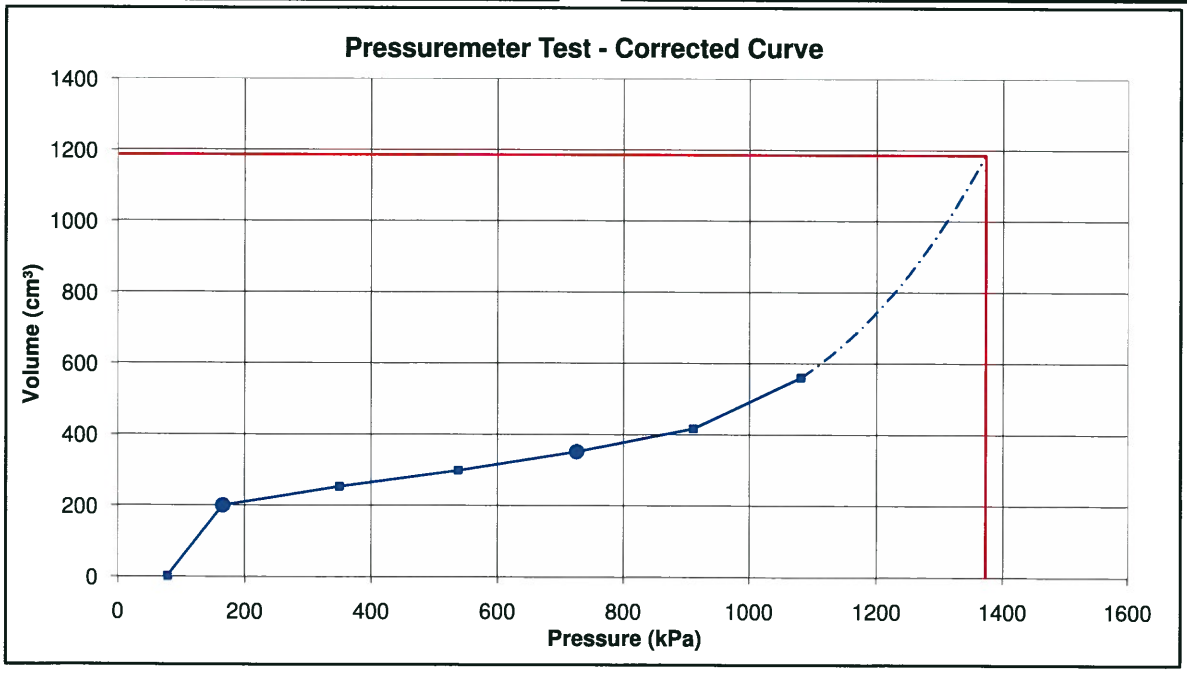
Pressiometric modulus E:	10,415 kPa
Ultimate pressure P_L:	1,372 kPa
Ratio E / P_L:	7.59
Yield pressure P_F:	726 kPa
Ratio P_L / P_F:	1.89

Calibration Sheet Reference

Probe No. 1

Remarks

Material: Very stiff gray SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; damp to moist. **Guard cell and central (water) cell burst due to void/disturbance at the top of the probe. It is believed that the test results are unaffected by this because the guard cell deformation prior to bursting was evidently at the very top of the probe, and did not affect the central cell.**



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-026-1	Test depth:	23.00 ft
Test date: (mm/dd/yyyy)	02/23/2009	Manometer height above ground:	3.50 ft
Test number:	1	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings			
Pressure psi	Volume in³	Pressure psi	Volume in³	$\Delta R/R_0$ %	
0	0.0	11	0.0	0.00	
29	12.1	24	12.1	11.94	◀
58	15.4	51	15.4	14.90	
87	18.2	78	18.2	17.41	
116	21.4	105	21.4	20.24	◀
145	25.4	132	25.3	23.63	
174	34.2	157	34.1	30.82	

Test Results

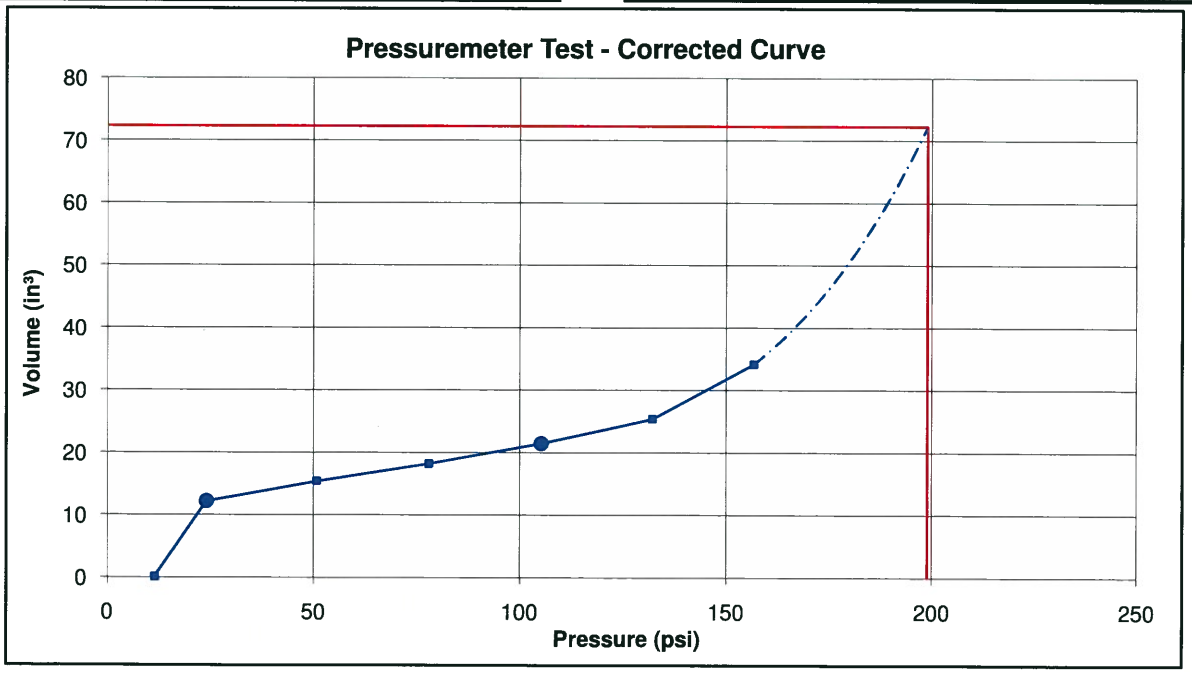
Pressiometric modulus E:	1,511 psi
Ultimate pressure P_L:	199 psi
Ratio E / P_L:	7.59
Yield pressure P_F:	105 psi
Ratio P_L / P_F:	1.89

Calibration Sheet Reference

Probe No. 1

Remarks

Material: Very stiff gray SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; damp to moist. **Guard cell and central (water) cell burst due to void/disturbance at the top of the probe. It is believed that the test results are unaffected by this because the guard cell deformation prior to bursting was evidently at the very top of the probe, and did not affect the central cell.**



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SUBJECT FRA-70-8.93
Pressuremeter Data

JOB NUMBER 0221-1004.01
SHEET NO. OF
COMP. BY SJR DATE 3/20/09
CHECKED BY DAA DATE 3/20/09

FIELD PRESSUREMETER DATA

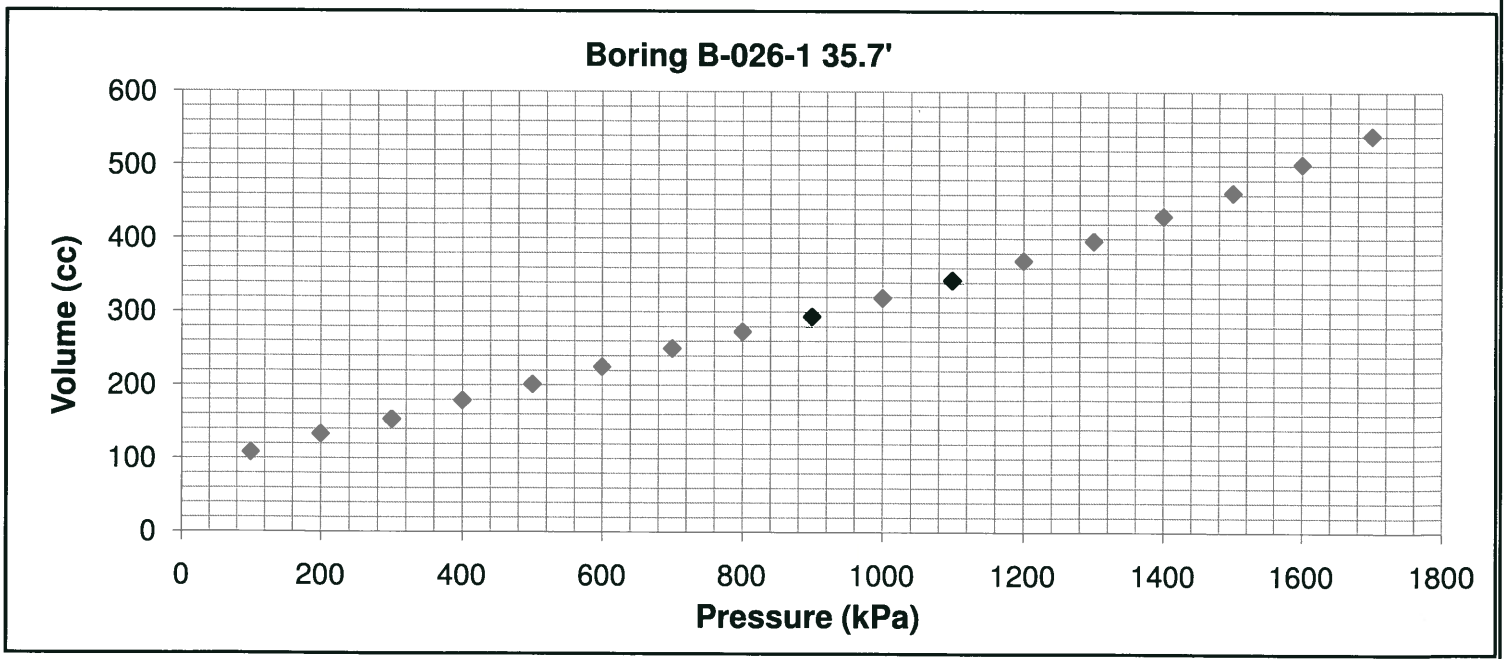
ASTM D 4719 - Method A

Project No.: 0221-1004.01
Test Date: 2/23/2009
Boring Number: B-026-1
Operator: SJR
Driller: JP
Depth of Probe: 35.7 (ft)
Probe No. 2

Project Name: FRA-70
Probe Size: NX (2.76")
Height of Gage: 3.5 (ft)
Initial Water Level: 0 cc
Boring Method: Tricone with drilling fluid
Soil Description: Very stiff to hard Sandy Silt (A-4a)

FIELD DATA

Pressure (kPa)	Vol (cc) t=30 sec	Vol (cc) t=60 sec	Δ
100	73	108	
200	129	133	*25*
300	148	153	*20*
400	172	179	*26*
500	196	201	*22*
600	218	225	*24*
700	244	250	*25*
800	265	273	*23*
900	287	294	*21*
1000	311	319	*25*
1100	335	344	*25*
1200	361	370	*26*
1300	387	397	*27*
1400	416	431	*34*
1500	449	463	*32*
1600	484	502	*39*
1700	524	541	*39*



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-026-1	Test depth:	10.88 m
Test date: (dd/mm/yyyy)	23/02/2009	Manometer height above ground:	1.07 m
Test number:	2	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings		
Pressure kPa	Volume cm³	Pressure kPa	Volume cm³	$\Delta R/R_0$ %
0	0.0	117	0.0	0.00
100	108.0	140	107.9	6.64
200	133.0	229	132.8	8.12
300	153.0	321	152.7	9.29 ◄
400	179.0	412	178.7	10.78
500	201.0	505	200.6	12.04
600	225.0	597	224.5	13.38
700	250.0	689	249.4	14.77
800	273.0	784	272.3	16.04
900	294.0	878	293.2	17.18 ◄
1000	319.0	972	318.2	18.52
1100	344.0	1066	343.1	19.85
1200	370.0	1160	369.0	21.22
1300	397.0	1254	395.9	22.63
1400	431.0	1347	429.8	24.37
1500	463.0	1440	461.7	25.99
1600	502.0	1532	500.6	27.94
1700	541.0	1624	539.6	29.86

Test Results

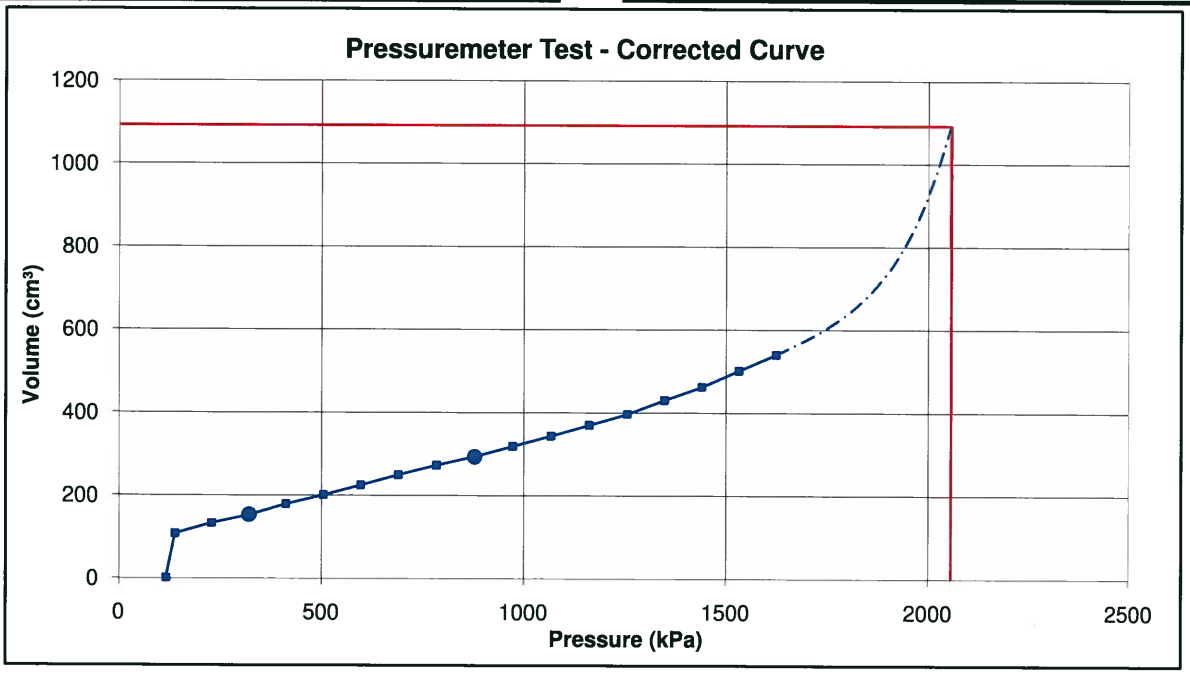
Pressiometric modulus E:	10,650 kPa
Ultimate pressure P_L:	2,057 kPa
Ratio E / P_L:	5.18
Yield pressure P_F:	878 kPa
Ratio P_L / P_F:	2.34

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Very stiff gray SILT AND CLAY (A-6a), little to some fine to coarse sand, trace to little gravel; damp to moist.



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-026-1	Test depth:	35.70 ft
Test date: (mm/dd/yyyy)	02/23/2009	Manometer height above ground:	3.50 ft
Test number:	2	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings		
Pressure psi	Volume in³	Pressure psi	Volume in³	$\Delta R/R_0$ %
0	0.0	17	0.0	0.00
15	6.6	20	6.6	6.64
29	8.1	33	8.1	8.12
44	9.3	47	9.3	9.29 ◄
58	10.9	60	10.9	10.78
73	12.3	73	12.2	12.04
87	13.7	87	13.7	13.38
102	15.3	100	15.2	14.77
116	16.7	114	16.6	16.04
131	17.9	127	17.9	17.18 ◄
145	19.5	141	19.4	18.52
160	21.0	155	20.9	19.85
174	22.6	168	22.5	21.22
189	24.2	182	24.2	22.63
203	26.3	195	26.2	24.37
218	28.3	209	28.2	25.99
232	30.6	222	30.6	27.94
247	33.0	236	32.9	29.86

Test Results

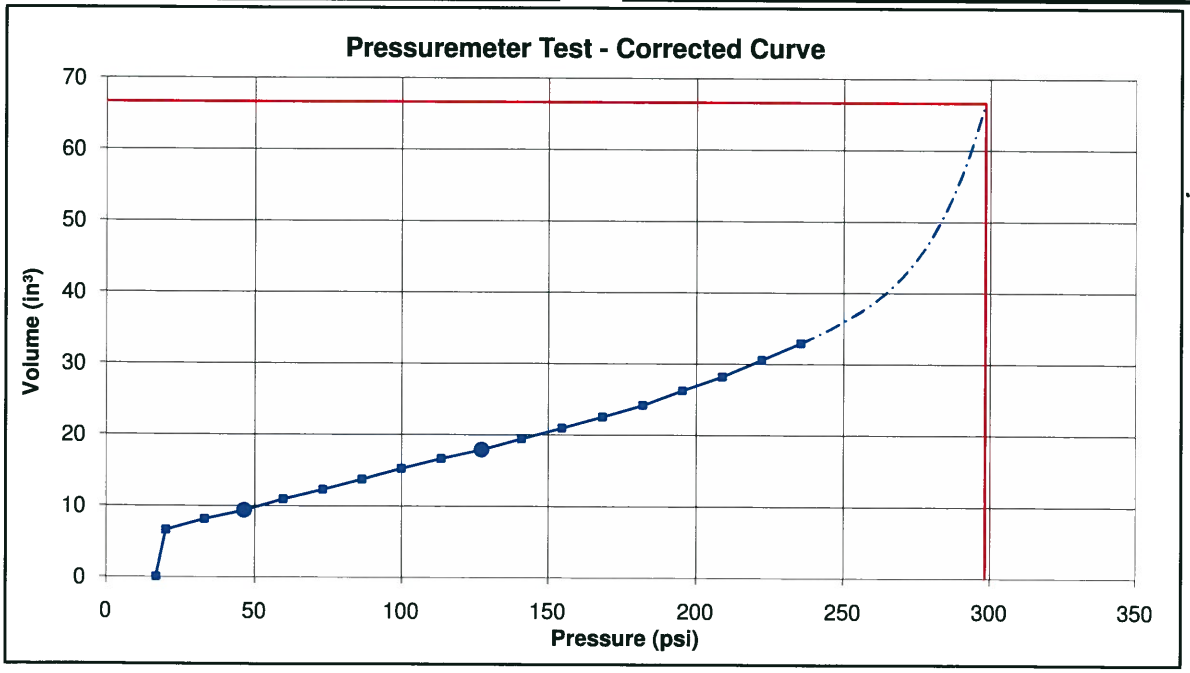
Pressiometric modulus E:	1,545 psi
Ultimate pressure P_L:	298 psi
Ratio E / P_L:	5.18
Yield pressure P_F:	127 psi
Ratio P_L / P_F:	2.34

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Very stiff gray SILT AND CLAY (A-6a), little to some fine to coarse sand, trace to little gravel; damp to moist.



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SUBJECT FRA-70-8.93
Pressuremeter Data

JOB NUMBER 0221-1004.01
SHEET NO. OF
COMP. BY SJR DATE 3/20/09
CHECKED BY DAA DATE 3/20/09

FIELD PRESSUREMETER DATA

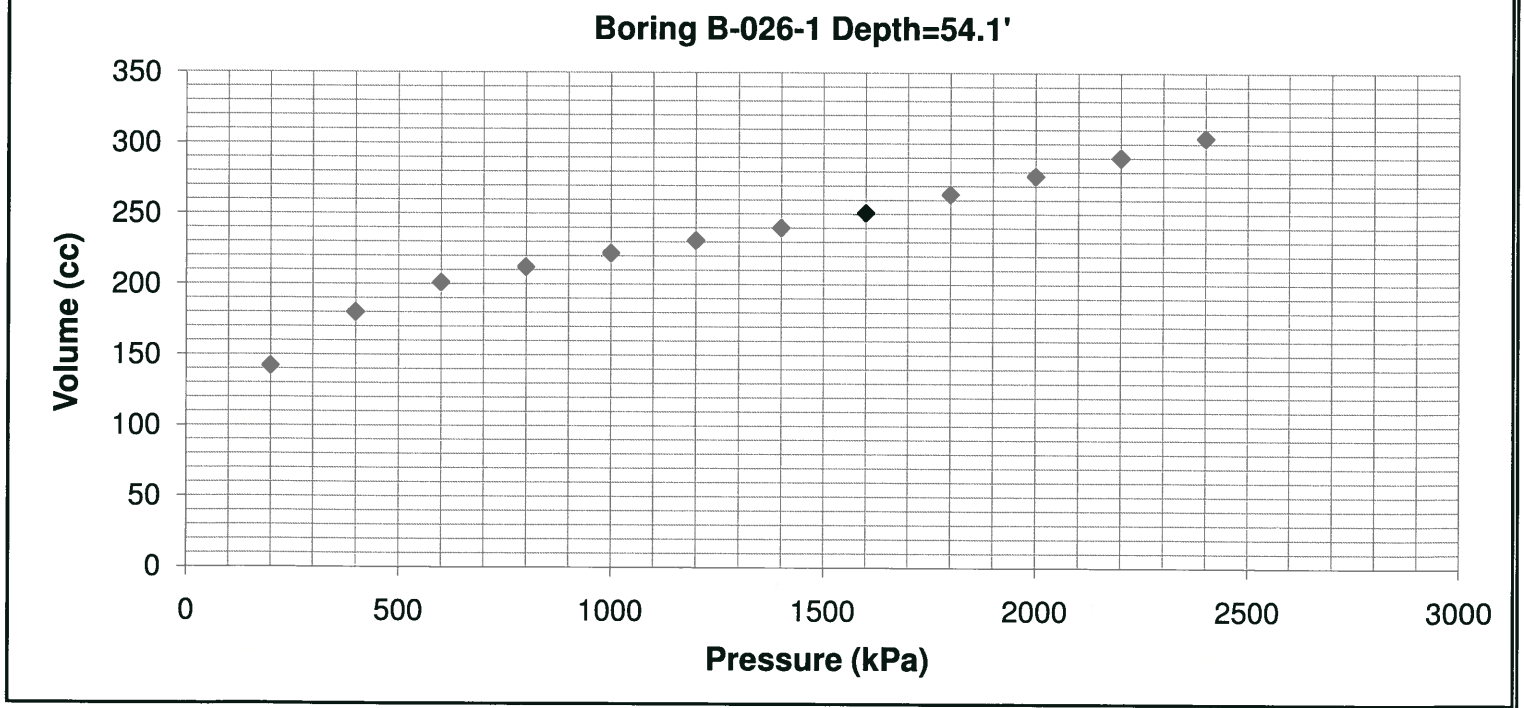
ASTM D 4719 - Method A

Project No.: 0221-1004.01
Test Date: 02/24/09
Boring Number: B-026-1
Operator: AJ
Driller: JP
Depth of Probe: 54.1 (ft)
Probe No. 2

Project Name: FRA-70
Probe Size: NX (2.76")
Height of Gage: 3.5 (ft)
Initial Water Level: 0 cc
Boring Method: Tricone with drilling fluid
Soil Description: Hard gray Silt and Clay (A-6a)

FIELD DATA

Pressure (kPa)	Vol (cc) t=30 sec	Vol (cc) t=60 sec	Δ
200	129	142	
400	176	180	*38*
600	197	201	*21*
800	210	212	*11*
1000	220	222	*10*
1200	230	231	*9*
1400	237	240	*9*
1600	248	251	*11*
1800	262	264	*13*
2000	275	277	*13*
2200	287	290	*13*
2400	300	304	*14*



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-026-1	Test depth:	16.49 m
Test date: (dd/mm/yyyy)	24/02/2009	Manometer height above ground:	1.07 m
Test number:	3	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings			
Pressure kPa	Volume cm³	Pressure kPa	Volume cm³	$\Delta R/R_0$ %	
0	0.0	172	0.0	0.00	
200	142.0	280	141.8	8.65	
400	180.0	466	179.7	10.84	
600	201.0	659	200.5	12.03	◄
800	212.0	856	211.3	12.64	
1000	222.0	1053	221.2	13.20	
1200	231.0	1250	230.0	13.69	
1400	240.0	1447	238.8	14.19	
1600	251.0	1644	249.6	14.79	◄
1800	264.0	1841	262.5	15.50	
2000	277.0	2038	275.3	16.20	
2200	290.0	2234	288.1	16.90	
2400	304.0	2431	302.0	17.65	

Test Results

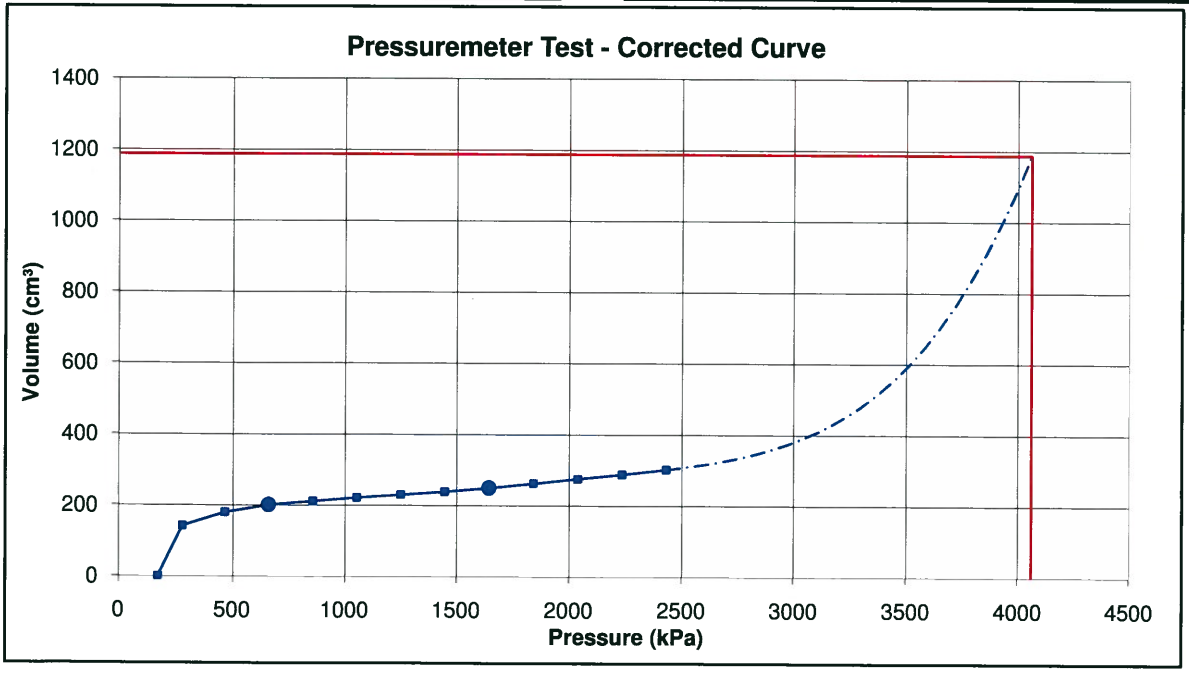
Pressiometric modulus E:	53,874 kPa
Ultimate pressure P_L:	4,060 kPa
Ratio E / P_L:	13.27
Yield pressure P_F:	1,644 kPa
Ratio P_L / P_F:	2.47

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Hard gray SILT AND CLAY (A-6a), some fine to coarse sand, trace to little gravel; contains sand seams; damp.



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-026-1	Test depth:	54.10 ft
Test date: (mm/dd/yyyy)	02/24/2009	Manometer height above ground:	3.50 ft
Test number:	3	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings			
Pressure psi	Volume in³	Pressure psi	Volume in³	$\Delta R/R_0$ %	
0	0.0	25	0.0	0.00	
29	8.7	41	8.7	8.65	
58	11.0	68	11.0	10.84	
87	12.3	96	12.2	12.03	◄
116	12.9	124	12.9	12.64	
145	13.5	153	13.5	13.20	
174	14.1	181	14.0	13.69	
203	14.6	210	14.6	14.19	
232	15.3	238	15.2	14.79	◄
261	16.1	267	16.0	15.50	
290	16.9	296	16.8	16.20	
319	17.7	324	17.6	16.90	
348	18.6	353	18.4	17.65	

Test Results

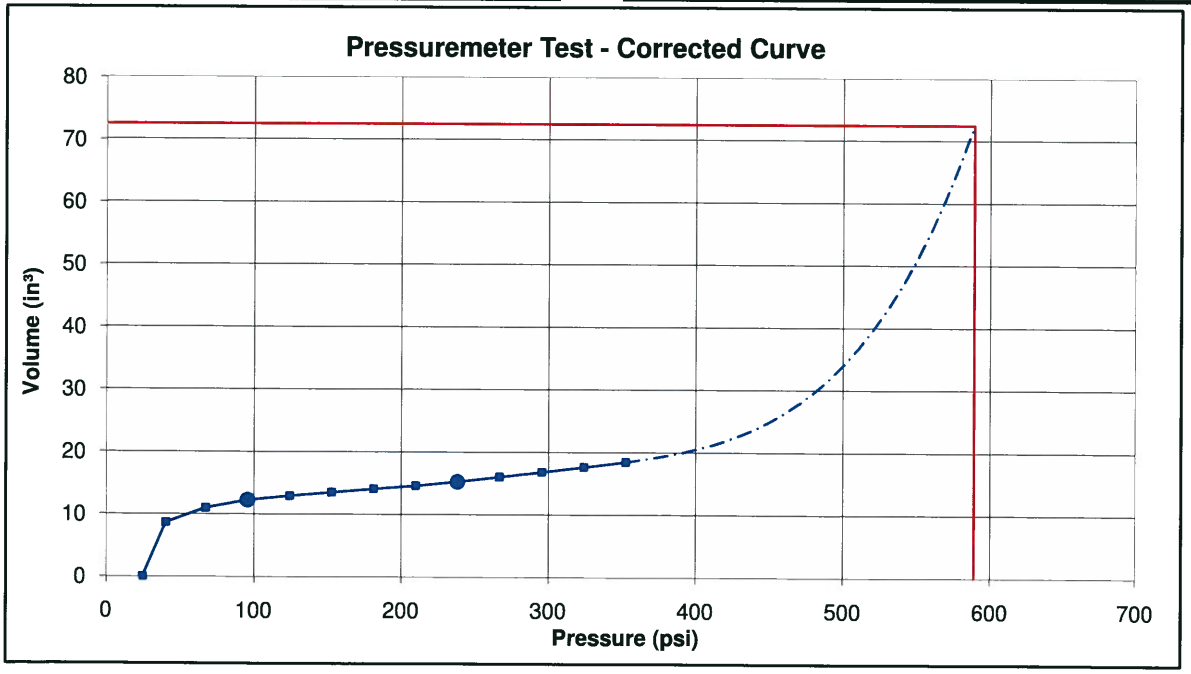
Pressiometric modulus E:	7,814 psi
Ultimate pressure P_L:	589 psi
Ratio E / P_L:	13.27
Yield pressure P_F:	238 psi
Ratio P_L / P_F:	2.47

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Hard gray SILT AND CLAY (A-6a), some fine to coarse sand, trace to little gravel; contains sand seams; damp.



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SUBJECT FRA-70-8.93
Pressuremeter Data

JOB NUMBER 0221-1004.01
SHEET NO. OF
COMP. BY SJR DATE 3/20/09
CHECKED BY DAA DATE 3/20/09

FIELD PRESSUREMETER DATA

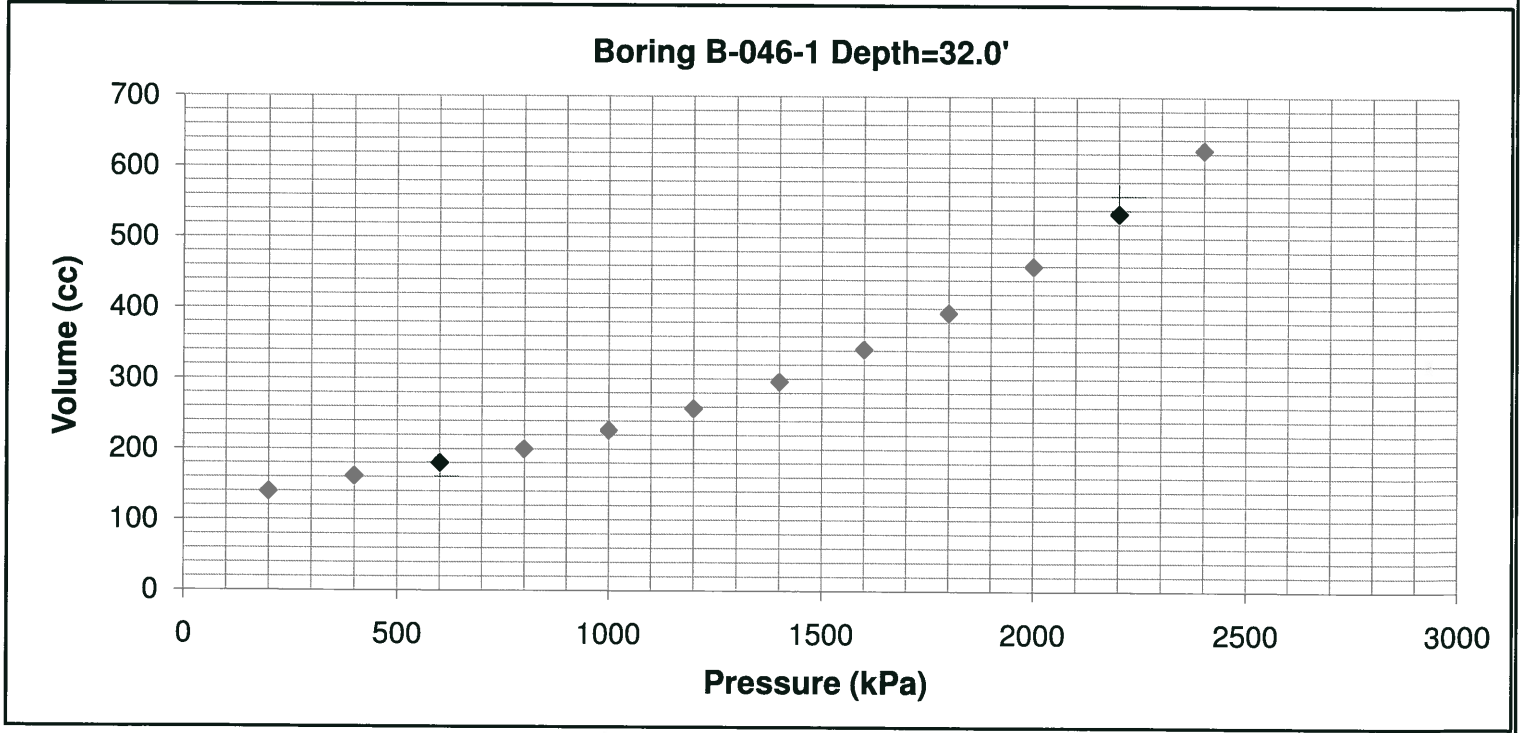
ASTM D 4719 - Method A

Project No.: 0221-1004.01
Test Date: 02/26/09
Boring Number: B-046-1
Operator: SJR
Driller: JP
Depth of Probe: 32.0 (ft)
Probe No. 2

Project Name: FRA-70
Probe Size: NX (2.76")
Height of Gage: 3.5 (ft)
Initial Water Level: 0 cc
Boring Method: Tricone with drilling fluid
Soil Description: Hard gray Silt and Clay (A-6a)

FIELD DATA

Pressure (kPa)	Vol (cc) t=30 sec	Vol (cc) t=60 sec	Δ
200	37	140	
400	158	162	*22*
600	177	180	*18*
800	196	200	*20*
1000	222	227	*27*
1200	250	258	*31*
1400	287	296	*38*
1600	327	342	*46*
1800	374	394	*52*
2000	436	460	*66*
2200	506	535	*75*
2400	585	*625*	*90*
			Estimated



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-046-1	Test depth:	9.75 m
Test date: (dd/mm/yyyy)	26/02/2009	Manometer height above ground:	1.07 m
Test number:	4	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings			
Pressure kPa	Volume cm³	Pressure kPa	Volume cm³	$\Delta R/R_0$ %	
0	0.0	106	0.0	0.00	
200	140.0	215	139.8	8.53	
400	162.0	406	161.7	9.80	◀
600	180.0	600	179.5	10.83	
800	200.0	794	199.3	11.96	
1000	227.0	985	226.2	13.48	◀
1200	258.0	1176	257.0	15.19	
1400	296.0	1367	294.8	17.26	
1600	342.0	1555	340.6	19.72	
1800	394.0	1744	392.5	22.45	
2000	460.0	1929	458.3	25.82	
2200	535.0	2114	533.1	29.55	
2400	625.0	2297	623.0	33.89	

Test Results

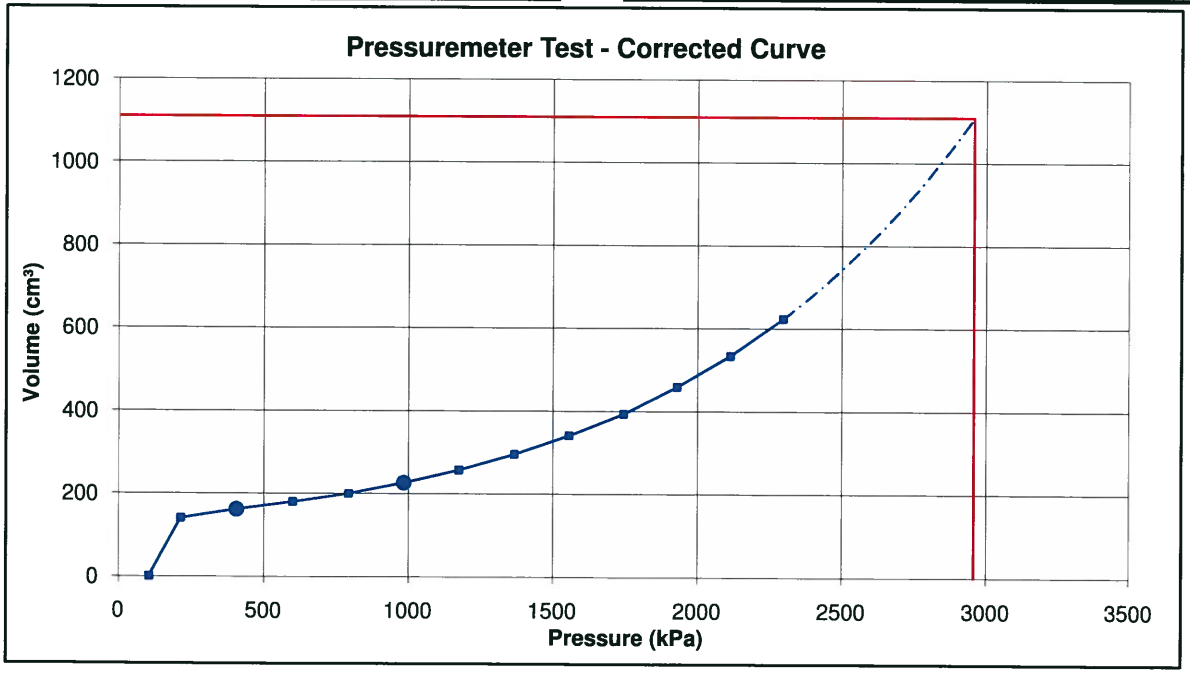
Pressiometric modulus E:	23,397 kPa
Ultimate pressure P_L:	2,957 kPa
Ratio E / P_L:	7.91
Yield pressure P_F:	985 kPa
Ratio P_L / P_F:	3.00

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Hard gray SILT AND CLAY (A-6a), some to "and" fine to coarse sand, little gravel; damp.



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-046-1	Test depth:	32.00 ft
Test date: (mm/dd/yyyy)	02/26/2009	Manometer height above ground:	3.50 ft
Test number:	4	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings		
Pressure psi	Volume in³	Pressure psi	Volume in³	$\Delta R/R_0$ %
0	0.0	15	0.0	0.00
29	8.5	31	8.5	8.53
58	9.9	59	9.9	9.80 ◀
87	11.0	87	11.0	10.83
116	12.2	115	12.2	11.96
145	13.9	143	13.8	13.48 ◀
174	15.7	171	15.7	15.19
203	18.1	198	18.0	17.26
232	20.9	226	20.8	19.72
261	24.0	253	24.0	22.45
290	28.1	280	28.0	25.82
319	32.6	307	32.5	29.55
348	38.1	333	38.0	33.89

Test Results

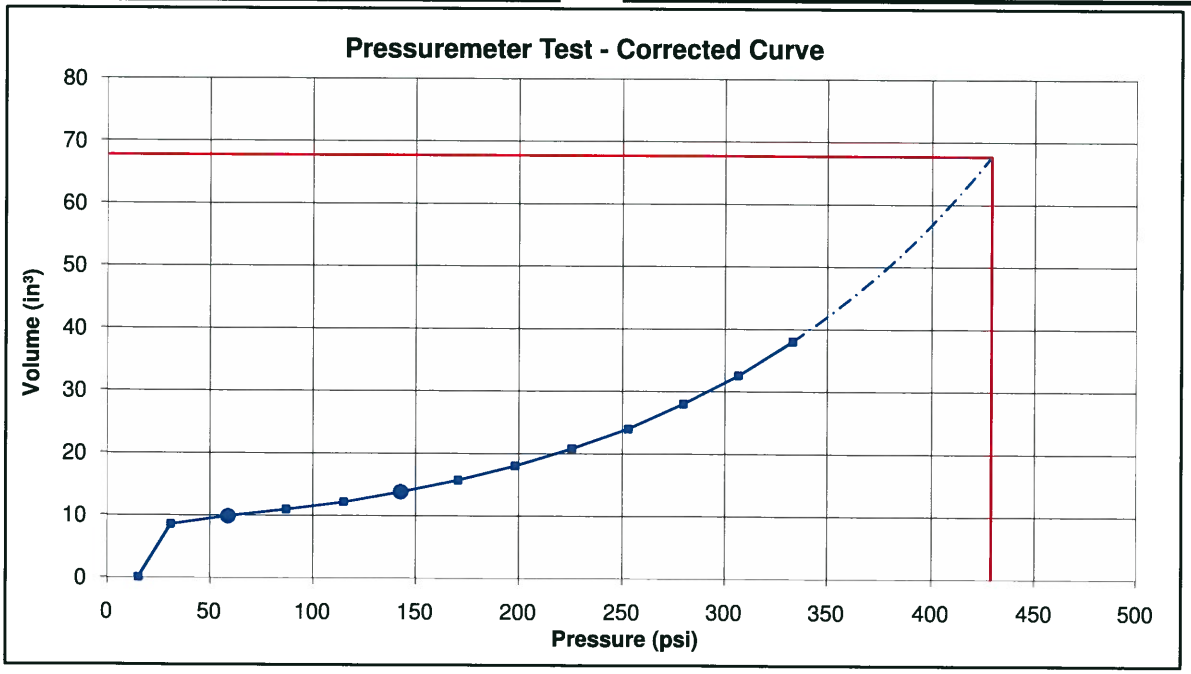
Pressiometric modulus E:	3,393 psi
Ultimate pressure P_L:	429 psi
Ratio E / P_L:	7.91
Yield pressure P_F:	143 psi
Ratio P_L / P_F:	3.00

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Hard gray SILT AND CLAY (A-6a), some to "and" fine to coarse sand, little gravel; damp.



DLZ

SUBJECT FRA-70-8.93
Pressuremeter Data

JOB NUMBER 0221-1004.01
SHEET NO. OF
COMP. BY SJR DATE 3/20/09
CHECKED BY DAA DATE 3/20/09

FIELD PRESSUREMETER DATA

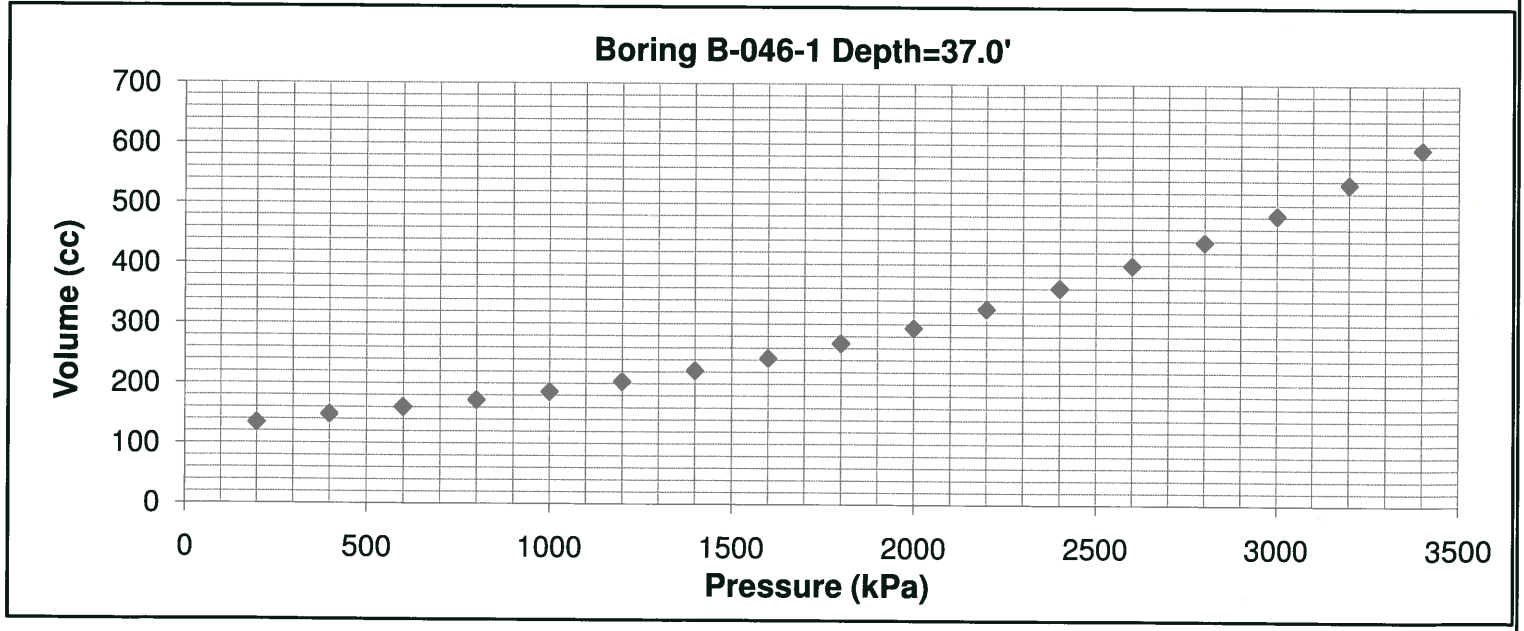
ASTM D 4719 - Method A

Project No.: 0221-1004.01
Test Date: 02/26/09
Boring Number: B-046-1
Operator: SJR
Driller: JP
Depth of Probe: 37.0 (ft)
Probe No. 2

Project Name: FRA-70
Probe Size: NX (2.76")
Height of Gage: 3.5 (ft)
Initial Water Level: 0 cc
Boring Method: Tricone with drilling fluid
Soil Description: Hard gray Silt and Clay (A-6a)

FIELD DATA

Pressure (kPa)	Vol (cc) t=30 sec	Vol (cc) t=60 sec	Δ
200	131	134	
400	146	148	*14*
600	157	160	*12*
800	170	172	*12*
1000	183	186	*14*
1200	199	203	*17*
1400	216	222	*19*
1600	238	243	*21*
1800	261	268	*25*
2000	286	294	*26*
2200	315	326	*32*
2400	349	361	*35*
2600	386	399	*38*
2800	425	438	*39*
3000	465	483	*45*
3200	513	535	*52*
3400	567	593	*58*



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-046-1	Test depth:	11.28 m
Test date: (dd/mm/yyyy)	26/02/2009	Manometer height above ground:	1.07 m
Test number:	5	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings			
Pressure kPa	Volume cm³	Pressure kPa	Volume cm³	$\Delta R/R_0$ %	
0	0.0	121	0.0	0.00	
200	134.0	233	133.8	8.18	
400	148.0	427	147.7	8.99	◀
600	160.0	622	159.5	9.68	
800	172.0	818	171.3	10.36	
1000	186.0	1013	185.2	11.16	◀
1200	203.0	1208	202.0	12.12	
1400	222.0	1402	220.8	13.18	
1600	243.0	1595	241.6	14.34	
1800	268.0	1789	266.5	15.72	
2000	294.0	1982	292.3	17.13	
2200	326.0	2174	324.1	18.84	
2400	361.0	2366	359.0	20.69	
2600	399.0	2558	396.8	22.67	
2800	438.0	2749	435.6	24.67	
3000	483.0	2940	480.5	26.94	
3200	535.0	3129	532.3	29.51	
3400	593.0	3318	590.1	32.32	

Test Results

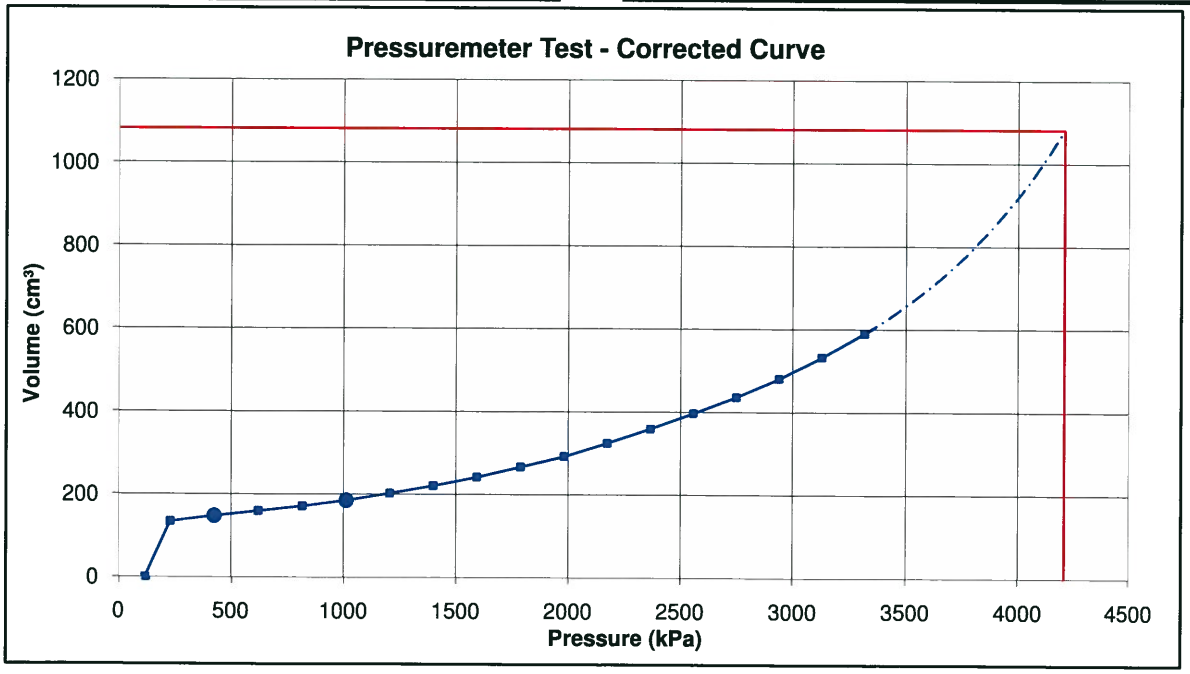
Pressiometric modulus E:	39,621 kPa
Ultimate pressure P_L:	4,206 kPa
Ratio E / P_L:	9.42
Yield pressure P_F:	1,013 kPa
Ratio P_L / P_F:	4.15

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Hard gray SILT AND CLAY (A-6a), some to "and" fine to coarse sand, little gravel; damp.



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-046-1	Test depth:	37.00 ft
Test date: (mm/dd/yyyy)	02/26/2009	Manometer height above ground:	3.50 ft
Test number:	5	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings		
Pressure psi	Volume in³	Pressure psi	Volume in³	$\Delta R/R_0$ %
0	0.0	18	0.0	0.00
29	8.2	34	8.2	8.18
58	9.0	62	9.0	8.99 ◀
87	9.8	90	9.7	9.68
116	10.5	119	10.5	10.36
145	11.4	147	11.3	11.16 ◀
174	12.4	175	12.3	12.12
203	13.5	203	13.5	13.18
232	14.8	231	14.7	14.34
261	16.4	259	16.3	15.72
290	17.9	288	17.8	17.13
319	19.9	315	19.8	18.84
348	22.0	343	21.9	20.69
377	24.3	371	24.2	22.67
406	26.7	399	26.6	24.67
435	29.5	426	29.3	26.94
464	32.6	454	32.5	29.51
493	36.2	481	36.0	32.32

Test Results

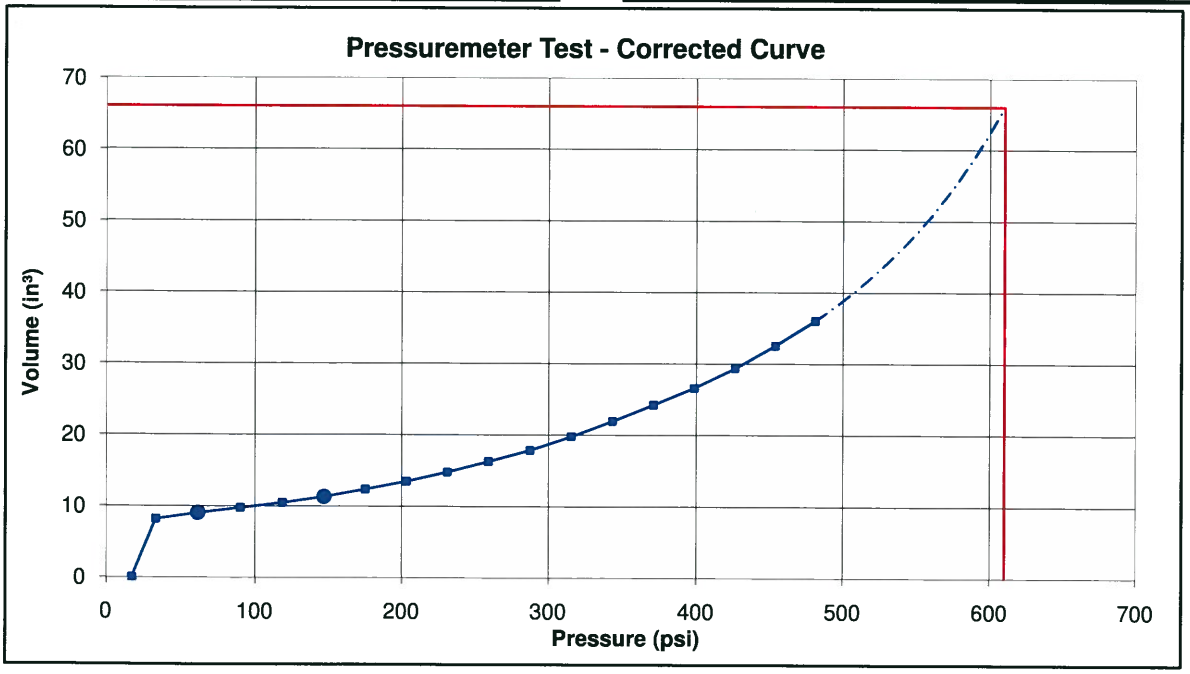
Pressiometric modulus E:	5,747 psi
Ultimate pressure P_L:	610 psi
Ratio E / P_L:	9.42
Yield pressure P_F:	147 psi
Ratio P_L / P_F:	4.15

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Hard gray SILT AND CLAY (A-6a), some to "and" fine to coarse sand, little gravel; damp.



DLZ

SUBJECT FRA-70-8.93
Pressuremeter Data

JOB NUMBER 0221-1004.01
SHEET NO. OF
COMP. BY SJR DATE 3/20/09
CHECKED BY DAA DATE 3/20/09

FIELD PRESSUREMETER DATA

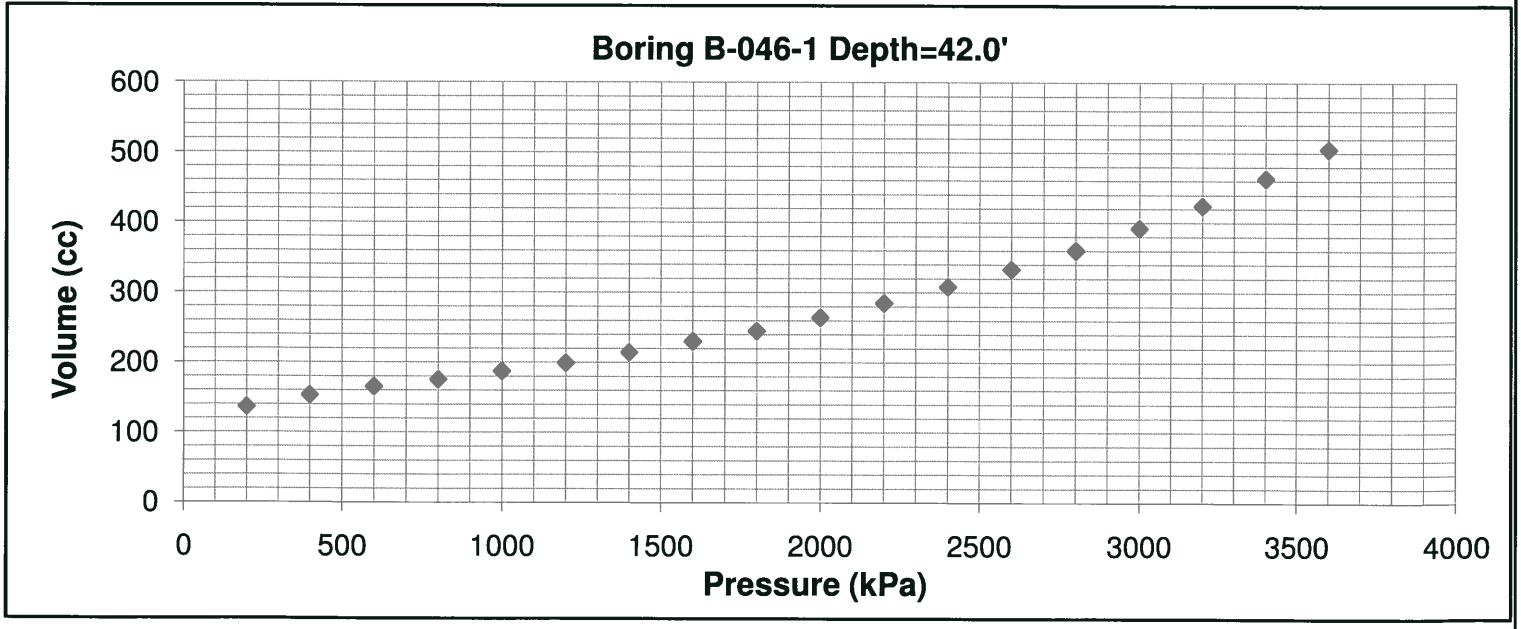
ASTM D 4719 - Method A

Project No.: 0221-1004.01
Test Date: 02/27/09
Boring Number: B-046-1
Operator: SJR
Driller: JP
Depth of Probe: 42.0 (ft)
Probe No. 2

Project Name: FRA-70
Probe Size: NX (2.76")
Height of Gage: 3.5 (ft)
Initial Water Level: 0 cc
Boring Method: Tricone with drilling fluid
Soil Description: Hard gray Silt and Clay (A-6a)

FIELD DATA

Pressure (kPa)	Vol (cc) t=30 sec	Vol (cc) t=60 sec	Δ
200	134	136	
400	148	153	*17*
600	162	165	*12*
800	173	175	*10*
1000	184	187	*12*
1200	197	199	*12*
1400	211	214	*15*
1600	226	230	*16*
1800	242	245	*15*
2000	259	264	*19*
2200	277	285	*21*
2400	299	308	*23*
2600	324	333	*25*
2800	351	360	*27*
3000	380	392	*32*
3200	410	424	*32*
3400	447	463	*39*
3600	487	505	*42*



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-046-1	Test depth:	12.80 m
Test date: (dd/mm/yyyy)	27/02/2009	Manometer height above ground:	1.07 m
Test number:	6	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings		
Pressure kPa	Volume cm³	Pressure kPa	Volume cm³	$\Delta R/R_0$ %
0	0.0	136	0.0	0.00
200	136.0	247	135.8	8.30
400	153.0	440	152.7	9.28
600	165.0	635	164.5	9.97 ◄
800	175.0	832	174.3	10.53
1000	187.0	1028	186.2	11.21
1200	199.0	1224	198.0	11.89
1400	214.0	1419	212.8	12.73
1600	230.0	1614	228.6	13.62
1800	245.0	1809	243.5	14.45 ◄
2000	264.0	2005	262.3	15.49
2200	285.0	2199	283.1	16.63
2400	308.0	2394	306.0	17.87
2600	333.0	2587	330.8	19.20
2800	360.0	2781	357.6	20.62
3000	392.0	2974	389.5	22.29
3200	424.0	3167	421.3	23.94
3400	463.0	3359	460.1	25.91
3600	505.0	3550	502.0	28.01

Test Results

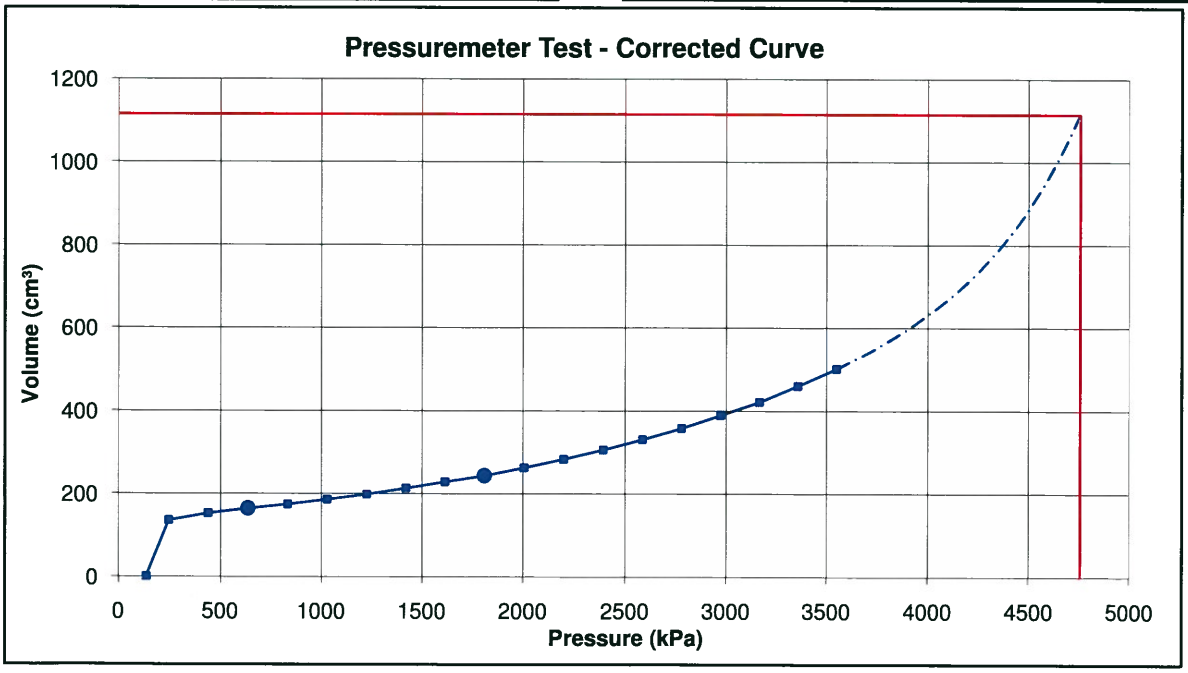
Pressiometric modulus E:	39,156 kPa
Ultimate pressure P_L:	4,752 kPa
Ratio E / P_L:	8.24
Yield pressure P_F:	1,809 kPa
Ratio P_L / P_F:	2.63

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Hard gray SILT AND CLAY (A-6a), some to "and" fine to coarse sand, little gravel; damp.



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-046-1	Test depth:	42.00 ft
Test date: (mm/dd/yyyy)	02/27/2009	Manometer height above ground:	3.50 ft
Test number:	6	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings			
Pressure psi	Volume in³	Pressure psi	Volume in³	$\Delta R/R_0$ %	
0	0.0	20	0.0	0.00	
29	8.3	36	8.3	8.30	
58	9.3	64	9.3	9.28	
87	10.1	92	10.0	9.97	◄
116	10.7	121	10.6	10.53	
145	11.4	149	11.4	11.21	
174	12.1	178	12.1	11.89	
203	13.1	206	13.0	12.73	
232	14.0	234	14.0	13.62	
261	15.0	262	14.9	14.45	◄
290	16.1	291	16.0	15.49	
319	17.4	319	17.3	16.63	
348	18.8	347	18.7	17.87	
377	20.3	375	20.2	19.20	
406	22.0	403	21.8	20.62	
435	23.9	431	23.8	22.29	
464	25.9	459	25.7	23.94	
493	28.3	487	28.1	25.91	
522	30.8	515	30.6	28.01	

Test Results

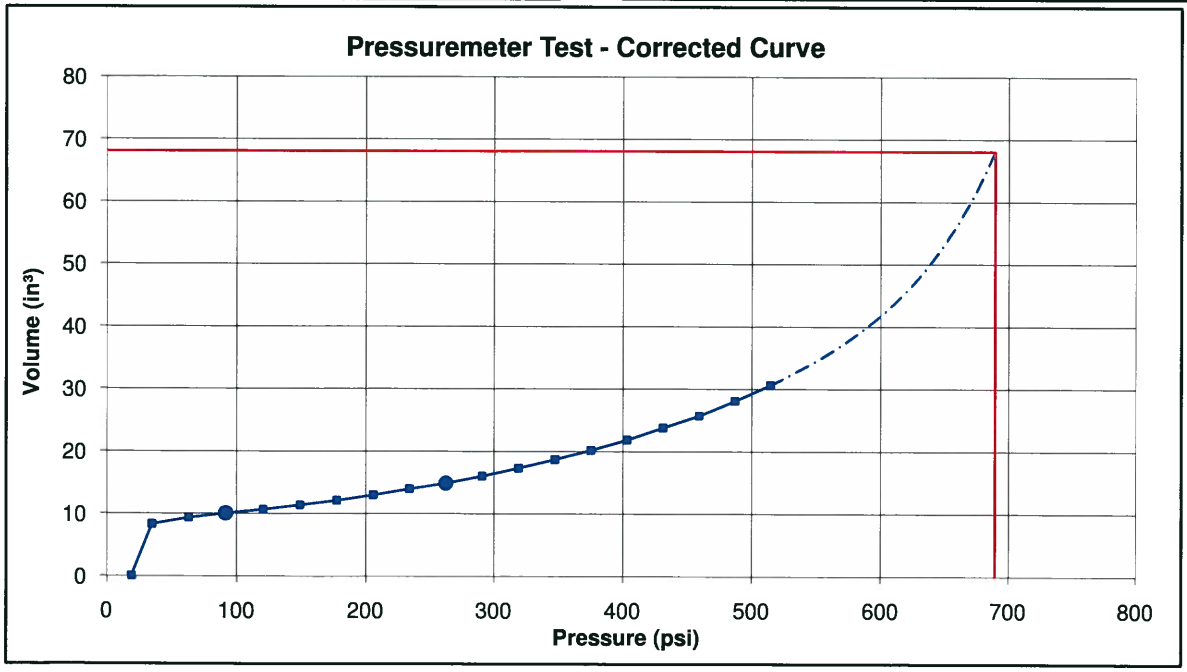
Pressiometric modulus E:	5,679 psi
Ultimate pressure P_L:	689 psi
Ratio E / P_L:	8.24
Yield pressure P_F:	262 psi
Ratio P_L / P_F:	2.63

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Hard gray SILT AND CLAY (A-6a), some to "and" fine to coarse sand, little gravel; damp.



DLZ

SUBJECT FRA-70-8.93
Pressuremeter Data

JOB NUMBER 0221-1004.01
SHEET NO. OF
COMP. BY SJR DATE 3/20/09
CHECKED BY DAA DATE 3/20/09

FIELD PRESSUREMETER DATA

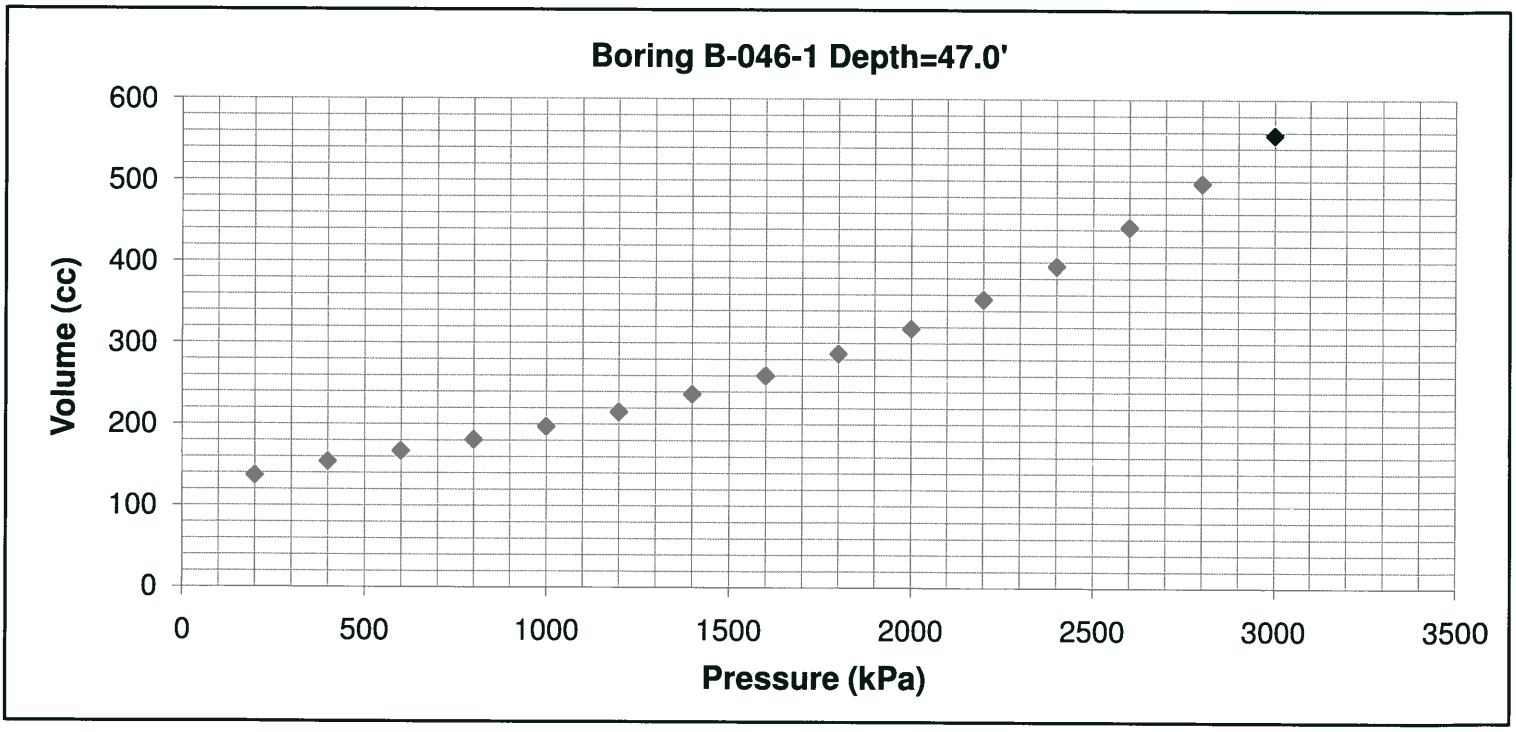
ASTM D 4719 - Method A

Project No.: 0221-1004.01
Test Date: 02/27/09
Boring Number: B-046-1
Operator: SJR
Driller: JP
Depth of Probe: 47.0 (ft)
Probe No. 2

Project Name: FRA-70
Probe Size: NX (2.76")
Height of Gage: 3.5 (ft)
Initial Water Level: 0 cc
Boring Method: Tricone with drilling fluid
Soil Description: Hard gray Silt and Clay (A-6a)

FIELD DATA

Pressure (kPa)	Vol (cc) t=30 sec	Vol (cc) t=60 sec	Δ
200	135	137	
400	152	154	*17*
600	165	167	*13*
800	178	181	*14*
1000	194	197	*16*
1200	211	215	*18*
1400	232	237	*22*
1600	253	260	*23*
1800	278	287	*27*
2000	309	318	*31*
2200	342	354	*36*
2400	381	395	*41*
2600	424	443	*48*
2800	474	497	*54*
3000	533	557	*60*



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-046-1	Test depth:	14.33 m
Test date: (dd/mm/yyyy)	27/02/2009	Manometer height above ground:	1.07 m
Test number:	7	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings			
Pressure kPa	Volume cm³	Pressure kPa	Volume cm³	$\Delta R/R_0$ %	
0	0.0	151	0.0	0.00	
200	137.0	261	136.8	8.36	
400	154.0	454	153.7	9.34	◄
600	167.0	649	166.5	10.08	
800	181.0	845	180.3	10.88	
1000	197.0	1040	196.2	11.78	
1200	215.0	1234	214.0	12.79	◄
1400	237.0	1427	235.8	14.02	
1600	260.0	1621	258.6	15.29	
1800	287.0	1814	285.5	16.76	
2000	318.0	2006	316.3	18.42	
2200	354.0	2198	352.1	20.33	
2400	395.0	2389	393.0	22.47	
2600	443.0	2578	440.8	24.93	
2800	497.0	2767	494.6	27.64	
3000	557.0	2955	554.5	30.59	

Test Results

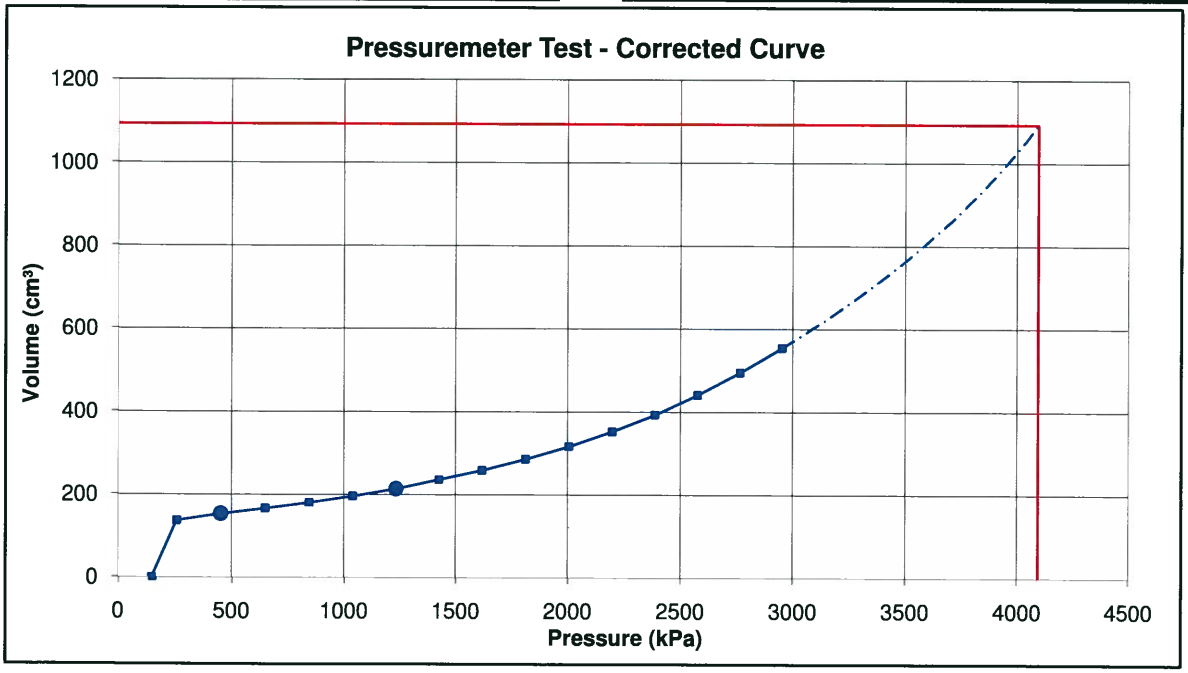
Pressiometric modulus E:	33,333 kPa
Ultimate pressure P_L:	4,094 kPa
Ratio E / P_L:	8.14
Yield pressure P_F:	1,234 kPa
Ratio P_L / P_F:	3.32

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Hard gray SILT AND CLAY (A-6a), some to "and" fine to coarse sand, little gravel; damp.



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-046-1	Test depth:	47.00 ft
Test date: (mm/dd/yyyy)	02/27/2009	Manometer height above ground:	3.50 ft
Test number:	7	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings			
Pressure psi	Volume in³	Pressure psi	Volume in³	$\Delta R/R_0$ %	
0	0.0	22	0.0	0.00	
29	8.4	38	8.3	8.36	
58	9.4	66	9.4	9.34	◄
87	10.2	94	10.2	10.08	
116	11.0	123	11.0	10.88	
145	12.0	151	12.0	11.78	
174	13.1	179	13.1	12.79	◄
203	14.5	207	14.4	14.02	
232	15.9	235	15.8	15.29	
261	17.5	263	17.4	16.76	
290	19.4	291	19.3	18.42	
319	21.6	319	21.5	20.33	
348	24.1	346	24.0	22.47	
377	27.0	374	26.9	24.93	
406	30.3	401	30.2	27.64	
435	34.0	429	33.8	30.59	

Test Results

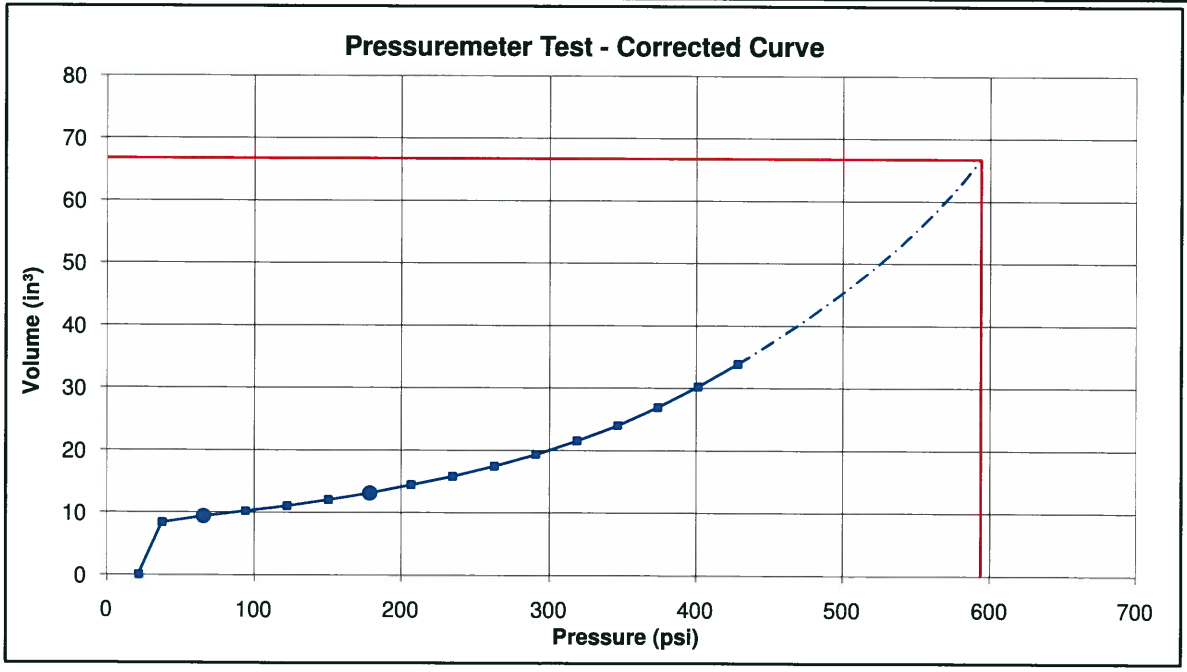
Pressiometric modulus E:	4,835 psi
Ultimate pressure P_L:	594 psi
Ratio E / P_L:	8.14
Yield pressure P_F:	179 psi
Ratio P_L / P_F:	3.32

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Hard gray SILT AND CLAY (A-6a), some to "and" fine to coarse sand, little gravel; damp.



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SUBJECT FRA-70-8.93
Pressuremeter Data

JOB NUMBER 0221-1004.01
SHEET NO. OF
COMP. BY SJR DATE 3/20/09
CHECKED BY DAA DATE 3/20/09

FIELD PRESSUREMETER DATA

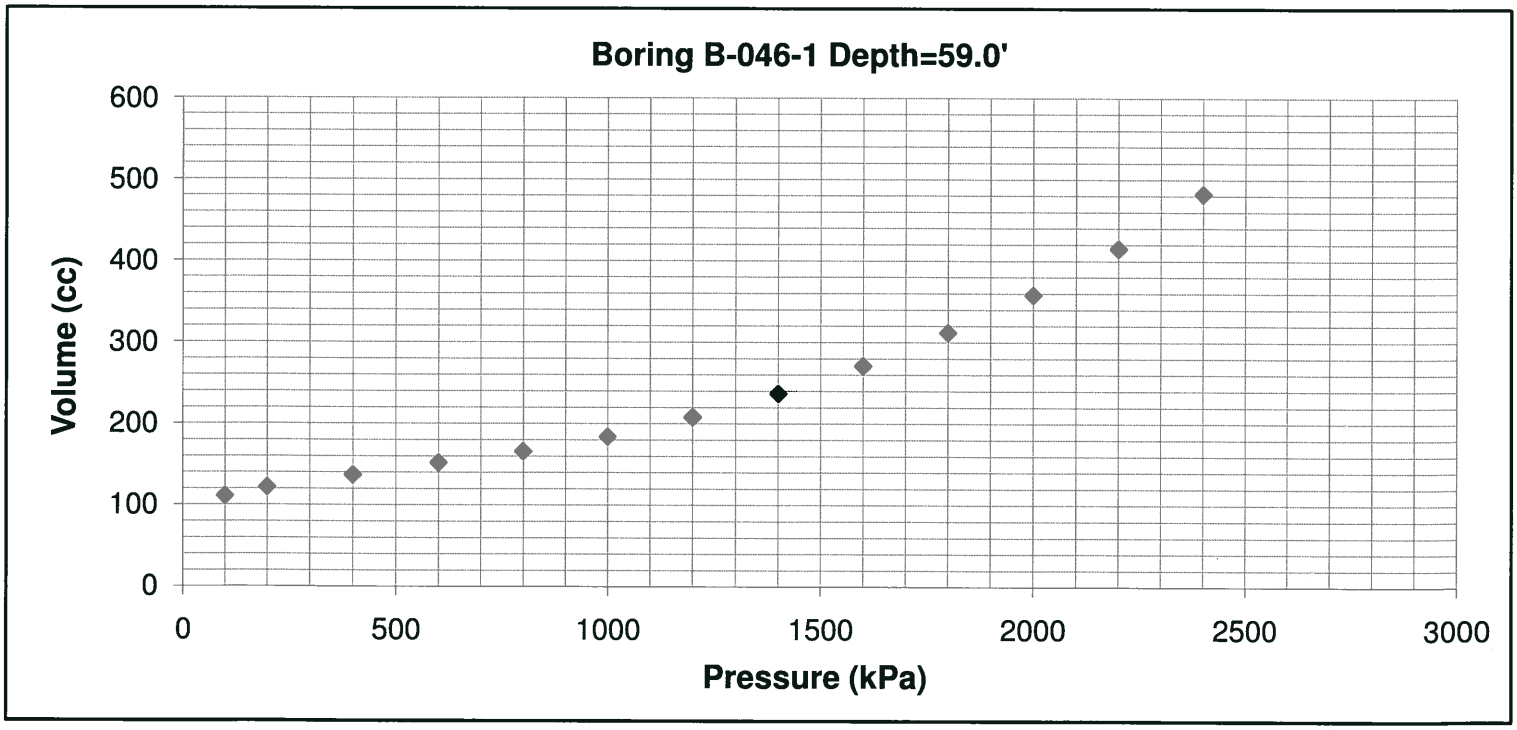
ASTM D 4719 - Method A

Project No.: 0221-1004.01
Test Date: 03/03/09
Boring Number: B-046-1
Operator: SJR
Driller: JP
Depth of Probe: 59.0 (ft)
Probe No. 2

Project Name: FRA-70
Probe Size: NX (2.76")
Height of Gage: 3.5 (ft)
Initial Water Level: 0 cc
Boring Method: Tricone with drilling fluid
Soil Description: Hard gray Sandy Silt (A-4a)

FIELD DATA

Pressure (kPa)	Vol (cc) t=30 sec	Vol (cc) t=60 sec	Δ
100	91	111	
200	120	122	*11*
400	135	137	*15*
600	148	152	*15*
800	163	166	*14*
1000	181	184	*18*
1200	203	208	*24*
1400	229	237	*29*
1600	261	271	*34*
1800	297	312	*41*
2000	342	358	*46*
2200	394	415	*57*
2400	455	482	*67*



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-046-1	Test depth:	17.98 m
Test date: (dd/mm/yyyy)	03/03/2009	Manometer height above ground:	1.07 m
Test number:	8	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings			
Pressure kPa	Volume cm³	Pressure kPa	Volume cm³	$\Delta R/R_0$ %	
0	0.0	187	0.0	0.00	
100	111.0	208	110.9	6.82	
200	122.0	303	121.8	7.47	◄
400	137.0	497	136.7	8.35	
600	152.0	691	151.5	9.21	
800	166.0	886	165.3	10.02	◄
1000	184.0	1080	183.2	11.04	
1200	208.0	1272	207.0	12.40	
1400	237.0	1462	235.8	14.02	
1600	271.0	1654	269.6	15.89	
1800	312.0	1844	310.5	18.11	
2000	358.0	2033	356.3	20.55	
2200	415.0	2220	413.1	23.52	
2400	482.0	2406	480.0	26.91	

Test Results

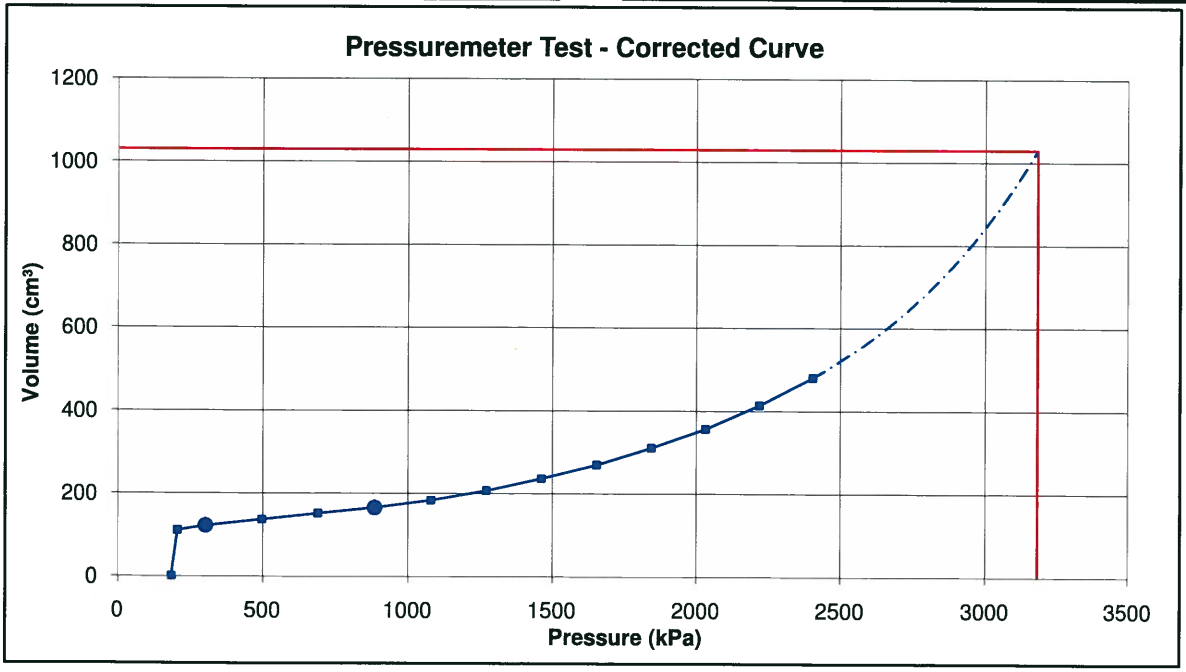
Pressiometric modulus E:	33,090 kPa
Ultimate pressure P_L:	3,183 kPa
Ratio E / P_L:	10.40
Yield pressure P_F:	886 kPa
Ratio P_L / P_F:	3.59

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Hard gray Sandy Silt (A-4a), some fine to coarse sand, trace gravel; damp.



G-AM Pressuremeter Test

Project name:	FRA -70 South Innerbelt	Use of a slotted casing:	No
Borehole name:	B-046-1	Test depth:	59.00 ft
Test date: (mm/dd/yyyy)	03/03/2009	Manometer height above ground:	3.50 ft
Test number:	8	Poisson's coefficient:	0.33
Probe size:	N	Fluid density:	1.000

Raw Readings		Corrected Readings			
Pressure psi	Volume in³	Pressure psi	Volume in³	$\Delta R/R_0$ %	
0	0.0	27	0.0	0.00	
15	6.8	30	6.8	6.82	
29	7.4	44	7.4	7.47	◄
58	8.4	72	8.3	8.35	
87	9.3	100	9.2	9.21	
116	10.1	128	10.1	10.02	◄
145	11.2	157	11.2	11.04	
174	12.7	184	12.6	12.40	
203	14.5	212	14.4	14.02	
232	16.5	240	16.5	15.89	
261	19.0	267	18.9	18.11	
290	21.8	295	21.7	20.55	
319	25.3	322	25.2	23.52	
348	29.4	349	29.3	26.91	

Test Results

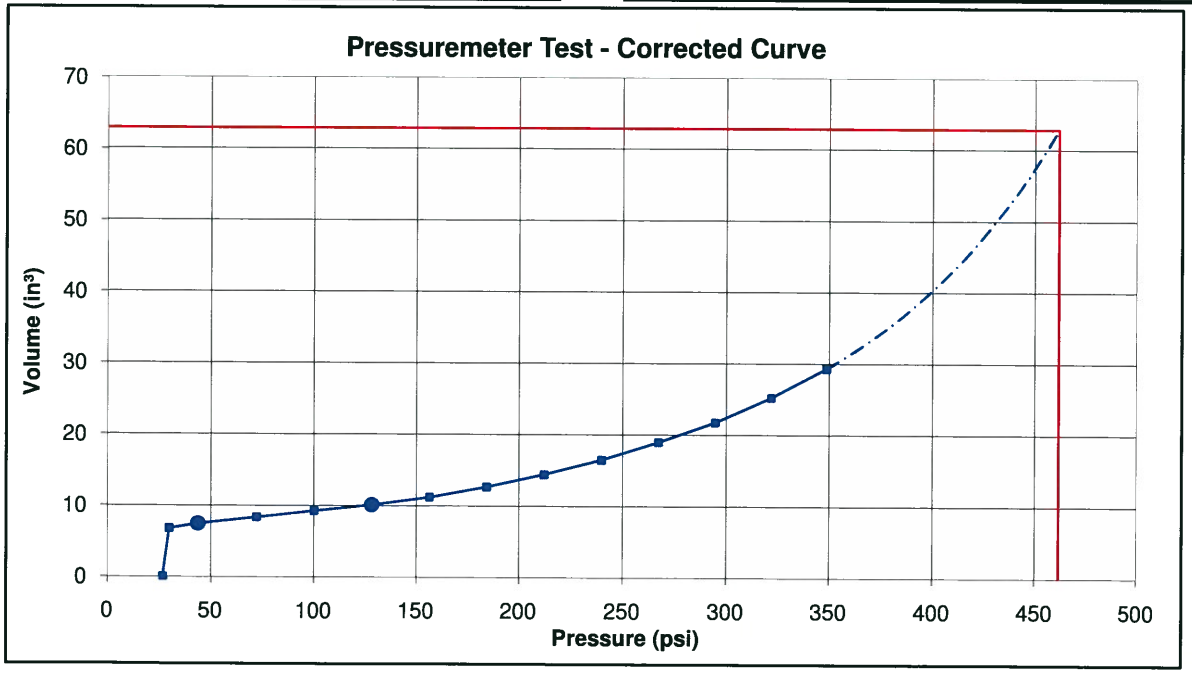
Pressiometric modulus E:	4,799 psi
Ultimate pressure P_L:	462 psi
Ratio E / P_L:	10.40
Yield pressure P_F:	128 psi
Ratio P_L / P_F:	3.59

Calibration Sheet Reference

Probe No. 2

Remarks

Material: Hard gray Sandy Silt (A-4a), some fine to coarse sand, trace gravel; damp.



Predicted p-y Curves

(Example curves for 48-inch diameter drilled shafts)

Definition of Terms: Predicted p-y Curves for Soil

Test depth (DCM) is defined as the depth from the ground surface to the center of the central measuring cell (center of the probe).

Probe diameter is the uninflated probe diameter. For N-sized probe, this value is 70 mm.

Initial Volume of probe is 790 cc.

Pile diameter (b).

Reduction or multiplication factor (α) is determined by correlations established by Robertson et al (1983).

DLZ

SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-026-1 N_{60}= 18
Soil Type: A-6a (Glacial Till) *Clay*
Test Depth: 23.0 feet
Test Type: PMT - Menard
Probe Dia.: 70.0 mm
2.76 inches
Radius of Probe: 35.0 mm
1.38 inches
Initial Volume: 790 cc
48.21 in^3
Probe Depth (DCM): 23.0 feet
276 inches
Shaft Diameter (b): 48 inches

Reduction Factor: (α) *(see following page)*

If $\frac{DCM}{b} > 4$ α= 1.5 for sand
α= 2.0 for clay

If $\frac{DCM}{b} \le 4$ $\alpha = \frac{1.5 \cdot DCM}{4 \cdot b}$ for sand

$\alpha = 0.67 + \frac{2.0 \cdot DCM}{4 \cdot b}$ for clay

Equations:

Eqn 1 $P = P_{Corrected} \cdot b \cdot \alpha$

Eqn 2 $Y = \frac{V_{Adj}}{2 \cdot V_0} \cdot \frac{b}{2}$

Corrected Pressuremeter Readings with Adjustments for Zero-Level

Zero Point Volume Adjustment: -10.5 in3
Initial In-Situ Pressure, P_{oh}: 6.8 psi

α= 2.00

Point No.	Press. (psi)	Vol. (in^3)	Zero Adjustment Press (psi)	Zero Adjustment Vol. (in^3)	Adjusted Origin Press (psi)	Adjusted Origin Vol. (in^3)	P (kip/in)	y (in)
	0	0	0	0	0.00	0	0.00	0.000
1	11	0.0	-6.8	0.5	4.20	0.5	0.40	0.124
2	24	12.1	-6.8	-10.0	17.20	2.1	1.65	0.523
3	51	15.4	-6.8	-10.5	44.20	4.9	4.24	1.220
4	78	18.2	-6.8	-10.5	71.20	7.7	6.84	1.917
5	105	21.4	-6.8	-10.5	98.20	10.9	9.43	2.713
6	132	25.3	-6.8	-10.5	125.20	14.8	12.02	3.684
7	157	34.1	-6.8	-10.5	150.20	23.6	14.42	5.87
8	171	42.9	-6.8	-10.5	164.20	32.4	15.76	8.07
9	187	57.2	-6.8	-10.5	180.20	46.7	17.30	11.63
10	195	67.6	-6.8	-10.5	188.20	57.1	18.07	14.21
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- Estimated Reading Based Upon Polinomial Estimation of Limit Pressure

DLZ

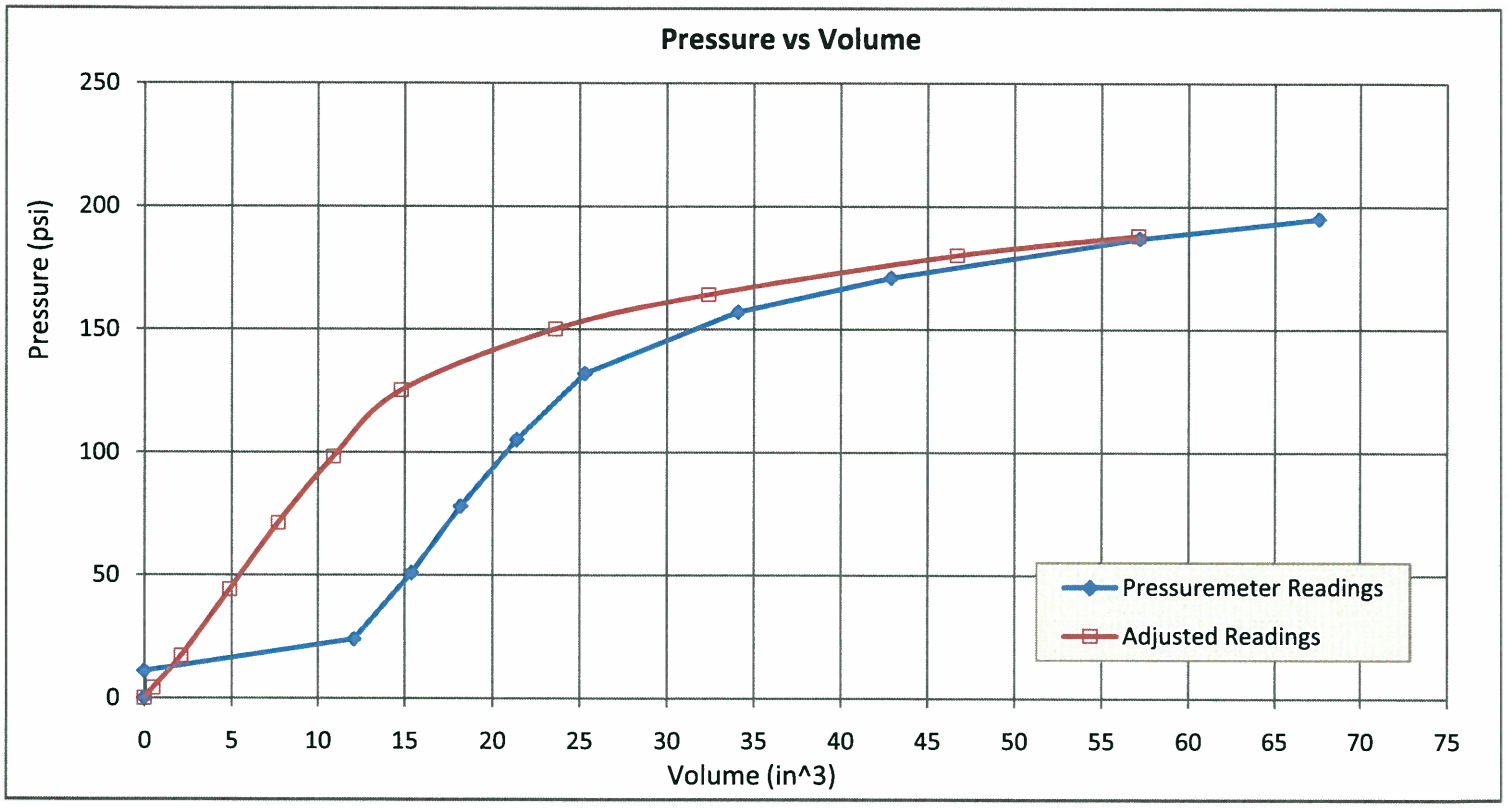
SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

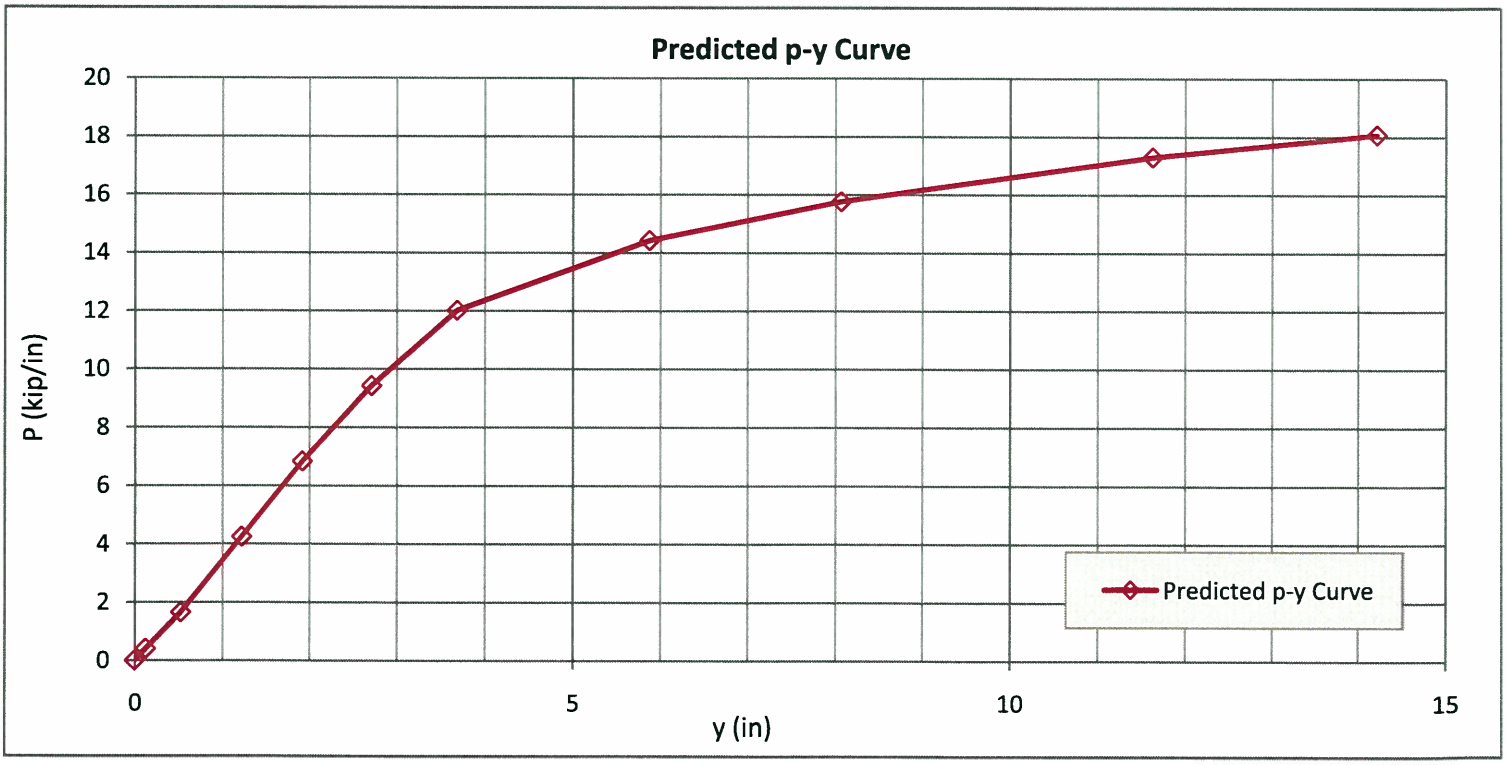
JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-026-1
Test Depth: 23.0 feet





DLZ

SUBJECT: FRA-70-8.93 — Predicted p-y Curves for Soil

JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-026-1 N_{60}= 18
Soil Type: A-6a (Glacial Till) *Clay*
Test Depth: 35.7 feet
Test Type: PMT - Menard
Probe Dia.: 70.0 mm; 2.76 inches
Radius of Probe: 35.0 mm; 1.38 inches
Initial Volume: 790 cc; 48.21 in^3
Probe Depth (DCM): 35.7 feet; 428.4 inches
Shaft Diameter (b): 48 inches

Reduction Factor: (α) *(see following page)*

If $\frac{DCM}{b} > 4$: α= 1.5 for sand; α= 2.0 for clay

If $\frac{DCM}{b} \le 4$: $\alpha = \frac{1.5 \cdot DCM}{4 \cdot b}$ for sand; $\alpha = 0.67 + \frac{2.0 \cdot DCM}{4 \cdot b}$ for clay

Equations:

Eqn 1 $P = P_{Corrected} \cdot b \cdot \alpha$

Eqn 2 $Y = \frac{V_{Adj}}{2 \cdot V_0} \cdot \frac{b}{2}$

Corrected Pressuremeter Readings with Adjustments for Zero-Level

Zero Point Volume Adjustment: -6.5 in3
Initial In-Situ Pressure, P_{oh}: 10.7 psi

α= 2.00

Point No.	Press. (psi)	Vol. (in^3)	Zero Adjustment Press (psi)	Zero Adjustment Vol. (in^3)	Adjusted Origin Press (psi)	Adjusted Origin Vol. (in^3)	P (kip/in)	y (in)
	0	0	0	0	0.00	0	0.00	0.000
1	17	0.0	-10.7	0.6	6.30	0.6	0.60	0.149
2	20	6.6	-10.7	-5.8	9.30	0.8	0.89	0.199
3	33	8.1	-10.7	-6.0	22.30	2.1	2.14	0.523
4	47	9.3	-10.7	-6.0	36.30	3.3	3.48	0.821
5	60	10.9	-10.7	-6.5	49.30	4.4	4.73	1.095
6	73	12.2	-10.7	-6.5	62.30	5.7	5.98	1.419
7	87	13.7	-10.7	-6.5	76.30	7.2	7.32	1.79
8	100	15.2	-10.7	-6.5	89.30	8.7	8.57	2.17
9	114	16.6	-10.7	-6.5	103.30	10.1	9.92	2.51
10	127	17.9	-10.7	-6.5	116.30	11.4	11.16	2.84
11	141	19.4	-10.7	-6.5	130.30	12.9	12.51	3.21
12	155	20.9	-10.7	-6.5	144.30	14.4	13.85	3.58
13	168	22.5	-10.7	-6.5	157.30	16.0	15.10	3.98
14	182	24.2	-10.7	-6.5	171.30	17.7	16.44	4.41
15	195	26.2	-10.7	-6.5	184.30	19.7	17.69	4.90
16	209	28.2	-10.7	-6.5	198.30	21.7	19.04	5.40
17	222	30.6	-10.7	-6.5	211.30	24.1	20.28	6.00
18	236	32.9	-10.7	-6.5	225.30	26.4	21.63	6.57
19	262	39.1	-10.7	-6.5	251.30	32.6	24.12	8.12
20	290	56.6	-10.7	-6.5	279.30	50.1	26.81	12.47
21								
22								
23								
24								
25								

- Estimated Reading Based Upon Polinomial Estimation of Limit Pressure

DLZ

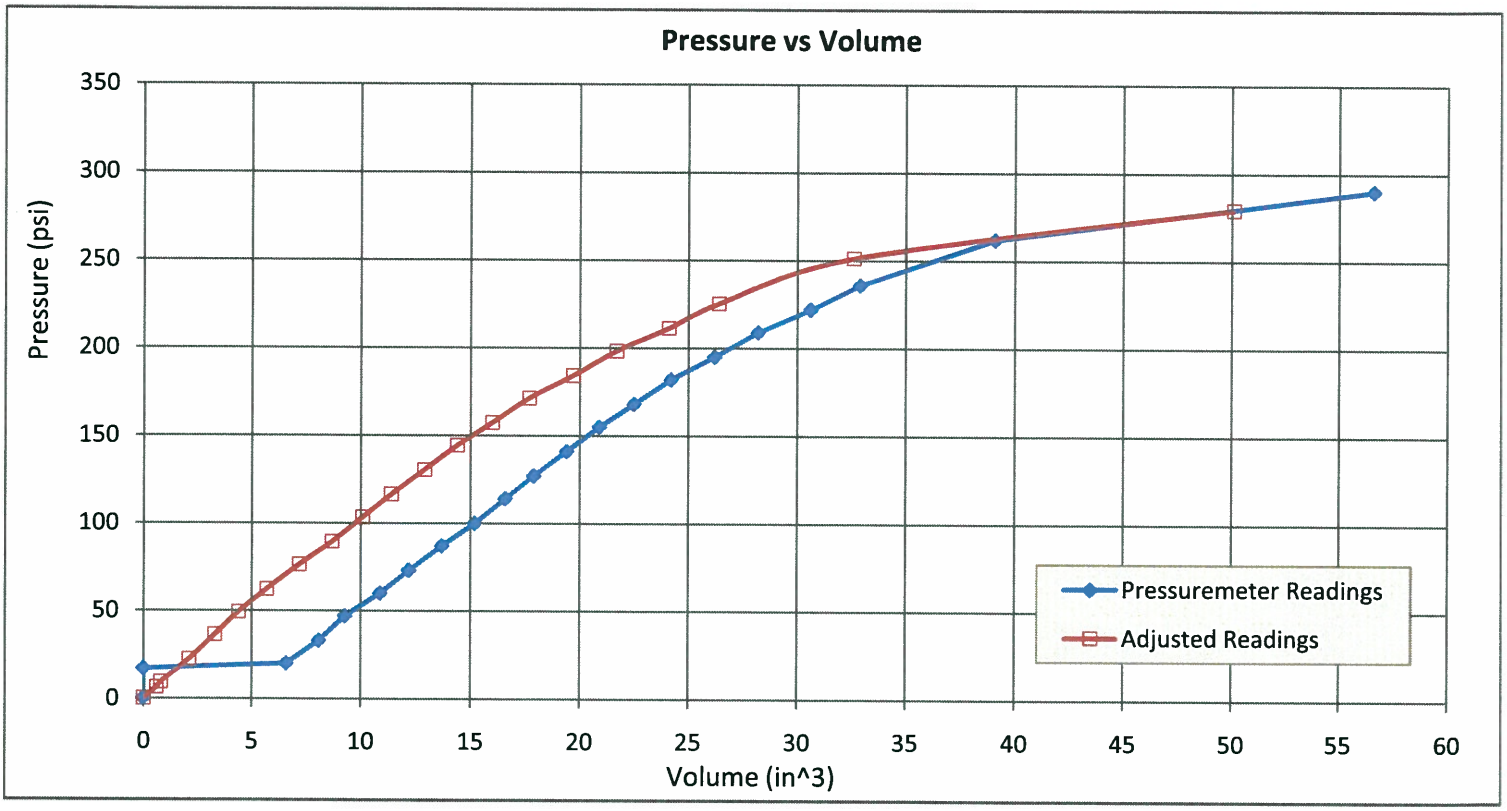
SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

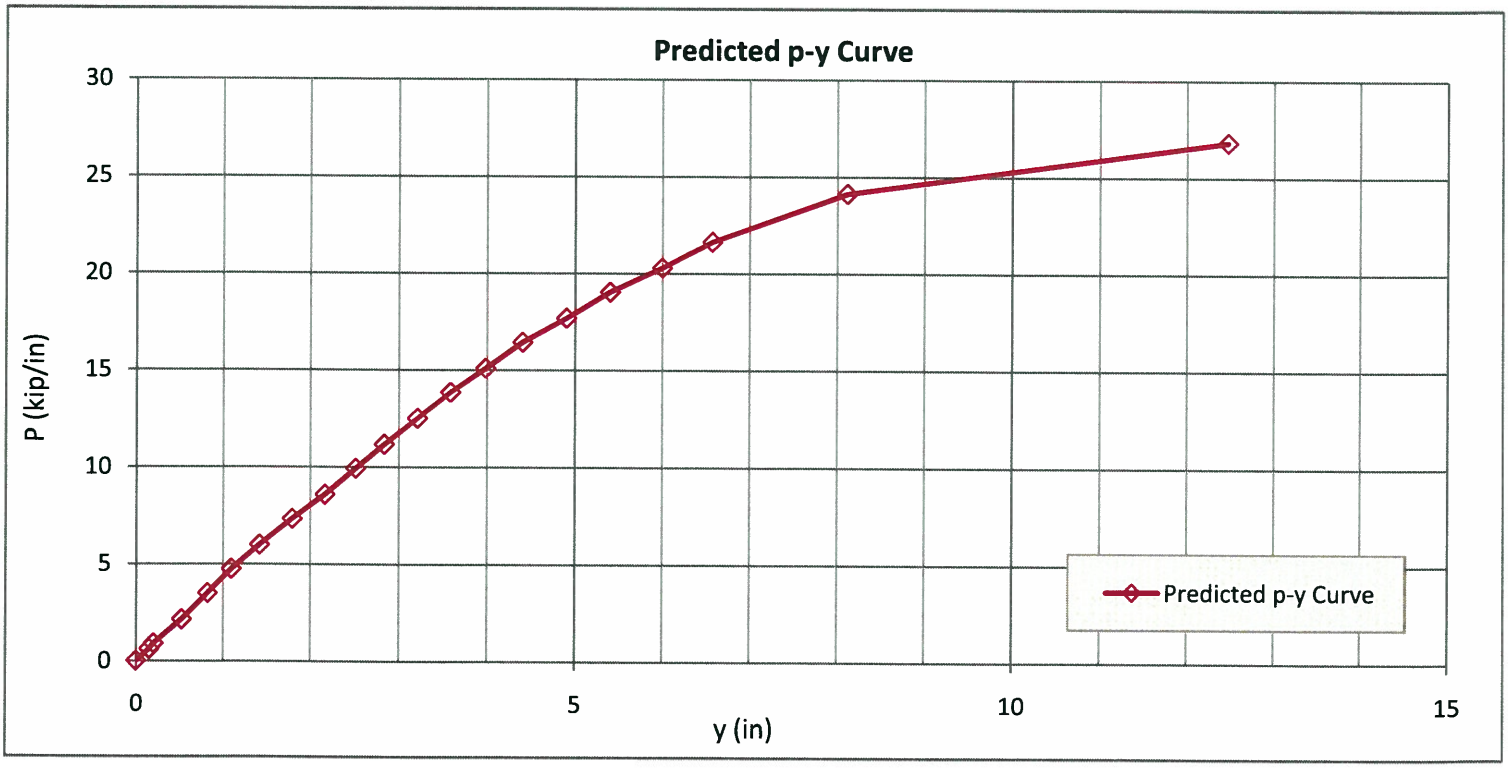
JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-026-1
Test Depth: 35.7 feet





DLZ

SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-026-1 N_{60}= 87
Soil Type: A-6a (Glacial Till) *Clay*
Test Depth: 54.1 feet
Test Type: PMT - Menard
Probe Dia.: 70.0 mm
2.76 inches
Radius of Probe: 35.0 mm
1.38 inches
Initial Volume: 790 cc
48.21 in^3
Probe Depth (DCM): 54.1 feet
649.2 inches

Shaft Diameter (b): 48 inches

Reduction Factor: (α) *(see following page)*

If $\frac{DCM}{b} > 4$: α= 1.5 for sand; α= 2.0 for clay

If $\frac{DCM}{b} \le 4$: $\alpha = \frac{1.5 \cdot DCM}{4 \cdot b}$ for sand; $\alpha = 0.67 + \frac{2.0 \cdot DCM}{4 \cdot b}$ for clay

Equations:

Eqn 1 $P = P_{Corrected} \cdot b \cdot \alpha$

Eqn 2 $Y = \frac{V_{Adj}}{2 \cdot V_0} \cdot \frac{b}{2}$

Corrected Pressuremeter Readings with Adjustments for Zero-Level

Zero Point Volume Adjustment: -10.0 in3
Initial In-Situ Pressure, P_{oh}: 16.1 psi

α= 2.00

Point No.	Press. (psi)	Vol. (in^3)	Zero Adjustment Press (psi)	Zero Adjustment Vol. (in^3)	Adjusted Origin Press (psi)	Adjusted Origin Vol. (in^3)	P (kip/in)	y (in)
	0	0	0	0	0.00	0	0.00	0.000
1	25	0.0	-16.1	0.3	8.90	0.3	0.85	0.075
2	41	8.7	-16.1	-7.9	24.90	0.8	2.39	0.199
3	68	11.0	-16.1	-9.5	51.90	1.5	4.98	0.373
4	96	12.2	-16.1	-10.0	79.90	2.2	7.67	0.548
5	124	12.9	-16.1	-10.0	107.90	2.9	10.36	0.722
6	153	13.5	-16.1	-10.0	136.90	3.5	13.14	0.871
7	181	14.0	-16.1	-10.0	164.90	4.0	15.83	1.00
8	210	14.6	-16.1	-10.0	193.90	4.6	18.61	1.15
9	238	15.2	-16.1	-10.0	221.90	5.2	21.30	1.29
10	267	16.0	-16.1	-10.0	250.90	6.0	24.09	1.49
11	296	16.8	-16.1	-10.0	279.90	6.8	26.87	1.69
12	324	17.6	-16.1	-10.0	307.90	7.6	29.56	1.89
13	353	18.4	-16.1	-10.0	336.90	8.4	32.34	2.09
14	402	20.6	-16.1	-10.0	385.90	10.6	37.05	2.64
15	461	26.4	-16.1	-10.0	444.90	16.4	42.71	4.08
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- Estimated Reading Based Upon Polinomial Estimation of Limit Pressure

DLZ

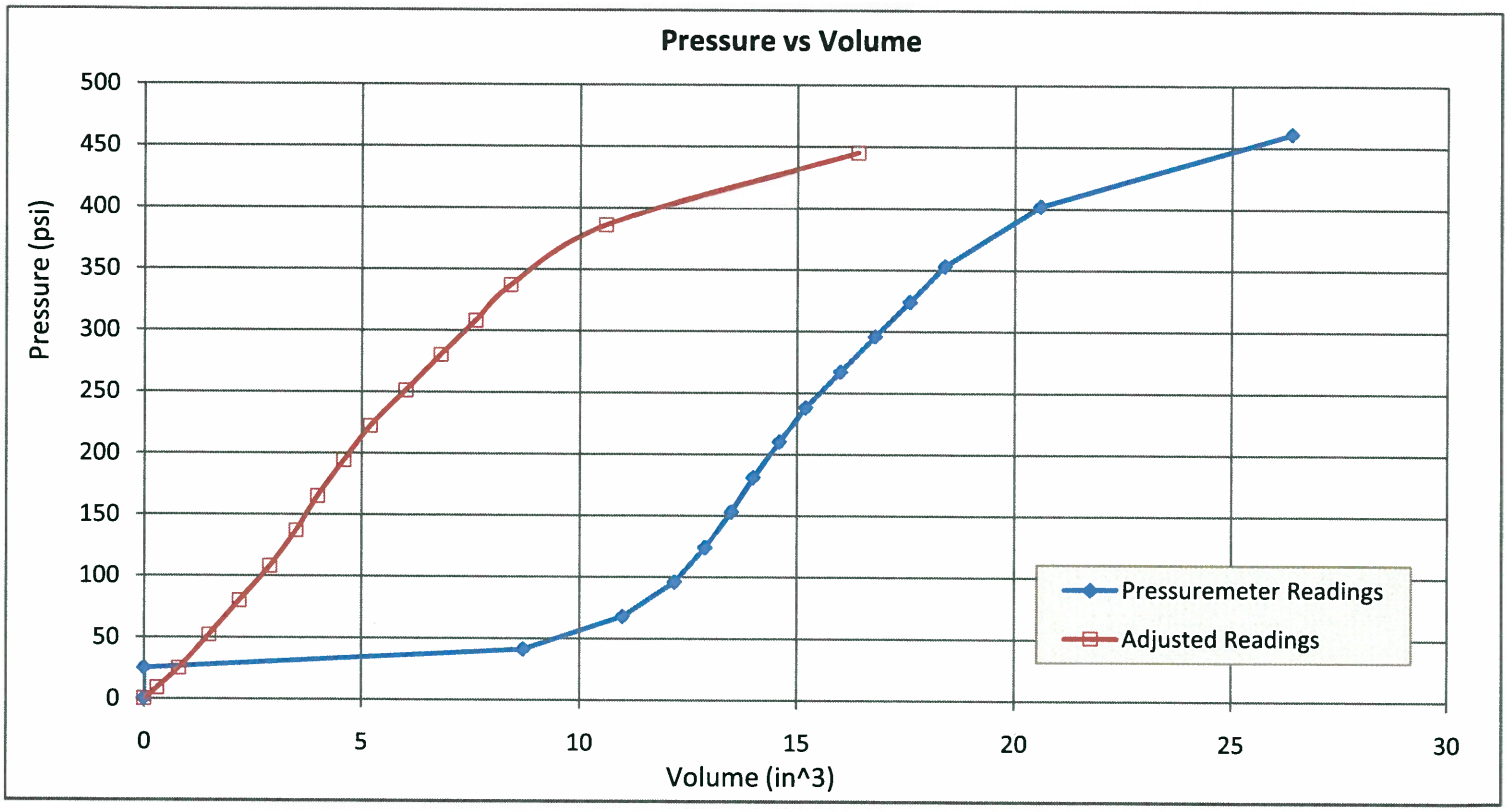
SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

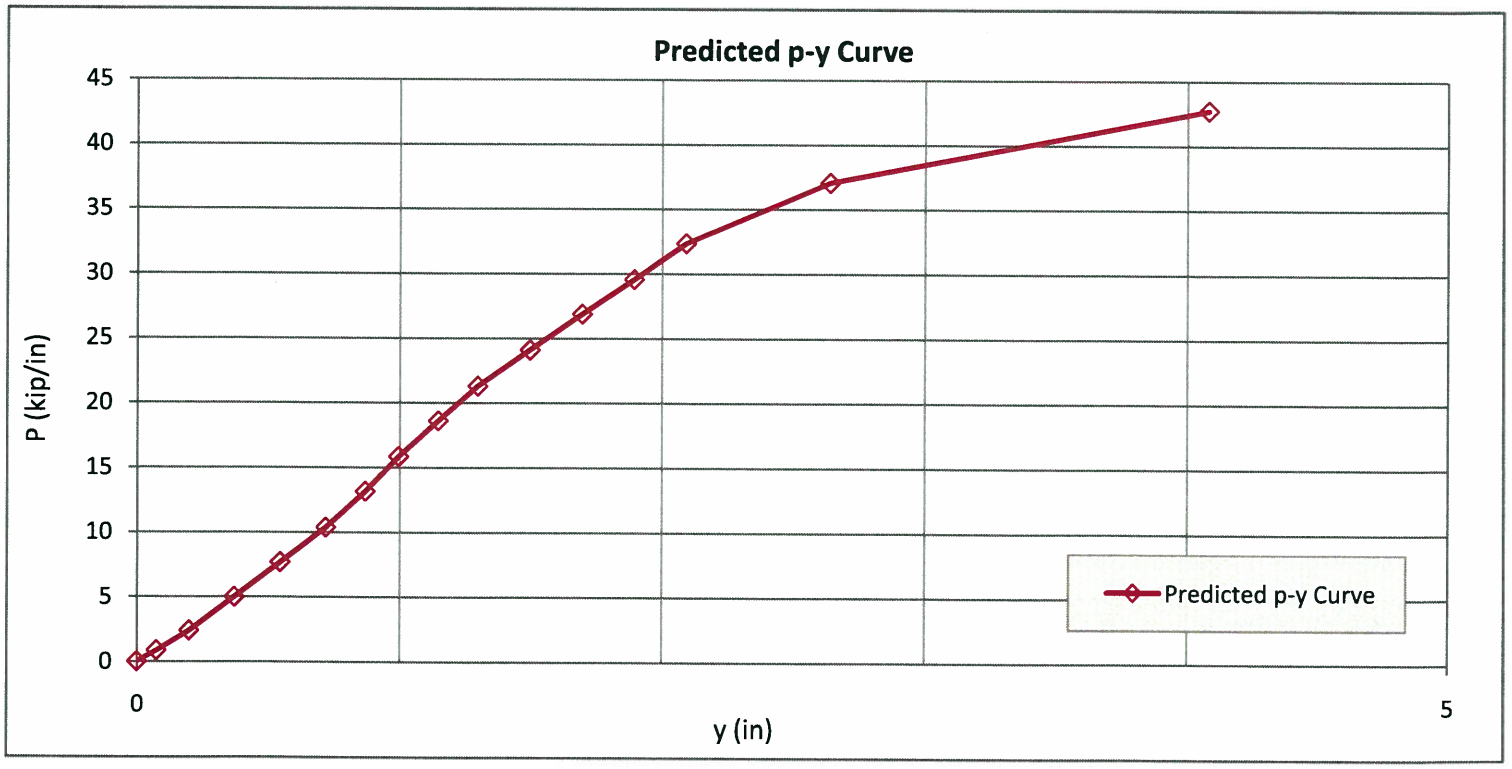
JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-026-1
Test Depth: 54.1 feet





DLZ

SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-046-1 N_{60}= 44

Soil Type: A-6a (Glacial Till) *Clay*

Test Depth: 32.0 feet

Test Type: PMT - Menard

Probe Dia.: 70.0 mm
2.76 inches

Radius of Probe: 35.0 mm
1.38 inches

Initial Volume: 790 cc
48.21 in^3

Probe Depth (DCM): 32.0 feet
384 inches

Shaft Diameter (b): 48 inches

Curve No. 3

Reduction Factor: (α) *(see following page)*

If $\frac{DCM}{b} > 4$: α= 1.5 for sand; α= 2.0 for clay

If $\frac{DCM}{b} \le 4$: $\alpha = \frac{1.5 \cdot DCM}{4 \cdot b}$ for sand; $\alpha = 0.67 + \frac{2.0 \cdot DCM}{4 \cdot b}$ for clay

Equations:

Eqn 1 $P = P_{Corrected} \cdot b \cdot \alpha$

Eqn 2 $Y = \frac{V_{Adj}}{2 \cdot V_0} \cdot \frac{b}{2}$

Corrected Pressuremeter Readings with Adjustments for Zero-Level

Zero Point Volume Adjustment: -8.5 in3

Initial In-Situ Pressure, P_{oh}: 9.5 psi

α= 2.00

Point No.	Press. (psi)	Vol. (in^3)	Zero Adjustment Press (psi)	Zero Adjustment Vol. (in^3)	Adjusted Origin Press (psi)	Adjusted Origin Vol. (in^3)	P (kip/in)	y (in)
	0	0	0	0	0.00	0	0.00	0.000
1	15	0.0	-9.5	0.2	5.50	0.2	0.53	0.037
2	31	8.5	-9.5	-7.9	21.50	0.6	2.06	0.149
3	59	9.9	-9.5	-8.4	49.50	1.5	4.75	0.373
4	87	11.0	-9.5	-8.5	77.50	2.5	7.44	0.622
5	115	12.2	-9.5	-8.5	105.50	3.7	10.13	0.921
6	143	13.8	-9.5	-8.5	133.50	5.3	12.82	1.319
7	171	15.7	-9.5	-8.5	161.50	7.2	15.50	1.79
8	198	18.0	-9.5	-8.5	188.50	9.5	18.10	2.36
9	226	20.8	-9.5	-8.5	216.50	12.3	20.78	3.06
10	253	24.0	-9.5	-8.5	243.50	15.5	23.38	3.86
11	280	28.0	-9.5	-8.5	270.50	19.5	25.97	4.85
12	307	32.5	-9.5	-8.5	297.50	24.0	28.56	5.97
13	333	38.0	-9.5	-8.5	323.50	29.5	31.06	7.34
14	377	49.4	-9.5	-8.5	367.50	40.9	35.28	10.18
15	401	57.1	-9.5	-8.5	391.50	48.6	37.58	12.10
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- Estimated Reading Based Upon Polinomial Estimation of Limit Pressure

DLZ

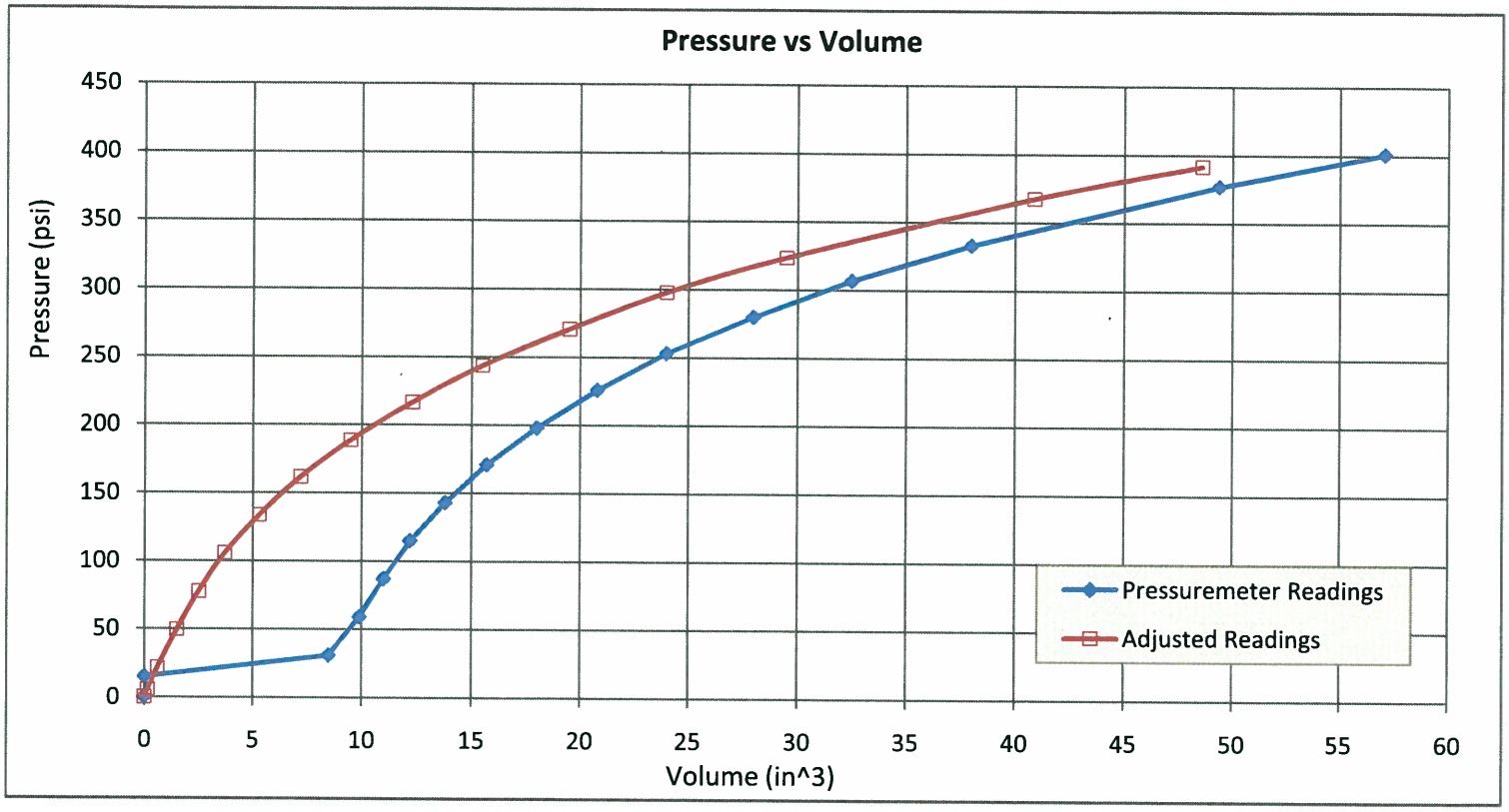
SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

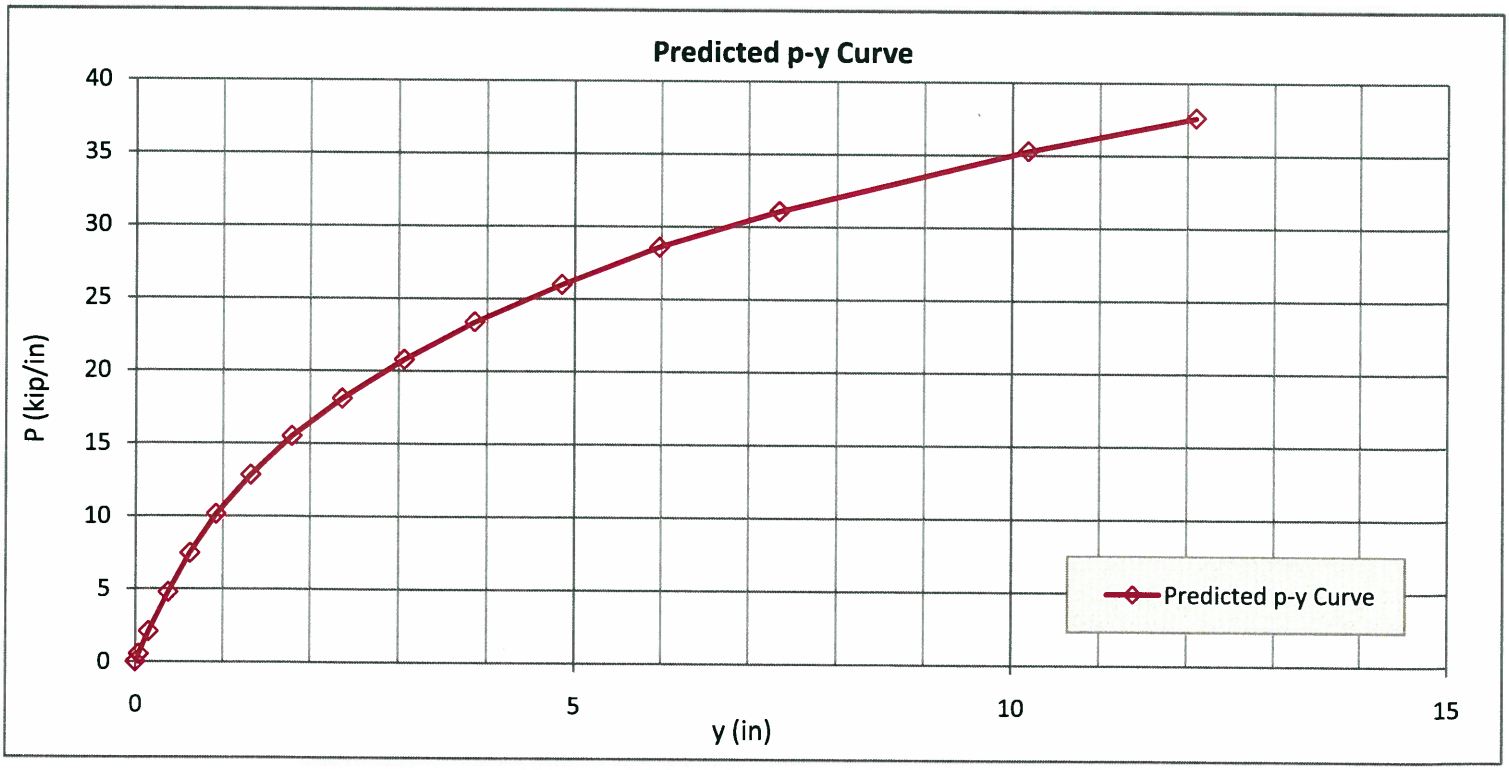
JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-046-1
Test Depth: 32.0 feet





DLZ

SUBJECT: FRA-70-8.93 — Predicted p-y Curves for Soil

JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-046-1 N_{60}= 63

Soil Type: A-6a (Glacial Till) *Clay*

Test Depth: 37.0 feet

Test Type: PMT - Menard

Probe Dia.: 70.0 mm; 2.76 inches

Radius of Probe: 35.0 mm; 1.38 inches

Initial Volume: 790 cc; 48.21 in^3

Probe Depth (DCM): 37.0 feet; 444 inches

Shaft Diameter (b): 48 inches

Curve No. 4 *(see following page)*

Reduction Factor: (α)

If $\frac{DCM}{b} > 4$: α= 1.5 for sand; α= 2.0 for clay

If $\frac{DCM}{b} \le 4$: $\alpha = \frac{1.5 \cdot DCM}{4 \cdot b}$ for sand; $\alpha = 0.67 + \frac{2.0 \cdot DCM}{4 \cdot b}$ for clay

Equations:

Eqn 1 $P = P_{Corrected} \cdot b \cdot \alpha$

Eqn 2 $Y = \frac{V_{Adj}}{2 \cdot V_0} \cdot \frac{b}{2}$

Corrected Pressuremeter Readings with Adjustments for Zero-Level

Zero Point Volume Adjustment: -8.0 in3

Initial In-Situ Pressure, P_{oh}: 11 psi

α= 2.00

Point No.	Press. (psi)	Vol. (in^3)	Zero Adjustment Press (psi)	Zero Adjustment Vol. (in^3)	Adjusted Origin Press (psi)	Adjusted Origin Vol. (in^3)	P (kip/in)	y (in)
	0	0	0	0	0.00	0	0.00	0.000
1	18	0.0	-11	0.1	7.00	0.1	0.67	0.025
2	34	8.2	-11	-7.8	23.00	0.4	2.21	0.100
3	62	9.0	-11	-8.0	51.00	1.0	4.90	0.249
4	90	9.7	-11	-8.0	79.00	1.7	7.58	0.423
5	119	10.5	-11	-8.0	108.00	2.5	10.37	0.622
6	147	11.3	-11	-8.0	136.00	3.3	13.06	0.821
7	175	12.3	-11	-8.0	164.00	4.3	15.74	1.07
8	203	13.5	-11	-8.0	192.00	5.5	18.43	1.37
9	231	14.7	-11	-8.0	220.00	6.7	21.12	1.67
10	259	16.3	-11	-8.0	248.00	8.3	23.81	2.07
11	288	17.8	-11	-8.0	277.00	9.8	26.59	2.44
12	315	19.8	-11	-8.0	304.00	11.8	29.18	2.94
13	343	21.9	-11	-8.0	332.00	13.9	31.87	3.46
14	371	24.2	-11	-8.0	360.00	16.2	34.56	4.03
15	399	26.6	-11	-8.0	388.00	18.6	37.25	4.63
16	426	29.3	-11	-8.0	415.00	21.3	39.84	5.30
17	454	32.5	-11	-8.0	443.00	24.5	42.53	6.10
18	481	36.0	-11	-8.0	470.00	28.0	45.12	6.97
19	540	46.2	-11	-8.0	529.00	38.2	50.78	9.51
20	573	54.0	-11	-8.0	562.00	46.0	53.95	11.45
21	599	62.2	-11	-8.0	588.00	54.2	56.45	13.49
22								
23								
24								
25								

- Estimated Reading Based Upon Polinomial Estimation of Limit Pressure

DLZ

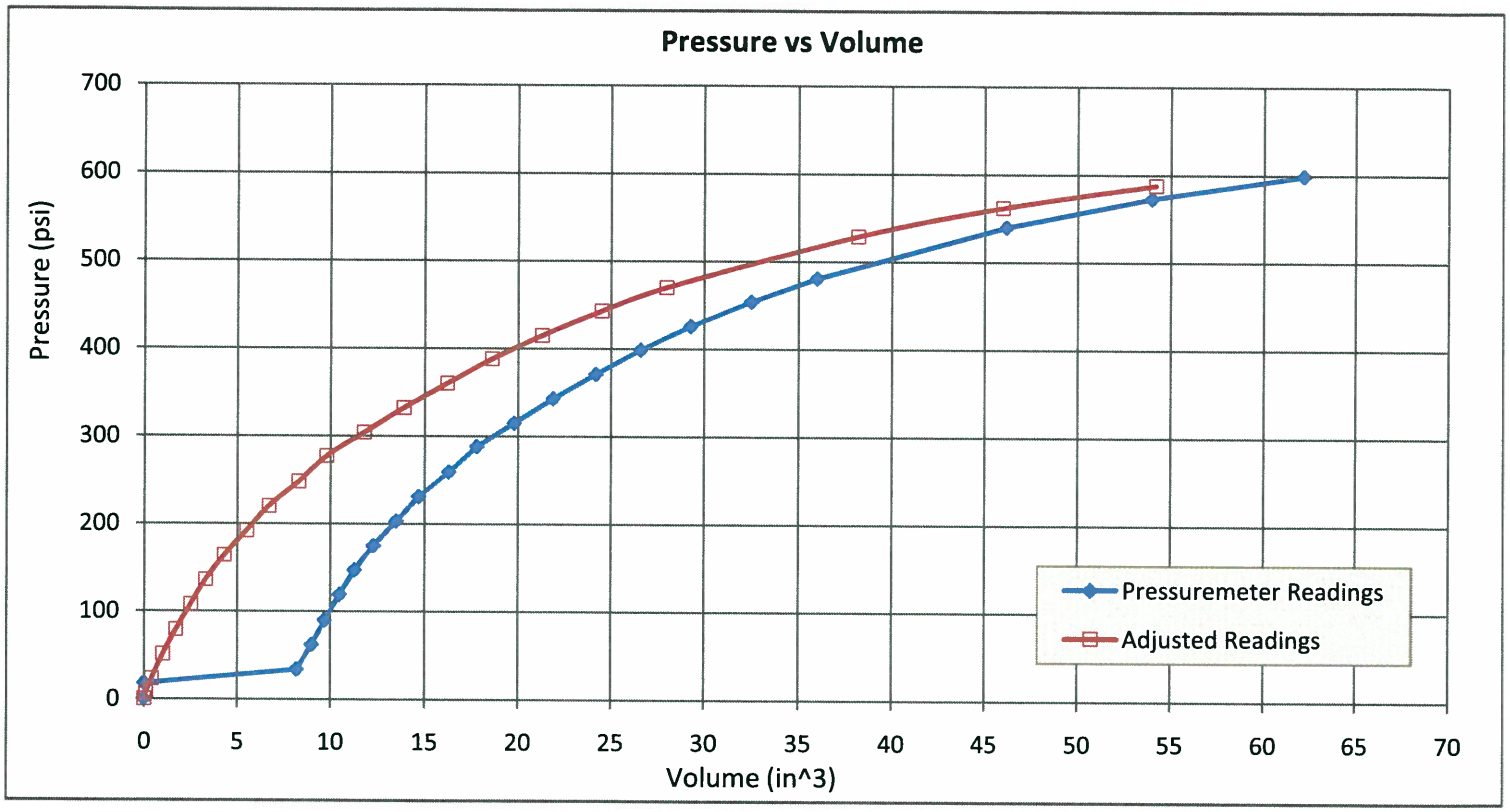
SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

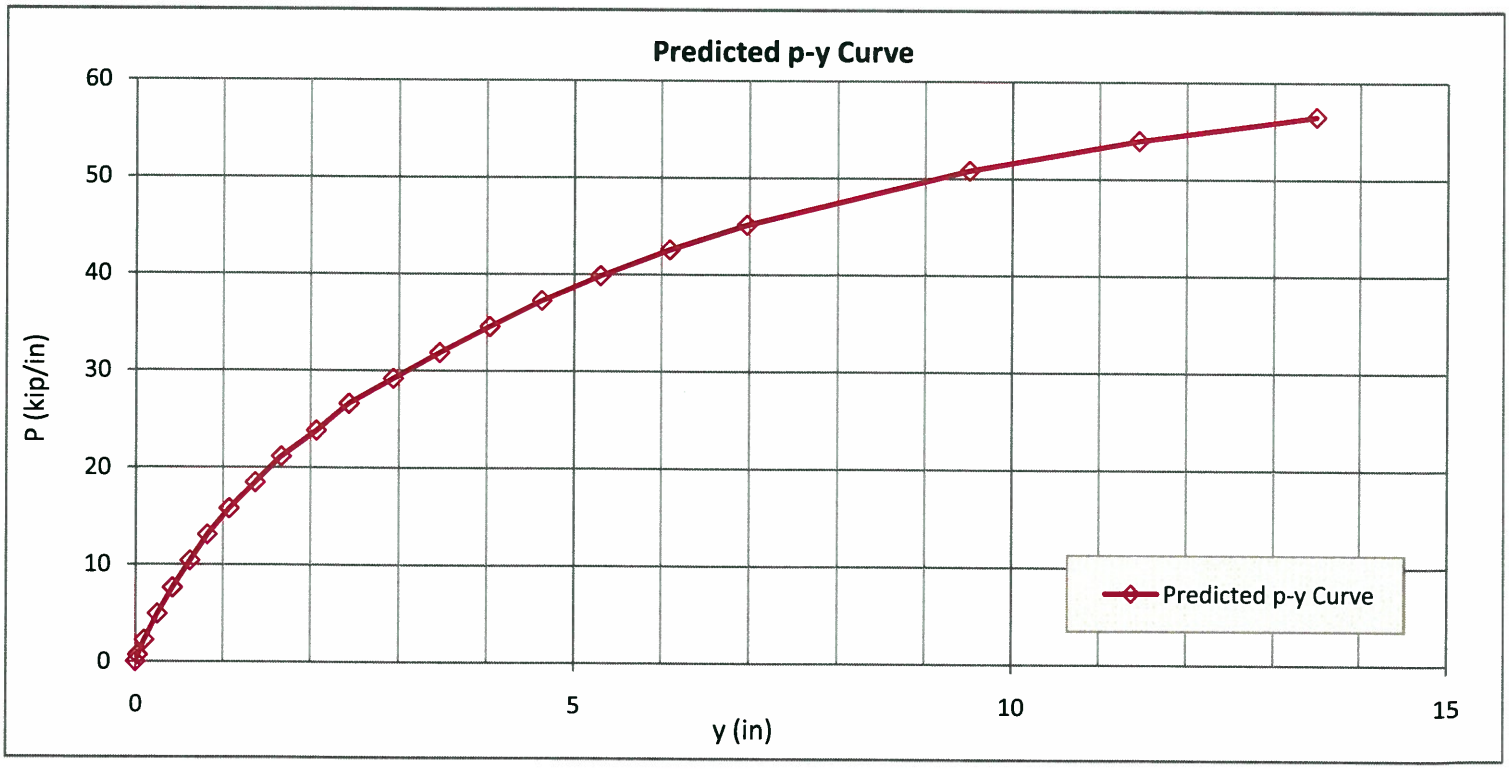
JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-046-1
Test Depth: 37.0 feet





DLZ

SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-046-1 N_{60}= 63
Soil Type: A-6a (Glacial Till) *Clay*
Test Depth: 42.0 feet
Test Type: PMT - Menard
Probe Dia.: 70.0 mm
2.76 inches
Radius of Probe: 35.0 mm
1.38 inches
Initial Volume: 790 cc
48.21 in^3
Probe Depth (DCM): 42.0 feet
504 inches
Shaft Diameter (b): 48 inches

Curve No. 5

(see following page)

Reduction Factor: (α)

If $\frac{DCM}{b} > 4$: α= 1.5 for sand; α= 2.0 for clay

If $\frac{DCM}{b} \le 4$: $\alpha = \frac{1.5 \cdot DCM}{4 \cdot b}$ for sand; $\alpha = 0.67 + \frac{2.0 \cdot DCM}{4 \cdot b}$ for clay

Equations:

Eqn 1 $P = P_{Corrected} \cdot b \cdot \alpha$

Eqn 2 $Y = \frac{V_{Adj}}{2 \cdot V_0} \cdot \frac{b}{2}$

Corrected Pressuremeter Readings with Adjustments for Zero-Level

Zero Point Volume Adjustment: -8.3 in3
Initial In-Situ Pressure, P_{oh}: 12.5 psi

α= 2.00

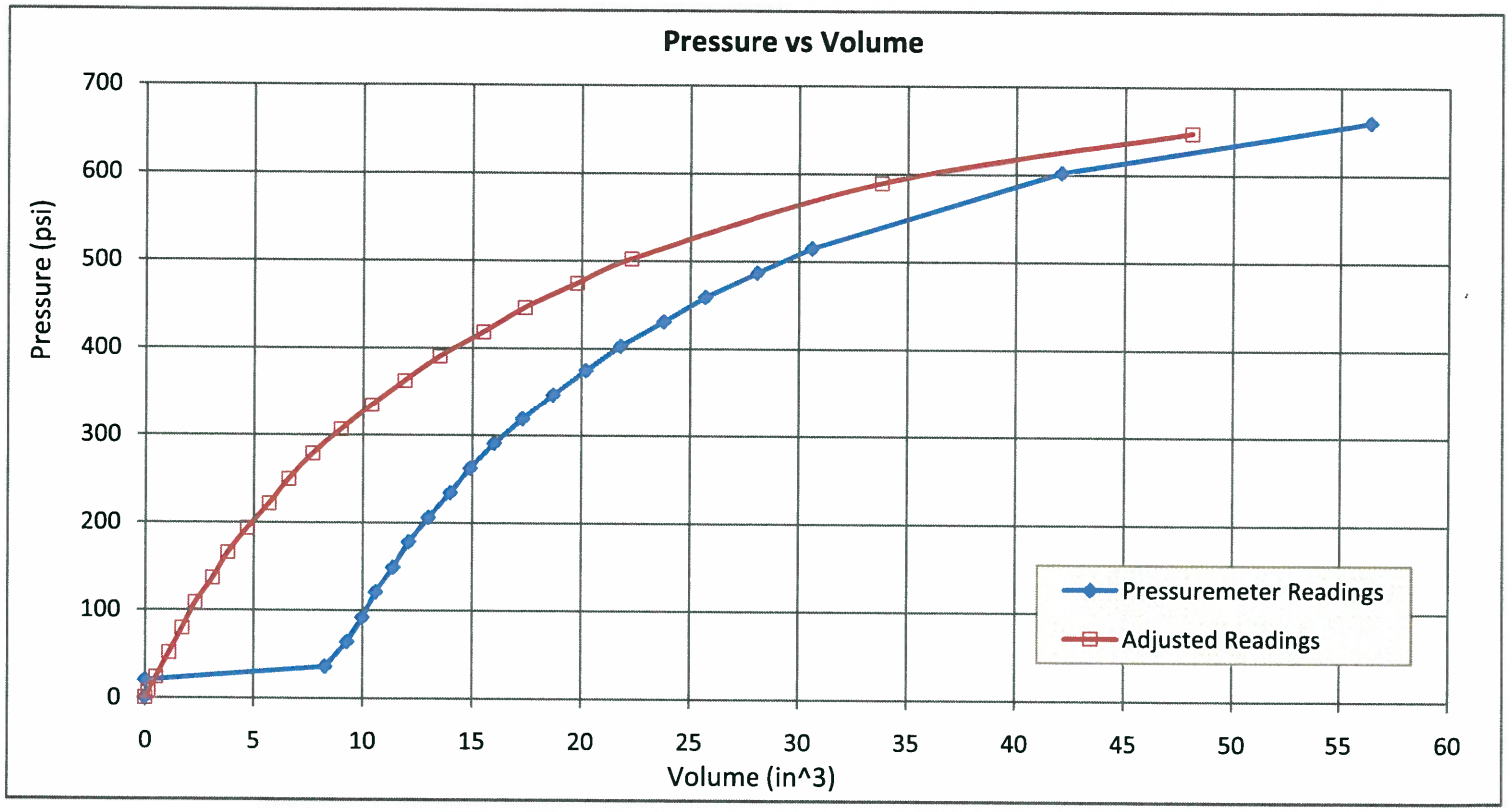
Point No.	Press. (psi)	Vol. (in^3)	Zero Adjustment Press (psi)	Zero Adjustment Vol. (in^3)	Adjusted Origin Press (psi)	Adjusted Origin Vol. (in^3)	P (kip/in)	y (in)
	0	0	0	0	0.00	0	0.00	0.000
1	20	0	-12.5	0.2	7.50	0.2	0.72	0.037
2	36	8.3	-12.5	-7.8	23.50	0.5	2.26	0.124
3	64	9.3	-12.5	-8.2	51.50	1.1	4.94	0.274
4	92	10	-12.5	-8.3	79.50	1.7	7.63	0.423
5	121	10.6	-12.5	-8.3	108.50	2.3	10.42	0.573
6	149	11.4	-12.5	-8.3	136.50	3.1	13.10	0.772
7	178	12.1	-12.5	-8.3	165.50	3.8	15.89	0.95
8	206	13	-12.5	-8.3	193.50	4.7	18.58	1.17
9	234	14	-12.5	-8.3	221.50	5.7	21.26	1.42
10	262	14.9	-12.5	-8.3	249.50	6.6	23.95	1.64
11	291	16	-12.5	-8.3	278.50	7.7	26.74	1.92
12	319	17.3	-12.5	-8.3	306.50	9.0	29.42	2.24
13	347	18.7	-12.5	-8.3	334.50	10.4	32.11	2.59
14	375	20.2	-12.5	-8.3	362.50	11.9	34.80	2.96
15	403	21.8	-12.5	-8.3	390.50	13.5	37.49	3.36
16	431	23.8	-12.5	-8.3	418.50	15.5	40.18	3.86
17	459	25.7	-12.5	-8.3	446.50	17.4	42.86	4.33
18	487	28.1	-12.5	-8.3	474.50	19.8	45.55	4.93
19	515	30.6	-12.5	-8.3	502.50	22.3	48.24	5.55
20	602	42.1	-12.5	-8.3	589.50	33.8	56.59	8.41
21	660	56.4	-12.5	-8.3	647.50	48.1	62.16	11.97
22								
23								
24								
25								

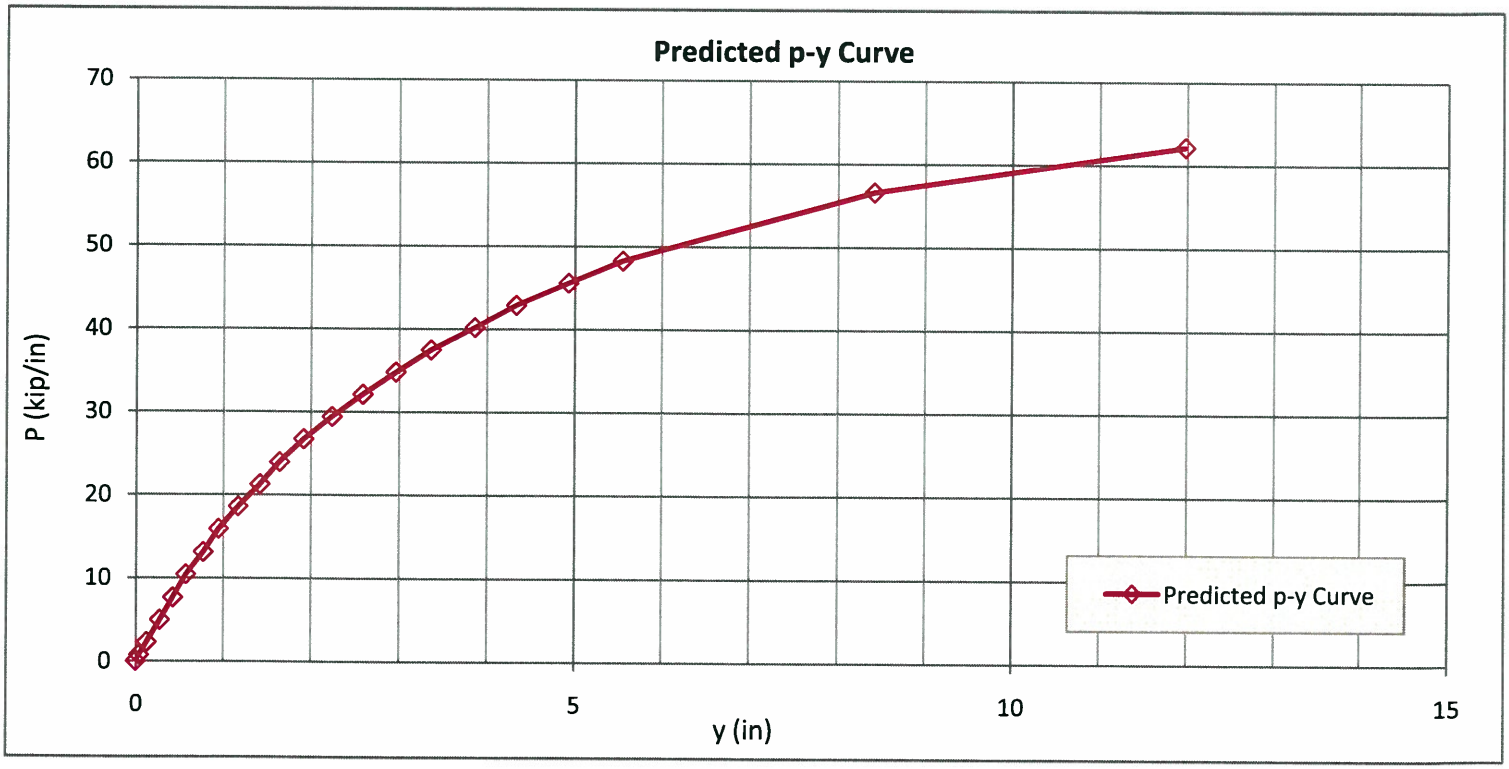
( ) - Estimated Reading Based Upon Polinomial Estimation of Limit Pressure

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-046-1
Test Depth: 42.0 feet





DLZ

SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Page 1

Boring: B-046-1 N_{60}= 61

Soil Type: A-6a (Glacial Till) *Clay*

Test Depth: 47.0 feet

Test Type: PMT - Menard

Probe Dia.: 70.0 mm
2.76 inches

Radius of Probe: 35.0 mm
1.38 inches

Initial Volume: 790 cc
48.21 in^3

Probe Depth (DCM): 47.0 feet
564 inches

Shaft Diameter (b): 48 inches

Curve No. 6

Reduction Factor: (α) *(see following page)*

If $\frac{DCM}{b} > 4$: α= 1.5 for sand; α= 2.0 for clay

If $\frac{DCM}{b} \le 4$: $\alpha = \frac{1.5 \cdot DCM}{4 \cdot b}$ for sand; $\alpha = 0.67 + \frac{2.0 \cdot DCM}{4 \cdot b}$ for clay

Equations:

Eqn 1 $P = P_{Corrected} \cdot b \cdot \alpha$

Eqn 2 $Y = \frac{V_{Adj}}{2 \cdot V_0} \cdot \frac{b}{2}$

Corrected Pressuremeter Readings with Adjustments for Zero-Level

Zero Point Volume Adjustment: -8.3 in3

Initial In-Situ Pressure, P_{oh}: 14 psi

α= 2.00

Point No.	Press. (psi)	Vol. (in^3)	Zero Adjustment Press (psi)	Zero Adjustment Vol. (in^3)	Adjusted Origin Press (psi)	Adjusted Origin Vol. (in^3)	P (kip/in)	y (in)
	0	0	0	0	0.00	0	0.00	0.000
1	22	0	-14	0.2	8.00	0.2	0.77	0.050
2	38	8.3	-14	-7.8	24.00	0.6	2.30	0.137
3	66	9.4	-14	-8.2	52.00	1.2	4.99	0.299
4	94	10.2	-14	-8.3	80.00	1.9	7.68	0.473
5	123	11	-14	-8.3	109.00	2.7	10.46	0.672
6	151	12	-14	-8.3	137.00	3.7	13.15	0.921
7	179	13.1	-14	-8.3	165.00	4.8	15.84	1.19
8	207	14.4	-14	-8.3	193.00	6.1	18.53	1.52
9	235	15.8	-14	-8.3	221.00	7.5	21.22	1.87
10	263	17.4	-14	-8.3	249.00	9.1	23.90	2.27
11	291	19.3	-14	-8.3	277.00	11.0	26.59	2.74
12	319	21.5	-14	-8.3	305.00	13.2	29.28	3.29
13	346	24	-14	-8.3	332.00	15.7	31.87	3.91
14	374	26.9	-14	-8.3	360.00	18.6	34.56	4.63
15	401	30.2	-14	-8.3	387.00	21.9	37.15	5.45
16	429	33.8	-14	-8.3	415.00	25.5	39.84	6.35
17	504	46	-14	-8.3	490.00	37.7	47.04	9.38
18	552	55.8	-14	-8.3	538.00	47.5	51.65	11.82
19								
20								
21								
22								
23								
24								
25								

[ ] - Estimated Reading Based Upon Polinomial Estimation of Limit Pressure

DLZ

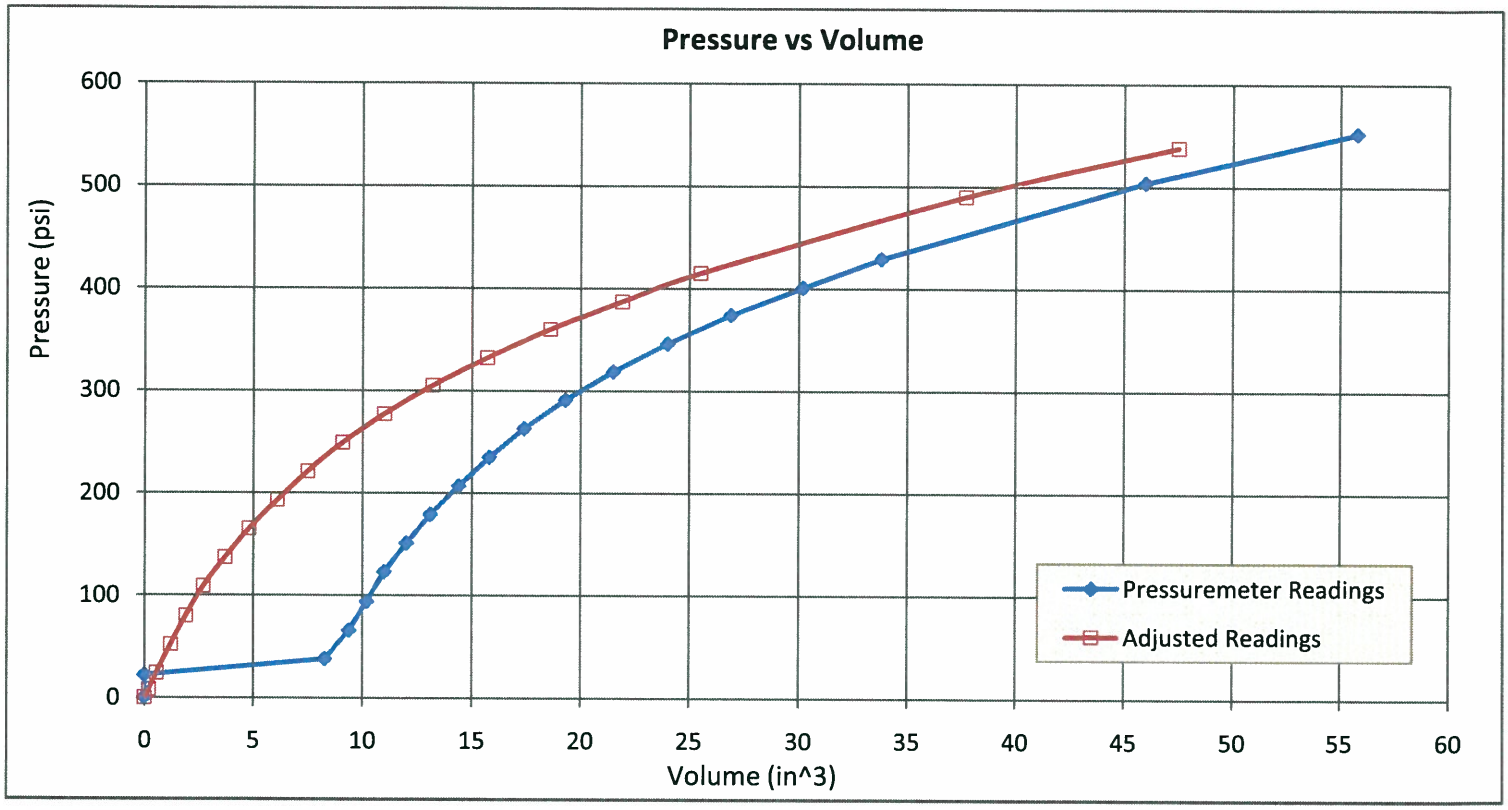
SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

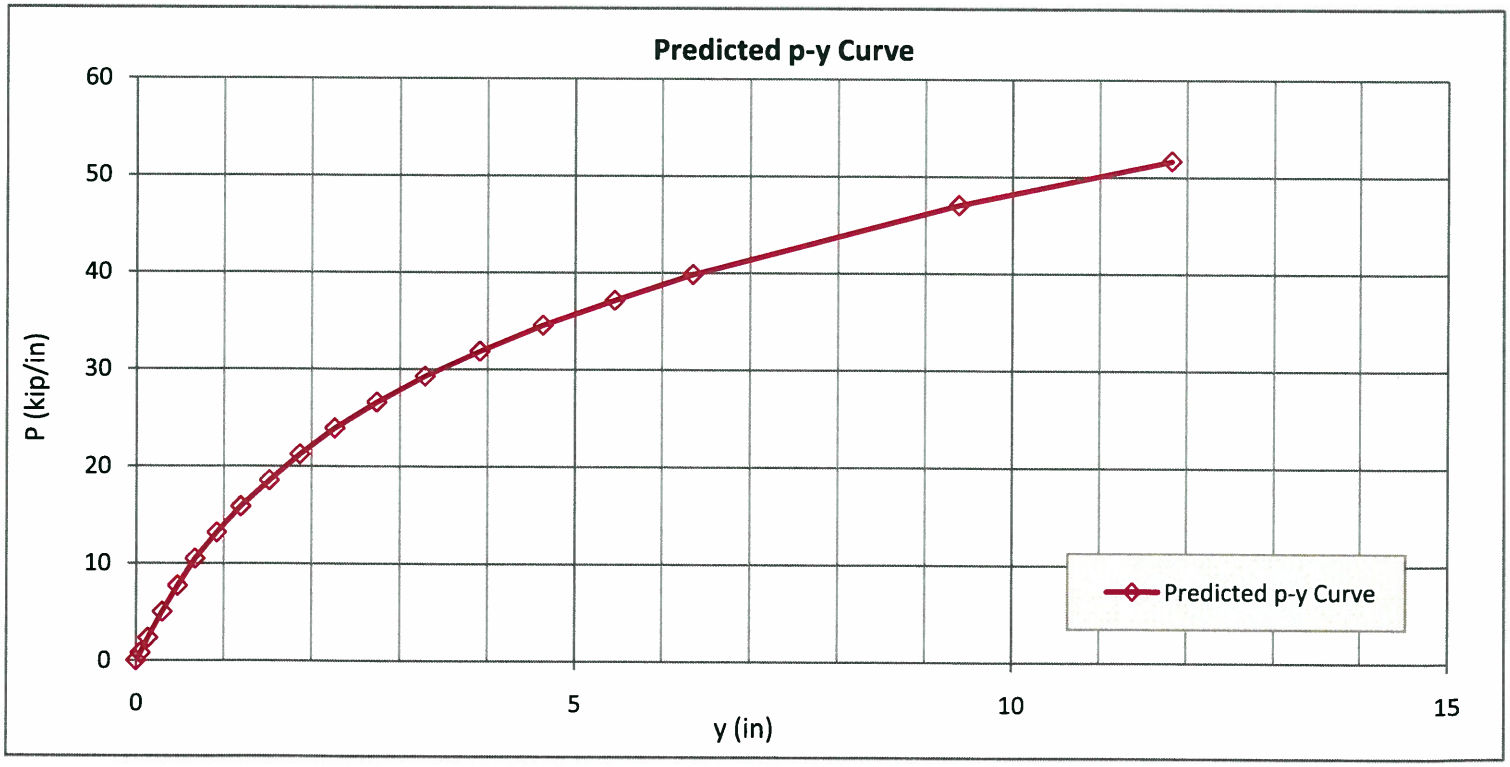
JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-046-1
Test Depth: 47.0 feet





DLZ

SUBJECT: FRA-70-8.93 — Predicted p-y Curves for Soil

JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-046-1 — N_{60}= 45
Soil Type: A-4a (Glacial Till) — *Clay*
Test Depth: 59.0 feet
Test Type: PMT - Menard
Probe Dia.: 70.0 mm; 2.76 inches
Radius of Probe: 35.0 mm; 1.38 inches
Initial Volume: 790 cc; 48.21 in^3
Probe Depth (DCM): 59.0 feet; 708 inches
Shaft Diameter (b): 48 inches

Curve No. 7 *(see following page)*

Reduction Factor: (α)

If $\frac{DCM}{b} > 4$: α= 1.5 for sand; α= 2.0 for clay

If $\frac{DCM}{b} \le 4$: $\alpha = \frac{1.5 \cdot DCM}{4 \cdot b}$ for sand; $\alpha = 0.67 + \frac{2.0 \cdot DCM}{4 \cdot b}$ for clay

Equations:

Eqn 1: $P = P_{Corrected} \cdot b \cdot \alpha$

Eqn 2: $Y = \frac{V_{Adj}}{2 \cdot V_0} \cdot \frac{b}{2}$

Corrected Pressuremeter Readings with Adjustments for Zero-Level

Zero Point Volume Adjustment: -7.0 in3
Initial In-Situ Pressure, P_{oh}: 17.6 psi

α= 2.00

Point No.	Press. (psi)	Vol. (in^3)	Zero Adjustment Press (psi)	Zero Adjustment Vol. (in^3)	Adjusted Origin Press (psi)	Adjusted Origin Vol. (in^3)	P (kip/in)	y (in)
	0	0	0	0	0.00	0	0.00	0.000
1	27	0	-17.6	0.2	9.40	0.2	0.90	0.050
2	30	6.8	-17.6	-6.5	12.40	0.3	1.19	0.075
3	44	7.4	-17.6	-6.8	26.40	0.6	2.53	0.149
4	72	8.3	-17.6	-7.0	54.40	1.3	5.22	0.324
5	100	9.2	-17.6	-7.0	82.40	2.2	7.91	0.548
6	128	10.1	-17.6	-7.0	110.40	3.1	10.60	0.772
7	157	11.2	-17.6	-7.0	139.40	4.2	13.38	1.05
8	184	12.6	-17.6	-7.0	166.40	5.6	15.97	1.39
9	212	14.4	-17.6	-7.0	194.40	7.4	18.66	1.84
10	240	16.5	-17.6	-7.0	222.40	9.5	21.35	2.36
11	267	18.9	-17.6	-7.0	249.40	11.9	23.94	2.96
12	295	21.7	-17.6	-7.0	277.40	14.7	26.63	3.66
13	322	25.2	-17.6	-7.0	304.40	18.2	29.22	4.53
14	349	29.3	-17.6	-7.0	331.40	22.3	31.81	5.55
15	401	40.4	-17.6	-7.0	383.40	33.4	36.81	8.31
16	452	58.4	-17.6	-7.0	434.40	51.4	41.70	12.80
17								
18								
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( ) - Estimated Reading Based Upon Polinomial Estimation of Limit Pressure

DLZ

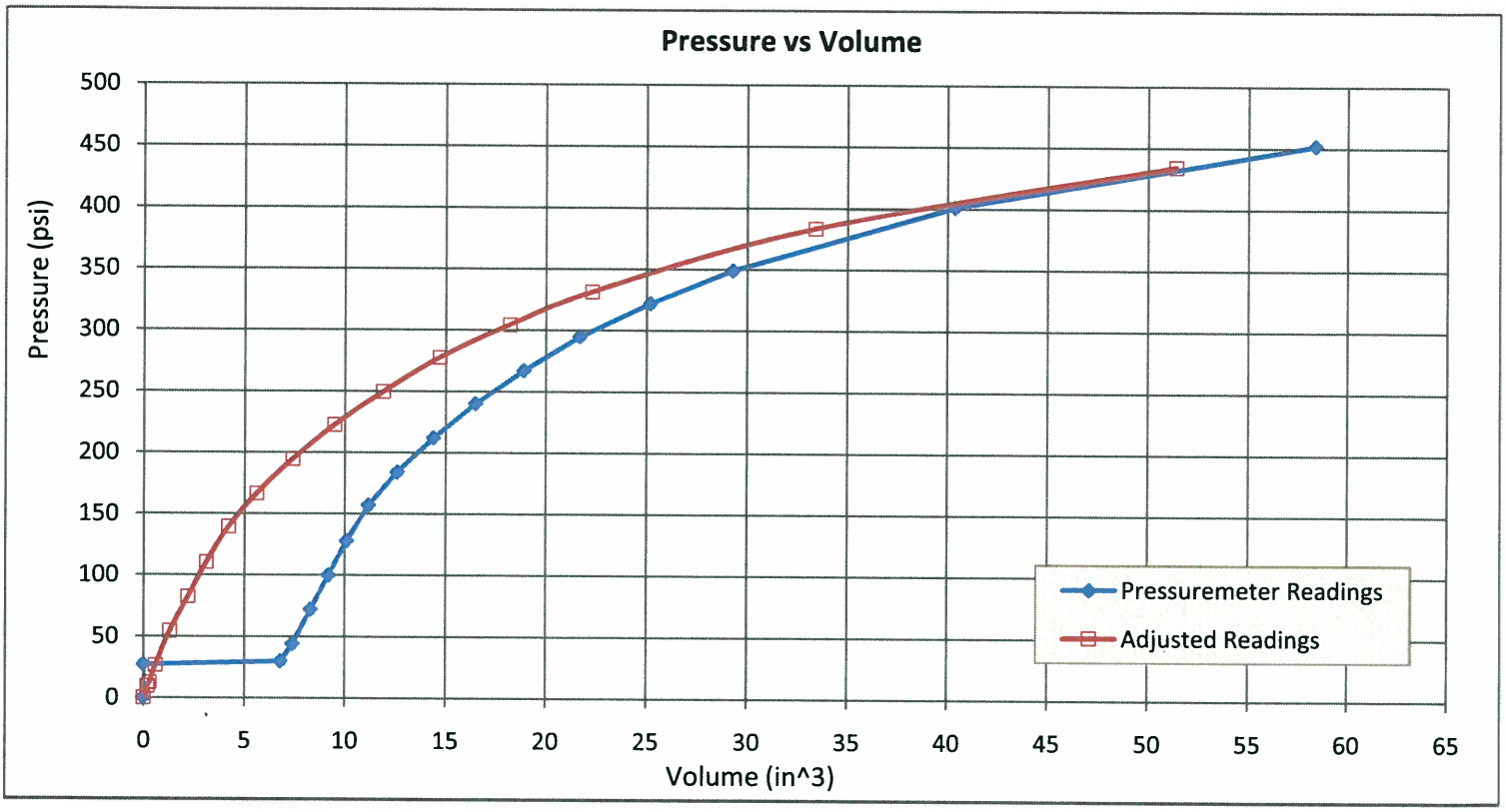
SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

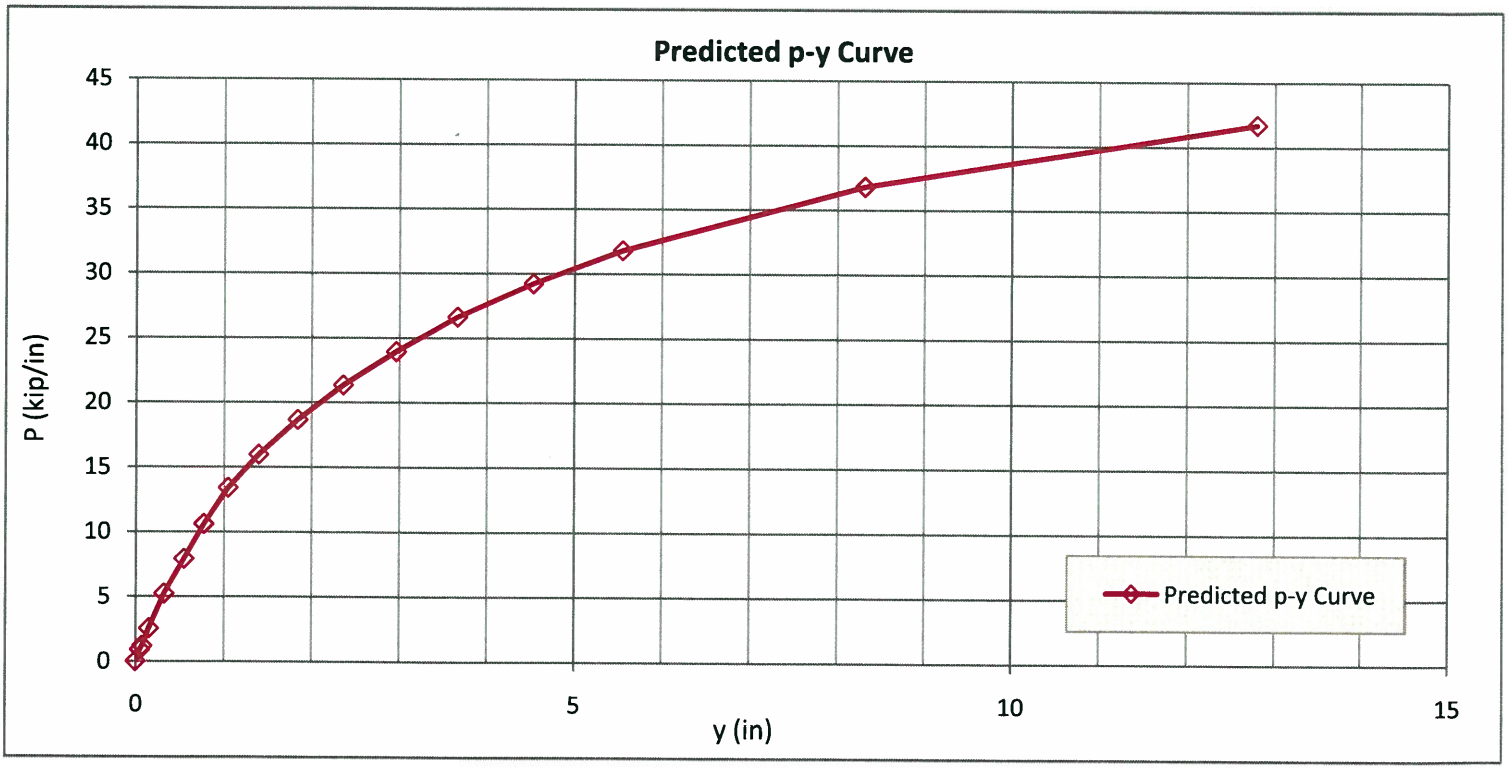
JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: B-046-1
Test Depth: 59.0 feet



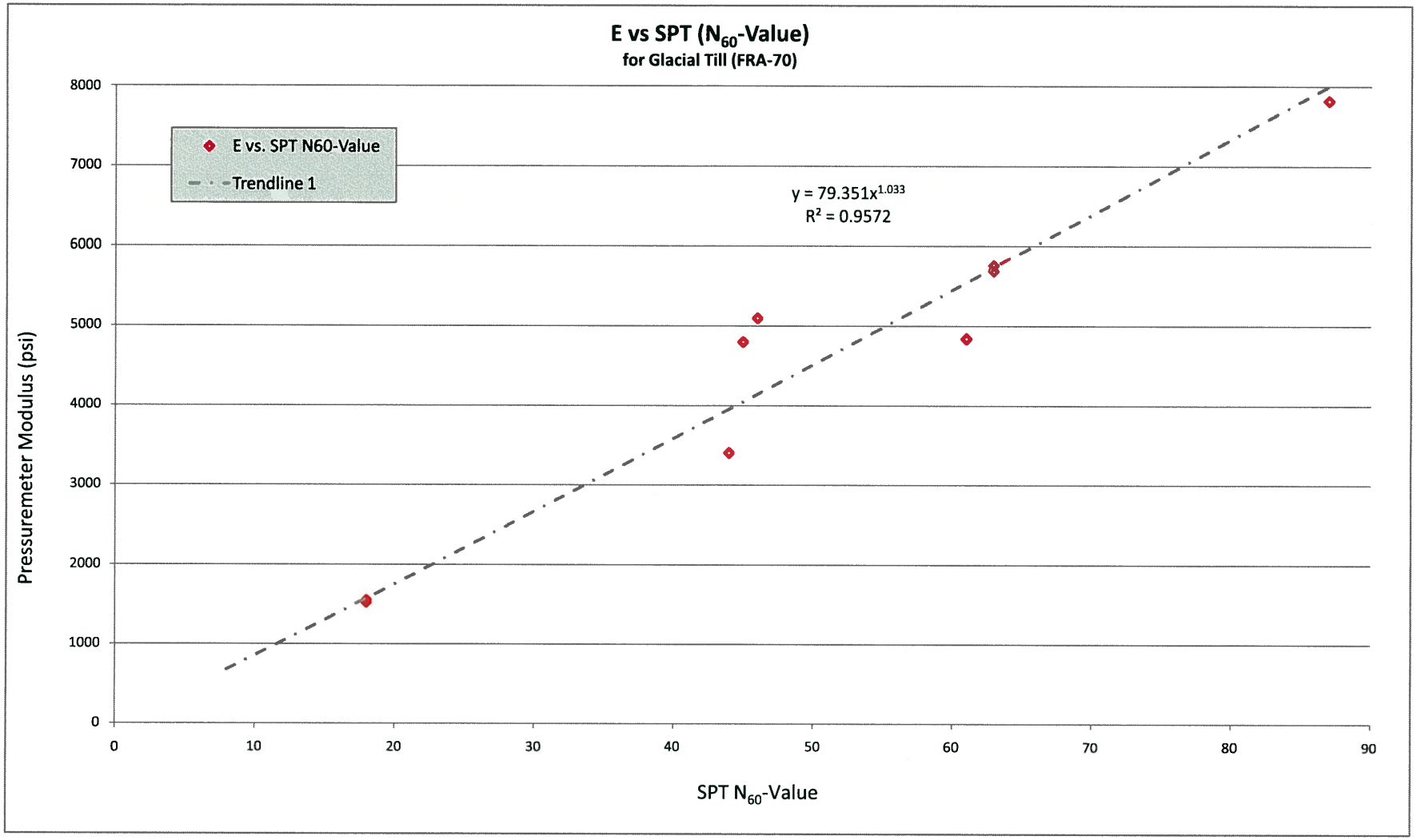


Correlation: Pressuremeter Modulus and SPT N_{60}-Value

Predicted p-y Curves Based Upon Correlation

(Example curves for 48-inch diameter drilled shafts)

	PMT No.	Depth (ft)	Soil Class.	Consistency	HP	SPT N_{60}-Value	PI	Silt	Clay	% passing #200	w (%)	E (psi)	P_L (psi)	P_Y (psi)	E/P_L	P_L/P_Y
B-026	1	23.0	A-6a	Very stiff	3.5	18	11	35	26	61	12	1511	199	105	7.59	1.90
B-026	2	35.7	A-4a	Very stiff	3	18	10	36	23	59	11	1545	298	127	5.18	2.35
B-026	3	54.1	A-6a	Hard	5	87	12	34	20	54	9	7814	589	238	13.27	2.47
B-046	4	32.0	A-6a	Hard	5	44	11	-	-	48	10	3393	429	143	7.91	3.00
B-046	5	37.0	A-6a	Hard	5	63	11	-	-	48	10	5747	610	147	9.42	4.15
B-046	6	42.0	A-6a	Hard	5	63	11	-	-	48	9	5679	689	262	8.24	2.63
B-046	7	47.0	A-6a	Hard	5	61	11	-	-	48	10	4835	594	179	8.14	3.32
B-046	8	59.0	A-4a	Hard	5	45	10	40	24	64	11	4799	462	128	10.39	3.61
B-199-1	10	24.6	A-4a	Hard	5	46	10	50	12	62	9	5086	500	254	10.17	1.97



DLZ

SUBJECT	FRA-70-8.93 Predicted p-y Curves for Soil	JOB NUMBER	0221-1004.01
		SHEET NO.	OF
		COMP. BY	SJR DATE 3/20/09
		CHECKED BY	DAA DATE 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: **Profile A** — **Curve No. 1**

Soil Type: Sandy Silt (Till) *Clay*

Test Depth: 28.0 feet

Test Type: PMT - Menard

Probe Dia.: 70.0 mm; 2.76 inches

Radius of Probe: 35.0 mm; 1.38 inches

Initial Volume: 790 cc; 48.21 in^3

Probe Depth (DCM): 28.0 feet; 336 inches

Shaft Diameter (b): **48** inches

N_{60}: 45 bpf

E: 4049 psi

Reduction Factor: (α) *(see following page)*

If $\frac{DCM}{b} > 4$: $\alpha = 1.5$ for sand; $\alpha = 2.0$ for clay

If $\frac{DCM}{b} \le 4$: $\alpha = \frac{1.5 \cdot DCM}{4 \cdot b}$ for sand; $\alpha = 0.67 + \frac{2.0 \cdot DCM}{4 \cdot b}$ for clay

Equations:

Eqn 1: $P = P_{Corrected} \cdot b \cdot \alpha$

Eqn 2: $Y = \frac{V_{Adj}}{2 \cdot V_0} \cdot \frac{b}{2}$

p-y curve based upon correlation between SPT-N60-value and E

$E = 79.351(N_{60})^{1.033}$

α = 2.00

Point No.	Press. (psi)	Vol. (in^3)	Fit Factor	Press. (psi)	Vol. (in^3)
	0	0	1.00	0	0.0
1	63	2.5	1.30	81	2.5
2	125	5.0	1.15	144	5.0
3	188	7.5	0.98	184	7.5
4	251	10.0	0.86	216	10.0
5	313	12.5	0.78	244	12.5
6	376	15.0	0.71	267	15.0
7	439	17.5	0.65	285	17.5
8	501	20.0	0.60	301	20.0
9	564	22.5	0.56	316	22.5
10	627	25.0	0.53	329	25.0

P (kip/in)	y (in)
0.00	0.000
7.82	0.622
13.84	1.245
17.69	1.867
20.70	2.489
23.47	3.112
25.63	3.734
27.38	4.356
28.88	4.979
30.33	5.601
31.59	6.223

DLZ

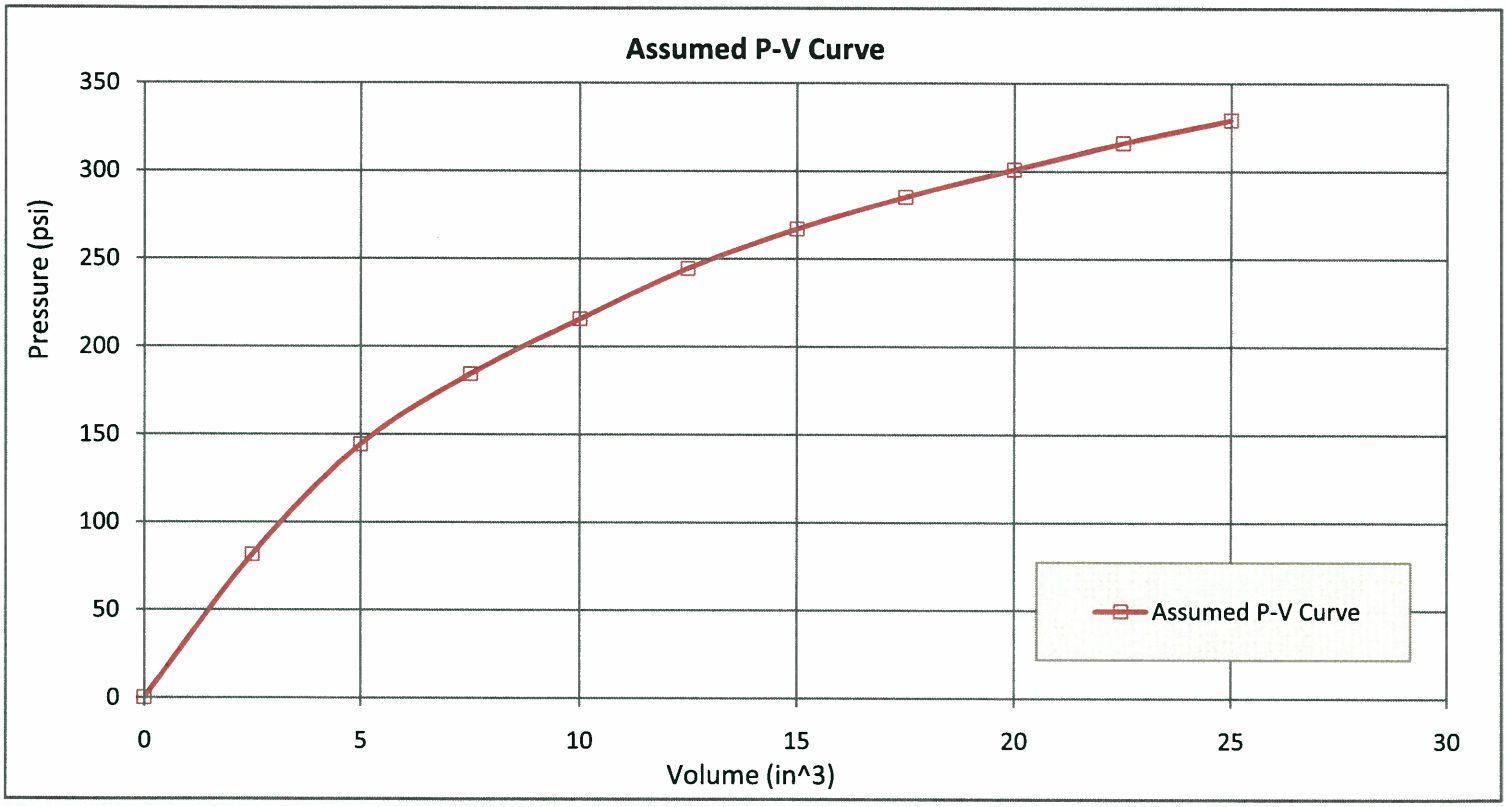
SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

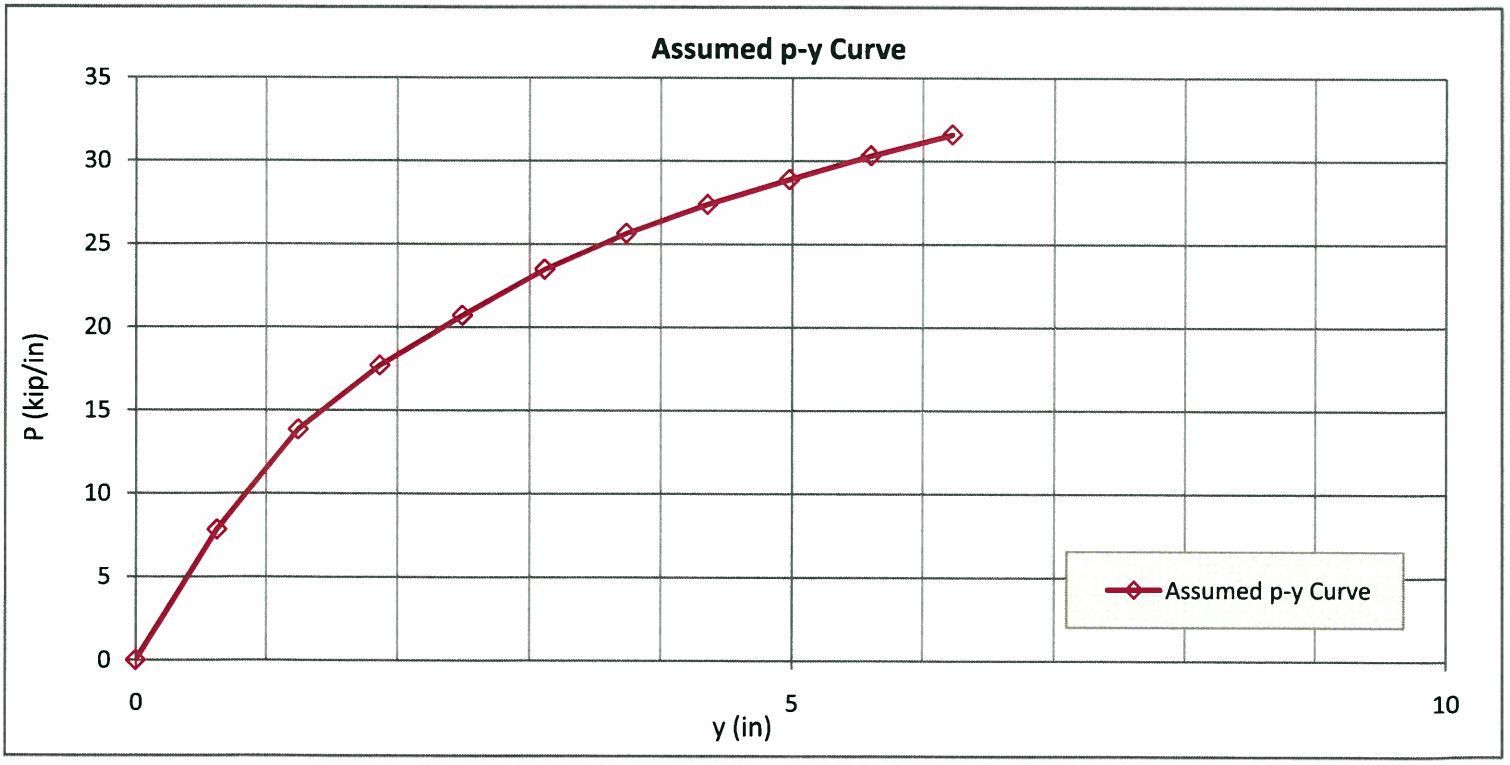
JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: Profile A
Test Depth: 28.0 feet





DLZ

SUBJECT	FRA-70-8.93	JOB NUMBER	0221-1004.01
	Predicted p-y Curves for Soil	SHEET NO.	OF
		COMP. BY	SJR DATE 3/20/09
		CHECKED BY	DAA DATE 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: **Profile A** — **Curve No. 2**

Soil Type: Sandy Silt (Till) *Clay*

Test Depth: 37.0 feet

Test Type: PMT - Menard

Probe Dia.: 70.0 mm; 2.76 inches

Radius of Probe: 35.0 mm; 1.38 inches

Initial Volume: 790 cc; 48.21 in^3

Probe Depth (DCM): 37.0 feet; 444 inches

Shaft Diameter (b): **48** inches

N_{60}: 58 bpf

E: 5262 **psi**

Reduction Factor: (α) *(see following page)*

If $\frac{DCM}{b} > 4$: $\alpha = 1.5$ for sand; $\alpha = 2.0$ for clay

If $\frac{DCM}{b} \le 4$: $\alpha = \frac{1.5 \cdot DCM}{4 \cdot b}$ for sand; $\alpha = 0.67 + \frac{2.0 \cdot DCM}{4 \cdot b}$ for clay

Equations:

Eqn 1 $P = P_{Corrected} \cdot b \cdot \alpha$

Eqn 2 $Y = \frac{V_{Adj}}{2 \cdot V_0} \cdot \frac{b}{2}$

p-y curve based upon correlation between SPT-N60-value and E

$E = 79.351(N_{60})^{1.033}$

α = 2.00

Point No.	Press. (psi)	Vol. (in^3)	Fit Factor	Press. (psi)	Vol. (in^3)
	0	0	1.00	0	0.0
1	81	2.5	1.00	81	2.5
2	163	5.0	1.00	163	5.0
3	244	7.5	0.95	232	7.5
4	326	10.0	0.87	284	10.0
5	407	12.5	0.79	322	12.5
6	489	15.0	0.72	352	15.0
7	570	17.5	0.66	376	17.5
8	652	20.0	0.62	401	20.0
9	733	22.5	0.58	425	22.5
10	815	25.0	0.55	448	25.0

P (kip/in)	y (in)
0.00	0.000
7.82	0.622
15.64	1.245
22.29	1.867
27.22	2.489
30.89	3.112
33.79	3.734
36.13	4.356
38.48	4.979
40.83	5.601
43.02	6.223

DLZ

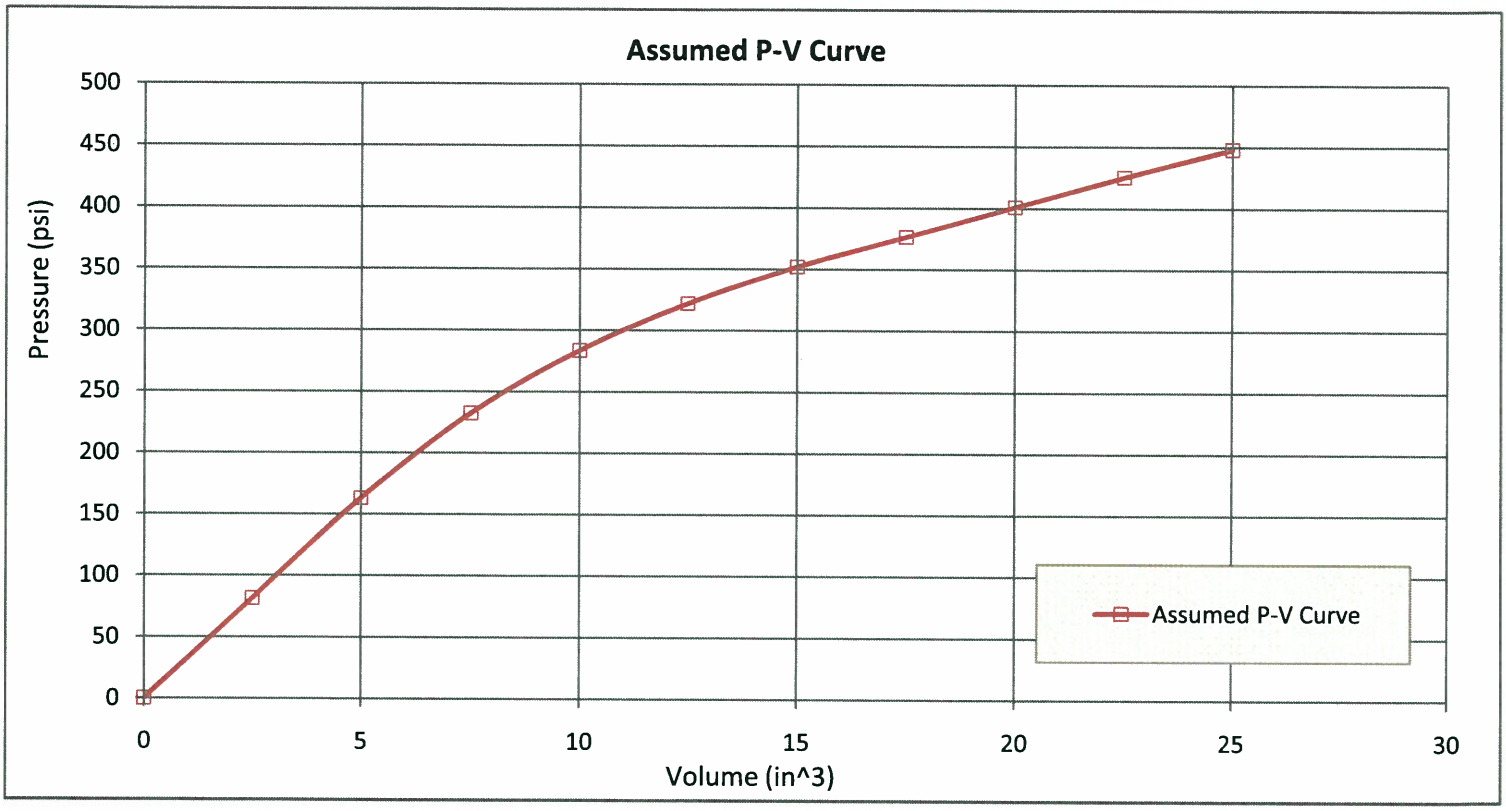
SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

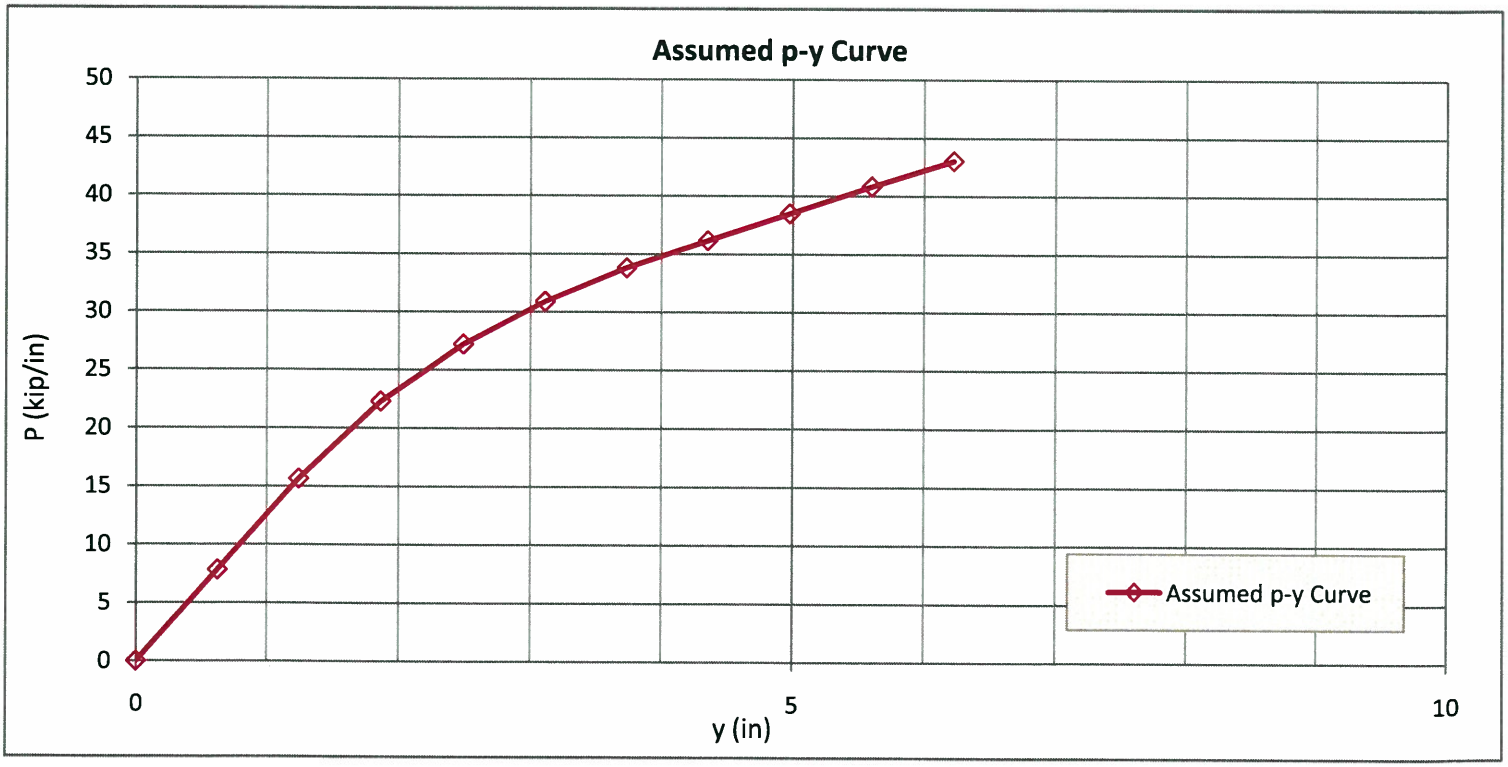
JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: Profile A
Test Depth: 37.0 feet





DLZ

SUBJECT: FRA-70-8.93
Predicted p-y Curves for Soil

JOB NUMBER: 0221-1004.01
SHEET NO.: OF
COMP. BY: SJR DATE: 3/20/09
CHECKED BY: DAA DATE: 3/20/09

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: **Profile B**
Soil Type: Sandy Silt (Till) *Clay*
Test Depth: 87.0 feet
Test Type: PMT - Menard
Probe Dia.: 70.0 mm
2.76 inches
Radius of Probe: 35.0 mm
1.38 inches
Initial Volume: 790 cc
48.21 in^3
Probe Depth (DCM): 87.0 feet
1044 inches

Shaft Diameter (b): **48** inches

N_{60}: 50 bpf
E: 4514 psi

Curve No. 8

Reduction Factor: (α) *(see following page)*

If $\frac{DCM}{b} > 4$: $\alpha = 1.5$ for sand; $\alpha = 2.0$ for clay

If $\frac{DCM}{b} \le 4$: $\alpha = \frac{1.5 \cdot DCM}{4 \cdot b}$ for sand; $\alpha = 0.67 + \frac{2.0 \cdot DCM}{4 \cdot b}$ for clay

Equations:

Eqn 1: $P = P_{Corrected} \cdot b \cdot \alpha$

Eqn 2: $Y = \frac{V_{Adj}}{2 \cdot V_0} \cdot \frac{b}{2}$

p-y curve based upon correlation between SPT-N60-value and E

$E = 79.351(N_{60})^{1.033}$

α = 2.00

Point No.	Press. (psi)	Vol. (in^3)	Fit Factor	Press. (psi)	Vol. (in^3)	P (kip/in)	y (in)
	0	0	1.00	0	0.0	0.00	0.000
1	70	2.5	1.30	91	2.5	8.72	0.622
2	140	5.0	1.15	161	5.0	15.43	1.245
3	210	7.5	0.98	205	7.5	19.73	1.867
4	280	10.0	0.86	240	10.0	23.08	2.489
5	349	12.5	0.78	273	12.5	26.17	3.112
6	419	15.0	0.71	298	15.0	28.58	3.734
7	489	17.5	0.65	318	17.5	30.53	4.356
8	559	20.0	0.60	335	20.0	32.21	4.979
9	629	22.5	0.56	352	22.5	33.82	5.601
10	699	25.0	0.53	367	25.0	35.22	6.223

Predicted p-y Curve for Soil

Reference: Roberston et. al. (1985)

Boring: Profile B
Test Depth: 87.0 feet