EXHIBIT G – GEOTECHNICAL REPORT (FINAL)

December 18, 2018
JOB NO. 12060G

FINAL

GEOTECHNICAL INVESTIGATION, LABORATORY TESTING AND REPORTING SERVICES FOR THE PROPOSED FIRE STATION ENGINE COMPANY 115 COMPANY AT THE NORTHWEST CORNER OF 119TH STREET AND MORGAN STREET, CHICAGO, ILLINOIS

PUBLIC BUILDING COMMISSION OF CHICAGO PROJECT NO. 07115

PREPARED FOR:

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REPORT SUMMARY

This is the subsurface investigation and geotechnical engineering analysis and evaluation for the proposed Engine Company 115 Fire Station Facility to be constructed on the property located at the northwest corner of South 119th Street and South Morgan Street in the City of Chicago, Illinois. This geotechnical report is the final geotechnical report for this project and is the follow-up geotechnical report to the previously prepared preliminary geotechnical report prepared by SEECO Consultants, Inc. titled ‘Preliminary Subsurface Exploration, Geotech Laboratory Testing and Geotechnical Engineering and Analysis for the Proposed Fire Station Engine Co. 115 Project located at Site ‘B’ near NWC of 119th St. and Morgan St., Chicago, Illinois’ dated October 31, 2018 with SEECO Job No. 12060G. The proposed Engine Company 115 Fire Station project includes the construction of a new approximately 27,000 gross square foot one story slab on grade fire station building with driveways and parking lots and an approximately 150 foot tall monopole communication tower at the project site

In general, soil and groundwater conditions encountered during the subsurface investigation at the project site require ground improvement techniques for the proposed one story, slab-on-grade fire station building that is to be constructed at the site with conventional footings such as interior and exterior continuous wall footings and interior spread footings.

Five (5) exploratory soil borings were drilled and sampled to depths ranging from 30 feet to 50 feet below existing ground level at the project site by SEECO Consultants, Inc. on the days October 11 and October 12, 2018 for the preliminary geotechnical report prepared by SEECO Consultants, Inc. dated October 31, 2018 with SEECO Job No. 12060G. After the final location of the proposed building was chosen on this project site by the PBCC, SEECO Consultants, Inc. drilled and sampled six (6) additional soil borings (B-6 to B-11) to depths ranging from 30 feet to 50 feet below the existing grade level on this project site within the proposed building footprint area and proposed monopole communication tower location.

Soil borings B-1 to B-11 were drilled and sampled through approximately 2 inches to 5.25 inches of bituminous concrete pavement overlying approximately 5 inches to 10 inches of dark brown sand

and gravel base course to crushed stone base course. Underlying the above mentioned pavement section, borings B-1 to B-11 generally encountered wet to moist loose dark brown, brown, and black silty sand to silty clay sand fill to cinders and topsoil fill to approximate depths of 1.5 feet to 4 feet below the existing ground surface level. Underlying the above mentioned urban fill soils, borings B-1 to B-11 generally encountered wet to moist loose brown and gray virgin poorly graded fine sand with little silt and clay to silty clayey sand to approximate depths of 9.5 feet to 10 feet below the existing ground surface level which is generally overlying stiff to very stiff gray virgin silty clay glacial till to the termination depths of 30 feet to 50 feet below the existing ground surface level at each boring location respectively.

The eleven (11) borings on this project site generally encountered groundwater at approximately 13 feet to 33 feet below the ground surface level while drilling or while sampling, which rose generally to approximately 5.5 feet to 10 feet below the existing ground surface level after removal of the hollow stem augers from the boreholes respectively. However, yearly and seasonal fluctuations can be anticipated in the water table due to changes in the groundwater hydrogeological regime.

To prepare this project site it is recommended to remove all existing bituminous concrete pavement section and base course section to subgrade level and strip clean any encountered black topsoil fill or black cinders fill within the proposed building footprint area and/or parking lot areas. After demolition of the existing asphalt parking lot and any existing storm sewer manholes, it is recommended to perform the ground improvement schemes provided under the subsection **Building Foundations** under **Geotechnical Engineering Recommendations** section in the body of this report.

Based on the loose sandy soils encountered within the upper 10 feet of the soil profile in borings B-3 and B-5 to B-10 drilled and sampled within the proposed building footprint area, this project site is feasible to construct the new one story slab on grade Fire Station Building with a conventional shallow foundation system consisting of exterior continuous wall footings and interior isolated spread footings, however ground improvement techniques will be required.

The ground improvement technique to be utilized within the building footprint area and driveway pavement areas for this project should be <u>Vibro-Compaction (Vibroflotation) Ground Improvement Method for Insitu Soil:</u> This ground improvement technique is an insitu treatment by densifying the loose silty sand fill to poorly graded virgin sand to virgin silty clayey sand to approximate depths of 9.5 feet to 10 feet below the existing grade level within the proposed building footprint area and proposed driveway pavement area by a vibration technique. The insitu sandy soils are densified by a high frequency vibrator probe attached to a crawler crane and also water injection into the soil to cause mobilization of the sand particles into a denser configuration. However, the effectiveness of this ground improvement technique is affected by the fines (silts and clays) content in the insitu soils, which higher the fines content of the sandy soil the densification effectiveness is lowered. It is recommended that a minimum of 65% relative density is achieved in the field after this ground improvement technique is implemented. It can estimated the grade will be lowered approximately 10% of the total treatment depth and therefore granular structural fill may have to be trucked onsite for regrading purposes (if needed depending on final site grading). To verify the relative density and bearing capacity of the improved subgrade soil it is recommended to establish a Quality Control program through Split Spoon Sampler Testing (SPT) within the proposed ground improvement areas after using the Vibroflotation Method.

As an alternative to the vibroflotation ground improvement, the insitu sandy soils within the proposed building footprint area (foundations and floor slab areas) should be excavated out to approximately 9.5 feet to 10 feet below the existing ground surface level and then the excavated sandy soils can then be placed back in the building area excavation in a controlled manner. The excavated insitu sandy soil should be placed in maximum 8 inch loose lifts with each lift compacted to a minimum of 95% (within building pad area) of the maximum dry density obtained in accordance with the Modified Proctor Test (ASTM D 1557-12). This procedure densifies the sandy soils on this project site to provide a suitable controlled bearing for the proposed Fire Station building foundations and first floor slab. A well-documented Quality Control (QC) program should be implemented with this ground improvement scheme to verify the compaction of each lift of placed soil to ensure the re-compacted soil is stabilized and suitable for bearing of the proposed Fire Station Building.

The foundation for the proposed fire station building can be supported at approximately 4 feet below the existing ground surface level bearing on the improved insitu sandy soils and can be designed for a maximum net allowable bearing capacity of 3,000 psf for either of the ground improve schemes presented above. Details of the foundation ground improvement schemes and foundation recommendations are provided under the subsection **Building Foundations** under **Geotechnical Engineering Recommendations** section in the body of this report.

Foundation recommendations and construction considerations for the proposed communication tower monopole are provided under subsection **Communication Tower Monopole Foundation** given under **Geotechnical Engineering Recommendations** section in the body of this report.

Details of the foundation recommendations, floor slab design, monopole commination tower foundation recommendations, general pavement design considerations, slug-in test and recommendations and general construction considerations at the site are given in the body of this report.

PROJECT OVERVIEW

Introduction

This geotechnical report is prepared for the proposed Engine Company 115 Fire Station which includes the construction of a new one story fire station building with driveways and parking lots and an approximately 150 foot tall monopole communication tower at the project site located at the northwest corner of 119th Street and Morgan Street in the City of Chicago, Illinois. The new fire station building will be an approximately 27,000 gross square foot one-story slab on grade building. A total of eleven (11) soil borings were drilled and sampled for this investigation as requested by the Public Building Commission of Chicago (PBCC) for this project.

This geotechnical report is the final geotechnical report for this project and is the follow-up geotechnical report to the previously prepared preliminary geotechnical report prepared by SEECO Consultants, Inc. titled ‘Preliminary Subsurface Exploration, Geotech Laboratory Testing and Geotechnical Engineering and Analysis for the Proposed Fire Station Engine Co. 115 Project located at Site ‘B’ near NWC of 119th St. and Morgan St., Chicago, Illinois’ dated October 31, 2018 with SEECO Job No. 12060G.

The purpose of this geotechnical report is to provide existing subsurface soil conditions, groundwater conditions encountered on this project site, provide foundation recommendations which include most feasible foundation types based on site soil and groundwater conditions, the net maximum allowable bearing capacity of these feasible foundation systems, and minimum foundation bearing depth of the proposed building foundations. Also, included are general pavement recommendations, infiltration testing and analysis, general construction considerations, and other pertinent geotechnical information.

The scope of services did not include any environmental assessment for the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater or air on or below or around this site. Any statement in this report or on the boring logs regarding odors, colors or unusual or suspicious items is strictly for the information of the Client.

This report includes the geotechnical recommendations, detailed **Soil Boring Logs** for each soil boring made at the project site, supporting geotechnical laboratory test data, and a **Boring Location Plan** which are included in the **Appendix** of this report.

Authorization

Authorization to complete this scope of work was presented through a SEECO Consultants, Inc. proposal dated September 28, 2018 between the Public Building Commission of Chicago and SEECO Consultants, Inc. which was awarded to SEECO Consultants, Inc. on October 16, 2018. On October 16, 2018, SEECO Consultants, Inc. received the Task Order/ Notice of Award, Contract No. PS2062E, Task Order No. 07115-PS2062E-001 dated October 16, 2018 signed by James L. Borkman, Director of Procurement of the PBC on 10/16/18 and signed by Lori Lypson, Chief of Staff of the PBC on 10/16/18.

Site Geology

The soils in this area are the product of the result of Wisconsinan Stage of the Continental Glacier. The Wisconsinan ice was the last to cover the North American Continent, receding from this area some 13,500 years ago. Present land forms in this area are the results of the Wisconsinan glaciation action during the Pleistocene Epoch. The soils were formed from the natural deposition erosion and weathering processes that have prevailed to the present time. The Pre-Wisconsin glacial deposits are found only in deep bedrock valleys and ravines where they were sheltered from the erosive action of the Wisconsinan Glaciation.

According to the Illinois State Geological Survey (ISGS) Surficial Geology of The Chicago Region (Willman, H.B. and Lineback, Jerry A., 1970), the native soils at this project site below the existing surficial existing asphalt pavement overlying urban fill soils have been assigned to the Lake Plain Formation. These soils were deposited during the Woodfordian, Twocreekan, and Valderan Substage of the Wisconsinan Glaciation stage. This soil is described as floors of glacial lakes flattened by wave erosion and by minor deposition in low areas, largely underlain by glacial till with thin deposits of silt, clay, and sand of the Equality Formation per the above referenced surficial geology map.

The soil borings performed at this project site generally encountered existing asphalt pavement overlying urban manmade fill materials consisting of sand, silt, clay, and gravel to the depth of approximately 4 feet below existing grade underlain by layers of loose virgin poorly graded sand to virgin silty clayey sandy soils which is underlain by very stiff to hard gray silty clay glacial till soils. The soil conditions encountered at this project site, in general, do not confirm the local site geology of this site based on the ISGS surficial geology map for this area due to the deep layer of surficial urban fill.

The details of the onsite soil conditions can be found in the **Site Soil Conditions** subparagraph of the report and the **Boring Logs** given in the **APPENDIX** of this Report.

Site Description

The Public Building Commission of Chicago (PBC) has elected to construct a new Fire Station for Engine Company 115 and new approximately 150 foot tall communication monopole on the project site located at the northwest corner of the intersection of South 119th Street and South Morgan Street in the City of Chicago. Refer to the **Boring Location Plan** provided in the **Appendix** of this report.

This project Site is a rectangular shaped property with West 118th Street as the north boundary, South Morgan Street as the east boundary, West 119th Street as the south boundary, and an industrial property along the western boundary. Based on Google Earth Maps, the project site is approximately ±4.5 acres in area. This project site appeared to be an existing asphalt parking lot that has been abandoned and deteriorating as for trees, bushes, shrubs, and other prairie flora is growing out of the existing asphalt pavement. The project site is relatively flat across the site. This site description is referenced from observations made by Mr. Matthew Boladz, P.E., Staff Engineer of SEECO Consultants, Inc., Project Geotechnical Engineer during the site visit on October 11, 2018.

Project Description

Based on email conversations between Ms. Kathy Thalmann, Design Project Manager for the Public Building Commission of Chicago for this project and the principal author of this report Mr. Matthew Boladz, P.E. of SEECO Consultants, Inc., Project Geotechnical Engineer on 10/17/2018 the following is known.

The proposed Fire Station building will be constructed near the southern middle third of the project site and the building footprint is orientated in a north-south direction. The proposed Fire Station will have a proposed gross footprint area of approximately 27,000 square feet in area. The proposed Fire Station will be a one-story slab on grade building and will be constructed of a combination of steel framing and load bearing masonry walls. The estimated applied service (DL+LL) column loads will be approximately 150 kips and the estimates applied service (DL+LL) wall loads will be approximately 5 kips per linear foot. The concrete first floor slab will be designed for HS20 truck loading conditions which is approximately 250 psf service trucks live loading. The fire truck garage is located at the southern portion of the proposed fire station building. The proposed fire truck driveway will be constructed at the southern portion of the project site. The proposed car parking lot will be constructed north of the proposed fire station building.

An approximately 150 foot tall monopole communication tower will be constructed west of the proposed fire station building and near the southwest corner of the project site. The actual applied vertical and horizontal loading conditions have not been provided for this proposed monopole communication tower at the time of this report (12/18/2018).

ANALYSIS AND RESULTS

Subsurface Exploration Procedures

Five (5) exploratory soil borings were drilled and sampled to depths ranging from 30 feet to 50 feet below existing ground level at the project site by SEECO Consultants, Inc. on the days October 11 and October 12, 2018 for the preliminary geotechnical report prepared by SEECO Consultants, Inc. dated October 31, 2018 with SEECO Job No. 12060G. After the final location of the proposed building was chosen on this project site by the PBCC, SEECO Consultants, Inc. drilled and sampled six (6) additional soil borings (B-6 to B-11) to depths ranging from 30 feet to 50 feet below the existing grade level on this project site within the proposed building footprint area and proposed monopole communication tower location. Distribution and depth of soil borings is given in the following **Table No. 1**:

Table No. 1: Boring Summary

Structure	Respective Boring Numbers	Depth of Each Boring (ft.)
Proposed Fire Station	B-3, B-8	50’
	B-5, B-6, B-7, B-9, B-10	30’
Proposed Driveways and Parking Lots	B-1, B-2, B-4	30’
Proposed Monopole Communication Tower	B-11	50’

A **Boring Location Plan** is included in the **Appendix** of this report.

The five (5) initial soil borings (B-1 to B-5) are subsurface exploration borings and were laid out in a grid like manner based on the locations chosen by the PBCC which was provided in the RFP dated September 24, 2018. These five (5) soil borings were laid out in the field by the principal author of this report on October 11, 2018. The additional six (6) soil borings (B-6 to B-11) were laid out in the field by the principal author of this report on November 29, 2018 based on the soil boring locations referenced from the 'Site Plan' Sheet A1.0 not dated prepared by DLR Group, Project Architect which was provided to SEECO Consultants, Inc. via email by Ms. Kathy Thalmann, Design Project Manager for the Public Building Commission of Chicago.

On October 11th and 12th, 2018 and also later on November 29, 20018 and December 4, 2018 a total of eleven (11) soil borings (B-1 through B-11) were drilled and sampled by a two (2) man drill crew from SEECO Consultants, Inc. using a Diedrich (Model D-50) truck mounted drill rig on this project site located at the northwest corner of 119th Street and South Morgan Street in the City of Chicago, Illinois. The soil borings were drilled and sampled at the locations indicated on the **<u>Boring Location Plan</u>** given in the **<u>Appendix</u>** of this report. The borings ground surface elevation and locations were surveyed in the field by representatives of McBride Engineering a Woman Business Enterprise (WBE) and sub-consultant to SEECO Consultants, Inc. in which the ground surface elevations in City of Chicago Datum (CCD) of each boring and Northing and Easting Illinois State Plane coordinates are provided at the top of the **<u>Boring Logs</u>** given in the **<u>Appendix</u>** of this report.

The soil borings were drilled and sampled utilizing a truck mounted drill rig (Diedrich Model D-50) which advances the boreholes by the hollow stem auger method. The soil samples were obtained utilizing split spoon samples in accordance with ASTM D 1586-11. In the split barrel sampling procedure, a split spoon sampler having a two-inch outside diameter and inside diameter of 1-3/8 inches and a length of two feet is driven into the soil. This sampler is advanced by driving with a 140 pound weight falling freely from a height of 30 inches with Standard Penetration Resistance being recorded as a number of blows required to advance the sampling spoon a distance of 12 inches after an initial driving of six inches had been used to seat the sampler. The Standard Penetration Resistance, or the "N" Value, measures roughly the consistency of clayey soils and is in general related to the bearing capacity of the material. Other factors are usually taken into consideration in determining the bearing capacity value and those include the type of soil, the type of loading, the dimensions and the depths of footings below the ground surface and the proximity of the groundwater table to the base of the footings.

Representative portion of the split spoon samples were placed in glass containers with screw-type lids and taken to SEECO Consultants, Inc. geotechnical laboratory for further examination and testing.

Geotech Laboratory Testing Program

The geotech testing program consisted of performing in-situ natural moisture content and visual classification on all soil samples and calibrated penetrometer unconfined compression tests on representative cohesive soil samples. In the pocket penetrometer test, the unconfined compressive strength of a cohesive soil to a maximum value of 4.5 tsf is estimated by measuring the resistance of a soil sample to penetration of small spring calibrated cylinder.

In situ moisture content or natural water content is determined in the laboratory as follows (ASTM D 2216-10). A portion of each sample is weighed, oven-dried at 110° ±5°C, and reweighed to obtain the weight of water in the sample. The moisture content is the ratio of the weight of water in the soil sample to the weight of the dry soil expressed as a percentage of the total dry weight. After completion of the testing program, each soil sample was visually classified on the basis of texture and plasticity in accordance with the Unified Soil Classification System (ASTM D 2487-17 and D 2488-17). The estimated group symbol according to this system is included following the description of the soil on the boring logs.

A total of fifteen (15) dry unit weight tests per ASTM D7263-09 (2018) and unconfined compressive strength tests per ASTM 2166-16 were performed on representative soils obtained from representative split spoon samples to determine the current in-situ dry unit weight, corresponding moisture and compressive strength of each representative cohesive sample. Liquid limit and plastic limit tests were performed in accordance with ASTM D4318-10 on a total of twenty-two (22) representative soil samples. A total of fifteen (15) particle size analyses (including sieve analysis and hydrometer analysis tests) were performed in accordance with ASTM D 422-63(2007) on representative soil samples. The Atterberg Limits tests and sieve analysis and hydrometer analysis tests were performed by Rubino Engineering a Women Business Enterprise (WBE) and sub consultant for SEECO Consultants, Inc.

A brief explanation of the **Unified Soil Classification System** is included in the **Appendix** of this report. All laboratory test data is noted on the **Boring Logs** which are also included in the **Appendix** of this report.

Site Soil Conditions

Soil borings B-1 to B-11 were drilled and sampled through approximately 2 inches to 5.25 inches of bituminous concrete pavement overlying approximately 5 inches to 10 inches of dark brown sand and gravel base course to crushed stone base course. Underlying the above mentioned pavement section, borings B-1 to B-11 generally encountered wet to moist loose dark brown, brown, and black silty sand to silty clay sand fill to cinders and topsoil fill to approximate depths of 1.5 feet to 4 feet below the existing ground surface level.

Underlying the above mentioned urban fill soils, borings B-1 to B-11 generally encountered wet to moist loose brown and gray virgin poorly graded fine sand with little silt and clay to silty clayey sand to approximate depths of 9.5 feet to 10 feet below the existing ground surface level which is generally overlying stiff to very stiff gray virgin silty clay glacial till to the termination depths of 30 feet to 50 feet below the existing ground surface level at each boring location respectively.

It is recommended that **Boring Logs** given in the **APPENDIX** of this report should be studied for the soil conditions present at each boring location respectively.

Site Groundwater Conditions

Groundwater elevations encountered for each individual boring location while drilling, while sampling and after the removal of the hollow stem augers from the boreholes at the time these borings were performed is given below in the following **Table No. 2.**

Table No. 2 – Approximate Groundwater Depths

Boring No.	Approximate Groundwater Level Depths at the time of Drilling & Sampling			
	While Sampling (Feet)	While Drilling (Feet)	After Hollow Stem Auger Removal –(Feet)	Date of Reading
B-1	17’	-	9.5’	10/11/2018
B-2	18’	-	10’	10/12/2018
B-3	-	13’	8.5’	10/11/2018
B-4	17’	-	10’	10/11/2018
B-5	13’	-	8.5’	10/12/2018
B-6	13’	-	9’	11/29/2018
B-7	7’	-	5.5’ (WCI)	11/29/2018
B-8	16.5’	-	10’	12/4/2018
B-9	-	13’	8’	11/29/2018
B-10	13’	-	8.5’	11/29/2018
B-11	-	33’	10’	12/4/2018

The eleven (11) borings on this project site generally encountered groundwater at approximately 13 feet to 33 feet below the ground surface level while drilling or while sampling, which rose generally to approximately 5.5 feet to 10 feet below the existing ground surface level after removal of the hollow stem augers from the boreholes respectively. Wet cave in occurred in boring B-7 after removal of the hollow stem augers from the borehole causing the ground water level to rise and this water level reading should not be considered the true ground water table. Wet cave in is when non-cohesive granular borehole sidewalls collapse into the borehole due to the water table after removal of the hollow stem augers from the borehole.

The yearly seasonal highs can be predicted by the gray color meaning the soil has not been exposed to water long enough to have been oxidized and turn brown to brownish gray.

The groundwater levels and times of recording are indicated above on the **Boring Logs** found in the **Appendix** of this report. However, yearly and seasonal fluctuations can be anticipated in the water table due to changes in the groundwater hydrogeological regime.

GEOTECHNICAL LABORATORY TEST RESULTS

Atterberg Limit Tests

A total of twenty-two (22) Atterberg Limit Tests were performed according to ASTM D4318-10 on the stiff to hard gray silty clay (CL) to aid in the USCS soil classification. The results of the twenty-two (22) Atterberg Limit Tests yields the values of plasticity indices (PI) and liquidity indices (LI) in which provide correlations for preconsolidation pressure of the in-situ soils and provide an indication of the degree of consolidation. Atterberg Limit test results were used to both to classify soils as well as an indication of the overconsolidation ratio for these soils layers in the zone of influence for the proposed building footings.

The twenty-two (22) Atterberg Limit tests performed on the chosen soil samples are summarized in **Table No. 3** as shown below.

Table No. 3- Atterberg Limit Test Summary

Boring	Sample/Depth (ft.)	Soil Description	Natural Moisture Content (w%)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)
B-1	S-4 / 11’	Hard Gray Silty Clay (CL)	16.4	34	19	15	-0.17
B-2	S-5 / 11.75’	Very Stiff Gray Silty Clay (CL)	16.4	33	19	14	-0.18
B-2	S-9 / 29’	Very Stiff Gray Silty Clay (CL)	19.9	39	20	19	0.0
B-3	S-5 / 19’	Very Stiff Gray Silty Clay (CL)	19.7	39	19	20	+0.04
B-3	S-10 / 39’	Hard Gray Silty Clay (CL)	14.9	29	16	13	-0.08
B-4	S-5 / 14’	Very Stiff Gray Silty Clay (CL)	18.8	39	20	19	-0.06
B-5	S-8 / 24’	Very Stiff Gray Silty Clay (CL)	18.5	36	19	17	-0.03
B-5	S-6 / 14’	Very Stiff Gray Silty Clay (CL)	18.1	39	18	21	+0.0
B-6	S-5 / 14’	Very Stiff Gray Silty Clay (CL)	17.6	35	18	17	-0.02
B-6	S-7 / 24’	Very Stiff Gray Silty Clay (CL)	15.7	28	18	10	-0.23
B-7	S-4 / 11’	Very Stiff Gray Silty Clay (CL)	16.5	35	18	17	-0.09
B-7	S-7 / 24’	Very Stiff Gray Silty Clay (CL)	16.5	35	19	16	-0.16

B-8	S-5 / 14’	Hard Gray Silty Clay (CL)	17.7	35	18	17	-0.02
B-8	S-9 / 34’	Stiff Gray Silty Clay (CL)	17.1	26	14	12	+0.25
B-9	S-5 / 14’	Very Stiff Gray Silty Clay (CL)	18.6	36	19	17	-0.02
B-9	S-7 / 24’	Very Stiff Gray Silty Clay (CL)	17.5	31	17	14	+0.04
B-10	S-6 / 19’	Very Stiff Gray Silty Clay (CL)	18.2	36	18	18	+0.01
B-10	S-8 / 29’	Very Stiff Gray Silty Clay (CL)	16.3	33	20	13	-0.28
B-11	S-5 / 14’	Very Stiff Gray Silty Clay (CL)	16.5	35	17	18	-0.03
B-11	S-8 / 29’	Very Stiff Gray Silty Clay (CL)	19.8	32	18	14	+0.13
B-11	S-9 / 34’	Very Stiff Gray Silty Clay (CL)	20.9	40	20	20	+0.05
B-11	S-11 / 44’	Very Stiff Gray Silty Clay (CL)	13.8	27	15	12	-0.1

The Atterberg Limit test results for these virgin silty clay indicate the liquid limit of these tested soil samples varies between approximately 26% to 40% and are less than 50% with corresponding plasticity indices (PI’s) being 10% to 21%. These twenty-two (22) representative silty clay soil samples with Atterberg Limit results plot on the plasticity chart as being “CL” type soils per the Unified Classification System. The LIs of these clay soils range from -0.28 to +0.25 values and indicate moderately overconsolidated to heavily overconsolidated silty clay glacial till soils.

The Atterberg Limits results are shown on the **ATTERBERG LIMITS TEST RESULTS** given in the **Appendix** of this report. The Atterberg Limit tests are also shown on the **Boring Logs** located in the **Appendix** of this report.

Unit Weight Tests and Unconfined Compressive Strength (Qu) Tests

A total of fifteen (15) wet and dry unit weights and fifteen (15) unconfined compressive strength tests (Qu) were taken on representative clay soil samples within potential bearing soil strata to aid in determining engineering soil properties necessary for foundation design.

For the virgin stiff to very stiff to hard gray silty clay, fifteen (15) unit weight tests were performed and the average dry unit weight for the samples tested is 116.1 pcf and the average wet unit weight for the samples tested is 136.4 pcf with an average moisture content of 17.5% and an average unconfined test strength (out of ten tests) of 3.4 TSF.

The unit weight tests and unconfined compressive strength tests are provided below in **Table No.4: Unit Weight and Unconfined Compressive Strength (Qu) Summary** and are typical for clay till soils in this area. The dry unit weights and unconfined compressive strength tests are also shown on the **Boring Logs** located in the **Appendix** of this report.

Table No.4: Unit Weight and Unconfined Compressive Strength (Qu) summary

Unit Weight & Unconfined Compressive Strength (Qu) Summary						
SOIL DESCRIPTION: Gray Silty Clay						
Boring	Sample No.	Depth (ft.)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Water Content (%)	Qu (TSF)
B-1	S-4	11.0	133.6	114.8	16.4	5.5
B-2	S-5	11.75	133.6	114.8	16.4	3.0
B-3	S-6	19	130.2	108.8	19.7	2.8
B-4	S-5	14	131.4	110.7	18.7	3.9
B-5	S-8	24	135.2	114.1	18.5	2.6
B-6	S-5	14	135.5	115.2	17.6	3.2
B-7	S-4	11	136.1	116.9	16.4	3.4
B-8	S-5	14	135.9	115.5	17.7	4.0
B-8	S-9	34	143.7	122.7	17.1	1.9
B-9	S-7	24	135.8	114.5	18.6	3.6
B-10	S-6	19	134.8	114.1	18.2	3.5
B-11	S-5	14	133.4	114.5	16.5	3.5
B-11	S-6	19	133.3	112.1	18.9	4.1
B-11	S-8	29	152.1	129.2	17.5	2.3
B-11	S-11	44	140.2	123.0	14.0	3.9
		Averages	**136.4**	**116.1**	**17.5**	**3.4**

Grain Size Analysis Tests

A total of fifteen (15) combined Sieve and Hydrometer analyses tests in accordance with ASTM D 422-63(2007)) were performed on representative soil samples in borings (B-1 to B-11) consisting of non-cohesive granular soils and cohesive clay soils for classification purposes.

The twelve (12) combined analysis test results performed on the representative granular soils are summarized as follows: Percentage of clay ranged from 12.1% to 19.7% Percentage of silt ranged from 7.8% to 44.2%. Percentage of sand ranged from 36.1% to 80.1%. Percentage of gravel ranged from 0.0% to 2.3%. The twelve (12) gradation tests indicate the USCS classifications are generally silty sand (SM) to silty clayey sand (SC-SM) material.

Three (3) combined analysis test results performed on the silty clay soils are summarized as follows: Percentage of clay ranged from 50.3% to 68.9% Percentage of silt ranged from 19.2% to 32.9%. Percentage of sand ranged from 11.8% to 16.1%. Percentage of gravel ranged from 0.0% to 0.7%. The three (3) gradation tests indicate the USCS classification as silty clay (CL).

The combined sieve and hydrometer analysis results are shown on the **GRAIN SIZE ANALYSIS RESULTS** given in the **Appendix** of this report. The location of the combined sieve and hydrometer analysis tests are also shown as "CA" on the **Boring Logs** located in the **Appendix** of this report.

GEOTECHNICAL FIELD TEST RESULTS

Field Slug-In Tests

On October 23, 2018, one (1) engineer from SEECO Consultants, Inc. and one (1) engineer from Kalgen Consultants, Inc., SEECO Consultants, Inc. Minority Business Enterprises (MBE) sub consultant carried out (2) slug-in tests I-1 and I-2 near the approximate soil borings B-1 and B-2 locations and borings B-4 and B-5 locations respectively on this Project Site for the proposed Engine Company 115 Fire Station project located at the northwest corner of South 119th Street and South Morgan Street in the City of Chicago, Illinois. Refer to the **Boring Location Plan** given in the

Appendix of this report for approximate slug-in test locations. The two (2) slug-in tests I-1 and I-2 were performed at an approximate depth of 4.0 feet below the existing ground surface level. The purpose of these tests is to compute the infiltration rate for the use of Best Management Practices (BMP) of the Urban Stormwater Best Management Practices of the City of Chicago Stormwater Management Manual for stormwater detention design in the proposed permeable pavement.

A four (4) feet deep borehole was blank drilled and a 4" inside diameter PVC pipe was inserted in the slug-in test locations I-1 to I-2 respectively. Water was added to the borehole and allowed to equilibrate for 15 minutes. An In-Situ Level Troll 700® used for sampling time and the water level was inserted in the borehole to approximately 0.5 feet above the bottom of the borehole. The Level Troll was connected to the laptop running Win-Situ software which allows real-time viewing and graphing of the slug-in test data. A slug of water was added to the borehole and the time and water level drop readings were recorded for a minimum of 30 minutes.

The collected slug-in test data was downloaded to a computer and analyzed in a Microsoft Excel spreadsheet program. Drop in the water level with time was observed during the test. The data from the test was reduced and analyzed as the infiltration rate of the subgrade soil. Based on the head drop for the given time interval, the infiltration rate at slug-in test locations I-1 and I-2 were found to be 0.87 in. / hr. and 0.95 in. /hr. respectively.

The long-term infiltration rates at all the test boreholes are greater than 0.5 inches/hr. which is the minimum infiltration required rate to consider infiltration of the stormwater into the subgrade as per City of Chicago Stormwater Management Ordinance Manual, 2016 edition. Therefore, it is concluded that the subgrade soils at these locations are permeable soils and these soils can be utilized to store excess stormwater runoff in the subsoil interstitial voids of these permeable soils. The result of the slug-in tests are attached in the **Appendix** of this report.

Table 5: Slug-In Test Results

Location	Slug-In Test No.	Approximate Bottom of Borehole Depth from Existing Ground Surface Level (feet)	Long Term Infiltration Rate Based on Slug-In Test (Inch./hour)	Recommended Average Long Term Infiltration Rate for This Project Site (Inch./hour)	Encountered Soil Type at Bottom of Borehole Based on Adjacent Soil Boring
Near Borings B-1 & B-2	I-1	4.0	0.87	0.91	Moist Loose Brown and Gray Poorly Graded Sand (SP), Little Silt
Near Borings B-4 & B-5	I-2	4.0	0.95		Moist to Saturated Loose Brown and Gray Poorly Graded Sand (SP), Little Silt

GEOTECHNICAL ENGINEERING RECOMMENDATIONS

Demolition

While onsite (10/11/2018), it was observed by the principal author of this report that this project site is an existing deteriorating asphalt parking lot which may have stormwater manhole sewers (none observed during boring layout) located on this project site. Therefore it is recommended to remove all existing storm sewer manholes (if present onsite) within the proposed building footprint area. It is also recommended to plug and abandon any existing storm sewer manholes within the proposed parking lot areas. Any demolition excavation should be backfilled with approved engineered granular fill material placed in maximum 8-inch loose lifts with each lift compacted to a minimum of 95% (proposed building area) and 90% (proposed pavement areas) of the maximum dry density in accordance with the Modified Proctor Test ASTM D 1557-12. This engineered fill material should be CA-6, Type B stone as per the State of Illinois "Standard Specifications for Road and Bridge Construction", 2016 Edition.

Site Preparation

It is recommended to remove all existing bituminous concrete pavement section and base course section to subgrade level and strip clean any encountered black topsoil fill or black cinders fill within the proposed building footprint area and/or parking lot areas. After demolition of the existing asphalt parking lot and any existing storm sewer manholes, it is recommended to perform the ground improvement schemes provided under the section **Building Foundations** below.

After the site ground improvement scheme has been performed, the proposed building footprint and parking lot areas should be proofrolled by using a rubber tire truck or tractor-trailer combination loaded with 20 tons of payload to verify that the surficial soils have been densified for the construction of the building slab on grade and proposed pavement areas respectively.

Also, if the alternative ground improvement scheme 'Remove, Replace and Recompact' insitu sandy soils ground improvement scheme is utilized it is recommended to proofroll the bottom of the building excavation by using a rubber tire truck or tractor-trailer combination loaded with 20 tons of payload before the backfill process begins and the following is recommended.

Upon proofrolling, if any of the floor slab or pavement areas are found to be pumping or excessive rutting is observed, then all the soft or unsuitable material should be removed and replaced with compacted selected granular fill to the proposed pavement subgrade elevation or bottom of granular drainage fill (subslab elevation) in the building floor slab areas.

During the site soil densification ground improvement scheme, the existing ground surface level will be lowered due to densifying the granular soils therefore is it recommended to raise the project site with a select granular fill to the bottom of the proposed building drainage fill and proposed bottom of pavement base course elevation if needed based upon final site grading plans.

The selected granular fill material should be placed in loose eight inch lifts and compacted to a minimum 95% (in the building area) or a minimum 90% (in the parking lot areas) of the maximum density in accordance with ASTM D 1557-12. A typical select granular fill material consists of crushed stone fill consists of CA-6, Type B-stone as per the State of Illinois Standard Specifications for Road and Bridge Construction, 2016 Edition.

A field engineer from SEECO Consultants, Inc. should be present during the placing of the engineered fill and for compaction testing of backfill material. This engineered fill material should be placed in lifts not to exceed eight inches in loose thickness with each lift compacted to the density requirements as given in the following **Table No. 6**: **Summary of Density Requirements**

Table No. 6: Summary of Density Requirements

Area	Density Requirements
Building	95% Maximum Density*
Parking lots	90% Maximum Density*
Open Areas (Grass Areas)	85% Maximum Density*

*In accordance with ASTM Number D 1557-12.

Building Foundations

This section covers the foundation recommendations for the construction of the one-story slab-on-grade Fire Station Building proposed to be constructed on the Project Site located at the northwest corner of 119th Street and Morgan Street in the City of Chicago, Illinois. Based on the loose sandy soils encountered within the upper 10 feet of the soil profile in borings B-3 and B-5 to B-10 drilled and sampled within the proposed building footprint area, this project site is feasible to construct the new one story slab on grade Fire Station Building with a conventional shallow foundation system consisting of exterior continuous wall footings and interior isolated spread footings, however ground improvement techniques will be required.

Deep foundation systems such as caissons or driven piling can be utilized to support the proposed building but these foundation systems would have construction costs far greater than the ground improvement techniques with conventional shallow foundation system recommended below due to the use of structural floor slabs supported by grade beams and caissons or piling.

The estimated applied service (DL+LL) column loads will be approximately 150 kips and the estimates applied service (DL+LL) wall loads will be approximately 5 kips per linear foot. The concrete first floor slab will be designed for HS20 firetruck loading conditions which is approximately 250 psf service firetruck live loading. The loading conditions referenced above were provided by Ms. Kathy Thalmann, Design Project Manager for the Public Building Commission of Chicago for this project to the principal author of this report Mr. Matthew Boladz, P.E. of SEECO Consultants, Inc., Project Geotechnical Engineer on 10/17/2018

Based on the loose poorly graded sand with little silt to clayey silty sand to silty sand encountered in all seven (7) soil borings (B-3, B-5 to B-10) to approximate depths of 9.5 feet to 10 feet below the existing grade level, it is recommended to use either of these ground improvement techniques which are option 1) Vibro-Compaction (vibroflotation) or as an alternative option 2) Remove, Replace and Recompact the insitu sandy soil to densify the insitu upper sandy soils. Details for each ground improvement technique are provided below. It is recommended to utilize one of these ground improvement techniques within the foundation and floor slab areas respectively based on the above mentioned loading conditions and also pavement areas exposed to firetruck loading conditions.

1) <u>Vibro-Compaction (Vibroflotation) Ground Improvement Method for Insitu Soil:</u> This ground improvement technique is an insitu treatment by densifying the loose silty sand fill to poorly graded virgin sand to virgin silty sand to virgin silty clayey sand to approximate depths of 9.5 feet to 10 feet below the existing grade level within the proposed building footprint area and proposed driveway areas exposed to fire truck loading conditions by a vibration technique. The insitu sandy soils are densified by a high frequency vibrator probe attached to a 60 ton to 100 ton crawler crane and also water injection into the soil to cause mobilization of the sand particles into a denser configuration. However, the effectiveness of this ground improvement technique is affected by the fines (silts and clays) content in the insitu soils, which higher the fines content of the sandy soil the densification effectiveness is lowered

and more vibrational effort is required or have smaller probe insertion grid spacing. The encountered silty sand to silty clayey sand soils will have a relative effectiveness of marginal to good results with relatively close probe spacing to be determined by the ground improvement subcontractor. It is recommended that a minimum of 65% relative density is achieved in the field after this ground improvement technique is implemented which approximately correlates to average blow counts greater than 10 blows per foot for SPT testing. It can estimated the grade will be lowered approximately 10% of the total treatment depth and therefore granular structural fill may have to be trucked onsite for regrading purposes if needed based on final lot grading plans. It is recommended to compact the surface with a vibratory smooth drum roller to ensure the surficial soils have been densified to support the proposed floor slab. The surficial sandy soils should be recompacted to a minimum 95% (in the building area) of the maximum density in accordance with ASTM D 1557-12. To verify the relative density and bearing capacity of the improved subgrade soil it is recommended to establish a Quality Control program through Split Spoon Sampler Testing (SPT) within the proposed ground improvement areas after using the Vibroflotation Method.

2) Remove, Replace and Recompact Insitu Soil: For this alternative ground improvement scheme it is recommended to excavate and remove all the insitu loose silty sand fill to poorly graded virgin sand to virgin silty clayey sand to approximate depths of 9.5 feet to 10 feet below the existing grade level within the proposed Fire Station building footprint area plus a 10 foot offset from the perimeter of the proposed building footprint area and stockpile this material onsite. For the proposed driveway areas exposed to fire truck loading conditions it is recommended to only excavate and re-compact approximately 2 feet to 3 feet below the existing ground surface level. Then, the excavated sandy soil should be utilized to backfill the building excavation area as a controlled engineered structural fill placed in maximum 8 inch loose lifts with each lift compacted to a minimum of 95% (within building pad area) or to

90% (within parking lot/driveway areas) of the maximum dry density obtained in accordance with the Modified Proctor Test (ASTM D 1557-12). This procedure densifies the sandy soils on this project site to provide a suitable controlled bearing for the proposed Fire Station building foundations and first floor slab. A well-documented Quality Control (QC) program should be implemented with this ground improvement scheme to verify the compaction of each lift of placed soil to ensure the re-compacted soil is stabilized and suitable for bearing of the proposed Fire Station Building. The building foundations may be designed for a maximum net allowable bearing capacity of 3,000 psf after replacement and compaction of the surficial sandy soils.

Based on the sandy soil profile encountered in the soil borings drilled and sampled within the proposed fire station building footprint area soil borings B-3 and B-5 to B-10 and also based on the dry sieve and hydrometer tests analysis of representative soil samples from borings B-3 and B-5 to B-10, it is concluded that this project site should utilize the Vibro-Compaction ground improvement method scheme for this project site as for improvement costs may be cheaper than the Remove, Replace, and Recompact ground improvement scheme. It is recommended to perform a cost feasibility study of both ground improvement schemes recommended above. Also, both ground improvement schemes may require re-grading as for during the densification process the grade will decrease and granular structural fill may be required to build the site back to proposed grade level depending on final site grading plan. The granular structural fill within the proposed building area (if needed) should consist of CA-6, Type B-stone as per the State of Illinois Standard Specifications for Road and Bridge Construction, 2016 Edition placed in loose eight inch lifts and each lift compacted to a minimum 95% of the maximum density in accordance with ASTM D 1557-12.

It is recommended to support the Fire Station building on conventional shallow footings consisting of continuous exterior wall footings and interior isolated spread footings after the ground improvement techniques have been implemented. Based on the improved subsurface soil conditions within the proposed building footprint area, it is concluded that the proposed Fire Station building can be supported on conventional shallow footing foundation system consisting of continuous exterior wall strip footings and interior isolated spread footings. The foundation for the proposed fire station building can be supported at approximately 4 feet below the existing ground surface level bearing on the improved insitu sandy soils and can be designed for a maximum net allowable bearing capacity of 3,000 psf for either the Remove, Replace and Recompact Scheme or the Vibroflotation Scheme. The maximum net allowable bearing pressure is the pressure in excess of the final effective vertical stress at the level of the footing base elevation. Since the soil within the zone of influence will be sandy soils, the settlement of the foundations will be immediate settlement due to construction loads and the building settlement should be negligible after final construction is complete. The expected total settlement should be less than 1 inch and the expected differential settlement should be less than 0.5 inches. The exterior footings should be provided a minimum of 3.5 feet of frost protection from external finish grade. It is also recommended that the minimum width of the proposed building wall footings should be 18 inches whereas the minimum size of isolated spread footings should be 36"x36" for lateral stability.

Floor Slab Design

A reinforced concrete floor slab is recommended for the proposed Fire Station building exposed to the firetruck wheel loading conditions (approximately 250 psf service live load), the other building floor slab area not exposed to firetruck wheel loading can be designed as a 'floating' floor slab at grade after the ground improvement techniques have been completed. Based on soil borings B-3 and B-5 to B-10 drilled and sampled within the proposed building footprint area on this project site, the subgrade soils generally require a ground improvement method as recommend in the previous section **Preliminary Foundation Engineering Recommendations.** Therefore, after the proposed building footprint area has undergone a ground improvement treatment the improved insitu soil would be sufficient to support a slab-on-grade floor slab with minimal reinforcement and should generally pass a proofroll test, however with the heavy wheel loading from the firetrucks (HS-20 loading) it is recommended to utilized reinforced concrete floor slab designed for the firetruck (HS-

20 loading) conditions. The floor slab should be constructed after placing a minimum six (6) inches of compacted crushed stone drainage fill. The crushed stone fill should be compacted to a minimum of 95% of the maximum dry density obtained in accordance with the Modified Proctor Test (ASTM D 1557-12). A typical crushed stone fill consists of CA-6, Type B-stone as per the State of Illinois Standard Specifications for Road and Bridge Construction, 2016 Edition.

The proposed concrete floor slab for the proposed Fire Station building should be designed for an average vertical subgrade modulus of 250 pci based on either the PCA methodology or the ACI-360R-06 publication "Design of Slabs-on-Ground" current edition by a Registered Structural Engineer in the State of Illinois. In order to minimize dampness in the concrete floor slab, a sheet of 6 mil thick visqueen positioned on the top of the granular drainage fill should be placed before the concrete floor slab on grade is poured.

Communication Tower Monopole Foundation

Drilled Shaft End Bearing Capacity

Since the lateral load analysis controls the needed embedment depth from existing grade level of the proposed Monopole drilled shaft caisson foundation, the gross ultimate end bearing capacity and the factored ultimate end bearing capacity have been provided at various depths to accommodate the designer for vertical soil bearing analysis based on the iterative process for the lateral load analysis. The drilled shaft caisson can be a straight shaft with no bell at the bottom of the shaft. Due to the diameter of the base of the Monopole Communication Tower the minimum caisson shaft diameter should be 9 feet. The proposed caisson shaft should bear within the virgin very stiff to hard gray silty clay strata from approximately 30 feet to 50 feet below the existing ground surface level at boring B-11 location.

The final structural design of the proposed Monopole drilled shaft foundation should be designed in accordance to TIA-222-G (August 2005 Edition) 'Structural Standard for Antenna Supporting Structures and Antennas' which states foundations are to be designed with the LFRD method. Per Section 9.4.1 *Design Strength of Soil or Rock* of the TIA-222-G (August 2005) 'Structural Standard for Antenna Supporting Structures and Antennas' the soil resistance factor (ϕ_{sG}) for bearing should be taken as 0.75 for self-supporting structures bearing on soil or rock to be applied to the nominal soil resistance (R_s). Therefore based on the LFRD method and on the virgin soil strata encountered at various possible design depths the following **Table No. 7** is a summary of the gross ultimate end bearing capacity and the factored ultimate gross end bearing capacity for the proposed drilled shaft caisson foundation system.

Table No. 7- Drilled Shaft End Bearing Capacity

Boring No.	Anticipated Bottom of Drilled Shaft Bearing Depth from Existing Grade (Ft.)	Soil Description	Gross Ultimate End Bearing Capacity (Nominal Soil Resistance Rs) - KSF	Factored Ultimate End Bearing Capacity (Factored Soil Resistance $\emptyset_s$Rs) - KSF
B-11	30.0	Virgin Very Stiff Gray Silty Clay (CL)	24.3 KSF	18.2 KSF
	40.0	Virgin Stiff Gray Silty Clay (CL-ML)	32.4 KSF	24.3 KSF
	50.0	Virgin Very Dense Gray Silt Hard Pan	33.75 KSF	25.3 KSF

Lateral Load Analysis

It is recommended to perform a laterally loaded pile analysis utilizing LPile 2018, Data Format Version 10 developed by Ensoft, Inc. for the proposed Monopole Communication Tower caisson foundation in order to determine the following for the proposed drilled shaft caisson foundation:

- minimum length and caisson shaft diameter,
- maximum design bending moments in caisson shaft,
- maximum shear forces in caisson shaft and
- maximum lateral deflections at the top of the caisson shaft

This will require an iterative approach to satisfy the minimum embedment depth and minimum diameter of the caisson shaft within the soil profile and also to satisfy the required minimum steel rebar reinforcement to resist the bending moments and shear forces applied within the caisson shaft.

The proper evaluation of the lateral performance of the drilled shaft caisson requires an approach that accounts for the soil nonlinearity especially near the ground surface. The most common design method for laterally loaded pile groups is based on the p-y curve approach. The p-y curve development is effected by the diameter of the pile, as in the larger the diameter the more load resistance of the soil on the pile is increased thus creating a shallower embedment depth. This version of LPILE computer program can handle LFRD method for the concrete design and develops Load-Deflection curves (P-Y curves) based on both unfactored and factored loads for concrete design and service checks. Per Section 9.4.1 *Design Strength of Soil or Rock* of the TIA-222-G (August 2005) 'Structural Standard for Antenna Supporting Structures and Antennas' the soil resistance factor (ϕ_s) for lateral soil resistance should be taken as 0.75 for all foundation types within soil or rock.

Based on the LFRD method the factored loading conditions have to be less than or equal to the factored resistance of the soil (in this case). Since, the lateral load analysis utilizes a fitted p-y curve approach for the 'soil resistance' the factored loading conditions are divided by the resistance factor thus creating an increase of the factored loads and keeping the p-y curve analysis as is creating a factor of safety as shown in the following equations:

$$\emptyset_s R_s \geq LF^*(R_{\text{Loading Conditions}})$$

$$R_s \geq \frac{LF^*(R_{\text{Loading Conditions}})}{\emptyset_s}$$

$\emptyset_s$ = Lateral Soil Resistance Factor = 0.75

R_s = Nominal Soil Resistance (p-y curve development from LPile)

LF = Load Factors per Section 2.3 *Combination of loads* of the TIA-222-G (August 2005) 'Structural Standard for Antenna Supporting Structures and Antennas'

$R_{\text{Loading Conditions}}$ = Applied Structural Loads

The following **Table No. 8** is a summary of the soil layer parameters to a depth of 50 feet below the existing ground surface level based on boring B-11 to be utilized as inputs for the LPile laterally loaded pile computer program. It is recommended to neglect the upper 10 feet of soil for lateral resistance due to frost action and disturbed fill soils. The lateral subgrade modulus 'K_H' are cyclic values for transient lateral loads.

Table No. 8

Soil Description	Approximate Soil Strata Depth from Existing Grade	Average Cohesion 'C' (PSF)	Total Unit Weight (PCF)	Effective Unit Weight (PCF)	Angle of Internal Friction 'Ø' (Degrees)	Lateral Subgrade Modulus 'K_H' (PCI)	50% Strain ε_{50}
Very Stiff to Hard Gray Silty Clay (CL)	10' - 30'	3,000	133	71	-	400	0.005
Very Stiff Gray Silty Clay (CL)	30' – 40'	2,700	140	78	-	400	0.005
Very Stiff Gray Silty Clay (CL)	40' – 50'	3,600	140	78	-	400	0.005

LPile utilizes an approach for minimum embedment depth of the pile by the depth at which the bending moments and shear forces are near or at zero. However, it is recommended to utilize a global static equilibrium analysis of unfactored horizontal loading (wind and/or earthquake loads) verses unfactored lateral load soil resistance with a minimum Factor of Safety of 1.5 as a check for the program. In other words, the lateral load soil resistance should be 1.5 times greater than the applied horizontal loading in ASD loading conditions.

The lateral load soil resistance force is the area underneath the horizontal soil pressure diagram which is simplified to the following equation for a clay profile:

Lateral Soil Force = 9 * C * B * Z_r (Kips)

C = Weighted Average Cohesion from **Table No. 8** (PSF)

B = Diameter of Caisson Shaft (FT)

Zr = Depth below Existing grade to inflection point (FT)

Below the inflection point Z_r the pressure diagram reflects by the same ordinance of 9*C*B to the assumed total embedment depth of D (in feet) below the existing ground surface level. To obtain Z_r, the summation of applied loading condition moments and soil resistance moments about the point of eccentricity above the caisson where e_y = M/P (in feet) is equal to zero. Then to solve for the ultimate horizontal load (H_u) the caisson can take is the summation of horizontal forces is equal to zero. Then the ratio of H_u to applied horizontal loading condition should be greater than or equal to 1.5 as the Factor of Safety.

Uplift Capacity

The foundation uplift resistance around the drilled piers or caisson shafts may be used to resist uplift due to wind and seismic forces as follows by adhesion between the soil layers and the concrete caisson shaft.

It is recommended that no tensile adhesion be taken into account for the soil layers encountered in boring B-11 from ground surface to an approximate depth of 10 feet below the finish ground surface elevation due to frost action in the soil and possible disturbance during construction and loose poorly graded sand soil. The adhesion factor for ultimate caisson capacity in tension should be taken as given in **Table 9: Adhesion Factors for Caisson Foundation**.

Table 9: Adhesion Factors for Caisson Foundation.

Soil Layer Description	**Minimum depth at which the soil layer is encountered (Feet)**	**Ultimate Tensile Adhesion Between Concrete and Soil C_A (psf)**
Very Stiff to Hard to Very Stiff Gray Silty Clay (CL)	10' – 50'	1,200

By this method, the ultimate tensile load resistance capacity of a single caisson is expressed for cohesive soils as:

T nominal$_{\text{(skin friction)}}$ = $\sum_{i=0}^{n} \pi * Ds * Ca_i * Le_i$

Where:

Ds = Diameter of the caisson shaft in feet

Ca_i = Ultimate Tensile Adhesion between Concrete and Soil

Wc = effective total weight of the drilled shaft in lbs.

Le_i = effective length of drilled caisson with the subject skin friction in tension, Respectively

Then the Total Nominal Uplift (Tensile) Capacity = $T_{nominal}$ (skin friction) + Wc

The Factored Total Uplift (Tensile) Capacity = $\emptyset_s$ * [$T_{nominal}$ (skin friction) + Wc]

$\emptyset_s$ = Factored Soil Resistance = 0.75

General Drilled Shaft Construction Considerations

The drilled shaft caisson can be a straight caisson shaft without a bell at the end. For the construction of the caisson, a temporary casing should be required due to the approximately 10 feet of moist non-cohesive granular sandy soils based on soil boring B-11 which may collapse into the drilled shaft if left open. It is recommended to use a temporary casing embedded a minimum 2 feet into the stiff to very stiff virgin silty clay below approximately 10 feet from existing grade level to keep the drilled shaft hole open during construction. Concrete can be poured into the center of the caisson by freefall procedure without letting the concrete collide with the reinforcement or side walls of the caisson to avoid segregation. It is recommended that concrete in the caisson should be kept at least two feet higher than the bottom of casing as the casing is pulled from the caisson.

Seismic Site Classification

The Chicago Building Code does not include seismic lateral load design therefore it is recommended to utilize the International Building Code (IBC), 2012 Edition. The Seismic Site Classification according to IBC 2012 for the proposed Fire Station building in City of Chicago, Illinois is provided in this section. The soil is classified per section 1613.3.2 “Site Class Definitions” per the 2012 edition of the *International Building Code* for the average properties on the top 100 feet of subsurface materials which refers to Chapter 20 of the ASCE 7-10 *Load Determination* Book. Therefore the site soil is classified per Table 20.3-1 ‘Site Classification’ of Chapter 20 of the ASCE 7-10 *Load Determination* book.

The soil borings (B-1 to B-11) were drilled and sampled to a termination depth of 30 feet to 50 feet below existing ground level which encountered loose sandy soil overlying very stiff to hard silty clay till soils for the 30 feet to 50 foot depth. Bedrock in this project area was not encountered at the termination depth of 30 feet to 50 feet below the existing grade and bedrock is generally 90 to 100 feet below the existing grade level from previous experience in this area. The blow counts range greater than 15 blows per foot but less than 50 blows per foot which indicate on average the soil conditions by Seismic Site Class definition of this site is “Site Class D” (Stiff Soil) per the 2012 *International Building Code and the ASCE 7-10 Load Determination Book.* The proposed Fire Station Building should be seismically designed based on the 2012 IBC.

<u>Recommendations for the Infiltration Based BMP’s (Based on Field Slug-In Test Results)</u>

For any Public development or redevelopment in the City of Chicago, Urban Stormwater Best Management Practices is necessary in order to obtain a permit from Department of Water Management, City of Chicago. City of Chicago requires providing rate control and volume control BMPs (Best Management Practices). Rate control BMPs includes providing detention basins, detention vaults, oversized storm sewer pipes, roof tops or in the pavement area. These systems require the construction of restrictors at the outlet so that the maximum discharge released is equal to or less than the maximum permissible release flow rate for the site.

Based on the slug-in test performed at the two (2) representative locations and based on the geotech laboratory combined analysis test result, the soils in slug-in test location I-1 and I-2 has mostly poorly graded fine sand with little silt to silty clayey sand soils to depths of 9.5 feet to 10 feet below the existing ground surface level which are generally permeable soils. Therefore, based on the slug-in tests (I-1 and I-2), the recommended design infiltration rate should be 0.91 inches per hour for any future green infrastructure or permeable pavement that is proposed to be constructed on this project site. It is recommended permeable pavement should only be utilized in parking lot areas not exposed to the heavy firetruck loading conditions (HS-20 truck loading).

Although the design infiltration rate does not require the use of an underdrain system (above 0.5 inches per hour), it is recommended any potential permeable pavement design should also include design of an underdrain system at this project location due to the variable fines content within the sandy soils. Also, per the City of Chicago Stormwater Management Ordinance Manual, 2016 edition the seasonal high groundwater table shall be a maximum 3.5 feet below any underdrain system. Minimum of 4-inch diameter PVC perforated underdrain pipes should be installed in the reservoir stone to drain the excess detention runoff to the storm sewer system and should be placed above the bottom filter fabric. The invert elevation of the perforated pipes should be at approximately 2 inch higher than the subgrade elevation and the perforated pipes should be wrapped with porous geotextile filter fabric and must be sloped toward the storm sewer. The spacing, number, and size of the PVC underdrain pipes should be designed based on the volume of the runoff to be drained.

Parking Lot Design Criteria

The design of the pavement should be based on Chapter 54 'Pavement Design' of IDOT Bureau of Design and Environmental Manual, current edition after the site is prepared as per the **Site Preparation** section of this report. It is recommended to utilize ground improvement in pavement locations exposed to fire truck (HS-20) loading conditions. Ground improvement should not be required within the standard duty parking lot areas, however thicker pavement sections may be required upon final design. The new bituminous concrete standard duty pavement design should be made utilizing an IBR value of three (3) for the insitu non-improved silty sand subgrade soils for flexible pavement design and the concrete pavement design should be performed utilizing a vertical subgrade modulus of 250 pci when the pavement is supported on the improved silty sand subgrade soils exposed to fire truck (HS-20) loading conditions. The pavement design method used should be based on Chapter 54 'Pavement Design' of IDOT Bureau of Design and Environmental Manual, current edition in the structural design of the flexible and rigid pavement sections. Heavy duty pavement should be constructed where the firetruck loading conditions are applied and also at the entrance driveway to the site.

Permeable or porous pavement can be utilized in parking lot areas not subject to firetruck traffic (HS-20 loading) conditions.

The crushed stone base course should consist of CA-6, Type B-stone as per the State of Illinois Standard Specifications for Road and Bridge Construction, 2016 Edition placed in 8 inch loose lifts with each lift compacted to a minimum of 90% of the maximum dry density obtained in accordance with the Modified Proctor Test (ASTM D 1557-12).

For the flexible pavement, the HMA surface course and HMA binder course should consist of hot mix asphalt mixtures as defined in Section 1030. Hot Mix Asphalt of the State of Illinois "Standard Specifications for Road and Bridge Construction," April 1, 2016, Edition. The HMA surface course and HMA binder course should be compacted to a minimum 93% and maximum 97% theoretical density as determined by AASHTO T 209-11. This is the IDOT Big "D" value which is used with the nuclear density testing of the asphalt in order to determine the percentage of in-place compaction achieved in the field. The field density of the bituminous concrete surface and binder courses should be tested with a nuclear density gauge by a SEECO Consultants, Inc. Field Engineer.

Potential Construction Problems

Groundwater Control

When considering the depth to the true groundwater table in relation to the proposed average excavation depth of the proposed Fire Station building ground improvement Remove, Replace and Recompact scheme and also foundations excavations, it is thought that groundwater problems will be minimal when excavating for the proposed Fire Station building, however due to the sandy soils encountered within the upper 9.5 feet to 10 feet surface water runoff infiltration will have to be mitigated after storm rainfall events. It is recommended that any water, if encountered, should be completely removed from the bottom of foundation excavation before placement of concrete for the proposed spread footing by sump and pump technique. Means and method for any possible dewatering are the responsibility of the contractor.

Weather Protection of Soils by Earthwork Contractor

It is the earthwork contractor's responsibility to utilize proper means and methods to protect all exposed soils (subgrade soils, subslab soil and soils at the bottom of footing excavations) throughout the entire construction process to ensure that any potential problems caused by the rain or surface water run-off or any other weather conditions (such as snow) is minimized. Undercutting competent soils that become wet, soft, or loose as result of the earthwork contractor's lack of mitigation and minimization of the rain and associated surface water run-off impact to the soil will be at the earthwork contractor's expense.

After the ground improvement has been completed, the surficial improved sandy soils may be left exposed open during construction, however since the surficial soils may be disturbed during construction therefore it is recommended to recompact the surface with a vibratory smooth drum roller. The disturbed surficial sandy soils should be recompacted to a minimum 95% (in the building area) or a minimum 90% (in the parking lot areas) of the maximum density in accordance with ASTM D 1557-12.

During the rainy seasons and normal conditions, surface runoff and seepage water that may accumulate overnight or momentarily in excavations can be removed by means of perimeter ditch, sump and pump procedures. Care should be exercised to remove all water, as well as any loosened or disturbed materials, from the base of all foundations immediately prior to the placing of concrete.

Excavations

Excavations that extend greater than five feet in depth should be designed in accordance with U.S. Department of Labor, Occupational Safety and Health Administration 1989 (OSHA) "Occupational Safety and Health Standards - Excavations; Final Rule" 29 CFR, Part 1926, Subpart P. Excavations with properly sloped or braced excavation earth retention systems to prevent excavation instability and provide safety.

The soils encountered on this project site generally consist of medium dense to loose silty sandy to silty clay soils to depths of 9.5 feet to 10 feet below existing ground surface which are Type B soils overlying very stiff to hard silty clay soils which are Type A soils. Any excavations for the proposed ground improvement scheme or building footings between 1 to 10 feet depth should be generally made with maximum allowable side slopes of 1H: 1V in these non-cohesive granular soils.

The general contractor and excavation subcontractor are responsible for the means and methods of safe construction excavation and construction sequencing or scheduling per the current OSHA regulations referenced above. Stockpiles of materials or construction equipment should not be placed near the edge of excavation slopes per OSHA.

Construction Consultation Engineering

A representative of the Geotechnical Engineer should be present at the site during the earthwork operations to ensure compliance with the specifications. Due to potential variations in site conditions, soil type and depth to net allowable bearing capacity for the foundation for the proposed building should be confirmed in the field by a Field Geotechnical Engineer from SEECO Consultants, Inc. during construction at this project site. A Field Geotechnical Engineer from SEECO Consultants, Inc. should be present to inspect the depth and check the compaction of each lift of soil for the “Remove, Replace and Recompact Scheme” at this project site to ensure soils of the required net allowable bearing capacity are encountered. If the Vibro-compaction scheme is utilized then it is recommended to verify the ground improvement scheme through additional soil borings with SPT testing after the Vibro-compaction is completed.

All proofroll inspections should be performed by a Field Geotechnical Engineer from SEECO Consultants, Inc. at this site. At this proposed site, field density tests to determine the degree of compaction for the engineered fill for the proposed building pad and pavement areas as well as for the demolition backfill, building backfill, drainage fill and pavement base course and bituminous concrete pavement should be performed by a Field Engineering Technician or Field Geotechnical Engineer from SEECO Consultants, Inc.

Closing Remarks

We trust this report and the information contained herein is sufficient for your present requirements. We have welcomed the opportunity to be of service to you on this project. If there are any questions regarding this report, please contact us at your convenience.

Respectfully submitted,

SEECO Consultants, Inc.

Matthew J. Boladz, P.E.
Geotechnical Staff Engineer

Collin W. Gray, S.E., P.E.
President

MB:arm
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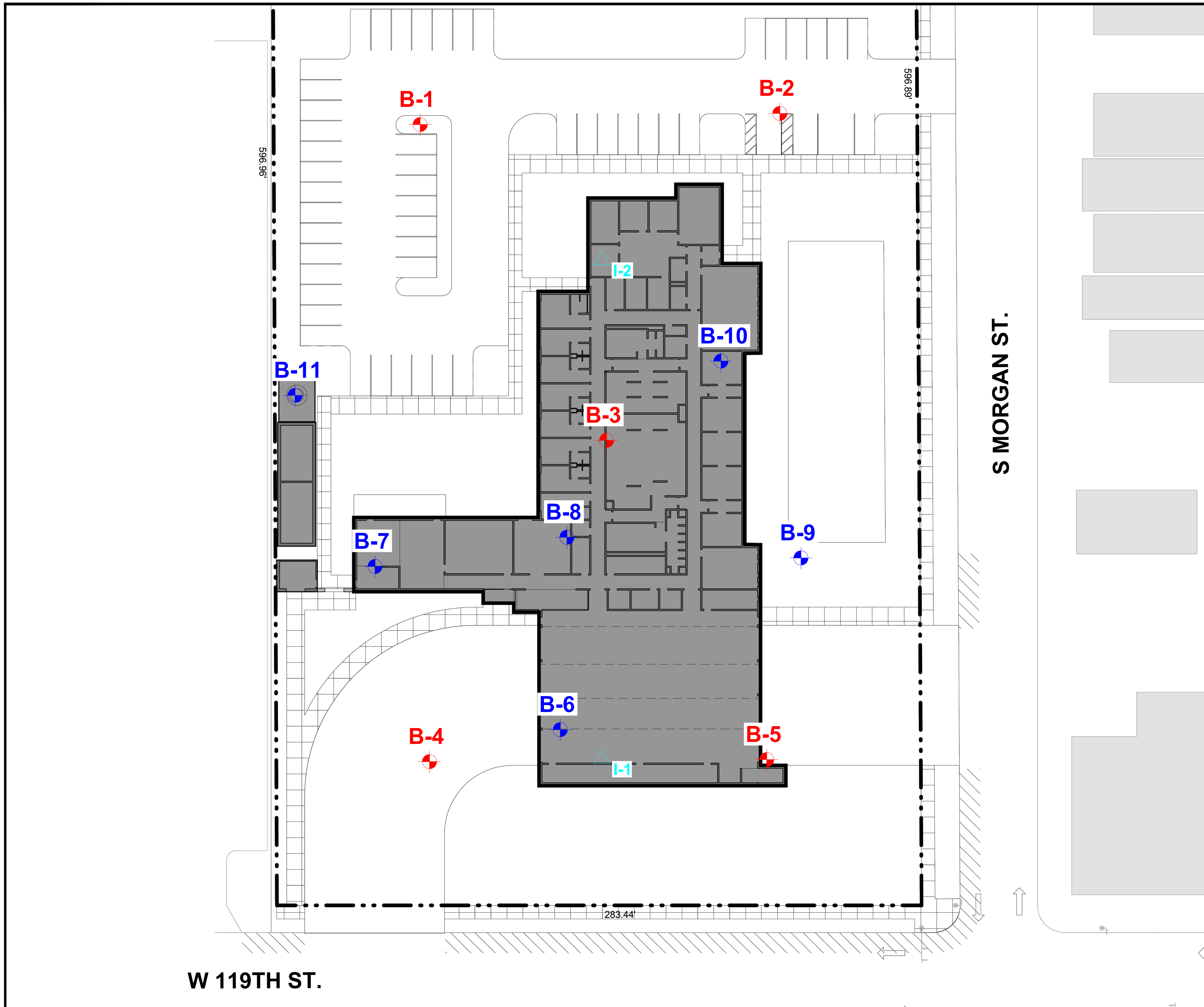
APPENDIX

1. BORING LOCATION PLAN
2. GENERAL NOTES
3. BORING LOGS
4. UNIFIED CLASSIFICATION
5. GRAIN SIZE ANALYSIS RESULTS
6. ATTERBERG LIMIT TEST RESULTS
7. FIELD SLUG-IN TEST RESULTS
8. GENERAL REMARKS

APPENDIX 1



LEGEND

- APPROXIMATE BORING LOCATION DRILLED ON 10/11/2018 AND 10/12/2018
- APPROXIMATE BORING LOCATION DRILLED ON 11/29/2018 AND 12/04/2018
- I-1 = APPROXIMATE INFILTRATION TEST LOCATION
- Project Site

VICINITY MAP

SCALE: NONE

NO.	DATE	REVISIONS	BY:

DRAWN BY SD
DESIGNED SD
APPROVED CWG

SEECO Consultants, Inc.
7350 Duvan Drive, Tinley Park, Illinois 60477
OFFICE: (708) 429-1666 FAX: (708) 429-1689

CLIENT
Public Building Commission of Chicago

PROJECT NAME & LOCATION
Proposed Fire Station for Engine Company 115
W 119th St., Chicago, IL

BORING LOCATION PLAN

DATE 12/07/2018
SCALE NONE
JOB NO. 12060G

SHEET 1 OF 1

APPENDIX 2

SEECO Consultants Inc.
7350 DUVAN DRIVE
TINLEY PARK, ILLINOIS 60477

GENERAL NOTES

DRILLING AND SAMPLING SYMBOLS

SS	SPLIT SPOON	1-3/8" I.D. x 2" O.D. (EXCEPT WHERE NOTED)
2T	THINWALL TUBE SAMPLER	2" O.D. x 1-7/8" I.D.
3T	THINWALL TUBE SAMPLER	3" O.D. x 2-7/8" I.D.
3P	PISTON SAMPLER	3" O.D. THINWALL TUBE
FA	CONTINUOUS FLIGHT AUGER	4" O.D.
HS	HOLLOW STEM AUGER	6-3/4" O.D. x 3-1/4" I.D.
HA	HAND AUGER	
RB	ROLLER ROCK BIT	
FT	FISHTAIL BIT	
DB	DIAMOND BIT	
AX	ROCK CORE	1-3/16" DIAMETER
BX	ROCK CORE	1-5/8" DIAMETER
NX	ROCK CORE	2-1/8" DIAMETER
AS	AUGER SAMPLE	
WS	WASH SAMPLE	
CA	COMBINED ANALYSIS	
SA	SIEVE ANALYSIS	

Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a two inch O.D. split spoon, except where noted.

WATER LEVEL MEASUREMENT SYMBOLS

▼	WATER LEVEL OBSERVATION	WD	WHILE DRILLING
WCI	WET CAVE-IN	BCR	BEFORE CASING REMOVAL
DCI	DRY CAVE-IN	ACR	AFTER CASING REMOVAL
WS	WHILE SAMPLING	AB	AFTER BORING

Water levels indicated on the boring logs are the levels measured in the boring at the times indicated. In pervious soils, the indicated elevations are considered reliable groundwater levels. In impervious soils, the accurate determination of groundwater elevations are not possible in even several days observation, and additional evidence on groundwater elevations must be sought.

SOIL IDENTIFICATION TERMINOLOGY

COHESIONLESS SOILS

COMPONENT	SIZE RANGE	DESCRIPTIVE TERM	PERCENT OF WEIGHT
BOULDERS	OVER 8"	TRACE	0 – 10
COBBLES	8" TO 3"	LITTLE	10 – 20
GRAVEL	3" TO #4 SIEVE (4.75 mm)	SOME	20 – 35
SAND	#4 TO #200 SIEVE (0.074 mm)	AND	35 – 50
SILT	PASSING #200 SIEVE (0.074 mm)		

SEECO Consultants Inc.
7350 DUVAN DRIVE
TINLEY PARK, ILLINOIS 60477

GENERAL NOTES

SOIL IDENTIFICATION TERMINOLOGY (Cont'd)

COHESIVE SOILS

DESCRIPTIVE TERM	PLASTICITY INDEX
CLAYEY SILT OR ORGANIC CLAYEY SILT	4 – 7
SILTY CLAY OR ORGANIC SILTY CLAY	8 – 30
CLAY OR ORGANIC CLAY	> 30

INTERMEDIATE SOILS

DESCRIPTIVE TERM	PLASTICITY INDEX
SILT	0 – 3

Unconfined compression tests are generally not applicable for intermediate soils.

CONSISTENCY OF COHESIVE SOILS

UNCONFINED COMP. STRENGTH, Qu, TSF	CONSISTENCY
<0.25	VERY SOFT
0.25 - 0.49	SOFT
0.50 - 1.00	MEDIUM
1.01 - 1.99	STIFF
2.00 - 3.99	VERY STIFF
4.00 - 8.00	HARD
>8.00	VERY HARD

RELATIVE DENSITY OF GRANULAR SOILS

1-3/8" I.D. x 2" O.D. with 140 pound hammer falling 30"

N – BLOWS/FT.	RELATIVE DENSITY
0 – 3	VERY LOOSE
4 – 9	LOOSE
10 – 29	MEDIUM DENSE
30 – 49	DENSE
50 – 80	VERY DENSE
>80	EXTREMELY DENSE

CONSISTENCY OF COHESIVE SOILS

N – BLOWS/FT.	RELATIVE DENSITY
0 – 2	VERY SOFT
2 – 4	SOFT
4 – 8	MEDIUM
8 – 15	STIFF
15 – 30	VERY STIFF
>30	HARD

APPENDIX 3

BORING LOG

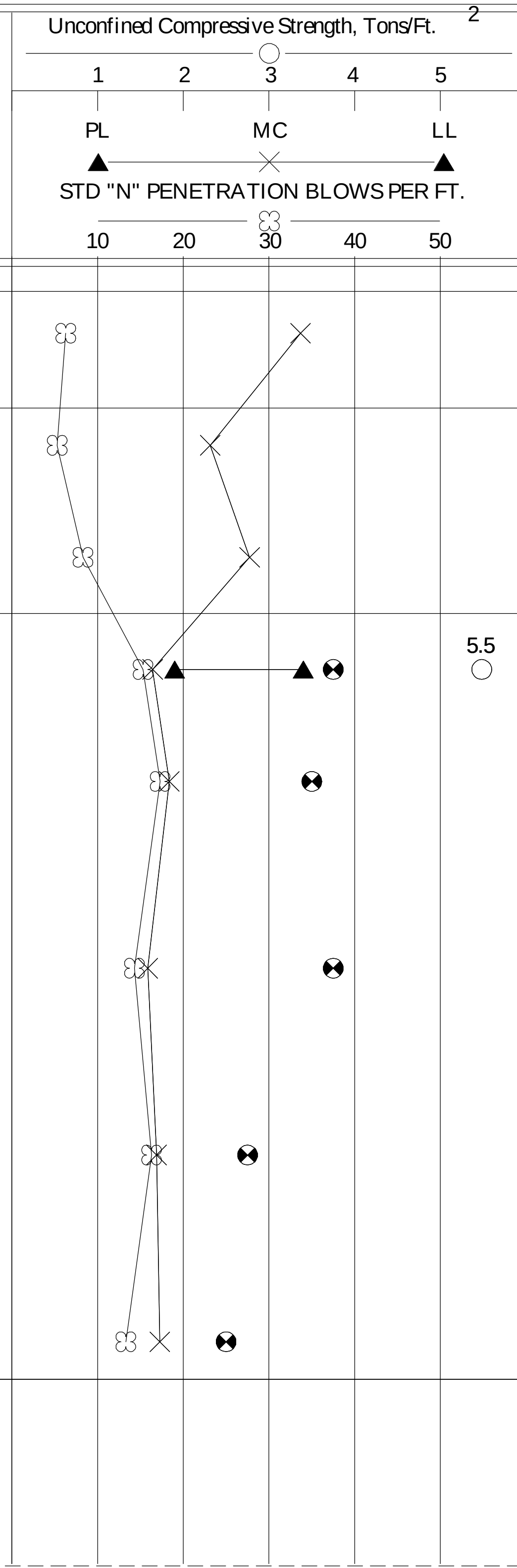
CLIENT **Public Building Commission of Chicago**	PROJECT **Proposed Fire Station Engine Company 115**
ENGINEER **Public Building Commission of Chicago**	LOCATION **119th St. & Morgan St., Chicago, Illinois**

BORING NUMBER **B-1**

APPROX. SURFACE ELEVATION (C.C.D.) + - **34.34**

NORTH **1826326.51** EAST **1171492.17**

DEPTH ELEVATION	SAMPLE NO.	SAMPLER TYPE	SAMPLE REC. (%)	DESCRIPTION OF MATERIALS (LABORATORY CLASSIFICATION)	UNIT DRY WT. LBS./FT³	REMARKS
		HS		2.5" BITUMINOUS CONCRETE PAVEMENT		
				8" CRUSHED STONE BASE COURSE		
2.5	1	SS	46	FILL: SILTY CLAYEY SAND, Dark Brown, Brown, and Black, Loose, Wet (SM-SC)		
		HS				
5.0	2	SS	67	SILTY CLAYEY SAND, Brown and Gray, Fine, Trace Gravel, Loose, Moist (SC-SM)		C.A. Test
		HS				
7.5	3	SS	50			
		HS				ACR
10.0	4	SS	71	SILTY CLAY, Gray, Trace Sand and Gravel, Hard to Very Stiff, Moist (CL)	114.8	
12.5		HS				
	5	SS	58			
15.0		HS				
17.5						WS
	6	SS	75			
20.0		HS				
22.5						
	7	SS	33			
25.0		HS				
27.5						
	8	SS	46			
30.0				End of Boring @ 30.0 Feet.		
32.5						



Calibrated Penetrometer Unconfined Compression

Water Level Observations			SEECO Consultants, Inc.	Boring Started	10/11/18		
			7350 Duvan Drive, Tinley Park, IL 60477	Boring Completed	10/11/18		
	17' WS	9.5' ACR		Driller	EN	Rig	D-50
			Approved By CWG / Job No. 12060G	Drawn By	MB	Sheet	1 of 1

BORING LOG

CLIENT **Public Building Commission of Chicago**	PROJECT **Proposed Fire Station Engine Company 115**
ENGINEER **Public Building Commission of Chicago**	LOCATION **119th St. & Morgan St., Chicago, Illinois**

BORING NUMBER **B-2**

APPROX. SURFACE ELEVATION (C.C.D.) + **35.13** -

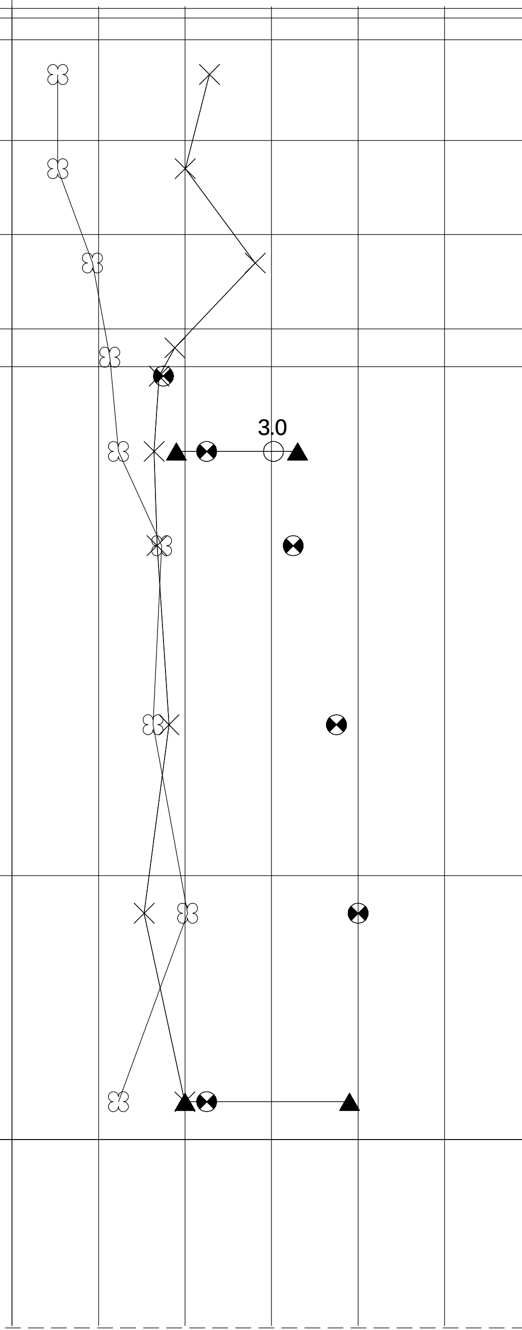
NORTH **1826278.79** EAST **1171720.33**

Unconfined Compressive Strength, Tons/Ft.^{2} — 1 2 3 4 5

PL MC LL

STD "N" PENETRATION BLOWS PER FT. — 10 20 30 40 50

DEPTH ELEVATION	SAMPLE NO.	SAMPLER TYPE	SAMPLE REC. (%)	DESCRIPTION OF MATERIALS (LABORATORY CLASSIFICATION)	UNIT DRY WT. LBS./FT.^{3}	REMARKS
		HS		3" BITUMINOUS CONCRETE PAVEMENT		
	1	SS	56	7" CRUSHED STONE BASE COURSE FILL: SILTY SAND, Dark Brown and Brown, Loose, Moist (SM)		
2.5		HS				
	2	SS	67	POORLY GRADED SAND, Brown, Fine, Little Silt, Trace Clay, Loose, Moist (SP)		
5.0		HS				
	3	SS	44	SILTY SAND, Brown and Gray, Loose, Moist (SM)		C.A. Test
7.5		HS				
	4A 4B	SS	50	POORLY GRADED SAND, Brown, Fine, Little Silt, Trace Clay, Medium Dense, Moist (SP)		
10.0		HS		SILTY CLAY, Gray, Little Sand, Trace Gravel, Stiff to Very Stiff, Moist (CL)		ACR
	5	SS	72		114.8	
12.5		HS				
	6	SS	89			C.A. Test
15.0		HS				
17.5						WS
	7	SS	71			
20.0		HS				
22.5						
	8	SS	58	SILTY CLAY, Gray, Trace Sand and Gravel, Hard to Very Stiff, Moist (CL)		
25.0		HS				
27.5						
	9	SS	63			
30.0				End of Boring @ 30.0 Feet.		
32.5						



Calibrated Penetrometer Unconfined Compression

Water Level Observations		
	18' WS	10' ACR

SEECO Consultants, Inc.
7350 Duvan Drive, Tinley Park, IL 60477

Approved By	CWG	Job No.	12060G
Boring Started	10/12/18		
Boring Completed	10/12/18		
Driller	EN	Rig	D-50
Drawn By	MB	Sheet	1 of 1

BORING LOG

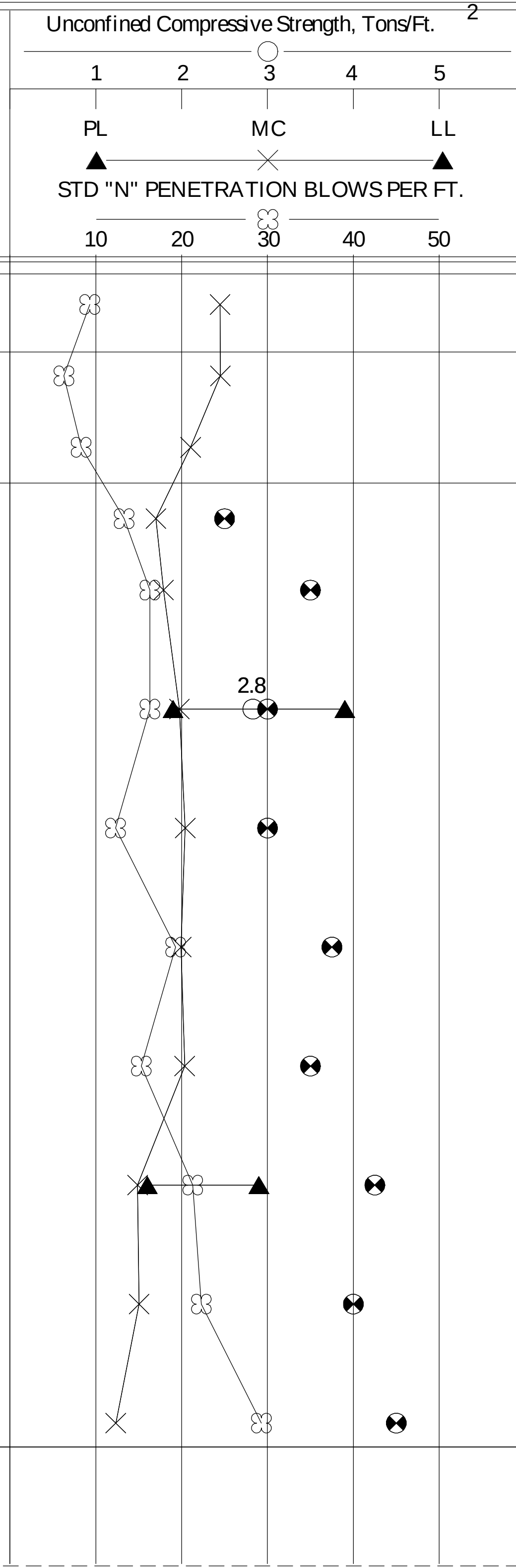
CLIENT: Public Building Commission of Chicago	PROJECT: Proposed Fire Station Engine Company 115
ENGINEER: Public Building Commission of Chicago	LOCATION: 119th St. & Morgan St., Chicago, Illinois

BORING NUMBER **B-3**

APPROX. SURFACE ELEVATION (C.C.D.) + - **35.89**

NORTH **1826141.13** EAST **1171624.26**

DEPTH ELEVATION	SAMPLE NO.	SAMPLER TYPE	SAMPLE REC. (%)	DESCRIPTION OF MATERIALS (LABORATORY CLASSIFICATION)	UNIT DRY WT. LBS./FT.³	REMARKS
		HS		2.5" BITUMINOUS CONCRETE PAVEMENT		
2.5	1	SS	50	6" SAND AND GRAVEL BASE COURSE, Dark Brown		
		HS				
5.0	2	SS	67	FILL: CLAYEY SAND, Dark Brown, Brown, Gray, Trace Black, Loose, Moist (SC)		
		HS				
7.5	3	SS	79	POORLY GRADED SAND, Brown Fine, Little Silt, Trace Clay, Loose, Moist (SP)		ACR
10.0		HS				
	4	SS	38	SILTY CLAY, Gray, Trace Sand and Gravel, Trace Sand, Very Stiff to Hard, Moist (CL)		
12.5		HS				WD
	5	SS	42			C.A. Test
15.0		HS				
17.5	6	SS	71		108.8	
20.0		HS				
22.5	7	SS	63			
25.0		HS				
27.5	8	SS	54			
30.0		HS				
32.5	9	SS	75			
35.0		HS				
37.5	10	SS	83			
40.0		HS				
42.5	11	SS	46			
45.0		HS				
47.5	12	SS	63			
50.0				End of Boring @ 50.0 Feet.		
52.5						



Calibrated Penetrometer Unconfined Compression

Water Level Observations	
13' WD	8.5' ACR

SEECO Consultants, Inc.
7350 Duvan Drive, Tinley Park, IL 60477

Boring Started	10/11/18
Boring Completed	10/11/18
Driller	EN
Rig	D-50
Approved By	CWG
Job No.	12060G
Drawn By	MB
Sheet	1 of 1

BORING LOG

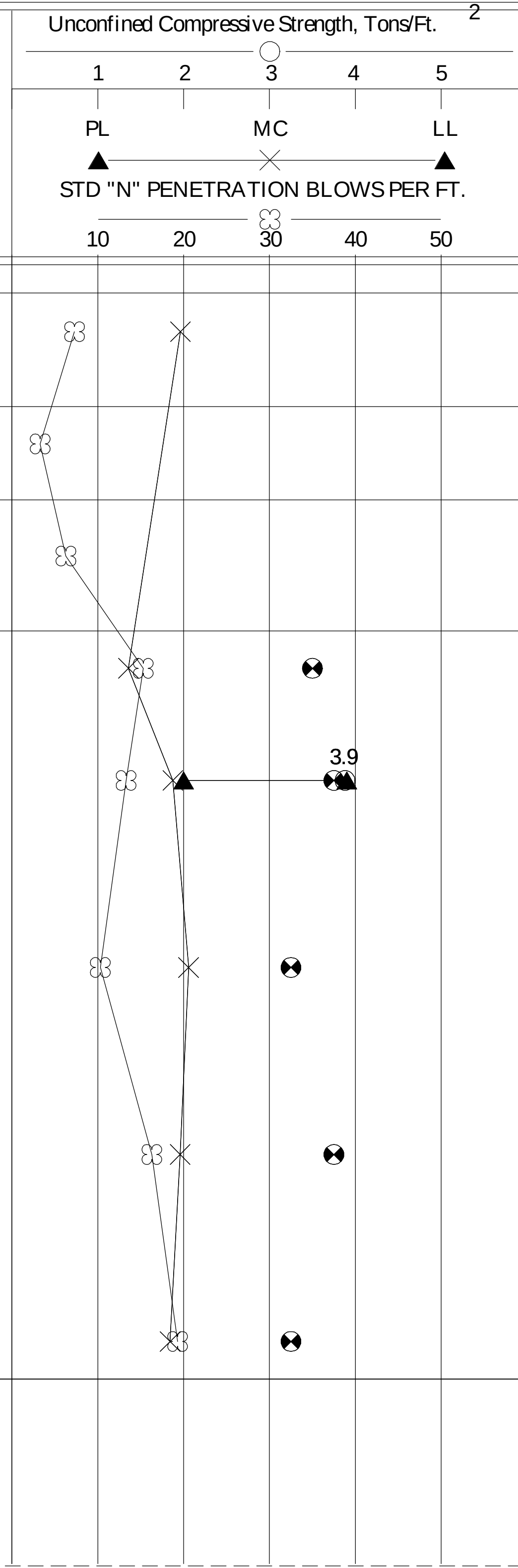
CLIENT	Public Building Commission of Chicago	PROJECT	Proposed Fire Station Engine Company 115
ENGINEER	Public Building Commission of Chicago	LOCATION	119th St. & Morgan St., Chicago, Illinois

BORING NUMBER **B-4**

APPROX. SURFACE ELEVATION (C.C.D.) + - **35.36**

NORTH **1826002.84** EAST **1171525.82**

DEPTH ELEVATION	SAMPLE NO.	SAMPLER TYPE	SAMPLE REC. (%)	DESCRIPTION OF MATERIALS (LABORATORY CLASSIFICATION)	UNIT DRY WT. LBS./FT³	REMARKS
		HS		2.5" BITUMINOUS CONCRETE PAVEMENT		
				9" CRUSHED STONE BASE COURSE		
2.5	1	SS	63	FILL: SILTY SAND, Black, Brown, and Gray, Loose, Moist (SM)		
		HS				WS
5.0	2	SS	38	POORLY GRADED SAND, Brown and Gray, Fine, Little Silt, Loose, Saturated (SP)		
		HS		SANDY SILT, Brown and Gray, Loose, Saturated (ML)		
7.5	3	SS	71			C.A. Test
		HS				
10.0	4	SS	50	SILTY CLAY, Gray, Trace Sand and Gravel, Very Stiff, Moist (CL)		ACR
12.5		HS				
	5	SS	79		110.7	
15.0		HS				
17.5						WS
	6	SS	58			
20.0		HS				
22.5						
	7	SS	50			
25.0		HS				
27.5						
	8	SS	75			
30.0				End of Boring @ 30.0 Feet.		
32.5						



Calibrated Penetrometer Unconfined Compression

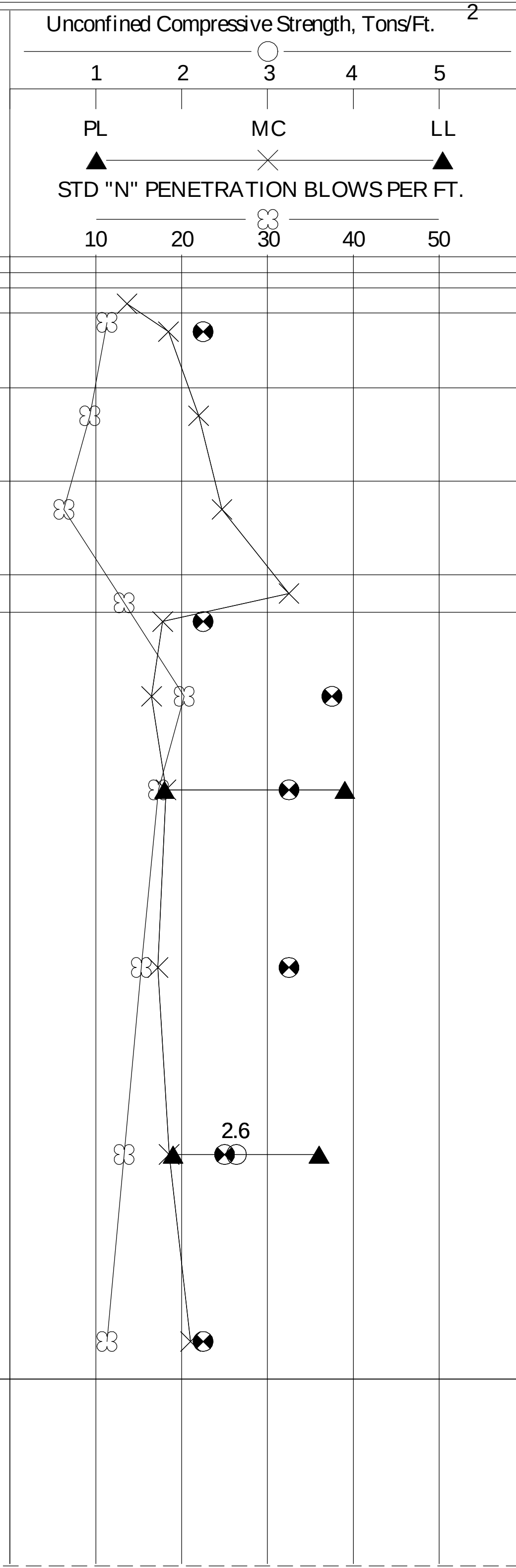
Water Level Observations		SEECO Consultants, Inc. 7350 Duvan Drive, Tinley Park, IL 60477	Boring Started	10/11/18		
4' WS (Infiltrated Water)			Boring Completed	10/11/18		
17' WS	10' ACR		Driller	EN	Rig	D-50
		Approved By CWG · Job No. 12060G	Drawn By	MB	Sheet	1 of 1

BORING LOG

CLIENT: Public Building Commission of Chicago
PROJECT: Proposed Fire Station Engine Company 115
ENGINEER: Public Building Commission of Chicago
LOCATION: 119th St. & Morgan St., Chicago, Illinois

BORING NUMBER: B-5
APPROX. SURFACE ELEVATION (C.C.D.) ± 35.35
NORTH 1826004.51 EAST 1171703.66

DEPTH ELEVATION	SAMPLE NO.	SAMPLER TYPE	SAMPLE REC. (%)	DESCRIPTION OF MATERIALS (LABORATORY CLASSIFICATION)	UNIT DRY WT. LBS./FT³	REMARKS
		HS		5" BITUMINOUS CONCRETE PAVEMENT		
	1A			5" CRUSHED STONE BASE COURSE		
2.5	1B	SS	56	8" FILL: SAND, Dark Brown and Black, Little Gravel, Medium Dense, Moist (SP)		
		HS				
5.0	2	SS	72	SILTY CLAY, Brown and Gray, Trace Sand and Gravel, Very Stiff, Moist (CL)		
		HS				
7.5	3	SS	83	POORLY GRADED SAND, Brown, Fine, Trace Silt, Loose, Moist (SP)		C.A. Test
		HS				
	4A	SS	67	SILTY CLAYEY SAND, Brown, Trace Gray, Loose, Moist (SC-SM)		ACR
10.0	4B			CLAYEY SILTY SAND, Brown and Gray, Medium Dense, Wet (SC-SM)		
		HS				
12.5	5	SS	89	SILTY CLAY, Gray, Trace Sand and Gravel, Very Stiff, Moist (CL)		WS
		HS				
15.0	6	SS	50			
17.5		HS				
20.0	7	SS	71			
22.5		HS				
25.0	8	SS	75		114.1	
27.5		HS				
30.0	9	SS	58			
32.5				End of Boring @ 30.0 Feet.		



Calibrated Penetrometer Unconfined Compression

Water Level Observations	
13' WS	8.5' ACR

SEECO Consultants, Inc.
7350 Duvan Drive, Tinley Park, IL 60477

Approved By: CWG | Job No.: 12060G
Boring Started: 10/12/18
Boring Completed: 10/12/18
Driller: EN | Rig: D-50
Drawn By: MB | Sheet: 1 of 1

BORING LOG

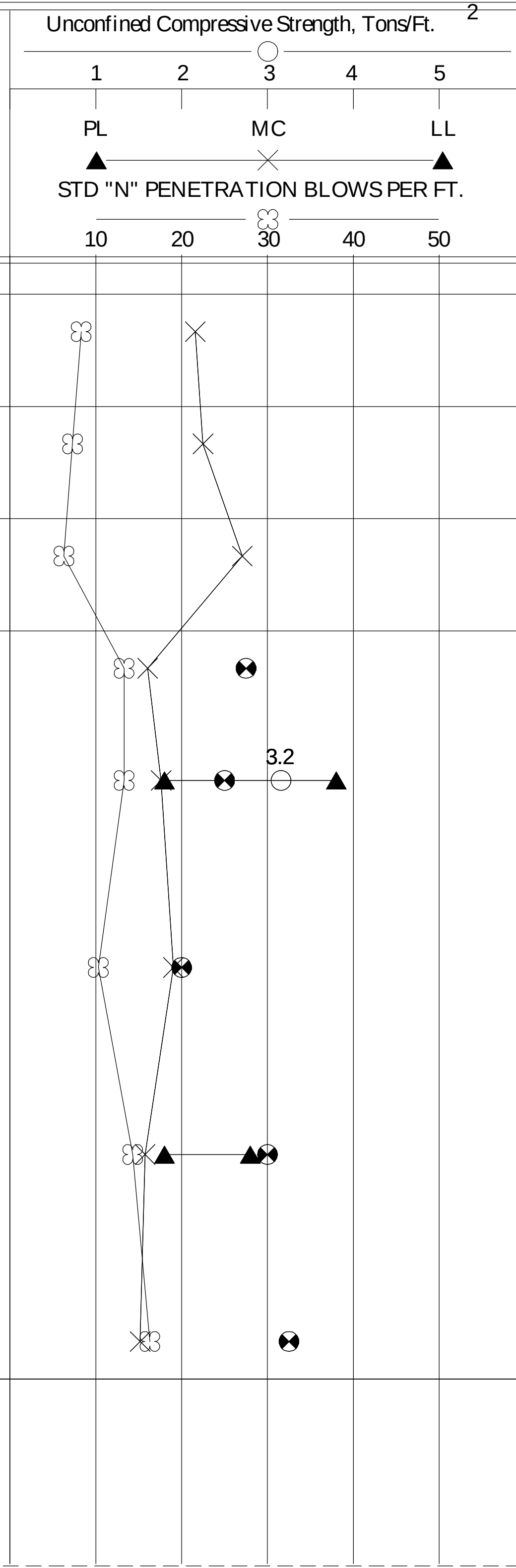
CLIENT	Public Building Commission of Chicago	PROJECT	Proposed Fire Station Engine Company 115
ENGINEER	Public Building Commission of Chicago	LOCATION	119th St. & Morgan St., Chicago, Illinois

BORING NUMBER **B-6**

APPROX. SURFACE ELEVATION (C.C.D.) + - **35.14**

NORTH **1826010.54** EAST **1171595.84**

DEPTH ELEVATION	SAMPLE NO.	SAMPLER TYPE	SAMPLE REC. (%)	DESCRIPTION OF MATERIALS (LABORATORY CLASSIFICATION)	UNIT DRY WT. LBS./FT.³	REMARKS
		HS		2" BITUMINOUS CONCRETE PAVEMENT		
2.5	1	SS	42	10" SAND AND GRAVEL BASE COURSE, Dark Brown		
		HS		FILL: SILTY CLAYEY SAND, Brown, Gray, and Black, Loose, Moist (SM-SC)		
5.0	2	SS	67	POORLY GRADED SAND, Brown and Gray, Fine, Little Silt, Trace Clay, Loose, Moist (SP)		
		HS				
7.5	3	SS	54	SILTY SAND, Brown and Gray, Little Clay, Loose, Moist (SM)		C.A. Test
		HS				ACR
10.0	4	SS	71	SILTY CLAY, Gray, Trace Sand and Gravel, Very Stiff, Moist (CL)		
12.5		HS				WS
	5	SS	50		115.2	
15.0		HS				
17.5	6	SS	75			
20.0		HS				
22.5	7	SS	63			
25.0		HS				
27.5	8	SS	33			
30.0				End of Boring @ 30.0 Feet.		
32.5						



Calibrated Penetrometer Unconfined Compression

Water Level Observations		SEECO Consultants, Inc.	Boring Started	11/29/18
		7350 Duvan Drive, Tinley Park, IL 60477	Boring Completed	11/29/18
13' WS	9' ACR		Driller EN	Rig D-50
		Approved By GG / Job No. 12060G	Drawn By MB	Sheet 1 of 1

BORING LOG

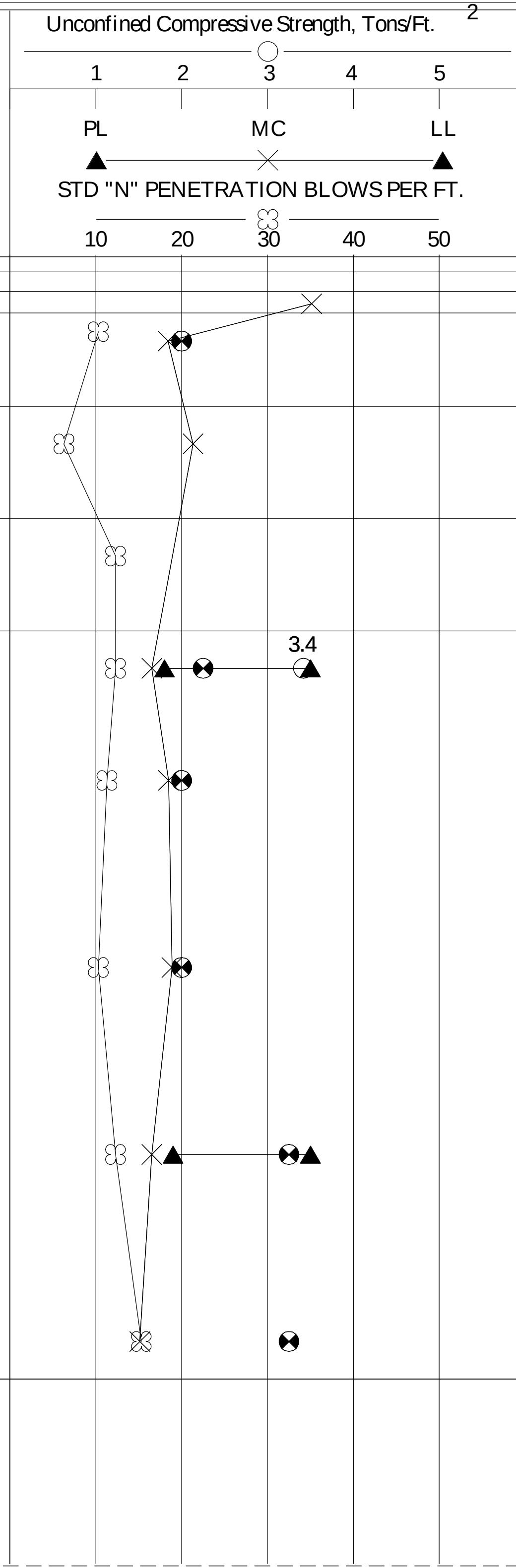
CLIENT	Public Building Commission of Chicago	PROJECT	Proposed Fire Station Engine Company 115
ENGINEER	Public Building Commission of Chicago	LOCATION	119th St. & Morgan St., Chicago, Illinois

BORING NUMBER **B-7**

APPROX. SURFACE ELEVATION (C.C.D.) + - **35.54**

NORTH **1826072.64** EAST **1171516.67**

DEPTH ELEVATION	SAMPLE NO.	SAMPLER TYPE	SAMPLE REC. (%)	DESCRIPTION OF MATERIALS (LABORATORY CLASSIFICATION)	UNIT DRY WT. LBS./FT 3.	REMARKS
		HS		4.5" BITUMINOUS CONCRETE PAVEMENT		
	1A			6.5" SAND AND GRAVEL BASE COURSE, Dark Brown		
2.5	1B	SS	50	7" FILL: SANDY SILT TOPSOIL, Black, Medium Dense, Wet (OL)		
		HS				
5.0	2	SS	75	FILL: SILTY CLAY, Brown, Gray, and Black, Trace Sand, Very Stiff, Moist (CL)		ACR
		HS		POORLY GRADED SAND, Brown and Gray, Fine, Little Silt, Loose, Moist (SP)		WS
7.5	3	SS	46	SILTY SAND, Brown and Gray, Little Clay, Medium Dense, Saturated (SP)		C.A. Test
		HS				
10.0	4	SS	63	(Saturated Below 7.0 Feet) SILTY CLAY, Gray, Trace Sand and Gravel, Very Stiff, Moist (CL)	116.9	
12.5		HS				
	5	SS	29			
15.0		HS				
17.5	6	SS	54			
20.0		HS				
22.5	7	SS	67			
25.0		HS				
27.5	8	SS	58			
30.0				End of Boring @ 30.0 Feet.		
32.5						



Note:
1) Wet-Cave-In (WCI) is when granular soil of the boreing sidewalls collapse due to the ground water after removing the hollow stem augers from the borehole cuase the groundwater level to rise,

Calibrated Penetrometer Unconfined Compression

Water Level Observations		SEECO Consultants, Inc. 7350 Duvan Drive, Tinley Park, IL 60477	Boring Started	11/29/18
			Boring Completed	11/29/18
7' WS	5.5' WCI		Driller EN	Rig D-50
		Approved By GG / Job No. 12060G	Drawn By MB	Sheet 1 of 1

BORING LOG

CLIENT: **Public Building Commission of Chicago**	PROJECT: **Proposed Fire Station Engine Company 115**
ENGINEER: **Public Building Commission of Chicago**	LOCATION: **119th St. & Morgan St., Chicago, Illinois**

BORING NUMBER **B-8**

APPROX. SURFACE ELEVATION (C.C.D.) ± **35.74**

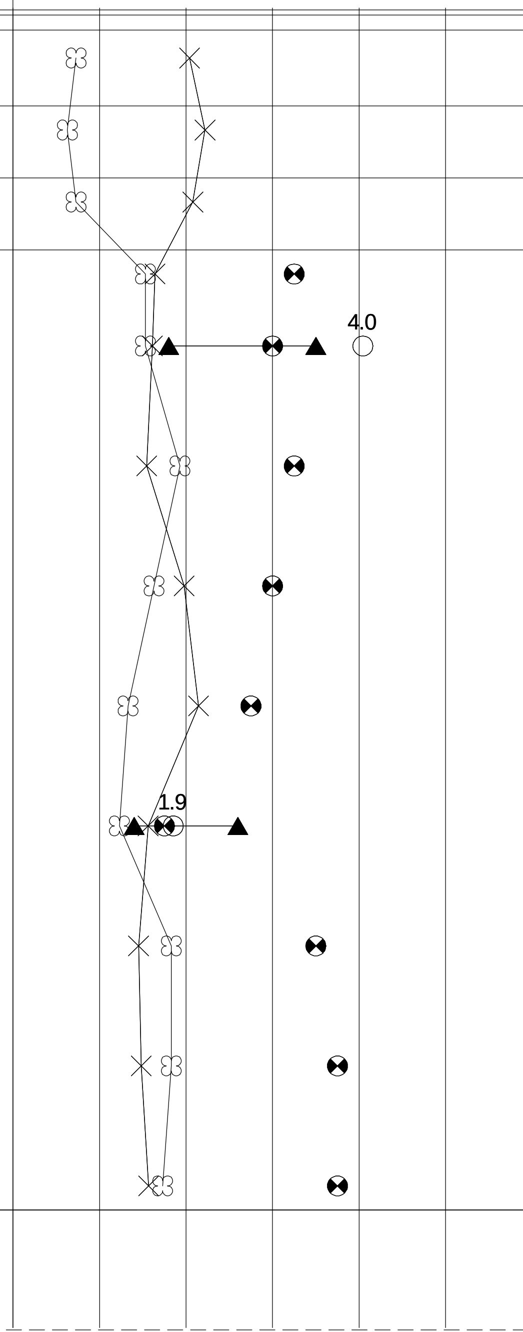
NORTH **1826093.97** EAST **1171594.59**

Unconfined Compressive Strength, Tons/Ft.^{2} ○ 1 2 3 4 5

PL ▲ MC × LL ▲

STD "N" PENETRATION BLOWS PER FT. 10 20 30 40 50

DEPTH ELEVATION	SAMPLE NO.	SAMPLER TYPE	SAMPLE REC. (%)	DESCRIPTION OF MATERIALS (LABORATORY CLASSIFICATION)	UNIT DRY WT. LBS./FT.^{3}	REMARKS
		HS		2.5" BITUMINOUS CONCRETE PAVEMENT		
2.5	1	SS	67	7.5" SAND AND GRAVEL BASE COURSE, Dark Brown		
		HS				
5.0	2	SS	50	FILL: CLAYEY SAND, Dark Brown, Brown, Trace Black, Trace Gravel, Loose, Moist (SC)		
		HS				
7.5	3	SS	75	POORLY GRADED SAND, Brown, Fine, Little Silt, Loose, Moist (SP)		C.A. Test
		HS				
10.0	4	SS	46	SILTY CLAYEY SAND, Brown, Loose, Moist (SC-SM)		▼ ACR
12.5		HS				
	5	SS	71	SILTY CLAY, Gray, Trace Sand and Gravel, Very Stiff to Stiff to Stiff, Moist (CL)	115.5	
15.0		HS				▽ WS
17.5	6	SS	58			
20.0		HS				
22.5	7	SS	79			
25.0		HS				
27.5	8	SS	75			
30.0		HS				
32.5	9	SS	38		122.7	
35.0		HS				
37.5	10	SS	42			
40.0		HS				
42.5	11	SS	54			
45.0		HS				
47.5	12	SS	67			
50.0				End of Boring @ 50.0 Feet.		
52.5						



⊗ Calibrated Penetrometer Unconfined Compression

Water Level Observations		SEECO Consultants, Inc.	Boring Started	12/4/18
		7350 Duvan Drive, Tinley Park, IL 60477	Boring Completed	12/4/18
16.5' WS	10' ACR		Driller EN	Rig D-50
		Approved By GG / Job No. 12060G	Drawn By MB	Sheet 1 of 1

BORING LOG

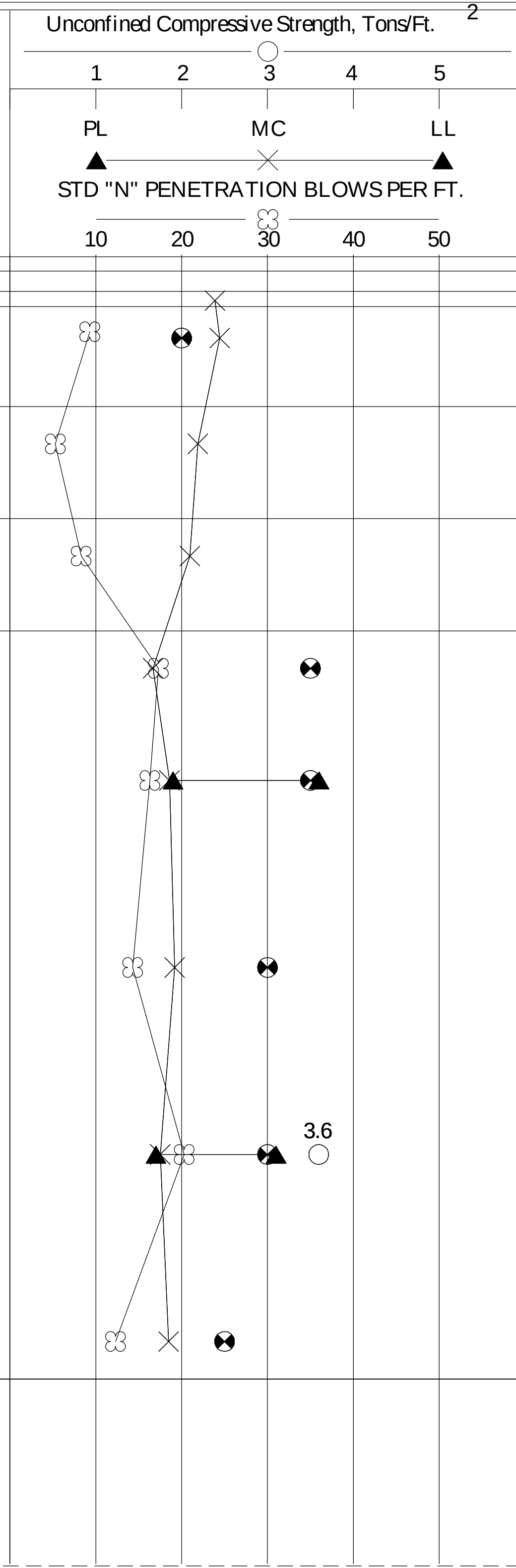
CLIENT	**Public Building Commission of Chicago**	PROJECT	**Proposed Fire Station Engine Company 115**
ENGINEER	**Public Building Commission of Chicago**	LOCATION	**119th St. & Morgan St., Chicago, Illinois**

BORING NUMBER **B-9**

APPROX. SURFACE ELEVATION (C.C.D.) ± **35.53**

NORTH **1826082.95** EAST **1171687.62**

DEPTH ELEVATION	SAMPLE NO.	SAMPLER TYPE	SAMPLE REC. (%)	DESCRIPTION OF MATERIALS (LABORATORY CLASSIFICATION)	UNIT DRY WT. LBS./FT 3.	REMARKS
		HS		4.5" BITUMINOUS CONCRETE PAVEMENT		
	1A			6.5" SAND AND GRAVEL BASE COURSE, Dark Brown		
2.5	1B	SS	67	5" FILL: CINDERS, Black, Little Gravel, Loose, Moist		
		HS		FILL: SILTY CLAY, Brown, Black, and Gray, Trace Sand and Gravel, Very Stiff, Moist (CL)		
5.0	2	SS	50			
		HS		POORLY GRADED SAND, Brown and Gray, Fine, Little Silt, Loose, Moist (SP)		
7.5	3	SS	38	CLAYEY SAND, Brown and Gray, Loose, Moist (SC)		ACR C.A. Test
		HS				
10.0	4	SS	71	SILTY CLAY, Gray, Trace Sand and Gravel, Very Stiff, Moist (CL)		
12.5		HS				WD
	5	SS	54			
15.0		HS				
17.5	6	SS	42			
20.0		HS				
22.5	7	SS	33		114.5	
25.0		HS				
27.5	8	SS	75			
30.0				End of Boring @ 30.0 Feet.		
32.5						



Calibrated Penetrometer Unconfined Compression

Water Level Observations	
13' WD	8' ACR

SEECO Consultants, Inc.
7350 Duvan Drive, Tinley Park, IL 60477

Boring Started	11/29/18		
Boring Completed	11/29/18		
Driller	EN	Rig	D-50
Approved By	GG	Job No.	12060G
Drawn By	MB	Sheet	1 of 1

BORING LOG

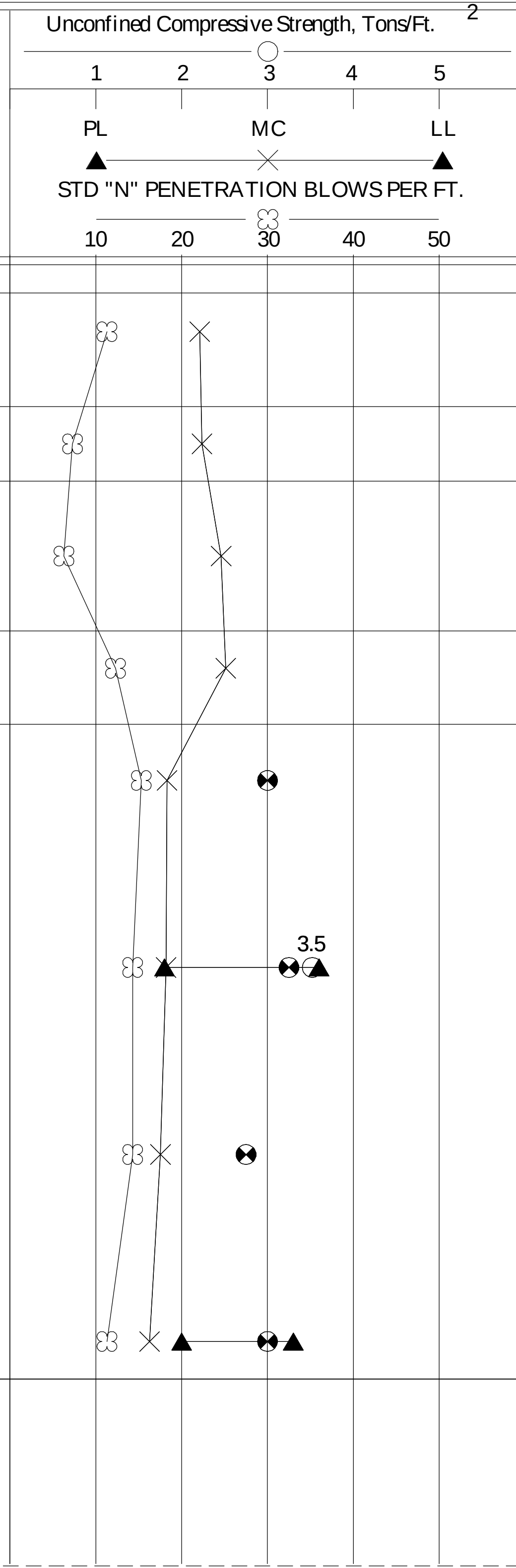
CLIENT: Public Building Commission of Chicago	PROJECT: Proposed Fire Station Engine Company 115
ENGINEER: Public Building Commission of Chicago	LOCATION: 119th St. & Morgan St., Chicago, Illinois

BORING NUMBER **B-10**

APPROX. SURFACE ELEVATION (C.C.D.) ± **35.65**

NORTH **1826157.78** EAST **1171653.05**

DEPTH ELEVATION	SAMPLE NO.	SAMPLER TYPE	SAMPLE REC. (%)	DESCRIPTION OF MATERIALS (LABORATORY CLASSIFICATION)	UNIT DRY WT. LBS./FT.^{3}	REMARKS
		HS		2.5" BITUMINOUS CONCRETE PAVEMENT		
	1	SS	46	9" SAND AND GRAVEL BASE COURSE, Dark Brown		
2.5		HS		FILL: SILTY SAND, Black, Brown, and Gray, Medium Dense, Moist (SM)		
5.0	2	SS	29	SILTY CLAYEY SAND, Brown and Gray, Loose, Moist (SM-SC)		C.A. Test
		HS		POORLY GRADED SAND, Brown and Gray, Little Silt, Trace Clay, Loose, Moist (SP)		
7.5	3	SS	54			ACR
		HS				
10.0	4	SS	67	SANDY SILT, Brown and Gray, Medium Dense, Moist (ML)		C.A. Test
12.5		HS		SILTY CLAY, Gray, Trace Sand and Gravel, Very Stiff, Moist (CL)		WS
	5	SS	42			
15.0		HS				
17.5	6	SS	63		114.1	
20.0		HS				
22.5	7	SS	58			
25.0		HS				
27.5	8	SS	33			
30.0				End of Boring @ 30.0 Feet.		
32.5						



Calibrated Penetrometer Unconfined Compression

Water Level Observations	
13' WS	8.5' ACR

SEECO Consultants, Inc.
7350 Duvan Drive, Tinley Park, IL 60477

Approved By	GG	Job No.	12060G
Boring Started	11/29/18		
Boring Completed	11/29/18		
Driller	EN	Rig	D-50
Drawn By	MB	Sheet	1 of 1

BORING LOG

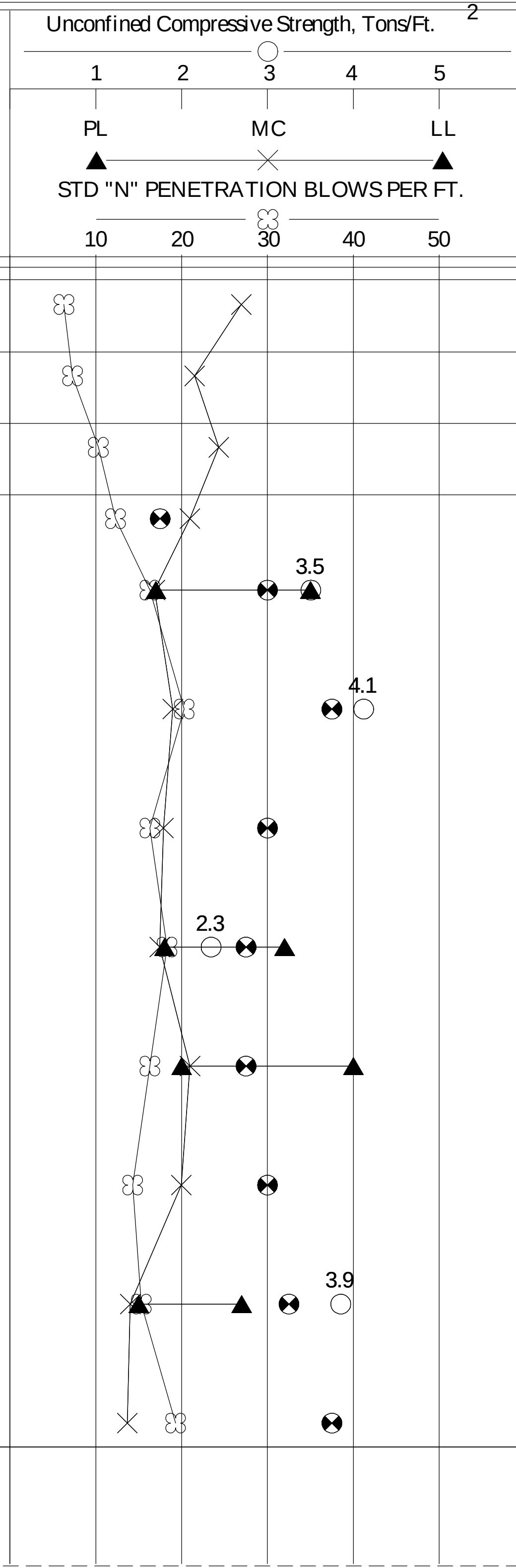
CLIENT: Public Building Commission of Chicago	PROJECT: Proposed Fire Station Engine Company 115
ENGINEER: Public Building Commission of Chicago	LOCATION: 119th St. & Morgan St., Chicago, Illinois

BORING NUMBER: **B-11**

APPROX. SURFACE ELEVATION (C.C.D.) + - **35.56**

NORTH **1826130.53** EAST **1171502.22**

DEPTH ELEVATION	SAMPLE NO.	SAMPLER TYPE	SAMPLE REC. (%)	DESCRIPTION OF MATERIALS (LABORATORY CLASSIFICATION)	UNIT DRY WT. LBS./FT.^{3}	REMARKS
		HS		5.25" BITUMINOUS CONCRETE PAVEMENT		
2.5	1	SS	38	6.25" SAND AND GRAVEL BASE COURSE, Dark Brown		
		HS		FILL: SILTY SAND, Dark Brown, Brown, and Black, Loose, Moist (SM)		
5.0	2	SS	58			C.A. Test
		HS		CLAYEY SAND, Brown, Loose, Moist (SC)		
7.5	3	SS	71			C.A. Test
		HS		SILTY SAND, Brown and Gray, Loose, Moist (SM)		
10.0	4	SS	63	SILTY CLAY, Gray, Trace Sand and Gravel, Stiff to Very Stiff, Moist (CL)		ACR
12.5		HS				
	5	SS	75		114.5	
15.0		HS				
17.5	6	SS	42		112.1	
20.0		HS				
22.5	7	SS	71			C.A. Test
25.0		HS				
27.5	8	SS	33		129.2	
30.0		HS				
32.5	9	SS	54			WD
35.0		HS				
37.5	10	SS	79			
40.0		HS				
42.5	11	SS	67		123.0	
45.0		HS				
47.5	12	SS	46			
50.0				End of Boring @ 50.0 Feet.		
52.5						



Calibrated Penetrometer Unconfined Compression

Water Level Observations		
	33' WD	10' ACR

SEECO Consultants, Inc.
7350 Duvan Drive, Tinley Park, IL 60477

Boring Started	12/4/18		
Boring Completed	12/4/18		
Driller	EN	Rig	D-50
Approved By	GG	Job No.	12060G
Drawn By	MB	Sheet	1 of 1

APPENDIX 4

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation: D 2487-10

(Based on United Soil Classification System)

SEECO Consultants, Inc.

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]

				Soil Classification Group Symbol	Group Name[B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well graded gravel[F]
			$Cu \geq 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel[F, G, H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu < 6$ and /or $1 > Cc > 3$[E]	SP	Poorly graded sand[I]
		Sands with fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G, H, I]
			Fines classify as CL or CH	SC	Clayey sand[G, H, I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI>7 and plots on or above "A" line[J]	CL	Lean clay[K, L, M]
			PI<4 or plots below "A" line[J]	ML	Silt[K, L, M]
		Organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OL	Organic clay[K, L, M, N]
				OL	Organic silt[K, L, M, O]
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay[K, L, M]
			PI plots below "A" line	MH	Elastic silt[K, L, M]
		Organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OH	Organic clay[K, L, M, P]
					Organic silt[K, L, M, Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A]Based on the material passing the three inch (75 MM) sieve

[B]If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name

[C]Gravels with 5 to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

[D]Sands with 5 to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

[E]$Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F]If soil contains $\geq$15% sand, add "with sand" to group name

[G]If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM

[H]If fines are organic, add "with organic fines" to group name

[I]If soils contains $\geq$15% gravel, add "with gravel" to group name

[J]If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay

[K]If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant

[L]If soil contains $\geq$30% plus No. 200, predominantly sand, add "sandy" to group name

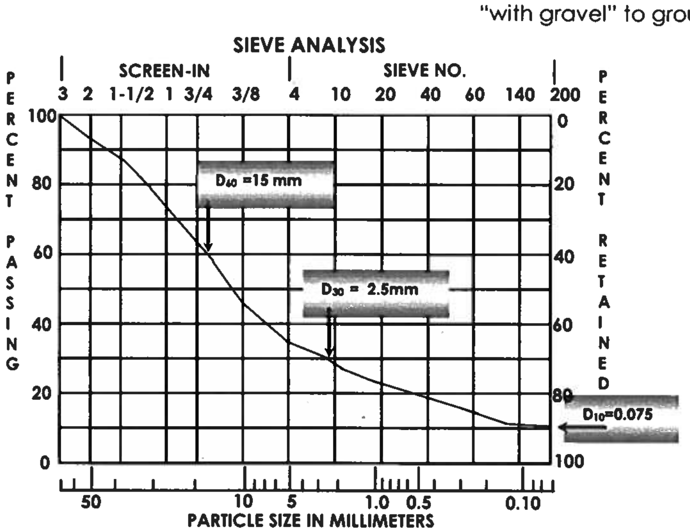
[M]If soil contains $\geq$30% plus No. 200, predominantly gravel, add "gravelly" to group name

[N]PI $\geq$4 and plots on or above "A" line

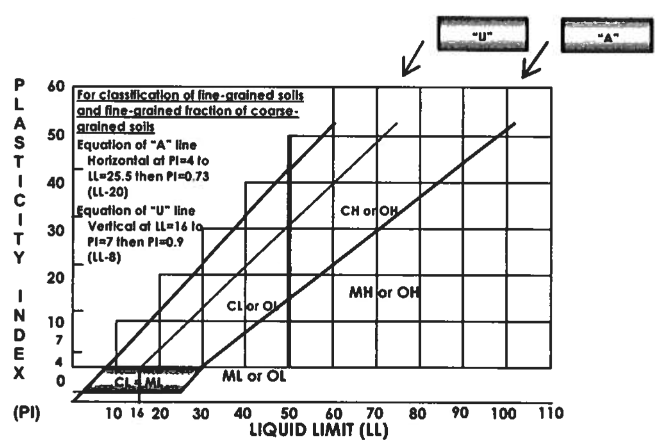
[O]PI <4 or plots below "A" line

[P]PI plots on or above "A" line

[Q]PI plots below "A" line



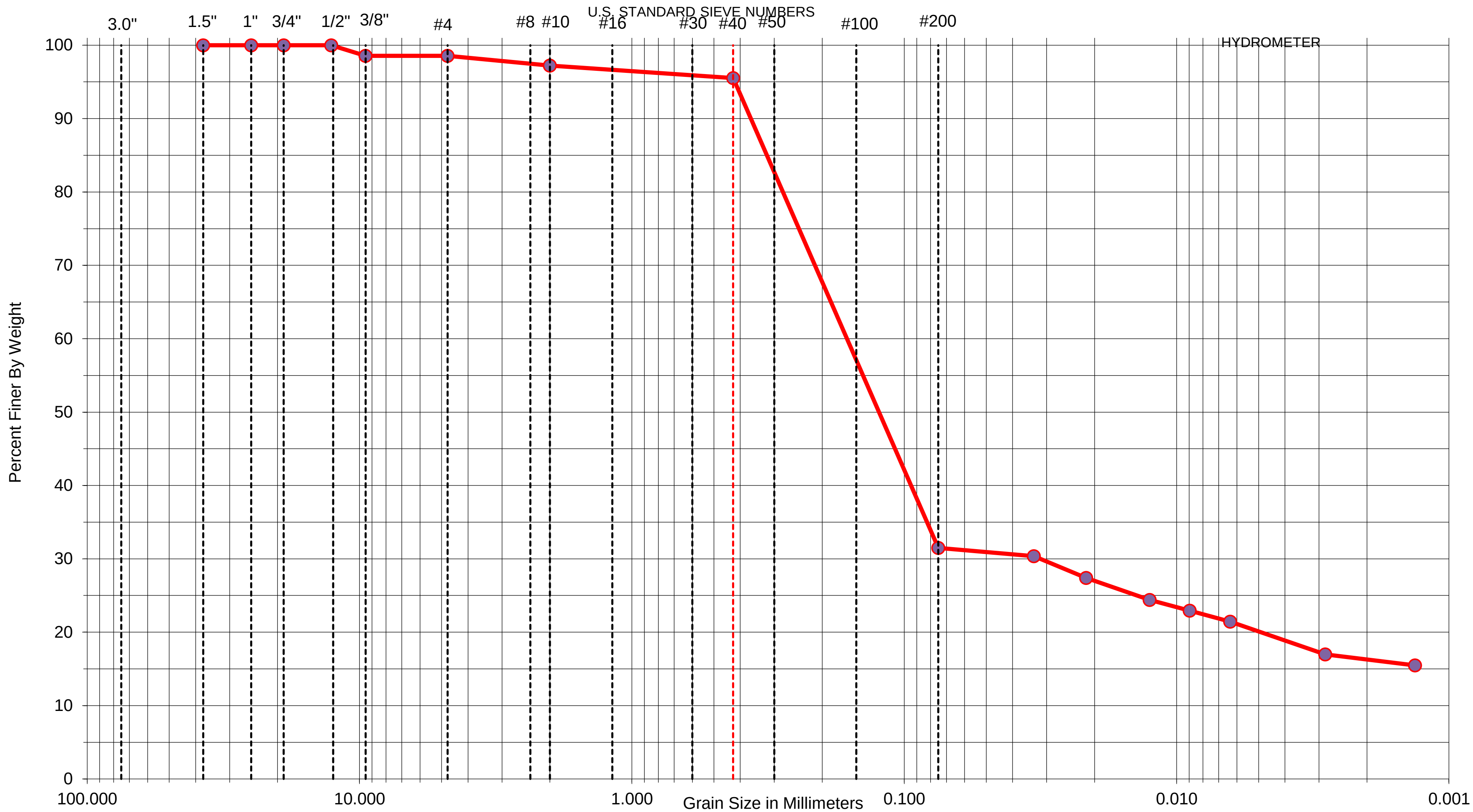
$$Cu = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200 \qquad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(2.5)^2}{0.075 \times 15} = 5.6$$



APPENDIX 5

rubino ENGINEERING INC.

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



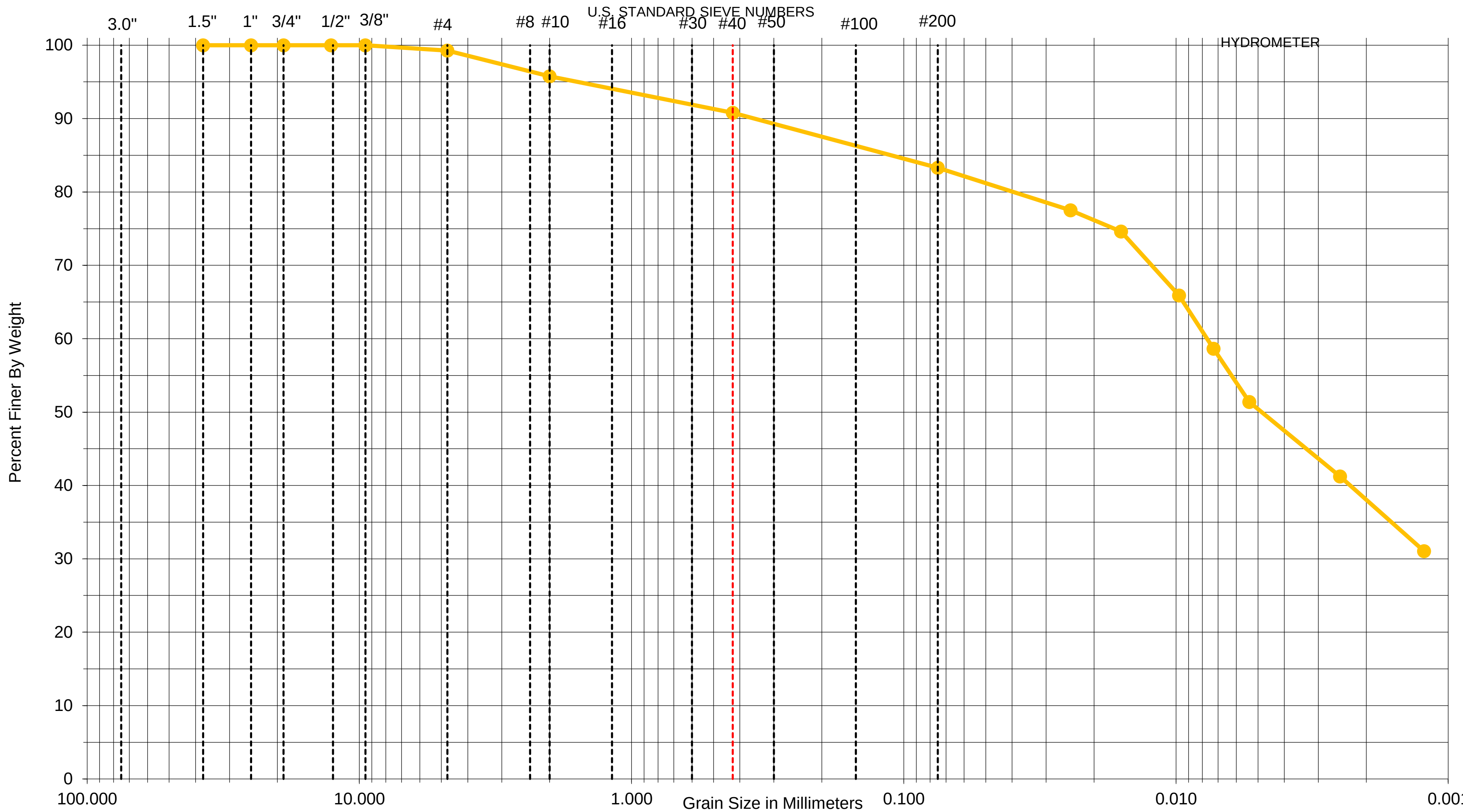
Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-1 S-2	5'	Brown & Gray Silty Clayey Sand (SC-SM)	23.1				1.5	67.1	12.4	19.0	0.162	0.029	

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL | **SEECO LAB** | File No. **G18.145**

Rubino Engineering Inc ● 425 Shepard Drive● Elgin, IL 60123 ● 847-931-1555 ● 847-931-1560 (Fax)

RUBINO ENGINEERING INC.

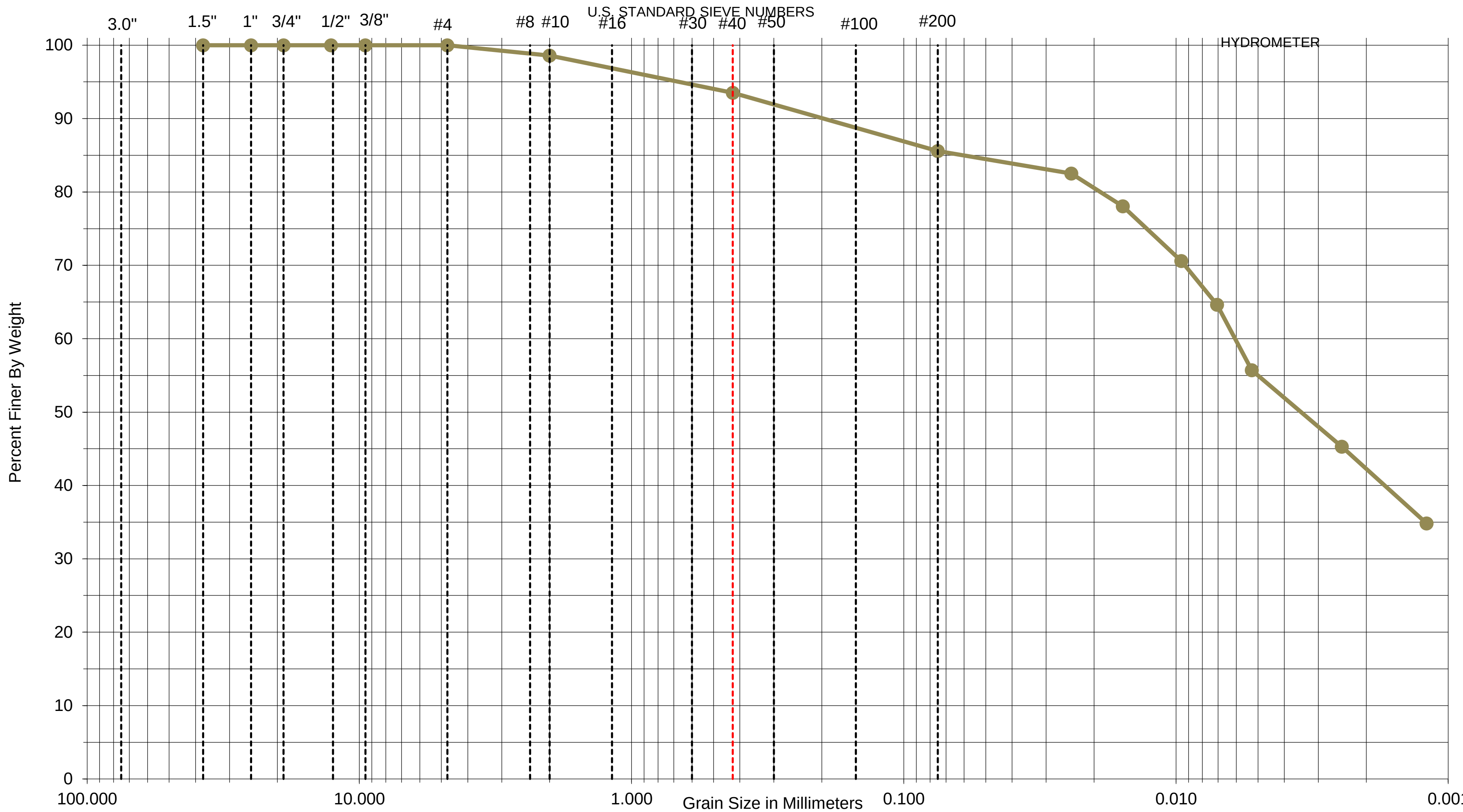
REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-2, S-6	14.25'	Gray Silty Clay (CL)	16.8	N/A			0.7	16.1	32.9	50.3	0.008		

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	**SEECO LAB**	File No.	**G18.145**

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-3, S-5	14.25'	Gray Silty Clay (CL)	17.9				0.0	14.4	30.6	55.0	0.006		

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL | **SEECO LAB** | File No. **G18.145**

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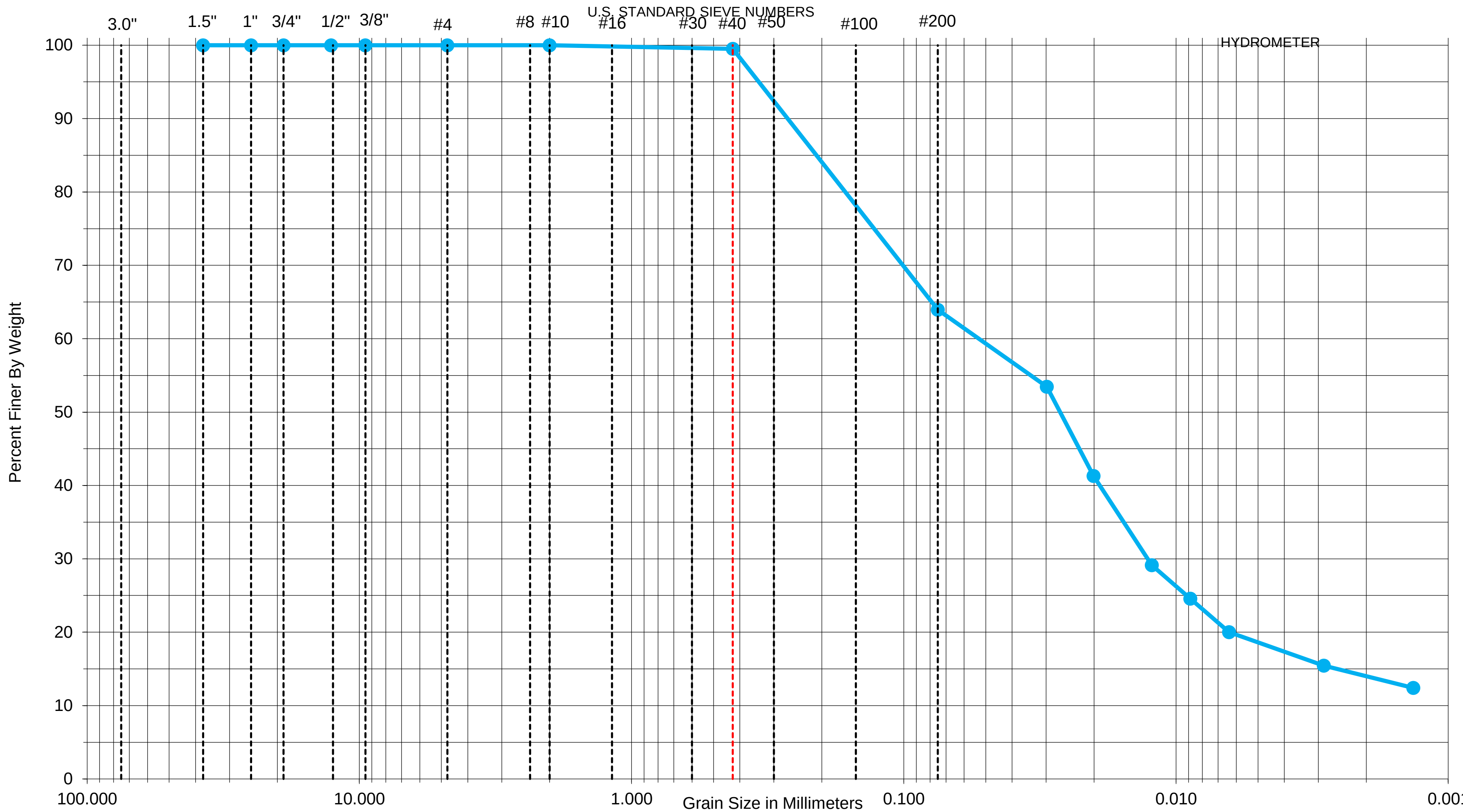
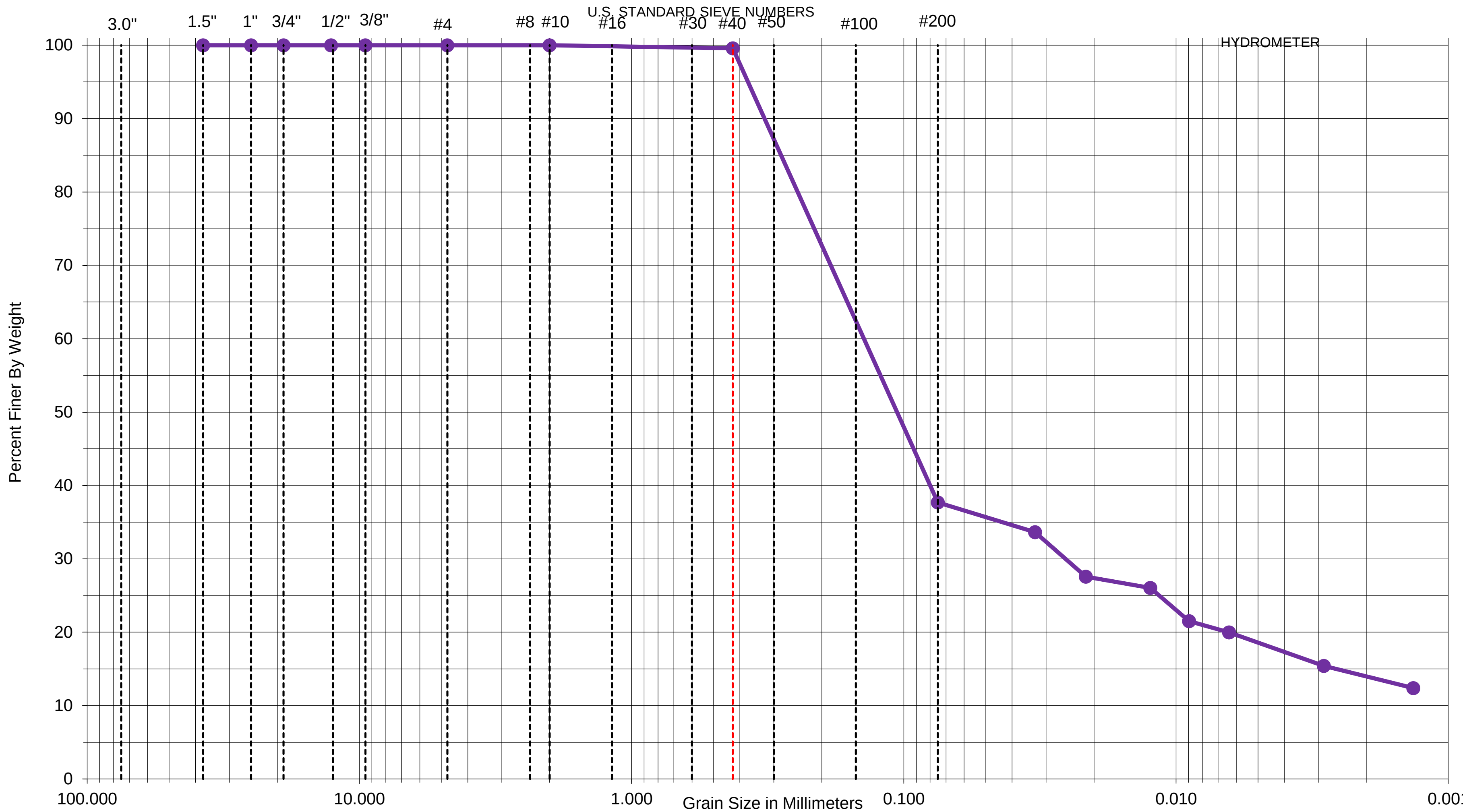
REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-4, S-3	8'	Brown & Gray Sandy Silt (ML)	N/A				0.0	36.1	44.2	19.7	0.058	0.013	

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	**SEECO LAB**	File No. **G18.145**

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-5, S-3	6.75'	Brown & Gray Silty Clayey Sand (SC-SM)	24.7				0.0	62.3	18.0	19.7	0.140	0.026	

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	**SEECO LAB**	File No.	**G18.145**

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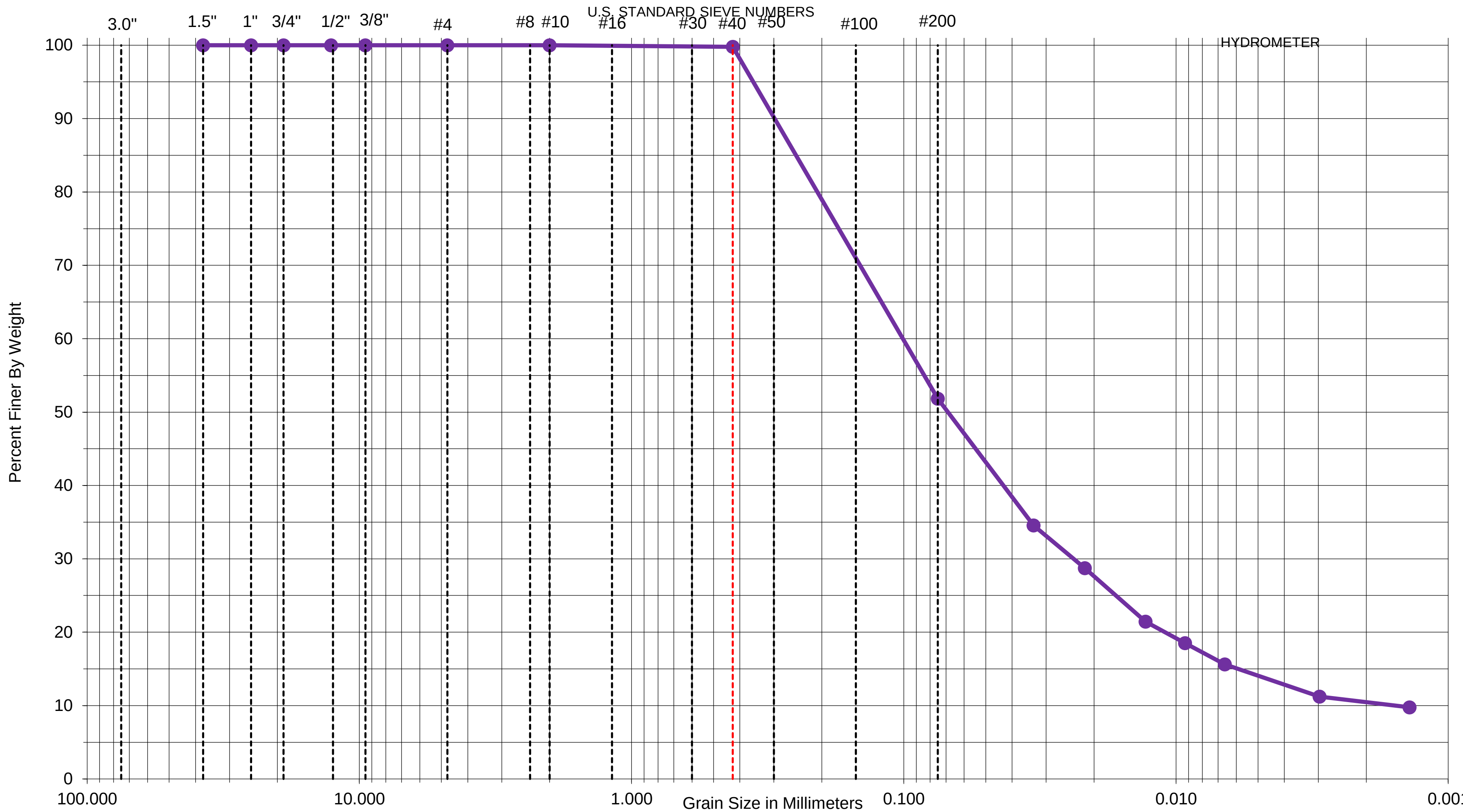
rubino ENGINEERING INC.

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-2, S-3	6.75'	Brown and Gray Silty Sand (SM)	28.1	N/A	2.643	82.13	0.0	48.2	38.7	13.1	0.135	0.024	0.002

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	SEECO LAB	File No.	G18.145

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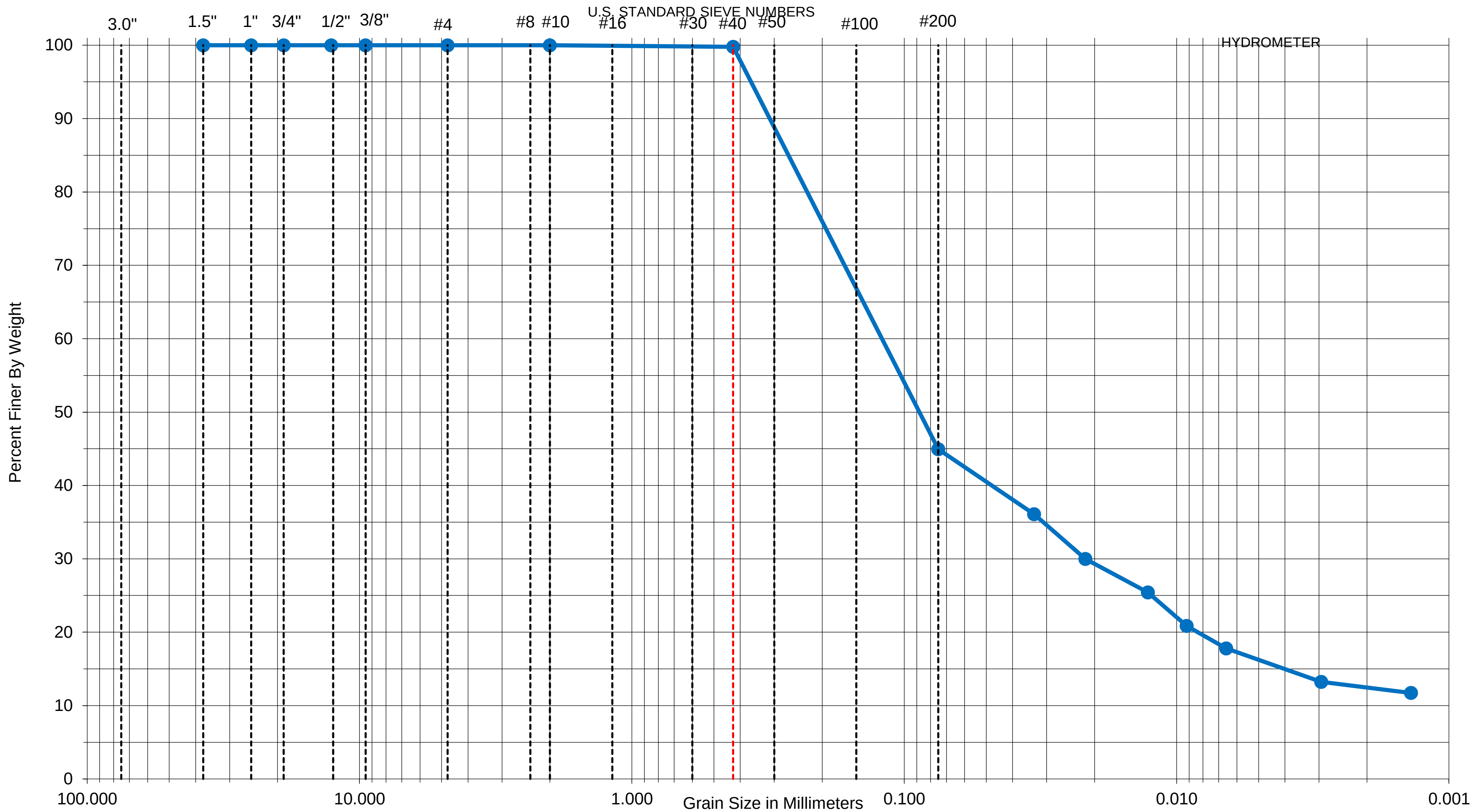
ENGINEERING INC.

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-6, S-3	8'	Brown and Gray Silty Sand, little Clay (SM)	27.1	N/A			0.0	55.1	29.7	15.2	0.171	0.022	

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	**SEECO LAB**	File No.	**G18.145**

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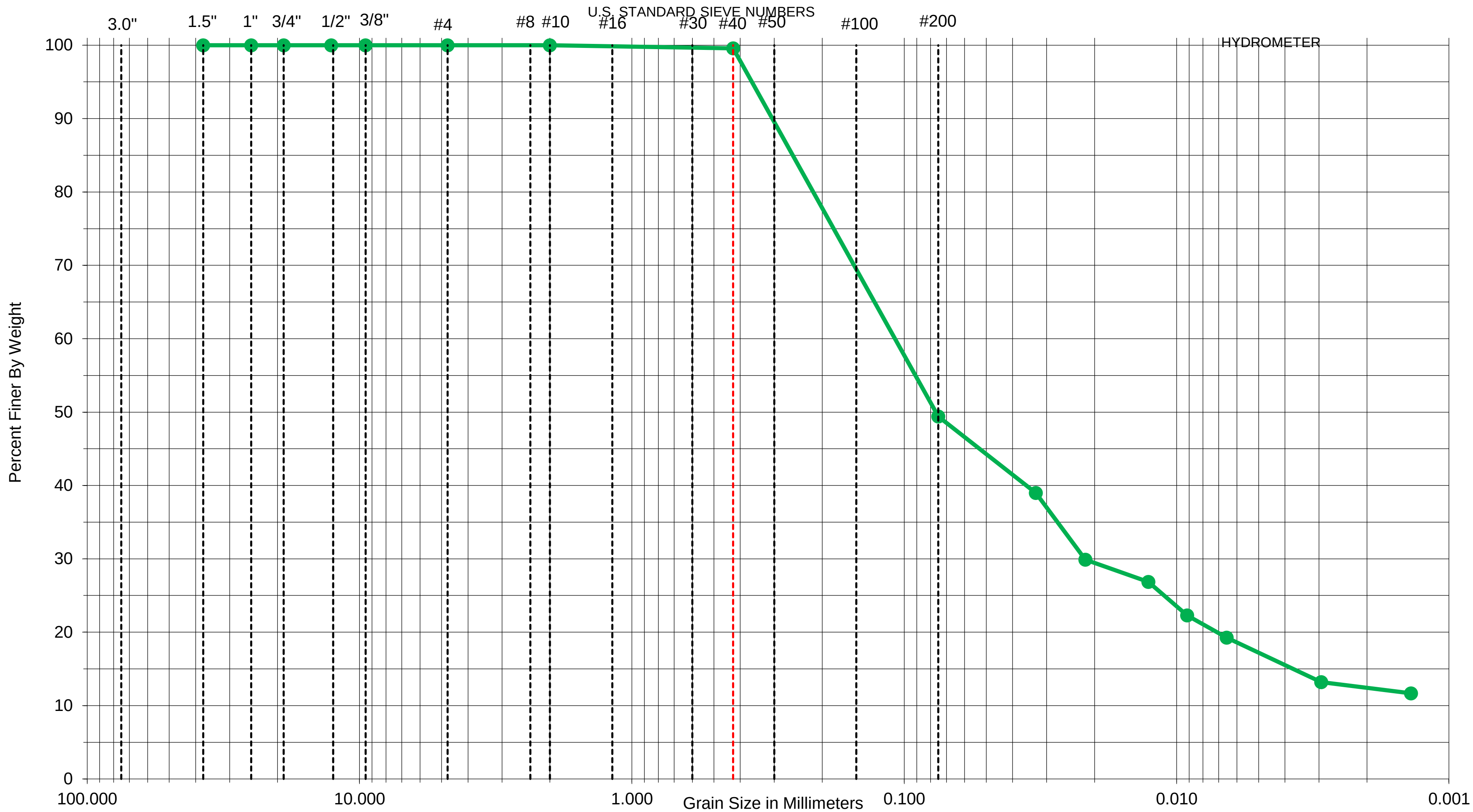
REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-7, S-3	8'	Brown and Gray Silty Sand, little Clay (SM)		N/A			0.0	50.6	34.2	15.2	0.149	0.022	

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	SEECO LAB	File No. G18.145

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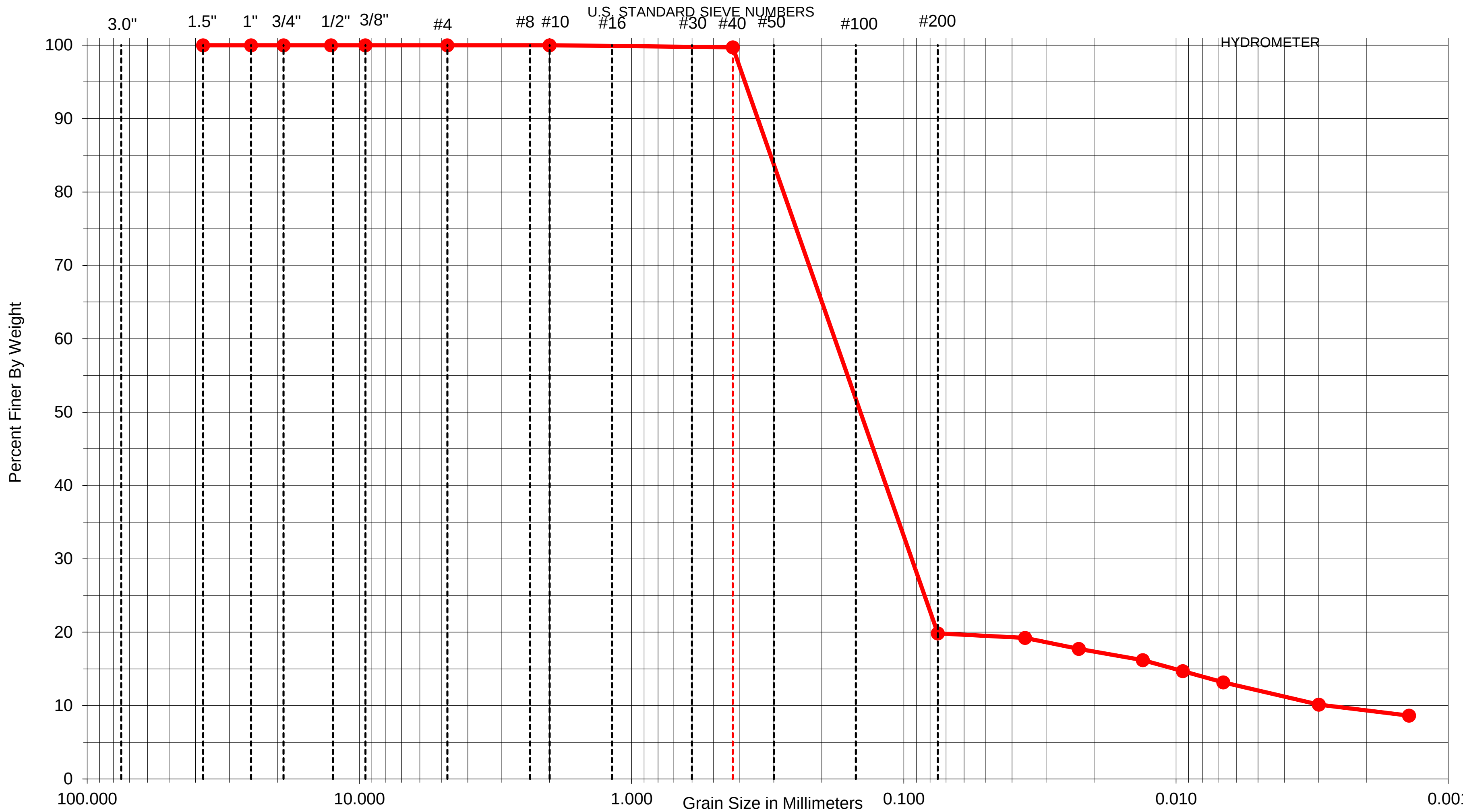
rubino ENGINEERING INC.

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL

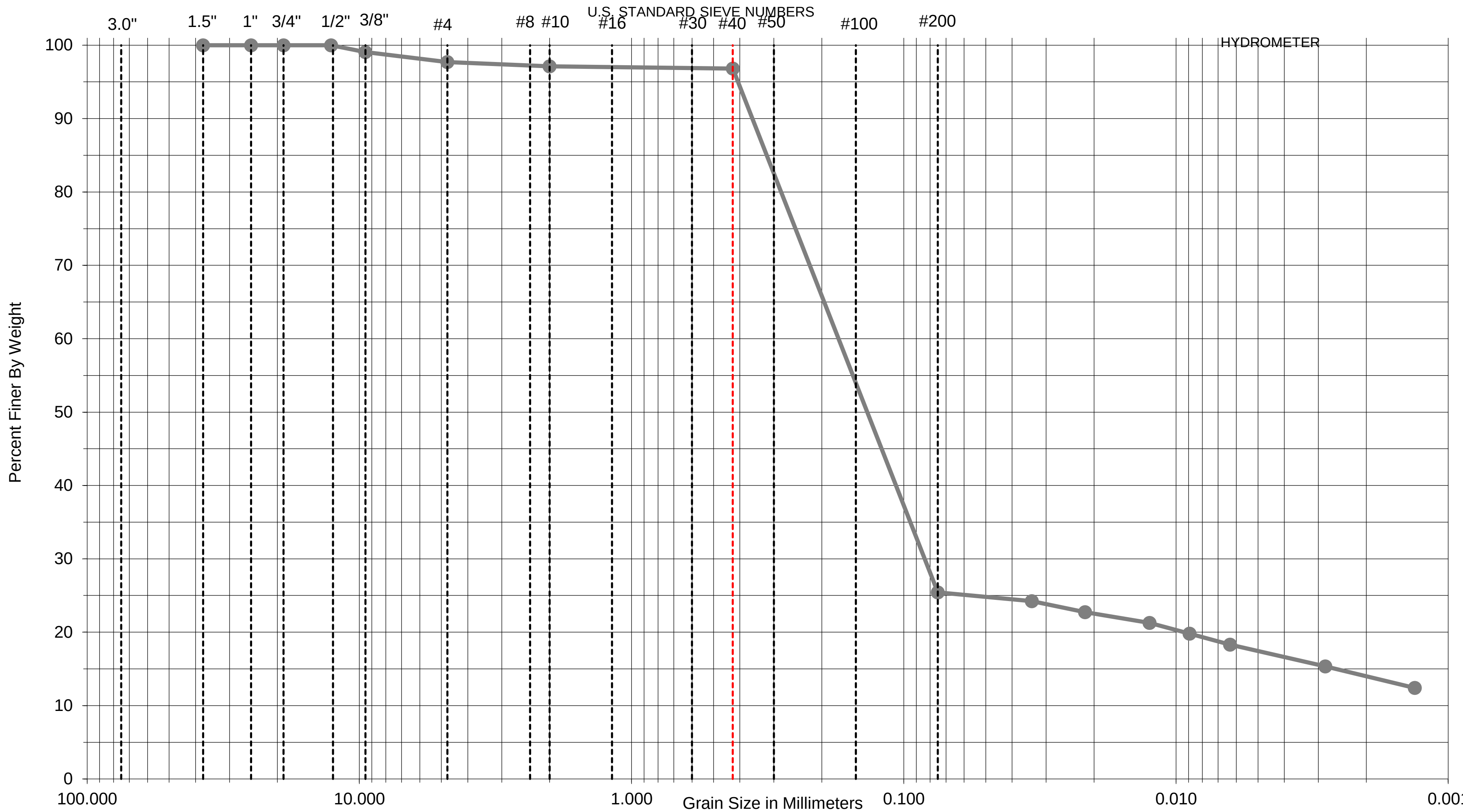


Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-8, S-3	8'	Brown Silty, Clayey Sand (SC-SM)	20.8	N/A	17.18	63.24	0.0	80.1	7.8	12.1	0.179	0.093	0.003

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	SEECO LAB	File No.	G18.145

Rubino Engineering Inc ● 425 Shepard Drive● Elgin, IL 60123 ● 847-931-1555 ● 847-931-1560 (Fax)

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL

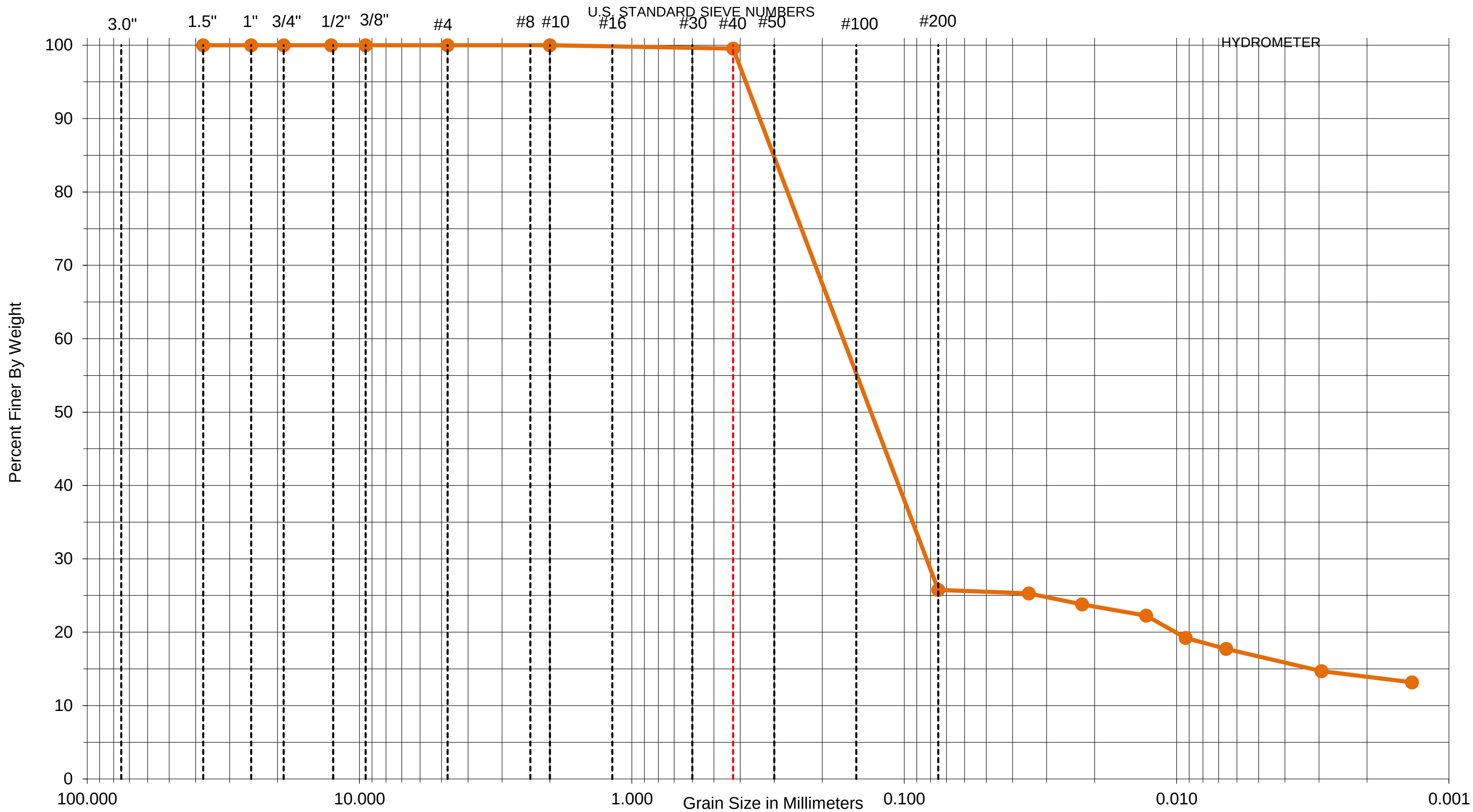


Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-9, S-3	8'	Brown and Gray Clayey Sand (SC)	20.9	N/A			2.3	72.3	7.8	17.6	0.174	0.084	

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	SEECO LAB	File No.	G18.145

Rubino Engineering Inc ● 425 Shepard Drive● Elgin, IL 60123 ● 847-931-1555 ● 847-931-1560 (Fax)

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-10, S-2	5'	Brown and Gray Silty, Clayey Sand (SC-SM)	22.4	N/A			0.0	74.2	9.1	16.7	0.168	0.829	

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	SEECO LAB	File No. G18.145

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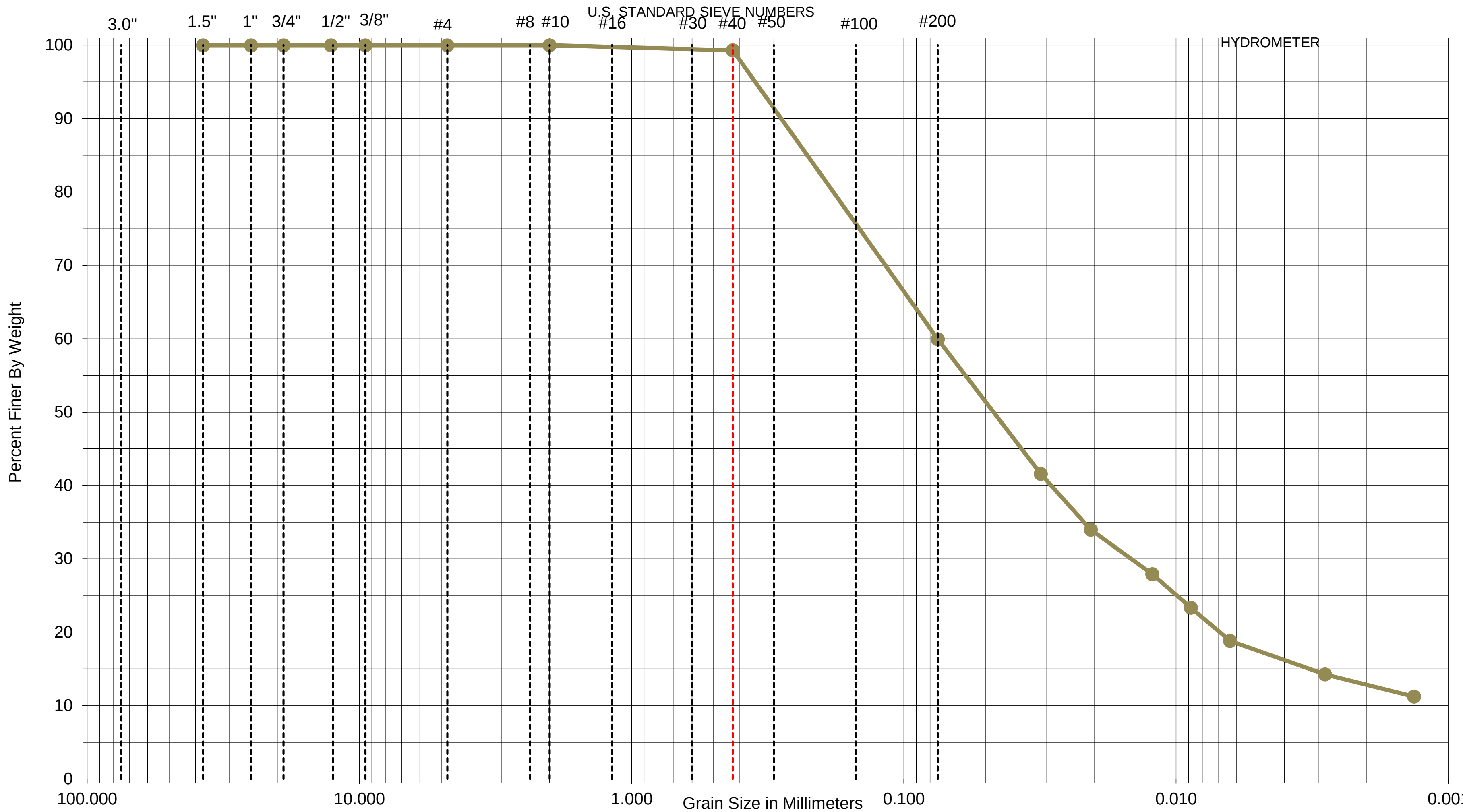
REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL

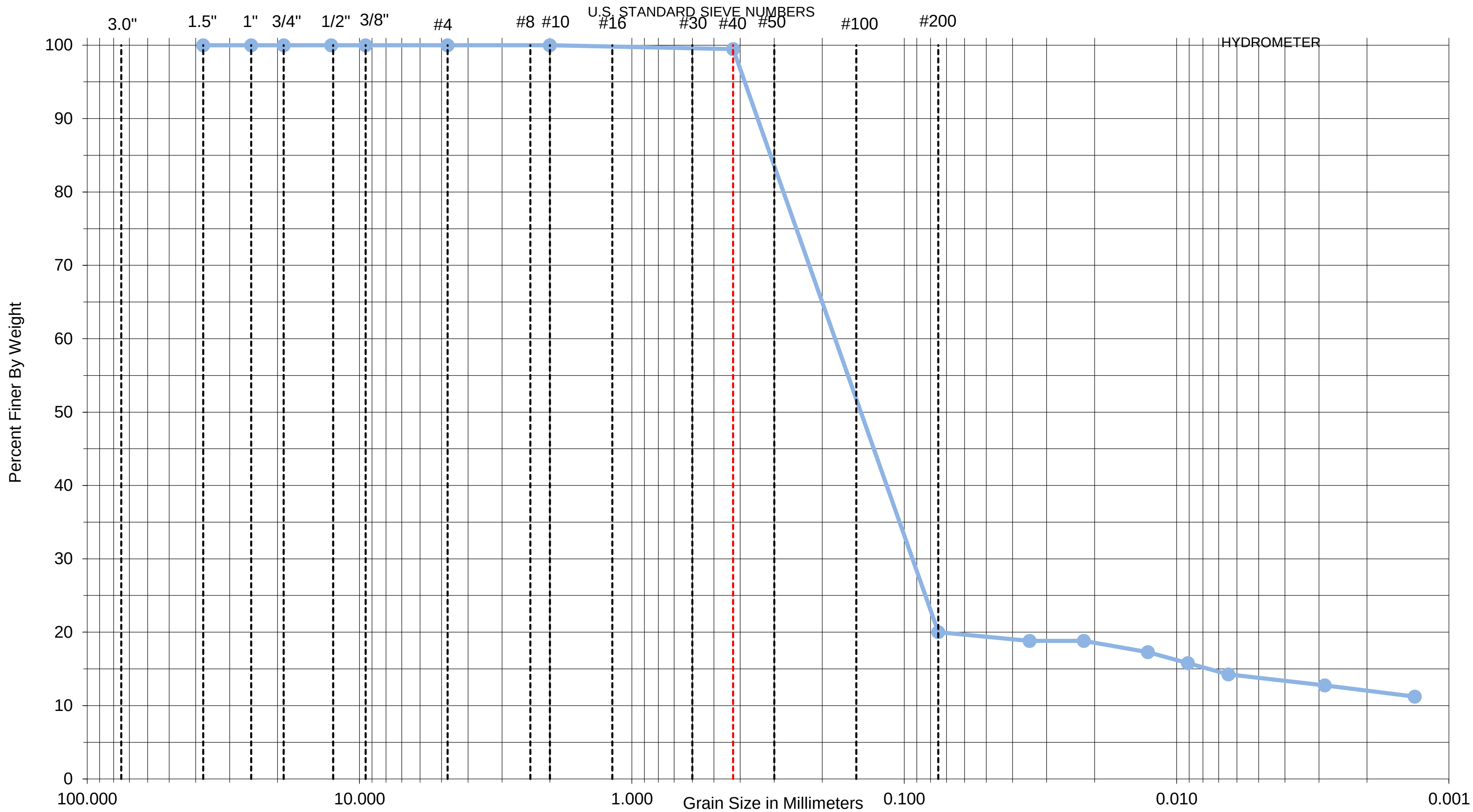


Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-10, S-4	11'	Brown and Gray Sandy Silt (ML)	25.1	N/A			0.0	40.1	41.3	18.6	0.076	0.015	

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	SEECO LAB	File No.	G18.145

Rubino Engineering Inc ● 425 Shepard Drive● Elgin, IL 60123 ● 847-931-1555 ● 847-931-1560 (Fax)

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-11, S-2	5'	Brown Clayey Sand (SC)	21.5	N/A			0.0	80.0	5.1	14.9	0.180	0.093	

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	SEECO LAB	File No.	G18.145

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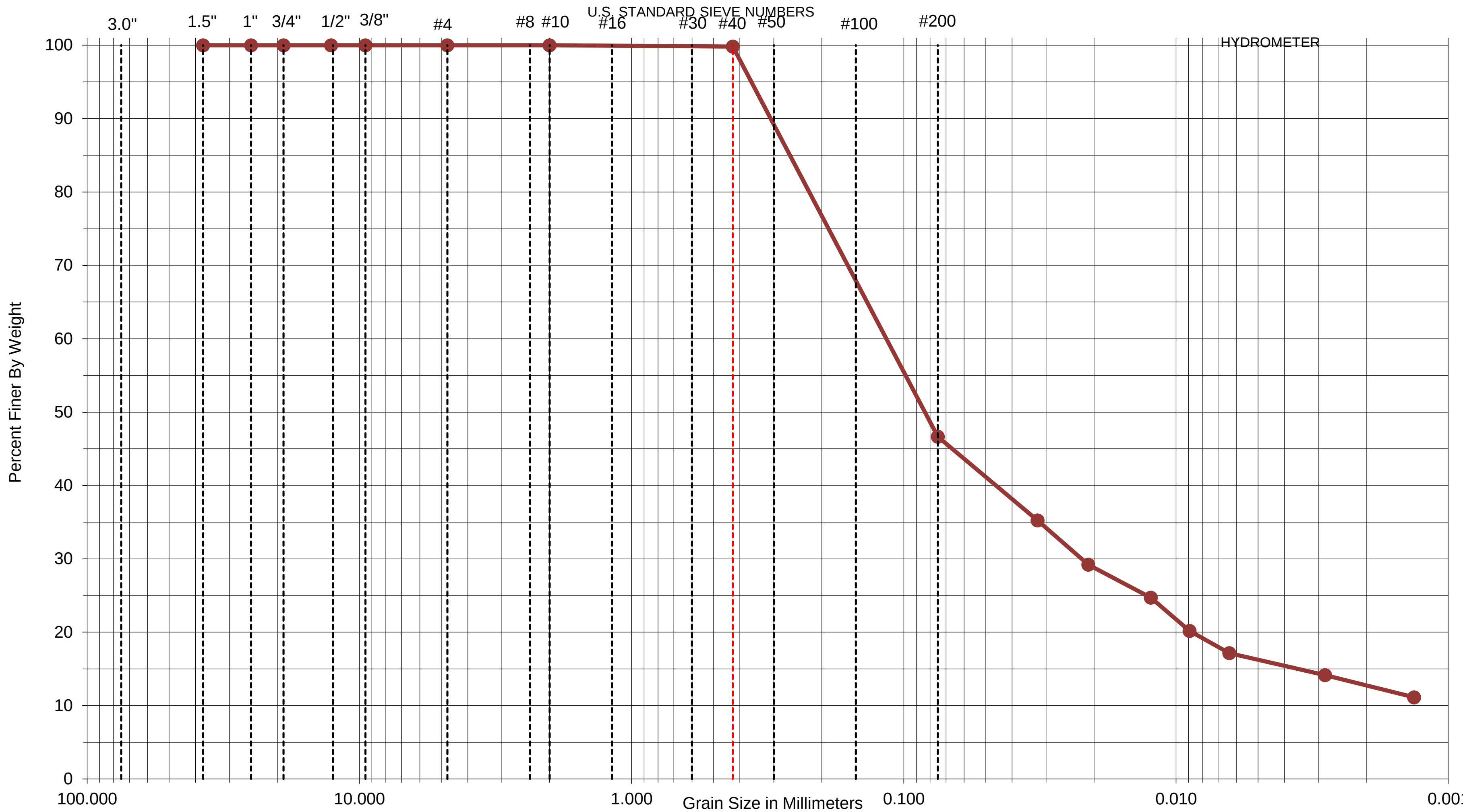
REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-11, S-3	8'	Brown and Gray Silty Sand (SM)	24.3	N/A			0.0	53.4	30.6	16.0	0.163	0.022	

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	**SEECO LAB**	File No.	**G18.145**

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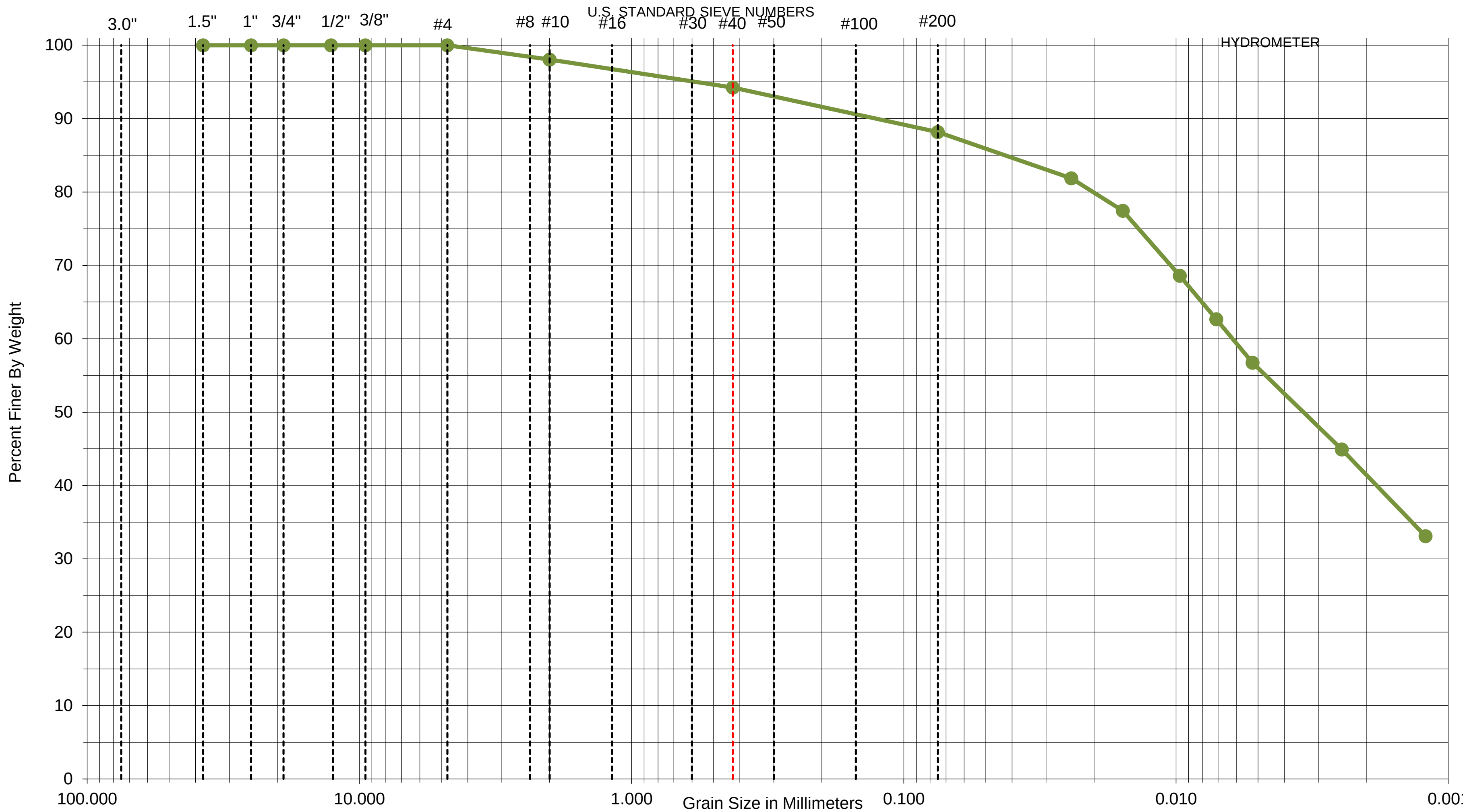
REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL



Key	Boring No.	Depth	USCS Classification	WC%	ORG%	Cc	Cu	%Gravel	%Sand	%Silt	%Clay	D60	D30	D10
●	B-11, S-7	24'	Gray Lean Clay (CL)	17.9	N/A			0.0	11.8	19.2	68.9	0.006		

REPORT OF PARTICLE-SIZE ANALYSIS OF SOIL	**SEECO LAB**	File No.	**G18.145**

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APPENDIX 6

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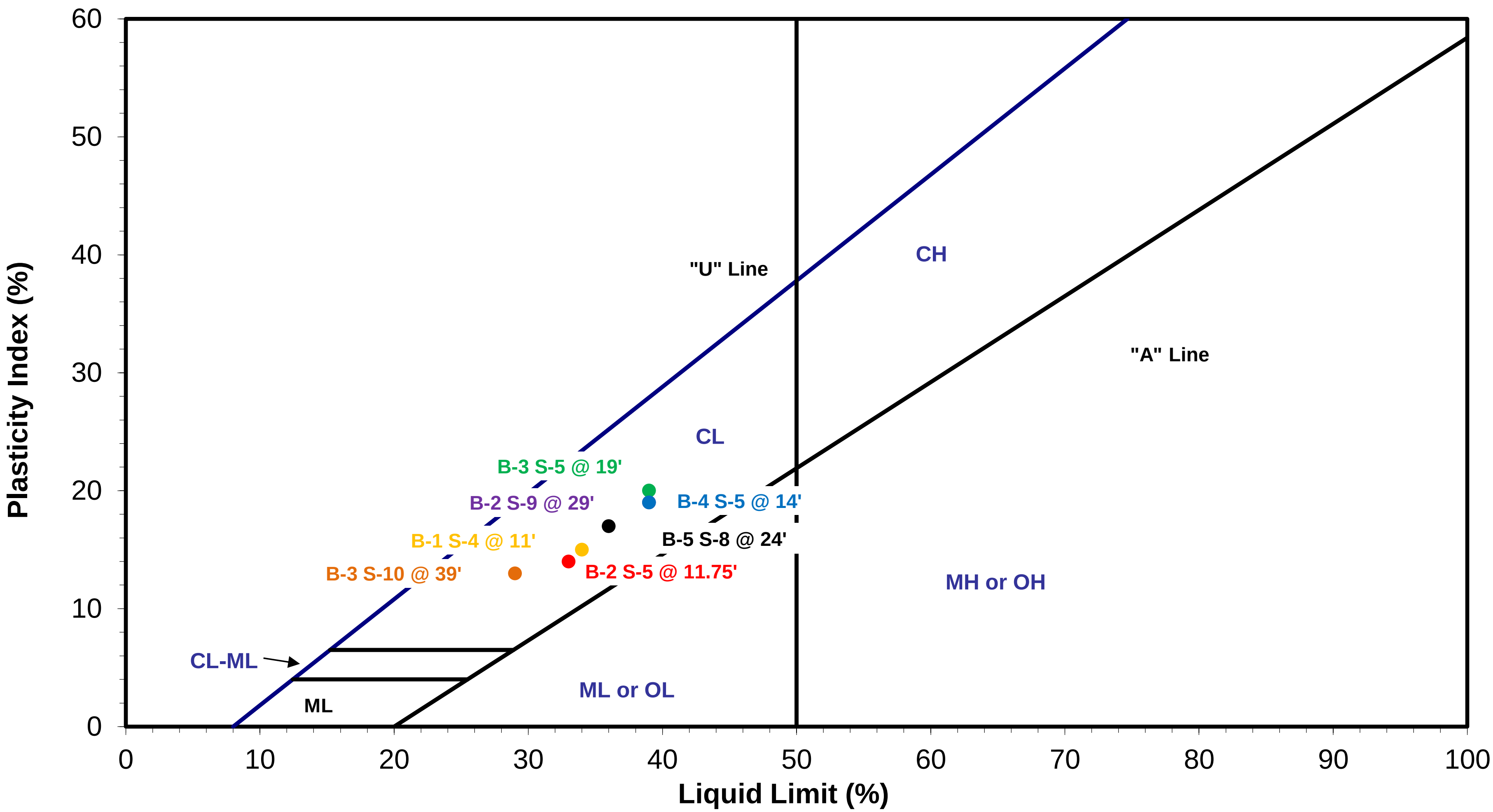
Report of Atterberg Limits Test (ASTM D4318 / AASHTO T89 / AASHTO T90)

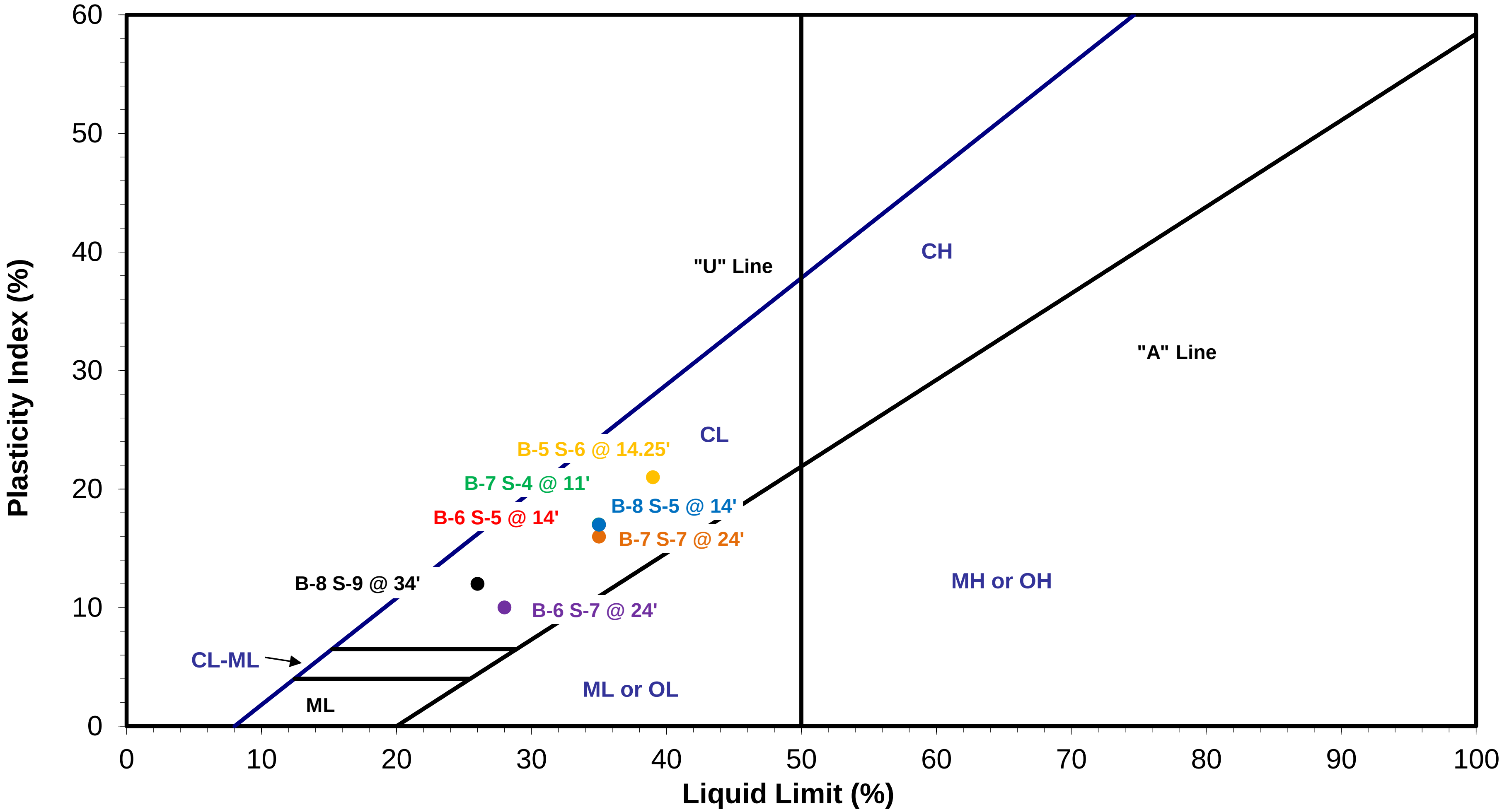


Boring #	B-1 S-4 @ 11'	B-2 S-5 @ 11.75'	B-2 S-9 @ 29'	B-3 S-5 @ 19'	B-3 S-10 @ 39'	B-4 S-5 @ 14'	B-5 S-8 @ 24'
LL	34	33	39	39	29	39	36
PL	19	19	20	19	16	20	19
PI	15	14	19	20	13	19	17
LI	-0.17	-0.18	0.0	+0.04	-0.08	-0.06	-0.03

Project: Proposed Fire Station Engine Co 115-PBC
Location: 119th St & S. Morgan St., Chicago, IL
Client: SEECO
Project #: G18.145

rubino ENGINEERING INC.

Report of Atterberg Limits Test (ASTM D4318 / AASHTO T89 / AASHTO T90)

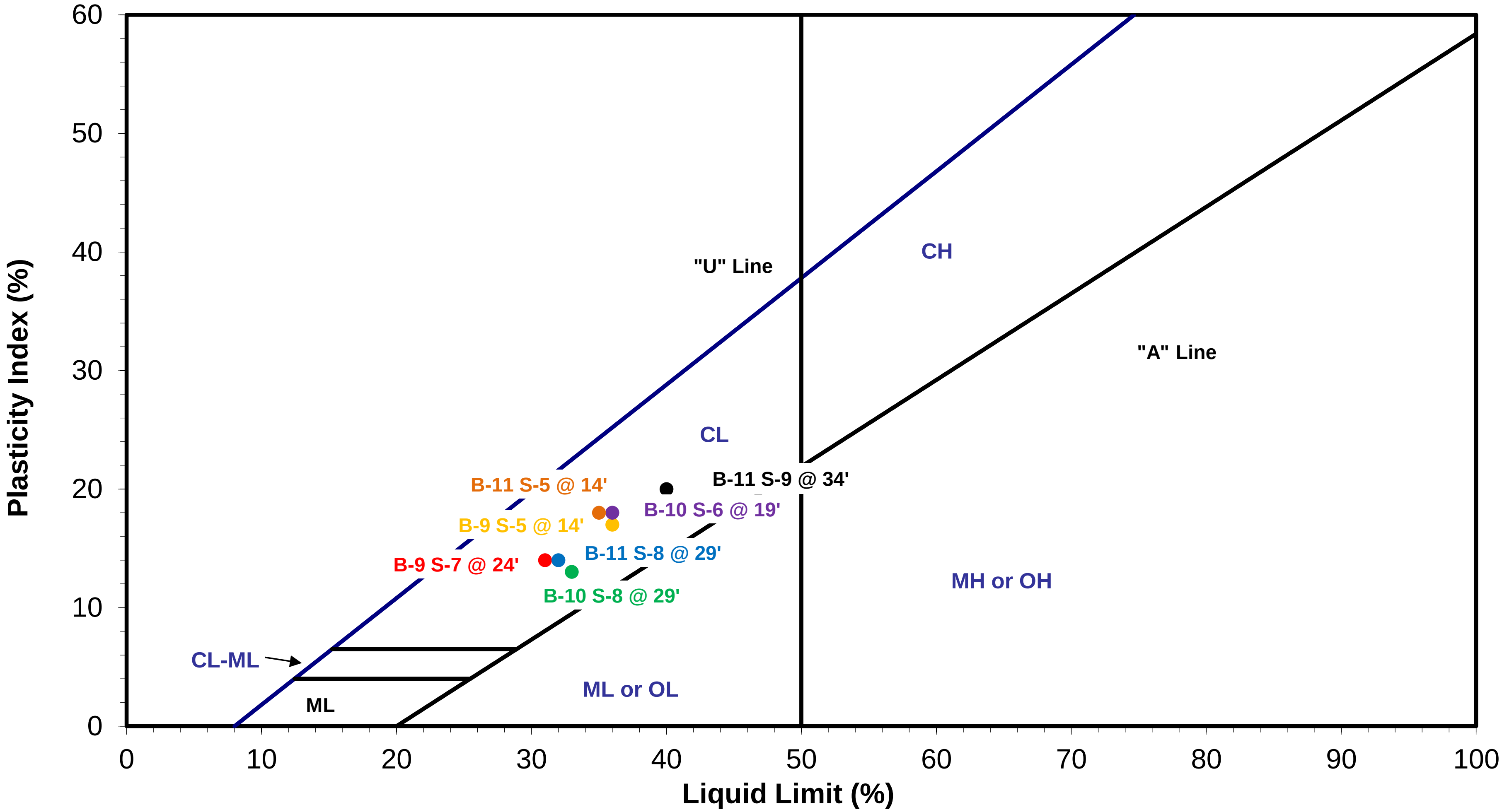


Boring #	B-5 S-6 @ 14.25'	B-6 S-5 @ 14'	B-6 S-7 @ 24'	B-7 S-4 @ 11'	B-7 S-7 @ 24'	B-8 S-5 @ 14'	B-8 S-9 @ 34'
LL	39	35	28	35	35	35	26
PL	18	18	18	18	19	18	14
PI	21	17	10	17	16	17	12
LI	0.00	-0.02	-0.23	-0.09	-0.16	-0.02	0.25

Project: Proposed Fire Station Engine Co 115-PBC
Location: 119th St & S. Morgan St., Chicago, IL
Client: SEECO
Project #: G18.145

rubino ENGINEERING INC.

Report of Atterberg Limits Test (ASTM D4318 / AASHTO T89 / AASHTO T90)

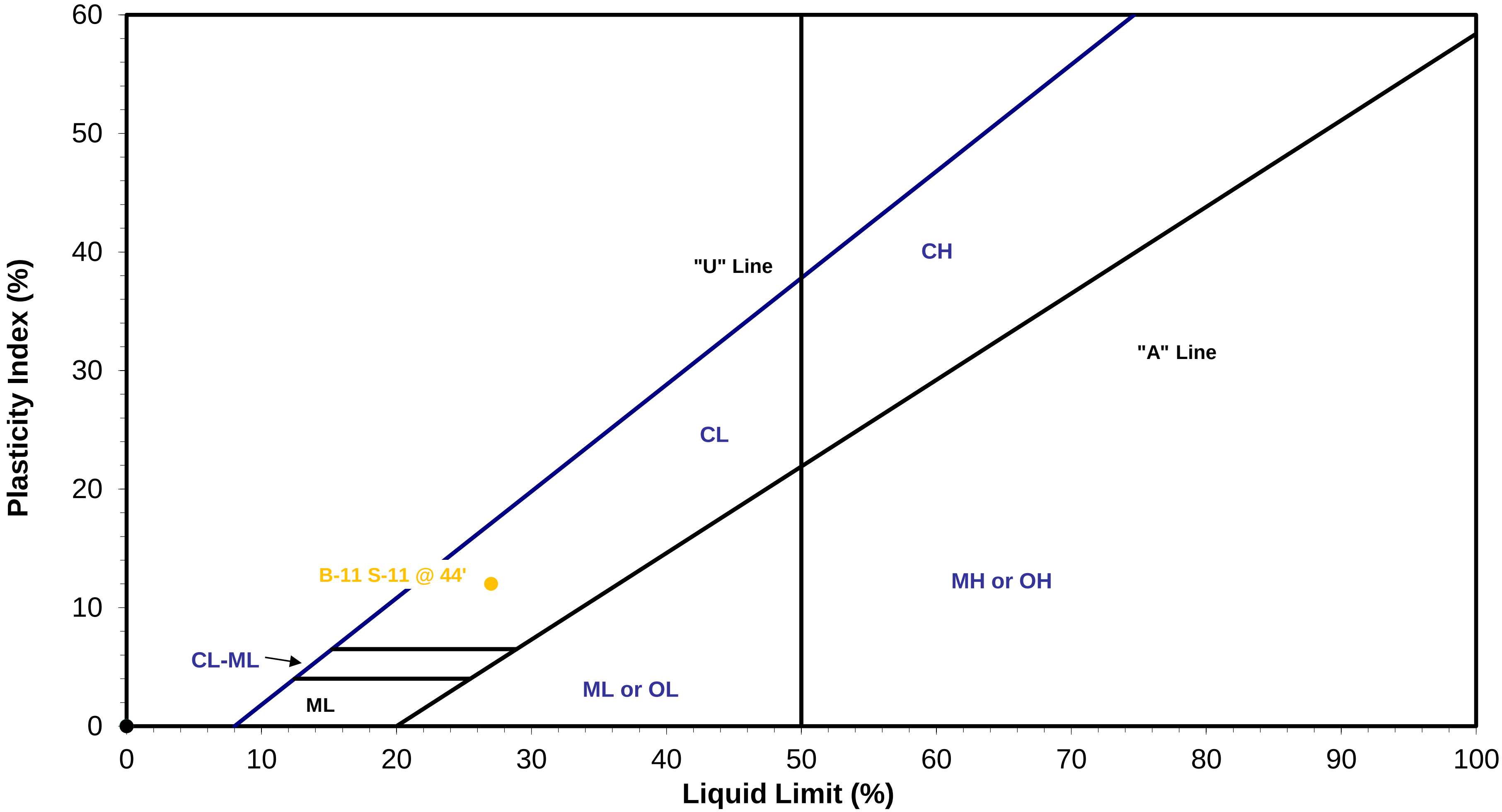


Boring #	B-9 S-5 @ 14'	B-9 S-7 @ 24'	B-10 S-6 @ 19'	B-10 S-8 @ 29'	B-11 S-5 @ 14'	B-11 S-8 @ 29'	B-11 S-9 @ 34'
LL	36	31	36	33	35	32	40
PL	19	17	18	20	17	18	20
PI	17	14	18	13	18	14	20
LI	-0.02	0.04	0.01	-0.28	-0.03	0.13	0.05

Project: Proposed Fire Station Engine Co 115-PBC
Location: 119th St & S. Morgan St., Chicago, IL
Client: SEECO
Project #: G18.145

ENGINEERING INC.

Report of Atterberg Limits Test (ASTM D4318 / AASHTO T89 / AASHTO T90)

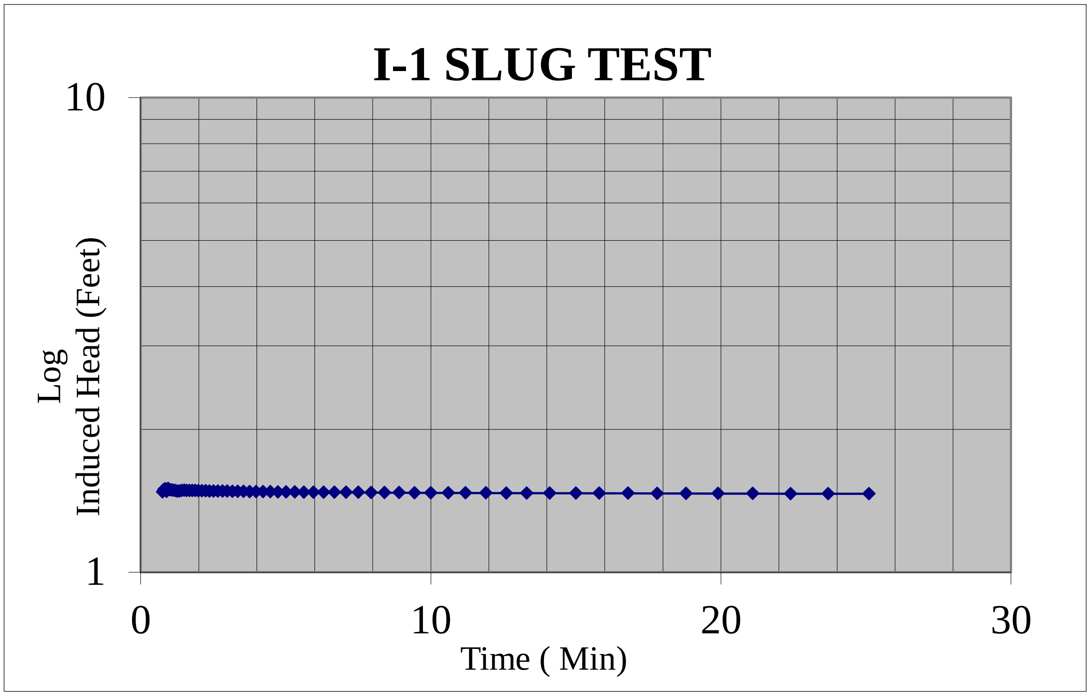


Boring #	B-11 S-11 @ 44'					
LL	27					
PL	15					
PI	12					
LI	-0.10					

Project: Proposed Fire Station Engine Co 115-PBC
Location: 119th St & S. Morgan St., Chicago, IL
Client: SEECO
Project #: G18.145

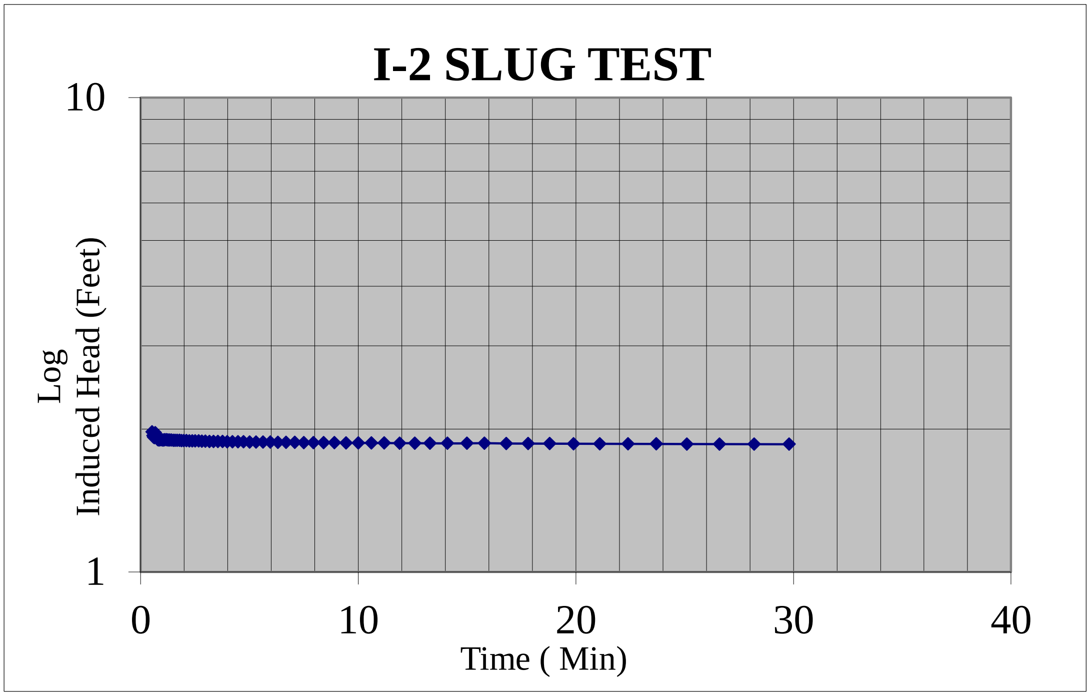
APPENDIX 7

PROPOSED FIRE STATION ENGINE COMPANY 115
119TH ST. & MORGAN STREET, CHICAGO, ILLINOIS
SEECO JOB NO: 12060G



Head Drop	0.029	ft.
Time Interval	0.402	hr.
I.D. of Pipe	4	in.
Head Drop in inch	0.348	in.
Rate of Infiltration	0.87	in/hr

PROPOSED FIRE STATION ENGINE COMPANY 115
119TH ST. & MORGAN STREET, CHICAGO, ILLINOIS
SEECO JOB NO: 12060G



Head Drop	0.038	ft.
Time Interval	0.480	hr.
I.D. of Pipe	4	in.
Head Drop in inch	0.456	in.
Rate of Infiltration	0.95	in/hr

APPENDIX 8

GENERAL REMARKS

This report has been prepared in order to aid in the evaluation of this property and to assist the architect and/or engineer in the design of this project. The scope is limited to the specific project and location described herein, and our description of the project represents our understanding of the significant aspects relevant to soil and foundation characteristics. In the event that any changes in the design or location of the building(s) as outlined in this report are planned, we should be informed so the changes can be reviewed and the conclusions of this report modified as necessary in writing by the geotechnical engineer. As a check, we recommend that we be authorized to review the project plans and specifications to confirm that the recommendations contained in this report have been interpreted in accordance with our intent. Without this review, we will not be responsible for misinterpretation of our data, our analysis, and/or our recommendations, nor how these are incorporated into the final design.

It is recommended that all construction operations dealing with earthwork and foundations be reviewed by an experienced geotechnical engineer to provide information on which to base a decision whether the design requirements are fulfilled in the actual construction. If you wish, we would welcome the opportunity to provide field construction services for you during construction.

The analysis and recommendations submitted in this report are based upon the data obtained from the soil borings performed at the locations indicated on the location diagram and from any other information discussed in this report. This report does not reflect any variations which may occur between these borings. In the performance of subsurface explorations, specific information is obtained at specific locations at specific times. However, it is a well-known fact that variations in soil and rock conditions exist on most sites between boring locations and also such situations as groundwater levels vary from time to time. The nature and extent of variations may not become evident until the course of construction. If variations then appear evident, it will be necessary for re-evaluation of the recommendations of this report after performing on-site observations during the construction period and noting the characteristics of any variations.