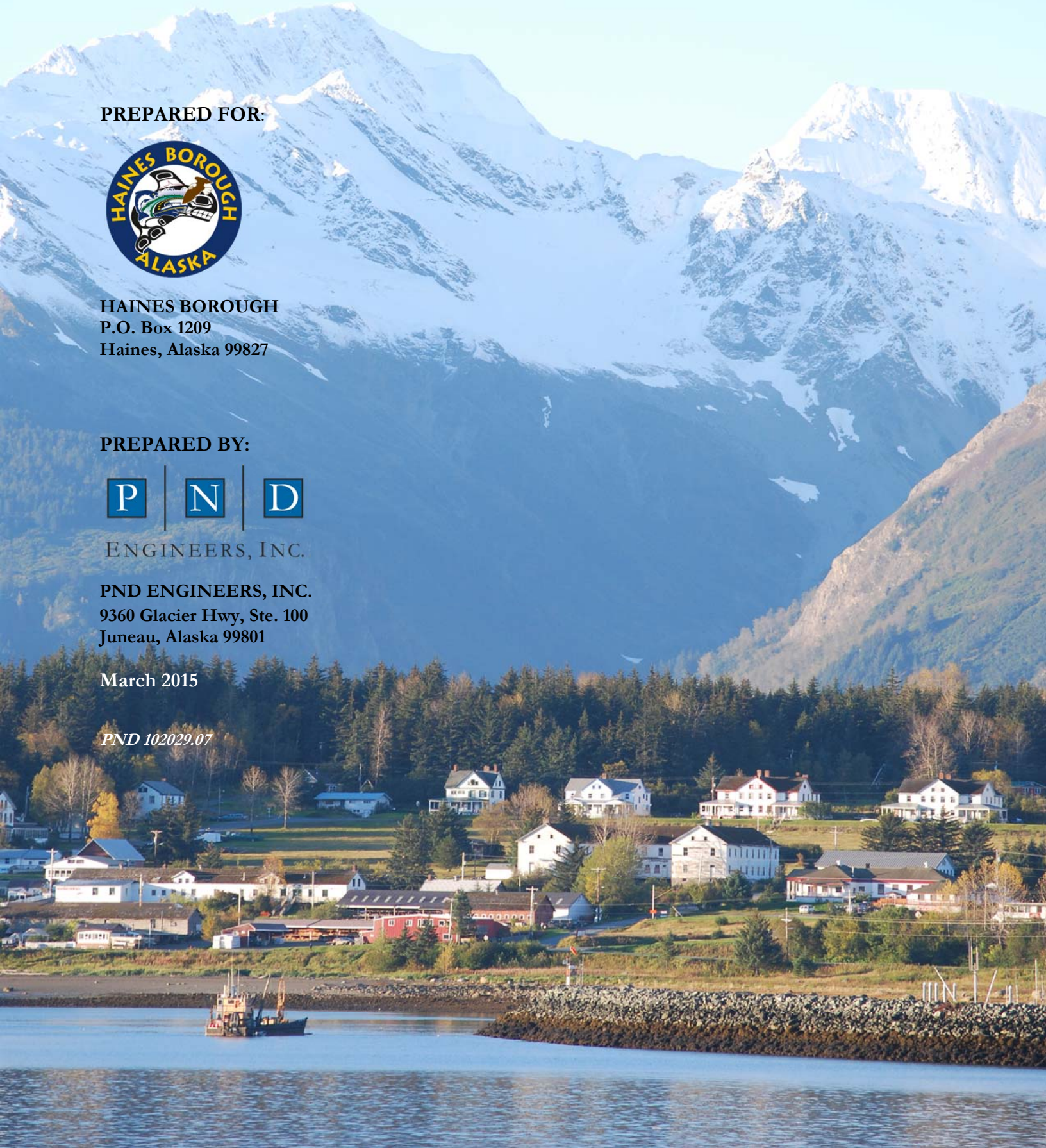
Haines Borough
South Portage Cove Harbor Expansion
GEOTECHNICAL ENGINEERING REPORT



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SOUTH PORTAGE COVE HARBOR EXPANSION
GEOTECHNICAL ENGINEERING REPORT

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TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Purpose and Scope 1
1.2 Project Description 1
1.3 Related Studies 2
2 FIELD INVESTIGATION AND LABORATORY TESTING 4
2.1 Field Investigation 4
2.1.1 Drilling Equipment 4
2.1.2 Drilling and Sampling Methods/Procedures 4
2.2 Laboratory Testing 6
2.2.1 Soil Classification 6
2.2.2 Moisture Content Testing 6
2.2.3 Percent Passing U.S. No. 200 Sieve and Limited Mechanical Analysis (LMA) 6
2.2.4 Sieve Analysis 6
2.2.5 Atterberg Limits Testing 6
2.2.6 One Dimensional Consolidation Testing 6
2.2.7 Unconfined Compression Strength Testing 7
2.2.8 CU Triaxial Shear Testing 7
3 REGIONAL SETTING AND SITE CONDITIONS 8
3.1 Setting 8
3.2 Climate 8
3.3 Tidal Ranges 9
3.4 Regional Geology 9
3.4.1 Surficial Deposits 9
3.4.2 Glaciers 10
3.4.3 Bedrock 12
3.5 Seismicity 13
3.6 Geologic Hazards 14
3.7 Existing Site Conditions 14
3.8 Subsurface Conditions 15
4 GEOTECHNICAL ANALYSIS AND DESIGN RECOMMENDATIONS 17
4.1 Pile Foundations 17
4.1.1 Design Considerations 17
4.1.1.1 Lateral Capacity 17
4.1.1.2 Axial Capacity 17
4.1.2 Partially Penetrating Wave Barrier Piles 18
4.1.2.1 Lateral Capacity 18
4.1.2.2 Axial Capacity 19
4.1.2.2.1 Open-Ended Steel Pipe Piles 19
4.1.2.2.2 SPIN FIN Piles 20
4.1.3 Marina Infrastructure Piles 20
4.1.3.1 Lateral Capacity 20
4.1.4 Pile Installation Considerations 21
4.1.4.1 Drivability 21
4.1.4.2 Constructability 22
4.1.4.3 Pile Driving Criteria and Verification of Pile Capacity 22
4.2 Basin Dredging 23

4.2.1 Dredge Soil Conditions 23
4.2.2 Slope Stability 23
4.3 Site Preparation and Earthwork 24
4.3.1 Engineered Fill 24
4.3.1.1 Materials 24
4.3.1.2 On-Site Soils 25
4.3.1.3 Placement and Compaction 25
4.3.2 Slopes and Shoring 25
4.3.3 Material Sources 25
4.4 Earthquake Design 26
4.4.1 Seismic Hazards 26
4.4.2 Seismic Design Parameters for Marine Infrastructure 27
4.5 Additional Considerations for In-Water Construction 27
4.6 Key Geotechnical Design Considerations 28
5 CLOSURE 29
6 REFERENCES 30

FIGURES

Figure 2-1. CME-850 Drill Rig 4
Figure 2-2. H-60 Vane Shear Apparatus 5
Figure 3-1. View of Portage Cove and Haines, Alaska. Existing Breakwater in Foreground 8
Figure 3-2. Boulder-Strewn Intertidal Bench 10
Figure 3-3. Large Boulders – Possibly Flood Deposited – Lying in a Drainage at the Mouth of Chilkoot Lake 11
Figure 3-4. Glacial Isostatic Rebound Results in Emergent Intertidal Delta Entering Chilkat Inlet. McClellan Flats is seen in the lower right. 12
Figure 3-5. Map Showing the Historic Seismicity Within the Southeast Alaska Panhandle 13
Figure 3-6. Artesian Water Flowing From Casing in Borehole 16
Figure 4-1. Waterfront Facility Liquefaction, Port Au Prince, Haiti (CPT Bobbitt, 2010). 26

TABLES

Table 2-1. Summary of Consolidation Test Results. 7
Table 3-1. Tide and Water Levels. 9
Table 4-1. Guideline Factor of Safety for Pile Capacity (after USACE 1991). 18
Table 4-2. Soil Profile for Design of Wave Barrier Piles. 19
Table 4-3. Soil Profile for Design of Moorage Float Piles and Drive-Down Float Piles. 21
Table 4-4. Guideline Minimum Pile Driving Hammer Requirement. 22
Table 4-5. Site Specific Design Spectra Parameters. 27

APPENDICES

A – Vicinity Map, Site Plans, and Site Profiles

B – Geotechnical Design Figures

C – Borehole Logs

D – Previous Exploration Logs

E – Laboratory Testing

F – Field Photographs

G – Engineering Analysis

H – GBA Publication: "Important Information about your Geotechnical-Engineering Report"

1 INTRODUCTION

1.1 Purpose and Scope

This report presents the results of a marine geotechnical investigation performed for the Haines Borough in support of the proposed South Portage Cove Harbor Expansion (SPCHE) project.

The scope of services summarized in this report includes:

- Background research and summaries of previous geotechnical and geologic data available for the project vicinity;
- Two subsurface exploration programs completed in 2012 and 2014 at the South Portage Cove Harbor Expansion project site;
- Laboratory testing on representative samples to determine general soil index properties, compressibility characteristics, and shear strength parameters;
- Engineering analyses and development of geotechnical recommendations for design of the proposed improvements; and
- Preparation of this geotechnical engineering report.

This report has been prepared for use by PND staff in support of the design efforts for the proposed harbor expansion infrastructure. A separate sediment characterization study of the proposed dredge material was prepared by PND (2015). This geotechnical engineering report is not intended to document or determine the extent of any hazardous materials or contamination at the project site since this is beyond the scope of this report.

PND received formal notice to proceed with the 2012 investigation program on August 15, 2012 and March 15, 2014 for the 2014 investigation program. Both field investigation programs were completed under the U.S. Army Corps of Engineers (USACE) Nationwide Permit (NWP) 6 – Survey Activities.

1.2 Project Description

Portage Cove Harbor is the only protected harbor servicing Haines, Alaska. User growth over the years has made congestion an issue. Navigation improvements within the harbor need consideration for larger commercial-size vessels due to the harbor's constrained size and shallow basin depth. Protection of the harbor from excessive wave action should be addressed as Portage Cove is exposed to broad, open marine waters of Lynn Canal that can funnel storm-generated waves into the harbor entrance with detrimental effects to harbor infrastructure and moored vessels. Other issues include improving upland access to and from moored vessels and expanding available loading, parking, and trailer storage space.

The Haines Borough is currently in the planning and design stages of implementing a phased approach for improvements to the Harbor with the following primary objectives:

- Expansion in moorage capacity with improved navigation for large vessels.
- Improved protection from excessive wave action.
- Enlarging the upland boat launch parking areas and waterfront accessibility.

Planned improvements, as part of the current SPCHE Master Plan, include the following:

- Installation of an approximate 700-foot-long permeable wave barrier.
- Harbor entrance and inner harbor basin dredging to bring the basin elevation to −15 feet mean lower low water (MLLW) datum; in the vicinity of existing Float A the basin will be dredged to −12 feet MLLW.
- Partial demolition of the transient float.
- Relocation of the existing sewer outfall line to allow for dredging and waver barrier construction.
- Installation of a 50-foot x 180-foot vehicle-accessible float with associated transfer bridge, moorage piles, hydraulic crane, and utilities.

- Installation of new moorage floats.
- Construction of a two-lane boat launch ramp with boarding floats.
- Expansion of the upland parking area that includes a rough graded parking area to allow upland disposal of portion of the dredge spoils.
- Construction of a sheet pile bulkhead and loading dock.

The planned improvements are shown on the Site Plans in Appendix A.

One of the principle objectives for the harbor expansion is to provide improved wave protection at the harbor entrance. Three alternatives for harbor protection have been considered over the conception of the project, namely:

- Rubble-Mound Breakwater;
- Partially Penetrating Wave Barrier (steel piling); and
- Floating Breakwater (wave attenuator).

The initial subsurface investigation in 2012 identified a soft to very soft compressible clay layer that both thickens and slopes steeply offshore in the immediate vicinity of the proposed breakwater extension alignment. Geotechnical engineering analyses to evaluate construction of a rubble-mound breakwater on top of the clay soil was completed and summarized in previous reports (PND 2013a, PND 2013b). PND's previous evaluations concluded that a rubble-mound breakwater if constructed would require staged construction and/or installation of wick drains to prevent generation of destabilizing excess porewater pressures. Excerpts from the draft geotechnical engineering report (PND 2013a) related to the analysis of the rubble-mound breakwater alternative which are not included in this final report are included in Appendix G.

A comprehensive alternatives analysis study which weighed the economic, constructability, and performance considerations for the various harbor protection schemes (PND 2013b) was prepared for Haines Borough. A series of harbor improvement concepts were developed and presented to the public, Harbor Board and the Haines Assembly to determine a preferred option for advancing the construction of the harbor improvements. The Haines Borough Assembly ultimately selected a preferred option that includes construction of a steel permeable wave barrier.

Following the Borough's option selection, additional boreholes were drilled and sampled in September 2014 to refine the interpreted subsurface site conditions for the final design and planning. The September 2014 drilling program included additional boreholes for the design of the wave barrier piles, a soil sampling program to characterize the proposed dredge material in the vicinity of the harbor entrance and inner harbor dredging areas, and upland infrastructure improvements. The dredge characterization portion of the investigation included chemical analytical laboratory testing to determine the suitability for offshore disposal of dredge material and the results of that study are summarized in a separate report (PND 2015).

1.3 Related Studies

Preparation of this geotechnical report included a review of information obtained from previous projects in the Portage Cove Harbor vicinity. The documents reviewed include geotechnical reports, exploration logs, geologic maps, and related geotechnical information, including:

- Report titled, *"Geotechnical Findings Report – Haines Small Boat Harbor, Haines, Alaska,"* prepared by the US Army Corps of Engineers Alaska District (USACE-AD) Soils and Geology Section, November 2005.
- Draft Report titled, "*South Portage Cove Harbor Expansion, Reconnaissance Geotechnical Investigation*," prepared by PND Engineers, Inc., for The Haines Borough, July 2010.
- Exploration Logs for, "*Haines Small Boat Harbor, Haines, Alaska,*" prepared by the USACE-AD, Soils and Geology Section, September 2004.
- Pile Driving Logs, Haines Boat and Harbor Facilities, Alaska Department of Public Works, April 1967.
- Pile Driving Logs, Haines Harbor Facilities, Department of Transportation, Division of Harbor Design and Construction, March-April 1978.

- Pile Driving Logs, Haines Harbor Facility Phase II, Alaska Department of Transportation and Public Facilities, April 1979.
- Pile Driving Records, Port Chilkoot Dock, April and May 1995.
- Pile Driving Records, Portage Cove Harbor Moorage Float, PND Engineers, Inc., July-September 2009.
- Acoustic Sub-bottom Survey, Chilkook Dock Site, Geo-Recon International, Ltd., November 27, 1993.

A synopsis of the information gathered as part of this investigation is provided below:

USACE-AD initially performed a reconnaissance study and geotechnical exploration program within the Haines Small Boat Harbor (Portage Cove Harbor) in September 2000 that consisted of the excavation of 14 test pits. The findings of the program were provided in a Geotechnical Report dated March 2001. A subsequent subsurface investigation performed by USACE-AD consisted of a total of 19 test borings conducted immediately north of the existing harbor, and the results were presented in a report dated November 2005. The investigation results reported thick and extensive soft clay deposits north of the harbor.

A subsequent limited reconnaissance geotechnical field investigation was completed by PND for the Haines Borough in July 2010 to support conceptual planning for the expansion of the existing South Portage Cove Harbor and to confirm whether or not soil types and consistency identified during the USACE-AD study were present and to what extent within the proposed harbor expansion limits. This study was performed south of the existing harbor within the intertidal shoreline vicinity of the planned dredge basin limits which, at the time of the study, was planned to a dredged elevation of –15 feet MLLW. The exploration program included ten excavated test pits extending to depths up to 20 feet deep. The excavations revealed the relative absence of the extensive clay deposits previously found north of the harbor, with the exception that in two of the excavations an approximately 2 to 3-foot clay layer was observed near the ground surface. Typical soils prevalent to this investigation site were gravelly sands with subordinate amounts of silts and clays; the soils would be classified as glacially deposited diamicton. The diamicton consisted of a light bluish-gray colored, dry to moist, dense to very dense soils with some cohesion. Coarse-grained soils were well cemented within a compact matrix of finer grained sands, silts, and clays. The coarser-grain soils consisted of sub-rounded gravels to 3-inch-diameter, with numerous sub-rounded cobbles and occasional sub-angular boulders to 4 feet in diameter. The grain size appeared to grade to coarser material in the test pits. The excavated compact soils would commonly break into cobble to boulder-size clumps.

Geophysical acoustic sub-bottom survey interpreted dense soil or a potential bedrock horizon at or below an elevation of approximately −150 feet MLLW completed near the south end of the proposed wave barrier; however, the findings were inconclusive and the 1993 report by Geo-Recon also interpreted that bedrock horizon may be as deep as 300 to 500 feet below the mudline.

A review of the pile driving logs for piles driven nearby the project site are generally consistent with the subsurface geotechnical information for the site where there is generally a surficial granular layer over soft clay over denser granular soils. The pile records do not indicate that piles have been driven significant depth into the denser granular soils beneath the soft clay layer.

The locations of previous geotechnical explorations (boreholes and test pits) pertinent to this investigation are shown on the site plans in Appendix A and the exploration logs are included in Appendix D, along with the approximate locations of three geophysical acoustic sub-bottom survey profiles that were completed near the proposed breakwater alignment.

Both the synopsis of information contained in this report and the complete reports on file at PND may be used to interpret site conditions in support of construction, and copies of these documents may be made available to potential Contractors upon request; however, the Engineer and Owner make no warranty either expressed or implied regarding the accuracy of geotechnical background information presented in this report or related to the original data. Contractors should use this information at their own risk and, if necessary, perform their own independent field geotechnical assessment.

2 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 Field Investigation

The geotechnical investigation was completed in two phases. The first drilling program being completed in October of 2012 and the second drilling program was completed in September of 2014.

The initial 2012 geotechnical field investigation was originally planned to consist of drilling 12 boreholes and a series of in-situ, vane shear test holes; however, due to both adverse weather and challenging subsurface drilling conditions encountered, the program was modified in the field in coordination with the Haines Borough. The vane shear testing was eliminated; one boring was eliminated and one additional boring added; and the depths of several borings were extended based on soil density/consistency and soil types encountered. The modified exploration program ultimately consisted of drilling 12 boreholes, BH-2 through BH-13, advanced to depths ranging between 61½ and 131½ feet below the existing mudline. Note BH-1 was eliminated as discussed above.

The 2014 geotechnical field investigation was planned to consist of drilling three offshore boreholes along the proposed wave barrier alignment and a series of 14 intertidal and upland boreholes oriented within the proposed harbor dredge areas. The second phase investigation ultimately consisted of drilling boreholes, B-1 through B-17, to depths ranging between 7 and 110 feet below the existing mudline. Note B-15 was eliminated due to time constraints related to adverse drilling and weather conditions.

The boreholes were completed using a drill rig staged over the water from a landing craft using drilling equipment owned and operated by Denali Drilling, Inc. of Anchorage, Alaska. The landing craft was provided by Poundstone Freight, LLC based out of Auke Bay, Alaska. A geologist and geotechnical engineer from PND logged the boreholes and managed the exploration program. The locations of boreholes completed for this project are shown on the Site Plans in Appendix A. A photo log of the field investigation is included as Appendix F of this report. Details of the field investigation program are described in the following sections.

2.1.1 Drilling Equipment

Figure 2-1. CME-850 Drill Rig

The drilling equipment included: a CME-850 track-mounted drill rig (Figure 2-1) and a truck-mounted Mobile B-61 drill rig; pump for circulating drilling fluids; 3½- and 4-inch flush coupled casing; 2 ⅝-inch-outside-diameter (O.D.) "NWJ" drill rods in 5-foot lengths; 3 ⅞-inch-diameter tricone bit; 1.4-inch-inside-diameter (I.D.) standard split-spoon sampler; and a 2.4-inch I.D. oversized split-spoon sampler. Automatic 140-lb and 340-lb hammers were used to advance the respective samplers into the soil. Bentonite, a drilling fluid additive, was available and utilized in the second investigation.

Diamond drill core equipment available in the event bedrock was encountered during the sampling program, or to spot core locations where refusal conditions were encountered included: Wireline NQ-size drill rods in 5-foot lengths, overshot, triple tube swivel type core barrel and diamond drill bit.

2.1.2 Drilling and Sampling Methods/Procedures

The borehole locations were determined using a combination of handheld GPS and swing ties using a Bushnell Laser and known surveyed locations throughout the harbor. Prior to the start of the investigation, the GPS and laser were checked for accuracy against survey monuments in the vicinity of the harbor and found to have horizontal accuracies of ± 10 feet and ±3 feet, respectively. Tide boards were intended to be used for determining the mudline elevations at the borehole collars; however, the placement of the tideboards proved problematic. Instead, tide charts and datums provided by NOAA for Station No. 9452400 and lead line measurements were used for estimating elevations of soil samples and subsurface observations made during drilling.

The boreholes were continuously monitored by PND personnel who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions, and prepared a detailed log of each borehole. Each soil sample obtained was visually classified in the field using a system based on the Unified Soil Classification System (USCS) and ASTM classification methods per ASTM D 2488, occasionally photographed, and sealed, labeled for transport to a laboratory for further examination and testing.

The boreholes were completed using rotary wash drilling techniques and cased with 3½ or 4-inch-diameter casing. The advanced casing was subsequently cleared of soil and rock material down to the sampling depth, utilizing the combination of circulating water and/or drilling mud and a tricone bit. Only water was used as the drilling fluid during the 2012 drilling and heaving sand and gravels and occasional artesian flow at depth obstructed and ultimately prevented the further advancement of the offshore boreholes. Bentonite, a clay drilling fluid additive, was used to control the heave and artesian conditions during the 2014 drilling. Soil cuttings from drilling were flushed with circulating water/mud, and inspected regularly using a sieve to collect and observe the material returned as part of the flushing process.

The soils encountered in the boreholes were typically sampled at 5-foot vertical intervals. Relatively undisturbed samples were obtained in the borings by smoothly advancing (pushing) a 3-inch-diameter, 2.5-foot-long seamless steel Shelby Tube into the soil. Disturbed soil samples were obtained with a 1.4-inch-I.D. split-barrel sampler with a 140-lb. automatic hammer free-falling 30 inches, commonly referred to as the Standard Penetration Test (SPT). Alternatively, a 2.5-inch-I.D. oversized split-barrel sampler driven with a 340-lb. automatic free-falling 30 inches was used to sample gravelly soils. The number of blows required for each 6 inches of penetration of the sampler was recorded in the field. This recorded number of blows provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the sampler, the penetration resistance for the partial penetration was entered on the logs.

Figure 2-2. H-60 Vane Shear Apparatus

Select cohesive soil samples were manually tested in the field to estimate undrained shear strength using Geonor H-60 Hand-Held Vane Tester (Figure 2-2) and/or a pocket penetrometer. The H-60 apparatus includes a handle with a spring scale-ring that records "pressure" required to cause a shear failure in the soil using a vane when twisted in a circular direction. Several different-sized vanes and extension rods are used depending on the location tested and the shear strength of the soil. The H-60 is capable of determining undrained shear strength for a range from 0 to 200 kilopascals (kPa) with an accuracy within ±10% of the measured reading. The test locations and measurements are recorded on the borehole logs in Appendix C.

The boring logs, shown in Appendix C, depict our interpretation of the field assessment, field visual classification, and laboratory data, and indicate the various types of soils and groundwater conditions encountered. The logs also indicate the depths at which these soils or their characteristics change, although the change may actually be gradual. If the change occurred between samples, it was interpreted. The soil consistencies noted on the boring logs are based on the blow count data obtained in the borings and judgment based on the conditions encountered.

Note that the blow count values shown on the borehole logs are uncorrected "field" blow counts. No attempt has been made to adjust the blow counts for overburden thickness or for various combinations of sampler and hammer weights. Standard Penetration Tests (SPTs) are based on a 140-lb. hammer, 1.4-inch I.D. split-spoon sampler driven with a 30-inch drop of the automatic hammer. Correction for drill rod length, type of hammer, efficiency, and other variables are not shown on the logs. These factors should be considered in the design, as appropriate.

2.2 Laboratory Testing

Soil samples obtained from the boreholes were transported to Anchorage, Alaska, for further examination and testing. Laboratory tests to evaluate the soil index properties of representative samples were performed by PND's Anchorage laboratory. The laboratory program consisted of tests for the determination of moisture content, plasticity characteristics (Atterberg limits), and grain-size distribution (sieve analysis). Laboratory tests to determine the compressibility (one-dimensional consolidation) and shear-strength parameters (triaxial shear) of representative soil samples were performed by DOWL HKM's Alaska Test Lab based in Anchorage, Alaska.

The laboratory tests were performed in general accordance with the test methods of ASTM International or other applicable procedures. A description of the laboratory testing procedures is presented in the following sections. The laboratory testing results are presented in Appendix E.

2.2.1 Soil Classification

ASTM D 2487 was used to classify the soil samples per the Uniform Soil Classification System (USCS) based on the laboratory testing results and to modify visual classifications as appropriate.

2.2.2 Moisture Content Testing

Moisture content tests were completed in general accordance with ASTM D 2216 for representative samples obtained from the boreholes. The results of these tests are presented on the Borehole Logs in Appendix C at the respective sample depths and elevations shown.

2.2.3 Percent Passing U.S. No. 200 Sieve and Limited Mechanical Analysis (LMA)

Selected samples were "washed" through the U.S. No. 200 mesh sieve to determine the relative percentages of coarse- and fine-grained particles in the soil. Additionally, the coarse fraction of the soil was sieved through the U.S. #4 mesh sieve to determine the percentage by weight of sand and gravel in the soil. These tests were used to verify field descriptions and to determine the fines content of the soil for analysis purposes. The determination of the percent passing the U.S. No. 200 sieve was conducted in general accordance with ASTM D 1140.

2.2.4 Sieve Analysis

Sieve analyses were performed on selected samples in general accordance with ASTM D 422. The wet sieve analysis method was used to determine the percentage of soil retained on the U.S. No. 200 mesh sieve. The results of the sieve analyses were plotted and then classified in general accordance with the USCS.

2.2.5 Atterberg Limits Testing

Atterberg Limits testing was performed on selected soil samples. The tests were used to classify the soil as well as to evaluate index properties. The liquid limit and plastic limit were estimated through a procedure performed in general accordance with ASTM D 4318.

2.2.6 One Dimensional Consolidation Testing

One-dimensional consolidation testing was performed to determine the settlement potential of selected, relatively undisturbed, thin-walled tube (Shelby Tube) samples obtained from the boreholes in accordance with ASTM D 2435. The consolidation test determines the magnitude and rate of consolidation of soil restrained laterally and drained axially while subjected to incrementally applied controlled-stress loading. Table 2-1 summarizes the results of the consolidation testing.

Table 2-1. Summary of Consolidation Test Results.

Borehole	Sample No.	Depth (feet)	Soil	*w* (%)	LL (%)	Modified Compression Index C_{ce}	Modified Recompression Index C_{re}
BH-4	3	15 to 18	CL	23	29	0.08	0.004
BH-4	7	35 to 38	CL	30	32	0.10	0.025
BH-5	4	20 to 23	CL	23	30	0.12	0.010
BH-7	3	15 to 18	CL	23	29	0.13	0.012
BH-7	7	35 to 38	CL	36	33	0.12	0.016
BH-8	6	30 to 33	CL	31	29	0.11	0.030
BH-10	7	30 to 33	CL	27	31	0.10	0.022
			Average	**28**	**30**	**0.11**	**0.017**
			COV [1]	18%	5%	15%	54%

Note: [1] The coefficient of variation is defined as: COV = Std. Dev./Mean. The COV provides a relative sense of the magnitude of variability of a data set. It is a dimensionless measure of the variability of the observations relative to the size of the measurements. A lower percentage indicates a lower variability in the data set.

2.2.7 Unconfined Compression Strength Testing

Unconfined Compression Strength (UCS) tests were performed on relatively undisturbed Shelby Tube samples obtained from the boreholes in accordance with ASTM D 2166. This is used to approximate the undrained shear strength of the soil by applying strained-controlled axial load to the specimen until failure.

2.2.8 CU Triaxial Shear Testing

Consolidated undrained (CU) triaxial tests were performed on relatively undisturbed Shelby Tube samples obtained from the boreholes. The tested samples were prepared in general accordance with ASTM D 4767 using the "wet method" for specimen saturation. The CU triaxial test is accomplished by first allowing the saturated soil specimen to consolidate under a confining pressure and then subjecting it to an axial load applied at a constant strain rate in an undrained state. Saturation is achieved by the application of back pressure, which draws pore air into solution and is checked by means of measuring Skempton's pore pressure coefficient "B" (B-value). The undrained state is achieved by closing the drainage lines, which allow consolidation prior to the application of axial load. Because the axial load is applied in the undrained state, volume change of the sample is not permitted during loading, resulting in the development of pore-pressure changes in compensation for the sample attempting to contract or dilate. Effective confining pressures are typically selected to cover the range of effective stress dictated by the in-situ stress state and future stress state (design) to develop shear strength parameters that are applicable to the anticipated loading. Axial load, strain, and pore pressure are recorded during the test. The recorded data was used to develop Mohr-Coulomb failure envelopes for both total stresses and effective stresses.

3 REGIONAL SETTING AND SITE CONDITIONS

3.1 Setting

Figure 3-1. View of Portage Cove and Haines, Alaska. Existing Breakwater in Foreground

The physiography of the Haines region is one of rugged topography with elevations ranging from sea level to peak elevations of over 7,000 feet. Portage Cove lies at the northeastern side of the Deshu Isthmus at the northern end of the Chilkat Peninsula within the Haines Borough, Alaska (Latitude 59°14'38"N, Longitude 135°30'34"W), (Figure 3-1). The Chilkat Peninsula projects southeastward from the mainland Takshanuk Mountains into Lynn Canal. The peninsula separates the marine waters of Chilkat Inlet to the northwest from the Lutak and Chilkoot Inlets to the north and northeast, respectively. Both the Chilkat and Chilkoot Inlets merge to the south with Lynn Canal, a deep, major navigable body of water providing large vessels passageway to the surrounding southeast Alaska Panhandle. Portage Cove has broad open-water exposure to Taiya Inlet to the north and Chilkoot Inlet and Lynn Canal to the south. The project site is shown relative to the surrounding physical features on the Vicinity Location Map, Sheet 1, included in Appendix A.

3.2 Climate

The Haines region experiences a relatively milder, continental-type climate as compared to the typical temperate rainforest/maritime climate conditions experienced in the surrounding southeast Alaska Panhandle.

The average monthly temperatures recorded in Haines range from 24° to 58°F, with a mean annual temperature of 40°F. Daily extreme temperatures have been recorded from -12° to 88°F. Annual precipitation averages about 63 inches, which includes approximately 172 inches of snow. Note: Data is from the Western Regional Climate Center, year 2000 to 2011, recorded at the Haines #2 Station (503502).

3.3 Tidal Ranges

Due to its broad, open marine-water exposure, Portage Cove is especially susceptible to storm surges when strong winds occur concurrently with extreme high tides. Lynn Canal, with its characteristic steep and narrow passageway and long fetch, can funnel strong southeast storm winds into Chilkoot Inlet and Portage Cove that can occur in the late summer, fall, and winter months.

The tides in Lynn Canal are semidiurnal with Diurnal Range (difference in height between mean higher high water and mean lower low water) of 16.7 feet and a Mean Range (difference in height between mean high water and mean low water) of around 14.1 feet. Tidal information for Skagway, Alaska, approximately 15.5 miles north-northeast up the Taiya Inlet from Portage Cove, was obtained from the National Oceanic and Atmospheric Administration (NOAA). NOAA's National Ocean Service Benchmark Data sheets, Station No. 9452400, report the following tidal information (Analysis Period: 01/01/2002 - 12/31/2006). This data is presented in Table 3-1:

Table 3-1. Tide and Water Levels.

Tidal Datum	Elevation, Feet
Highest Observed Water Level (10/22/1945)	26.1
Extreme High Water (EHW)[1]	22.5
High Tide Line (HTL)[1]	21.2
Mean Higher High Water (MHHW)	16.7
Mean High Water (MHW)	15.7
Mean Low Water (MLW)	1.6
Mean Low Lower Water (MLLW)	0
Lowest Observed Water Level (12/14/2008)	-6.8

Note: [1]From USACE

3.4 Regional Geology

The region's expansive present-day geomorphic features and extensive sediment deposits record a relatively brief, recent period in the geologic history of the region dominated predominately by Quaternary-age glacial processes. Preserved in broad braided flood plains, intermontane alluvial fans, intertidal deltas, and marine basins are substantial amounts and types of glacially derived sediment, including boulders scattered throughout the region and extensive thick deposits of glacial outwash.

3.4.1 Surficial Deposits

The surficial soils found in the vicinity of Haines are generally glacially derived sediments and include glacial erratics, glaciomarine diamicton, and outwash deposits.

Glacial erratics, cobble- to boulder-sized rock, were rafted aboard the glaciers and deposited throughout the surrounding Haines drainage valleys, upland marine shorelines, and lower intertidal beach areas and marine sediment floors; glacial erratics are known to reach enormous sizes (Figure 3-2).

Figure 3-2. Boulder-Strewn Intertidal Bench

Glaciomarine diamicton deposits, typically massive and compact to dense, are comprised of coarse-grained sands and gravels up to cobble and boulder-sized rock, supported within a finer-grained, cemented matrix of primarily cohesive silt, clay, and sand. Abundant broken and unbroken marine fossils may be present in diamicton deposits.

Other glacial sediments in the area include outwash deposits shed from the outlying river valley drainages, consisting of varying proportions of boulders, cobbles, gravels, sands, silts, and clays.

3.4.2 Glaciers

Field studies performed in locations along the North Pacific in North America, including southeast Alaska, record evidence of an extensive Pleistocene-aged mass of glacial ice, The Cordilleran Ice Sheet, spanning from Kodiak, Alaska, along the coastal mountains into Southeast Alaska and British Colombia, and further into northern Washington and northwestern Montana (Heusser 1960). The ice sheet coalesced with Pacific Coastal Mountain alpine and valley glaciers, forming continuous ice coverage up to 4,000 to 5,000 feet thick (Booth et al. 2004). The immense volumes and lateral extent of the glacial ice both scoured and deposited various forms of sediment throughout the region (Lemke and Yehle 1972). Cyclical advancements and retreats of the glacial ice mass spilled out onto the outer continental shelf. Elongate basins and their tributaries were scoured that over-steepened the valley walls and created conditions for large-scale, massive rockslides. Near tidewater locations, landslide-induced waves would have produced significant wave heights that impacted the region's shorelines; the same conditions exist presently in the surrounding coastal regions of Haines and Skagway. Lituya Bay, in southeast Alaska, is probably the most infamous occurrence with wave heights up to 1,720 feet.

Valley glaciers loaded with sediment in the upland basins extended to tidewater. Icebergs calved from these tidewater glaciers and rafted sediment away from the glacier's terminus to where eventually the icebergs melted, and the rafted sediments deposited in scattered, localized zones in the region's bays and along the shorelines.

Glacier-dammed lakes of various sizes would have been present in the region. Valley glaciers within the Chilkat or Chilkoot River basins blocked off ice-free side tributaries with their characteristic narrow and deep bedrock valley walls. The ice-impounded lakes were subject to repeated failure, with rapid drainage that resulted in catastrophic flooding. The glacial outburst flooding scoured the surrounding basins and transported massive sediment loads, depositing thick horizons of outwash, and blanketing the valley bottoms to the major inlets and outlying marine basins. These megaflood events – *jokulhlaups* – have occurred extensively throughout Alaska, and are known to have been commonly associated with Pleistocene-age glacial events around the world (Baker, 2002). One extreme example of a glacial-induced megaflood was the Missoula Flood located in the northwestern region of Montana. 2,500 km^3 (3.25 x 10^{12} cubic yards) of water was impounded to 600 meters (2,000 feet) in depth, behind a lobe of the Cordilleran Ice Sheet forming Glacial Lake Missoula. Episodic failure of the dam produced high-energy flood waters that eroded eastern Washington State. The floods possessed immense power with extensive bedrock erosion and extraordinary sediment loads deposited in the form of graded beds 100 to 160 meters (300 to 500 feet) in height located in continental shelf submarine rift valleys located 1000 km (600 miles) offshore from the mouth of the Columbia River. Locations in southeast Alaska where jokulhlaups either have occurred or regularly occur today include near the Mendenhall Glacier in Juneau, at the Hubbard Glacier in Russell Fiord, the Endicott River in Glacier Bay, and the Salmon Glacier near Hyder (located 75 miles from Ketchikan at the head of Portland Canal, a 70-mile-long fiord at the United States/Canada border). The large, elongated boulders scattered along the drainage at the mouth of Chilkoot Lake in Haines may have been flood deposited as evidenced by their long axis positioned perpendicular to the flow of the drainage basin (Figure 3-3).

Figure 3-3. Large Boulders – Possibly Flood Deposited – Lying in a Drainage at the Mouth of Chilkoot Lake

A phenomenon known as *glacial isostatic rebound,* where the land surface either rises or lowers relative to sea level, resulted from past glaciations and is presently occurring in the Haines region. The glacier's immense weight resulted in a redistribution of mass of the earth's crust. Where the ice was thickest, the crust depressed under the weight of the ice while along the margins with little ice mass the crust rose, creating a "forebulge". These events caused complex adjustments to the regional bedrock and localized variations in mean sea level affecting the southeast Alaska shorelines. With the retreat and melting of the glaciers, the newly released mass allowed the reverse to occur, where the crust forebulge lowered and the depressed crust rebounded. It manifests in recent land emergence in the form of raised marine terraces, raised beach and intertidal delta deposits, and wave-cut benches common throughout the entire region. The published current regional uplift rate for Haines is approximately 0.9 inches per year (Freymueller et al. 2008), (Figure 3-4). Most of Haines is located on these uplifted sediments resulting in substantial cohesive silt and clay in the upland areas.

Figure 3-4. Glacial Isostatic Rebound Results in Emergent Intertidal Delta Entering Chilkat Inlet. McClellan Flats is seen in the lower right.

3.4.3 Bedrock

Regional bedrock in the Haines area is structurally controlled by prehistoric and complex low-angle thrust faulting, and northwest-southeast-trending high-angle strike slip faulting. The faulting events juxtapositioned regional assemblages of crustal blocks of differing geologic affinities, termed *terranes or belts*; the blocks range from less than a square mile to thousands of square miles in extent. The lineal, narrow, and deep fiords such as Taiya, Chilkoot, and Chilkat Inlets, and the Chilkoot and Chilkat river basins reflect the faulted, crustal block positioning. The terranes or belts are intruded by younger-age, quartz-rich, crystalline igneous rocks that form plutonic belts and tabular dike swarms such as the Mount Kashagnak pluton exposed northwest of Haines and the Lutak Inlet Pluton exposed along the Lutak inlet shoreline (Gehrels, 2000). The crystalline igneous bodies form much of the mainland coastal mountainous terrane observed eastward across Chilkoot Inlet and Upper Lynn Canal. The dike swarms possess a predominant northwesterly trend. The quartz-rich igneous bodies are the source areas for the glacial erratics observed scattered about the Haines region.

Basalt flows, considered part of the Triassic-age Wrangellia Terrane (Gehrels 2000), form the Takshanuk Mountains, a northwest-southeast-trending spine of rock and the Chilkat Peninsula that protrudes into Lynn Canal. The rock is composed of massive to bedded, pillowed basalt flows and capped by thin sequences of limestone and chert. The basalt rocks are overlain by clastic and mud-rich rock of the Gravina Belt. Chlorite-rich rock of the Wrangellia Terrane and Gravina Belt are the source areas for the silt and clay deposits in the Chilkat River Valley and submarine basins at the mouth of Chilkat Inlet and Portage Cove. After periods of heavy rainfalls, large plumes of silt and clay-laden water are visible emanating from the head of the inlet.

Low grade metamorphism was imparted to the bedded volcanic rocks of the Chilkat Peninsula. Regional structural geologic mapping in the area has recorded, preserved within the bedded rocks, open and gently plunging folds with wave lengths of several hundred meters to several kilometers. The fold axes trend northwesterly and are thought to be correlated across the Chilkoot Inlet (Gehrels 2000).

3.5 Seismicity

Portage Cove, as with all sites in Southeast Alaska, is in a seismically active area. A plot of the historic seismicity of the Southeast Alaska Panhandle is shown on Figure 3-5.

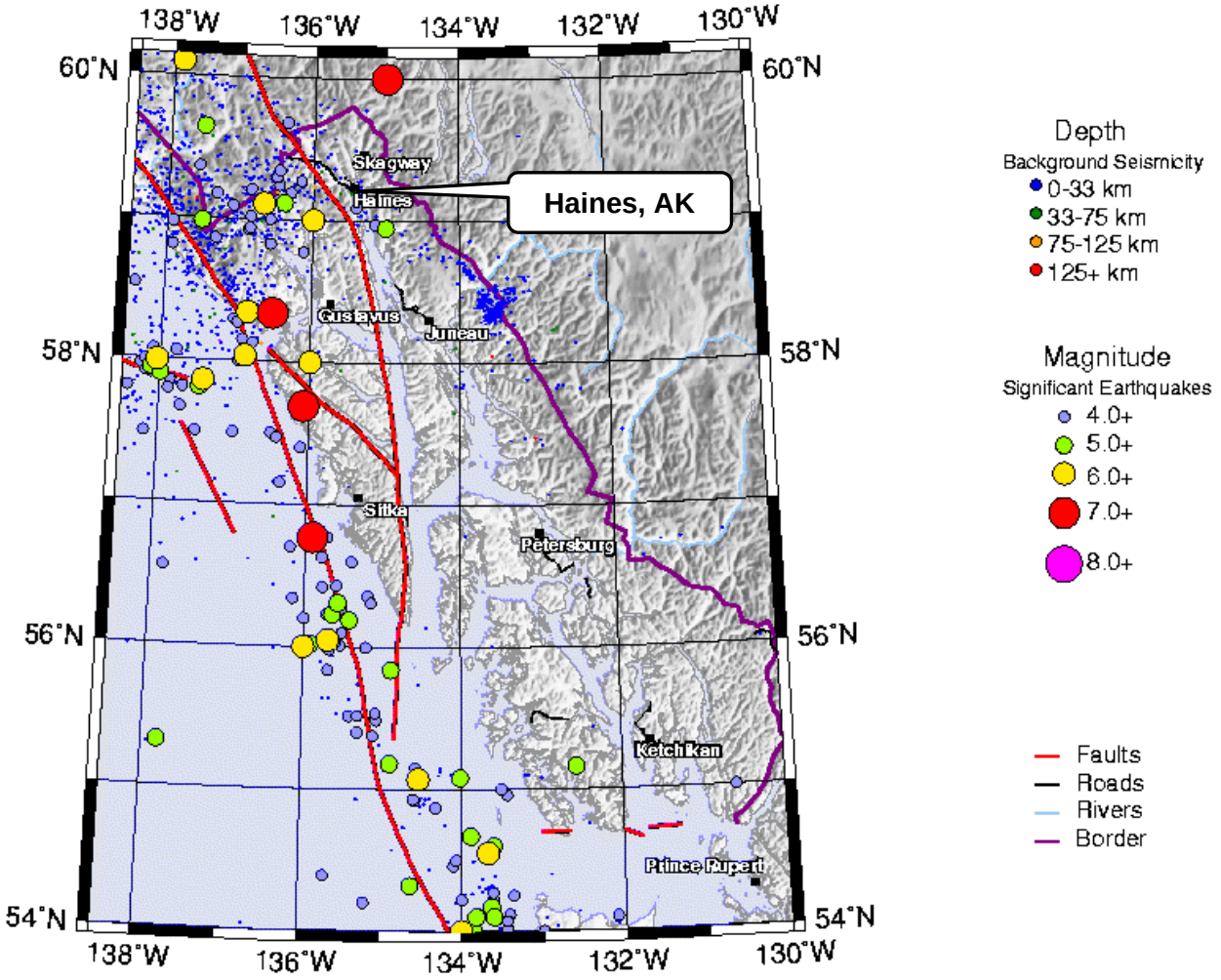

Figure 3-5. Map Showing the Historic Seismicity Within the Southeast Alaska Panhandle

Seismicity displayed is from 1899 to 12/2004 (from Alaska Earthquake Information Center).

The nearest and most active fault systems in the region are the Denali Fault and the Fairweather-Queen Charlotte fault system. The Denali Fault is located approximately 5 miles southwest at its nearest proximity to the project area. The southeast portion of the Denali Fault is thought to be capable of producing an earthquake with a moment magnitude (Mw) of 7.9 (Wesson et al.2007) with a recurrence interval on the order of between 1,000 and 4,500 years (DeMets and Dixon 1999; Fletcher and Freymueller 2003). The nearest trace of the Fairweather-Queen Charlotte fault system, the Fairweather Onshore Fault, is located approximately 75 miles southwest of the project site. The Fairweather Onshore Fault is estimated to be capable of generating earthquakes up to 8.0 Mw in size with a recurrence interval of 150 years (Wesson et al, 2007). There have been at least 8 earthquakes of magnitude 6 or greater over the past 40 years along the Fairweather-Queen Charlotte, including the January 5, 2013 Mw 7.5 earthquake that occurred offshore with an epicenter approximately 60 miles west of Craig, Alaska.

3.6 Geologic Hazards

Both the seismic setting and steep terrain of the region contribute to the geologic hazards for Haines and the surrounding area. The primary hazards associated with seismic events in the region are strong ground shaking and earthquake-induced slope failure. The potential exists in the Haines region for both land-based and submarine landslides caused by earthquake-induced ground shaking or other triggering events. Subsequent to ground shaking or landsliding, large damaging waves generated, either directly from fault displacement (tsunamis) or due to earthquake-induced landslides (seiches), are not uncommon to the region.

In Southeastern Alaska, hazards tied with seismic activity are generally greatest in areas adjacent to the Gulf of Alaska coastline and decrease to the northeast. These hazards are generally expected to be more likely associated with displacements along the more active Fairweather-Queen Charlotte fault system and, to a lesser extent, the less-active Denali Fault. Notwithstanding, some potential for major ground shaking exists anywhere in the region, and strong ground shaking may result in damage to facilities. Furthermore, earthquake-induced slope failures are most likely to occur in water-saturated sediments and in unstable rock debris on steep slopes.

The potential for tsunami (seismic sea waves) generation and propagation up Lynn Canal to the vicinity of Portage Cove is expected to be low because the vertical offsets of the Fairweather-Queen Charlotte fault system and Denali Fault are minor compared to the horizontal displacements (Combellick and Long 1983). In other words, because these faults are strike-slip, their displacements are characteristically parallel with the fault and not in the up-down direction that causes tsunamis.

3.7 Existing Site Conditions

Portage Cove Harbor is situated southeast of the intersection of Main Street, terminating into Front Street in Haines, Alaska. The general site location and configuration is shown on the Vicinity Map and Site Plans in Appendix A.

The harbor is fronted by Front Street to the west, which serves as the main upland access to the harbor. Adjacent to the harbor are two parking areas: one with an asphalt-paved surface along Front Street and a second south of the harbor surfaced with gravel. The harbor is presently protected from northern and eastern exposure by a rubble-mound breakwater with a crest elevation of approximately +25 feet MLLW. A transient float that performs as a floating breakwater provides some protection from southern exposure. Moorage within the harbor consists of a newly reconfigured main float system and a transient float. Upland access from the main float system is by an aluminum gangway adjacent the paved parking area. Upland access to the transient float is by a gangway adjacent the gravel parking area.

The existing harbor facilities include:

- Harbormaster office located adjacent the paved parking area.
- Boat Launch Ramp located north of the Harbormaster office.
- Ice Plant located on the gravel parking lot near the transient float.
- Floatplane Dock located on the transient float.
- Fueling Facility accessed by the transient float.
- Net Repair Float adjacent Float A – has no shore bound access and goes dry at low tide levels.
- Timber Boat Repair Grid adjacent Float A.

The ground surface along the parking areas is gently sloping from an approximate elevation +34 feet MLLW at the paved parking area to about +27 feet MLLW at the graveled parking area. To the east of the gravel parking area the topography descends to a broad, nearly flat, intertidal bench that parallels the shoreline at an average elevation of about +15 feet MLLW. The bench is strewn with large, cobble to boulder-sized rocks, see Figure 3-2. Ponded water forms in this area at lower tide levels. The concentration of visible large cobbles and boulders on the beach surface noticeably diminishes offshore to where the marine sediment surface consists predominantly of sand, approximately at elevation 0 feet MLLW.

The basin depth at the harbor entrance is approximately −20 feet MLLW and rises within the harbor to depths varying from −12 to −15 feet MLLW. The basin depth along the transient float is variable, with the bathymetry ranging from about −8 to −15 feet MLLW along the northern edge and between about −7 to −10 feet MLLW along the southern edge. The submarine mudline from the harbor entrance is believed to drop relatively steeply offshore down to an elevation of approximately −50 feet MLLW, and transitions to a gentler slope further offshore.

The record drawings prepared by the USACE show the original design rubble-mound breakwater and the dredge slope geometry. The typical breakwater section was 1½H:1V side slopes with an 8-foot crest width. The dredge slopes were inclined no steeper than 2½H:1V with a minimum separation distance of 15 feet from the breakwater or jetty.

A detailed hydrographic survey, performed in April 2013 by David Evans and Associates, Inc., produced bathymetric contours to confirm the basin mudline profile and bathymetry in and around the harbor.

A 16-inch-diameter sewer outfall pipe extends from the harbor upland parking area to immediately south of the rubble-mound breakwater, and further offshore to a bottom elevation of −80 feet MLLW. This is depicted on the existing conditions of the site plan Sheet 2 in Appendix A. Prior to drilling, a diver swam the harbor basin bottom in an attempt to locate the pipe. The diver, however, observed the sewer pipe in the harbor vicinity to be completely buried with sediment, and the pipe location could not be verified. An attempt was made to follow the sewer pipe up from the offshore outfall. The sewer outfall consists of an 80-foot length of perforated diffuser pipe, installed at the terminus of the sewer outfall pipe. The diver located the outfall and estimated that approximately 60 feet of the 80-foot perforated pipe was buried with sediment.

3.8 Subsurface Conditions

Portage Cove is located within a geologically mapped area described as surficial sedimentary deposits and Triassic-age basalt rock (Gehrels and Berg 1992). Alluvium in the region generally consist of poorly consolidated and poorly sorted sand, gravel, and boulders derived from nearby glacial deposits forming the flat valley floors of most of the larger streams and rivers. The near surface soils encountered in the current study boreholes are generally consistent with the mapped geology.

Logs of subsurface conditions encountered in the current study boreholes are included in Appendix C. Borehole log standard details are shown on Figures C-1 through C-3, which provide a description of symbols used on the logs. Photographs of soil samples obtained are include in Appendix F and provide for visual reference of the sampled material. Generalized subsurface soil profiles developed based on the borehole logs are included in Appendix B, Sheets 4 through 10 of 10.

Results of the drilling investigation provide evidence of a complex record of sediment deposition in the Portage Cove area. The following general descriptions summarize subsurface conditions observed in the boreholes:

- A surficial layer of primarily poorly graded sand with a variable thickness. In several boreholes, this upper sandy layer was absent.
- Shoreward deposits of cohesionless (sand and/or gravel to cobble and boulder) sediments containing intermittent finer upward sequences and matrix-supported sediment lenses.
- A stratum of soft, cohesive soils (lean clay) sloping and thicker offshore and northward from the upper layer(s) of cohesionless soils.
- An underlying layer at depth consisting of alternating stratum of either compact, hard matrix-supported sediments, or cohesionless and poorly graded sand or gravel with subordinate amounts of silt.
- Bedrock was not encountered in the boreholes.

The near surface soils generally consist of recent alluvial deposits of loose, poorly-graded fine- to medium-grain sand, ranging from about 1 to 13 feet thick. Observation of the outfall sewer pipe being buried with sediment may suggest a submarine high-energy environment exists, with extensive littoral drift occurring in the harbor area.

Underlying the sand and shoreward were horizons of cohesionless sediment with the following characteristics:

- The cohesionless sediment was both observed and inferred to occur in intermittent horizons of cyclical, fining upward sequences suggestive of prograding delta beds. The horizons, when observed within the sampler, ranged in thickness from inches to feet. Where no sampling was performed, the intermittent smooth and grinding action of the drill steel suggested multiple intervals of fine- to coarse-grained sediment. Cobble- and boulder-sized material was inferred within the horizons, based on drilling characteristics.
- Intermittent lenses of bluish gray, matrix-supported sand and gravel indicative of glacially deposited diamicton were observed within the above sediment.

Grading and sloping offshore and northward from the cohesionless sediments were thick horizons of very soft to soft clay with the following characteristics:

- Greenish gray in color, moist to wet, low to medium plasticity, and slow to no dilatancy. The consistency of the sediment was generally cohesive, very soft to soft with localized firm to stiff intervals. The consistency of the sediment appeared to soften with depth. Occasional trace amounts of angular to sub-rounded gravel were encountered within the cohesive sediment.

Underlying both of the above horizons at depth were alternating stratum and varying in thickness of the following:

- Compact, hard matrix-supported sediments
- Dense to very dense, sand and/or gravel with subordinate amount of silt
- Hard silt lenses

Matrix-supported sediments exist similar to those previously described in the upper horizons. The cohesionless sediments typically are poorly graded with fine to medium grained gravels and very fine to fine grained sands. Difficult drilling conditions developed when advancing through the alternating strata. Adverse conditions encountered included impeded casing advance due to very dense granular sediment or very hard silt, heaving sands and fine gravels, and occasional artesian flow. In several boreholes, water was observed rising up the casing or drill steel (Figure 3-6). Borehole BH-7 had water arising from a depth of 65 feet with an estimated flow rate of 0.5 gallons per minute. The conditions at these locations were such that the drilling was unable to advance, with subsequent termination of the boreholes.

Figure 3-6. Artesian Water Flowing From Casing in Borehole

The above conditions typically begin within a localized zone, nearly flat to gently sloping offshore, at an approximate depth ranging from 65 to 80 feet below the mudline surface. In the second investigation, bentonite was added to the drilling fluids in an attempt to control the adverse conditions and maintain the borehole openings. The bentonite proved successful in maintaining the borehole opening; however the drill advancement rate remained slow and difficult. At the bottom of B-14, thin and alternating lenses of hard silt and very fine grained, dense sand overlay poorly graded gravel with sand. The drilling advancement rate was slow and due to time constraints, the borehole was terminated.

The conditions described above may be structurally controlled by bedrock, although bedrock was not encountered in the boreholes. The extent at depth of the conditions within the vicinity of the proposed wave barrier construction is unknown.

4 GEOTECHNICAL ANALYSIS AND DESIGN RECOMMENDATIONS

The following sections contain geotechnical analysis and design recommendations provided for the successful design, construction, and long-term performance of the project.

4.1 Pile Foundations

Pile foundations are planned to support the proposed Partially Penetrating Wave Barrier and for the marina infrastructure (docks, floats, dolphins, etc.).

Throughout the progression of the design, various steel pipe pile and pile tip configurations have been considered for the project. As currently envisioned, the partially penetrating wave barrier structure will consist of 32-foot on-center bearing pile clusters of 30-inch-diameter vertical and batter steel pipe piles, with the batter piles at a 1H:2V (horizontal to vertical) batter. These bearing piles may be fabricated with SPIN FIN® pile tips. The piles forming the partially penetrating barrier wall will be 24-inch diameter steel pipe piles and PS31 steel sheet piles. Steel pipe piles planned for the moorage float piles will be 12 and 16-inch-diameter and the piles for drive-down float will be 24-inch-diameter.

Pile design and construction recommendations are presented in the subsequent sections of this report.

4.1.1 Design Considerations

4.1.1.1 Lateral Capacity

Project piles will be exposed to wind, wave, and/or vessel lateral loading initially resisted structurally by the pile and then transferred to the surrounding soil. The interaction of the soil-pile system is complex because the soil reaction along the pile is a function of the pile deflection, while the deflection at any given point along the pile depends upon the soil resistance and the structural stiffness of the pile.

Lateral load capacities, pile deflection, shear stresses, and pile bending moments can be evaluated with computer software such as LPile. The *p-y* or "load-yield" analysis carried out by LPile evaluates the soil-pile system behavior as a non-linear material with a high initial modulus that reaches an ultimate resistance prior to soil yielding plastically. Recommended geotechnical parameters (i.e. effective unit weight, internal angle of friction, undrained shear strength, *p-y* models, *p-y* modulus, and strain factors) specific for each pile case for input into LPile software are presented in the following report sections.

4.1.1.2 Axial Capacity

Pile embedment depth estimates based on static analysis using the Allowable Stress Design (ASD) approach can be evaluated employing minimum factors of safety applied to the ultimate (unfactored) pile capacity for both compression and tension loading in accordance with the U.S. Army Corps of Engineers pile design methodology (USACE 1991 and 1998). Guideline factors of safety based on the USACE method for determining capacity and loading condition are presented in Table 4-1.

Table 4-1. Guideline Factor of Safety for Pile Capacity (after USACE 1991).

Method of Determining Capacity	Loading Condition [2]	Minimum Factor of Safety [3]	
		Compression	Tension
Theoretical or empirical prediction to be verified by static pile load test	Usual	2.0	2.0
	Unusual	1.5	1.5
	Extreme	1.15	1.15
Theoretical or empirical prediction to be verified by dynamic testing [1]	Usual	2.5	3.0
	Unusual	1.9	2.25
	Extreme	1.4	1.7
Theoretical or empirical prediction not verified by load test	Usual	3.0	3.0
	Unusual	2.25	2.25
	Extreme	1.7	1.7

Note: [1] Dynamic testing requires PDA/CAPWAP/Signal Matching/Restrike and should be completed on a minimum of 2 piles per unique site condition and at least 2 percent of production piles. Pile capacity is verified on remaining piles using a refined wave equation analysis calibrated to the PDA-CAPWAP results.

[2] Loading Conditions:

Usual – These conditions include normal operation and frequent flood conditions. Basic allowable stresses and safety factors should be used for this type of loading condition.

Unusual – Higher allowable stresses and lower safety factors may be used for unusual loading conditions such as maintenance, infrequent floods, barge impact, construction, or hurricanes. For these conditions allowable stress may be increased up to 33 percent.

Extreme – High allowable stresses and low safety factors are used for extreme loading conditions such as accidental or natural disasters that have a very remote probability of occurrence and that involve emergency maintenance conditions after such disasters. For these conditions allowable stresses may be increased up to 75 percent.

[3] Factors of safety are guideline values and deviations from these values may be justified at the discretion of the Engineer of Record.

4.1.2 Partially Penetrating Wave Barrier Piles

The current plan for the partially penetrating wave barrier includes construction of an approximately 700-foot-long arc-shaped steel pile barrier extending southward from the southern terminus of the existing rubble-mound breakwater.

The wave force (deemed the controlling lateral load applied to the wave barrier structure) on the order of a service (unfactored) 600 kips per bearing pile will be required based upon a force per linear foot on the wave barrier acting on the clusters spaced at 32 feet on center.

4.1.2.1 Lateral Capacity

The following table, Table 4-2, provides soil parameters for the lateral design of the partially penetrating wave barrier piles.

Table 4-2. Soil Profile for Design of Wave Barrier Piles.

Soil Layer	Soil Type	Approx. Depth Below Mudline (feet)	Effective Unit Weight (pcf)	Internal Angle of Friction ϕ' (degrees)	Undrained Shear Strength s_u (psf)	*p-y* Curve Model	*p-y* Modulus (static) *K* [1] (pci)	Strain Factor ε_{50} [1]
1	Loose Sand	0 to 2	--	--	--	--	--	--
2	Loose to Med. Dense Sand	2 to 10	56	30 top 34 bottom	--	Sand (Reese)	75	--
3	Soft to Very Soft Clay	10 to 35 south 10 to 50 north [2]	56	--	3.75 d +250 [3]	Soft Clay (Matlock)	--	0.020
4	Dense to Very Dense Sand	> 35 south > 50 north [2]	61	36	--	Sand (Reese)	125	--

Notes: [1] Alternatively, use LPile program defaults for *K* and/or ε_{50}.
[2] Depth to bottom of clay layer varies along the wave barrier alignment. Based on boreholes B-14, B-10, and BH-4, the clay layer is approximately 25 feet thick and 40 feet thick at the south and north ends of the breakwater alignment respectively (linearly interpolate linearly along alignment to estimate clay thickness).
[3] c' = 3.75 × d + 250 psf; where d = depth from top of clay layer in feet.

4.1.2.2 Axial Capacity

In developing the generalized soil profile for axial pile analyses and recommendations presented below for open-ended steel pipe piles and SPIN FIN piles, the subsurface conditions were evaluated at multiple locations along the proposed alignment to assess the variability of soil layer thicknesses and engineering soil properties. Based on our understanding of the subsurface conditions along the alignment, Borehole BH-4 was considered the controlling soil profile (i.e. thickest clay layer) and used for the pile capacity evaluations. As noted above in Section 4.1.1.2 "Axial Capacity" the soft to very soft clay layer is estimated to be about 25 feet thick and 40 feet thick at the south and north ends of the proposed breakwater alignment respectively and this variability should be considered when determining pile lengths for the project.

The compressive (downward) axial load capacity of a pipe pile comprises the resistance developed through skin friction (side frictional resistance of the surrounding soils embedding the pile) and end bearing. Whereas the uplift (tension) capacity is developed just from skin friction. In contrast, piles fabricated with SPIN FIN pile tips generate large bearing capacity type resistance that is in addition to the skin friction and end bearing common to conventional pipe piles since the SPIN FIN pile tip acts as an enlarged anchor by forming a soil plug under axial loading.

4.1.2.2.1 Open-Ended Steel Pipe Piles

The axial pile capacity recommendations for open-ended steel pipe piles discussed herein incorporate the following assumptions:

- Piles will be steel pipe driven open ended;
- Bearing piles will be fitted with driving shoes, barrier piles will not have driving shoes;
- Center-to-center pile spacing will be greater than three times the pile diameter, such that group effects are negligible; and
- Piles are assumed not develop plugged conditions for determining end-bearing capacity.

The design of open-ended steel pipe pile should consider the pile movement required for the mobilization of the skin friction and end bearing portions of the total compressive axial capacity; generally less than half an inch is needed to mobilize full skin friction, whereas movement of an inch or more is typically required to develop or mobilize the full end bearing resistance.

Figures B-3 through B-6 in Appendix B presents estimates of downward (compression) and uplift (tensile) pile capacities for the planned bearing (30-inch diameter, ¾-inch thick) and barrier (24-inch diameter, ½-inch thick) steel pipe piles appropriate for the design of the proposed wave barrier. These estimates are based on interpreted soil conditions encountered in the boreholes completed in the vicinity of the proposed wave barrier alignment and calculated using the single pile, static analysis methodology of the United States Army Corps of Engineers. The pile capacities shown on Figures B-3 through B-6 in Appendix B are ultimate (unfactored) capacities and do not include safety factors. Recommend safety factors based on method for determining capacity and loading conditions are presented in section, Section 4.1.1.2 "Axial Capacity" of this report.

4.1.2.2.2 SPIN FIN® Piles

SPIN FIN piles are steel pipe piles fabricated with fins (thick steel plate) at the tip of the pile which protrude outside the diameter of the pile in a spiral configuration. For this project, the pipe pile ends are recommended to remain open and fitted with a cutting shoe, similar to that used for the open-ended steel pipe piles.

When driven, SPIN FIN piles tend to rotate and slice through the soil. Once welded to the pile cap, the torsional-rigid pipe pile is prevented from rotating causing the SPIN FIN pile tip to form a soil plug that creates an enlarged anchor. Bearing capacity on the enlarged soil plug acts in both tension and compression loading similar to the end bearing of a plugged pipe pile tip under compressive loading. Hence large magnitude pile capacities are generated due to the large effective bearing area generated by the SPIN FIN pile tip in addition to pile shaft skin friction of conventional pipe piles.

The axial pile resistance (capacity) of SPIN FIN piles should be evaluated using PND's proprietary design methodology based on the uncorrected standard penetration test blow counts observed during the borehole drilling and inferred soil densities. For SPIN FIN piles embedded in the lower dense to very dense sand and gravel soils encountered beneath the very soft to soft clay along the partially penetrating wave barrier alignment, an average uncorrected SPT N-value of N=45 and a total unit soil unit weight of 125 pcf is recommended for design. For calculating the uplift capacity of SPIN FIN piles, it is recommended that the bearing cone be truncated at the soft to very soft clay horizon with the dense to very dense sand and gravel; however, the contribution to the vertical effective stress from these soils should not be ignored and should be considered for estimating the capacity of SPIN FIN piles.

4.1.3 Marina Infrastructure Piles

Steel pipe piles planned for the moorage float piles will be 12 and 16-inch-diameter and the piles for drive-down float will be 24-inch-diameter. It is understood that negligible axial loading is anticipated so design of marina infrastructure piles will be governed by lateral loading.

4.1.3.1 Lateral Capacity

The soil profile presented in Table 4-3 is based on a "typical" soil profile developed from the results of the boreholes completed within the marina.

Table 4-3. Soil Profile for Design of Moorage Float Piles and Drive-Down Float Piles.

Soil Layer	Soil Type	Approx. Depth Below Mudline (feet)	Effective Unit Weight (pcf)	Internal Angle of Friction ϕ' (degrees)	Undrained Shear Strength s_u (psf)	*p-y* Curve Model	*p-y* Modulus (static) *K* [1] (pci)	Strain Factor ε_{50} [1]
1	Loose to Med. Dense Sand/Gravel	0 to 5	51	30	--	Sand (Reese)	25	--
2	Medium Dense to Dense Sand/Gravel	5 to 25	56	34	--	Sand (Reese)	75	--
3	Medium Dense to Dense Sand	25 to 35	56	33	--	Sand (Reese)	60	--
4	Medium Dense Sand/Gravel	35 to 50	61	34	--	Sand (Reese)	75	--
5	Loose to Dense Sand	> 50	51	31	--	Sand (Reese)	40	--

Notes: [1] Alternatively, use LPile program defaults for *K* and/or ε_{50}.

4.1.4 Pile Installation Considerations

Installation of piles at the site may be challenging due to the dense to very dense sand and gravel deposits as encountered during the geotechnical investigations and due to the presence of cobbles and boulders within the site soils. As such, driving piles to the required embedment depths to develop tension capacity may necessitate overdriving the piles beyond the compressive capacity requirements. It will be the responsibility of the Contractor to select appropriate pile driving equipment to achieve embedment without damaging the pile and to address difficult driving conditions and deal with obstructions if encountered. Selection of pile driving equipment is the responsibility of the Contractor though subject to approval by the Engineer.

Actual pile embedment and acceptance should be based on driving criteria determined by the Engineer. All pile installations should be conducted with the Engineer present and continuous monitoring of pile driving should be performed to maintain a driving record of each pile installation in order to determine if the driving criteria is met.

4.1.4.1 Drivability

The Contractor should size the pile-driving hammer to achieve required minimum tip elevation and to verify capacity based on pile driving criteria established for the project. The Contractor's drivability analysis results, pile installation monitoring and testing procedures, and pile driving methodology should be based on the actual hammer and piles that will be used for the project and subject to review and acceptance by the Engineer prior to mobilizing equipment to the site. PND is available to evaluate the pile-hammer combination and develop pile refusal criteria once the hammer has been selected.

Based on preliminary drivability analysis, PND recommends the following guideline minimum rated pile hammer energies and minimum ram weight presented in Table 4-4.

Table 4-4. Guideline Minimum Pile Driving Hammer Requirement.

Pile Tip [1]	Minimum Rated Pile Hammer Energy (ft-lbs)	Minimum Pile Hammer Ram Weight (lbs)
Open-Ended	80,000	12,500
SPIN FIN Tip	120,000	17,000

Note: [1] 30-inch diameter; ¾-inch thick, steel pipe pile section.

4.1.4.2 Constructability

The dense to very dense sand and gravel underlying the soft clay deposits and presence of cobbles and/or boulders at the site may present challenges for driving piles. The use of closed ended pipe piles are not recommended. The installation of finned-piles, like SPIN FIN piles, shear the soils by way of twisting during installation but can "lock up" when driving through very dense soils due to the twisting action not occurring; however, do to the large tension (uplift) demand on the bearing piles, PND recommends the SPIN FIN piles be considered. Regardless of pile type selected, provisions should be included in the design and project specifications to accommodate the potential for very dense driving conditions and encountering obstructions. Based on our experience, the following methods may be appropriate for dealing with difficult pile driving conditions anticipated at the site:

- Using a cutting shoe made of steel of a higher grade and higher yield strength than the pile for driving the open-ended steel pipe piles;
- Drilling pilot holes prior to and/or during pile installation to provide stress relief;
- Use of drilling and/or a down hole hammer to advance past obstructions; and
- Use of sacrificial bits fabricated to the toe of open-ended steel pipe piles and drilling the piles in place.

The transition/connection from the new pile breakwater to the existing rubble-mound breakwater will require the installation of piles through the existing rubble-mound breakwater and may require excavation to install piles where oversized material (e.g. rubble, armor, boulders) is present. Based on record drawings from the USACE, it's anticipated that the existing rubble-mound breakwater core was likely constructed using run-of-quarry material. Accordingly, boulder-size rocks should be expected within the rubble-mound and should be anticipated during pile driving.

4.1.4.3 Pile Driving Criteria and Verification of Pile Capacity

PND recommends that a pile-driving monitoring program be implemented to include full-time observation and documentation of driven pile installations by a Geotechnical Engineer. The Geotechnical Engineer should observe the pile driving, evaluate/maintain pile-driving records, verify whether the soil conditions encountered during pile installation are consistent with those assumed for design, and to verify adequate capacity and/or embedment has been achieved. The pile design recommendations presented in this report are based on anticipated site conditions and soil parameters correlated to the results of the subsurface investigation. If pile resistance encountered during driving indicates that the soil conditions differ significantly from those assumed and discussed in this report, it may be appropriate for the Engineer to develop revisions to these recommendations.

Driving criteria are dependent on the driving hammer characteristics, capacity required, group action, field verification procedure(s), and other details. Once pile-driving equipment is selected, hammer specific driving criteria can be developed. It is recommended that pile capacity be evaluated based on field verification of pile capacity based on dynamic testing (PDA/CAPWAP) and/or wave equation analysis. Static pile testing is not planned for the project.

The following guideline pile driving procedure and criteria is recommended for the project:

1. Full-time monitoring of pile driving to be completed by PND to record potential hammer energy delivered to the pile-based hammer performance (stroke, blows, etc.). Additional monitoring and analysis (PDA, CAPWAP, wave equation, etc.) will be completed as needed determined by the Engineer. The Contractor shall assist the Engineer in monitoring the pile installation.
2. Fuel settings of the pile-driving hammer should be adjusted by the Contractor as needed to control driving stresses.
3. The Contractor shall drive piles to minimum tip elevations shown on plans. This may require the need to overdrive piles beyond the compression capacity criteria in order to develop the required embedment and/or tension capacity. Vibratory equipment may be used advance the piles to the depth practical.
4. The Contractor shall continue driving piles until required resistance is verified based on the driving criteria established for the project (e.g. using the safety factors presented above based on loading and testing). Resistance to be verified in the field by PND, based on the driving criteria established for the project.
5. Restrike of piles to verify capacity to be completed following a minimum setup period of 48 hours. Restrike should be performed using a warm hammer and capacity estimate based on the first one inch of driving.
6. PND to provide additional acceptance criteria if driving criteria is still not met after restrike. This may include additional driving, PDA testing, or acceptance of pile capacity using a lower factor of safety.
7. Acceptance of driven piles shall be solely determined by the Engineer.

4.2 Basin Dredging

There are currently three planned dredge areas:

- The main basin to -15 feet MLLW.
- Near the existing boat grid/north of "A" Float to -12 feet MLLW.
- Along the east toe at the northern end of the existing breakwater.

The proposed dredging limits are shown approximately on the Site Plans in Appendix A.

Due to the oversized material (boulders and cobbles) within the site soils and very dense glacially consolidated (cemented) sediments, hydraulic dredging is not recommended. PND anticipates that dredging activities can be completed using large clamshell dredges and large excavators. It should be noted that a CAT 345B L Excavator was used to excavate the test pit explorations completed in 2010 to depths ranging up to 20 feet deep in the vicinity of the proposed dredge areas.

4.2.1 Dredge Soil Conditions

Soil within the dredge areas include stratified deposits of lean clay, sand, and gravel with variable silt and cobbles and occasional boulders. Surficial soil within the dredge areas varies from loose, fine-grained granular silt and sand to boulder-size material. Above approximately 0 feet MLLW a surficial boulder field exists with occasional subrounded boulders to 10 feet in diameter. Below approximately 0 feet MLLW, surficial loose sand and silt sediment exists in varying thickness. Subsurface soil in the dredge areas is typically coarse, granular, and dense. The coarse granular material is typically subrounded and commonly matrix supported within silt to fine-grained sand size particles. The matrix can often cement the coarser size material and give the soil the appearance and hardness of concrete. Undisturbed soil of this type was often found near dry to moist and difficult to excavate. The soil when disturbed and hydrated however loosened and flowed into lobate formations on the ground surface. A thin layer of lean clay was encountered in the dredge area's northern mid-region and is interpreted to thicken offshore.

4.2.2 Slope Stability

To achieve the desired grade changes in the dredge areas, we recommend that all dredge slopes be inclined no steeper than 2½H:1V (horizontal to vertical). For dredge slopes with a minimum of 18-inch thickness of armor rock facing (including toe berm transition from armor rock to native soil) a maximum slope inclination 2H:1V is recommended. The thickness of the armor rock should be at least two stones thick. A geotextile separation fabric between the armor rock and native soil should be considered to prevent fines migration due to waves, tides, currents, and prop wash.

Where dredge areas approach breakwater or jetty structures, we recommend that dredge encroaches no closer than 20 feet (i.e. maintain a minimum 20-foot-wide bench from the toe of the breakwater/jetty to the beginning of the dredge slope), to preserve the existing factor of safety against global failure of these structures.

Shallower slopes and/or structurally supported dredge cuts may be necessary to protect against sub-marine slope failure, depending on the final dredge geometry, especially where the dredge limits encroach the toe of existing breakwater and jetty structures or are locally steeper. Steeper dredge slopes and/or shorter setbacks may be used but should be checked for slope stability based on the actual site conditions.

Slope stability analysis should be completed to support dredge slopes design. This may necessitate modifications to planned slope inclinations and/or layout to maintain adequate stability of the slopes and upslope improvements. If dredge geometries and/or extents deviate from the discussion herein additional modifications may be required to add or incorporate structural elements to support embankment toes (sheet piles, armor rock buttressing, etc.). Excerpts related to the preliminary slope stability analysis of the generalized dredge slopes from draft geotechnical engineering report (PND 2013a) which are not included in this final report are included in Appendix G.

4.3 Site Preparation and Earthwork

Site preparation and earthwork is expected to include some or all of the following: demolition of existing pavements; demolition appurtenant structures; abandonment of existing and construction of new buried utilities; excavation in soil; removal of boulders; fill placement; and dredging activates. Site grading along Front Street will include the construction of a surface parking area and bulkhead dock. The current plan for upland parking improvements would increase the parking area from about 32,600 square feet to 136,400 square feet which will double the standard parking capacity from 20 to 40 stalls and add 48 spaces for vehicles with boat trailers. Construction of the parking area will raise the existing site grade from approximately Elevation 16 feet to Elevation 27 feet and place approximately 16,000 cubic yards of fill material. The 320-foot-long bulkhead loading dock will have a retained wall height of about 50 feet and would add an additional 24,500 square feet of usable upland space.

Site preparation, excavation and fill placement should be observed, evaluated, and tested under the supervision of a Geotechnical Engineer to confirm that these activities have been completed in a manner consistent with the recommendations presented in this report and that the subsurface conditions are as expected.

4.3.1 Engineered Fill

4.3.1.1 Materials

For the purpose of this report, "engineered fill" refers to materials used to raise site grades, backfill excavations, and support foundations, structures, and pavements. Engineered fill materials should be free from muck, frozen material, roots, sod, or other deleterious matter and should be durable and sound. Recommended guideline material specifications for engineered fill are presented below. Additional gradation criteria should be determined by the Civil Engineer based on the fill application.

- Common borrow used to raise site grades, backfill utility trenches or support structures, foundations, or pavements should generally meet the criteria for Type A Selected Material as described in Section 703-2.07 of the AKDOT Standard Specifications.
- Crushed surfacing base course below pavements should generally meet the criteria of Section 703-2.03 Base Course of the AKDOT Standard Specification.
- Pipe zone bedding material used to support and cover utility pipes should generally meet the criteria of Section 703-2.03 Base Course (Gradation C-1) of the AKDOT Standard Specification.
- Free draining gravel backfill placed within 2 feet behind retaining walls should generally meet the criteria for Porous Backfill Material as described in Section 703.2.10 of the AKDOT Standard Specification.

- Geotextile used for soil Separation or Stabilization should generally meet the criteria of Section 729-2.01 of the AKDOT Standard Specification.

4.3.1.2 On-Site Soils

The use of imported materials for engineered fill should be planned for this project. However, based on laboratory sieve analysis, material within portions of the planned dredged area have low fines content and may be suitable for reuse as engineered fill. Excavated on-site materials meeting the criteria for engineered fill may be stockpiled and reused at the direction of the Geotechnical Engineer or Owner's Representative.

4.3.1.3 Placement and Compaction

Engineered fill should be placed in horizontal lifts not exceeding 12 inches and compacted to the specified density with a vibratory steel drum roller. Smaller compaction equipment (e.g. vibratory hoe-packs, jumping jacks) should be used where drum rollers cannot fit and/or when overstressing adjacent improvements is a concern. Lift thickness should not exceed 6 inches where smaller compaction equipment is used. No hauling or grading equipment should be used in lieu of appropriate compaction equipment. A suitable number of in-place moisture and density tests should be performed on each lift to document that the required compaction has been achieved before the placement of the subsequent lift.

Engineered fill placed to support hardscapes or pavements should be compacted to at least 95 percent of the maximum dry density (MDD) per ASTM D 1557 within 2 feet of final pavement subgrade; compaction of 90 percent MDD is required for engineered fill below 2 feet of final pavement subgrade. Compaction of 95 percent MDD is required for full thickness of engineered fill placed to support structures or foundations.

4.3.2 Slopes and Shoring

All temporary cut slopes and shoring must comply with the provisions of OSHA's Excavation and Trenching Standard and/or other applicable regulatory standards. The Contractor performing the work has the primary responsibility for protection of workers and adjacent improvements. This responsibility includes determining the need for shoring and establishing the safe inclination of temporary cut slopes.

For planning purposes, permanent cut or fill slopes for the site should not be inclined steeper that 2H:1V (horizontal to vertical). Actual permanent slope inclinations should be determined on a case-by-case basis which considers relevant factors like site geometry, soil type, water/seepage conditions, loading, slope protection, etc. Steeper slopes may be appropriate in special cases such as slopes constructed of riprap which may be inclined 1½H:1V. Conversely, shallower slopes may be required to maintain adequate stability where grade changes are made in weak soils, in the presence of destabilizing seepage, beneath water, and/or encroaching upon existing improvements.

4.3.3 Material Sources

For planning purposes, the nearest private quarry to the site is operated by Southeast Road Builders at 4.5 mile Haines Highway outside of the Haines Borough. We understand that the quarry rock is greenstone (metamorphosed basalt) has a specific gravity of 2.9 to 3.0 and an abrasion resistivity of 12. Typical costs for materials delivered from the quarry to a stockpile at the site are as follows:

- Pit run/riprap/armor rock: $25 to $40 per cubic yard depending on project specifications
- Common borrow: $12 per cubic yard

Note that these cost estimates are for planning purposes only and are based on typical situations and should be verified for project bidding as material specification, fuel costs, and other factors influence these values. Additionally, Southeast Road Builders should be contacted to confirm the quantity of quarry rock available at this site.

4.4 Earthquake Design

As with all sites in Southeast Alaska, there is a risk of earthquake-induced ground shaking, and the intensity of the ground shaking could be severe. The severity of ground shaking is primarily a function of the earthquake magnitude, depth, and proximity to the site. Accordingly, seismic hazards including liquefaction, lateral spreading, and fault rupture should be incorporated into the design, as appropriate.

Structures that are designed in accordance with modern seismic codes and with proper foundations and structural detailing have performed well during recent earthquakes. However, modern seismic codes are formulated to provide only life safety protection during a large earthquake, and therefore cosmetic and structural damage are considered acceptable. If more robust performance during a large earthquake is desirable, it may be prudent to upgrade the design of the structure beyond the current seismic code levels.

4.4.1 Seismic Hazards

The site was evaluated for seismic hazards including liquefaction, lateral spreading, and fault rupture.

Liquefaction is a phenomenon where excess pore water pressure develops in saturated soils due to vibration/ground shaking, usually produced by earthquakes, that result in loss of shear strength in the soil deposit. Generally, liquefaction-prone soils are very loose to medium dense, clean to moderately silty sands, and some silts below the groundwater table. Several consequences of soil liquefaction include:

- Surface deformation (e.g., ground settlement, sand boils, and lateral spreading);
- Settlement of structures supported on foundations on or above liquefied soils due to loss of bearing capacity; and
- Reduction in lateral support for below grade structures, like deep foundations and retaining walls, embedded in liquefied soils. Soil liquefaction can cause unprecedented damage to dock facilities as was seen in the 2010 Port Au Prince, Haiti earthquake (Figure 4-1).

Figure 4-1. Waterfront Facility Liquefaction, Port Au Prince, Haiti (CPT Bobbitt, 2010).

Some of the unconsolidated sand and gravel deposits encountered in the boreholes are considered to have a high potential for liquefaction. Liquefaction-induced settlement at the site should be considered during the design earthquake event. Post-earthquake slope instability (e.g., seismically induced landslide) at the site should also be considered during the design earthquake event.

The nearest mapped fault is located about 5 miles from the site. Based on the absence of mapped faults that cross the site, it is our opinion that the risk for fault displacement resulting in ground rupture at the surface is remote.

4.4.2 Seismic Design Parameters for Marine Infrastructure

We recommend using the provisions outlined by ASCE publication "Seismic Guidelines for Ports" for the planned marine improvements. This publication recommends a multi-level approach to design as described below. This same approach has been adopted by the State of California's Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS) and is the generally accepted seismic design criteria for port facilities, including the seismic assessment of US military wharf/pier facilities in high seismic areas.

Level 1 establishes an Operating Level Earthquake (OLE) for ground motions that have a 50% probability of exceedance within a 50-year period (72-year return period). For this seismic event, the structure is designed so that operations are not interrupted and damage that does occur is repairable in a short timeframe.

Level 2 design is for a Contingency Level Earthquake (CLE) where shaking is more severe. The CLE ground motions would have a 10% probability of exceedance within a 50-year period (475-year return period). For this seismic event, the structure would undergo damage that is controlled but not necessarily a threat to life safety.

In contrast, the maximum considered earthquake (MCE) corresponds to a 2% probability of exceedance within a 50-year period (2,475-year return period). The MCE event is the seismic criteria used for buildings as outlined by ASCE 7-05 and IBC 2009. In some cases it is used for other critical facilities besides buildings including marine facilities.

The Site Specific Design Spectra parameters for site class, "bedrock" Peak Ground Acceleration (PGA), short period spectral response acceleration (S_S), and one-second period spectral response acceleration (S_1) are presented below in Table 4-5 for the OLE, CLE, and MCE based on the 1998 USGS Seismic Hazard Maps for Alaska. Note the S_S and S_1 are for Site Class B and will need to be adjusted for the given site class pursuant to the appropriate code used for design.

Table 4-5. Site Specific Design Spectra Parameters.

Parameter	OLE "Level 1" Recommended Value 50% PE in 50 years (72-year EQ)	CLE "Level 2" Recommended Value 10% PE in 50 years (475-year EQ)	MCE "IBC" Recommended Value 2% PE in 50 years (2475-year EQ)
Site Class	E	E	E
Peak Ground Acceleration	0.072g	0.20g	0.53g
S_S (site class B)	0.16g	0.47g	1.21g
S_1 (site class B)	0.072g	0.19g	0.47g

4.5 Additional Considerations for In-Water Construction

In-water work in Alaska necessitates the following:

- Review and approval through the USACE (e.g., NWP, LOP, or Individual permit).
- An ADF&G "Fish Habitat Permit" may be required for such work as pile driving, fill, dredging, or construction in or near waters significant to anadromous fish or other sensitive species.

Permit conditions may include:

- Agency stipulated in-water work-timing restrictions (work-windows can differ slightly between agencies; allowable window is determined by common overlapping dates);
- In-water construction may be further restricted to periods of lower water;
- A bubble curtain may be required during installation of driven steel piles;
- Work barges may not be permitted to ground out; operation in eelgrass or kelp beds may be restricted or prohibited; and

- If a fish kill occurs or fish are observed in distress all activity must cease and permitting agencies be notified.

4.6 Key Geotechnical Design Considerations

Throughout this report, discussions of relevant geotechnical considerations have been presented along with guideline recommendations. In some instances, further analyses should be completed to support and refine these recommendations for final design. The following summary is intended to identify the key geotechnical design considerations for the project and provide a basis for evaluating alternative designs for the project.

The site geology and setting will present challenges to construction. Specifically:

- Cobbles and boulders are present throughout the site and should be anticipated during earthwork and construction activities.
- Difficult pile driving conditions should be anticipated due to very dense soils, cobbles, boulders, and potentially, bedrock.
- Very soft cohesive clay deposits are present within Portage Cove and are sloping offshore. Design of foundations on or in these soils will be a challenge. It is anticipated that construction on these soils will present several engineering challenges, namely, low shear strength and bearing capacity, long-term settlement potential, and low lateral and axial pile capacity.
- Liquefiable soils are present at the site.
- Sandy/gravelly soils overlying the clay may make dredging activities difficult.

5 CLOSURE

This report was prepared in accordance with generally accepted professional principles and practices in the field of geotechnical engineering at the time this report was prepared. The conclusions and recommendations submitted in this report are based on information provided to us describing the proposed site grading and construction, and based on the field geotechnical investigation and laboratory testing conducted and used in preparation of this report. The nature and extent of subsurface variations across the site may not become evident until construction. If during construction, fill type, debris, soil, rock, bedrock, surface water, or groundwater conditions appear to be different from those described herein, PND's Geotechnical Engineer should be advised at once, so re-evaluation of the conditions observed in this report can be considered in conjunction with the design documents and field variations noted.

PND is not responsible for safety programs, methods, or procedures of operation, or the construction of the design recommendations provided in this report. Where recommendations are general or not called out, the recommendations shall conform to standards of the industry. This geotechnical report is for use on this project only and is not intended for reuse without written approval from PND. This geotechnical report is not to be used in a manner that would constitute a detriment directly or indirectly to PND.

Section 1.3 of this report provides a synopsis of additional geotechnical data researched and obtained in the preparation of this geotechnical report. The information is provided for informational purposes only, and PND makes no warranty either expressed or implied as to the suitability or accuracy of this information. Author's notes have been included in this section as they relate to our interpretation of potential inaccuracies in the data. This information and the original documents summarized in this report may contain additional inaccuracies. Readers should make their own interpretation of the data to determine the suitability and accuracy of this information.

PND is a member of the GBA (formally ASFE). Included in Appendix H is a copy of the GBA publication, "Important Information about your Geotechnical-Engineering Report." The publication is included in this report to help the Owner, Contractor, and others who read this document understand the limitations described above, and the additional limitations contained in this publication and made a part of this report.

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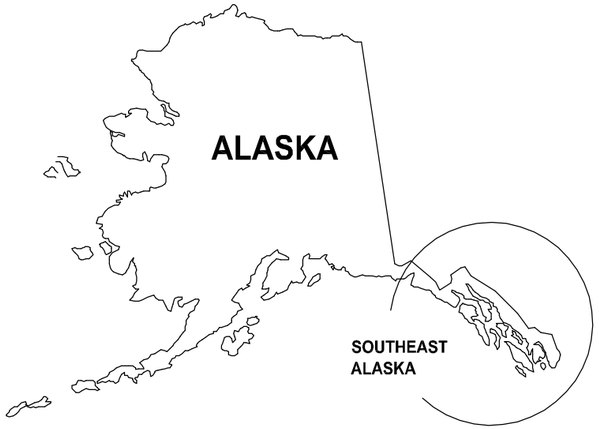
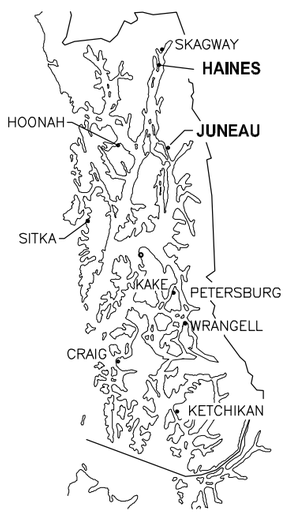
APPENDIX A

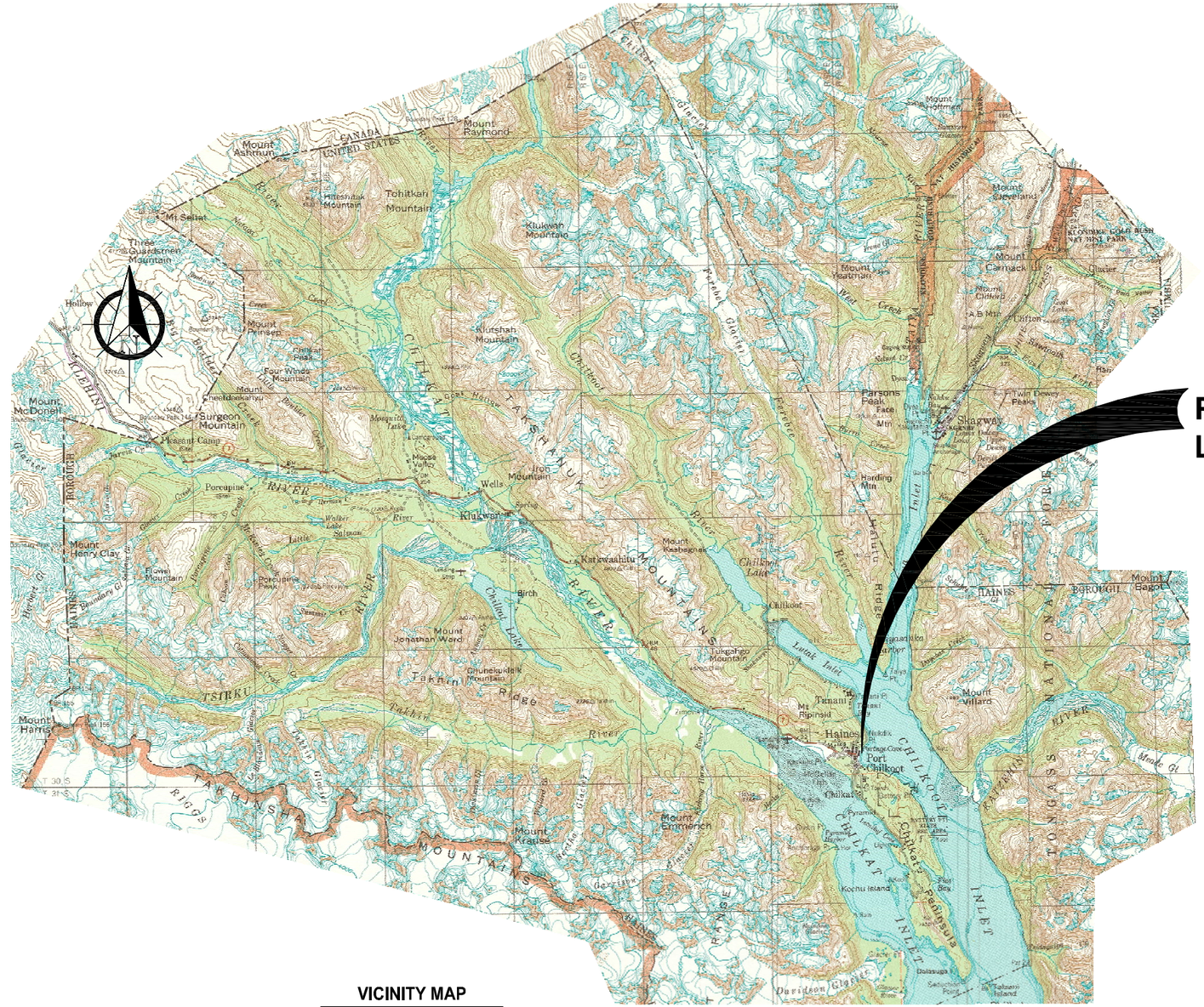
Vicinity Map, Site Plans, and Site Profiles



LOCATION MAP



SOUTHEAST ALASKA



VICINITY MAP

SCALE IN MILES

0 3 6

TOPOGRAPHY MAP FROM:

USGS ALASKA TOPOGRAPHIC SERIES
SKAGWAY, ALASKA–CANADA, 1982.

REVISIONS

REV.	DATE	DESCRIPTION	DWN.	CKD.	APP.

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DESIGN: PJD CHECKED: CMK
DRAWN: PJD APPROVED: MH
SCALE: AS SHOWN
DATE: FEB. 2015

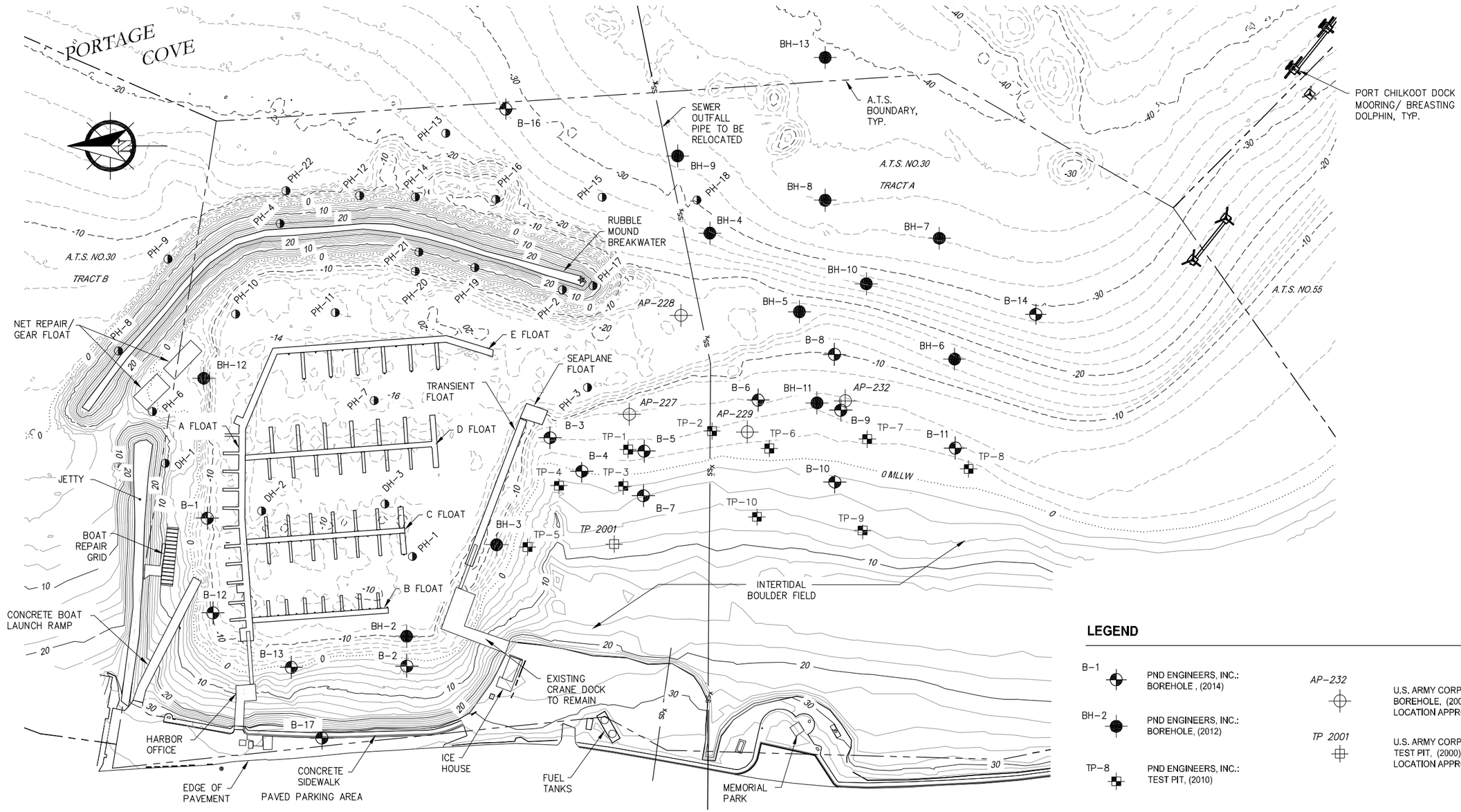
HAINES BOROUGH
SOUTH PORTAGE COVE
HARBOR EXPANSION

SHEET TITLE:
VICINITY MAP

PN&D PROJECT NO.: 102029.07

A

SHEET 1 OF 10



LEGEND

B–1	PND ENGINEERS, INC.: BOREHOLE , (2014)
BH–2	PND ENGINEERS, INC.: BOREHOLE, (2012)
TP–8	PND ENGINEERS, INC.: TEST PIT, (2010)
AP–232	U.S. ARMY CORPS OF ENGINEERS: BOREHOLE, (2004) LOCATION APPROXIMATE
TP 2001	U.S. ARMY CORPS OF ENGINEERS: TEST PIT, (2000) LOCATION APPROXIMATE
DH–1 PH–1	U.S. ARMY CORPS OF ENGINEERS: PROBE AND DRILLHOLES, (1957, 1973, 1975) LOCATION APPROXIMATE

EXISTING CONDITIONS PLAN

SCALE IN FEET
0 80 160 FT.

NOTES:

1. VERTICAL DATUM IS MEAN LOWER LOW WATER (MLLW = 0 FEET).
2. BATHYMETRIC CONTOURS FROM DAVID EVANS AND ASSOCIATES, INC., APRIL 2013.; UPLANDS TOPOGRAPHIC CONTOURS FROM PND ENGINEERS, INC., APRIL 2013.

REVISIONS

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DRAWN: PJD APPROVED: MH
SCALE: AS SHOWN
DATE: FEB. 2015

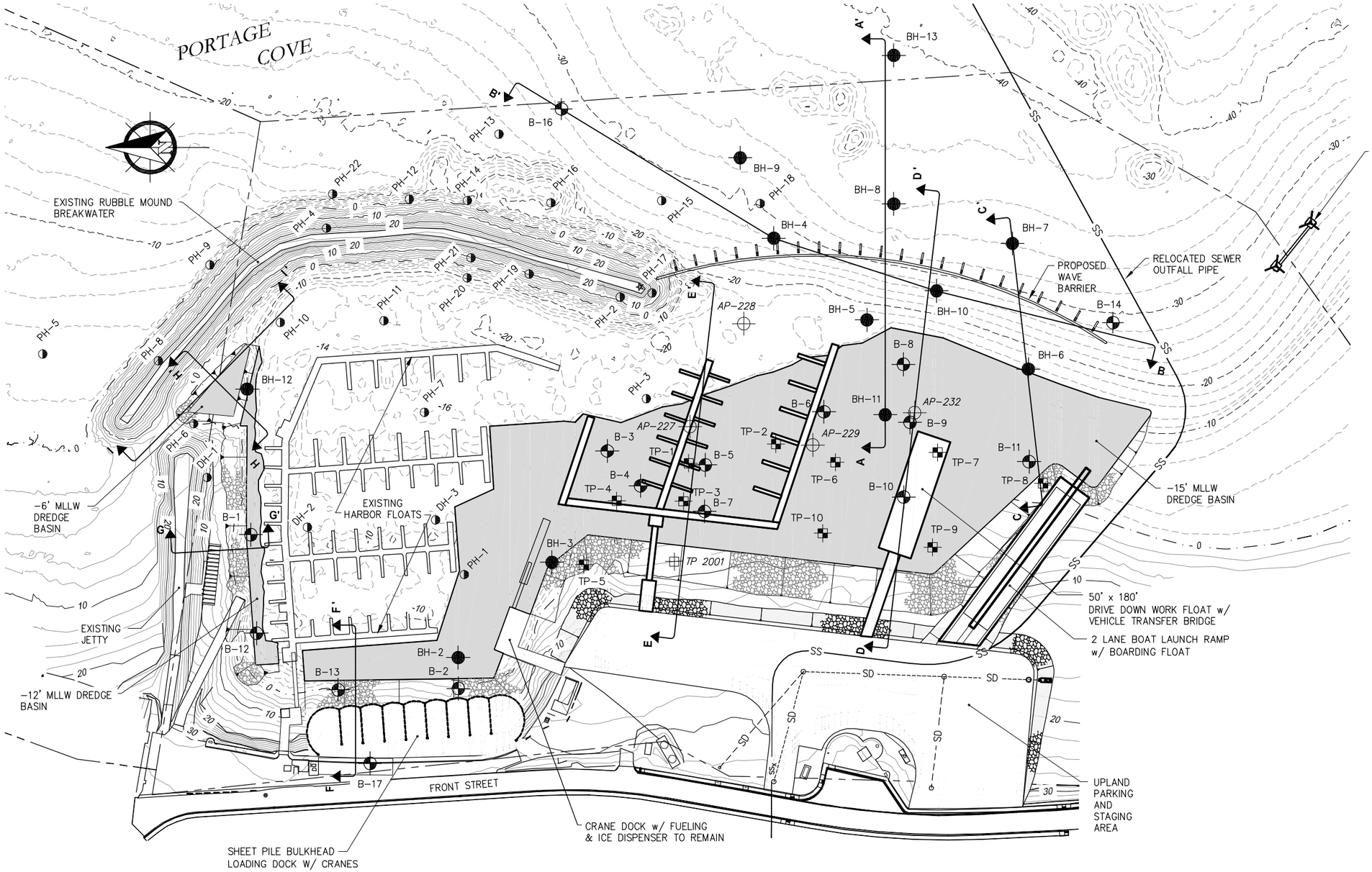
HAINES BOROUGH
SOUTH PORTAGE COVE
HARBOR EXPANSION

SHEET TITLE:
EXISTING CONDITIONS WITH SAMPLING LOCATIONS

PND PROJECT NO.: 102029.07

A

SHEET 2 OF 10



LEGEND

B-1	PND ENGINEERS, INC.: BOREHOLE , (2014)
BH-2	PND ENGINEERS, INC.: BOREHOLE, (2012)
TP-8	PND ENGINEERS, INC.: TEST PIT, (2010)
AP-232	U.S. ARMY CORPS OF ENGINEERS: BOREHOLE, (2004) LOCATION APPROXIMATE
TP 2001	U.S. ARMY CORPS OF ENGINEERS: TEST PIT, (2000) LOCATION APPROXIMATE
DH-1 PH-7	U.S. ARMY CORPS OF ENGINEERS: PROBE AND DRILLHOLES, (1957, 1973, 1975) LOCATION APPROXIMATE
A A'	GENERALIZED SUBSURFACE PROFILE LOCATION

SITE PLAN

SCALE IN FEET
0 80 160 FT.

NOTES:

1. VERTICAL DATUM IS MEAN LOWER LOW WATER (MLLW = 0 FEET).
2. BATHYMETRIC CONTOURS FROM DAVID EVANS AND ASSOCIATES, INC., APRIL 2013.; UPLANDS TOPOGRAPHIC CONTOURS FROM PND ENGINEERS, INC., APRIL 2013.

HAINES BOROUGH ALASKA

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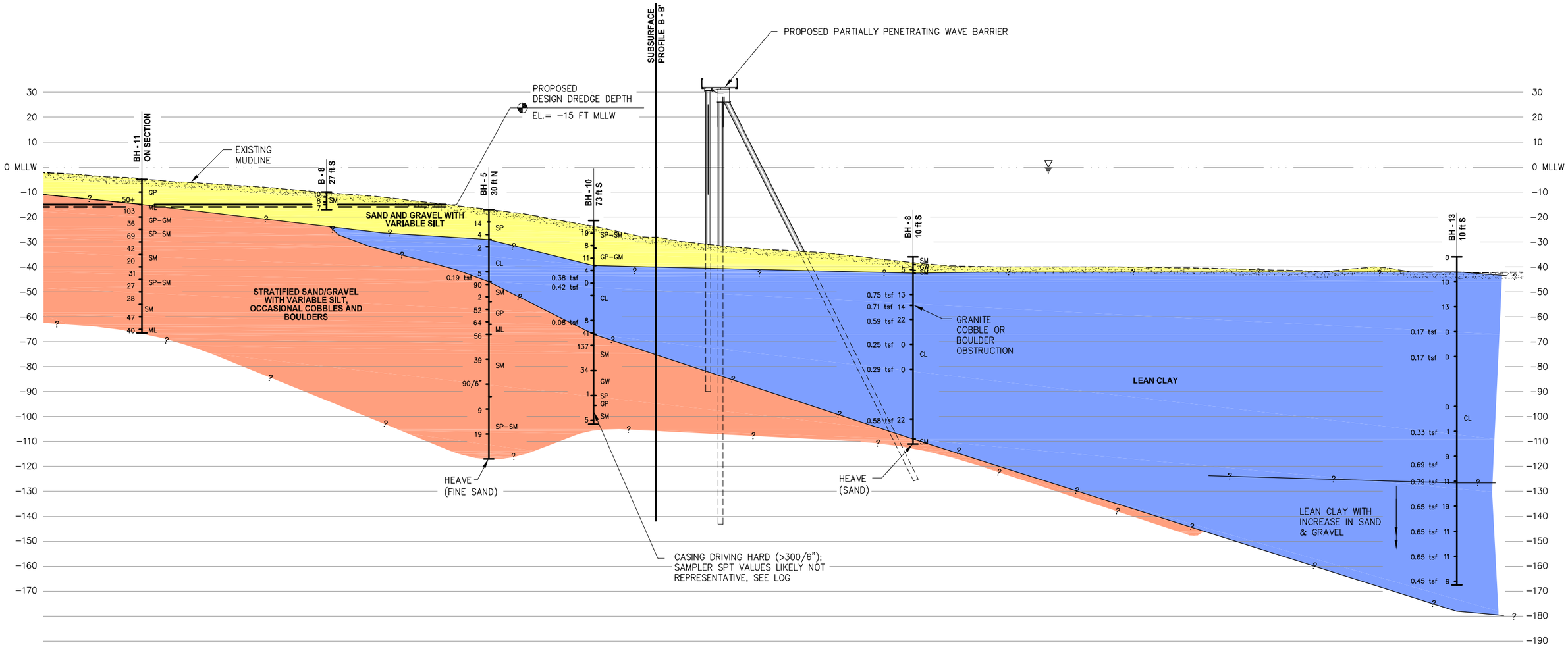
HAINES BOROUGH
SOUTH PORTAGE COVE HARBOR EXPANSION

SHEET TITLE:
GEOTECHNICAL SITE PLAN WITH SAMPLING LOCATIONS

PND PROJECT NO.: 102029.07

A

SHEET 3 OF 10



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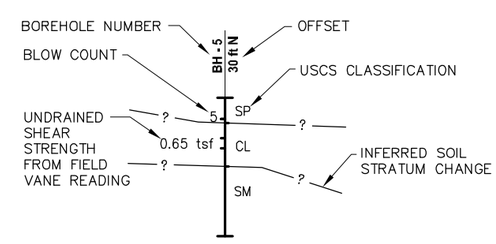
PROFILE A - A'

SCALE IN FEET

0 20 40 FT.

NOTE: HORIZONTAL SCALE EQUALS VERTICAL SCALE

LEGEND



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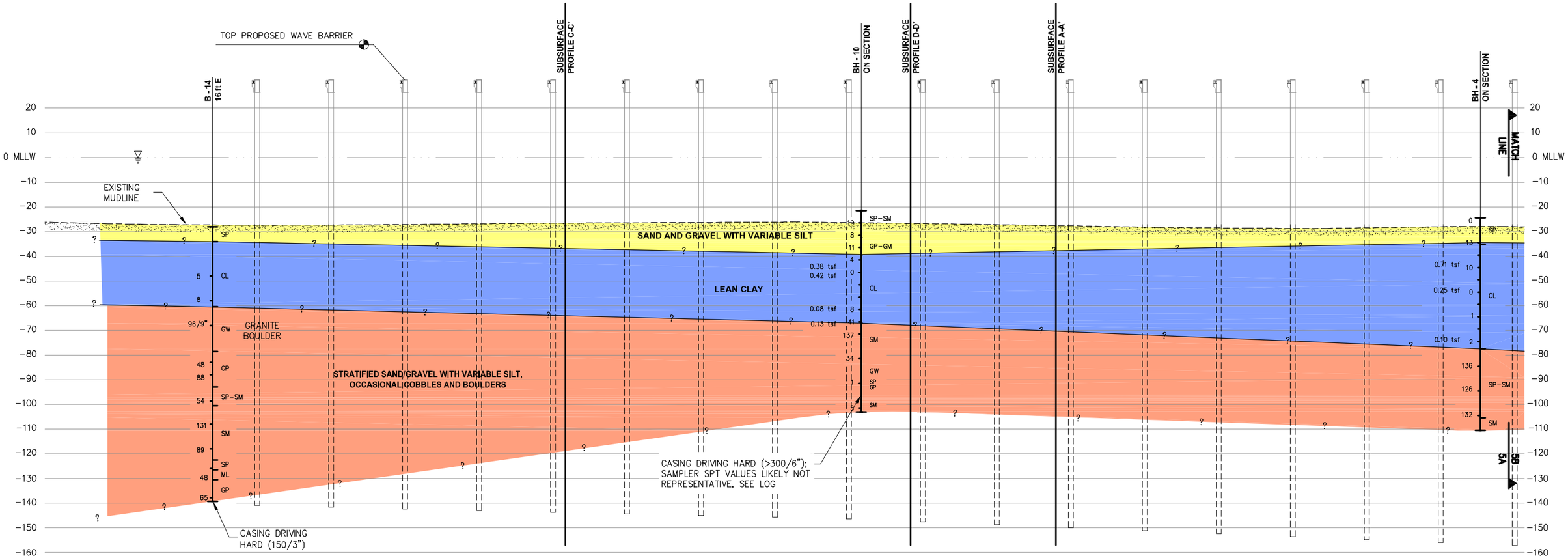
HAINES BOROUGH
SOUTH PORTAGE COVE HARBOR EXPANSION

SHEET TITLE: GENERALIZED SUBSURFACE PROFILE A - A'

PND PROJECT NO.: 102029.07

A

SHEET 4 OF 10



PROFILE B - B'

SCALE IN FEET

0 20 40 FT.

NOTE: HORIZONTAL SCALE EQUALS VERTICAL SCALE

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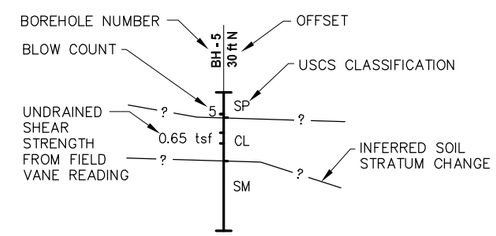
LEGEND



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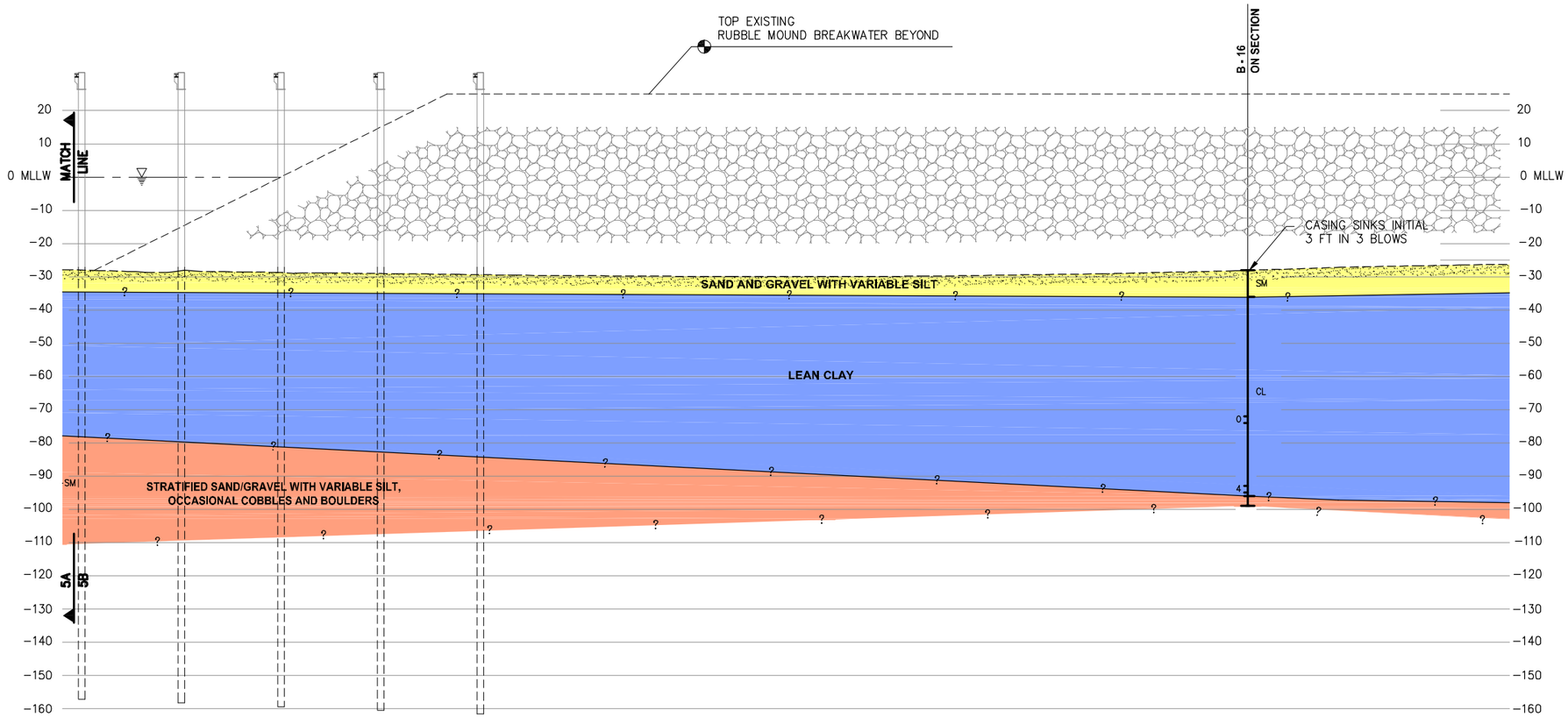
HAINES BOROUGH
SOUTH PORTAGE COVE HARBOR EXPANSION

SHEET TITLE:
GENERALIZED SUBSURFACE PROFILE B - B'

PND PROJECT NO.: 102029.07

A
SHEET 5A OF 10

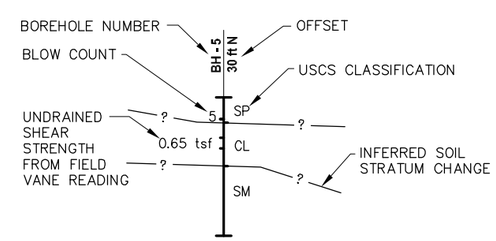


PROFILE B - B'

SCALE IN FEET
0 20 40 FT.

NOTE: HORIZONTAL SCALE EQUALS VERTICAL SCALE

LEGEND



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HAINES BOROUGH ALASKA

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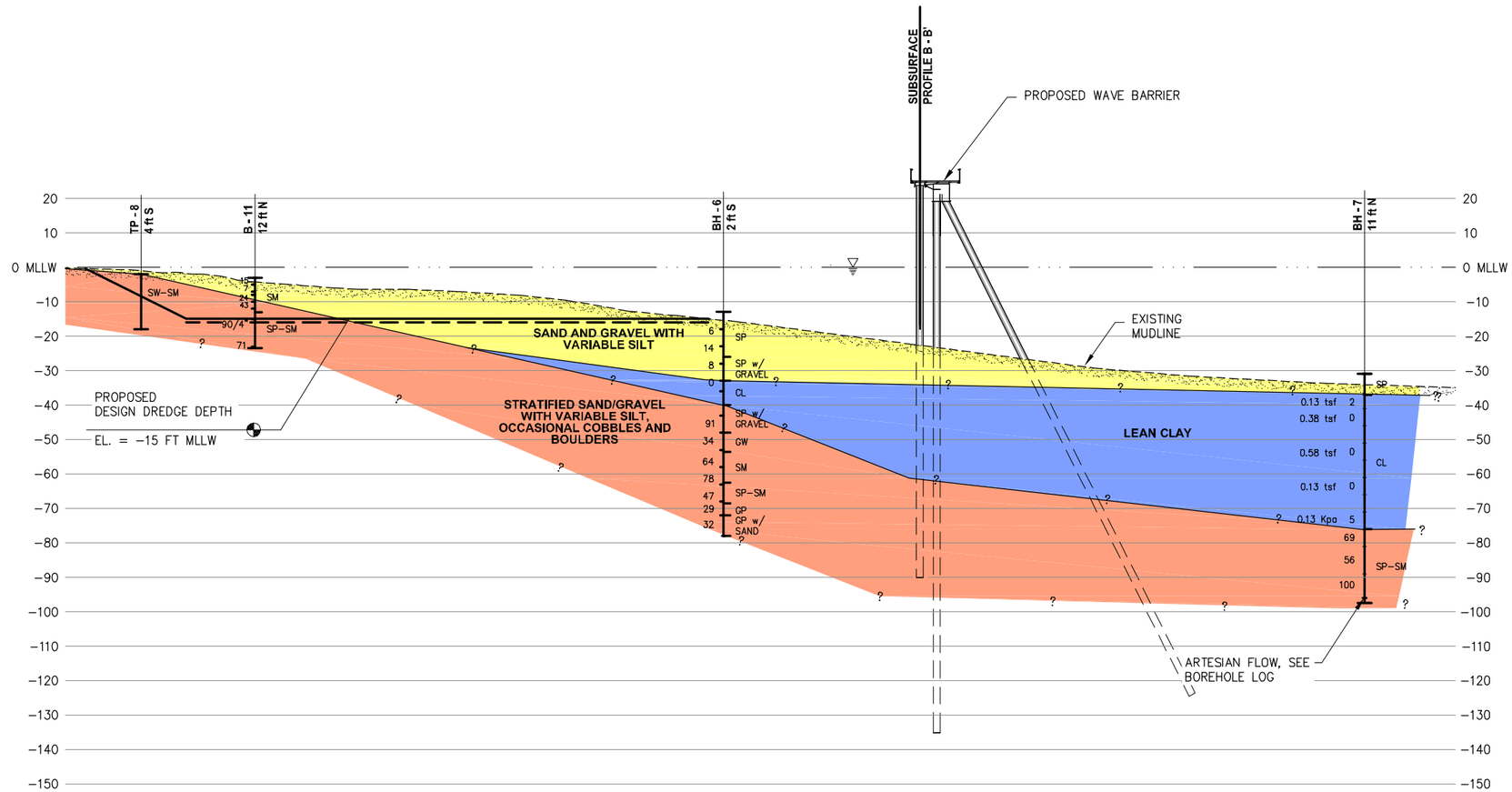
HAINES BOROUGH
SOUTH PORTAGE COVE
HARBOR EXPANSION

SHEET TITLE:
GENERALIZED SUBSURFACE
PROFILE B - B'

PND PROJECT NO.: 102029.07

A

SHEET 5B OF 10



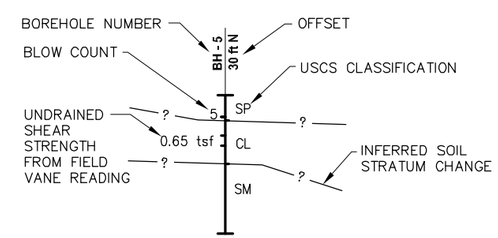
PROFILE C-C'

SCALE IN FEET

0 20 40 FT.

NOTE: HORIZONTAL SCALE EQUALS VERTICAL SCALE

LEGEND



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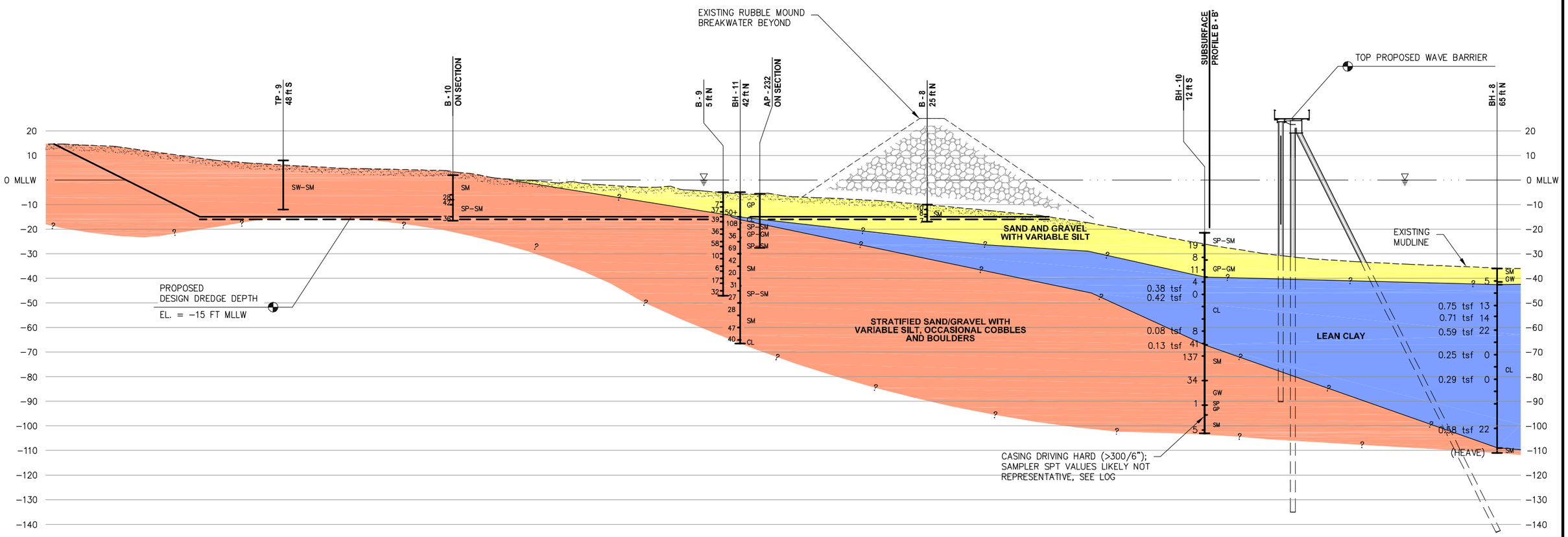
HAINES BOROUGH
SOUTH PORTAGE COVE HARBOR EXPANSION

SHEET TITLE:
GENERALIZED SUBSURFACE PROFILE C - C'

PND PROJECT NO.: 102029.07

A

SHEET 6 OF 10

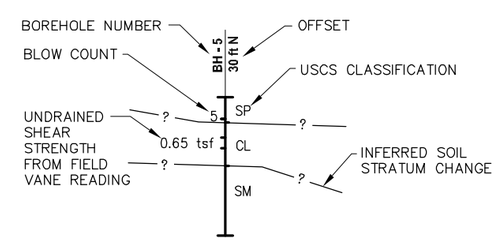


PROFILE D - D'

SCALE IN FEET
0 20 40 FT.

NOTE: HORIZONTAL SCALE EQUALS VERTICAL SCALE

LEGEND



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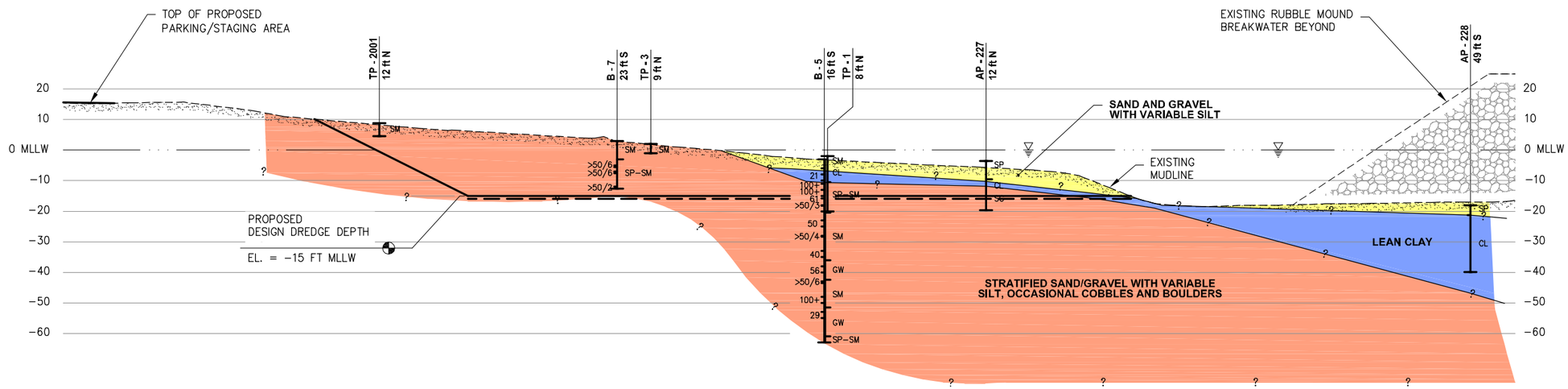
HAINES BOROUGH
SOUTH PORTAGE COVE HARBOR EXPANSION

SHEET TITLE:
GENERALIZED SUBSURFACE PROFILE D - D'

PND PROJECT NO.: 102029.07

A

SHEET 7 OF 10



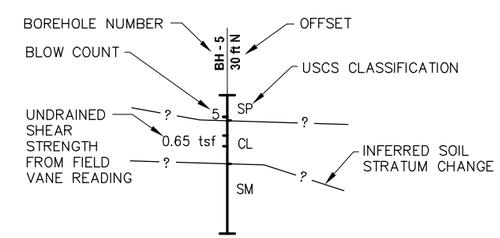
PROFILE E - E'

SCALE IN FEET

0 20 40 FT.

NOTE: HORIZONTAL SCALE EQUALS VERTICAL SCALE

LEGEND



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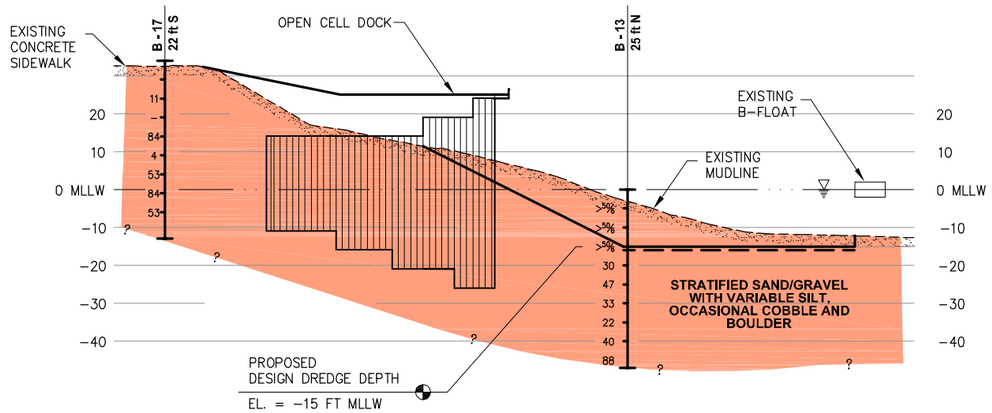
HAINES BOROUGH
SOUTH PORTAGE COVE HARBOR EXPANSION

SHEET TITLE:
GENERALIZED SUBSURFACE PROFILE E - E'

PND PROJECT NO.: 102029.07

A

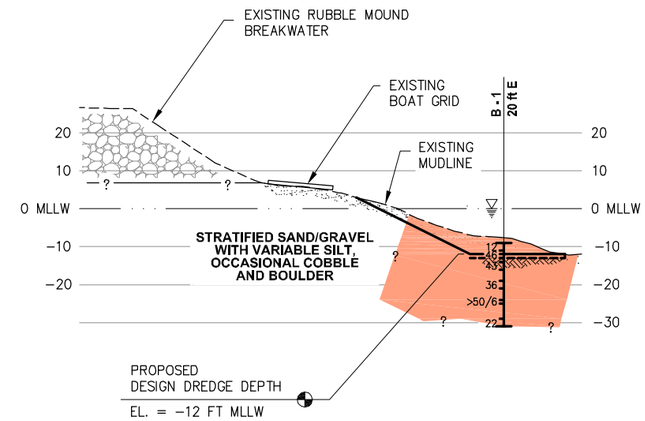
SHEET 8 OF 10



PROFILE F - F'

SCALE IN FEET
0 20 40 FT.

NOTE: HORIZONTAL SCALE EQUALS VERTICAL SCALE



PROFILE G - G'

SCALE IN FEET
0 20 40 FT.

NOTE: HORIZONTAL SCALE EQUALS VERTICAL SCALE

NOTES

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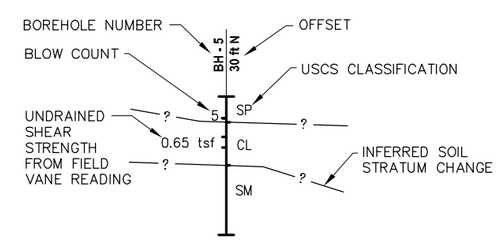

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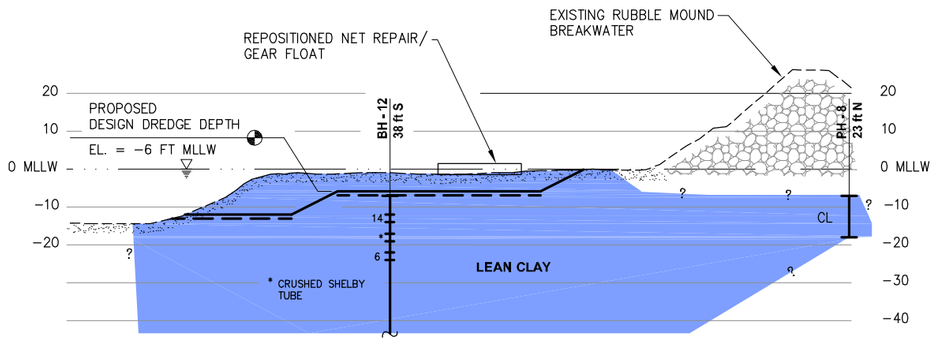
HAINES BOROUGH
SOUTH PORTAGE COVE HARBOR EXPANSION

SHEET TITLE:
GENERALIZED SUBSURFACE PROFILE F-F' AND PROFILE G-G'

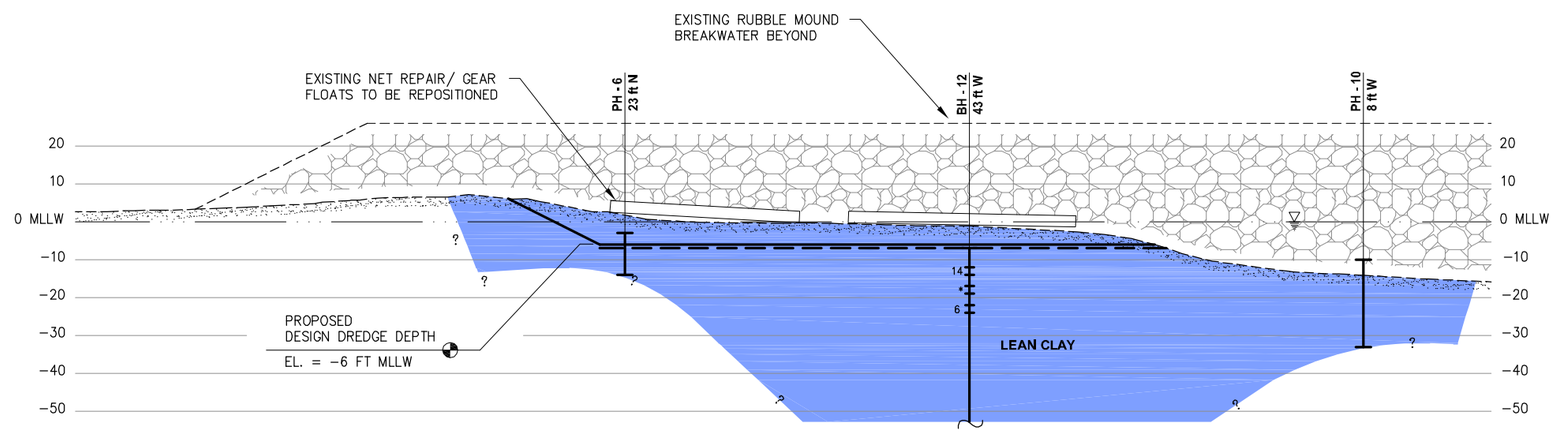
PND PROJECT NO.: 102029.07

A



PROFILE H - H'

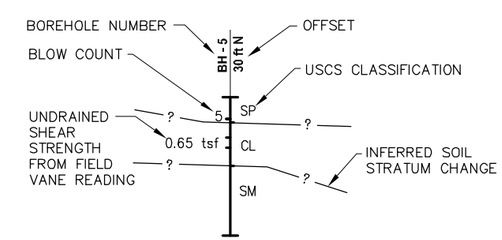
SCALE IN FEET
0 20 40 FT.
NOTE: HORIZONTAL SCALE EQUALS VERTICAL SCALE



PROFILE I - I'

SCALE IN FEET
0 20 40 FT.
NOTE: HORIZONTAL SCALE EQUALS VERTICAL SCALE

LEGEND



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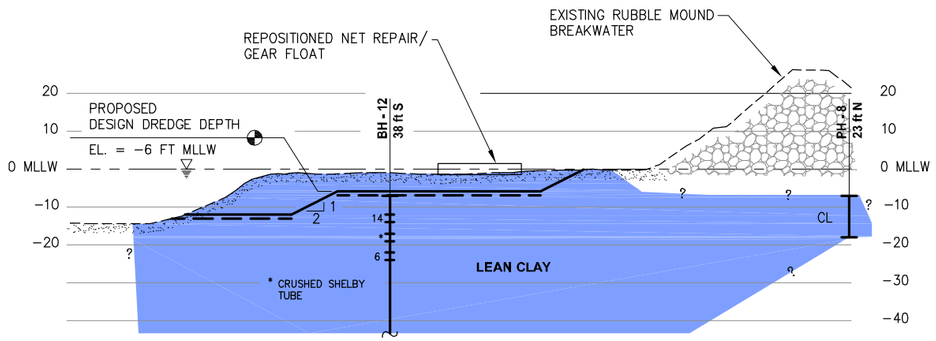
SHEET TITLE:
GENERALIZED SUBSURFACE PROFILE H-H' AND PROFILE I-I'

PND PROJECT NO.: 102029.07

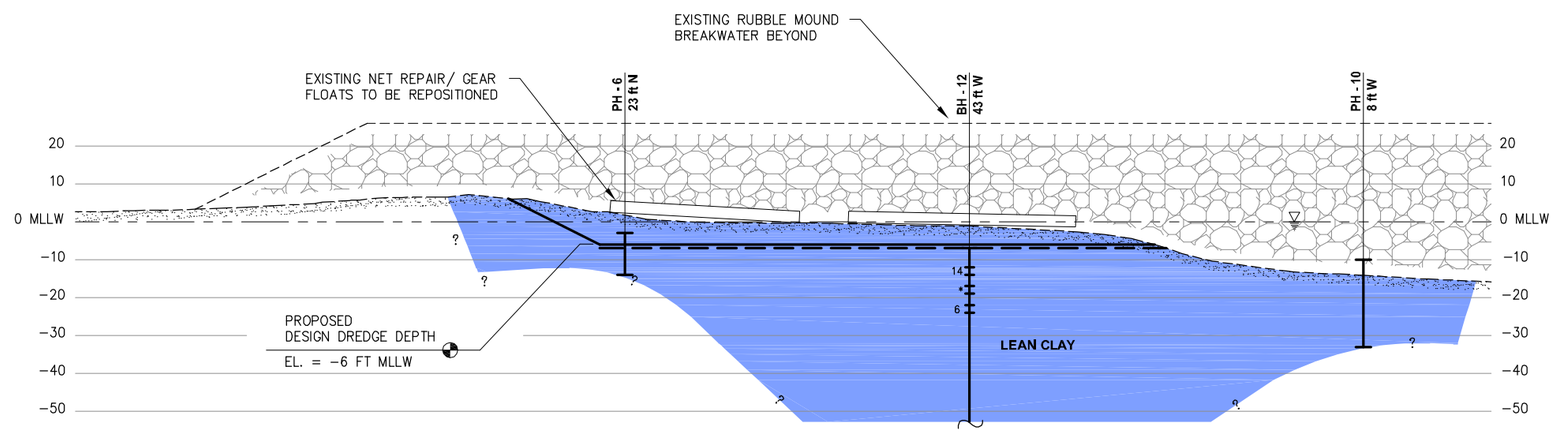
A
SHEET 10 OF 10



PROFILE H - H'

SCALE IN FEET
0 20 40 FT.

NOTE: HORIZONTAL SCALE EQUALS VERTICAL SCALE

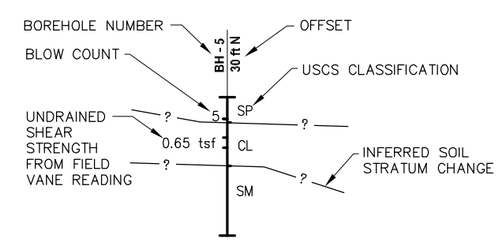


PROFILE I - I'

SCALE IN FEET
0 20 40 FT.

NOTE: HORIZONTAL SCALE EQUALS VERTICAL SCALE

LEGEND



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HAINES BOROUGH
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SHEET TITLE:
GENERALIZED SUBSURFACE PROFILE H-H' AND PROFILE I-I'

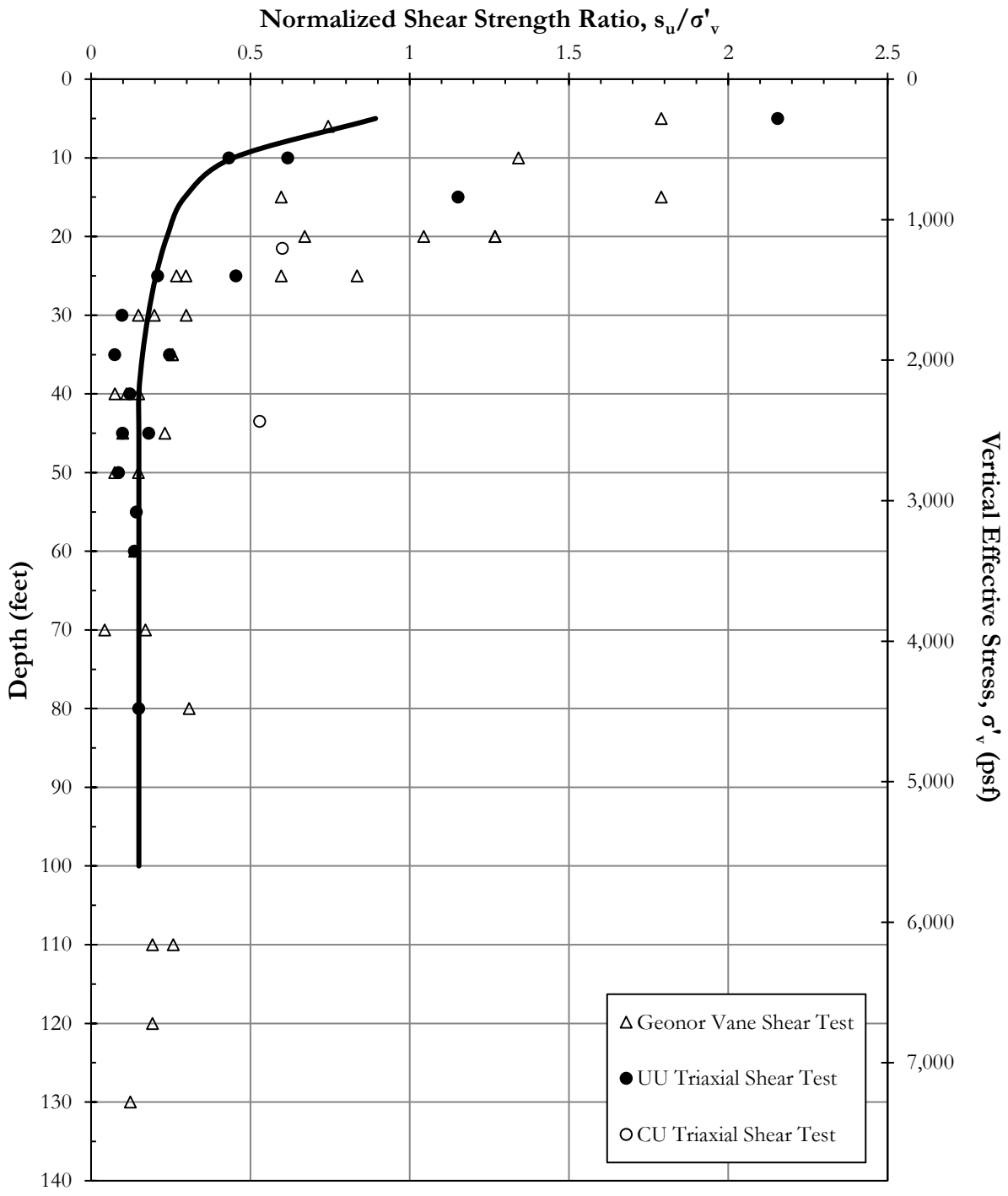
PND PROJECT NO.: 102029.07

A
SHEET 10 OF 10

APPENDIX B

Geotechnical Design Figures

Normalized Shear Strength Profile
South Portage Cove Harbor Clay



P | N | D
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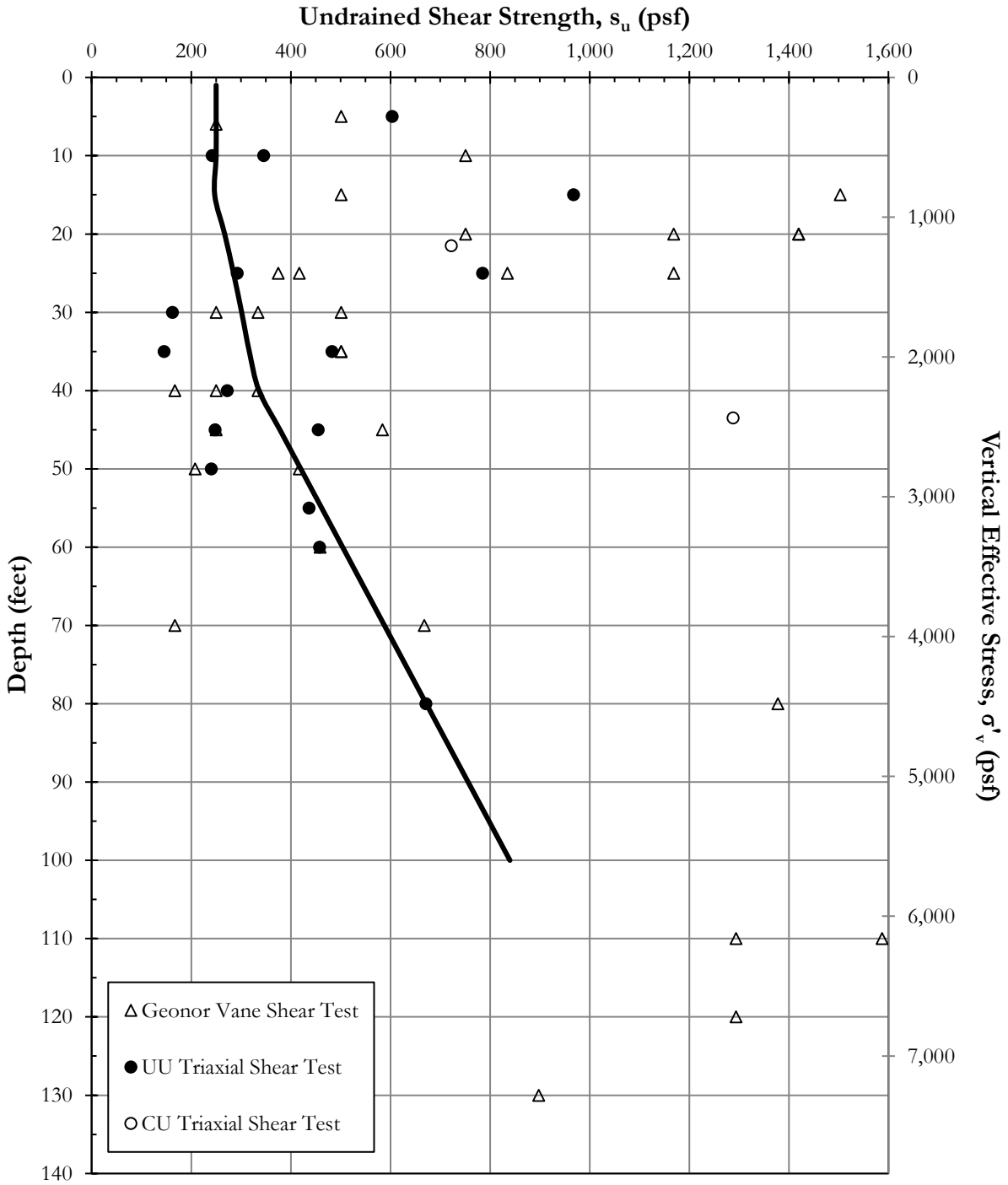
South Portage Cove Harbor Expansion

Figure B-1

Undrained Shear Strength Profile
South Portage Cove Harbor Clay



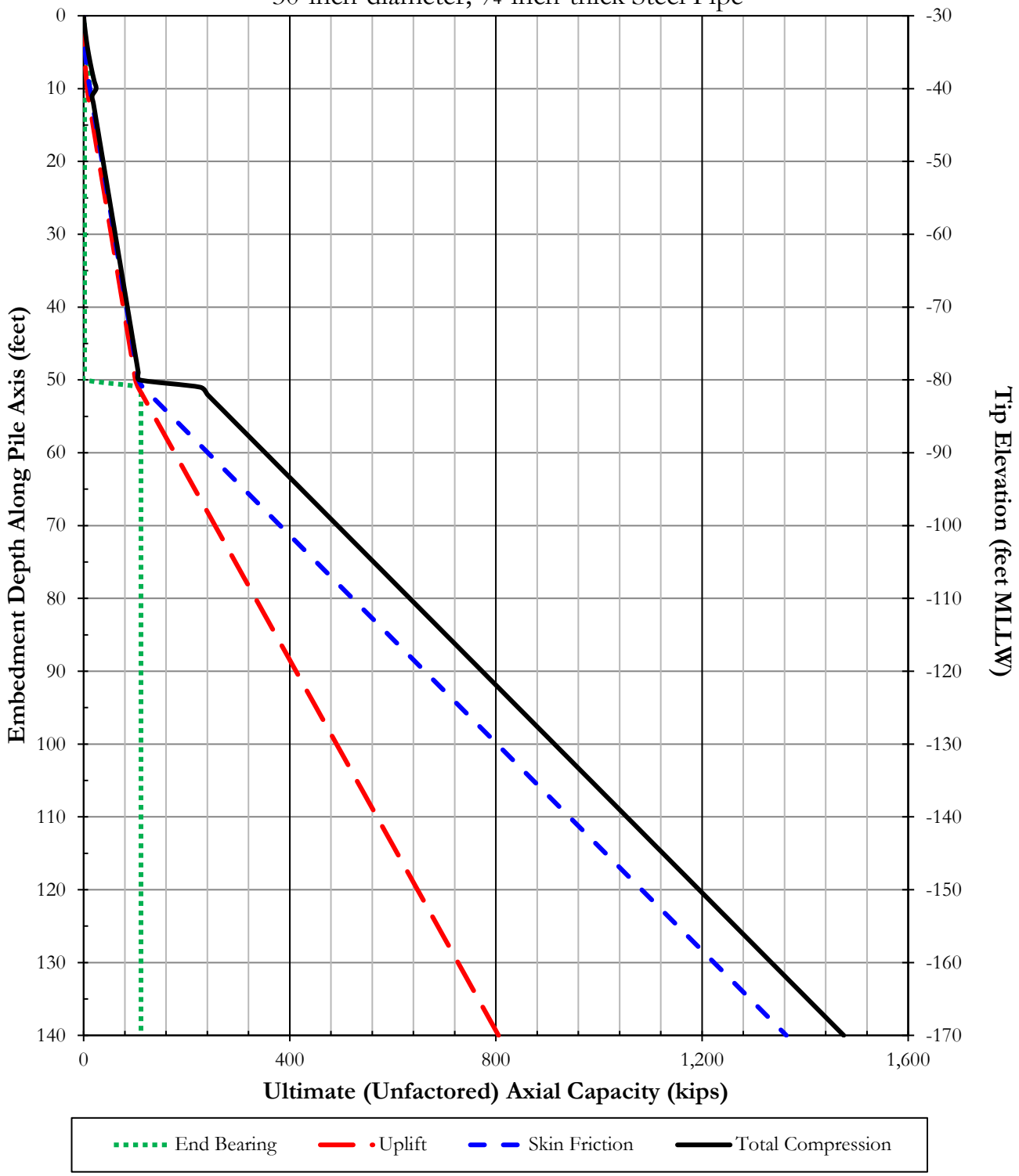
P | N | D
ENGINEERS, INC.

South Portage Cove Harbor Expansion

Figure B-2

Axial Pile Capacity
Partially Penetrating Wave Barrier
Vertical Bearing Piles

30-inch-diameter; ¾-inch-thick Steel Pipe



P | N | D
ENGINEERS, INC.

South Portage Cove Harbor Expansion

Figure B-3

Axial Pile Capacity
Partially Penetrating Wave Barrier
Inside Harbor 2V:1H Batter Bearing Piles

30-inch-diameter; ¾-inch-thick Steel Pipe

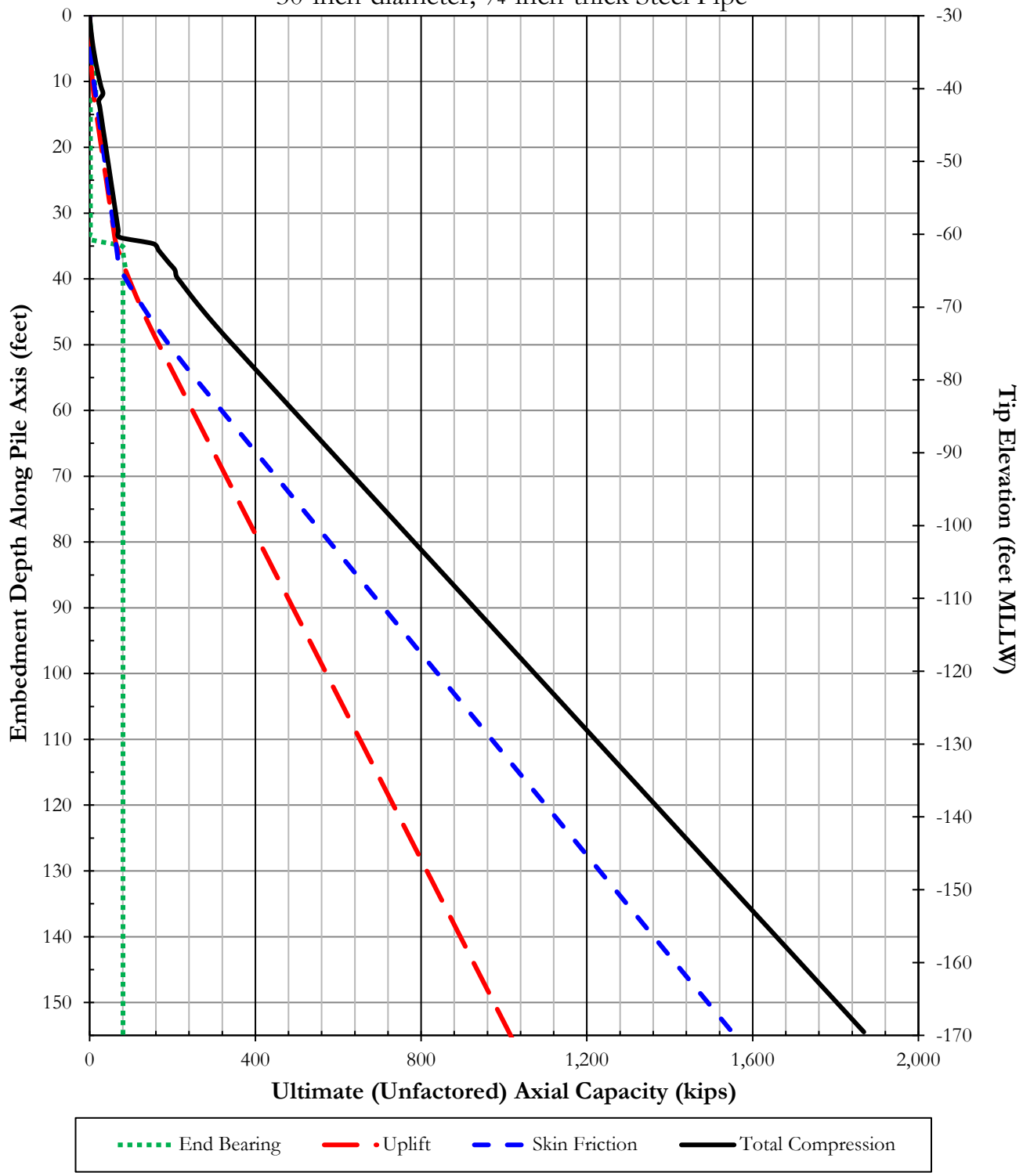


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Figure B-4

Axial Pile Capacity
Partially Penetrating Wave Barrier
Outside Harbor 2V:1H Batter Bearing Piles

30-inch-diameter; ¾-inch-thick Steel Pipe

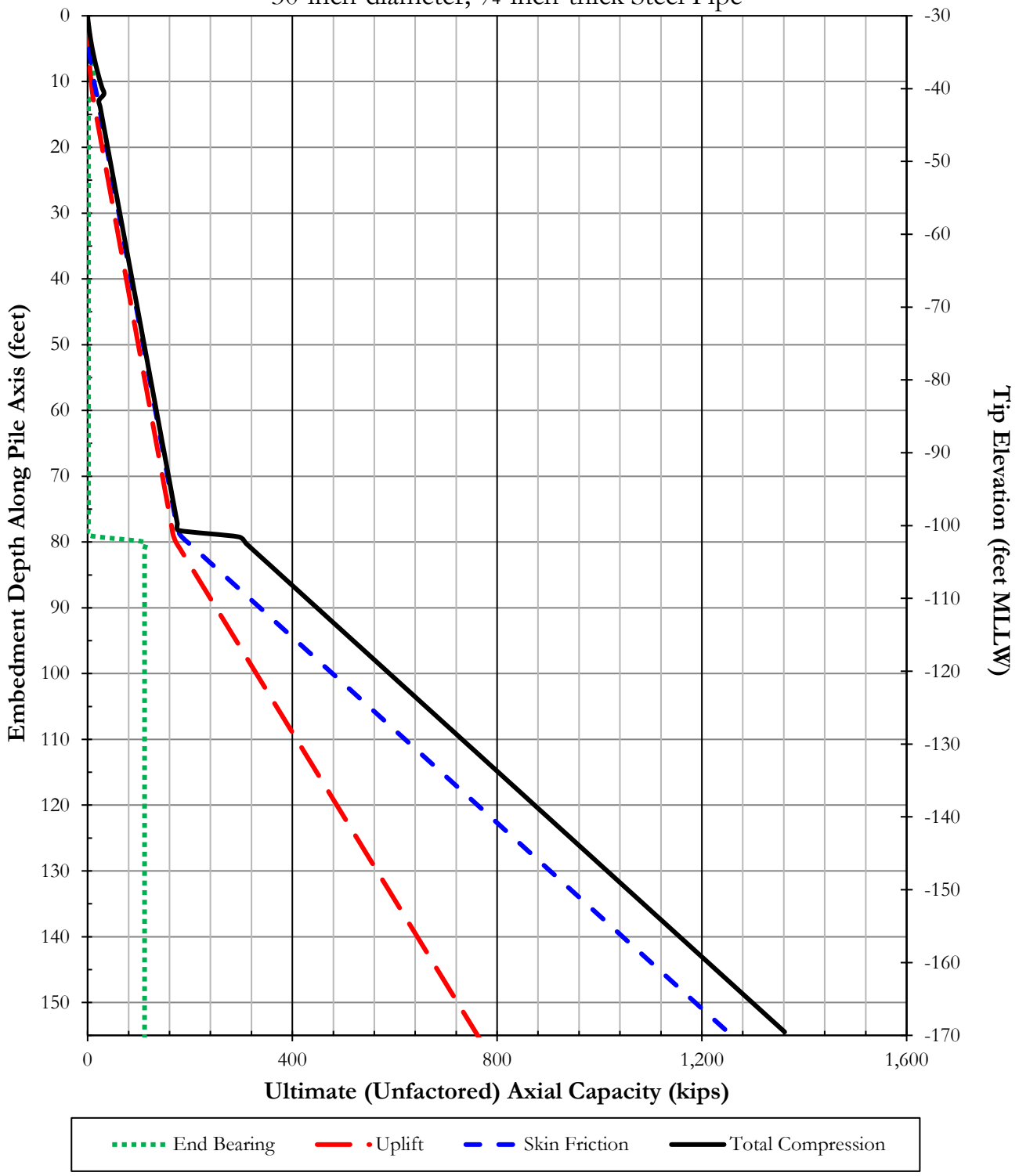

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Figure B-5

Axial Pile Capacity
Partially Penetrating Wave Barrier
Vertical Barrier Piles

24-inch-diameter; ½-inch-thick Steel Pipe

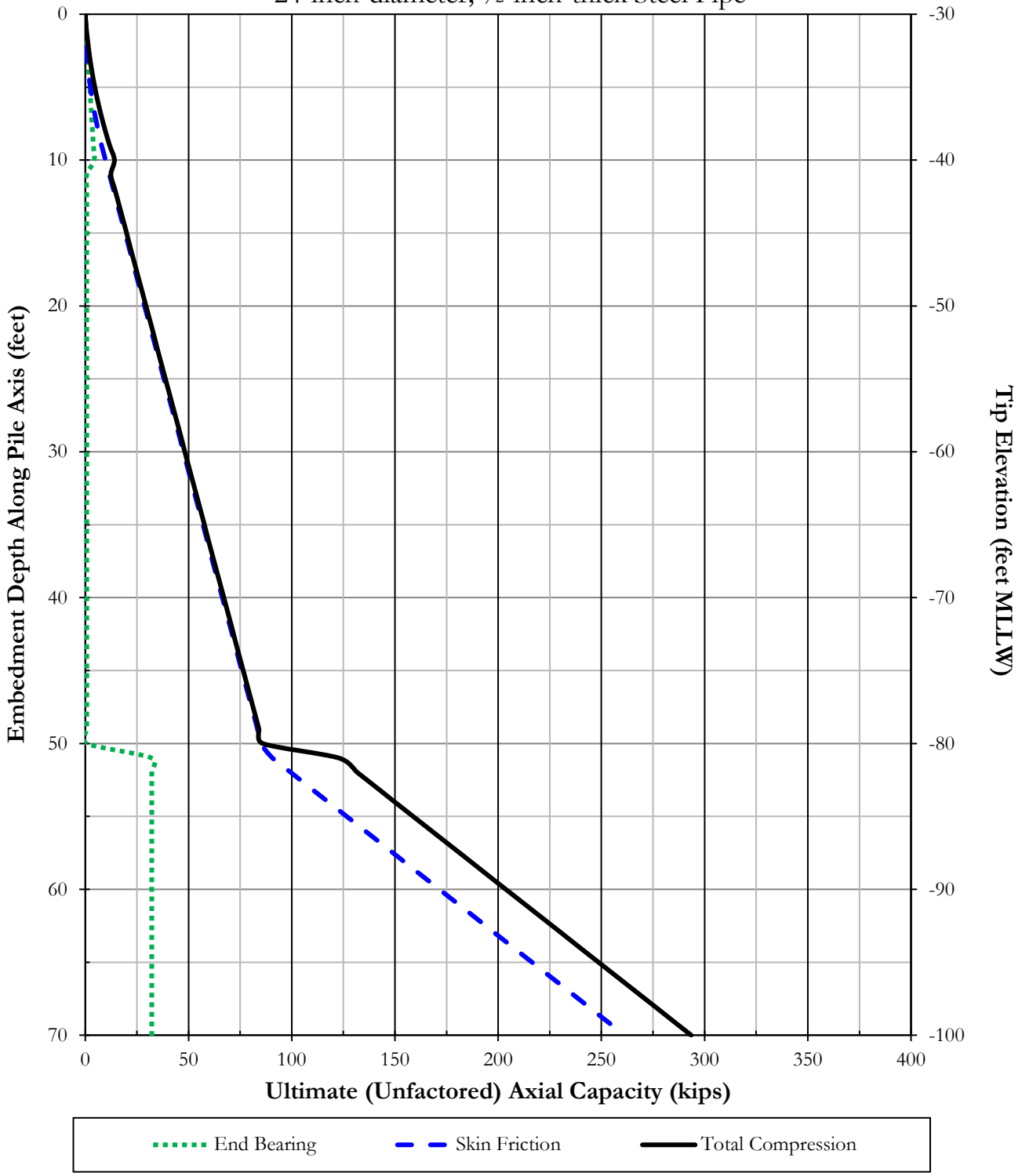

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Figure B-6

APPENDIX C

Borehole Logs

SOILS CLASSIFICATION, CONSISTENCY AND SYMBOLS

CLASSIFICATION

Identification and classification of the soil is accomplished in general accordance with the ASTM version of the Unified Soil Classification System (USCS) as presented in ASTM Standard D2487. The standard is a qualitative method of classifying soil into the following major divisions (1) coarse grained, (2) fine grained, and (3) highly organic soils. Classification is performed on the soils passing the 75 mm (3 inch) sieve and if possible the amount of oversize material (> 75 mm particles) is noted on the soil logs. This is not always possible for drilled test holes because the oversize particles are typically too large to be captured in the sampling equipment. Oversize materials greater than 300 mm (12 inches) are termed boulders, while materials between 75 mm and 300 mm are termed cobbles. Coarse grained soils are those having 50% or more of the non-oversize soil retained on the No. 200 sieve (0.075 mm); if a greater percentage of the coarse grains is retained on the No. 4 (4.76 mm) sieve the coarse grained soil is classified as gravel, otherwise it is classified as sand. Fine grained soils are those having more than 50% of the non-oversize material passing the No. 200 sieve; these may be classified as silt or clay depending their Atterberg liquid and plastic limits or observations of field consistency. Refer to the most recent version of ASTM D2487 for a complete discussion of the classification method.

SOIL CONSISTENCY - CRITERIA

Soil consistency as defined below and determined by normal field and laboratory methods applies only to non-frozen material. For these materials, the influence of such factors as soil structure, i.e. Fissure systems, shinkage cracks, slickensides, etc., must be taken into consideration in making any correlation with the consistency values listed below. In permafrost zones, the consistency and strength of frozen soils may vary significantly and unexplainably with ice content, thermal regime and soil type.

Standard Penetration Test (Blows/ft) Relative to Density/Consistency

N60	Density	Relative Density
0-4	Very Loose	0-15%
4-10	Loose	15-35%
10-30	Medium	35-65%
30-50	Dense	65-85%
> 50	Very Dense	>85%

N60	Consistency	Undrained Shear Strength psf
< 2	Very Soft	< 250
2 - 4	Soft	250 - 500
4 - 8	Medium	500 - 1000
8 - 15	Stiff	1000 - 2000
15 - 30	Very Stiff	2000 - 4000
> 30	Hard	> 4000

Ref: Terzaghi, Peck, and Mesri Soil Mechanics in Engineering Practice, 3rd Edition, pg 60-63

ASTM D1586 Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils

ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (USCS)

SAMPLER TYPE SYMBOLS

A	Auger Sample	Hs	1.4" Split Spoon w/ Air Hammer	Ss	1.4" Split Spoon w/ 140# Hammer
Bs	Bulk (grab) Sample	Pb	Pitcher Barrel	St	1.4" Split Spoon w/ 47# Hammer
Cs	Core Barrel w/ Single Tube	Sl	2.5" Split Spoon w/ 140# Hammer	Sx	2.0" Split Spoon w/ 47# Hammer
Cd	Core Barrel w/ Double Tube	Sm	2.5" Split Spoon w/ 300# Hammer	Sz	1.4 Split Spoon w/ 340# Hammer
Ct	Core Barrel w/ Triple Tube	Sh	2.5" Split Spoon w/ 340# Hammer	Ts	Shelby Tube
Hl	2.5" Split Spoon w/ Air Hammer	Sp	2.5" Split Spoon, Pushed	Tm	Modified 2.5 O.D. Shelby Tube

Notes:

1. Split Spoon size refers to sampler inside diameter.
2. 30-inch drop used for 140# and 340# hammers unless noted otherwise.

Depth (Feet)	Water Table	GRAPHIC SYMBOL	SOIL/ROCK DESCRIPTION Soil Name, Color, Moisture Condition, Relative Density, Soil Structure, Mineralogy, Other Information Rock Name, Description	SAMPLES Number	Type	Location	Recovery (%) (RQD)	Penetration Blows per 6/Inch (per Foot)* or {*Rock Quality*}	GRAPH BLOW COUNT (BPF)* 20 40 60 80 POCKET PEN. (TSF) 1 2 3 4 VANE SHEAR (TSF) 2 4 6 8	COMMENTS Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation Additional Information	Elevation (Feet)
0.0			0' - 0.30' A.C. PAVEMENT								24.43
	▼		POORLY-GRADED GRAVEL W/ SILT AND SAND (GP-GM) Gray, Moist, Dense, Subangular	1	Ss		30	20-20-25 (45)	■	Begin drilling 10/24/03 8:00 a.m. 1.5' to 2' - Hard, loud drilling (Cobbles/Boulder encountered)	
2											22.43
			SLATY ARGILLITE grayish black, fine grained, thin bedded, medium hard, BX-U, steeply dipping	2	Ct		56 (50)	{Poor}		drillhole blockage	
1	2	3	4	5	6	7	8	9	10	11	12

COLUMN DESCRIPTIONS

1	Depth	Depth (in feet) below the ground surface.
2	Water Level	Groundwater level recorded while drilling. Depths and times are recorded in comments column.
3	Graphic Log	Graphic depiction of materials encountered.
4	Soil/ Rock Description	Description of materials encountered, including USCS soil descriptions and rock descriptions defined in Fig. B-5 and B-6.
5	Sample Number	Sample identification number.
6	Sample Type	Type of soil or rock sample collected at depth interval depicted; symbols explained on Fig. B-1.
7	Sample Location	Location of soil or rock sample taken.
8	Sample Recovery	Soil: Percentage of sample recovered. Rock: Percentage of sample recovered and RQD value.
9	Sample Blows or Rock Quality	Soil: Number of blows to advance driven sampler each 6-inch interval using sampler type specified with a 30-inch drop. Blows per foot given in parentheses. Rock: Rock quality as defined from RQD value.
10	Graphs	Graphic log depicting blow counts per foot with a specified split spoon, Pocket Penetration and Vane Shear tests depicted where taken on fine grained soils.
11	Comments	Comments or observations on drilling/sampling by driller or PND field personnel.
12	Elevation	Elevation (in feet) with respect to Mean Lower Low Water (MLLW) or other datum where specified.

GENERAL NOTES

1. Field descriptions may have been modified to reflect laboratory test results.
2. Descriptions on these boring logs apply only at the specific locations at the time the borings were drilled. They are not warranted to be representative of subsurface conditions at other locations or times.
3. Split spoon blow counts shown are uncorrected raw data. Various hammer sizes and split spoon sizes were used and have not been corrected to a Standard Penetration Test (SPT). Blow counts may vary substantially between SPT and these methods.

Soil Legend

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	Well-graded gravels, gravel sand mixtures, little or no fines
				GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE (4.75mm)	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	Silty gravels, gravel-sand-silt mixtures
				GC	Clayey gravels, gravel-sand-clay mixtures
	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	Well-graded sands, gravely sands, little or no fines
MORE THAN 50% RETAINED ON NO. 200 SIEVE (0.075mm)				SP	Poorly graded sands, gravelly sands, little or no fines
	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE (4.75mm)	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	Silty sands, sand-silt mixtures
				SC	clayey sands, sand-clay mixtures
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
				OL	Organic silts and organic silty clays of low plasticity
MORE THAN 50% PASSING NO. 200 SIEVE (0.075mm)	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	Inorganic silts, micaceous or diatomceous fine sandy or silty soils, elastic silts
				CH	Inorganic clays of high plasticity, fat clays
				OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS				PT	Peat and other highly organic soils

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications as per ASTM 2488

Stratigraphic Contact

———————— Distinct contact between soil strata or geologic units

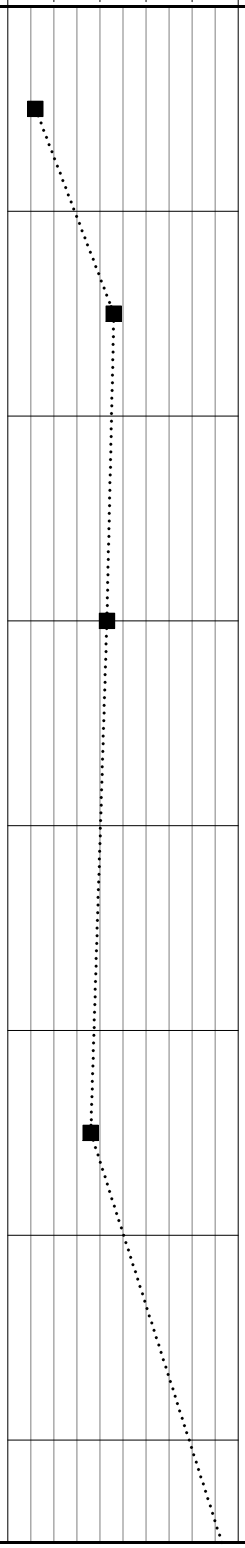
– – – – – – – – – – Approximate location of soil strata change within a geologic soil unit

Laboratory / Field Tests List of Abbreviations

%F	Percent Fines	HA	Hydrometer Analysis	PP	Pocket Penetrometer
AL	Atterberg Limits	LMA	Limited Mechanical Analysis	SA	Sieve Analysis
CP	Laboratory Compaction test	MC	Moisture Content	TV	Torvane
CO	Consolidation test	MD	Moisture content and Dry density	TX	Triaxial Shear
DP	Depth "Peat" Probe	OC	Organic Content	UC	Unconfined Compression
DS	Direct Shear	PM	Permeability or Hydraulic Conductivity	VS	Vane Shear

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, medium dense to dense; occasional subrounded gravel to 3-in dia. and cobbles	1	Sh		50	3-6-6-6 (12)	Begin Drilling: 9-7-14; Time: 11:30 AM 4-in dia. casing reinforced strong grinding of the tricone bit to 4 ft	-9.0
2.5				2	Sh		100	18-24-22-18 (46)		-11.5
5.0			POORLY-GRADED GRAVEL WITH SAND (GP) gray, wet, dense; subrounded gravel to 2-in dia.	3	Sh		84	19-25-18-25 (43)	MC=5.3%;SA (%F=4.9) milky fines in cuttings	-14.0
7.5			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP) gray, wet, dense; subrounded gravel to 3-in dia.						strong grinding of the tricone bit	-16.5
10.0				4	Sh		75	14-18-18-18 (36)		-19.0
12.5									milky fines in cuttings	-21.5
15.0										-24.0

GRAPH: BLOW COUNT (20, 40, 60, 80); POCKET PEN (tsf) (1, 2, 3, 4); VANE SHEAR (tsf) (0.2, 0.4, 0.6, 0.8)



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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-1

FIGURE C-2
1 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP) gray, wet, dense; subrounded gravel to 3-in dia.*(continued)*	5	Sh			20-50/6" (50/6")*		*obstruction at 16 ft; blow count likely overstated recovery percentage of sample interval not noted in the field	-24.0
17.5											-26.5
			POORLY-GRADED SAND WITH GRAVEL (SP) gray, wet, medium dense; subrounded gravel to 2-in dia.								
20.0				6	Sh			12-10-12-16 (22)		MC=7.4%;SA (%F=3.6) recovery percentage of sample interval not noted in the field	-29.0
			Total sampled depth = 22 ft							End Drilling: 9-7-14; Time: 3:10 PM	
22.5											-31.5
25.0											-34.0
27.5											-36.5
30.0											-39.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-1

FIGURE C-2
2 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, loose; occasional subrounded gravel to 3-in dia. and cobbles	1	Bs					Begin Drilling: 9-12-14; Time: 8:20 PM 4-in dia. casing reinforced soil at Sample No.1 and No.2 were obtained by hand digging due to the difficulty encountered in obtaining sample material at similar depth in BH-13	4.0
2.5				2	Bs						1.5
5.0											-1.0
7.5				3	Sh		50	2-2-2-2 (4)			-3.5
10.0			SILTY SAND WITH GRAVEL (SM) light gray, wet, dense; subrounded gravel to 3-in dia.	4	Sh		38	12-15-21-19 (36)			-6.0
12.5											-8.5
15.0											-11.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-2

FIGURE C-3
1 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	GRAPH: BLOW COUNT (20 40 60 80) / POCKET PEN (tsf) (1 2 3 4) / VANE SHEAR (tsf) (0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0			SILTY SAND WITH GRAVEL (SM) light gray, wet, dense; subrounded gravel to 3-in dia.*(continued)*								-11.0
17.5											-13.5
20.0				5	Sh		50	24-25-25-28 (50)			-16.0
			Total sampled depth = 21 ft							End Drilling: 9-12-14; Time: 11:30 PM	
22.5											-18.5
25.0											-21.0
27.5											-23.5
30.0											-26.0

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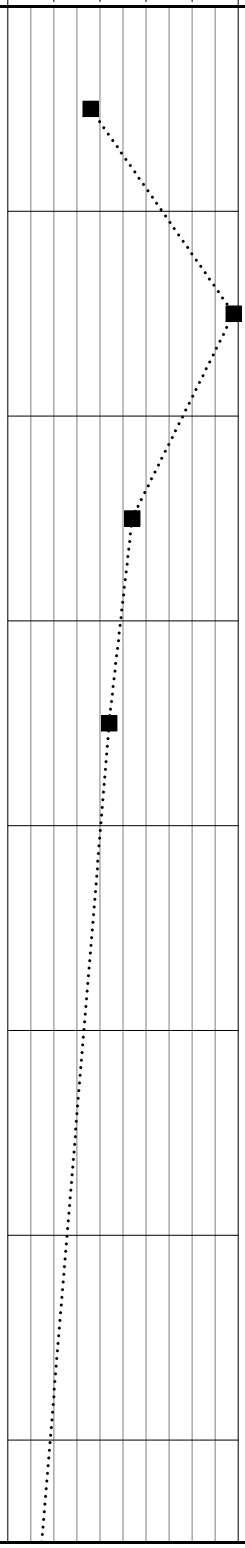
BOREHOLE B-2

FIGURE C-3
2 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND WITH GRAVEL (SM) grayish green, wet, dense to very dense; subangular to subrounded gravel to 3-in dia. and occasional cobble	1	Sh		50	4-18-18-10 (36)	Begin Drilling: 9-6-14; Time: 12:05 PM	-4.5
2.5				2	Sh		84	8-50-48-50 (98)	hard advance and strong grinding of the tricone bit	-7.0
5.0			GRAVELLY LEAN CLAY WITH SAND (CL) grayish green, wet, hard; medium plasticity Classification infered based on nearby sampled boreholes	3	Sh		100	5-18-36-48 (54)		-9.5
				4	Sh		100	4-10-34-50 (44)	milky fines in cuttings	
7.5			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) grayish green, wet, dense; subrounded gravel to 3-in dia.							-12.0
				5	Sh		50	4-48		
10.0										-14.5
12.5			POORLY-GRADED SAND WITH GRAVEL (SP) grayish green, wet, loose; subangular to subrounded gravel to 1-in dia.							-17.0
15.0										-19.5

GRAPH: BLOW COUNT (20, 40, 60, 80); POCKET PEN (tsf) (1, 2, 3, 4); VANE SHEAR (tsf) (0.2, 0.4, 0.6, 0.8)



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BOREHOLE B-3

FIGURE C-4
1 of 5

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0			POORLY-GRADED SAND WITH GRAVEL (SP) grayish green, wet, loose; subangular to subrounded gravel to 1-in dia. *(continued)*	6	Sh		50	1-4-7-15 (11)		MC=5.2%;SA (%F=0.8) slow and hard advance of the tricone bit; drill rig bouncing	-19.5
17.5											-22.0
			POORLY-GRADED SAND (SP) light gray, wet, loose to medium dense; fine grained sand								
20.0											-24.5
			POORLY-GRADED GRAVEL WITH SAND (GP) grayish green, wet, loose to medium dense; subrounded gravel to 3/4-in dia.	7A 7B	Sh		75	1-3-6-13 (9)		MC=0.8%;SA (%F=0.1) tricone bit grinding	
22.5											-27.0
25.0											-29.5
			POORLY-GRADED GRAVEL WITH SILT AND SAND (GP-GM) gray, wet, medium dense; subrounded gravel to 2.25-in dia.	8A 8B	Sh		100	2-12-12-12 (24)		MC=6.5%;SA (%F=7.4) tricone bit grinding	
27.5											-32.0
			POORLY-GRADED GRAVEL (GP) gray, wet, medium dense; subrounded gravel to 1/2-in dia.								
30.0											-34.5

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-3

FIGURE C-4
2 of 5

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
30.0			POORLY-GRADED GRAVEL (GP) gray, wet, medium dense; subrounded gravel to 1/2-in dia.*(continued)*	9A						-34.5
				9B 9C	Sh		67	3-4-10-16 (14)		
			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, medium dense; subrounded gravel to 1.5-in dia.							
32.5										-37.0
			POORLY-GRADED GRAVEL WITH SAND (GP) dark gray, wet, medium dense; subangular to subrounded gravel to 1-in dia.						tricone bit grinding	
35.0									MC=3.0%;SA (%F=1.5)	-39.5
				10	Sh		59	5-8-10-12 (18)		
37.5										-42.0
			SILTY SAND WITH GRAVEL (SM) gray, wet, dense; subrounded gravel to 2.0-in dia. Description based on nearby sampled boreholes							
40.0									*blow count likely overstated: sampler pushing cobble or boulder (at 41.5 ft drill steel "ringing")	-44.5
				11	Sh		0	6-20-20-50/3" (40)*	NO RECOVERY	
42.5										-47.0
45.0										-49.5

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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BOREHOLE B-3

FIGURE C-4
3 of 5

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
45.0			SILTY SAND WITH GRAVEL (SM) gray, wet, dense; subrounded gravel to 2.0-in dia.*(continued)*							very rough and slow drilling	-49.5
47.5			WELL-GRADED GRAVEL WITH SAND (GW) gray, wet, dense Description based on nearby sampled boreholes								-52.0
50.0				12	Sh		0	5-18-21-25/1" (39)		NO RECOVERY	-54.5
52.5											-57.0
55.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, dense Description based on nearby sampled boreholes							casing drives extremely hard	-59.5
57.5											-62.0
60.0											-64.5

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SOUTH PORTAGE COVE
HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-3

FIGURE C-4
4 of 5

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, dense*(continued)* Description based on nearby sampled boreholes	13	Sh		0	4-11-25-37 (36)		NO RECOVERY	-64.5
			Total sampled depth = 62 ft							End Drilling: 9-7-14; Time: 2:30 AM	
62.5											-67.0
65.0											-69.5
67.5											-72.0
70.0											-74.5
72.5											-77.0
75.0											-79.5

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-3

FIGURE C-4
5 of 5

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND WITH GRAVEL (SM) gray, wet, dense to very dense; subangular to subrounded gravel to 3-in dia. and occasional cobble to boulder-size material							Begin Drilling: 9-12-14; Time: 2:55 PM 4-in dia. casing reinforced landingcraft couldn't position over intended borehole target due to surrounding large surficial boulders	0.0
2.5										casing drive hard	-2.5
5.0											-5.0
				1	Sh		0	50 (50/6")*		*blow count likely overstated due to gravels NO RECOVERY	
7.5			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, loose to dense; subangular to subrounded gravel to 3-in dia.							casing BPF (>120/ 6-in) *obstruction at 9.5 ft; blow count likely overstated	-7.5
				2	Sh			47-48-48-50/5" (96)*		recovery percentage of sample interval not recorded in the field	
10.0										stop casing advance (freehole down to 15 ft); intermittent 3 to 6-in drops as the tricone bit advances	-10.0
12.5											-12.5
15.0											-15.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-4

FIGURE C-5
1 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet) / Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0		POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, loose to dense; subangular to subrounded gravel to 3-in dia.*(continued)* Note density decrease	3	Sh		34	2-1-8-20 (9)			-15.0
		Total sampled depth = 17 ft							End Drilling: 9-12-14; Time: 4:00 PM	
17.5										-17.5
20.0										-20.0
22.5										-22.5
25.0										-25.0
27.5										-27.5
30.0										-30.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-4

FIGURE C-5
2 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND WITH GRAVEL (SM) subangular to subrounded gravel to 3-in dia. and occasional cobble to boulder-size material						Begin Drilling: 9-12-14; Time: 8:45 PM 4-in dia. casing reinforced	-3.0
2.5			LEAN CLAY (CL) gray, wet, very stiff; medium plasticity; slow dilatancy							-5.5
5.0				1	Sh		67	1-2-19-33 (21)	PP = 0.75tsf MC=24.1%; AL	-8.0
7.5			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, very dense; subrounded gravel to 3.0-in dia.	2	Sh		67	58-85-74-80 (100+)		-10.5
10.0				3	Sh		67	90-88-92-97 (100+)	casing drives extremely hard; switch to 3-in dia. casing within 4-in casing	-13.0
12.5				4	Sh		0	4-6-55 (61)	NO RECOVERY at 13.5 ft unable to advance either casing or sampler; pulled casing and repositioned approximately 8 ft north; drive casing to 9 ft below mudline; (Sh sampler 60 blows/3-in)	-15.5
15.0										-18.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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BOREHOLE B-5

FIGURE C-6
1 of 4

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, very dense; subrounded gravel to 3.0-in dia.*(continued)*	5	Sh		50	50/3" (50/3")*	*obstruction at 15 ft; blow count likely overstated	-18.0
17.5										-20.5
20.0				6A						-23.0
			SILTY SAND WITH GRAVEL (SM) gray, wet, dense; subrounded gravel to 1.5-in dia.	6B	Sh		21	2-12-38-45 (50)		
22.5									strong grinding of the tricone bit	-25.5
									milky fines in cuttings	
25.0				7	Sh		0	50/4" (50/4")*	*obstruction at 25 ft; blow count likely overstated NO RECOVERY	-28.0
27.5										-30.5
									strong grinding of the tricone bit	
30.0										-33.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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BOREHOLE B-5

FIGURE C-6
2 of 4

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
30.0			SILTY SAND WITH GRAVEL (SM) gray, wet, dense; subrounded gravel to 1.5-in dia.*(continued)*	8	Sh		25	4-12-28-28 (40)			-33.0
										milky fines in cuttings	
32.5											-35.5
			WELL-GRADED GRAVEL WITH SAND (GW) grayish green, wet, dense; subangular to subrounded gravel to 1/2-in dia.								
35.0										MC=2.1%;SA (%F=0.8)	-38.0
				9	Sh		100	11-28-28-12 (56)			
37.5											-40.5
40.0			SILTY SAND WITH GRAVEL (SM) gray, wet, very dense; subrounded gravel to 2.0-in dia.	10	Sh		0	50 (50/6")*		*obstruction at 40 ft; drill steel "ringing"; approx. 30 minutes to clear obstruction with tricone bit NO RECOVERY	-43.0
42.5											-45.5
45.0											-48.0

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BOREHOLE B-5

FIGURE C-6
3 of 4

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
45.0			SILTY SAND WITH GRAVEL (SM) gray, wet, very dense; subrounded gravel to 2.0-in dia.*(continued)* Subrounded coarse grains supported within very fine to fine grained, hard matrix	11	Sh		67	52-64-50 (100+)	MC=6.8%;SA (%F=13.0)	-48.0
47.5									at 49 ft: lost water head in casing	-50.5
50.0				12A						-53.0
			WELL-GRADED GRAVEL WITH SAND (GW) grayish green, wet, medium dense; subrounded gravel to 2.0-in dia.	12B	Sh		34	4-7-22-34 (29)	MC=0.8%%;SA (%F=0.1)	
52.5									strong grinding of the tricone bit noticeable water pressure coming up casing	-55.5
55.0										-58.0
									predominantly fine grained sand in cuttings	
57.5										-60.5
			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) based on nearby sampled bholes							
									at 60 ft: approx. 8 ft of heave	
60.0			Total drilled depth = 60ft						End Drilling: 9-13-14; Time: 3:36 PM	-63.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-5

FIGURE C-6
4 of 4

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND (SM) gray, wet, loose to medium dense; occasional subrounded gravel to 1.5-in dia.	1	Sh		50	5-8-6-4 (14)		Begin Drilling: 9-10-14; Time: 10:00 PM 4-in dia. casing reinforced	-7.5
2.5				2	Sh		71	8-13-11-7 (24)			-10.0
5.0			SANDY LEAN CLAY (CL) greenish gray, wet, soft to medium stiff; occasional subrounded gravel to 1.5-in dia.	3	Sh			4-2-2-6 (4)		sampler sent down multiple times to obtain sample material recovery percentage not recorded	-12.5
				4	Sh			3-10-6 (16)		sampler sent down multiple times to obtain sample material recovery percentage not recorded	
7.5			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, very loose to loose; subrounded gravel to 2.5-in dia.	5	Sh		50	4-4-2 (6)			-15.0
10.0											-17.5
12.5											-20.0
15.0											-22.5

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BOREHOLE B-6

FIGURE C-7
1 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, very loose to loose; subrounded gravel to 2.5-in dia.*(continued)*	6	Sh		13	2-1-2-1 (3)			-22.5
17.5										strong grinding of the tricone bit	-25.0
			SILTY SAND WITH GRAVEL (SM) gray, wet, dense; subrounded gravel to 2.5-in dia.								
20.0				7	Sh		53	4-8-48-50/3" (56)*		MC=8.6%;SA (%F=18.4) *obstruction at 21.5 ft; blow count likely overstated	-27.5
22.5										casing BPF > 150/6-in; halted casing advance; strong grinding of the tricone bit; drill rig bouncing	-30.0
			Total drilled depth = 24 ft							End Drilling: 9-11-14; Time: 11:05 AM	
25.0											-32.5
27.5											-35.0
30.0											-37.5

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-6

FIGURE C-7
2 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND (SM) gray, wet, medium dense to dense; occasional subrounded gravel to 3.0-in dia., and subrounded cobble to boulder size material							Begin Drilling: 9-12-14; Time: 12:10 PM 4-in dia. casing reinforced landingcraft couldn't position over intended borehole target due to surrounding large surficial boulders; consideration also given to buried sewer outfall pipe; borehole relocated approx. 100 ft north	3.0
2.5										strong grinding of the tricone bit with drill rig bouncing	0.5
5.0											-2.0
			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, medium dense to dense; subrounded gravel to 3.0-in dia.								
7.5				1	Sh		34	50/3" (50/3")*		*obstruction at 8 ft; blow count likely overstated	-4.5
10.0				2	Sh		25	50/4" (50/4")*		*obstruction at 10 ft; blow count likely overstated	-7.0
12.5										halt casing advance (freehole down to 15 ft)	-9.5
										strong grinding of the tricone bit with drillrig bouncing	
15.0											-12.0

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BOREHOLE B-7

FIGURE C-8
1 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0				3	Sh		0	35-50/2" (50/2")*		*obstruction at 15.5 ft; blow count likely overstated NO RECOVERY	-12.0
			Total sampled depth = 15.6 ft							End Drilling: 9-12-14; Time: 1:40 PM	
17.5											-14.5
20.0											-17.0
22.5											-19.5
25.0											-22.0
27.5											-24.5
30.0											-27.0

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BOREHOLE B-7

FIGURE C-8
2 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	GRAPH: BLOW COUNT (20 40 60 80) / POCKET PEN (tsf) (1 2 3 4) / VANE SHEAR (tsf) (0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND (SM) gray, wet, loose; occasional subrounded gravel to 1.5-in dia.							Begin Drilling: 9-10-14; Time: 12:00 PM 4-in dia. casing reinforced	-10.0
				1	Sh		34	4-4-6-5 (10)			
2.5				2	Sh		75	3-3-5-4 (8)		steady casing advance	-12.5
5.0				3	Sh		34	2-4-3-1 (7)		sampler sunk 2 ft after last blow	-15.0
			Total sampled depth = 7 ft							End Drilling: 9-10-14; Time: 3:40 PM	
7.5											-17.5
10.0											-20.0
12.5											-22.5
15.0											-25.0

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BOREHOLE B-8

FIGURE C-9
1 of 1

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND (SM) gray, wet, loose; occasional subrounded gravel to 1.5-in dia.							Begin Drilling: 9-9-14; Time: 7:40 PM 4-in dia. casing reinforced	-5.0
2.5											-7.5
5.0				1	Sh			3-3-4-5 (7)		recovery percentage of sample interval not noted in the field	-10.0
			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) light gray, wet, dense; subangular to subrounded gravel to 1.5-in dia.	2	Sh			9-20-17-19 (37)		recovery percentage of sample interval not noted in the field	
7.5											-12.5
10.0				3	Sh		38	8-20-19-24 (39)			-15.0
12.5											-17.5
15.0											-20.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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BOREHOLE B-9

FIGURE C-10
1 of 3

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) light gray, wet, dense; subangular to subrounded gravel to 1.5-in dia.*(continued)*	4	Sh		30	2-15-21-23 (36)		-20.0
17.5										-22.5
20.0				5	Sh		75	9-26-32-40 (58)	MC=6.4%;SA (%F=10.0)	-25.0
22.5										-27.5
			SILTY SAND (SM) gray, wet, loose to medium dense							
25.0			Classification infered and based on nearby sampled boreholes and drill action	6	Sh		0	2-4-6-19 (10)*	NO RECOVERY *blow count likely understated due to sluff in casing	-30.0
27.5									drilling action and casing advance indicate increasing density and gravel content	-32.5
30.0										-35.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-9

FIGURE C-10
2 of 3

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
30.0			SILTY SAND (SM) gray, wet, loose to medium dense*(continued)*	7	Sh		0	1-2-4-20 (6)*		*blow count likely understated due to sluff in casing NO RECOVERY	-35.0
32.5										drilling action and casing advance indicate similar soil conditions from approx. 25 ft below mudline to borehole bottom	-37.5
35.0				8	Sh		0	5-9-8-16 (17)		NO RECOVERY	-40.0
37.5											-42.5
40.0			Increase in soil density indicated by elevated SPT value	9	Sh		0	4-8-24-42 (32)		NO RECOVERY	-45.0
42.5			Total sampled depth = 42 ft							End Drilling: 9-10-14; Time: 5:30 AM	-47.5
45.0											-50.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-9

FIGURE C-10
3 of 3

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	GRAPH	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND WITH GRAVEL (SM) gray, wet, medium dense; subrounded gravel to 3.0-in dia.							Begin Drilling: 9-10-14; Time: 11:05 AM 4-in dia. casing reinforced landingcraft couldn't position over intended borehole target due to surrounding large surficial boulders	2.0
2.5											-0.5
5.0										strong grinding of the tricone bit down to 8 ft	-3.0
7.5											-5.5
				1	Sh		84	8-14-14-17 (28)			
10.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, dense; subrounded gravel to 1.5-in dia.								-8.0
				2	Sh		84	12-18-24-22 (42)			
12.5											-10.5
15.0											-13.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-10

FIGURE C-11
1 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, dense; subrounded gravel to 1.5-in dia.*(continued)*								-13.0
17.5				3	Sh		100	15-18-18 (36)			-15.5
			Total sampled depth = 18.5 ft							End Drilling: 9-10-14; Time: 1:15 PM	
20.0											-18.0
22.5											-20.5
25.0											-23.0
27.5											-25.5
30.0											-28.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-10

FIGURE C-11
2 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND (SM) gray, wet, loose to dense; occasional subrounded gravel to 1.5-in dia.							Begin Drilling: 9-13-14; Time: 12:00 AM 4-in dia. casing reinforced	-3.0
				1	Sh		38	8-8-7-7 (15)			
2.5				2	Sh		58	5-4-3-1 (7)			-5.5
5.0											-8.0
				3	Sh		75	2-7-17-22 (24)			
7.5				4	Sh		58	27-25-18-27 (43)			-10.5
10.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, medium dense to very dense; occasional subrounded gravel to 3.0-in dia.								-13.0
12.5				5	Sh		60	13-90/4" (90/4")*		*blow count likely overstated due to gravel	-15.5
15.0											-18.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-11

FIGURE C-12
1 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, medium dense to very dense; occasional subrounded gravel to 3.0-in dia.*(continued)*								-18.0
17.5											-20.5
20.0				6	Sh		0	71		NO RECOVERY	-23.0
			Total sampled depth = 20.5 ft							End Drilling: 9-14-14; Time: 7:20 AM	
22.5											-25.5
25.0											-28.0
27.5											-30.5
30.0											-33.0

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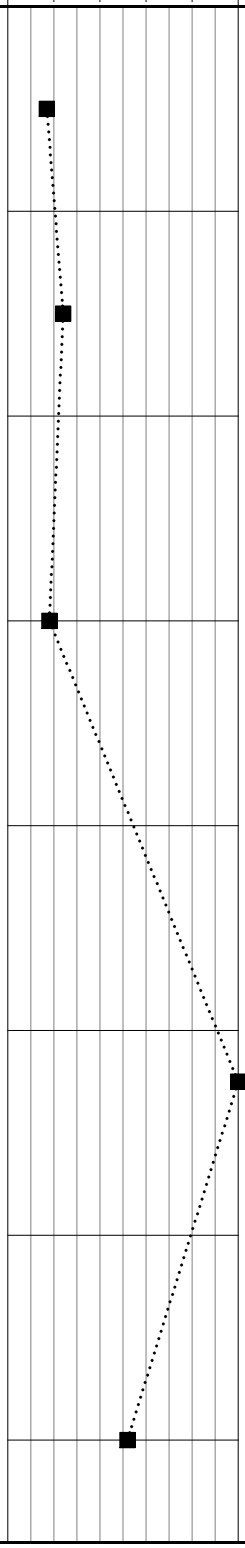
BOREHOLE B-11

FIGURE C-12
2 of 2

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, medium dense; occasional subrounded gravel to 3.0-in dia. and cobbles	1	Sh		46	4-7-10-10 (17)	Begin Drilling: 9-7-14; Time: 3:45 PM 4-in dia. casing reinforced	-9.5
2.5				2	Sh		59	9-12-12-16 (24)		-12.0
									strong grinding of the tricone bit	
5.0				3	Sh		75	6-8-10-10 (18)		-14.5
7.5										-17.0
10.0				4	Sh		25	8-50/6" (50/6")*	*obstruction at 11 ft; blow count likely overstated	-19.5
12.5			SILTY SAND WITH GRAVEL (SM) gray, wet, dense; subrounded gravel to 1.5-in dia.; gravel supported in fine grained matrix						borehole cleaned down to 13ft MC=8.5%;SA (%F=28.8)	-22.0
				5	Sh		100	12-26-26-31 (52)		
15.0			Total sampled depth = 15ft						End Drilling: 9-7-14; Time: 6:45 PM	-24.5

GRAPH: BLOW COUNT (20, 40, 60, 80); POCKET PEN (tsf) (1, 2, 3, 4); VANE SHEAR (tsf) (0.2, 0.4, 0.6, 0.8)



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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-12

FIGURE C-13
1 of 1

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND (SM) gray, wet, very loose						Begin Drilling: 9-5-14; Time: 10:05 AM 4-in dia. casing reinforced sampler sunk initial 6-in under weight of hammer, then sunk 12-in after first blow	0.0
				1	Sh		30	0-1-0-0 (1)		
2.5				2	Sh		30	1 (*)	*sampler sunk 1.5 ft after first hammer blow	-2.5
5.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, medium dense; subrounded gravel to 3-in dia. and occasional cobbles	3	Sh		67	50/6" (50/6")*	*obstruction at 5.5 ft; blow count likely overstated	-5.0
7.5				4	Sh		0	24-50/6" (50/6")	NO RECOVERY	-7.5
10.0				5	Sh		100	10-48-50/4" (98/14")*	*obstruction at 11 ft; blow count likely overstated	-10.0
12.5									intermittent color change in hole wash (clear to milky white to clear)	-12.5
			SILTY SAND WITH GRAVEL (SM) light gray, wet, very dense; subrounded gravel to 3-in dia.							
15.0										-15.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-13

FIGURE C-14
1 of 4

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0			SILTY SAND WITH GRAVEL (SM) light gray, wet, very dense; subrounded gravel to 3-in dia.*(continued)*	6	Sh		50	8-44-20-25 (64)*	*blow count likely overstated due to cobble-size material	-15.0
17.5										-17.5
			POORLY-GRADED GRAVEL WITH SILT AND SAND (GP-GM) light gray, wet, medium dense; subrounded gravel to 1.5-in dia.							
20.0				7	Sh		59	8-16-14-22 (30)	MC=5.4%;SA (%F=6.8)	-20.0
22.5									milky white wash color changing to clear	-22.5
			POORLY-GRADED GRAVEL WITH SAND (GP) grayish green, wet, dense; angular to subrounded gravel to 1/4-in dia.							
25.0				8	Sh		59	8-27-20-19 (47)	MC=4.5%;SA (%F=4.8)	-25.0
27.5									milky white wash color	-27.5
			SILTY SAND (SM) light gray, wet, dense; trace subrounded gravel to 1-in dia.							
30.0										-30.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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BOREHOLE B-13

FIGURE C-14
2 of 4

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
30.0			SILTY SAND (SM) light gray, wet, dense; trace subrounded gravel to 1-in dia.*(continued)* 2-in thick lens consisting of hard/very dense, matrix supported sand and fine gravel	9	Sh		59	10-15-18-18 (33)		MC=12.5%;SA (%F=33.1)	-30.0
32.5										intermittent hard casing advance indicates variable density of soil horizons	-32.5
35.0			SILTY GRAVEL WITH SAND (GM) gray, wet, medium dense to very dense; gravel to 3/4-in dia.	10	Sh		13	3-7-15-50/3" (22)		casing refusal at 45 ft	-35.0
37.5											-37.5
40.0				11	Sh		0	5-10-30-55 (40)		NO RECOVERY	-40.0
42.5											-42.5
45.0											-45.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-13

FIGURE C-14
3 of 4

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
45.0			SILTY GRAVEL WITH SAND (GM) gray, wet, medium dense to very dense; gravel to 3/4-in dia.*(continued)*	12	Sh		0	18-33-55-50 (88)		NO RECOVERY attempt to drive casing with no advance at 47 ft	-45.0
			Total sampled depth = 47 ft							End Drilling: 9-6-14; Time: 1:50 AM	
47.5											-47.5
50.0											-50.0
52.5											-52.5
55.0											-55.0
57.5											-57.5
60.0											-60.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-13

FIGURE C-14
4 of 4

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			POORLY-GRADED SAND WITH SILT (SP-SM)							Begin Drilling: 9-14-14; Time: 11:40 AM 4-in dia. casing reinforced	-28.0
			This log BH-14 is a composite of two boreholes (The initial BH-14 and BH-14B); while drilling BH-14 the casing snapped with approximately 60 ft of casing below mudline; the landingcraft was repositioned and BH-14B resumed							initial black-colored wash with fines in the cuttings	
2.5			The intent of this borehole is to begin soil sampling directly under a thick cohesive soil horizon delineated from a previous drilling program							fine grained sand and silt in cuttings	-30.5
5.0			Where no sampling is performed, the soil classification is based on previously sampled nearby boreholes, cuttings during the borehole wash and nature of the drilling action								-33.0
7.5			LEAN CLAY (CL) greenish gray, wet, medium stiff; trace subrounded gravel to 1-in dia.							abundant milky green fines/ mud in cuttings	-35.5
10.0										smooth and steady advance of tricone bit	-38.0
12.5											-40.5
15.0											-43.0

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BOREHOLE B-14

FIGURE C-15
1 of 8

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80 / POCKET PEN (tsf) 1 2 3 4 / VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0			LEAN CLAY (CL) greenish gray, wet, medium stiff; trace subrounded gravel to 1-in dia.*(continued)*								-43.0
17.5											-45.5
20.0			Low angle, finely laminated	1	Sh		100	2-2-3-3 (5)			-48.0
										milky green fines in cuttings	
22.5											-50.5
25.0											-53.0
27.5											-55.5
30.0											-58.0

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BOREHOLE B-14

FIGURE C-15
2 of 8

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
30.0			LEAN CLAY (CL) greenish gray, wet, medium stiff; trace subrounded gravel to 1-in dia.*(continued)* Increase in coarse sand and gravel	2	Sh		34	2-4-4-4 (8)			-58.0
32.5			SILTY SAND WITH GRAVEL (SM) gray, wet, dense; subrounded gravel to 2.5-in dia.							abrupt hard casing advance with 150 blows/3-in at approx. 32.5 ft (obstruction with casing ringing at 33 ft) drilled with tricone bit; granite chips in cuttings indicate granite boulder; approx. 30 minutes to clear	-60.5
35.0											-63.0
										abundant silt and sand in cuttings	
37.5											-65.5
40.0				3	Sh		40	28-46-50/3" (96/9")*		*obstruction at 41 ft: blow count likely overstated	-68.0
			Matrix supported coarse sand and gravels								
42.5											-70.5
										slow advance with coarse grinding with abundant milky green fines and coarse sand in cuttings	
45.0											-73.0

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BOREHOLE B-14

FIGURE C-15
3 of 8

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
45.0			SILTY SAND WITH GRAVEL (SM) gray, wet, dense; subrounded gravel to 2.5-in dia.*(continued)*								-73.0
47.5											-75.5
										at 48 ft driller states upward water pressure in drill: abundant fine grained sand in cuttings; drill water hose blows out, drill rods won't spin, suspected heaving of sands	
50.0										casing advanced in attempt to clear potential artesian conditions, sampled at 55 ft	-78.0
			WELL-GRADED GRAVEL WITH SAND (GW) greenish gray, wet, dense; angular to subrounded gravel to 1/4-in dia.								
52.5										fine grained gravel and coarse grained sand in cuttings	-80.5
55.0										MC=4.0%;SA (%F=1.6)	-83.0
				4	Sh		100	12-24-24-38 (48)			
57.5											-85.5
			POORLY-GRADED GRAVEL WITH SILT AND SAND (GP-GM) gray, wet, very dense; subangular gravel to 1.5-in dia.								
60.0											-88.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-14

FIGURE C-15
4 of 8

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			POORLY-GRADED GRAVEL WITH SILT AND SAND (GP-GM) gray, wet, very dense; subangular gravel to 1.5-in dia.*(continued)*	5	Sh		81	24-45-43-50 (88)*		*sampled a total of 21-in with 50 blows last 3-in MC=5.3%;SA (%F=7.5) begin adding bentonite to borehole wash down to 68 ft	-88.0
62.5										casing breaks with approx. 63 ft into mudline; restart hole	-90.5
65.0			POORLY-GRADED GRAVEL WITH SAND (GP) greenish gray, wet, dense; subangular to subrounded gravel to 1/2-in dia.								-93.0
67.5										bentonite added just prior to driving sampler MC=5.2%;SA (%F=3.2)	-95.5
			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, dense; subangular to subrounded gravel to 1-in dia.	6A 6B	Sh		67	11-26-28-36 (54)		MC=7.2%;SA (%F=9.7)	
70.0											-98.0
72.5			SILTY SAND WITH GRAVEL (SM) light gray, moist, very dense								-100.5
75.0											-103.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-14

FIGURE C-15
5 of 8

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
75.0			SILTY SAND WITH GRAVEL (SM) light gray, moist, very dense*(continued)*								-103.0
77.5											-105.5
80.0				7	Sh		78	29-66-65 (100+)		MC=8.4%;SA (%F=29.6)	-108.0
										milky fines with abundant fine grained sand in cuttings	
82.5											-110.5
85.0											-113.0
			SILTY SAND (SM) light gray, wet, very dense; trace subrounded gravel to 1-in dia.								
87.5											-115.5
										bentonite added just prior to driving sampler	
90.0											-118.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-14

FIGURE C-15
6 of 8

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
90.0			SILTY SAND (SM) light gray, wet, very dense; trace subrounded gravel to 1-in dia.*(continued)*	8	Sh		100	18-39-50 (89)		MC=10.9%;SA (%F=29.9)	-118.0
92.5			Matrix supported soil grains; rapid dilatency							gray and milky white fines and sand in cuttings	-120.5
										smooth steady advance in casing	
95.0			POORLY-GRADED SAND (SP) dark gray, wet, loose								-123.0
97.5										bentonite added prior to advancing sampler into soil	-125.5
										MC=16.5%;SA (%F=4.1)	
			WELL-GRADED SAND WITH GRAVEL (SW) greenish gray, wet, dense	9A 9B 9C	Sh		100	4-12-36-50/6" (48)		MC=5.9%;SA (%F=3.4) MC=16.2%; (%F=54.9%)	
100.0			SANDY SILT (ML) light gray, wet, very dense Subequal amounts of alternating thin hard silt and very dense very fine grained sand lenses								-128.0
102.5										milky fines abruptly end in borehole wash	-130.5
			POORLY-GRADED GRAVEL WITH SAND (GP) greenish gray, wet, dense; subangular to subrounded fine to medium gravel to 1/2-in dia. with subangular to subrounded coarse sands								
105.0											-133.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-14

FIGURE C-15
7 of 8

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
105.0			POORLY-GRADED GRAVEL WITH SAND (GP) greenish gray, wet, dense; subangular to subrounded fine to medium gravel to 1/2-in dia. with subangular to subrounded coarse sands*(continued)*								-133.0
										fine gravels in cuttings	
107.5										bentonite added to borehole prior to advancing sampler into soil	-135.5
										casing driving extremely hard: approx. 150 blows/ 3-in. MC=0.7%;SA (%F=0.1)	
				10	Sh		100	4-15-50/4" (65/10")			
110.0			Total sampled depth = 110.2 ft								-138.0
										End Drilling: 9-16-14; Time: 1:15 PM	
112.5											-140.5
115.0											-143.0
117.5											-145.5
120.0											-148.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-14

FIGURE C-15
8 of 8

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND (SM) greenish gray, wet, loose to medium dense The intent of this borehole is to begin soil sampling directly under a thick cohesive soil horizon delineated from a previous drilling program							Begin Drilling: 9-17-14; Time: 12:15 PM 4-in dia. casing reinforced casing sunk 3 ft into mudline after 3 blows	-28.0
2.5											-30.5
5.0			Where no sampling is performed, the soil classification is based on previously sampled nearby boreholes, cuttings during the borehole wash and nature of the drilling action								-33.0
7.5											-35.5
			LEAN CLAY (CL) greenish gray, wet, very soft								
10.0										green milky fines/ mud in cuttings	-38.0
12.5											-40.5
15.0											-43.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-16

FIGURE C-16
1 of 5

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0			LEAN CLAY (CL) greenish gray, wet, very soft*(continued)*								-43.0
17.5											-45.5
20.0											-48.0
22.5											-50.5
25.0										green, milky colored fines in wash	-53.0
27.5										smooth and steady advance rate down to 40 ft	-55.5
30.0											-58.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-16

FIGURE C-16
2 of 5

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
30.0			LEAN CLAY (CL) greenish gray, wet, very soft*(continued)*								-58.0
32.5										green milky fines/ mud in cuttings; smooth and steady advance rate	-60.5
35.0											-63.0
37.5											-65.5
40.0											-68.0
42.5											-70.5
			Sh sampler contained greenish gray, saturated and very soft lean clay; trace subrounded gravel to 1.5-in dia.					0-0-0-0		PP = 0.00tsf	
45.0											-73.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
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BOREHOLE B-16

FIGURE C-16
3 of 5

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
45.0			LEAN CLAY (CL) greenish gray, wet, very soft*(continued)*	1	Sh		59	(0)		sampler pushed into soil by weight of the drill rods	-73.0
47.5											-75.5
50.0										green milky fines/ mud in cuttings; smooth and steady advance rate	-78.0
52.5											-80.5
55.0											-83.0
57.5											-85.5
60.0											-88.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-16

FIGURE C-16
4 of 5

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	GRAPH: BLOW COUNT (20 40 60 80) / POCKET PEN (tsf) (1 2 3 4) / VANE SHEAR (tsf) (0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			LEAN CLAY (CL) greenish gray, wet, very soft*(continued)*								-88.0
										begin grinding of tricone bit	
62.5											-90.5
65.0										sampler contained greenish gray, saturated, very soft lean clay similar to previous sample	-93.0
				2	Sh		100	1-2-2-2 (4)			
67.5											-95.5
			BOULDER							hard grinding at 68 ft, then obstruction; drilled approx. 45 minutes with tricone bit; abundant angular white quartz, coarse sand-size in cuttings	
			Boulder: angular pieces of white quartz-rich strongly weathered, greenstone rock found within the core barrel								
70.0										obstruction drilled with diamond drill bit and core barrel; clear after drilling 3 ft; attempted to probe with cap on NWJ rod; immediately hit refusal conditions upon re-entering hole indicating boulder moved	-98.0
			Total drilled depth = 71 ft								
72.5										End Drilling: 9-17-14; Time: 7:20 PM	-100.5
75.0											-103.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE B-16

FIGURE C-16
5 of 5

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			ASPHALT							Begin Drilling: 9-7-14; Time: 10:00 PM 4.25-in dia. hollow stem auger casing reinforced	34.0
			WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM) brownish gray, dry, loose; angular to subrounded gravel to 3/4-in dia.; indicative of imported fill								
2.5											31.5
5.0				1	Sh		17	2-4-4-4 (8)			29.0
7.5											26.5
			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) brownish gray, moist, loose; angular to subrounded gravel to 1-in dia.								
10.0				2	Sh		59	3-5-6-8 (11)		MC=9.2%;SA (%F=9.0)	24.0
12.5											21.5
			WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM) gray, moist, angular to subrounded gravel to 2-in dia.; 2-in dia. rock fragment stuck in tip								
15.0											19.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

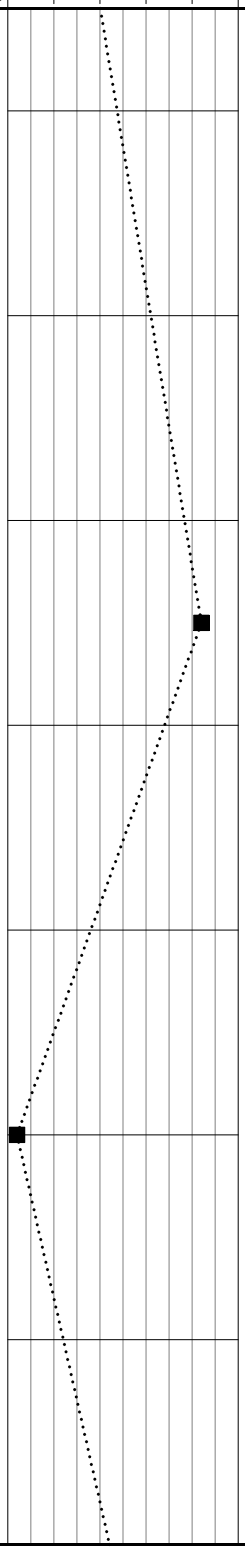
BOREHOLE B-17

FIGURE C-17
1 of 4

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
15.0			WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM) gray, moist, angular to subrounded gravel to 2-in dia.; 2-in dia. rock fragment stuck in tip*(continued)*	3	Sh			55 (55/6")*	*blow count not representative Recovery not noted	19.0
17.5										16.5
			SILTY SAND WITH GRAVEL (SM) light gray, wet, very dense; angular to rounded gravel to 3/4-in dia.							
20.0									MC=7.0%;SA (%F=13.7)	14.0
				4	Sh		100	11-37-47-38 (84)		
22.5										11.5
			SILTY SAND WITH GRAVEL (SM) light gray, moist, loose; gravel to 1/4-in dia.							
25.0									sampler sunk 6-in under weight of hammer	9.0
				5	Sh		50	0-1-3-17 (4)	MC=10.4%;SA (%F=42.7)	
27.5										6.5
30.0										4.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8



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BOREHOLE B-17

FIGURE C-17
2 of 4

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
30.0			SILTY SAND WITH GRAVEL (SM) light gray, moist, loose; gravel to 1/4-in dia.*(continued)* Note increase in clay hardness	6	Sh		86	10-22-31-35 (53)*		*sampled a total of 21-in with 35 blows in last 3-in	4.0
32.5										pull auger casing at 30 ft and begin driving 4-in flush coupled casing down to 35 ft	1.5
			SILTY SAND WITH GRAVEL (SM) light gray, wet, dense to very dense; subangular to subrounded gravel to 1.5-in dia.								
35.0				7	Sh		23	9-32-52 (84)			-1.0
37.5											-3.5
40.0				8	Sh		25	7-15-38-30/3" (53)		MC=10.5%;SA (%F=25.7)	-6.0
42.5											-8.5
45.0											-11.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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BOREHOLE B-17

FIGURE C-17
3 of 4

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
45.0			SILTY SAND WITH GRAVEL (SM) light gray, wet, dense to very dense; subangular to subrounded gravel to 1.5-in dia.*(continued)*								-11.0
			Total drilled depth = 47 ft							End Drilling: 9-8-14; Time: 7:30 AM	
47.5											-13.5
50.0											-16.0
52.5											-18.5
55.0											-21.0
57.5											-23.5
60.0											-26.0

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SOUTH PORTAGE COVE
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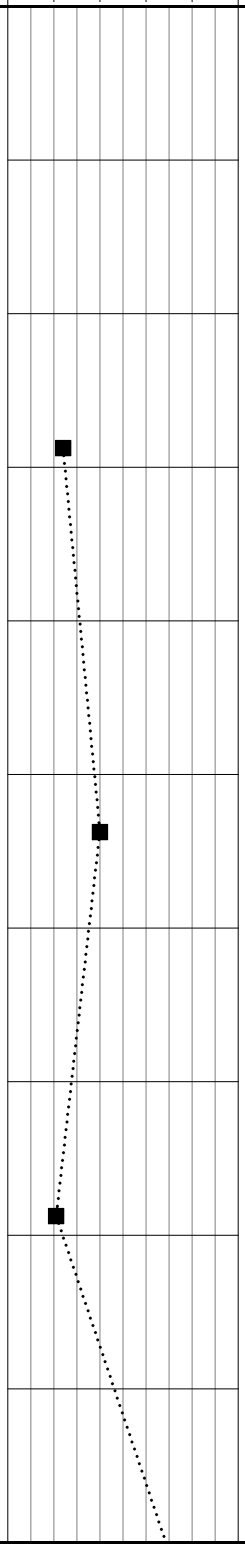
BOREHOLE B-17

FIGURE C-17
4 of 4

BOREHOLE LOG 102029.07 SPCHE ADDITIONAL GEOTECH.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY GRAVEL WITH SAND (GM) gray and black, wet, medium dense; occasional subrounded cobbles and boulders to 3 ft. diameter based on surficial deposits						Begin Drilling: 9/24/12; Time: 9:00PM Casing sank initial 2.5 ft. under own weight	-11.0
2.5										-13.5
5.0										-16.0
			SILTY SAND WITH GRAVEL (SM) gray, wet, medium dense to dense; subangular to subrounded gravel to 2" dia	1A 1B	Sh		67	14-12-12 (24)	MC=4.2% MC=7.7%	
7.5										-18.5
10.0				2	Sh		60	15-20-20 (40)	MC=8.3%; LMA (%F=18.6) drilling is slow, rough	-21.0
12.5										-23.5
15.0				3	Sh		22	2-6-15 (21)	MC=8.4%	-26.0
17.5			POORLY-GRADED GRAVEL WITH SILT AND SAND (GP-GM) gray, wet, very dense; subangular to subrounded gravel to 1" dia; cobble fragments							-28.5
20.0										-31.0

GRAPH: BLOW COUNT (20, 40, 60, 80); POCKET PEN (tsf) (1, 2, 3, 4); VANE SHEAR (tsf) (0.2, 0.4, 0.6, 0.8)



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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

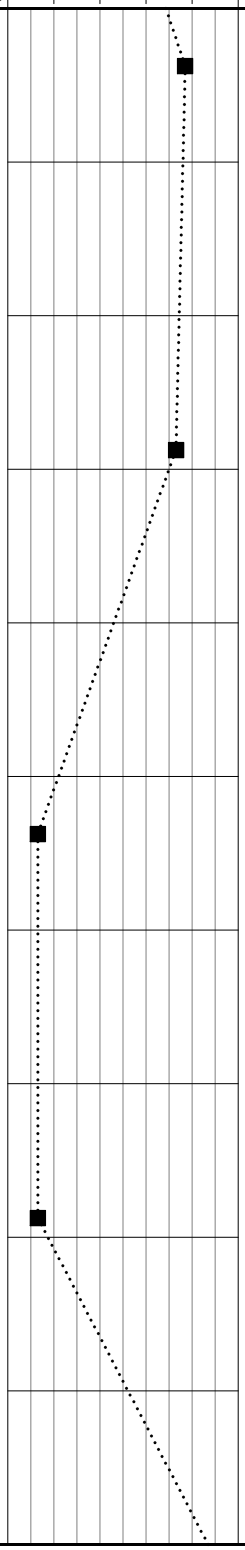
BOREHOLE BH-2

FIGURE C-18
1 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
20.0									drilling is slow, rough	-31.0
				4	Sh		56	16-41-36 (77)	MC=5.6%; LMA (%F=11.4)	
22.5										-33.5
			SILTY SAND WITH GRAVEL (SM) gray, wet, very dense							
25.0				5	Sh		73	20-41-32 (73)	MC=7.1%	-36.0
27.5										-38.5
			POORLY-GRADED GRAVEL WITH SAND (GP) gray, wet, medium dense; subangular to subrounded gravel to 2" dia							
30.0				6	Sh		22	10-7-6 (13)	MC=6.0%; SA (%F=4.3)	-41.0
32.5										-43.5
35.0				7	Sh		17	9-7-6 (13)	MC=6.4%; LMA (%F=5.4)	-46.0
37.5										-48.5
40.0										-51.0

GRAPH: BLOW COUNT (20, 40, 60, 80); POCKET PEN (tsf) (1, 2, 3, 4); VANE SHEAR (tsf) (0.2, 0.4, 0.6, 0.8)



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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

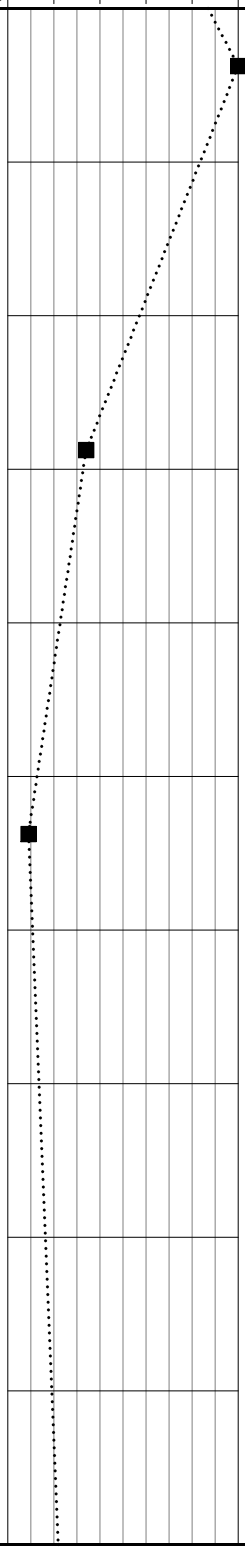
BOREHOLE BH-2

FIGURE C-18
2 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
40.0			SILTY SAND WITH GRAVEL (SM) gray, wet, dense to very dense; subangular to subrounded gravel to 2" dia	8	Sh		44	31-86-17 (100+)	MC=7.1%	-51.0
42.5										-53.5
45.0				9	Sh		89	14-14-20 (34)	MC=11.3%; SA (%F=36.1)	-56.0
47.5										-58.5
50.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, loose; subangular to subrounded gravel to 2" dia	10B	Sh		44	1-3-6 (9)	MC=10.3%	-61.0
			POORLY-GRADED SAND (SP) gray, wet, loose	10A					MC=6.4%	
52.5										-63.5
55.0			POORLY-GRADED SAND WITH SILT (SP-SM) gray, wet, medium dense							-66.0
57.5										-68.5
60.0										-71.0

GRAPH: BLOW COUNT (20, 40, 60, 80); POCKET PEN (tsf) (1, 2, 3, 4); VANE SHEAR (tsf) (0.2, 0.4, 0.6, 0.8)



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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-2

FIGURE C-18
3 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	GRAPH: BLOW COUNT (20 40 60 80); POCKET PEN (tsf) (1 2 3 4); VANE SHEAR (tsf) (0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0										MC=13.2%	-71.0
			GRAVELLY LEAN CLAY WITH SAND (CL) gray, wet, very stiff	11A 11B	Sh		100	2-7-16 (23)			
62.5											-73.5
65.0											-76.0
										at 66 ft. casing wash water abruptly turned brown-colored, then abrupty returned back to previous	
67.5											-78.5
70.0			SILTY SAND WITH GRAVEL (SM) gray, wet, medium dense							MC=14.4%; SA (F=24.7)	-81.0
				12A 12B 12C	Sh		100	2-3-15 (18)		MC=5.0%; LMA (%F=1.6)	
			GRAVEL WITH SAND (GP) gray, wet, medium dense							MC=1.8%	
			Total sampled depth = 71.5 ft							Terminated Drilling: 9/25/12; Time: 11:00AM	
72.5										difficult pulling casing after hole termination	-83.5
75.0											-86.0
77.5											-88.5
80.0											-91.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

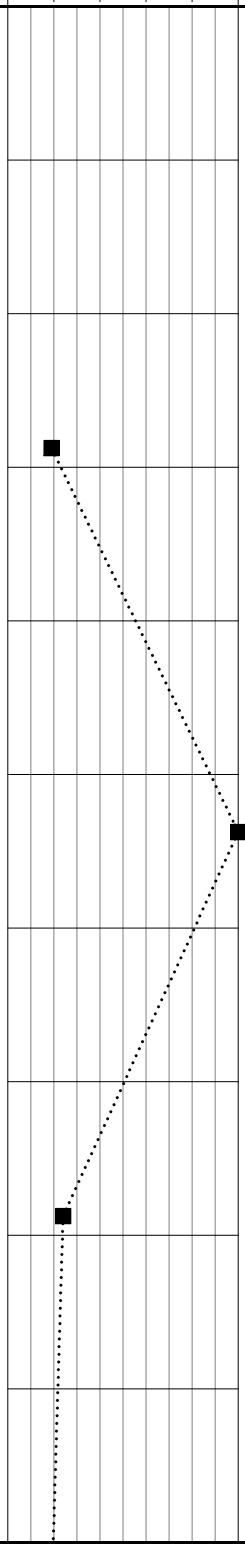
BOREHOLE BH-2

FIGURE C-18
4 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			POORLY-GRADED SAND WITH GRAVEL (SP) gray, wet, medium dense; subrounded gravel to 2" dia						Begin Drilling: 9/24/12; Time: 9:00AM 4.25 in. dia. casing driven w/ 340 lb auto hammer	-11.5
2.5										-14.0
5.0			POORLY-GRADED GRAVEL (GP) gray, wet, medium dense to very dense	1A					MC=10.9%	-16.5
				1B	Sh		67	11-10-9 (19)	MC=8.0%; LMA (%F=3.6)	
7.5									steady drill steel advance when cleaning casing	-19.0
10.0				2	Sh		100	28-164-126 (100+)	MC=11.9%	-21.5
12.5										-24.0
			POORLY-GRADED GRAVEL WITH SILT (GP-GM) gray, wet, medium dense							
15.0				3	Sh		45	9-12-12 (24)	MC=7.5%; LMA (%F=7.9)	-26.5
17.5										-29.0
20.0										-31.5

GRAPH: BLOW COUNT (20, 40, 60, 80); POCKET PEN (tsf) (1, 2, 3, 4); VANE SHEAR (tsf) (0.2, 0.4, 0.6, 0.8)



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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

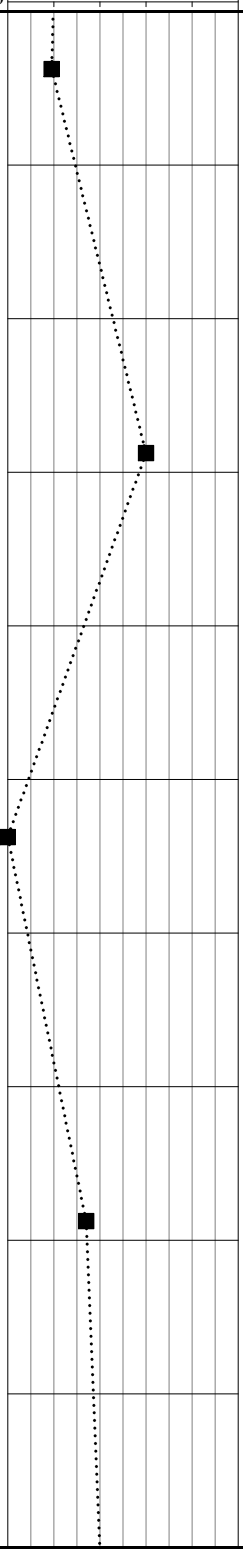
BOREHOLE BH-3

FIGURE C-19
1 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
20.0			POORLY-GRADED SAND (SP)	4A					MC=8.4%	-31.5
			POORLY-GRADED SAND WITH SILT (SP-SM) gray, wet, medium dense	4B	Sh		56	4-9-10 (19)	MC=10.3%	
			POORLY-GRADED SAND (SP) gray, wet, very dense; fine sand							
22.5										-34.0
									intermittent grinding/smooth drill steel advance when cleaning casing	
25.0				5A						-36.5
				5B	Sh		89	7-22-38 (60)	MC=7.7%	
									MC=15.1%	
27.5										-39.0
30.0			POORLY-GRADED GRAVEL WITH SAND (GP) gray, wet, very dense	6A	Sh		100	6-18->50 (>68)	MC=8.7%; LMA (%F=3.3)	-41.5
			SILTY SAND WITH GRAVEL (SM) bluish gray, moist, very dense	6B					MC=6.6%; SA (%F=19.0)	
32.5										-44.0
35.0			POORLY-GRADED GRAVEL (GP) gray, wet, dense	7A	Sh		100	6-16-18 (34)	MC=3.1%	-46.5
			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, dense	7B					MC=9.4%; LMA (%F=10.7)	
37.5										-49.0
40.0										-51.5

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8



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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

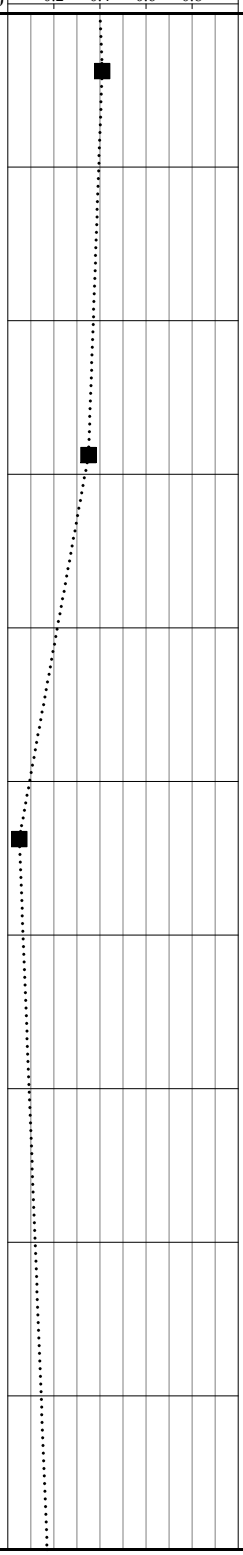
BOREHOLE BH-3

FIGURE C-19
2 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
40.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, dense*(continued)*	8	Sh		89	7-17-24 (41)	MC=4.1%	-51.5
42.5									steady drill steel advance w/ occasional thin intervals of grinding when cleaning casing	-54.0
45.0			WELL-GRADED GRAVEL WITH SAND (GW) gray, wet, dense	9A 9B	Sh		67	5-19-16 (35)	MC=5.9%; SA (%F=1.1)	-56.5
			WELL-GRADED GRAVEL WITH SILT AND SAND (GW-GM) gray, moist, dense						MC=7.0%; LMA (%F=11.7)	
47.5										-59.0
50.0			POORLY-GRADED SAND (SP) gray, wet, loose						MC=21.1%	-61.5
			POORLY-GRADED GRAVEL (GP) gray, wet, loose	10A 10B	Sh		67	4-2-3 (5)	MC=5.9%	
52.5										-64.0
55.0									steady drill steel advance w/ occasional thin intervals of grinding when cleaning casing	-66.5
57.5										-69.0
60.0										-71.5

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8



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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-3

FIGURE C-19
3 of 4

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			POORLY-GRADED SAND (SP) gray and grayish green, moist, medium dense; poorly-graded gravels at bottom	11A						MC=15.2%; LMA (%F=1.5)	-71.5
				11B	Sh		67	1-4-14 (18)		MC=5.5%	
				11C						MC=1.9%	
			Total sampled depth = 61.5 ft							End Drilling: 9/24/12; Time: 5:00PM	
62.5											-74.0
65.0											-76.5
67.5											-79.0
70.0											-81.5
72.5											-84.0
75.0											-86.5
77.5											-89.0
80.0											-91.5

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-3

FIGURE C-19
4 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			POORLY-GRADED SAND (SP) dark gray, wet, very loose to medium dense; angular sand; broken white shell fragments; traces of gravel and fines	1	Ss		0	0-0-0 (0)*		Begin Drilling: 10/4/12; Time: 2:30PM *4.25 in. casing sunk initial 5 ft under own weight; advanced Ss for sample - trace of fine grained sand in sampler	-24.5
2.5										NO RECOVERY	-27.0
5.0										medium-grained angular black/green-colored sand and broken white shell fragments in cuttings	-29.5
7.5											-32.0
10.0										MC=18.3%	-34.5
			LEAN CLAY (CL) greenish gray, wet, stiff; consistency varies with depth as noted	2A 2B	Ss		34	4-6-7 (13)		MC=21.7%	
12.5										milky green-colored fines in cuttings	-37.0
15.0										*500 psi	-39.5
				3	Ts		100	*		MC=23.0%; DD=105 pcf AL; CO	
17.5											-42.0
20.0											-44.5

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-4

FIGURE C-20
1 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
20.0			LEAN CLAY (CL) greenish gray, wet, stiff; consistency varies with depth as noted*(continued)* Trace of subangular to subrounded gravel to 1/4" dia.	4	Ss		100	4-5-5 (10)		VS = 0.71tsf PP = 3.75tsf MC=23.3%; AL	-44.5
22.5											-47.0
25.0										*300 psi (smooth push)	-49.5
				5	Ts		100	*		MC=25.0%; DD=102 pcf AL; TX	
27.5										milky green-colored fines in cuttings	-52.0
										MC=29.4%; AL	
30.0			Very soft; trace subrounded gravel to 1/2" dia.	6	Ss		100	0-0-0 (0)*		VS = 0.25tsf PP = 0.00tsf *sampler sunk under weight of hammer	-54.5
32.5											-57.0
35.0										*250 psi (smooth push)	-59.5
				7	Ts		100	*		MC=29.6%; DD=71 pcf AL; CO	
37.5											-62.0
40.0											-64.5

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-4

FIGURE C-20
2 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
40.0			LEAN CLAY (CL) greenish gray, wet, stiff; consistency varies with depth as noted*(continued)*	8	Ss		0	0-0-1 (1)*		*sampler sunk initial 6" under rod weight - next 6" under weight of hammer NO RECOVERY - greenish gray-colored fines adhere to sampler wall	-64.5
42.5											-67.0
45.0										*500 psi (smooth push)	-69.5
				9	Ts		100	*		MC=33.9%; DD=93 pcf AL; TX	
47.5											-72.0
50.0			Trace of subrounded gravel to 3/4" dia.	10	Ss		89	1-1-1 (2)		VS = 0.10tsf PP = 0.75tsf MC=26.5%	-74.5
52.5			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) black and gray, wet, very dense							at 53 ft. drilling gets rougher (soil contact based on drilling action)	-77.0
55.0											-79.5
57.5											-82.0
60.0											-84.5

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-4

FIGURE C-20
3 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) black and gray, wet, very dense*(continued)* Subangular to subrounded gravel to 1" dia.	11	Ss		39	65-66-70 (100+)		MC=8.2%	-84.5
62.5											-87.0
65.0											-89.5
67.5											-92.0
70.0				12	Ss		22	11-44-82 (100+)		driller uses polymer to clean hole MC=10.1%; SA (%F=10.1)	-94.5
			Subangular to subrounded gravel to 1/2" dia.								
72.5										at 73 ft. casing drives extremely hard - 150 blows in 6 inches	-97.0
75.0										drilled w/ tricone bit to 80 ft. prior to driving casing; casing BPF=160	-99.5
77.5											-102.0
80.0											-104.5

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-4

FIGURE C-20
4 of 5

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
80.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM)	13	Ss		0	66-134 (134)		NO RECOVERY drill to 81 ft. attempt sample; able to drill thru soil w/out difficulty but unable to drive casing	-104.5
			SILTY SAND WITH GRAVEL (SM) black and gray, wet, very dense Subangular to subrounded gravel to 1" dia.	14	Ss		78	46-61-71 (132)		MC=7.1%; SA (%F=17.9)	
82.5											-107.0
										advanced hole w/out casing reinforcement to 86 ft; hole caves jamming drill steel; unable to advance casing; cuttings contain mixture of gravel, sand and fines	
85.0											-109.5
			Total drilled depth = 86.0 ft							End Drilling: 10/5/12; Time: 3:15AM	
87.5											-112.0
90.0											-114.5
92.5											-117.0
95.0											-119.5
97.5											-122.0
100.0											-124.5

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-4

FIGURE C-20
5 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			POORLY-GRADED SAND (SP) gray, wet, loose to medium dense; subangular sand						Begin Drilling: 9/20/12; Time: 7:05PM 4.25 in. dia. casing reinforced	-17.0
2.5										-19.5
5.0				1	Ss		100	6-6-8 (14)*	MC=20.4% *casing sunk approx. 1 ft. coincident with sampler blows	-22.0
7.5										-24.5
10.0				2	Ss		100	8-3-1 (4)		-27.0
12.5			LEAN CLAY (CL) gray, wet, soft							-29.5
15.0				3	Ss		100	0-0-2 (2)*	MC=25.6%; AL PP = 1.25tsf *sampler sunk initial 1 ft. under weight of hammer	-32.0
17.5										-34.5
20.0										-37.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

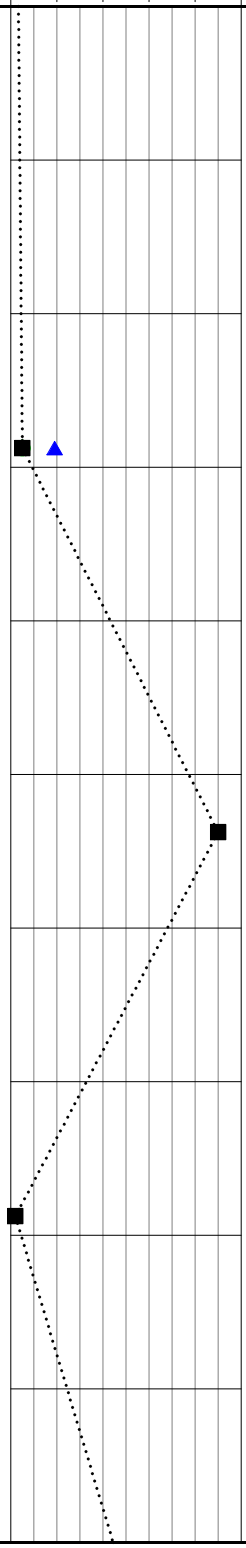
BOREHOLE BH-5

FIGURE C-21
1 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
20.0			LEAN CLAY (CL) gray, wet, soft*(continued)*						*700 psi	-37.0
				4	Ts			*	MC=22.5%; DD=107 pcf AL; CO	
22.5									no recovery percentage noted in field	-39.5
25.0				5	Ss		100	0-2-3 (5)*	VS = 0.19tsf PP = 0.25tsf *sampler sunk initial 6-in. under weight of hammer MC=26.0%; AL	-42.0
27.5										-44.5
			SILTY SAND WITH GRAVEL (SM) gray, wet, very loose						Contact based on drilling; cuttings show sandy soil	
30.0				6	Ss			3-34-56 (90)*	MC=8.0%; LMA (%F=12.2) *Cobble or boulder based on BPF no recovery percentage noted in field	-47.0
32.5									chatter from drill steel	-49.5
35.0				7	Ss		0	2-1-1 (2)	NO RECOVERY	-52.0
37.5			POORLY-GRADED GRAVEL WITH SAND (GP) gray and white, wet, very dense						Contact based on drilling: at 37 ft. strong grinding of the drill steel	-54.5
40.0										-57.0

GRAPH: BLOW COUNT (20, 40, 60, 80); POCKET PEN (tsf) (1, 2, 3, 4); VANE SHEAR (tsf) (0.2, 0.4, 0.6, 0.8)



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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-5

FIGURE C-21
2 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
40.0			POORLY-GRADED GRAVEL WITH SAND (GP) gray and white, wet, very dense*(continued)*	8	Ss		67	2-6-46 (52)		MC=2.7%; LMA (%F=2.1)	-57.0
										strong grinding of drill steel down to 45 ft.; driller attempts un-cased advance of hole to 45 ft.; repeated caving of hole	
42.5											-59.5
45.0										MC=6.3%; SA (F=2.1)	-62.0
				9A	Sh		100	7-18-46 (64)			
				9B	Sh					MC=8.4%	
			SILT WITH GRAVEL (ML) bluish gray, dry to moist, hard; subrounded gravel to 1.5" dia.; coarse fraction matrix supported - diamicton								
47.5											-64.5
50.0			POORLY-GRADED SAND (SP)	10A						MC=20.6%	-67.0
			WELL-GRADED GRAVEL WITH SAND (GW)	10B	Sh		100	6-20-36 (56)		MC=5.4%; SA (%F=3.0)	
				10C						MC=12.9%	
			SILTY SAND (SM) bluish gray, wet, dense to very dense; intermittant variations in soil horizons - see comments							while cleaning hole down to 60 ft. driller notes intermittent soil changes based on grinding/smooth action of drill steel	
52.5											-69.5
55.0											-72.0
57.5											-74.5
			Cobble or boulder at 58 ft. based on drilling - see comments							at 58 ft. driller switched tricone bits; 6 in. advance in 45 minutes	
60.0											-77.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-5

FIGURE C-21
3 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT (20 40 60 80); POCKET PEN (tsf) (1 2 3 4); VANE SHEAR (tsf) (0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			POORLY-GRADED SAND (SP)							MC=16.8%	-77.0
			WELL-GRADED GRAVEL WITH SAND (GW)	11A 11B 11C	Sh		100	9-17-22 (39)		MC=4.1%; SA (%F=2.3) MC=10.9%	
			SILTY SAND WITH GRAVEL (SM) bluish gray, moist, medium dense; subrounded gravels to 2" dia and matrix supported; diamicton								
62.5											-79.5
65.0											-82.0
67.5											-84.5
70.0			2-in dia. rock in sampler	12	Sh		0	11-90 (90/6")		NO RECOVERY	-87.0
72.5											-89.5
75.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, loose; subangular to subrounded gravel to 3/4" dia.								-92.0
77.5											-94.5
80.0											-97.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-5

FIGURE C-21
4 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
80.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, loose; subangular to subrounded gravel to 3/4" dia.*(continued)*	13	Sh		67	7-5-4 (9)		MC=13.0%; SA (%F=11.1)	-97.0
82.5											-99.5
85.0											-102.0
87.5											-104.5
90.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, medium dense; subangular to subrounded gravel to 2" dia.	14	Sh		100	2-7-12 (19)		MC=9.8%; LMA (%F=8.4)	-107.0
92.5											-109.5
95.0										at 95 ft. heaving sands; continued hole advance to 100 ft.; unable to sample; fine sands in cuttings	-112.0
97.5											-114.5
100.0			Total drilled depth = 100 ft							Terminated Drilling: 9/22/12; Time: 1:40AM	-117.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-5

FIGURE C-21
5 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			POORLY-GRADED SAND (SP) dark greenish gray, wet, loose to medium dense; broken shells and 1" layer of wood chips noted							Begin Drilling: 9/19/12; Time: 9:30AM 4.25 in. dia. casing reinforcement	-13.0
2.5											-15.5
5.0				1	Ss		56	1-3-3 (6)		steady drill steel advance MC=27.6%; LMA (%F=4.4)	-18.0
7.5											-20.5
10.0				2	Ss		12	2-4-10 (14)		MC=13.7%	-23.0
12.5			POORLY-GRADED SAND WITH GRAVEL (SP) dark greenish gray, wet, loose							at 13 ft. drill rods grinding (soil contact based on drilling action)	-25.5
15.0			Abundant broken shells; 2 in. horizon of fine sand - fining upward, overlying 2-in. of angular to subrounded gravel to 1.5 in. dia. overlying 2 in. band of fine sand - fining down depth	3	Ss		34	6-4-4 (8)		MC=13.5%	-28.0
17.5										at 18 ft. drill steel strongly grinding; greenish-colored milky fines in cuttings	-30.5
20.0											-33.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

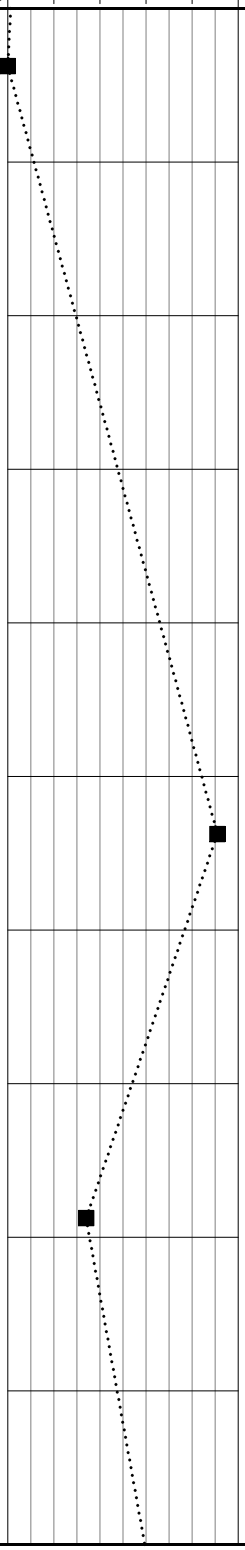
BOREHOLE BH-6

FIGURE C-22
1 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
20.0			SANDY LEAN CLAY WITH GRAVEL (CL) dark greenish gray, wet, very soft	4	Ss		0	0-0-0 (0)*	*sampler sunk under weight of rods NO RECOVERY - clay w/ platy angular gravel sticking to sampler	-33.0
22.5									drill steel strongly grinding *500 psi	-35.5
25.0				5	Ts		0	*	NO RECOVERY - sample slipped out of tube at casing/ water contact slow advance of casing	-38.0
27.5			POORLY-GRADED SAND WITH GRAVEL (SP) gray, wet, very dense; subangular to subrounded gravel to 1" dia						snapped casing w/ approx. 20 ft. in mud; terminated hole; moved borehole approx. 5 ft. and advanced casing initial 30 ft. to begin new hole	-40.5
30.0				6	Ss		34	7-74-17 (91)	MC=6.8%	-43.0
32.5										-45.5
35.0			WELL-GRADED GRAVEL WITH SAND (GW) white and gray, wet, dense to very dense; subangular to subrounded gravel to 1" dia	7	Ss		45	3-9-25 (34)	MC=6.3%; SA (%F=0.9)	-48.0
37.5										-50.5
40.0										-53.0

GRAPH: BLOW COUNT (20, 40, 60, 80); POCKET PEN (tsf) (1, 2, 3, 4); VANE SHEAR (tsf) (0.2, 0.4, 0.6, 0.8)



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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

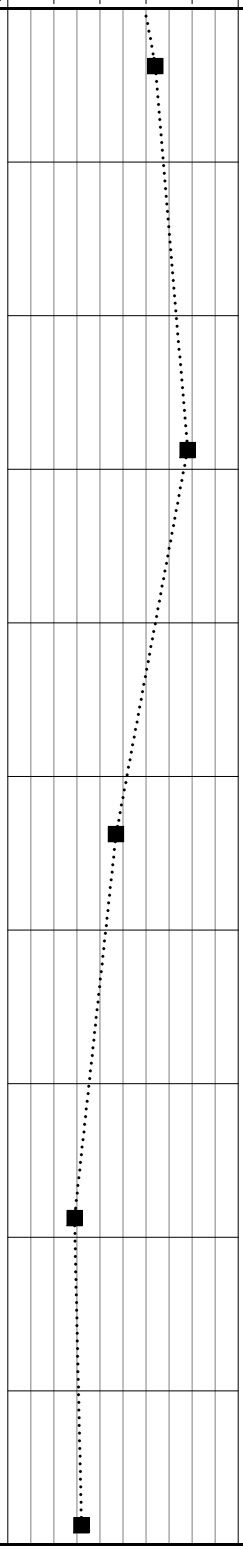
BOREHOLE BH-6

FIGURE C-22
2 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
40.0									MC=5.8%	-53.0
				8A 8B	Ss		66	2-13-51 (64)	MC=8.6%	
			SILTY SAND WITH GRAVEL (SM) gray, wet, dense to very dense; subangular to subrounded gravel to 1" dia							
42.5										-55.5
45.0				10	Ss		45	0-8-70 (78)	no sample No. 9 (sample number mislabled out of sequence) MC=12.0%; SA (%F=22.2)	-58.0
47.5										-60.5
50.0			SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, dense; sand lenses based on drilling - see comments	11	Ss		56	0-44-3 (47)	MC=8.9%; LMA (%F=8.7)	-63.0
52.5									from 52 to 55 ft. short intervals of smooth/grinding/bouncing of drill steel cleaning down to 55 ft. driller noted 3 ft. of heave (coarse-grained and angular poorly graded sand) switched to 340-lb hammer and Sh sampler MC=19.0%	-65.5
55.0			POORLY-GRADED SAND (SP)							-68.0
			POORLY-GRADED GRAVEL (GP) dark greenish gray, wet, medium dense to dense; angular to subrounded polished similar to beach gravels to 1/2" dia	12A 12B	Sh		89	1-4-25 (29)	MC=7.1%; LMA (%F=2.4)	
57.5										-70.5
			POORLY-GRADED GRAVEL WITH SAND (GP)	13	Sh		67	5-10-22 (32)	at 59 ft. driller noted approx. 3 ft. of heave MC=5.2%; SA (%F=1.8)	
60.0										-73.0

GRAPH: BLOW COUNT (20, 40, 60, 80); POCKET PEN (tsf) (1, 2, 3, 4); VANE SHEAR (tsf) (0.2, 0.4, 0.6, 0.8)



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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-6

FIGURE C-22
3 of 4

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			POORLY-GRADED GRAVEL WITH SAND (GP) dark greenish gray, wet, dense; angular to subrounded polished similar to beach gravels to 1/2" dia*(continued)*								-73.0
62.5											-75.5
										at 65 ft. casing blows > 100 for 6 in.; driller notes difficulty in casing advance	
65.0			Total drilled depth = 65.0 ft.							Terminated Drilling: 9/20/12; Time: 1:30PM	-78.0
67.5											-80.5
70.0											-83.0
72.5											-85.5
75.0											-88.0
77.5											-90.5
80.0											-93.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-6

FIGURE C-22
4 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND (SM) greenish gray, wet, loose; based on sampled surroundings							Begin Drilling: 9/25/12; Time: 5:00PM 4.25 in. dia. casing driven w/ 340 lb auto hammer BH-7 log is a composite of two drilled holes - first hole terminated with refusal conditions at 58 ft. due to deteriorating weather; second drilling was set up in the same location as the first hole at 5 ft. casing sank 1 ft. under own weight	-31.0
2.5											-33.5
5.0											-36.0
			LEAN CLAY (CL) greenish gray, wet, very soft	1	Sh		45	0-1-1 (2)*		VS = 0.13tsf PP = 0.00tsf *sampler sunk initial 1 ft. under weight of rods MC=25.7%	
7.5											-38.5
										switched to Ss sampler; sank under weight of rods	
10.0				2	Ss		100	0-0-0 (0)		VS = 0.38tsf PP = 2.75tsf MC=28.0%	-41.0
12.5											-43.5
15.0										*15 to 17 ft. 500 psi; 17 to 18 ft. 750 psi; bottom 6 in. of shelby tube dented	-46.0
				3	Ts		100	*		MC=23.2%; DD= 106 pcf; AL; CO	
17.5											-48.5
20.0											-51.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-7

FIGURE C-23
1 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
20.0			LEAN CLAY (CL) greenish gray, wet, very soft*(continued)*	4	Ss		100	0-0-0 (0)*		VS = 0.58tsf PP = 2.00tsf *sampler sunk under weight of rods MC=25.8%; AL	-51.0
22.5											-53.5
25.0										*250 psi; trimmed top 4 inches off tube	-56.0
				5	Ts		100	*		MC=30.3%; DD=93 pcf; AL; TX	
27.5											-58.5
										intermittent intervals of smooth/grinding and bouncing action of drill steel	
30.0				6	Ss		100	0-0-0 (0)*		VS = 0.13tsf PP = 0.00tsf *sampler sunk under weight of hammer MC=38.3%; AL	-61.0
32.5											-63.5
35.0										*psi not recorded	-66.0
				7	Ts			*		MC=35.8%; DD= 85 pcf; AL; CO	
37.5											-68.5
40.0											-71.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-7

FIGURE C-23
2 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
40.0			LEAN CLAY (CL) greenish gray, wet, very soft*(continued)*	8	Ss		100	2-2-3 (5)	VS = 0.13tsf PP = 0.25tsf MC=32.4%; AL	-71.0
42.5									slow advance of casing; BPF>100	-73.5
45.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, very dense; density loosens down depth as noted	9	Ss		67	21-32-37 (69)	too gravelly for shelby tube MC=7.9%; LMA (%F=12.4)	-76.0
47.5									water noted welling up from within casing	-78.5
50.0				10	Sh		39	46-33-23 (56)	MC=8.0%; SA (%F=9.6)	-81.0
52.5									drilling very slow and rough; possible boulder	-83.5
55.0										-86.0
57.5				11	Sh		0	100/6" (100/6")	No recovery - sampler contained two pieces (2 in dia. x 1 in. thick) green-colored, very fine to fine grain. hard, massive greenstone	-88.5
60.0										-91.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-7

FIGURE C-23
3 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, very dense								-91.0
62.5										at 65 ft. water flowing up from casing, using bucket measured 0.5 gpm; attempted sample with approx. 10 ft. of heave; cutings are very fine grained sand with minor amounts of silt	-93.5
65.0	▽			12	Sh		0	5-7-7 (14)*		*blow count suspect NO RECOVERY	-96.0
			Total sampled depth = 66.5 ft							Terminated Drilling: 10/5/12; Time: 4:20PM	
67.5											-98.5
70.0											-101.0
72.5											-103.5
75.0											-106.0
77.5											-108.5
80.0											-111.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-7

FIGURE C-23
4 of 4

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND (SM) greenish gray, wet, loose; based on sampled surroundings							Begin Drilling: 9/22/12; Time: 9:45AM 4.25 in. dia. casing reinforced	-36.0
2.5			WELL-GRADED GRAVEL (GW) dark gray, wet, loose								-38.5
5.0				1A 1B	Sh		67	4-4-1 (5)*		*sampler sunk additional approx. 2.5 ft after last blow MC=11.6% MC=15.3%	-41.0
			SILTY SAND (SM) greenish gray, wet, very loose; subrounded gravel to 2" dia.								
7.5			LEAN CLAY (CL) greenish gray, moist, consistency varies as noted Stiff							soft clay/silt in cuttings	-43.5
10.0				2	Ts		56	*		*400 psi MC=28.6%; DD=98 pcf AL; TX	-46.0
12.5											-48.5
15.0			Gravel lens based on sample	3A 3B	Ss		100	4-6-7 (13)		VS = 0.75tsf MC=29.3%; AL MC=22.6%	-51.0
17.5										at 19 ft. hit obstruction; drilled with tricone bit for 15 minutes; sampler cleared hole; crystalline granite chips found in cuttings	-53.5
			Granite cobble or or boulder based on drilling - see comment								
20.0											-56.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-8

FIGURE C-24
1 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
20.0			LEAN CLAY (CL) greenish gray, moist, consistency varies as noted*(continued)*	4	Ss		73	25-8-6 (14)		VS=0.71 tsf MC=23.5%; AL	-56.0
										noted encountering gravel when cleaning hole to 25 ft. depth based on drill steel grinding; no Ts sampling attempted at sample 5	
22.5			Increase in coarse fraction - see comment								-58.5
25.0				5	Ss		100	0-14-8 (22)*		VS = 0.59tsf PP = 3.00tsf MC=24.7% *sampler sunk initial 6 in. under weight of rods	-61.0
			Very stiff								
27.5											-63.5
										stopped casing reinforcing at 30 ft.	
30.0										*30 to 32 ft. 400 psi (smooth push) 32 to 33 ft. increase to 500 psi	-66.0
				6	Ts		100	*		MC=31.1%; DD=91 pcf; AL; CO	
32.5											-68.5
35.0				7	Ss		100	0-0-0 (0)*		VS = 0.25tsf PP = 0.50tsf *sampler sunk under weight of rods MC=29.0%; AL	-71.0
			Very soft								
37.5											-73.5
40.0											-76.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-8

FIGURE C-24
2 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
40.0			LEAN CLAY (CL) greenish gray, moist, consistency varies as noted*(continued)* Very soft							*shelby tube sunk initial 1.5 ft. under weight of rods; 400 psi remainder	-76.0
				8	Ts		100	*		MC=35.4%; DD=88 pcf; AL; TX	
42.5											-78.5
45.0				9	Ss		100	0-0-0 (0)*		VS = 0.29tsf PP = 1.00tsf *sampler sunk under weight of rods MC=33.1%	-81.0
47.5											-83.5
50.0										*400 psi (smooth push)	-86.0
				10	Ts		0	*		NO RECOVERY	
52.5											-88.5
55.0										*300-350 psi (smooth push)	-91.0
				11	Ts		21	*		MC=28.4%; DD=94 pcf; AL; TX	
57.5											-93.5
60.0											-96.0

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Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-8

FIGURE C-24
3 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT (20 40 60 80) / POCKET PEN (tsf) (1 2 3 4) / VANE SHEAR (tsf) (0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			LEAN CLAY (CL) greenish gray, moist, consistency varies as noted*(continued)*								-96.0
62.5										milky fines in cuttings	-98.5
65.0			Very stiff	12	Ss		100	1-8-14 (22)		VS = 1.00tsf PP = 3.75tsf MC=22.0%	-101.0
67.5											-103.5
70.0											-106.0
72.5			SILTY SAND WITH GRAVEL (SM) Contact based on drilling							at 75 ft. approx. 3 ft. of heave; advanced casing to 75 ft., attempted sample with no recovery	-108.5
75.0			Total drilled depth = 75.0 ft							Terminated Drilling: 9/23/12; Time: 12:30AM	-111.0
77.5											-113.5
80.0											-116.0

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Project No.: 102029.04
Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-8

FIGURE C-24
4 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SILTY SAND (SM) greenish gray, wet, very loose	1A	Ss		100	0-1-1 (2)		Begin Drilling: 10/01/12; Time: 10:35AM 4.25 in. dia. reinforced casing MC=36.0%; LMA (%F=45.4) MC=24.7%; LMA (%F=9.7)	-31.0
				1B							
2.5			POORLY-GRADED SAND WITH SILT (SP-SM) gray, wet, very loose								-33.5
			LEAN CLAY (CL) greenish gray, wet, very soft								
5.0				2	Ss		100	0-0-0 (0)*		VS = 0.25tsf PP = 1.00tsf *sampler sunk under weight of rods MC=29.5%	-36.0
7.5											-38.5
10.0				3	Ts		100	*		*300 psi MC=26.5%; DD=99 pcf AL PI=17; TX	-41.0
12.5										at 14 ft casing snapped; halted drilling; pulled out, repositioned and resumed drilling	-43.5
15.0				4	Ss		100	5-1-0 (1)*		VS = 0.25tsf PP = 0.00tsf *sampler sunk 12 in. after last blow MC=30.4%; AL	-46.0
17.5											-48.5
20.0											-51.0

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Project No.: 102029.04
Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-9

FIGURE C-25
1 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
20.0			LEAN CLAY (CL) greenish gray, wet, very soft*(continued)*							*300 psi	-51.0
				5	Ts		100	*		Ts accidently dropped 10 ft to sample depth; deformed at bottom edge	
22.5										MC=32.1%; DD=98 pcf AL; CO; TX	-53.5
25.0				6	Ss		100	0-0-0 (0)*		VS = 0.21tsf PP = 0.00tsf *sampler sunk initial 12 in. under rod weight, remainder pushed in MC=30.9% AL	-56.0
27.5											-58.5
30.0				7	Ts		100	*		*30 to 32 ft. 300 psi; 32 to 33 ft. 400 psi MC=28.5%; DD=96 pcf AL; TX	-61.0
32.5											-63.5
35.0				8	Ss		100	0-0-0 (0)*		VS = 0.25tsf PP = 0.00tsf *sampler sunk under weight of hammer MC=29.7%; AL	-66.0
37.5											-68.5
40.0											-71.0

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Project No.: 102029.04
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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-9

FIGURE C-25
2 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
40.0			LEAN CLAY (CL) greenish gray, wet, very soft*(continued)*								-71.0
42.5										*350 psi (smooth and steady push)	-73.5
				9	Ts		26	*		MC=32.0%; DD=95 pcf AL;CO:TX	
45.0											-76.0
47.5											-78.5
50.0				10	Ss		100	0-0-0 (0)*		VS = 0.21tsf PP = 0.00tsf *sampler sunk under weight of hammer MC=31.1%	-81.0
52.5											-83.5
55.0											-86.0
57.5											-88.5
60.0											-91.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-9

FIGURE C-25
3 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT (20 40 60 80); POCKET PEN (tsf) (1 2 3 4); VANE SHEAR (tsf) (0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			LEAN CLAY (CL) greenish gray, wet, medium stiff	11	Ss		52	8-3-4 (7)		VS = 0.23tsf PP = 1.00tsf couldn't advance Ts, switched to Ss MC=26.4%	-91.0
62.5											-93.5
65.0											-96.0
										chatter in drill steel	
67.5											-98.5
70.0				12	Ss		100	2-4-4 (8)		VS = 0.08tsf PP = 0.00tsf MC=31.9%	-101.0
72.5											-103.5
75.0											-106.0
77.5											-108.5
80.0											-111.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-9

FIGURE C-25
4 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
80.0			LEAN CLAY (CL) greenish gray, wet, medium stiff*(continued)*	13	Ts		63	*		*psi not recorded Ts pushed in only 2 ft MC=21.7%; DD=109 pcf AL; TX	-111.0
82.5			POORLY-GRADED GRAVEL WITH SILT AND SAND (GP-GM) black and gray, wet, very dense							rough drilling and slow advance	-113.5
85.0											-116.0
										casing advanced to 90 ft.; polymer used to facilitate flush of cuttings	
87.5											-118.5
90.0				14	Sh		33	12-214/6" (214/6")		MC=10.4%; LMA (F%=5.4)	-121.0
92.5										drilling rough and slow advance	-123.5
95.0											-126.0
97.5			Total drilled depth = 97.5 ft							hole caved; unable to advance casing; no sample obtainable	-128.5
										Terminated Drilling: 10/02/12; Time: 4:10AM	
100.0											-131.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-9

FIGURE C-25
5 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			POORLY-GRADED SAND WITH SILT (SP-SM) black and gray, wet, medium dense						Begin Drilling: 10/5/12; Time: 7:30PM	-21.5
2.5										-24.0
5.0				1	Ss		45	20-16-3 (19)	MC=17.7%; SA (%F=11.3)	-26.5
7.5										-29.0
10.0				2	Ss		0	1-4-4 (8)	NO RECOVERY rough drilling w/ slow advance begins at 11 ft.	-31.5
			POORLY-GRADED GRAVEL WITH SILT AND SAND (GP-GM) black and gray, wet, medium dense Contact based on drilling - see comments							
12.5										-34.0
15.0				3	Ss		12	5-2-9 (11)	MC=10.3%; SA (%F=10.6)	-36.5
17.5										-39.0
			LEAN CLAY (CL) greenish gray, wet, soft							
20.0										-41.5

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-10

FIGURE C-26
1 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
20.0			LEAN CLAY (CL) greenish gray, wet, soft*(continued)*	4	Ss		50	6-3-1 (4)		VS = 0.38tsf PP = 1.00tsf MC=25.2%; AL	-41.5
22.5											-44.0
25.0			Very soft	5	Ss		100	2-0-0 (0)*		VS = 0.42tsf PP = 1.25tsf *sampler sunk last 15-in. on second blow MC=26.6%	-46.5
27.5											-49.0
30.0				6	Ts		9	*		*350 psi	-51.5
32.5											-54.0
35.0				7	Ts		67	*		*push pressure not recorded MC=27.1%; DD=94 pcf AL; CO	-56.5
37.5											-59.0
40.0											-61.5

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-10

FIGURE C-26
2 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
40.0			LEAN CLAY (CL) greenish gray, wet, soft*(continued)*	8	Ss		100	0-2-6 (8)*		VS = 0.08tsf PP = 0.00tsf *sampler sunk 10-in. under weight of hammer MC=28.0%	-61.5
42.5										drill steel action suggested increased gravels; gravel lens between 43 to 45 ft.	-64.0
45.0				9A 9B	Ss		100	8-13-28 (41)		VS = 0.13tsf PP = 0.25tsf MC=31.5%; AL MC=9.6%; SA (%F=12.6)	-66.5
			SILTY SAND WITH GRAVEL (SM) black and gray, wet, dense to very dense							hole caved; casing advanced to 50 ft.	
47.5											-69.0
50.0				10	Ss		67	96-65-72 (137)		MC=8.7%	-71.5
52.5											-74.0
55.0											-76.5
57.5											-79.0
60.0											-81.5

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-10

FIGURE C-26
3 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			WELL-GRADED GRAVEL WITH SAND (GW) greenish gray, wet, dense; gravel angular to subrounded, unweathered greenstone fragments	11	Ss		67	4-12-22 (34)	MC=8.0%; SA (%F=0.9)	-81.5
62.5										-84.0
65.0									from 60 to 70 ft. intermittent intervals of violent drill steel bouncing/smooth action	-86.5
67.5										-89.0
70.0			POORLY-GRADED SAND (SP) greenish gray, wet, very loose; very fine to medium- grained sand fining upward	12A 12B 12C 12D 12E	Ss		100	2-1-0 (1)*	*sampler sunk approx. 12-in. after third blow MC=21.9% LMA(%F=6.2) MC=13.3% LMA(%F=3.4) MC=10.5% MC=8.7%; SA (%F=3.0) MC=5.9%	-91.5
72.5			POORLY-GRADED GRAVEL (GP) greenish gray and tan, wet, very loose							-94.0
75.0			SILTY SAND WITH GRAVEL (SM) greenish gray, moist, very dense; description based on nature of drilling and surrounding sampled holes						from 74 to 75 ft. casing blows > 300 / 6 in.; drilled w/ tricone bit for 1/2 hour w/ advance to 75 ft; subsequent spot core of 5 ft interval down to 80 ft. with core barrel and diamond drill bit	-96.5
77.5				13	Ct		0		NO RECOVERY	-99.0
80.0										-101.5

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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Project No.: 102029.04
Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-10

FIGURE C-26
4 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT (20 40 60 80) / POCKET PEN (tsf) (1 2 3 4) / VANE SHEAR (tsf) (0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
80.0			SILTY SAND WITH GRAVEL (SM)	14	Sh		0	1-3-2 (5)*		*after 6 blows, sampler sunk approx 1 ft NO RECOVERY, replaced sampler catcher and 2nd attempt at sample showed no recovery, vfn grnd sand stuck to Sh walls	-101.5
			Total sampled depth = 81.5 ft							Terminated Drilling: 10/6/12; Time: 3:00PM	
82.5											-104.0
85.0											-106.5
87.5											-109.0
90.0											-111.5
92.5											-114.0
95.0											-116.5
97.5											-119.0
100.0											-121.5

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Checked: CMK
Project No.: 102029.04
Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

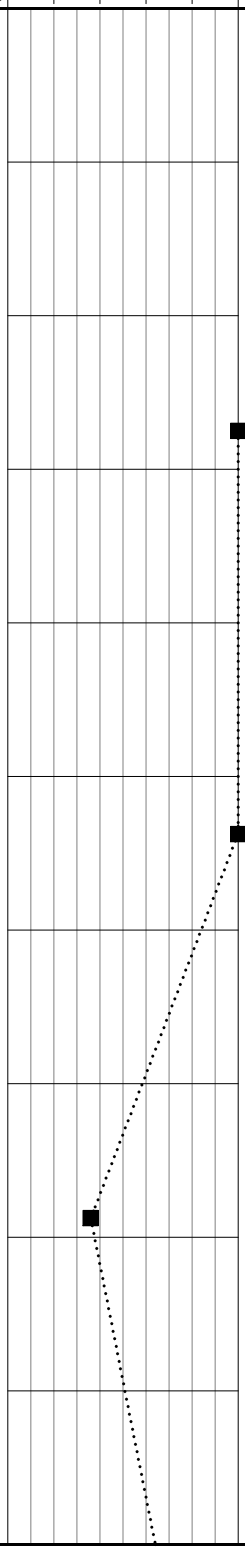
BOREHOLE BH-10

FIGURE C-26
5 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			POORLY-GRADED GRAVEL WITH SAND (GP) gray, wet, medium dense; occasional subangular to subrounded cobbles and boulders based on nearby sampled surrounding						Begin Drilling: 10/3/12; Time: 6:00PM initial difficulty seating 4.25 in. dia. casing plumb	-5.0
2.5									drill steel grinding	-7.5
5.0				1	Sh		83	4->50/3" (>50/3")	MC=4.3%; SA (%F=4.3)	-10.0
									cobble or boulder-size material based on drill steel	
7.5									tricone bit grinding down to 20 ft.	-12.5
10.0			GRAVELLY LEAN CLAY (CL) bluish gray, dry to moist, very hard	2	Sh		100	16-50-53 (100+)	MC=8.6%	-15.0
12.5			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) gray, wet, dense							-17.5
			POORLY-GRADED GRAVEL WITH SILT AND SAND (GP-GM) gray, wet, dense							
15.0				3A 3B	Sh		67	6-19-17 (36)	MC=8.5%; SA (%F=10.3)	-20.0
17.5										-22.5
			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) black and gray, wet, very dense							
20.0										-25.0

GRAPH: BLOW COUNT (20, 40, 60, 80); POCKET PEN (tsf) (1, 2, 3, 4); VANE SHEAR (tsf) (0.2, 0.4, 0.6, 0.8)



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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-11

FIGURE C-27
1 of 4

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
20.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) black and gray, wet, very dense*(continued)*	4	Sh		95	41-45-24 (69)	MC=8.5%; SA (%F=8.4)	-25.0
22.5										-27.5
25.0			SILTY SAND WITH GRAVEL (SM) black and gray, wet, medium dense to dense	5	Sh		100	13-19-23 (42)	MC=8.5%; LMA (%F=19.8)	-30.0
27.5										-32.5
30.0				6	Sh		34	10-10-10 (20)	MC=7.2%	-35.0
32.5										-37.5
35.0				7	Sh		39	11-16-15 (31)	MC=7.3%; LMA (%F=11.5)	-40.0
37.5										-42.5
			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) black and gray, wet, medium dense							
40.0										-45.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8

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Project No.: 102029.04
Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

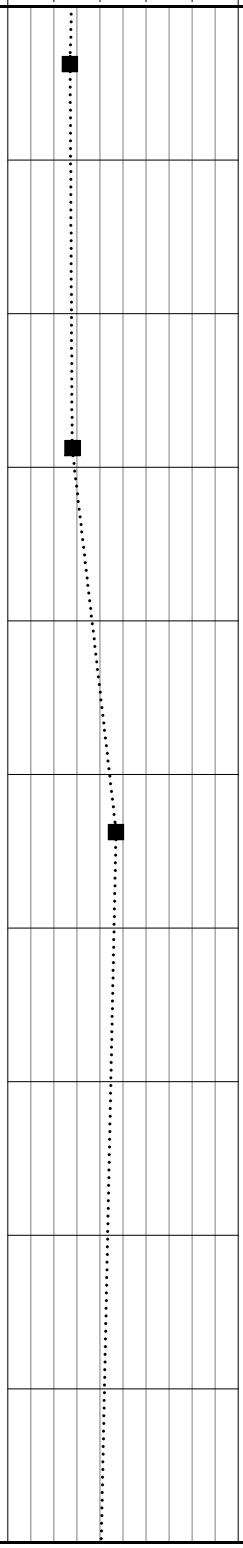
BOREHOLE BH-11

FIGURE C-27
2 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
40.0			POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM) black and gray, wet, medium dense*(continued)*	8	Sh		56	13-12-15 (27)	MC=6.5%; SA (%F=6.9)	-45.0
42.5										-47.5
45.0			SILTY SAND (SM) gray, wet, medium dense	9	Sh		50	8-12-16 (28)	MC=13.2%	-50.0
47.5										-52.5
50.0			SILTY SAND WITH GRAVEL (SM) black and gray, wet, dense	10	Sh		89	23-25-22 (47)	MC=7.7%; LMA (%F=22.7)	-55.0
52.5										-57.5
55.0										-60.0
57.5										-62.5
60.0										-65.0

GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8



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Project No.: 102029.04
Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-11

FIGURE C-27
3 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot) or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80 / POCKET PEN (tsf) 1 2 3 4 / VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			GRAVELLY LEAN CLAY (CL) black and gray, moist, hard	11	Sh		84	15-21-19 (40)		MC=9.0%; AL (non-plastic)	-65.0
			Total sampled depth = 61.5 ft							Terminated Drilling: 10/4/12; Time: 1:45AM	
62.5											-67.5
65.0											-70.0
67.5											-72.5
70.0											-75.0
72.5											-77.5
75.0											-80.0
77.5											-82.5
80.0											-85.0

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Checked: CMK
Project No.: 102029.04
Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-11

FIGURE C-27
4 of 4

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			LEAN CLAY (CL) greenish gray, wet, consistency softens down depth as noted Stiff							Begin Drilling: 9/26/12; Time: 3:20PM 4.25 in. dia. casing reinforced, firm surface at mudline	-7.0
2.5											-9.5
5.0				1	Ss		67	4-6-8 (14)		VS = 1.04tsf PP = 4.50tsf MC=24.5%	-12.0
7.5											-14.5
10.0				2	Ts		0	*		*1100 psi (crushed tube) NO RECOVERY	-17.0
12.5											-19.5
15.0			Medium stiff	3	Ss		45	0-2-4 (6)		VS = 0.46tsf PP > 4.5 tsf MC=22.7%; AL	-22.0
17.5											-24.5
20.0											-27.0

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Project No.: 102029.04
Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-12

FIGURE C-28
1 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
20.0			LEAN CLAY (CL) greenish gray, wet, consistency softens down depth as noted*(continued)*	4	Ts		0	*	>>	VS = 1.13tsf *20 to 20.5 ft. 250 psi; abrupt increase to 1,000 psi to 22 ft.; tube completely sheared off from head NO RECOVERY	-27.0
22.5											-29.5
25.0			Very stiff	5	Ss		28	22-10-8 (18)		MC=32.0%	-32.0
27.5											-34.5
30.0			Stiff	6	Ss		100	3-5-7 (12)		VS = 0.79tsf PP = 2.25tsf MC=25.0%; AL	-37.0
32.5											-39.5
35.0				7	Ts		100	*		*750 psi MC=22.4%; DD=102 pcf; AL; TX	-42.0
37.5											-44.5
40.0											-47.0

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Project No.: 102029.04
Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-12

FIGURE C-28
2 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT (20 40 60 80); POCKET PEN (tsf) (1 2 3 4); VANE SHEAR (tsf) (0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
40.0			LEAN CLAY (CL) greenish gray, wet, consistency softens down depth as noted*(continued)* Medium stiff	8	Ss		100	2-3-3 (6)		VS = 0.50tsf PP = 1.25tsf MC=29.9%; AL	-47.0
42.5											-49.5
45.0										*400 psi	-52.0
				9	Ts		100	*		MC=26.7%; DD=97 pcf; AL PI=15; TX	
47.5											-54.5
50.0			Stiff	10	Ss		0	4-5-5 (10)		NO RECOVERY	-57.0
52.5											-59.5
55.0				11	Ss		100	2-2-6 (8)		VS = 0.54tsf PP = 2.75tsf MC=27.8%; AL	-62.0
57.5											-64.5
60.0											-67.0

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Data Entry: PJD
Checked: CMK
Project No.: 102029.04
Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-12

FIGURE C-28
3 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH (BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			LEAN CLAY (CL) greenish gray, wet, consistency softens down depth as noted*(continued)*							*500 psi; driller noted push resistance noticeably increased after 2 ft of advance	-67.0
				12	Ts		84	*		MC=32.2%; DD=94 pcf; AL; TX(UU)	
62.5											-69.5
65.0											-72.0
67.5											-74.5
70.0										VS = 0.25tsf PP = 0.00tsf	-77.0
				13	Ss		67	0-3-5 (8)*		*sampler sank initial 6" under weight of hammer MC=28.4%	
72.5											-79.5
	▽		SANDY LEAN CLAY (CL) gray, wet, stiff; subrounded gravel to 1.24" dia.							driller noted coarse material at 74 ft.	
75.0				14	Ss		34	4-3-5 (8)		MC=17.2%	-82.0
77.5										significant amount of water flowing up from casing	-84.5
			POORLY-GRADED GRAVEL WITH SILT AND SAND (GP-GM) black and gray, wet, dense								
80.0											-87.0

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Checked: CMK
Project No.: 102029.04
Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-12

FIGURE C-28
4 of 5

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT (20 40 60 80); POCKET PEN (tsf) (1 2 3 4); VANE SHEAR (tsf) (0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
80.0			POORLY-GRADED GRAVEL WITH SILT AND SAND (GP-GM) black and gray, wet, dense*(continued)*	15	Sh		59	4-10-28-97 (38)		MC=3.6%; SA (%F=7.1)	-87.0
			Total sampled depth = 82.0 ft							Terminated Drilling: 9/26/12; Time: 11:15PM	
82.5											-89.5
85.0											-92.0
87.5											-94.5
90.0											-97.0
92.5											-99.5
95.0											-102.0
97.5											-104.5
100.0											-107.0

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Checked: CMK
Project No.: 102029.04
Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-12

FIGURE C-28
5 of 5

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80 / POCKET PEN (tsf) 1 2 3 4 / VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			LEAN CLAY (CL) greenish gray, wet, consistency varies with depth as noted Very soft	1	Ss		0	0-0-0 (0)		Begin Drilling: 10/2/12; Time: 10:40AM 4.25 in. dia. casing reinforced NO RECOVERY	-36.0
2.5											-38.5
5.0										*500 psi (smooth push)	-41.0
				2	Ts		100	*		MC=25.6%; DD=104 pcf; AL; TX green/gray - colored milky fines in cuttings	
7.5											-43.5
10.0			Stiff	3	Ss		17	2-4-6 (10)*		*sampler sank initial 3" under weight of hammer	-46.0
12.5											-48.5
15.0										*600 psi	-51.0
				4	Ts		73	*		MC=23.3%; DD=106 pcf; AL; TX	
17.5											-53.5
20.0											-56.0

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Project No.: 102029.04
Date: Feb. 2015

SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-13

FIGURE C-29
1 of 7

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
20.0			LEAN CLAY (CL) greenish gray, wet, consistency varies with depth as noted*(continued)* Stiff	5	Ss		0	10-6-7 (13)		NO RECOVERY	-56.0
22.5										green/gray-colored, milky fines in cuttings	-58.5
25.0			Increase of gravels based on shelby tube - see comment							*250 to 300 psi (smooth push); tube crushed @ bottom edge	-61.0
				6	Ts		6	*			
27.5											-63.5
30.0			Very soft	7	Ss		100	0-0-0 (0)*		VS = 0.17tsf PP = 0.50tsf *sampler sank under weight of hammer MC=32.8%; AL	-66.0
32.5											-68.5
35.0										*300 psi (smooth push)	-71.0
				8	Ts			*		MC=39.8%; DD=82 pcf; AL; TX	
37.5											-73.5
40.0											-76.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-13

FIGURE C-29
2 of 7

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
40.0			LEAN CLAY (CL) greenish gray, wet, consistency varies with depth as noted*(continued)* Very soft Trace angular black gravel to 3/4" diameter	9	Ss		100	0-0-0 (0)*		VS = 0.17tsf PP = 0.00tsf *sampler sank under weight of hammer MC=37.9%; AL	-76.0
42.5											-78.5
45.0											-81.0
47.5											-83.5
50.0										*300 psi (smooth push)	-86.0
				10	Ts		100	*		MC=36.6%; DD=86 pcf; AL; TX	
52.5											-88.5
55.0										green/gray-colored milky fines in cuttings	-91.0
57.5											-93.5
60.0											-96.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-13

FIGURE C-29
3 of 7

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
60.0			LEAN CLAY (CL) greenish gray, wet, consistency varies with depth as noted*(continued)* Very soft	11	Ss		0	0-0-0 (0)*		*sampler sank under weight of hammer NO RECOVERY - greenish gray fines adhered to 1.5 ft. depth of sampler wall	-96.0
62.5											-98.5
65.0											-101.0
67.5											-103.5
			Increase in sand, gravel based on drilling - see - comment							drill steel grinding at 68 ft.; switch to Sh sampler	
70.0			Sample 12A: soil saturated Sample 12B: contained trace angular gravel to 3/4" diameter	12B 12A	Sh		100	4-1-0 (1)*		*sampler sunk after 5th blow VS = 0.33tsf PP = 1.50tsf MC=43.2%; AL MC=33.0%	-106.0
72.5											-108.5
75.0											-111.0
77.5											-113.5
80.0											-116.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-13

FIGURE C-29
4 of 7

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
80.0	▽		LEAN CLAY WITH GRAVEL (CL) greenish gray, wet, stiff; subrounded gravel to 1.5" diameter; difficulty in retrieving soil from sampler - very compact	13	Sh		100	3-4-5 (9)		VS = 0.69tsf at approx. 80 ft. trickle of water flowing out from casing MC=23.0%; AL	-116.0
82.5										slight grinding of drill steel down to 90 ft.	-118.5
85.0											-121.0
87.5											-123.5
90.0			GRAVELLY LEAN CLAY (CL) greenish gray, wet, stiff; subangular gravel to 3" diameter; difficulty in retrieving soil from sampler - very compact	14	Sh		100	6-6-5 (11)		MC=17.6%	-126.0
92.5										low to moderate grinding action of drill steel down to 100 ft.	-128.5
95.0											-131.0
97.5											-133.5
100.0											-136.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-13

FIGURE C-29
5 of 7

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT (20 40 60 80); POCKET PEN (tsf) (1 2 3 4); VANE SHEAR (tsf) (0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
100.0			LEAN CLAY (CL) greenish gray, moist, consistency varies with depth as noted; trace subangular to subrounded gravel to 1" diameter	15	Sh		89	4-6-13 (19)		VS = 0.79tsf PP = >4.5tsf MC=17.3%; AL	-136.0
102.5											-138.5
105.0											-141.0
107.5											-143.5
110.0				16	Sh		67	5-4-7 (11)		VS = 0.65tsf PP = >4.5tsf MC=18.3%	-146.0
112.5											-148.5
115.0											-151.0
117.5											-153.5
			From 117 ft to 120 ft. probable gravel lense - see comment							at 120 ft. uncased hole caves; reinforced casing resumed; polymer used when cleaning hole	
120.0											-156.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-13

FIGURE C-29
6 of 7

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery % (RQD %)	Penetration Blows per 6/Inch (per foot)* or {Rock Quality}	GRAPH: BLOW COUNT (20 40 60 80); POCKET PEN (tsf) (1 2 3 4); VANE SHEAR (tsf) (0.2 0.4 0.6 0.8)	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
120.0			LEAN CLAY (CL) greenish gray, moist, consistency varies with depth as noted; trace subangular to subrounded gravel to 1" diameter*(continued)* Stiff	17	Sh		34	2-4-7 (11)		VS = 0.65tsf PP = >4.5tsf MC=15.7%	-156.0
122.5											-158.5
125.0											-161.0
127.5											-163.5
130.0			Medium stiff	18	Sh		67	2-3-3 (6)		VS = 0.45tsf PP = 2.50tsf MC=27.0%; AL	-166.0
			Total sampled depth = 131.5 ft							at 130 ft. maximum drill rods used - hole terminated	
132.5										Terminated Drilling: 10/3/12; Time: 6:20AM	-168.5
135.0											-171.0
137.5											-173.5
140.0											-176.0

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SOUTH PORTAGE COVE HARBOR EXPANSION
Haines, Alaska

BOREHOLE BH-13

FIGURE C-29
7 of 7

BOREHOLE LOG 102029 SOUTH PORTAGE COVE HARBOR EXPANSION - CMK EDITS.GPJ PND ENGINEERS.GDT 2/18/15 ©2015

APPENDIX D

Previous Exploration Logs

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery (RQD) (%)	Penetration Blows per 6/Inch (per foot)	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SURFACE BEACH DEPOSITS greenish gray, moist, very loose; coarse sand with abundant cobbles and boulders, mixed organics w/ white shell fragments							Date: 7/12/2010	-2.0
2.5			LEAN CLAY (CL) greenish gray, moist, soft; nonplastic plasticity; earthy odor								-4.5
	▽		SAND (SP) greenish gray, moist, loose; 80% coarse sand; 10% fines; trace amounts coarse gravel; 10% shell fragments								
5.0											-7.0
7.5											-9.5
10.0			GRAVELLY SAND (SW-SM) bluish gray, dry to moist, dense to very dense; 35% fine to coarse, rounded gravel; 45% fine to coarse sand; 10% fines; abundant rounded gravels and occasional cobbles and boulders strongly cemented within a fine-grain matrix; soils are very compact in- place but "flow" when hydrated; sand grn size appears to coarsen down depth							excavated soils commonly form cobble to boulder-size clumps with coarse clasts embedded within the strongly cemented fine-grain matrix; down depth the matrix grains appear to coarsen; and the clumps are not as common	-12.0
12.5											-14.5
15.0										with continued water seepage down depth, the excavated soil density loosens	-17.0
17.5										Terminated at: 18.0 ft, 7/12/2010	-19.5
20.0											-22.0
22.5											-24.5
25.0											-27.0

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S PORTAGE COVE HARBOR EXPANSION
Portage Cove
Haines, Alaska

TEST PIT 1

FIGURE 1

BOREHOLE LOG 102029.02 SOUTH PORTAGE COVE.GPJ PND ENGINEERS.GDT 9/23/10 ©2010

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery (RQD) (%)	Penetration Blows per 6/Inch (per foot)	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SURFACE BEACH DEPOSITS greenish gray, moist, very loose							Date: 7/12/2010	-2.0
			SILTY CLAY (CL-ML) greenish gray, moist, soft; 18% fine to coarse gravel; 9% sand; 72% fines; medium plasticity; PI=6								
2.5	▽		SAND (SP) greenish gray, moist, loose; 80% coarse sand; 10% fines; 10% broken shell fragments; the layer appears to be a buried beach deposit								-4.5
5.0											-7.0
7.5			GRAVELLY SAND (SW-SM) bluish gray, dry to moist, dense to very dense; 25% fine to coarse, subrounded to rounded gravel; 50% fine to coarse sand; 10% fines; abundant rounded cobbles and an occasional subangular boulder up to 4' dia.; gravels and cobbles/boulders embedded in a compact fine-grained sand/silt matrix; soils are dry to moist and compact in place but become loose when hydrated and excavated								-9.5
10.0										The bluish gray compact, dense soils are considered glacially deposited diamicton, when excavated commonly form cobble to boulder-size clumps; subsequent to water seepage the soils hydrate and become very loose and "flow"	-12.0
12.5											-14.5
15.0											-17.0
17.5										Terminated at: 18.0 ft, 7/12/2010	-19.5
20.0											-22.0
22.5											-24.5
25.0											-27.0

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S PORTAGE COVE HARBOR EXPANSION
Portage Cove
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TEST PIT 2

FIGURE 1

BOREHOLE LOG 102029.02 SOUTH PORTAGE COVE.GPJ PND ENGINEERS.GDT 9/23/10 ©2010

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery (RQD) (%)	Penetration Blows per 6/Inch (per foot)	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SURFACE BEACH DEPOSITS greenish gray, moist, very loose								2.0
			GRAVELLY SAND (SW-SM) bluish gray, dry to moist, dense; glacial diamicton; this test pit was excavated only to determine the presence of a near surface clay layer similar to that found in TP's 1 & 2								
2.5										Terminated at: 3.0 ft, 7/12/2010	-0.5
5.0											-3.0
7.5											-5.5
10.0											-8.0
12.5											-10.5
15.0											-13.0
17.5											-15.5
20.0											-18.0
22.5											-20.5
25.0											-23.0

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S PORTAGE COVE HARBOR EXPANSION
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TEST PIT 3

FIGURE 1

BOREHOLE LOG 102029.02 SOUTH PORTAGE COVE.GPJ PND ENGINEERS.GDT 9/23/10 ©2010

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery (RQD) (%)	Penetration Blows per 6/Inch (per foot)	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SURFACE BEACH DEPOSITS greenish gray, moist, very loose								3.0
2.5											0.5
5.0	▽										-2.0
7.5											-4.5
10.0			GRAVELLY SAND (SW-SM) bluish gray, dry to moist, dense to very dense; diamicton similar to previous test pits; the sand size grains appear to grade down depth to a coarser grain-size								-7.0
12.5											-9.5
15.0											-12.0
17.5											-14.5
20.0										Terminated at: 20.0 ft, 7/12/2010	-17.0
22.5											-19.5
25.0											-22.0

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S PORTAGE COVE HARBOR EXPANSION
Portage Cove
Haines, Alaska

TEST PIT 4

FIGURE 1

BOREHOLE LOG 102029.02 SOUTH PORTAGE COVE.GPJ PND ENGINEERS.GDT 9/23/10 ©2010

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery (RQD) (%)	Penetration Blows per 6/Inch (per foot)	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SURFACE BEACH DEPOSITS greenish gray, moist, very loose								3.0
2.5											0.5
5.0			GRAVELLY SAND (SW-SM) bluish gray, dry to moist, dense to very dense; diamicton similar to previous pits; initially harder excavating - soils nearly dry; walls had no sloughing; due to incoming tide, pit filled with water - flooded @ 14'								-2.0
7.5											-4.5
10.0											-7.0
12.5											-9.5
										Terminated at: 14.0 ft, 7/12/2010	
15.0											-12.0
17.5											-14.5
20.0											-17.0
22.5											-19.5
25.0											-22.0

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S PORTAGE COVE HARBOR EXPANSION
Portage Cove
Haines, Alaska

TEST PIT 5

FIGURE 1

BOREHOLE LOG 102029.02 SOUTH PORTAGE COVE.GPJ PND ENGINEERS.GDT 9/23/10 ©2010

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery (RQD) (%)	Penetration Blows per 6/Inch (per foot)	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SURFACE BEACH DEPOSITS greenish gray, moist, very loose								-2.0
2.5											-4.5
5.0											-7.0
7.5			SAND WITH GRAVEL (SP) bluish gray, dry to moist, dense to very dense; diamicton; initially hard digging with walls holding firm; @ lower depth > water seepage from upslope; down depth soils become saturated and when excavated - very loose; bottom of pit walls sloughed considerably with ponded water								-9.5
10.0											-12.0
12.5											-14.5
15.0	▽										-17.0
17.5										Terminated at: 18.0 ft, 7/12/2010	-19.5
20.0											-22.0
22.5											-24.5
25.0											-27.0

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S PORTAGE COVE HARBOR EXPANSION
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Haines, Alaska

TEST PIT 6

FIGURE 1

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery (RQD) (%)	Penetration Blows per 6/Inch (per foot)	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SURFACE BEACH DEPOSITS greenish gray, moist, very loose								-2.0
2.5											-4.5
5.0											-7.0
7.5			GRAVELLY SAND (SW-SM) bluish gray, dry to moist, dense to very dense; diamicton similar to previous pits; @ 12' a 4' dia. boulder; walls held firm to bottom of pit; due to incoming tide, pit was terminated early inorder to excavate TP-8; no water seepage w/in pit								-9.5
10.0											-12.0
12.5											-14.5
15.0											-17.0
										Terminated at: 16.0 ft, 7/12/2010	
17.5											-19.5
20.0											-22.0
22.5											-24.5
25.0											-27.0

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S PORTAGE COVE HARBOR EXPANSION
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Haines, Alaska

TEST PIT 7

FIGURE 1

BOREHOLE LOG 102029.02 SOUTH PORTAGE COVE.GPJ PND ENGINEERS.GDT 9/23/10 ©2010

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery (RQD) (%)	Penetration Blows per 6/Inch (per foot)	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SURFACE BEACH DEPOSITS greenish gray, moist, very loose								-2.0
2.5											-4.5
5.0											-7.0
7.5			GRAVELLY SAND (SW-SM) bluish gray, dry to moist, diamicton similar to previous pits; down depth the matrix appears to grade to a coarser-grain matrix with less silt								-9.5
10.0											-12.0
12.5											-14.5
15.0	▽										-17.0
17.5										Terminated at: 18.0 ft, 7/12/2010	-19.5
20.0											-22.0
22.5											-24.5
25.0											-27.0

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S PORTAGE COVE HARBOR EXPANSION
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TEST PIT 8

FIGURE 1

BOREHOLE LOG 102029.02 SOUTH PORTAGE COVE.GPJ PND ENGINEERS.GDT 9/23/10 ©2010

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery (RQD) (%)	Penetration Blows per 6/Inch (per foot)	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SURFACE BEACH DEPOSITS greenish gray, moist, very loose								8.0
2.5											5.5
5.0											3.0
7.5											0.5
10.0			GRAVELLY SAND (SW-SM) bluish gray, dry to moist, dense to very dense; diamicton similar to previous pits; sides of walls held firm to bottom; no water seepage w/in pit								-2.0
12.5											-4.5
15.0											-7.0
17.5											-9.5
20.0										Terminated at: 20.0 ft, 7/12/2010	-12.0
22.5											-14.5
25.0											-17.0

P | N | D
ENGINEERS, INC.

Logged By: PJD
Data Entry: PJD
Checked: CRS
Project No.:
Date: Jul 2010

S PORTAGE COVE HARBOR EXPANSION
Portage Cove
Haines, Alaska

TEST PIT 9

FIGURE 1

BOREHOLE LOG 102029.02 SOUTH PORTAGE COVE.GPJ PND ENGINEERS.GDT 9/23/10 ©2010

Depth (feet)	Water Table	Graphic Symbol	SOIL DESCRIPTION: Soil Name, Color, Moisture Content, Relative Density, Soil Structure, Mineralogy, Other Information	SAMPLES: Number	Type	Location	Recovery (RQD) (%)	Penetration Blows per 6/Inch (per foot)	GRAPH: BLOW COUNT 20 40 60 80; POCKET PEN (tsf) 1 2 3 4; VANE SHEAR (tsf) 0.2 0.4 0.6 0.8	COMMENTS: Casing Depth, Drilling Rate, Fluid Loss, Drill Pressure, Tests, Instrumentation, Additional Information	Elevation (feet)
0.0			SURFACE BEACH DEPOSITS greenish gray, moist, very loose								8.0
2.5											5.5
5.0											3.0
7.5			GRAVELLY SAND (SW-SM) bluish gray, dry to moist, dense to very dense; diamicton; similar to previous pits; noticeably hard digging/scraping w/ excavator bucket; sand grains appear to coarsen down depth with less silt; no water seepage w/in pit								0.5
10.0											-2.0
12.5											-4.5
15.0											-7.0
17.5										Terminated at: 18.0 ft, 7/12/2010	-9.5
20.0											-12.0
22.5											-14.5
25.0											-17.0

P | N | D
ENGINEERS, INC.

Logged By: PJD
Data Entry: PJD
Checked: CRS
Project No.:
Date: Jul 2010

S PORTAGE COVE HARBOR EXPANSION
Portage Cove
Haines, Alaska

TEST PIT 10

FIGURE 1

BOREHOLE LOG 102029.02 SOUTH PORTAGE COVE.GPJ PND ENGINEERS.GDT 9/23/10 ©2010

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section
EXPLORATION LOG

Project:	Haines Small Boat Harbor, Haines, Alaska
Page	1 of 1
Date:	11 Sep 2004
Drilling Agency:	☒ Alaska District ☐ Other
Elevation Datum:	MLLW ☐ MSL ☒ other
Location:	Northing: 825,217 m; Easting: 717,467 m
Top of Hole Elevation:	-1.1 m
Hole Number, Field:	TB-13
Permanent:	AP-227
Operator:	William Tester
Inspector:	Inocencio Roman
Type of Hole:	☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer
Depth to Groundwater:	NA
Depth Drilled:	4.6 m
Total Depth:	4.9 m
Hammer Weight:	154 kg
Split Spoon I.D.:	64 mm
Size and Type of Bit:	98 mm Tricone
Type of Equipment:	CME-850 Autohammer
Type of Samples:	Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
		1			1 2 2 2	SP	Poorly graded SAND				51			Dark grey with white specks, wet, fine sand, nonplastic (NP) fines, sewer odor
1		2			1 2 1 3	SP	Poorly graded SAND				13			Dark grey and grey with white specks, wet, subangular to subrounded gravel, fine sand, NP fines, sea shells
		3			3 5 2 3	SP-SM	Poorly graded SAND with Silt	11	78	11	6			Grey with white specks, wet, subrounded to rounded gravel, fine to coarse sand, NP fines, sea shells
2		4			2 2 1 2	CL	Lean CLAY with Sand	9	19	72	6		19	Greenish grey, wet, subangular to subrounded gravel, fine to coarse sand, plastic fines, sea shells
		5			1 13 43	SC	Clayey SAND with gravel	37	47	16	25		9	Grey, wet, subangular to subrounded gravel, fine to coarse sand, plastic fines
3		6			50/100mm 4 8 70/50mm	SC	Clayey SAND with gravel	35	39	26	25		11	Greenish grey, wet, subangular to subrounded gravel, fine to coarse sand, plastic fines
4		7			8 53	NR	No Recovery				>76			No recovery, several pieces of fractured cobble and heaving sand in sampler. Abandoned hole, encountered refusal at 4.9 meters due to collapse of casing shoe
5														Bottom of Hole 4.9 m
6														Groundwater Measurement Not Applicable
7														PID = (Cold/Hot) Photo Ionization Detector
8														
9														

EXPLORATION LOG HAINESSBH.GPJ ACE_ANC.GDT 12/9/05

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section
EXPLORATION LOG

Project: Haines Small Boat Harbor, Haines, Alaska

Date: 12 Sep 2004

Drilling Agency: ☒ Alaska District ☐ Other

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 825,184 m; Easting: 717,525 m

Top of Hole Elevation: -5.5 m

Hole Number, Field: TB-14 Permanent: AP-228

Operator: William Tester

Inspector: Inocencio Roman

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: NA

Depth Drilled: 6.1 m

Total Depth: 6.7 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 98 mm Tricone

Type of Equipment: CME-850 (See Note Below)

Type of Samples: Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Samples 3, 4, and 5 were taken with SPT.
		1			0 0 2 2	SP	Poorly graded SAND							Dark grey with white specks, wet, fine sand, nonplastic (NP) fines, sewer odor
1														
2		2			3 1 1 1	NR	No Recovery							No recovery, clay at the shoe (64 millimeter split spoon)
3		3			0 0 2 2	CL	Lean CLAY							Greenish grey, wet, fine to coarse sand, plastic fines (switched to Standard Penetration Test)
4														
5		4			1 2 5 5	CL	Lean CLAY with Sand	5	13	82			19	Greenish grey, wet, subangular to subrounded gravel, fine to coarse sand, plastic fines
6		5			1 2 2 4	CL	Lean CLAY	0	10	90			21	Greenish grey, wet, fine to coarse sand, plastic fines
7														Bottom of Hole 6.7 m Groundwater Measurement Not Applicable PID = (Cold/Hot) Photo Ionization Detector Drive samples were first acquired using 64 millimeter split spoon and 154 kg hammer, but switched to Standard Penetration Test (64 kg Hammer and 35 millimeter split spoon).
8														
9														

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section
EXPLORATION LOG

Project: Haines Small Boat Harbor, Haines, Alaska

Date: 12 Sep 2004

Drilling Agency: ☒ Alaska District ☐ Other

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 825,170 m Easting: 717,457 m

Top of Hole Elevation: -0.6 m -1.8

Hole Number, Field: TB-15 Permanent: AP-229

Operator: William Tester

Inspector: Inocencio Roman

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: NA

Depth Drilled: 4.6 m

Total Depth: 4.6 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 98 mm Tricone

Type of Equipment: CME-850 Autohammer

Type of Samples: Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
		1a			3 2 1 1	GP-GC CL	Poorly graded GRAVEL with Clay and Sand; Gravelly lean CLAY with Sand				38			Dark grey, wet, subangular to subrounded gravel, fine to coarse sand, plastic fines, sea shells; Greenish grey, wet, subangular to subrounded gravel, fine to coarse sand, plastic fines
1		1b												
2		2			19 53/100mm	GC	Clayey GRAVEL with Sand	51	31	18	51			Greenish grey to dark grey, wet, subangular to subrounded gravel, fine to coarse sand, plastic fines, firm, upper 100 millimeters consist mainly of clay
3		3			55/125mm	GP	Poorly graded GRAVEL	93	7	0	32			Grey, wet, subangular to subrounded gravel, fine to coarse sand, (fines may have been washed out by wash boring method)
4														Drill action indicates clay, abandoned hole because tidal flucuations caused the water level to become too shallow for the barge
5														Bottom of Hole 4.6 m Groundwater Measurement Not Applicable PID = (Cold/Hot) Photo Ionization Detector
6														
7														
8														
9														

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section
EXPLORATION LOG

Project: Haines Small Boat Harbor, Haines, Alaska

Date: 14 Sep 2004

Drilling Agency: ☒ Alaska District ☐ Other

Elevation Datum: MLLW ☐ MSL ☒ other

Location: Northing: 825,124 m Easting: 717,477 m

Top of Hole Elevation: -1.7 m

Hole Number, Field: TB-16 Permanent: AP-232

Operator: William Tester

Inspector: Inocencio Roman

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: NA

Depth Drilled: 6.1 m

Total Depth: 6.7 m

Hammer Weight: 154 kg

Split Spoon I.D.: 64 mm

Size and Type of Bit: 98 mm Tricone

Type of Equipment: CME-850 Autohammer

Type of Samples: Drive

Depth (m)	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
1	1			6 27 22 20	GP-GM	Poorly graded GRAVEL with Silt, Sand, and Cobbles				>76			Dark grey with white specks, wet, subangular to subrounded gravel, fine to coarse sand, nonplastic (NP) fines, sea shells, cobbles
2	2			30 48 52/125mm	SM	Silty SAND	13	65	22	13			Dark grey, wet, subrounded to rounded gravel, fine sand, NP fines
3	3			27 42 52/100mm	SM	Silty SAND with Gravel	25	54	21	44			Dark grey, wet, subangular to subrounded gravel, fine sand, NP fines
4	4			30 27 36 51/125mm	SM	Silty SAND with Gravel	24	58	18	25			Dark grey, wet, subangular to subrounded gravel, fine to coarse sand, NP fines
6	5			4 3 17 20	GW	Well-graded GRAVEL with Sand and Cobbles	62	33	5	>76			Grey, wet, subangular to subrounded gravel, fine to coarse sand, NP fines, cobbles
7													Bottom of Hole 6.7 m Groundwater Measurement Not Applicable PID = (Cold/Hot) Photo Ionization Detector
8													
9													

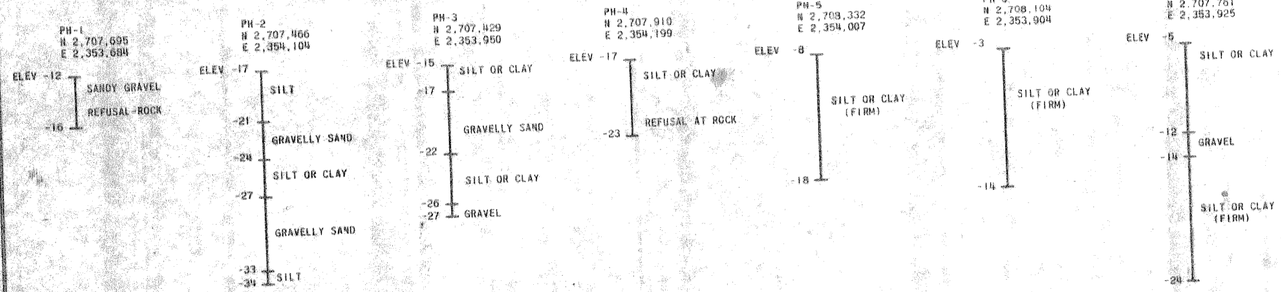
CORPS OF ENGINEERS

PROBE HOLES

PH-1 THRU PH-7
CORPS OF ENGINEERS
APRIL 1973

MISCELLANEOUS DATA

JET PROBE - 1 1/2" DIA. (A-ROD)
NOZZLE -1 4" DIA.
PUMP -600 PSI MAX

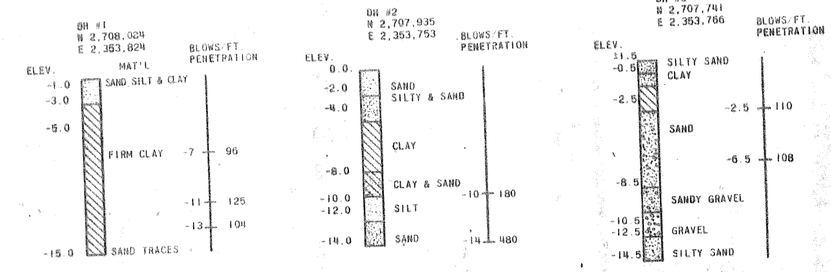


DRILL HOLES

A & E
MARCH 1957

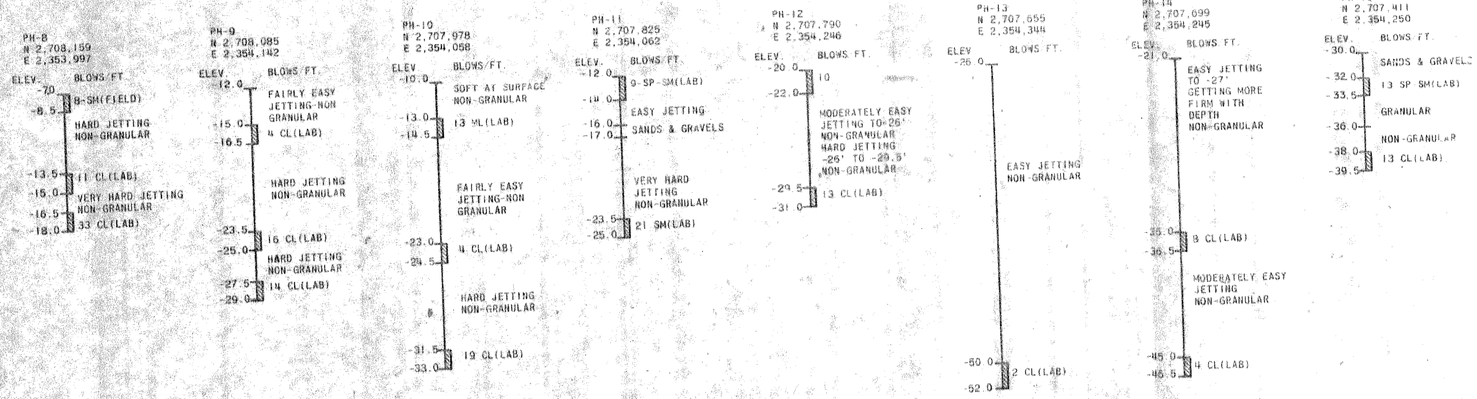
MISCELLANEOUS DATA

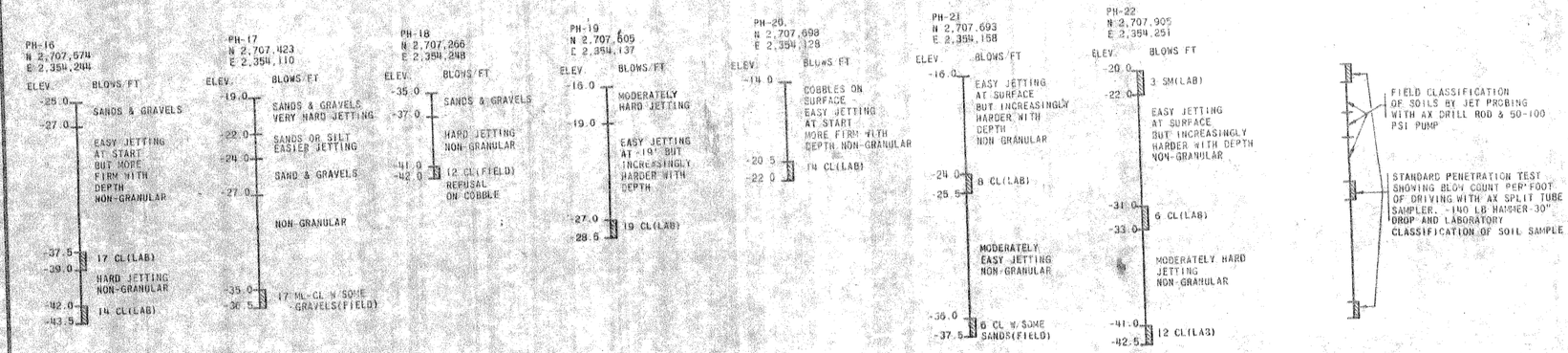
WEIGHT OF HAMMER = 2400 LB.
AVERAGE FALL OF HAMMER = 24"
SIZE OF CASING = 6"



NOTE: EXISTING BREAKWATER COMPLETED IN 1958.

PH-8 THRU PH-22
CORPS OF ENGINEERS
APRIL 1975





FIELD CLASSIFICATION OF SOILS BY JET PROBING WITH AX DRILL ROD & 50-100 PSI PUMP

STANDARD PENETRATION TEST SHOWING BLOW COUNT PER FOOT OF DRIVING WITH AX SPLIT TUBE SAMPLER. -140 LB HAMMER-30" DROP AND LABORATORY CLASSIFICATION OF SOIL SAMPLE

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

HAINES, ALASKA
HAINES HARBOR

SOIL LOGS

DESIGNED: RLO
DRAWN: WW
CHECKED: RLO
PREPARED: KEH
CHIEF
SUPERVISED: Hale Moore Soil SECTION
CHIEF
SUBMITTED: F&M Branch
CHIEF
RECOMMENDED:
CHIEF, ENGINEERING DIVISION

APPROVED:
COLONEL, CE DISTRICT ENGINEER
SCALE As Shown
DATE 1 APR 76
FILE NUMBER I-HAI-94-04-02
SHEET 4 OF 4

INV. NO. DACW85-

APPENDIX E

Laboratory Testing

Note:
ASTM D 2487 provides a guideline for minimum sample sizes for laboratory tests. Limited recovery and samples sizes recovered from split spoon procedures may result in conditions that do not meet these guidelines. The reader is cautioned that gradations may not accurately reflect the actual field conditions. In addition, the split spoon diameter may limit the maximum particle size recovered which could impact the gradation reported. PND has interpreted soil types shown in this report based on visual examination, laboratory testing and general drilling characteristics to estimate soil conditions encountered at each borehole location.

SOUTH PORTAGE COVE HARBOR EXPANSION
LABORATORY TESTING SUMMARY

BOREHOLE	SAMPLE NUMBER	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% FINES	ADDITIONAL TESTING			USCS CLASSIFACTION
					LL	PL	PI				UU TRIAXIAL	CU TRIAXIAL	CONSOLIDATION	
B-1	3	5-7	5.3		-	-	-	49.8	45.3	4.9				GP
B-1	6	20-22	7.4		-	-	-	44.2	52.1	3.6				SP
B-3	6	15-17	5.2		-	-	-	46.7	52.5	0.8				SP
B-3	7B	20.6-22	0.8		-	-	-	80.3	19.6	0.1				GP
B-3	8B	25.8-27	6.5		-	-	-	46.8	45.8	7.4				GP-GM
B-3	10	35-37	3.0		-	-	-	72.1	26.5	1.5				GP
B-5	1	5-7	24.1		27	18	9	-	-	-				CL
B-5	9	35-37	2.1		-	-	-	71.4	27.8	0.8				GW
B-5	11	45-46.5	6.8		-	-	-	40.5	46.5	13.0				SM
B-5	12B	50.3-52	0.8		-	-	-	79.8	20.0	0.1				GW
B-6	7	20-21.25	8.6		-	-	-	30.9	50.7	18.4				SM
B-9	5	20-22	6.4		-	-	-	38.6	51.4	10.0				SP-SM
B-12	5	13-15	8.5		-	-	-	31.0	40.2	28.8				SM
B-13	7	20-22	5.4		-	-	-	54.2	39.0	6.8				GP-GM
B-13	8	25-27	4.5		-	-	-	63.8	31.4	4.8				GP
B-13	9	30-32	12.5		-	-	-	4.8	62.1	33.1				SM
B-14	4	55-57	4.0		-	-	-	57.3	41.1	1.6				GW
B-14	5	60-62	5.3		-	-	-	48.9	43.7	7.5				GP-GM
B-14	6A	68-69	5.2		-	-	-	67.5	29.3	3.2				GP
B-14	6B	69-70	7.2		-	-	-	44.6	45.7	9.7				SP-SM
B-14	7	80-81.5	8.4		-	-	-	26.2	44.2	29.6				SM
B-14	8	90-91.5	10.9		-	-	-	13.5	56.6	29.9				SM
B-14	9A	98-98.6	16.5		-	-	-	0.6	95.3	4.1				SP
B-14	9B	98.6-99.3	5.9		-	-	-	28.2	68.3	3.4				SW
B-14	9C	99.3-100	16.2		-	-	-	-	-	54.9				ML
B-14	10	109-110.5	0.7		-	-	-	70.0	29.9	0.1				GP
B-17	2	10-12	9.2		-	-	-	38.4	52.6	9.0				SP-SM
B-17	4	20-22	7.0		-	-	-	41.3	45.0	13.7				SM
B-17	5	25-27	10.4		-	-	-	19.7	37.6	42.7				SM
B-17	8	40-42	10.5		-	-	-	26.1	48.2	25.7				SM
BH-2	1A	5-5.5	4.2		-	-	-	-	-	-				GM
BH-2	1B	5.5-6.5	7.7		-	-	-	-	-	-				SM
BH-2	2	10-11.5	8.3		-	-	-	26.3	55.0	18.6				SM
BH-2	3	15-16.5	8.4		-	-	-	-	-	-				SM
BH-2	4	20-21.5	5.6		-	-	-	51.0	37.6	11.4				GP-GM

SOUTH PORTAGE COVE HARBOR EXPANSION
LABORATORY TESTING SUMMARY

BOREHOLE	SAMPLE NUMBER	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% FINES	ADDITIONAL TESTING			USCS CLASSIFACTION
					LL	PL	PI				UU TRIAXIAL	CU TRIAXIAL	CONSOLIDATION	
BH-2	5	25-26.5	7.1		-	-	-	-	-	-				SM
BH-2	6	30-31.5	6.0		-	-	-	53.4	42.3	4.3				GP
BH-2	7	35-36.5	6.4		-	-	-	58.4	36.2	5.4				GP
BH-2	8	40-41.5	7.1		-	-	-	-	-	-				SM
BH-2	9	45-46.5	11.3		-	-	-	17.7	46.2	36.1				SM
BH-2	10A	50-51.0	10.3		-	-	-	-	-	-				SP-SM
BH-2	10B	51.0-51.5	6.4		-	-	-	-	-	-				SP
BH-2	11A	60-60.5	13.2		-	-	-	-	-	-				SP-SM
BH-2	12A	70-70.5	14.4		-	-	-	23.6	51.7	24.7				SM
BH-2	12B	70.5-71.0	5.0		-	-	-	62.9	35.5	1.6				GP
BH-2	12C	71-71.5	1.8		-	-	-	-	-	-				GP
BH-3	1A	5-5.2	10.9		-	-	-	-	-	-				SP
BH-3	1B	5.2-6.5	8.0		-	-	-	53.9	42.5	3.6				GP
BH-3	2	10-11.5	11.9		-	-	-	-	-	-				GP
BH-3	3	15-16.5	7.5		-	-	-	50.0	42.1	7.9				GP-GM
BH-3	4A	20-20.3	8.4		-	-	-	-	-	-				SP
BH-3	4B	20.3-21.5	10.3		-	-	-	-	-	-				SP-SM
BH-3	5A	25-26	7.7		-	-	-	-	-	-				SP
BH-3	5B	26-26.5	15.1		-	-	-	-	-	-				SP
BH-3	6A	30-31	8.7		-	-	-	57.5	39.1	3.3				GP
BH-3	6B	31-31.5	6.6		-	-	-	35.1	45.9	19.0				SM
BH-3	7A	35-36	3.1		-	-	-	-	-	-				GP
BH-3	7B	36-36.5	9.4		-	-	-	34.0	55.3	10.7				SP-SM
BH-3	8	40-41.5	4.1		-	-	-	-	-	-				SP-SM
BH-3	9A	45-45.5	5.9		-	-	-	66.6	32.2	1.1				GW
BH-3	9B	45.5-46.5	7.0		-	-	-	44.1	44.2	11.7				GW-GM
BH-3	10A	50-50.75	21.1		-	-	-	-	-	-				SP
BH-3	10B	50.75-51.5	5.9		-	-	-	-	-	-				GP
BH-3	11A	60-60.3	15.2		-	-	-	1.7	96.8	1.5				SP
BH-3	11B	60.3-60.6	5.5		-	-	-	-	-	-				SP
BH-3	11C	60.6-61.5	1.9		-	-	-	-	-	-				GP
BH-4	2A	10-10.75	18.3		-	-	-	-	-	-				SP
BH-4	2B	10.75-11.5	21.7		-	-	-	-	-	-				CL
BH-4	3	15-18	23.0	105	29	17	12	-	-	-			X	CL
BH-4	4	20-21.5	23.3		29	19	10	-	-	-				CL
BH-4	5	25-28	25.0	102	28	16	12	-	-	-	X			CL

SOUTH PORTAGE COVE HARBOR EXPANSION
LABORATORY TESTING SUMMARY

BOREHOLE	SAMPLE NUMBER	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% FINES	ADDITIONAL TESTING			USCS CLASSIFACTION
					LL	PL	PI				UU TRIAXIAL	CU TRIAXIAL	CONSOLIDATION	
BH-4	6	30-31.5	29.4		30	19	11	-	-	-				CL
BH-4	7	35-38	29.6	71	32	18	14	-	-	-			X	CL
BH-4	9	45-48	33.9	93	33	18	15	-	-	-	X			CL
BH-4	10	50-51.5	26.5		-	-	-	-	-	-				CL
BH-4	11	60-61.5	8.2		-	-	-	-	-	-				SP-SM
BH-4	12	70-71.5	10.1		-	-	-	42.6	47.3	10.1				SP-SM
BH-4	14	81-82.5	7.1		-	-	-	33.9	48.2	17.9				SM
BH-5	1	5-6.5	20.4		-	-	-	-	-	-				SP
BH-5	3	15-16.5	25.6		28	18	10	-	-	-				CL
BH-5	4	20-23	22.5	107	30	17	13	-	-	-			X	CL
BH-5	5	25-26.5	26.0		29	19	10	-	-	-				CL
BH-5	6	30-31.5	8.0		-	-	-	39.2	48.7	12.2				SM
BH-5	8	40-41.5	2.7		-	-	-	80.7	17.3	2.1				GP
BH-5	9A	45-46.25	6.3		-	-	-	62.4	35.4	2.1				GP
BH-5	9B	46.25-46.5	8.4		-	-	-	-	-	-				ML
BH-5	10A	50-50.3	20.6		-	-	-	-	-	-				SP
BH-5	10B	50.3-50.7	5.4		-	-	-	64.3	32.6	3.0				GW
BH-5	10C	50.7-51.5	12.9		-	-	-	-	-	-				SM
BH-5	11A	60-60.5	16.8		-	-	-	-	-	-				SP
BH-5	11B	60.5-60.9	4.1		-	-	-	53.8	43.9	2.3				GW
BH-5	11C	60.9-61.5	10.9		-	-	-	-	-	-				SM
BH-5	13	80-81.5	13.0		-	-	-	15.3	73.6	11.1				SP-SM
BH-5	14	90-91.5	9.8		-	-	-	30.6	61.0	8.4				SP-SM
BH-6	1	5-6.5	27.6		-	-	-	1.2	94.4	4.4				SP
BH-6	2	10-11.5	13.7		-	-	-	-	-	-				SP
BH-6	3	15-16.5	13.5		-	-	-	40.1	56.8	3.1				SP
BH-6	6	30-31.5	6.8		-	-	-	-	-	-				SP
BH-6	7	35-36.5	6.3		-	-	-	64.3	34.8	0.9				GW
BH-6	8A	40-40.8	5.8		-	-	-	-	-	-				GW
BH-6	8B	40.8-41.5	8.6		-	-	-	-	-	-				SM
BH-6	10	45-46.5	12.0		-	-	-	35.3	42.5	22.2				SM
BH-6	11	50-51.5	8.9		-	-	-	39.8	51.5	8.7				SP-SM
BH-6	12A	55-55.5	19.0		-	-	-	-	-	-				SP
BH-6	12B	55.5-56.5	7.1		-	-	-	43.9	53.8	2.4				GP
BH-6	13	59-60.5	5.2		-	-	-	65.8	32.3	1.8				GP
BH-7	1	6-7.5	25.7		-	-	-	-	-	-				CL

SOUTH PORTAGE COVE HARBOR EXPANSION
LABORATORY TESTING SUMMARY

BOREHOLE	SAMPLE NUMBER	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% FINES	ADDITIONAL TESTING			USCS CLASSIFACTION
					LL	PL	PI				UU TRIAXIAL	CU TRIAXIAL	CONSOLIDATION	
BH-7	2	10-11.5	28.0		-	-	-	-	-	-				CL
BH-7	3	15-18	23.2	106	29	17	12	-	-	-			X	CL
BH-7	4	20-21.5	25.8		28	18	10	-	-	-				CL
BH-7	5	25-28	30.3	93	34	19	15	-	-	-	X			CL
BH-7	6	30-31.5	38.3		30	19	11	-	-	-				CL
BH-7	7	35-38	35.8	85	33	18	15	-	-	-			X	CL
BH-7	8	40-41.5	32.4		30	18	12	-	-	-				CL
BH-7	9	45-46.5	7.9		-	-	-	35.9	51.7	12.4				SP-SM
BH-7	10	50-51.5	8.0		-	-	-	41.0	49.4	9.6				SP-SM
BH-8	1A	5-5.75	11.6		-	-	-	-	-	-				GW
BH-8	1B	5.75-6.5	15.3		-	-	-	-	-	-				SM
BH-8	2	10-13	28.6	98	30	18	12	-	-	-	X			CL
BH-8	3A	15-15.5	29.3		32	19	13	-	-	-				CL
BH-8	3B	15.5-16.5	22.6		-	-	-	-	-	-				CL
BH-8	4	19.5-21	23.5		29	18	11	-	-	-				CL
BH-8	5	25-26.5	24.7		-	-	-	-	-	-				CL
BH-8	6	30-33	31.1	91	29	17	12	-	-	-			X	CL
BH-8	7	35-36.5	29.0		31	18	13	-	-	-				CL
BH-8	8	40-43	35.4	88	32	19	13	-	-	-	X			CL
BH-8	9	45-46.5	33.1		-	-	-	-	-	-				CL
BH-8	11	55-58	28.4	94	38	21	17	-	-	-	X			CL
BH-8	12	65-66.5	22.0		-	-	-	-	-	-				CL
BH-9	1A	0-1.25	36.0		-	-	-	0.8	53.8	45.4				SM
BH-9	1B	1.25-1.5	24.7		-	-	-	0.6	89.7	9.7				SP-SM
BH-9	2	5-6.5	29.5		-	-	-	-	-	-				CL
BH-9	3	10-13	26.5	99	35	18	17	-	-	-	X			CL
BH-9	4	15-16.5	30.4		28	17	11	-	-	-				CL
BH-9	5	20-23	32.1	98	30	17	13	-	-	-		X	X	CL
BH-9	6	25-26.5	30.9		30	19	11	-	-	-				CL
BH-9	7	30-33	28.5	96	33	18	15	-	-	-	X			CL
BH-9	8	35-36.5	29.7		31	18	13	-	-	-				CL
BH-9	9	42-45	32.0	95	29	18	11	-	-	-		X	X	CL
BH-9	10	50-51.5	31.1		-	-	-	-	-	-				CL
BH-9	11	60-61.5	26.4		-	-	-	-	-	-				CL
BH-9	12	70-71.5	31.9		-	-	-	-	-	-				CL
BH-9	13	80-82	21.7	109	26	17	9	-	-	-	X			CL

SOUTH PORTAGE COVE HARBOR EXPANSION
LABORATORY TESTING SUMMARY

BOREHOLE	SAMPLE NUMBER	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% FINES	ADDITIONAL TESTING			USCS CLASSIFACTION
					LL	PL	PI				UU TRIAXIAL	CU TRIAXIAL	CONSOLIDATION	
BH-9	14	90-91	10.4		-	-	-	64.6	30.0	5.4				GP-GM
BH-10	1	5-6.5	17.7		-	-	-	10.1	78.6	11.3				SP-SM
BH-10	3	15-16.5	10.3		-	-	-	48.1	41.3	10.6				GP-GM
BH-10	4	20-21.5	25.2		31	19	12	-	-	-				CL
BH-10	5	25-26.5	26.6		-	-	-	-	-	-				CL
BH-10	7	35-38	27.1	94	31	17	14	-	-	-			X	CL
BH-10	8	40-41.5	28.0		-	-	-	-	-	-				CL
BH-10	9A	45-45.7	31.5		32	19	13	-	-	-				CL
BH-10	9B	45.7-46.5	9.6		-	-	-	29.5	58.0	12.6				SM
BH-10	10	50-51.5	8.7		-	-	-	-	-	-				SM
BH-10	11	60-61.5	8.0		-	-	-	53.7	45.4	0.9				GW
BH-10	12A	70-70.4	21.9		-	-	-	-	93.8	6.2				SP
BH-10	12B	70.4-70.8	13.3		-	-	-	8.6	88.1	3.4				SP
BH-10	12C	70.8-71	10.5		-	-	-	-	-	-				SP
BH-10	12D	71-71.3	8.7		-	-	-	40.6	56.4	3.0				SW
BH-10	12E	71.3-71.5	5.9		-	-	-	-	-	-				GP
BH-11	1	5-6	4.3		-	-	-	57.8	38.0	4.3				GP
BH-11	2	10-11.5	8.6		-	-	-	-	-	-				CL
BH-11	3A	15-16	8.5		-	-	-	47.7	42.1	10.3				GP-GM
BH-11	4	20-21.5	8.5		-	-	-	31.4	60.3	8.4				SP-SM
BH-11	5	25-26.5	8.5		-	-	-	30.0	50.1	19.8				SM
BH-11	6	30-31.5	7.2		-	-	-	-	-	-				SM
BH-11	7	35-36.5	7.3		-	-	-	43.0	45.5	11.5				SM
BH-11	8	40-41.5	6.5		-	-	-	32.5	60.6	6.9				SP-SM
BH-11	9	45-46.5	13.2		-	-	-	-	-	-				SM
BH-11	10	50-51.5	7.7		-	-	-	27.7	49.6	22.7				SM
BH-11	11	60-61.5	9.0		NP	NP	NP	-	-	-				NP
BH-12	1	5-6.5	24.5		-	-	-	-	-	-				CL
BH-12	3	15-16.5	22.7		30	18	12	-	-	-				CL
BH-12	5	25-26.5	32.0		-	-	-	-	-	-				CL
BH-12	6	30-31.5	25.0		31	18	13	-	-	-				CL
BH-12	7	35-38	22.4	102	33	19	14	-	-	-	X			CL
BH-12	8	40-41.5	29.9		30	18	12	-	-	-				CL
BH-12	9	45-48	26.7	97	33	18	15	-	-	-	X			CL
BH-12	11	55-56.5	27.8		32	18	14	-	-	-				CL
BH-12	12	60-63	32.2	94	30	17	13	-	-	-	X			CL

SOUTH PORTAGE COVE HARBOR EXPANSION
LABORATORY TESTING SUMMARY

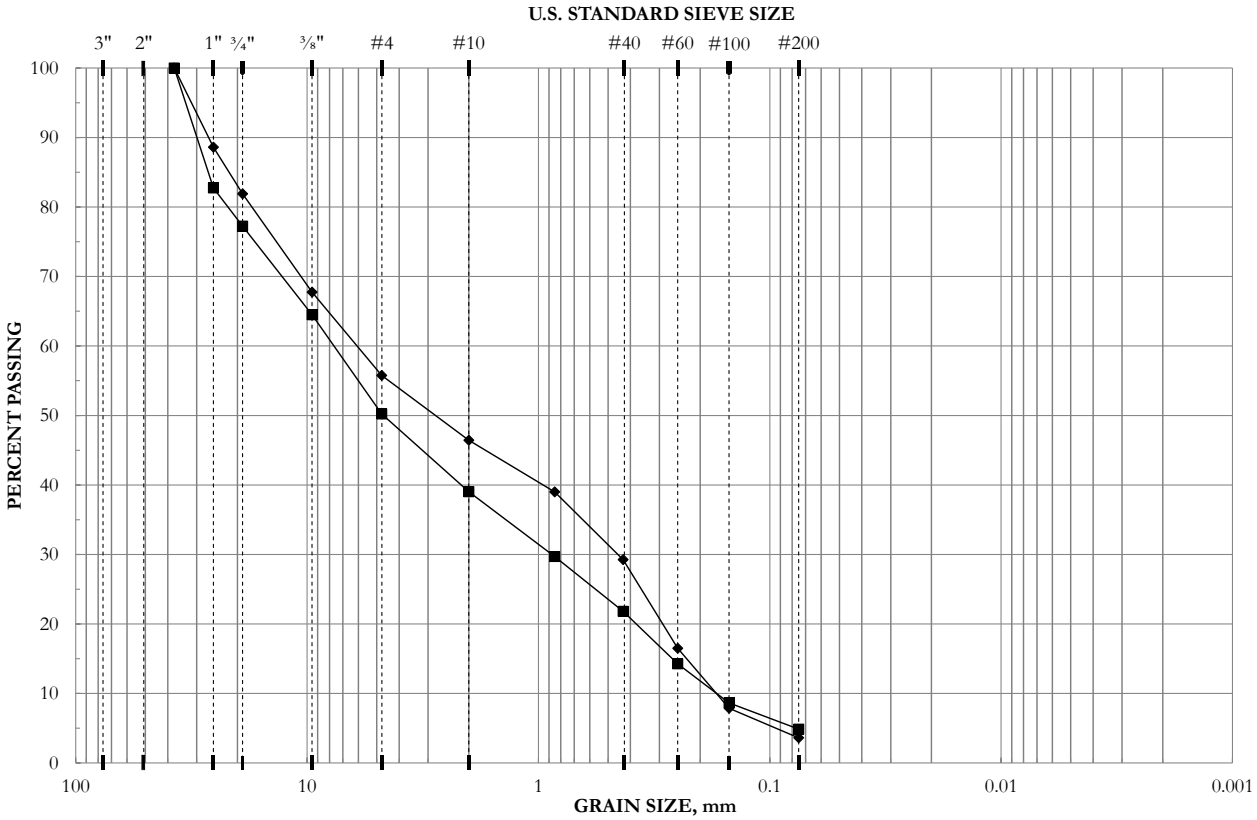
BOREHOLE	SAMPLE NUMBER	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% FINES	ADDITIONAL TESTING			USCS CLASSIFACTION
					LL	PL	PI				UU TRIAXIAL	CU TRIAXIAL	CONSOLIDATION	
BH-12	13	70-71.5	28.4		-	-	-	-	-	-				CL
BH-12	14	75-76.5	17.2		-	-	-	-	-	-				CL
BH-12	15	80-81.5	3.6		-	-	-	66.9	26.0	7.1				GP-GM
BH-13	2	5-8	25.6	104	31	18	13	-	-	-	X			CL
BH-13	4	15-18	23.3	106	30	17	13	-	-	-	X			CL
BH-13	7	30-31.5	32.8		32	18	14	-	-	-				CL
BH-13	8	35-38	39.8	82	32	19	13	-	-	-	X			CL
BH-13	9	40-41.5	37.9		30	18	12	-	-	-				CL
BH-13	10	50-53	36.6	86	30	16	14	-	-	-	X			CL
BH-13	12A	70-70.5	43.2		33	19	14	-	-	-				CL
BH-13	12B	70.5-71.5	33.0		-	-	-	-	-	-				CL
BH-13	13	80-81.5	23.0		29	17	12	-	-	-				CL
BH-13	14	90-91.5	17.6		-	-	-	-	-	-				CL
BH-13	15	100-101.5	17.3		32	18	14	-	-	-				CL
BH-13	16	110-111.5	18.3		-	-	-	-	-	-				CL
BH-13	17	120-121.5	15.7		-	-	-	-	-	-				CL
BH-13	18	130-131.5	27.0		35	19	16	-	-	-				CL

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	B-1 #3	5-7	poorly graded GRAVEL with sand (GP)
◆	B-1 #6	20-22	poorly graded SAND with gravel (SP)

	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	B-1 #3	5-7	5.3	49.8	45.3	4.9	0.6	45.1	7.7	0.9	0.2
◆	B-1 #6	20-22	7.4	44.2	52.1	3.6	0.2	0.0	6.1	0.5	0.2

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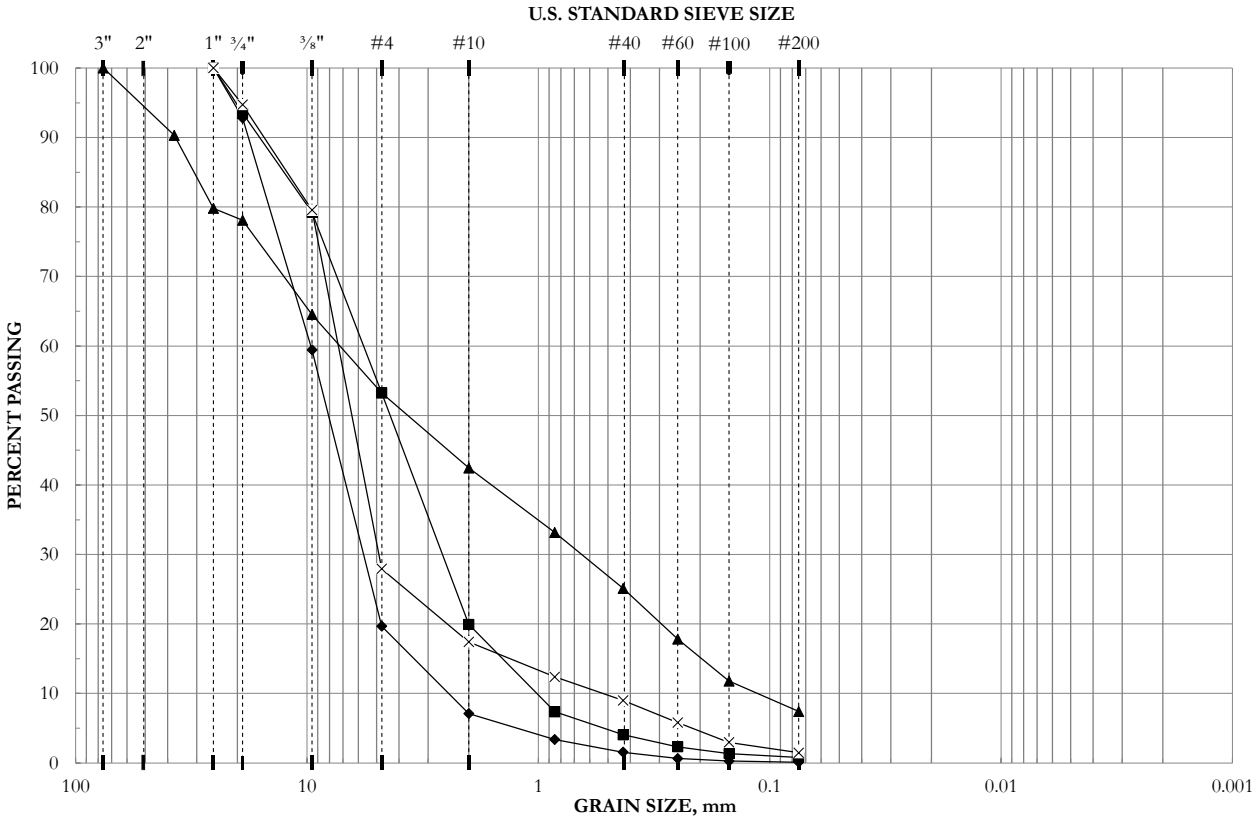
FIGURE E-1

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	B-3 #6	15-17	poorly graded SAND with gravel (SP)
◆	B-3 #7B	20.6-22	poorly graded GRAVEL with sand (GP)
▲	B-3 #8B	25.8-27	poorly graded GRAVEL with silt and sand (GP-GM)
X	B-3 #10	35-37	poorly graded GRAVEL with sand (GP)

	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	B-3 #6	15-17	5.2	46.7	52.5	0.8	1.2	5.6	5.7	2.6	1.0
◆	B-3 #7B	20.6-22	0.8	80.3	19.6	0.1	1.4	3.9	9.6	5.7	2.4
▲	B-3 #8B	25.8-27	6.5	46.8	45.8	7.4	0.5	63.6	7.2	0.7	0.1
X	B-3 #10	35-37	3.0	72.1	26.5	1.5	6.2	13.9	7.3	4.9	0.5

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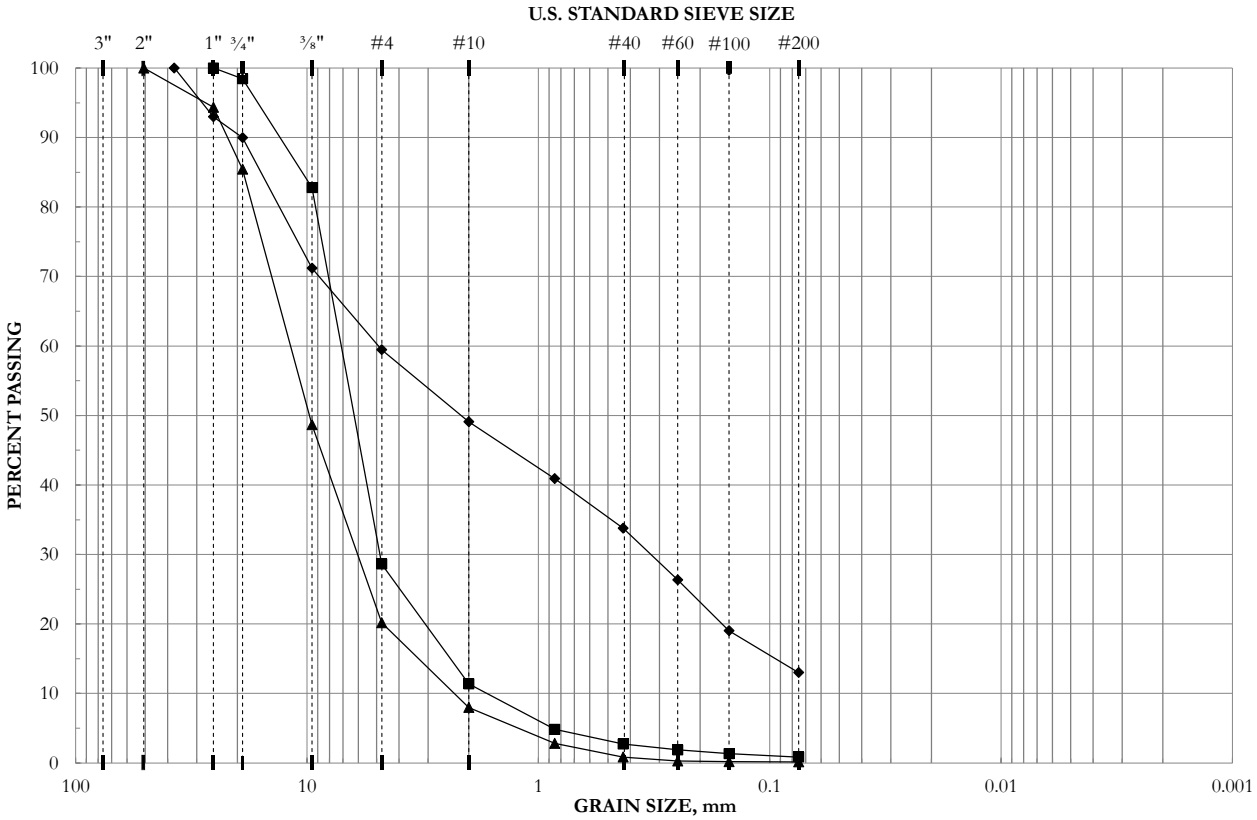
FIGURE E-2

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	B-5 #9	35-37	well-graded GRAVEL with sand (GW)
◆	B-5 #11	45-46.5	silty SAND with gravel (SM)
▲	B-5 #12B	50.3-52	well-graded GRAVEL with sand (GW)

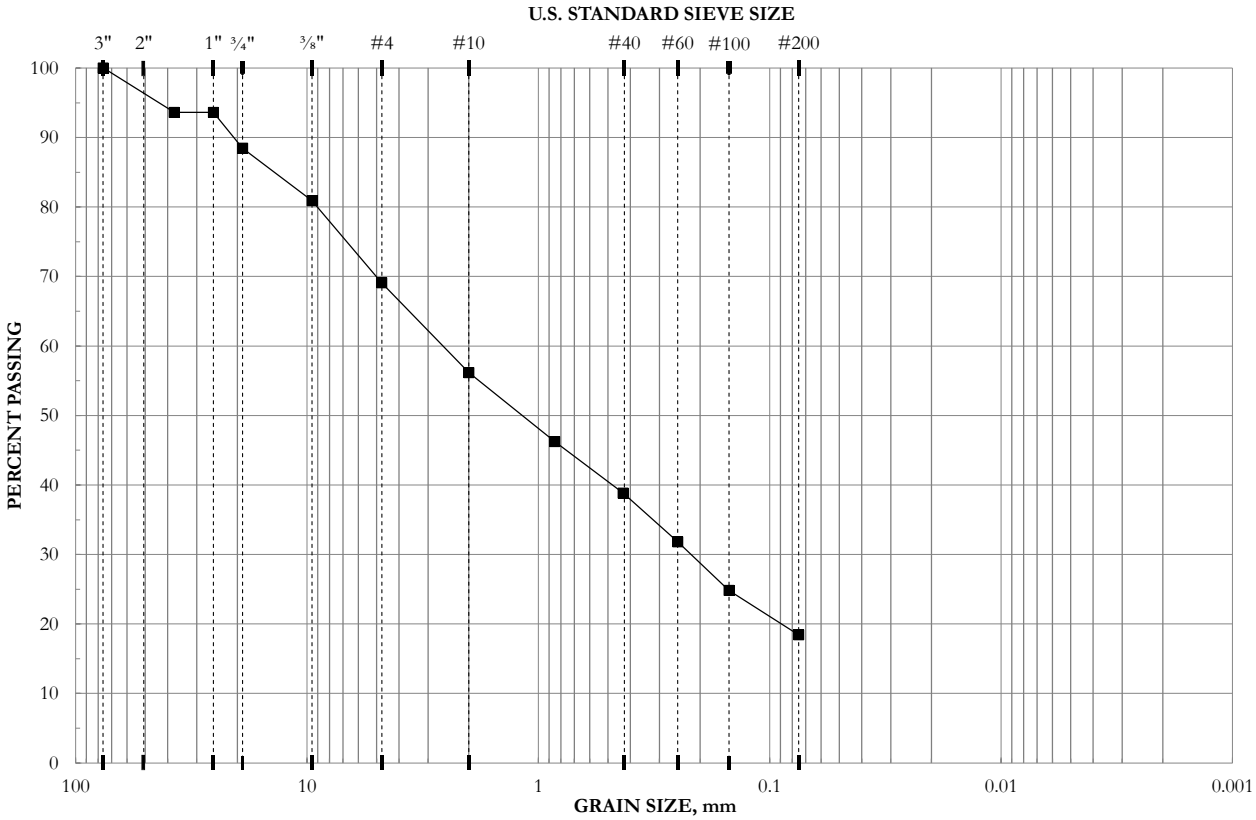
	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	B-5 #9	35-37	2.1	71.4	27.8	0.8	2.0	4.3	7.1	4.8	1.7
◆	B-5 #11	45-46.5	6.8	40.5	46.5	13.0	--	--	4.9	0.3	--
▲	B-5 #12B	50.3-52	0.8	79.8	20.0	0.1	1.3	5.1	11.8	6.0	2.3

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample	Depth (feet)	USCS Classification
■ B-6 #7	20-21.25	silty SAND with gravel (SM)

Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■ B-6 #7	20-21.25	8.6	30.9	50.7	18.4	--	--	2.6	0.2	--

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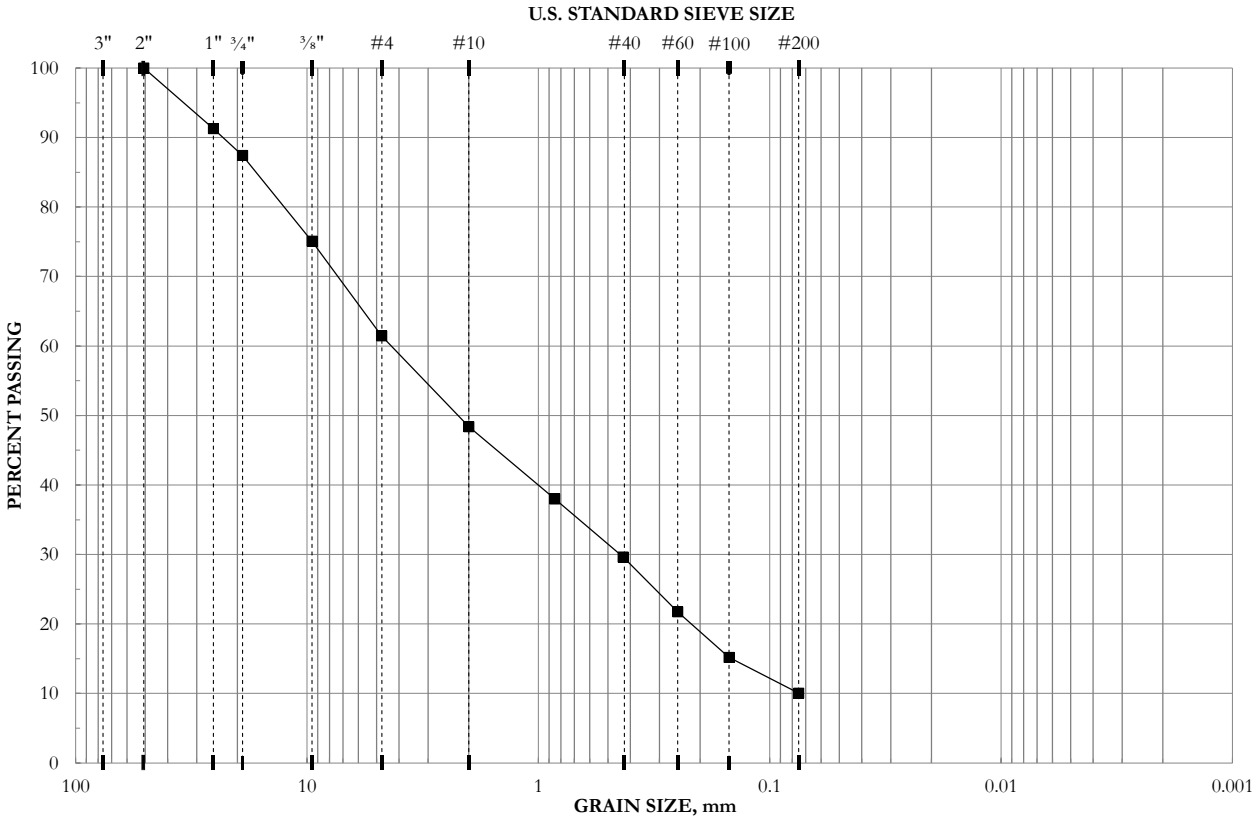
FIGURE E-4

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample	Depth (feet)	USCS Classification
■ B-9 #5	20-22	poorly graded SAND with silt and gravel (SP-SM)

Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■ B-9 #5	20-22	6.4	38.6	51.4	10.0	--	--	4.3	0.4	--

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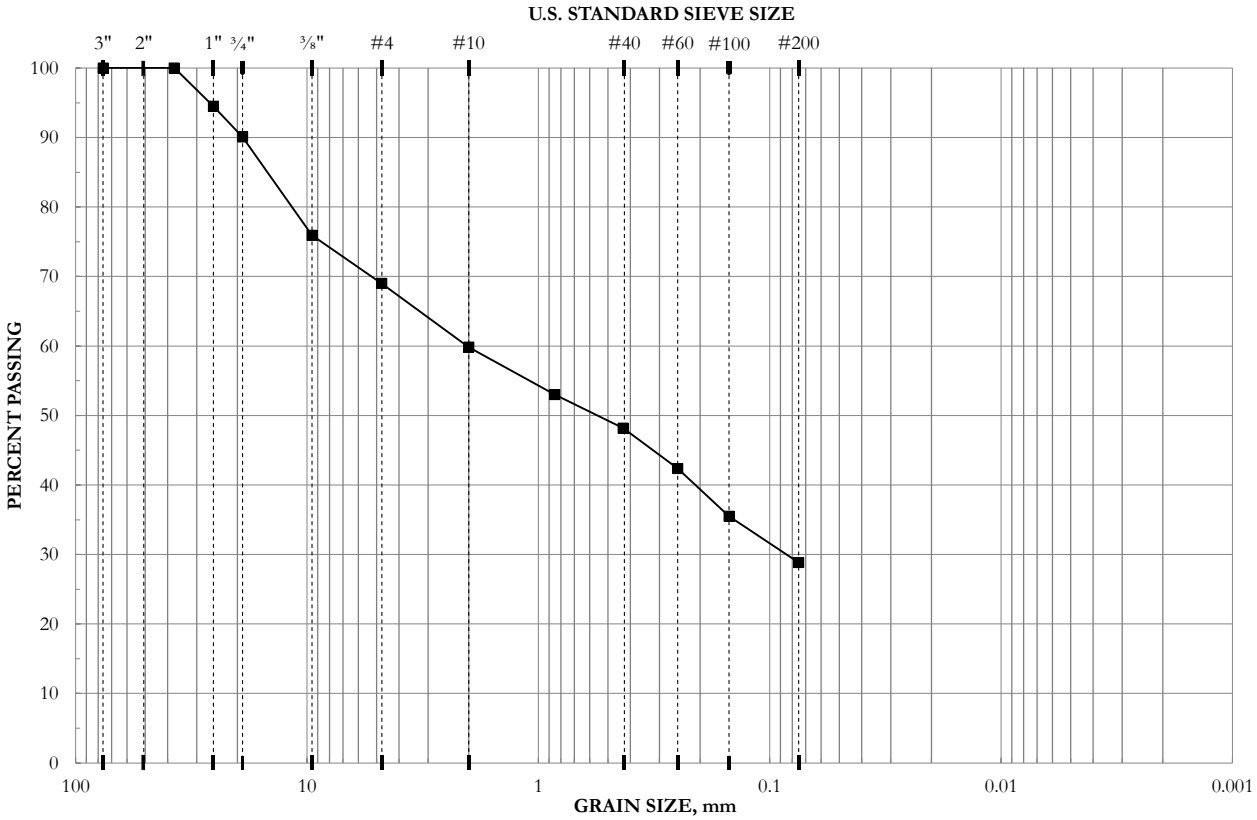
FIGURE E-5

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample	Depth (feet)	USCS Classification
■ B-12 #5	13-15	silty SAND with gravel (SM)

Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■ B-12 #5	13-15	8.5	31.0	40.2	28.8	--	--	2.0	0.1	--

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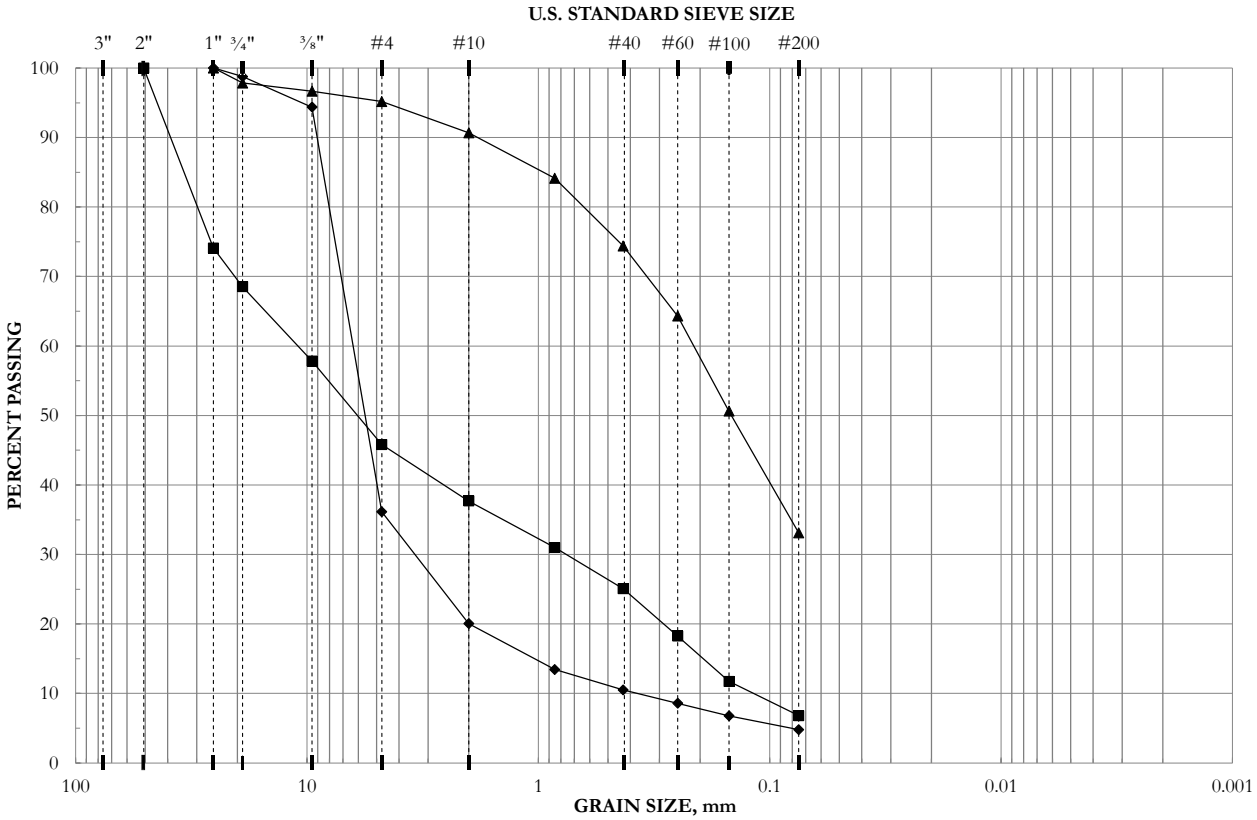
FIGURE E-6

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	B-13 #7	20-22	poorly graded GRAVEL with silt and sand (GP-GM)
◆	B-13 #8	25-27	poorly graded GRAVEL with sand (GP)
▲	B-13 #9	30-32	silty SAND (SM)

	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	B-13 #7	20-22	5.4	54.2	39.0	6.8	0.4	93.1	10.9	0.8	0.1
◆	B-13 #8	25-27	4.5	63.8	31.4	4.8	5.0	16.9	6.3	3.4	0.4
▲	B-13 #9	30-32	12.5	4.8	62.1	33.1	--	--	0.2	0.0	--

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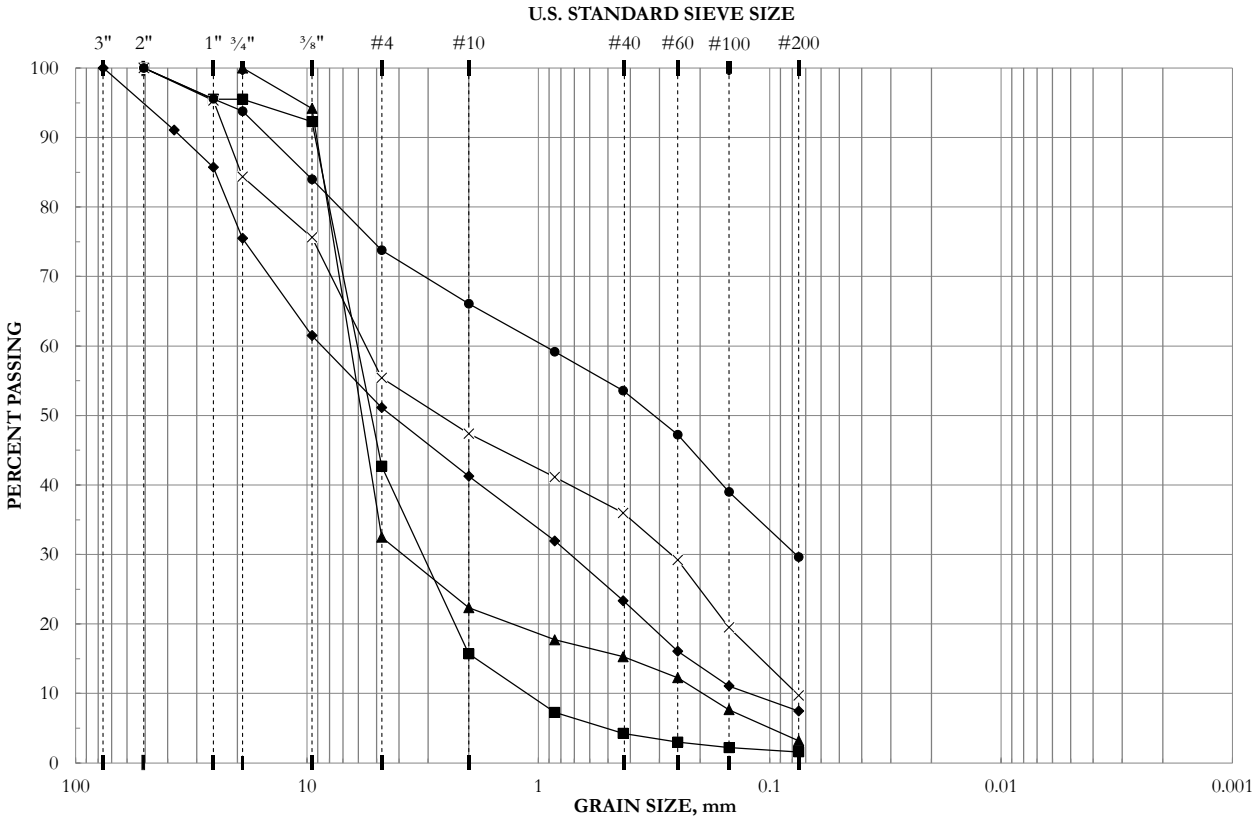
FIGURE E-7

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	B-14 #4	55-57	well-graded GRAVEL with sand (GW)
◆	B-14 #5	60-62	poorly graded GRAVEL with silt and sand (GP-GM)
▲	B-14 #6A	68-69	poorly graded GRAVEL with sand (GP)
X	B-14 #6B	69-70	poorly graded SAND with silt and gravel (SP-SM)
●	B-14 #7	80-81.5	silty SAND with gravel (SM)

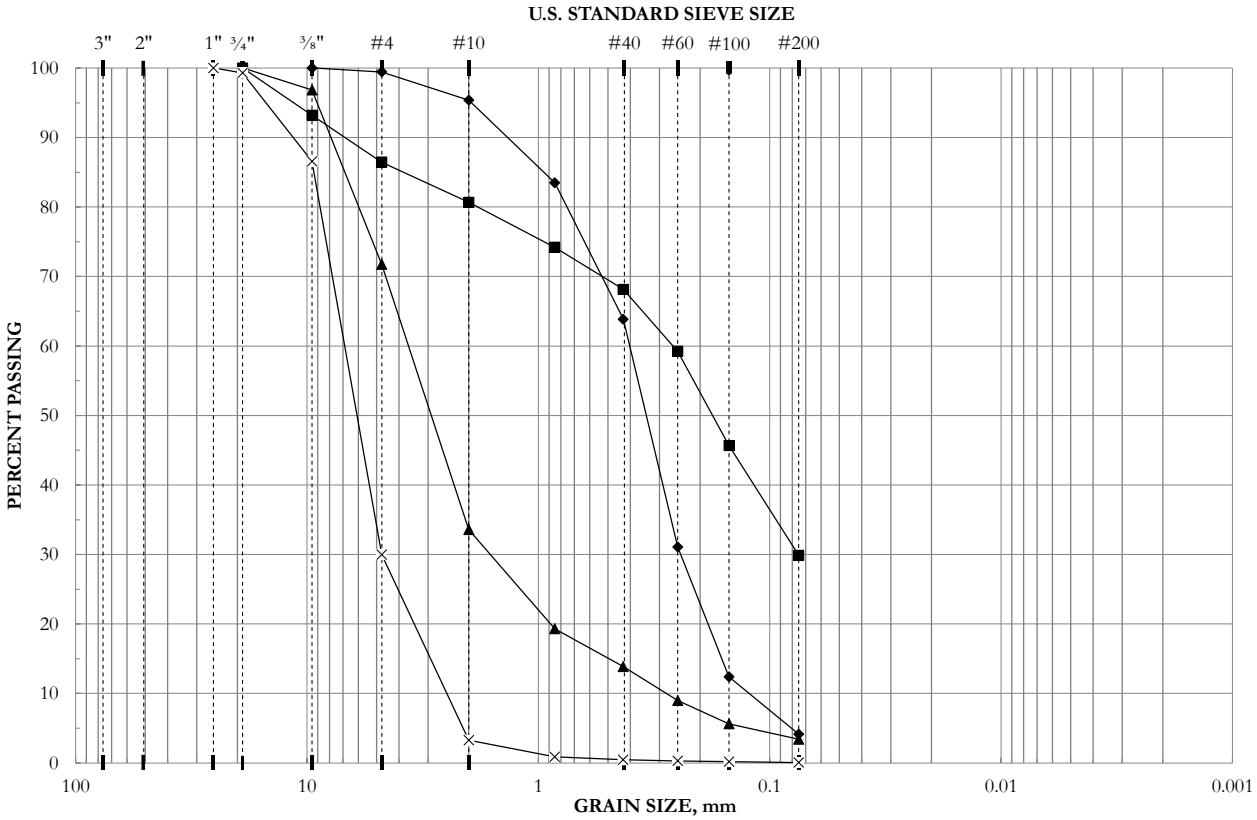
	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	B-14 #4	55-57	4.0	57.3	41.1	1.6	1.5	5.4	6.1	3.2	1.1
◆	B-14 #5	60-62	5.3	48.9	43.7	7.5	0.5	70.4	8.6	0.7	0.1
▲	B-14 #6A	68-69	5.2	67.5	29.3	3.2	11.8	33.3	6.5	3.8	0.2
X	B-14 #6B	69-70	7.2	44.6	45.7	9.7	0.2	72.7	5.6	0.3	0.1
●	B-14 #7	80-81.5	8.4	26.2	44.2	29.6	--	--	0.9	0.1	--

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	B-14 #8	90-91.5	silty SAND (SM)
◆	B-14 #9A	98-98.6	poorly graded SAND (SP)
▲	B-14 #9B	98.6-99.3	well-graded SAND with gravel (SW)
X	B-14 #10	109-110.5	poorly graded GRAVEL with sand (GP)

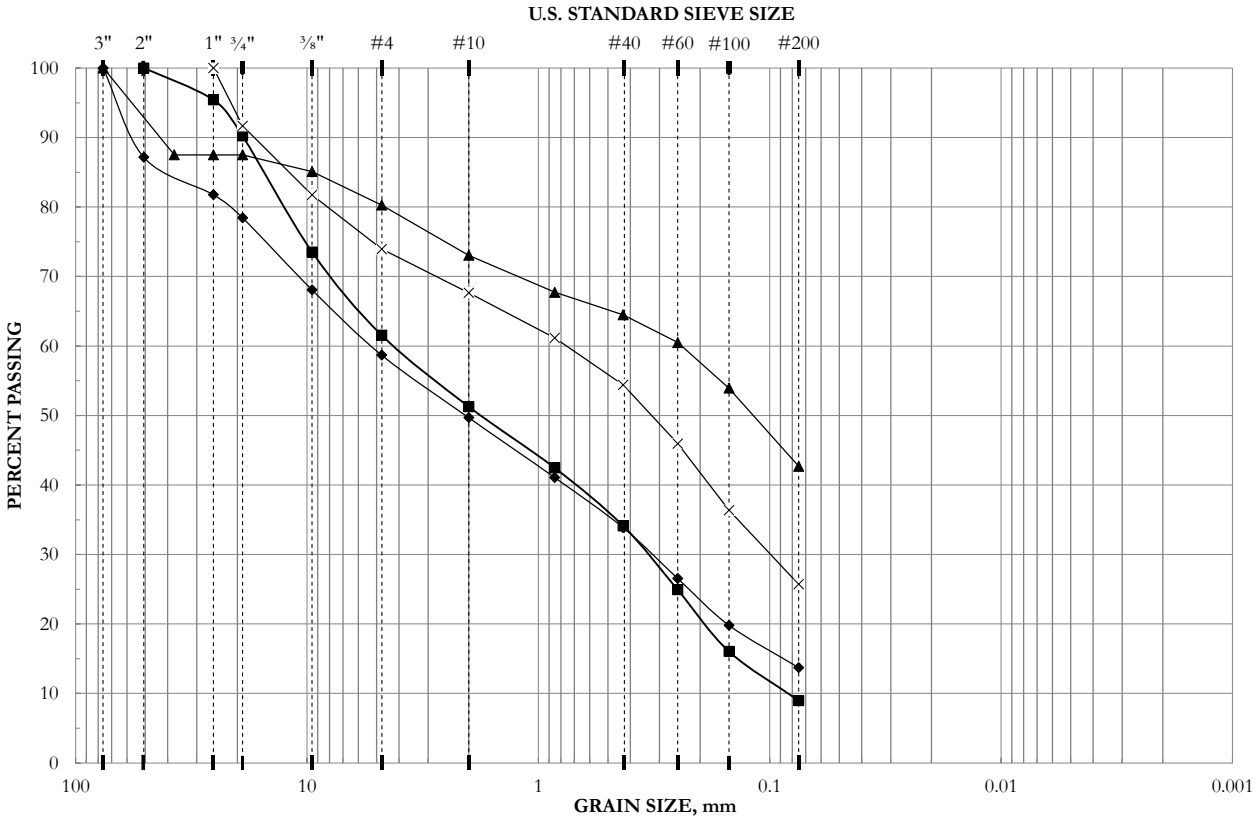
	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	B-14 #8	90-91.5	10.9	13.5	56.6	29.9	--	--	0.3	0.1	--
◆	B-14 #9A	98-98.6	16.5	0.6	95.3	4.1	1.2	3.3	0.4	0.2	0.1
▲	B-14 #9B	98.6-99.3	5.9	28.2	68.3	3.4	2.6	13.0	3.6	1.6	0.3
X	B-14 #10	109-110.5	0.7	70.0	29.9	0.1	1.3	2.8	6.9	4.8	2.5

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	B-17 #2	10-12	poorly graded SAND with silt and gravel (SP-SM)
◆	B-17 #4	20-22	silty SAND with gravel (SM)
▲	B-17 #5	25-27	silty SAND with gravel (SM)
X	B-17 #8	40-42	silty SAND with gravel (SM)

	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	B-17 #2	10-12	9.2	38.4	52.6	9.0	0.3	50.3	4.2	0.3	0.1
◆	B-17 #4	20-22	7.0	41.3	45.0	13.7	--	--	5.2	0.3	--
▲	B-17 #5	25-27	10.4	19.7	37.6	42.7	--	--	0.2	0.0	--
X	B-17 #8	40-42	10.5	26.1	48.2	25.7	--	--	0.8	0.1	--

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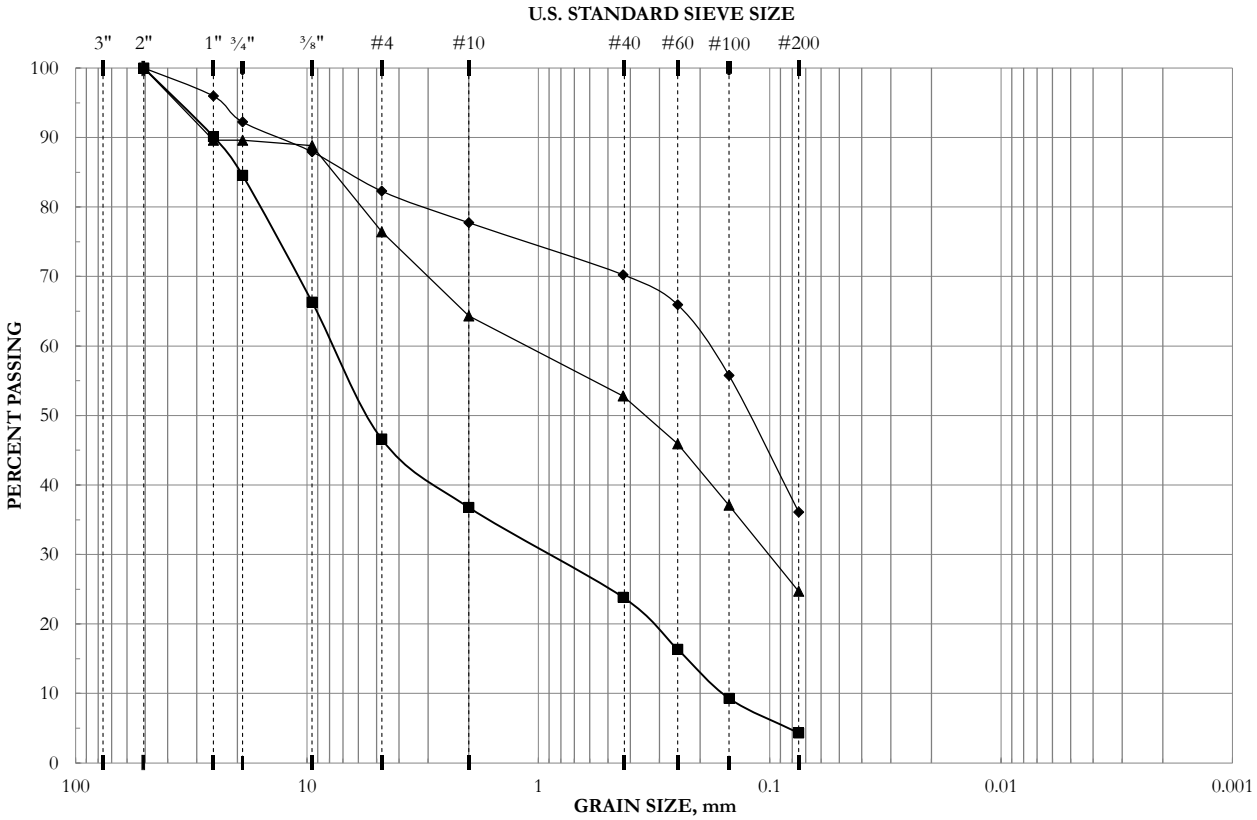
FIGURE E-10

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	BH-2 #6	30-31.5	poorly graded GRAVEL with sand (GP)
◆	BH-2 #9	45-46.5	silty SAND with gravel (SM)
▲	BH-2 #12A	70-70.5	silty SAND with gravel (SM)

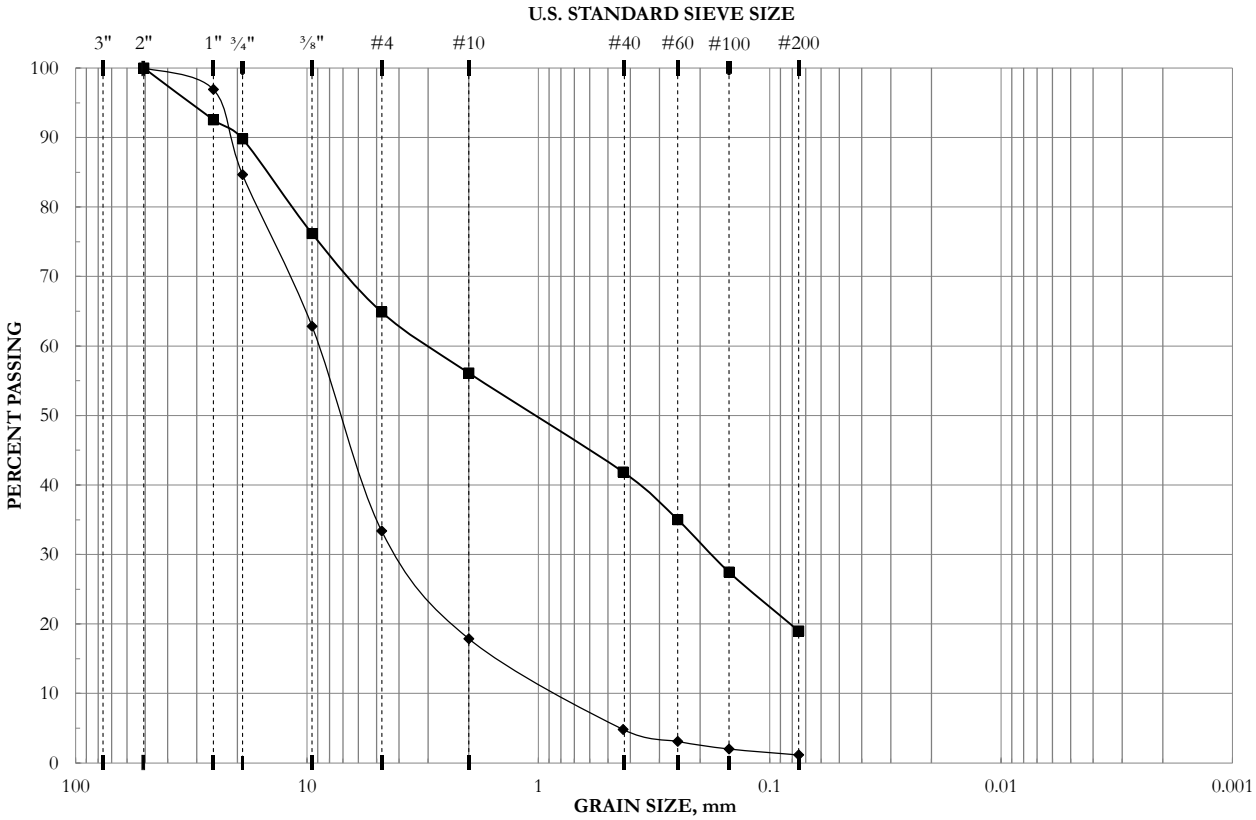
	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	BH-2 #6	30-31.5	6.0	53.4	42.3	4.3	0.7	48.3	7.6	0.9	0.2
◆	BH-2 #9	45-46.5	11.3	17.7	46.2	36.1	--	--	0.2	--	--
▲	BH-2 #12A	70-70.5	14.4	23.6	51.7	24.7	--	--	1.1	0.1	--

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	BH-3 #6B	31-31.5	silty SAND with gravel (SM)
◆	BH-3 #9A	45-45.5	well-graded GRAVEL with sand (GW)

	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	BH-3 #6B	31-31.5	6.6	35.1	45.9	19.0	--	--	2.9	0.2	--
◆	BH-3 #9A	45-45.5	5.9	66.6	32.2	1.1	2.2	11.2	8.9	3.9	0.8

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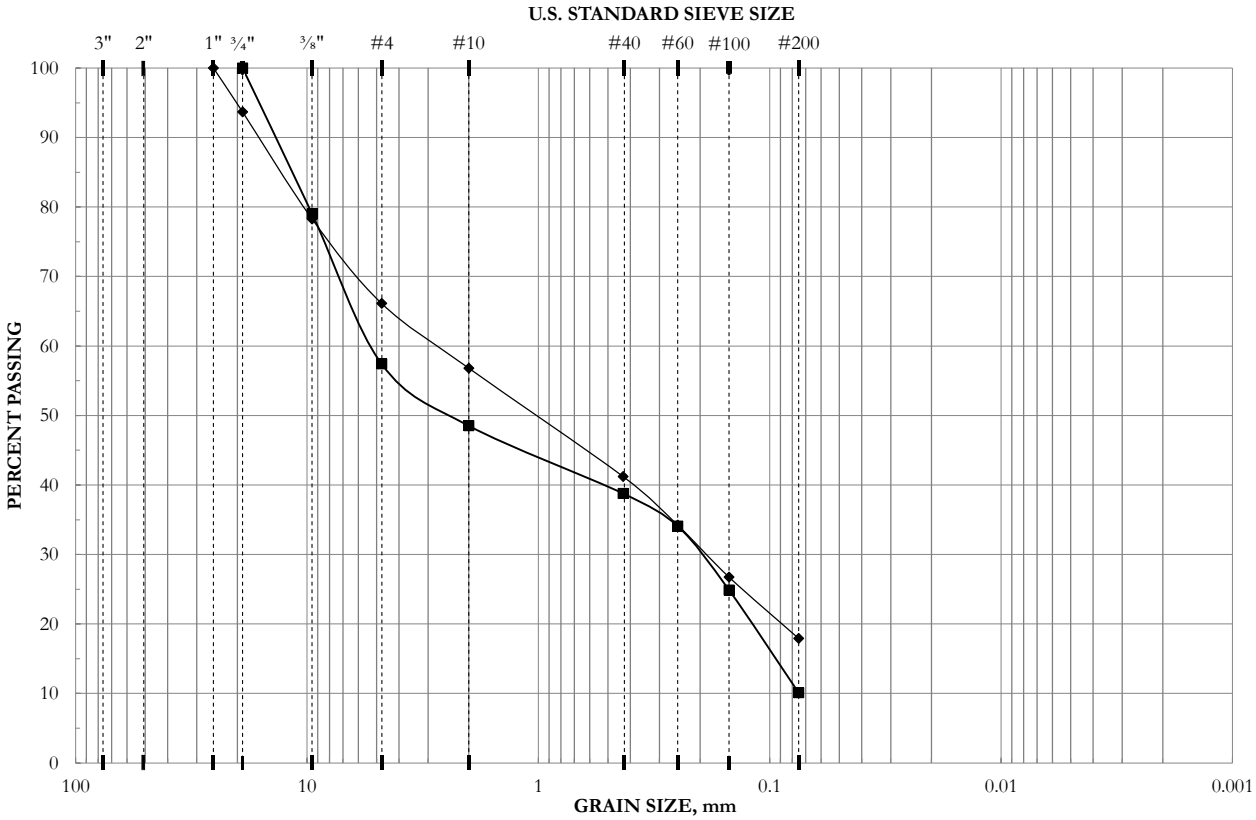
FIGURE E-12

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	BH-4 #12	70-71.5	poorly graded SAND with silt and gravel (SP-SM)
◆	BH-4 #14	81.82.5	silty SAND with gravel (SM)

	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	BH-4 #12	70-71.5	10.1	42.6	47.3	10.1	--	--	5.2	0.2	--
◆	BH-4 #14	81.82.5	7.1	33.9	48.2	17.9	--	--	2.7	0.2	--

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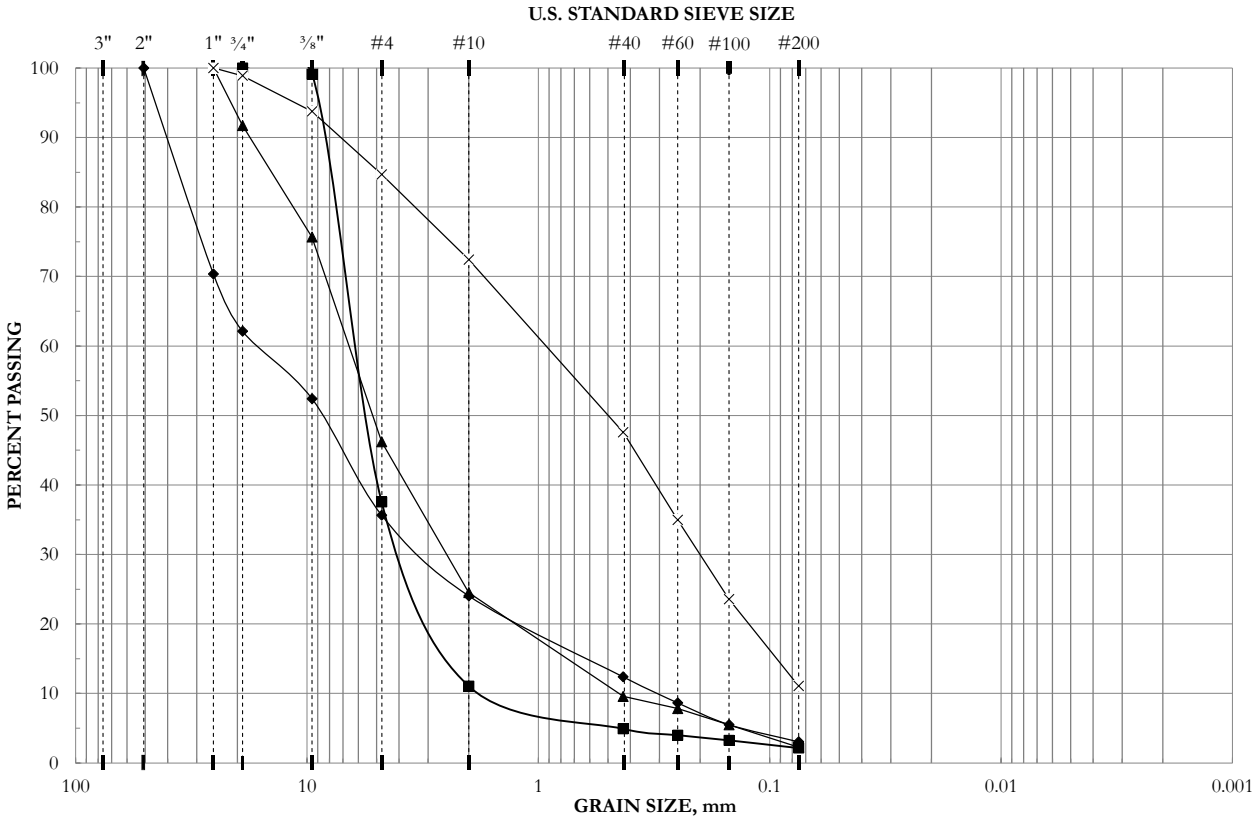
FIGURE E-13

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	BH-5 #9A	45-46.25	poorly graded GRAVEL with sand (GP)
◆	BH-5 #10B	50.3-50.7	well-graded GRAVEL with sand (GW)
▲	BH-5 #11B	60.5-60.9	well-graded GRAVEL with sand (GW)
X	BH-5 #13	80-81.5	poorly graded SAND with silt and gravel (SP-SM)

	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	BH-5 #9A	45-46.25	6.3	62.4	35.4	2.1	1.5	4.0	6.1	3.7	1.5
◆	BH-5 #10B	50.3-50.7	5.4	64.3	32.6	3.0	2.0	53.7	16.3	3.1	0.3
▲	BH-5 #11B	60.5-60.9	4.1	53.8	43.9	2.3	2.1	14.6	6.6	2.5	0.4
X	BH-5 #13	80-81.5	13.0	15.3	73.6	11.1	--	--	0.9	0.2	--

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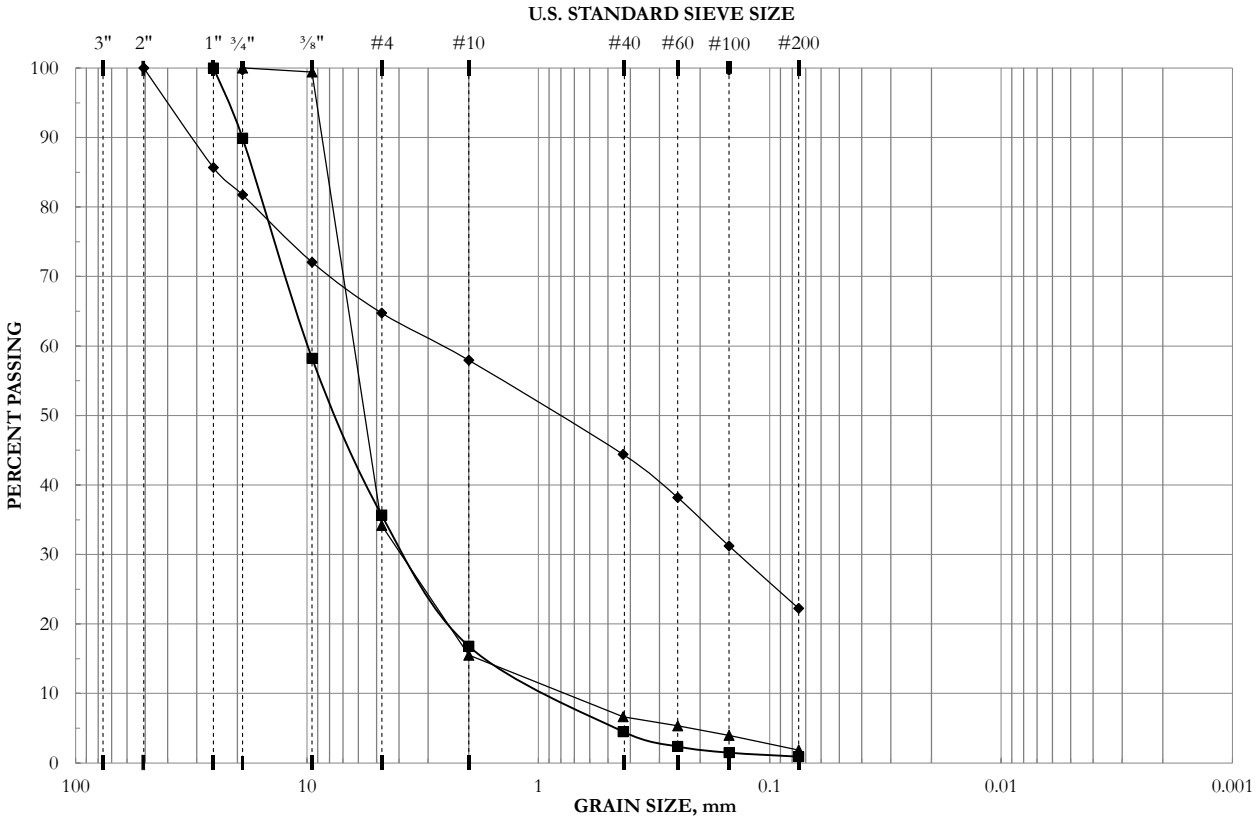
FIGURE E-14

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	BH-6 #7	35-36.5	well-graded GRAVEL with sand (GW)
◆	BH-6 #10	45-46.5	silty SAND with gravel (SM)
▲	BH-6 #13	59-60.5	poorly graded GRAVEL with sand (GP)

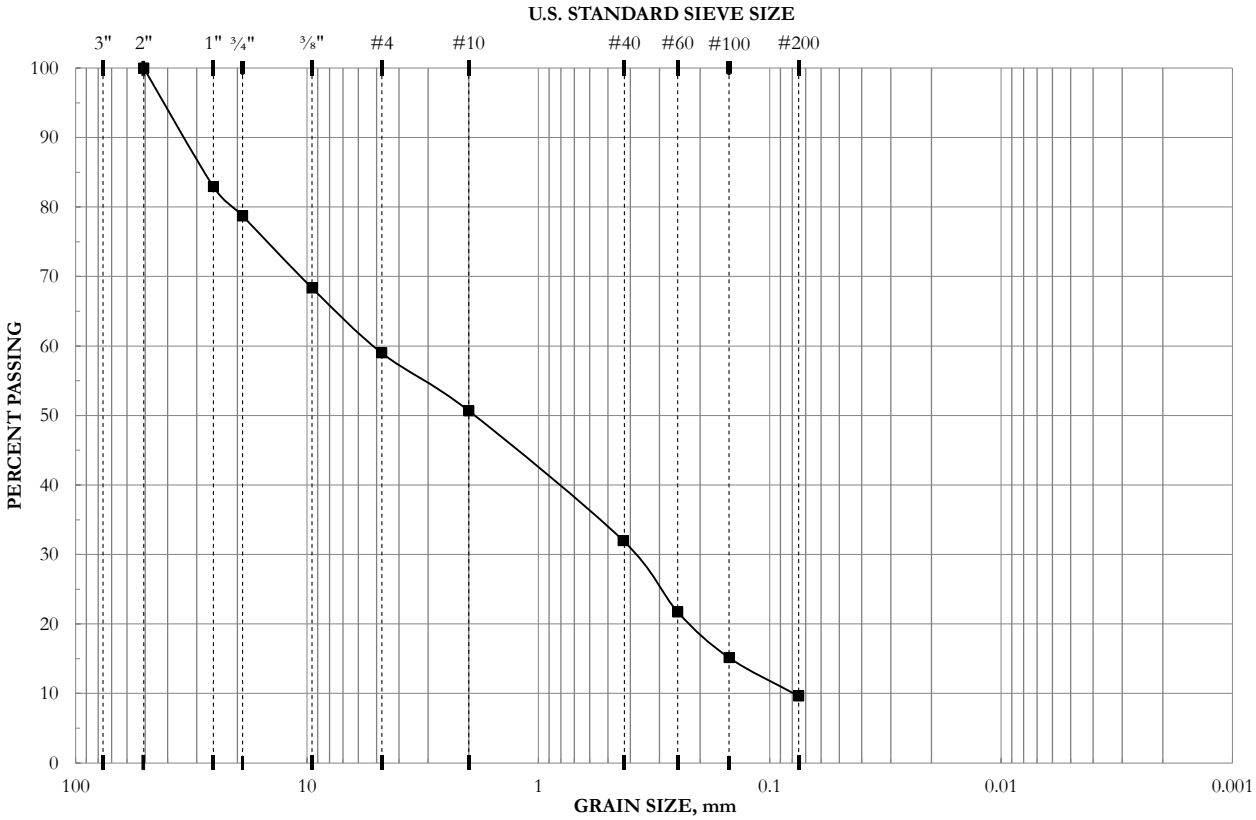
	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	BH-6 #7	35-36.5	6.3	64.3	34.8	0.9	1.6	11.6	9.9	3.7	0.9
◆	BH-6 #10	45-46.5	12.0	35.3	42.5	22.2	--	--	2.6	0.1	--
▲	BH-6 #13	59-60.5	5.2	65.8	32.3	1.8	3.2	8.1	6.3	3.9	0.8

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample	Depth (feet)	USCS Classification
■ BH-7 #10	50-51.5	poorly graded SAND with silt and gravel (SP-SM)

Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■ BH-7 #10	50-51.5	8.0	41.0	49.4	9.6	0.4	65.2	5.1	0.4	0.1

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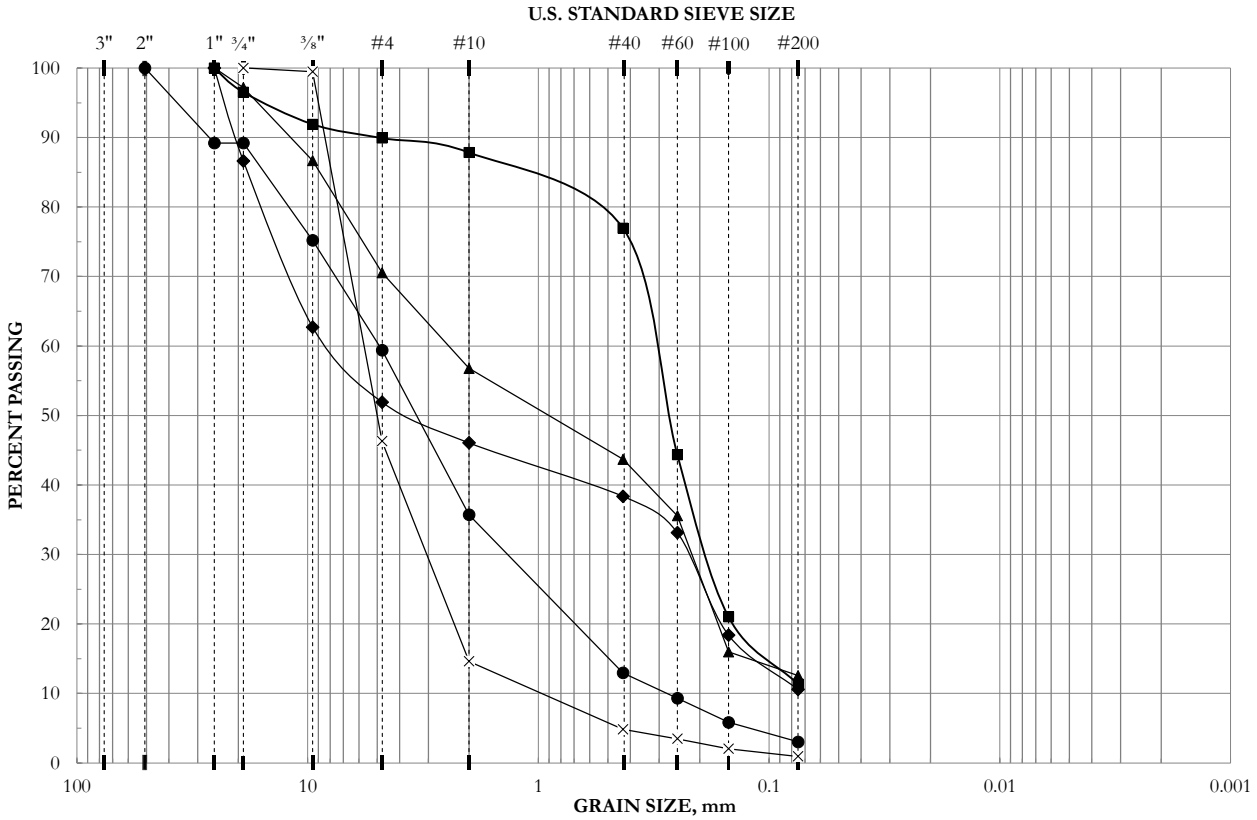
FIGURE E-16

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	BH-10 #1	5-6.5	poorly graded SAND with silt (SP-SM)
◆	BH-10 #3	15-16.5	poorly graded GRAVEL with silt and sand (GP-GM)
▲	BH-10 #9B	45.7-46.5	silty SAND with gravel (SM)
X	BH-10 #11	60-61.5	well-graded GRAVEL with sand (GW)
●	BH-10 #12D	71-71.3	well-graded SAND with gravel (SW)

	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	BH-10 #1	5-6.5	17.7	10.1	78.6	11.3	--	--	0.3	0.2	--
◆	BH-10 #3	15-16.5	10.3	48.1	41.3	10.6	--	--	8.0	0.2	--
▲	BH-10 #9B	45.7-46.5	9.6	29.5	58.0	12.6	--	--	2.5	0.2	--
X	BH-10 #11	60-61.5	8.0	53.7	45.4	0.9	1.7	5.9	5.7	3.0	1.0
●	BH-10 #12D	71-71.3	8.7	40.6	56.4	3.0	1.4	17.6	4.9	1.4	0.3

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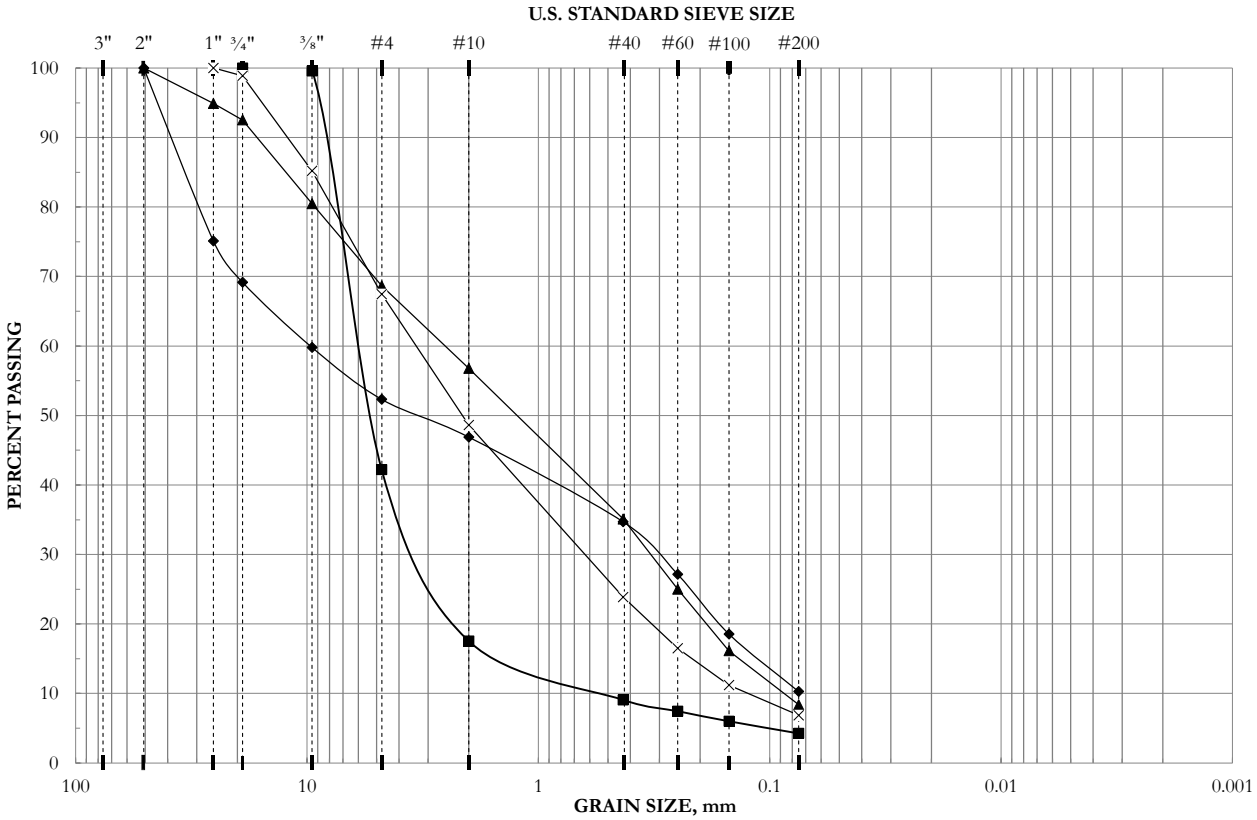
FIGURE E-17

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

	Sample	Depth (feet)	USCS Classification
■	BH-11 #1	5-6	poorly graded GRAVEL with sand (GP)
◆	BH-11 #3A	15-16	poorly graded GRAVEL with silt and sand (GP-GM)
▲	BH-11 #4	20-21.5	poorly graded SAND with silt and gravel (SP-SM)
X	BH-11 #8	40-41.5	poorly graded SAND with silt and gravel (SP-SM)

	Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■	BH-11 #1	5-6	4.3	57.8	38.0	4.3	3.2	11.6	5.9	3.1	0.5
◆	BH-11 #3A	15-16	8.5	47.7	42.1	10.3	--	--	9.7	0.3	--
▲	BH-11 #4	20-21.5	8.5	31.4	60.3	8.4	0.5	29.2	2.5	0.3	0.1
X	BH-11 #8	40-41.5	6.5	32.5	60.6	6.9	0.9	27.2	3.4	0.6	0.1

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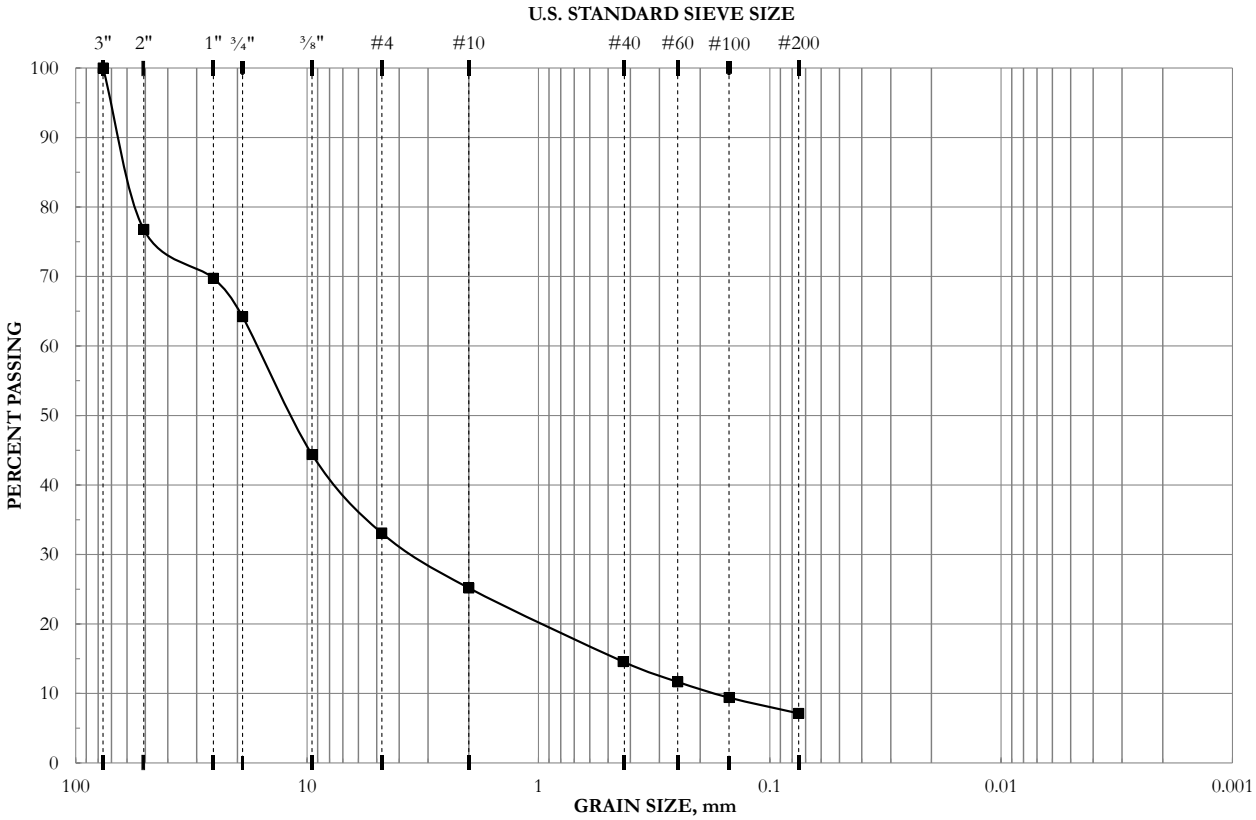
FIGURE E-18

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422 & D 1140

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

Sample	Depth (feet)	USCS Classification
■ BH-12 #15	80-81.5	poorly graded GRAVEL with silt and sand (GP-GM)

Sample	Depth (feet)	% MC	% Gravel	% Sand	% Fines	Cc	Cu	D_{60}	D_{30}	D_{10}
■ BH-12 #15	80-81.5	3.6	66.9	26.0	7.1	4.1	95.6	16.4	3.4	0.2

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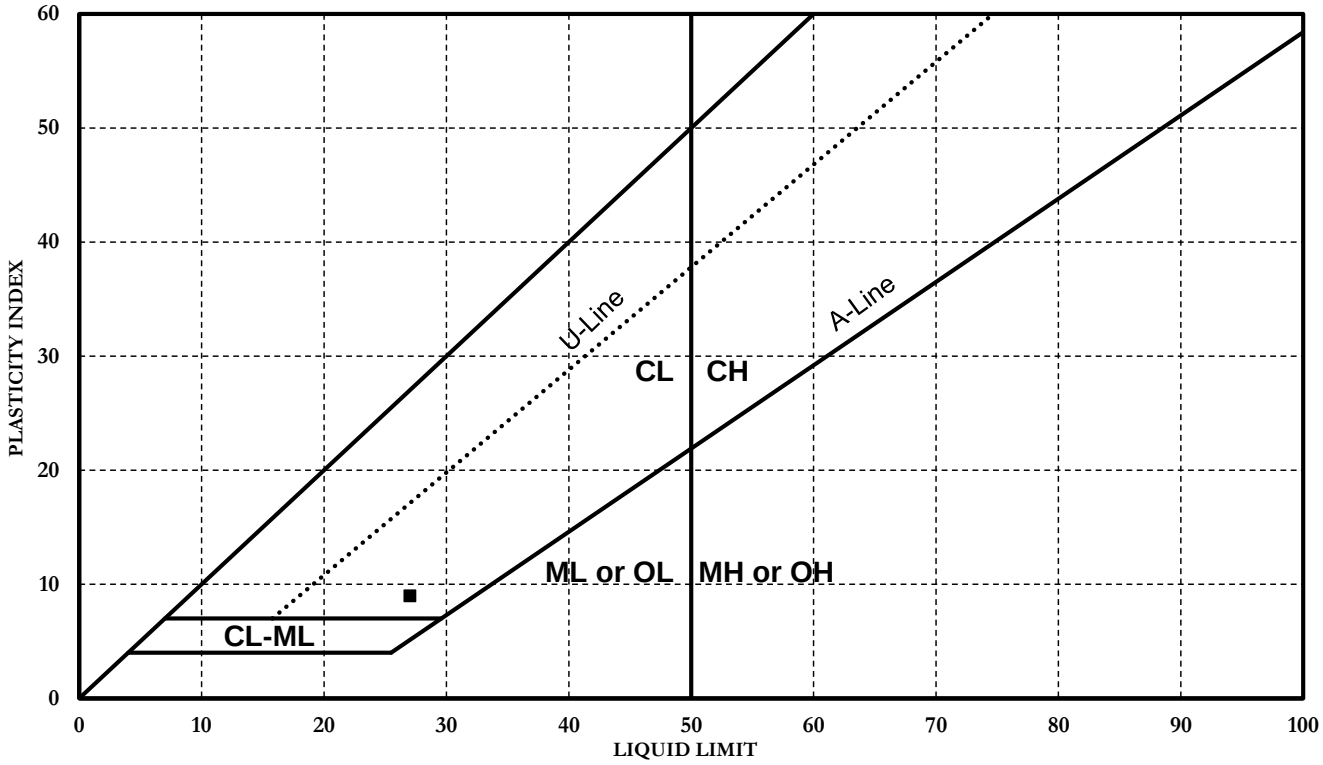
FIGURE E-19

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
ASTM D 4318

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



	Sample	Depth (feet)	USCS Classification	% MC	LL	PL	PI
■	B-5 #1	5-7	LEAN CLAY (CL)	24.1	27	18	9

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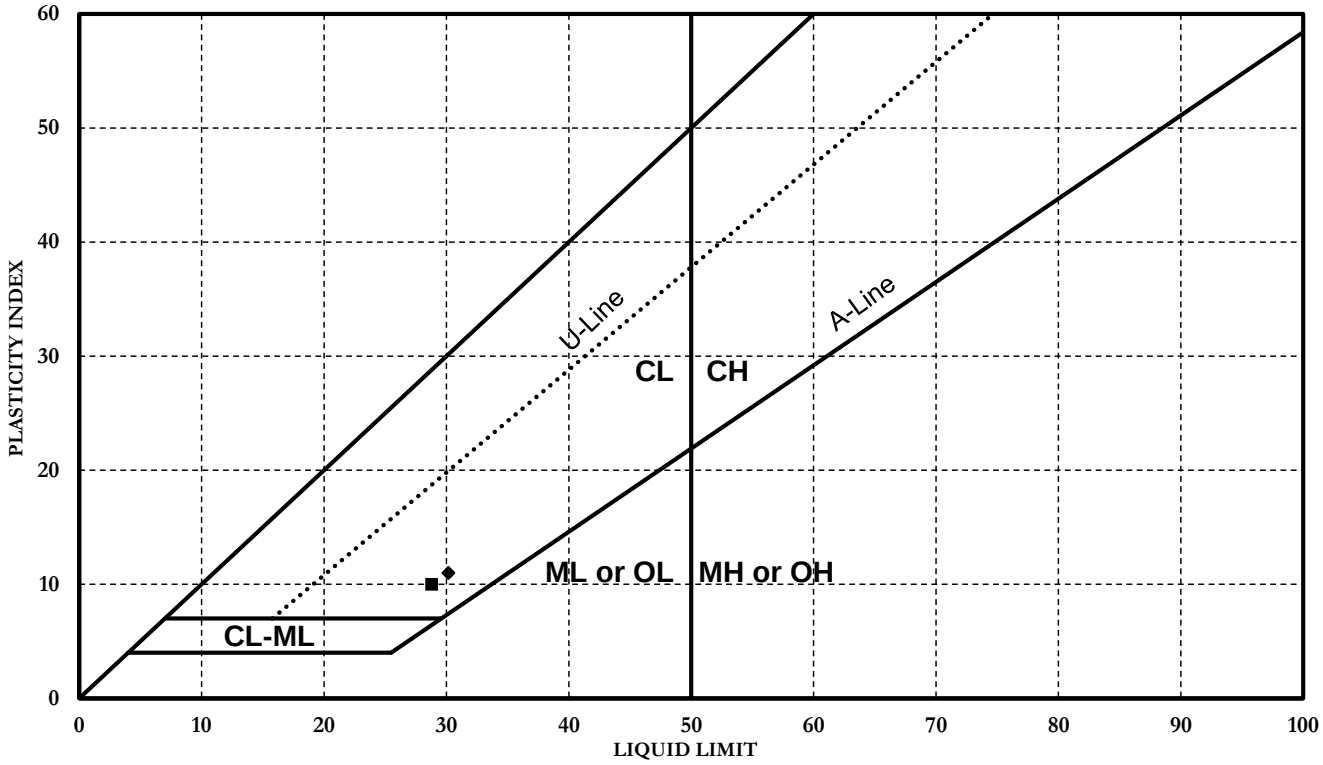
FIGURE E-20

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
ASTM D 4318

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



	Sample	Depth (feet)	USCS Classification	% MC	LL	PL	PI
■	BH-4 #4	20-21.5	LEAN CLAY (CL)	23.3	29	19	10
◆	BH-4 #6	30-31.5	LEAN CLAY (CL)	29.4	30	19	11

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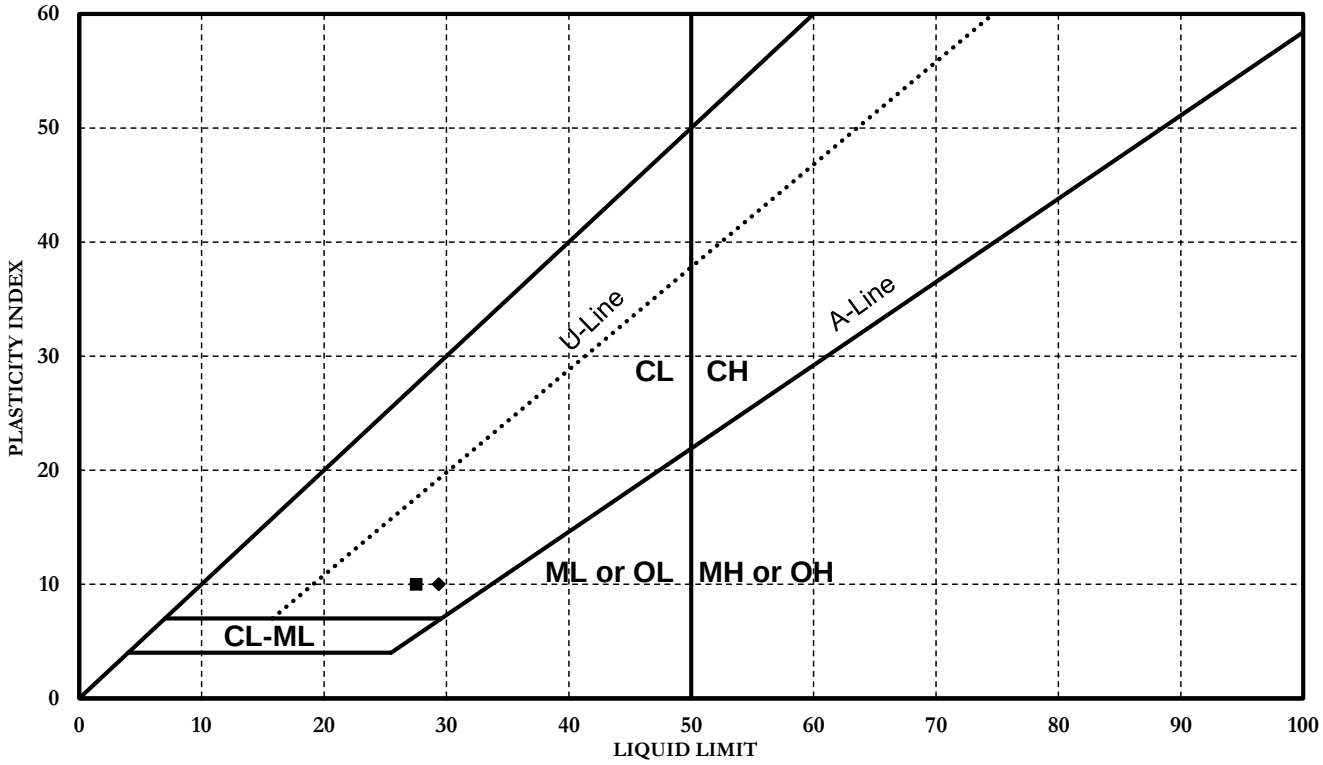
FIGURE E-21

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
ASTM D 4318

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



	Sample	Depth (feet)	USCS Classification	% MC	LL	PL	PI
■	BH-5 #3	15-16.5	LEAN CLAY (CL)	25.6	28	18	10
◆	BH-5 #5	25-26.5	LEAN CLAY (CL)	26.0	29	19	10

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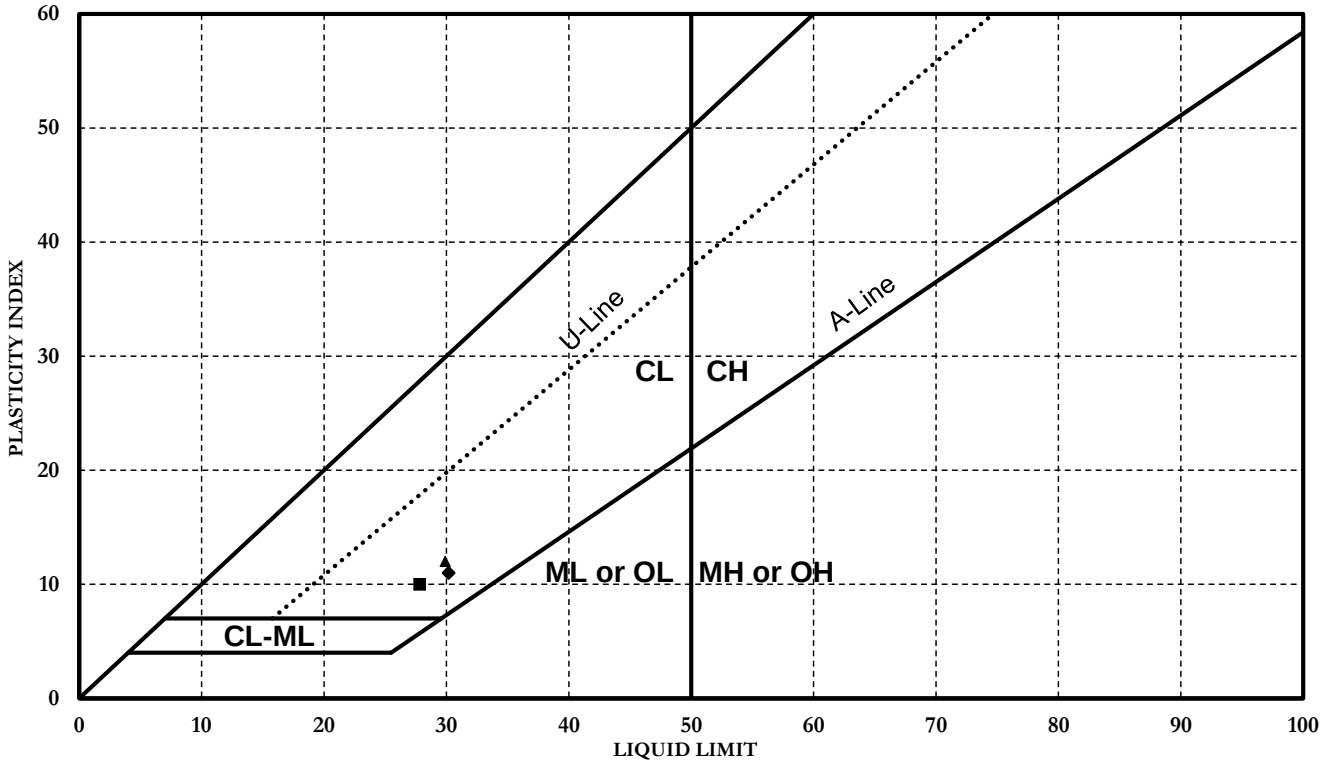
FIGURE E-22

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
ASTM D 4318

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



	Sample	Depth (feet)	USCS Classification	% MC	LL	PL	PI
■	BH-7 #4	20-21.5	LEAN CLAY (CL)	25.8	28	18	10
◆	BH-7 #6	30-31.5	LEAN CLAY (CL)	38.3	30	19	11
▲	BH-7 #8	40-41.5	LEAN CLAY (CL)	32.4	30	18	12

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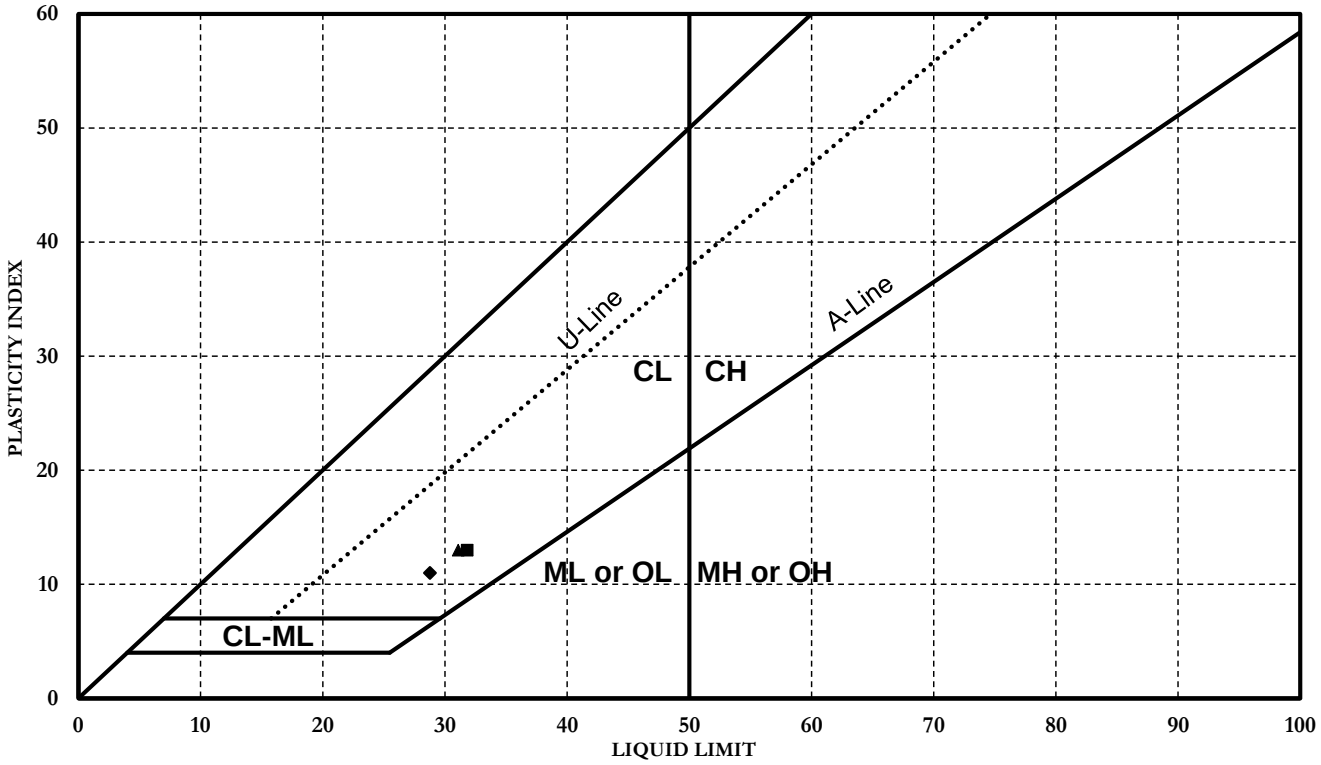
FIGURE E-23

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
ASTM D 4318

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



	Sample	Depth (feet)	USCS Classification	% MC	LL	PL	PI
■	BH-8 #3A	15-15.5	LEAN CLAY (CL)	29.3	32	19	13
◆	BH-8 #4	19.5-21	LEAN CLAY (CL)	23.5	29	18	11
▲	BH-8 #7	35-36.5	LEAN CLAY (CL)	29.0	31	18	13

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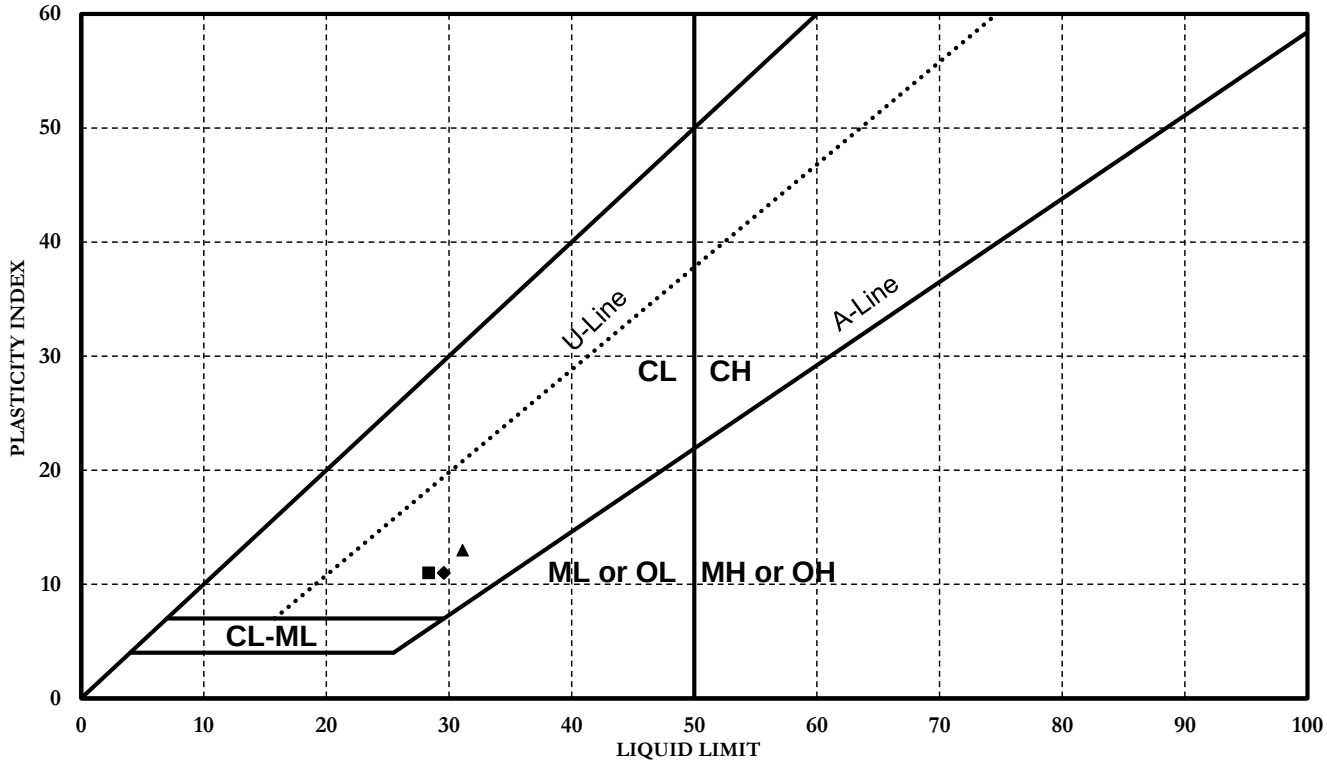
FIGURE E-24

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
ASTM D 4318

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



	Sample	Depth (feet)	USCS Classification	% MC	LL	PL	PI
■	BH-9 #4	15-16.5	LEAN CLAY (CL)	30.4	28	17	11
◆	BH-9 #6	25-26.5	LEAN CLAY (CL)	30.9	30	19	11
▲	BH-9 #8	35-36.5	LEAN CLAY (CL)	29.7	31	18	13

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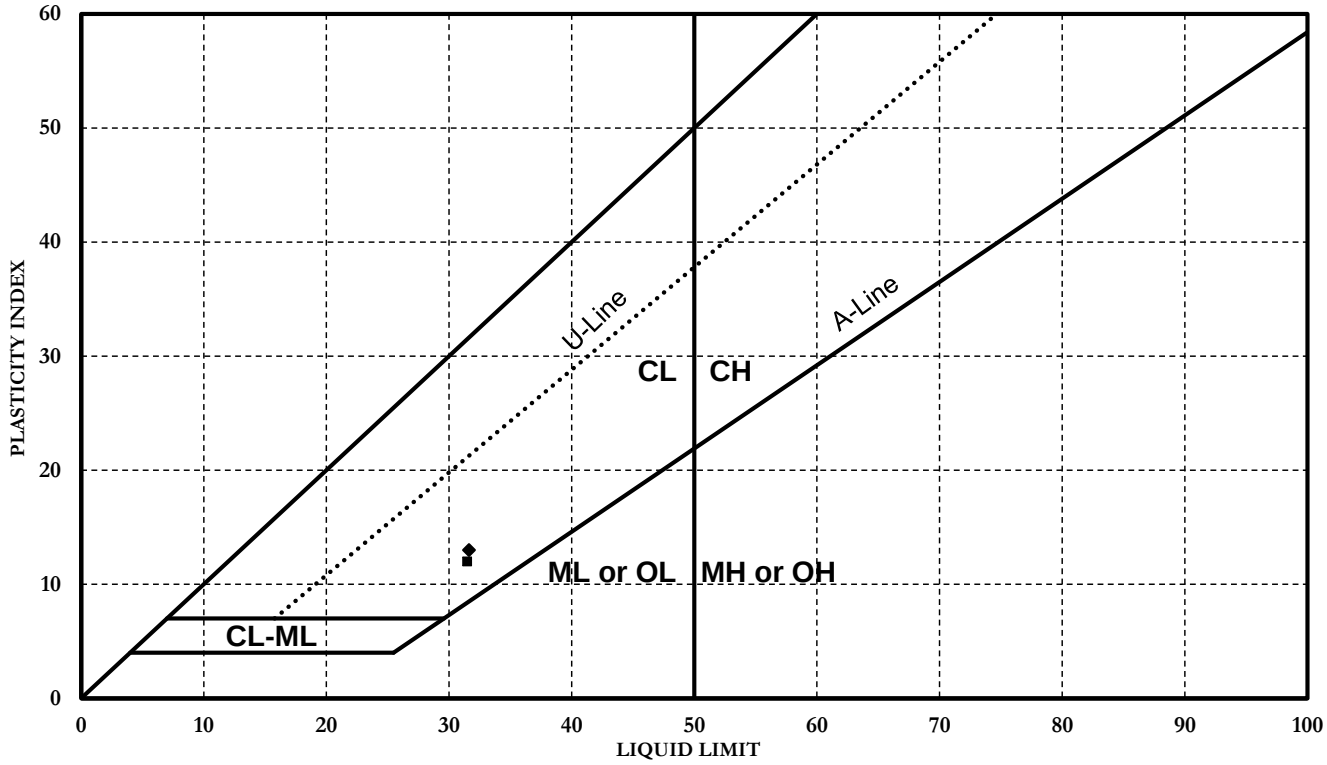
FIGURE E-25

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
ASTM D 4318

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



	Sample	Depth (feet)	USCS Classification	% MC	LL	PL	PI
■	BH-10 #4	20-21.5	LEAN CLAY (CL)	25.2	31	19	12
◆	BH-10 #9A	45-45.7	LEAN CLAY (CL)	31.5	32	19	13

P | N | D
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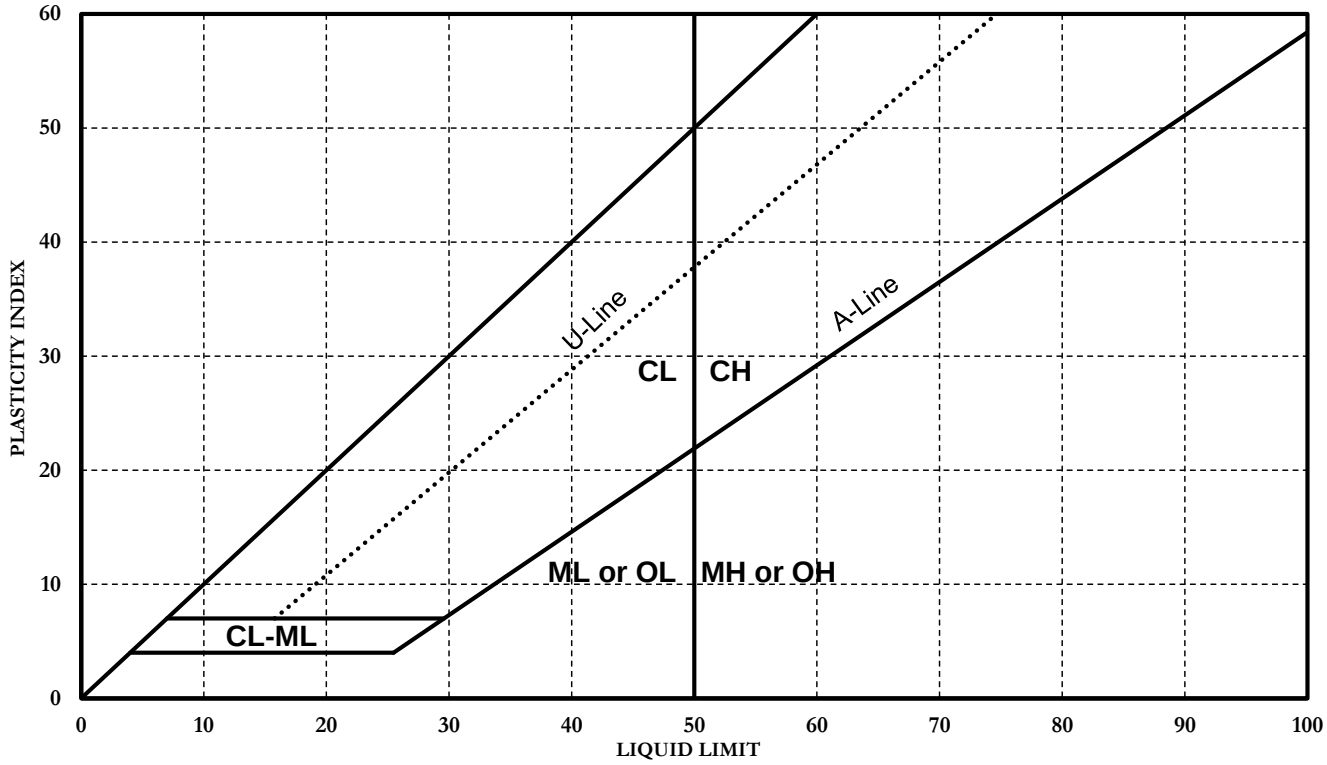
FIGURE E-26

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
ASTM D 4318

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



	Sample	Depth (feet)	USCS Classification	% MC	LL	PL	PI
■	BH-11 #11	60-61.5	NON PLASTIC	9.0	NP	NP	NP

P | N | D
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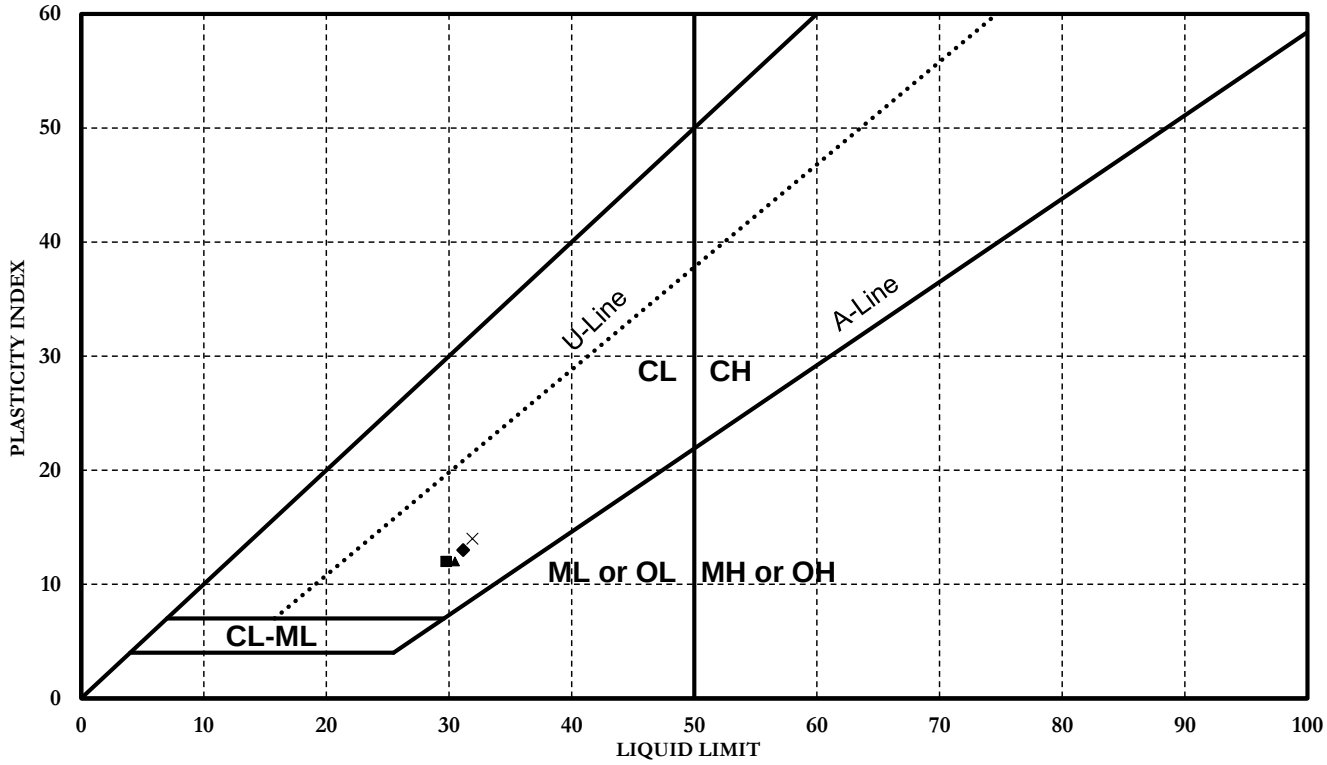
FIGURE E-27

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
ASTM D 4318

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



	Sample	Depth (feet)	USCS Classification	% MC	LL	PL	PI
■	BH-12 #3	15-16.5	LEAN CLAY (CL)	22.7	30	18	12
◆	BH-12 #6	30-31.5	LEAN CLAY (CL)	25.0	31	18	13
▲	BH-12 #8	40-41.5	LEAN CLAY (CL)	29.9	30	18	12
X	BH-12 #11	55-56.5	LEAN CLAY (CL)	27.8	32	18	14

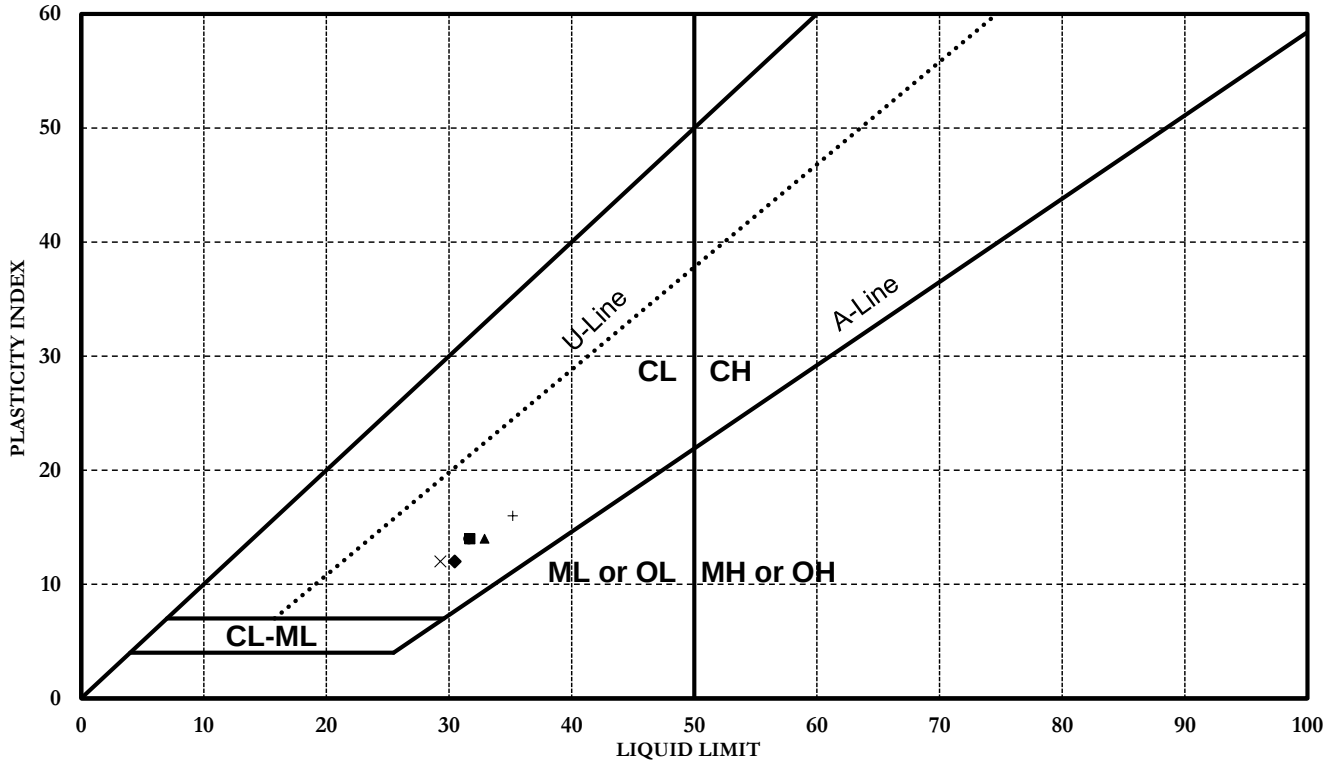
P | N | D
ENGINEERS, INC.

FIGURE E-28

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
ASTM D 4318

PROJECT: South Portage Cove Harbor Expansion

JOB #: 102029



	Sample	Depth (feet)	USCS Classification	% MC	LL	PL	PI
■	BH-13 #7	30-31.5	LEAN CLAY (CL)	32.8	32	18	14
◆	BH-13 #9	40-41.5	LEAN CLAY (CL)	37.9	30	18	12
▲	BH-13 #12A	70-70.5	LEAN CLAY (CL)	43.2	33	19	14
X	BH-13 #13	80-81.5	LEAN CLAY (CL)	23.0	29	17	12
●	BH-13 #15	100-101.5	LEAN CLAY (CL)	17.3	32	18	14
+	BH-13 #18	130-131.5	LEAN CLAY (CL)	27.0	35	19	16

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Testing Report Summary

		Date Sample Recv'd	12/28/2012
Client	PND	W.O. #	A33608
Project	South Portage Cove	Lab #	1-25
Location	See below		

All results will be posted to the website for your access and convenience. Samples will be kept for 30 days before being disposed. Please contact us if you would like the remaining material returned.

Lab ID	Sample ID	Test Performed	Test Method	Results	
1	BH-4, SA 3, 16.5'	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils	ASTM D4318	Liquid Limit	29
				Plastic Limit	17
				Plasticity Index	12
				Estimated % > #40	10
				USCS Classification	Lean Clay
2	BH-4, SA 5, 26.5'			Liquid Limit	28
				Plastic Limit	16
				Plasticity Index	12
				Estimated % > #40	10
				USCS Classification	Lean Clay
3	BH-4, SA 7, 36.5'			Liquid Limit	32
				Plastic Limit	18
				Plasticity Index	14
				Estimated % > #40	10
				USCS Classification	Lean Clay
4	BH-4, SA 9, 46.5'			Liquid Limit	33
				Plastic Limit	18
				Plasticity Index	15
				Estimated % > #40	10
				USCS Classification	Lean Clay
5	BH-5, SA 4, 21.5'			Liquid Limit	30
				Plastic Limit	17
				Plasticity Index	13
				Estimated % > #40	10
				USCS Classification	Lean Clay

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Testing Report Summary, cont'd

		Date Sample Recv'd	12/28/2012
Client	PND	W.O. #	A33608
Project	South Portage Cove	Lab #	1-25
Location	See below		

Lab ID	Sample ID	Test Performed	Test Method	Results	
6	BH-7, SA 3, 16.5'	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils	ASTM D4318	Liquid Limit	29
				Plastic Limit	17
				Plasticity Index	12
				Estimated % > #40	10
				USCS Classification	Lean Clay
7	BH-7, SA 5, 26.5'			Liquid Limit	34
				Plastic Limit	19
				Plasticity Index	15
				Estimated % > #40	5
				USCS Classification	Lean Clay
8	BH-7, SA 7, 36.5'			USCS Classification	33
				Plastic Limit	18
				Plasticity Index	15
				Estimated % > #40	10
				USCS Classification	Lean Clay
9	BH-8, SA 2, 11.5'			Liquid Limit	30
				Plastic Limit	18
				Plasticity Index	12
				Estimated % > #40	10
				USCS Classification	Lean Clay
10	BH-8, SA 6, 31.5'			Liquid Limit	29
				Plastic Limit	17
				Plasticity Index	12
				Estimated % > #40	10
				USCS Classification	Lean Clay
11	BH-8, SA 8, 41.5'			Liquid Limit	32
				Plastic Limit	19
				Plasticity Index	13
				Estimated % > #40	5
				USCS Classification	Lean Clay

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Testing Report Summary, cont'd

		Date Sample Recv'd	12/28/2012
Client	PND	W.O. #	A33608
Project	South Portage Cove	Lab #	1-25
Location	See below		

Lab ID	Sample ID	Test Performed	Test Method	Results	
12	BH-8, SA 11, 56.5'	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils	ASTM D4318	Liquid Limit	38
				Plastic Limit	21
				Plasticity Index	17
				Estimated % > #40	10
				USCS Classification	Lean Clay
13	BH-9, SA 3, 11.5'			Liquid Limit	35
				Plastic Limit	18
				Plasticity Index	17
				Estimated % > #40	5
				USCS Classification	Lean Clay
14	BH-9, SA 5, 21.5'			Liquid Limit	30
				Plastic Limit	17
				Plasticity Index	13
				Estimated % > #40	10
				USCS Classification	Lean Clay
15	BH-9, SA 7, 31.5'			Liquid Limit	33
				Plastic Limit	18
				Plasticity Index	15
				Estimated % > #40	10
				USCS Classification	Lean Clay
16	BH-9, SA 9, 43.5'			Liquid Limit	29
				Plastic Limit	18
				Plasticity Index	11
				Estimated % > #40	10
				USCS Classification	Lean Clay
17	BH-9, SA 13, 81.5'			Liquid Limit	26
				Plastic Limit	17
				Plasticity Index	9
				Estimated % > #40	60
				USCS Classification	Lean Clay

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Testing Report Summary, cont'd

		Date Sample Recv'd	12/28/2012
Client	PND	W.O. #	A33608
Project	South Portage Cove	Lab #	1-25
Location	See below		

Lab ID	Sample ID	Test Performed	Test Method	Results	
18	BH-10, SA 7, 36.5'	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils	ASTM D4318	Liquid Limit	31
				Plastic Limit	17
				Plasticity Index	14
				Estimated % > #40	10
				USCS Classification	Lean Clay
19	BH-12, SA 7, 36.5'			Liquid Limit	33
				Plastic Limit	19
				Plasticity Index	14
				Estimated % > #40	10
				USCS Classification	Lean Clay
20	BH-12, SA 9, 46.5'			Liquid Limit	33
				Plastic Limit	18
				Plasticity Index	15
				Estimated % > #40	10
				USCS Classification	Lean Clay
21	BH-12, SA 12, 61.5'			Liquid Limit	30
				Plastic Limit	17
				Plasticity Index	13
				Estimated % > #40	10
				USCS Classification	Lean Clay
22	BH-13, SA 2, 6.5'			Liquid Limit	31
				Plastic Limit	18
				Plasticity Index	13
				Estimated % > #40	10
				USCS Classification	Lean Clay
23	BH-13, SA 4, 16.5'			Liquid Limit	30
				Plastic Limit	17
				Plasticity Index	13
				Estimated % > #40	10
				USCS Classification	Lean Clay

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Testing Report Summary, cont'd

		Date Sample Recv'd	12/28/2012
Client	PND	W.O. #	A33608
Project	South Portage Cove	Lab #	1-25
Location	See below		

Lab ID	Sample ID	Test Performed	Test Method	Results	
24	BH-13, SA8, 36.5'	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils	ASTM D4318	Liquid Limit	32
				Plastic Limit	19
				Plasticity Index	13
				Estimated % > #40	10
				USCS Classification	Lean Clay
25	BH-13, SA 10, 51.5'			Liquid Limit	30
				Plastic Limit	16
				Plasticity Index	14
				Estimated % > #40	10
				USCS Classification	Lean Clay

If you have questions regarding this summary report or the test procedures, please contact us.

Maria
Maria E. Kampsen, P.E.
Laboratory Supervisor

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March 4, 2013
W.O. A33608

Mr. Christopher Kokesh
PND
1736 Fourth Avenue S, Suite A
Seattle, Washington 98134

Subject: Consolidation and Triaxial Testing
South Portage Cove

Dear Mr. Kokesh:

DOWL HKM has completed the testing program you requested for the South Portage Cove project. We were requested to perform 15 unconsolidated undrained triaxial tests, 2 consolidated undrained triaxial tests with pore water measurements, 7 consolidation tests, and 25 plastic and liquid limit tests. Attached are the triaxial graphs, the consolidation graphs, and the plastic and liquid limit results with the classifications for each sample.

TRIAXIAL TESTING

The triaxial testing was performed in accordance with ASTM D2850-07, "Unconsolidated-Undrained Triaxial Compression Test," and ASTM D4767-11 "Unconsolidated-Undrained Triaxial Compression Test." Attached are the stress strain curves and Mohr diagram for each test. Below are the tabulated results and triaxial parameters.

Unconsolidated Undrained Triaxial Data

Sample ID	Test Type	Density (pcf)	Initial Moisture Content (%)	Confining Pressure (psi)	Shear Failure (psi)	% Strain at Failure	Mohr Shear Stress (psi)
BH-4,S-5	UU	101.6	25.0	12	10.89	15.0	5.45
BH-4,S-9	UU	92.8	33.9	20	3.44	15.0	1.72
BH-7,S-5	UU	92.9	30.3	12	4.30	10.24	2.03
BH-8, S-2	UU	98.3	28.6	5	3.37	15.0	1.68
BH-8, S-8	UU	87.9	35.4	18	3.78	10.25	1.89
BH-8, S-11	UU	93.6	28.4	25	6.07	14.09	3.03
BH-9, S-3	UU	99.4	26.5	5	4.79	15.0	2.40
BH-9,S-7	UU	96.3	28.5	14	2.25	13.83	1.127

Sample ID	Test Type	Density (pcf	Initial Moisture Content (%)	Confining Pressure (psi)	Shear Failure (psi)	% Strain at Failure	Mohr Shear Stress (psi)
BH-9, S-13	UU	108.5	21.7	35	9.33	15.0	4.66
BH-12, S-7	UU	102.1	22.4	16	11.97	15.0	3.35
BH-12, S-9	UU	96.9	26.7	20	6.32	15.0	3.16
BH-12, S-12	UU	93.8	32.2	27	6.40	15.0	3.18
BH-13, S-2	UU	103.6	25.6	3	8.38	15.0	4.19
BH-13, S-4	UU	105.5	23.3	7	13.44	15.0	6.72
BH-13, S-8	UU	82.0	39.8	16	2.04	12.36	1.01
BH-13, S-10	UU	86.0	36.6	22	3.34	13.26	1.67

The consolidated undrained triaxial tests were saturated and checked for the B value prior to consolidating the samples. The B value for each sample was over 95%. The samples were consolidated at the requested confining pressures. During the consolidation process, the volume change was measured and plotted on a time rate of consolidation curve of square root of time. Once the consolidation was verified to be 100%, the samples were tested for the strength characteristics. The triaxial consolidation curves are attached along with the triaxial plots.

Consolidated Undrained Triaxial Tests								
Sample ID	Confining Pressure (psi)	Shear Failure (psi)	% Strain at Failure	Max Pore Pressure (psi)	% Strain at Max Pore Pressure	Mohr Total Stress Sigma 1	Mohr Effective Stress Sigma 1	Mohr Effective Stress Sigma 3
BH-9, S-5	5.5	7.95	9.96	3.27	3.66	13.5	10.19	2.23
	17.8	23.55	15.0	11.73	5.28	41.4	29.67	6.07
	30.2	41.60	15.0	19.78	5.45	71.8	52.02	10.42
BH-9, S-9	1.4	15.31	15.0	-3.65	15.0	16.72	20.37	5.05
	23.5	27.05	15.0	15.98	4.58	50.6	34.62	7.52
	35.8	33.63	10.98	25.04	6.06	69.5	44.46	10.76

The volume change for each sample is listed as follows:

- BH-9, S-5 Confining Pressure 5.5 psi – Total Volume Change 16.5 cubic centimeter
- BH-9, S-5 Confining Pressure 17.8 psi – Total Volume Change 44.1 cubic centimeter
- BH-9, S-5 Confining Pressure 30.2 psi – Total Volume Change 48.5 cubic centimeter
- BH-9. S-9 Confining Pressure 11.2 psi – Total Volume Change 25.4 cubic centimeter
- BH-9, S-9 Confining Pressure 23.5 psi – Total Volume Change 56.1 cubic centimeter
- BH-9, S-9 Confining Pressure 35.8 psi – Total Volume Change 86.7 cubic centimeter

Consolidation Testing

The consolidation tests were performed in accordance with ASTM D2435-11, "One-Dimensional Consolidation Properties of Soils." The loading sequence for each consolidation test is listed on the consolidation report included with the consolidation curves that are attached. The densities, moisture contents, and load pressures are located on the consolidation cures and time rate of consolidation curves.

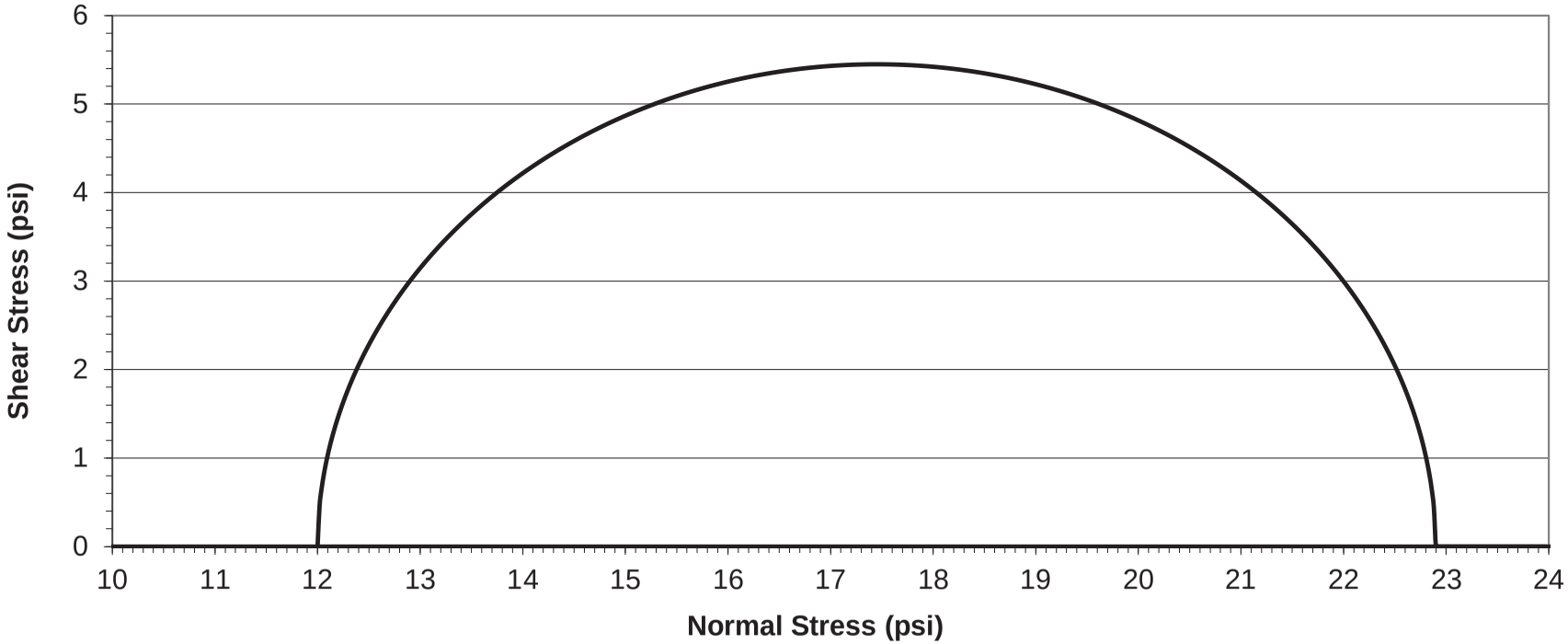
If you have any questions concerning this data, please call or email me at 562-2000 or dandersen@dowlhkm.com.

Sincerely,
DOWL HKM

David L. Andersen, P.E.
Senior Materials Engineer

DOWL HKM

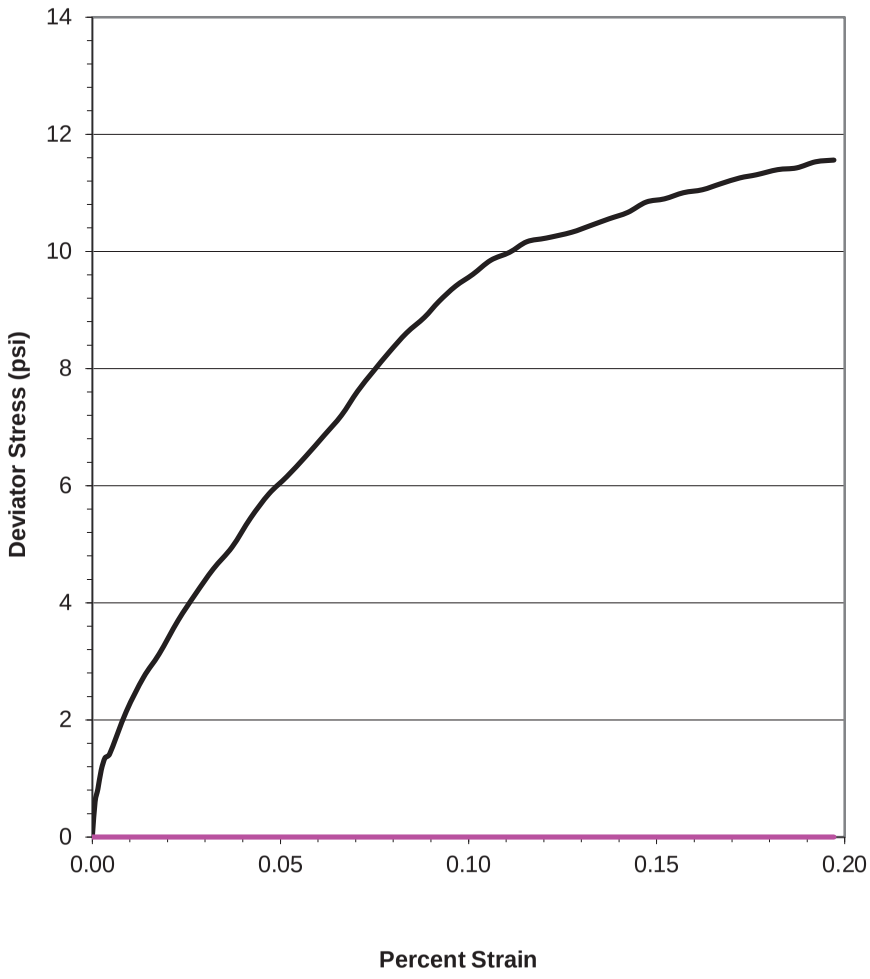
Project :	PND	Lab #	2	σ_3 =	12.0 psi	$\gamma\delta$ =	101.6 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-4						
Sample #	5						
Depth :	26.5						
Date:	1/25/2013						

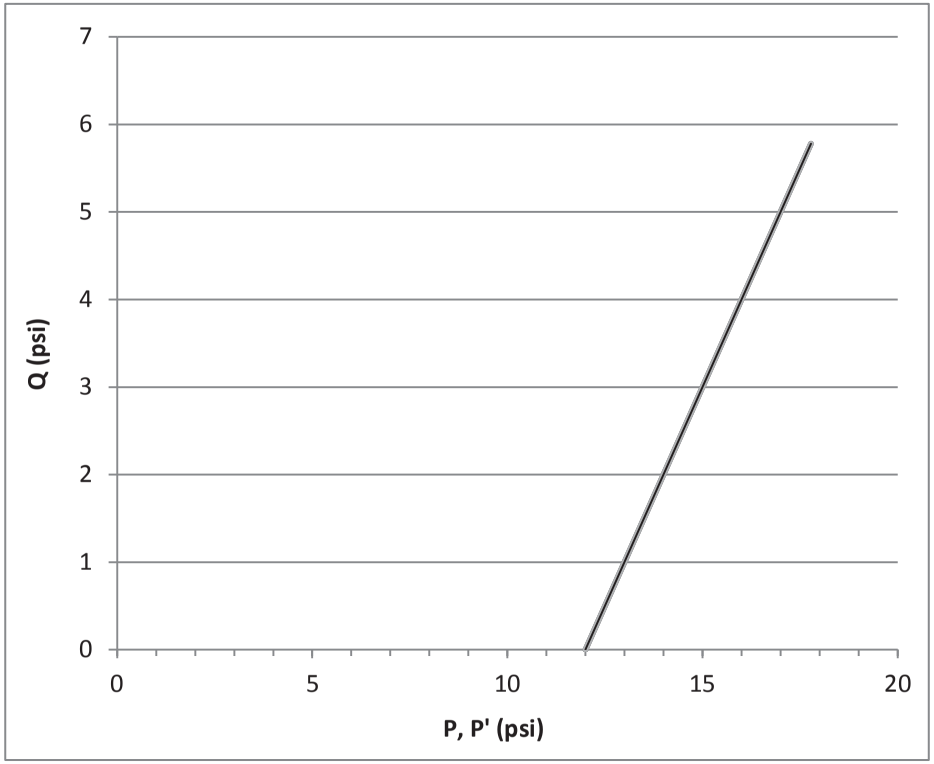


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND		
Client:	South Portage Cove		
WO #	A33608		
Boring #	BH-4	Depth	26.5 ft
Sample #	5		
Initial Dry Density:		101.6 pcf	
Effective Confining Pressure :		12 psi	
Final Moisture Content:		25 %	
Laboratory #	2		
Date:	1/25/2013		



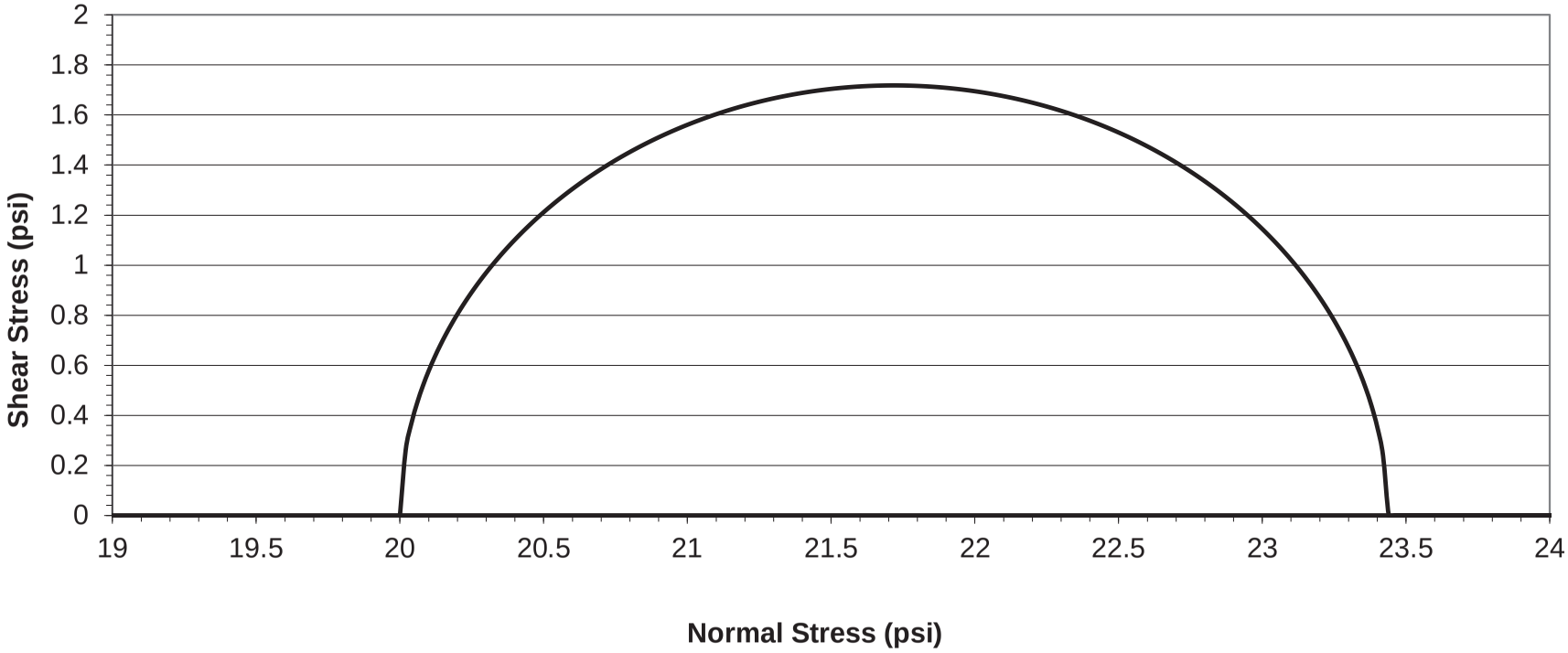


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

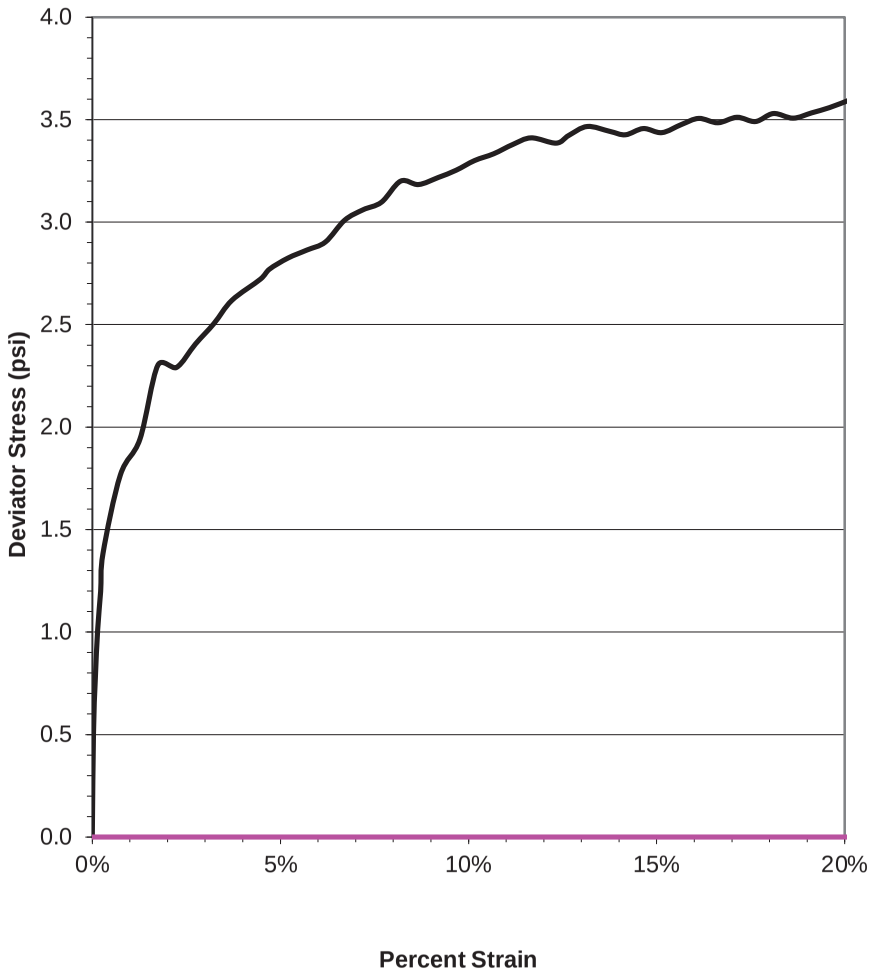
Project :	PND	Lab #	4	σ_3 =	20.0 psi	$\gamma\delta$ =	92.8 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-4						
Sample #	9						
Depth :	46.5'						
Date:	1/28/2013						

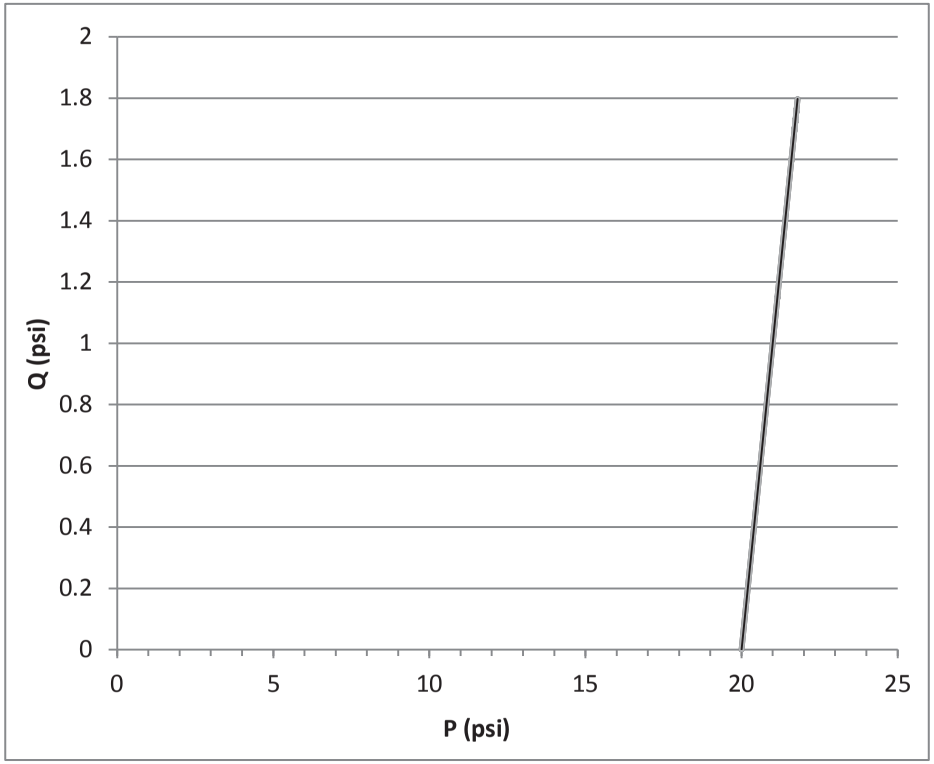


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND			
Client:	South Portage Cove			
WO #	A33608			
Boring #	BH-4	Depth	46.5'	ft
Sample #	9			
Initial Dry Density:		92.8 pcf		
Effective Confining Pressure :		20 psi		
Final Moisture Content:		33.9 %		
Laboratory #	4			
Date:	1/28/2013			



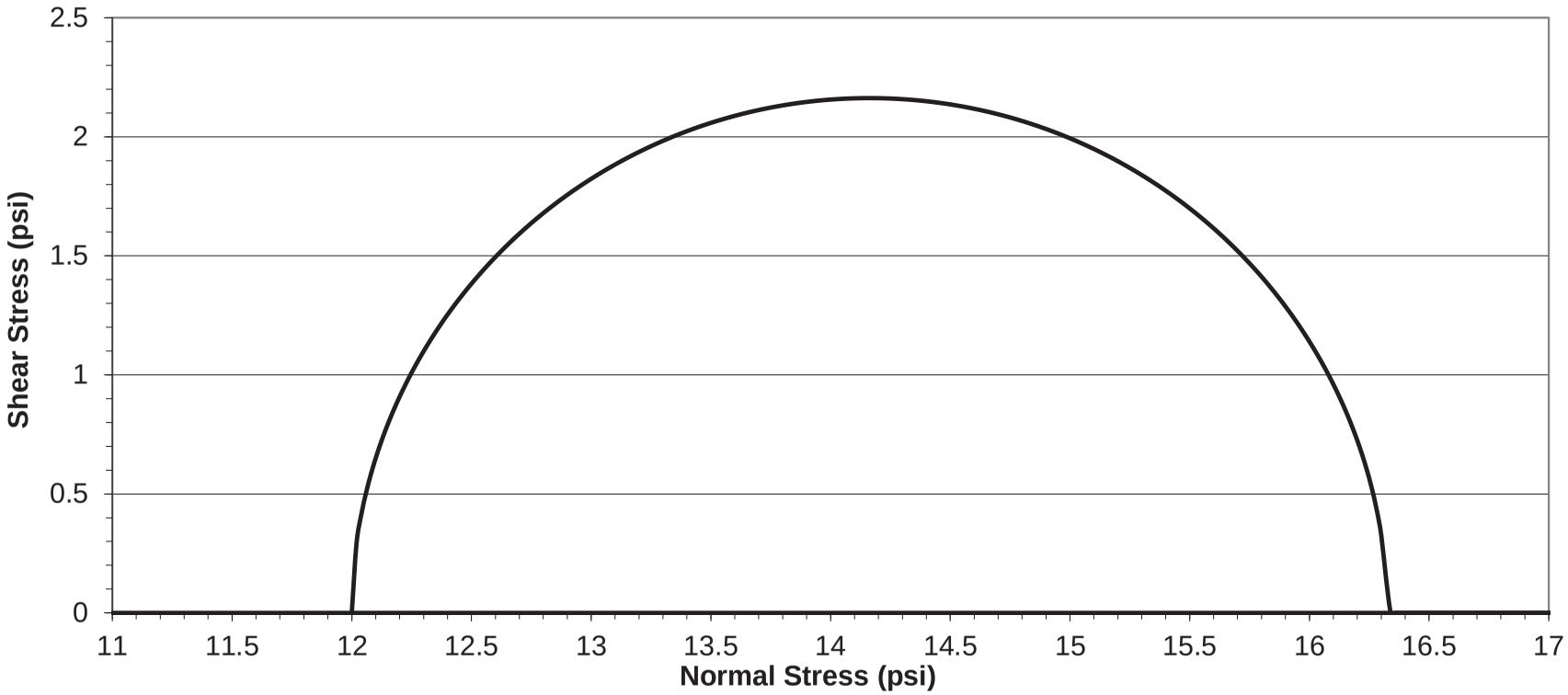


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

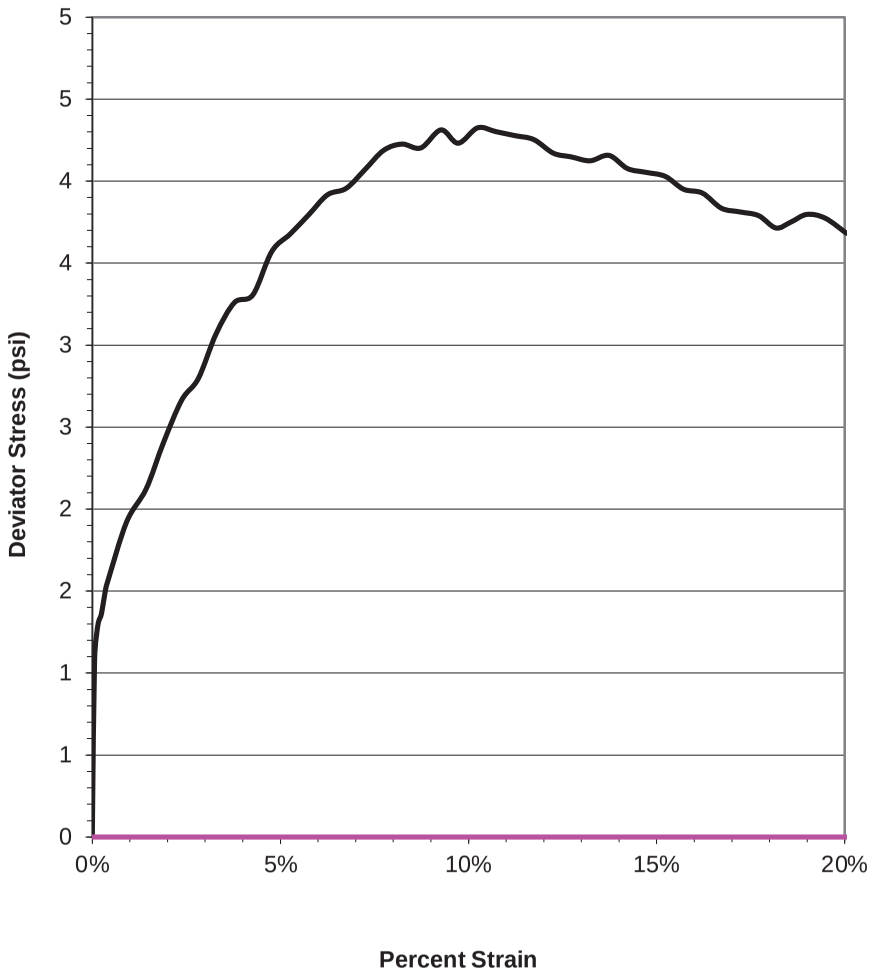
Project :	PND	Lab #	7	σ_3 =	12.0 psi	$\gamma\delta$ =	92.9 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-7						
Sample #	5						
Depth :	26.5						
Date:	1/30/2013						

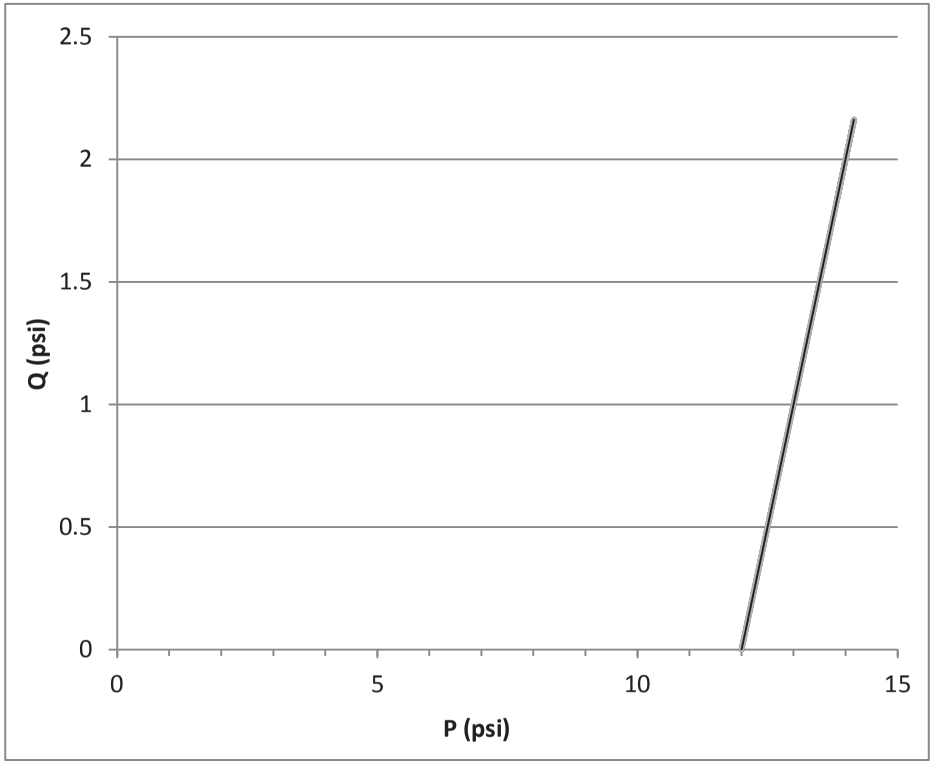


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND		
Client:	South Portage Cove		
WO #	A33608		
Boring #	BH-7	Depth	26.5 ft
Sample #	5		
Initial Dry Density:		92.9 pcf	
Effective Confining Pressure :		12 psi	
Final Moisture Content:		30.6 %	
Laboratory #	7		
Date:	1/30/2013		



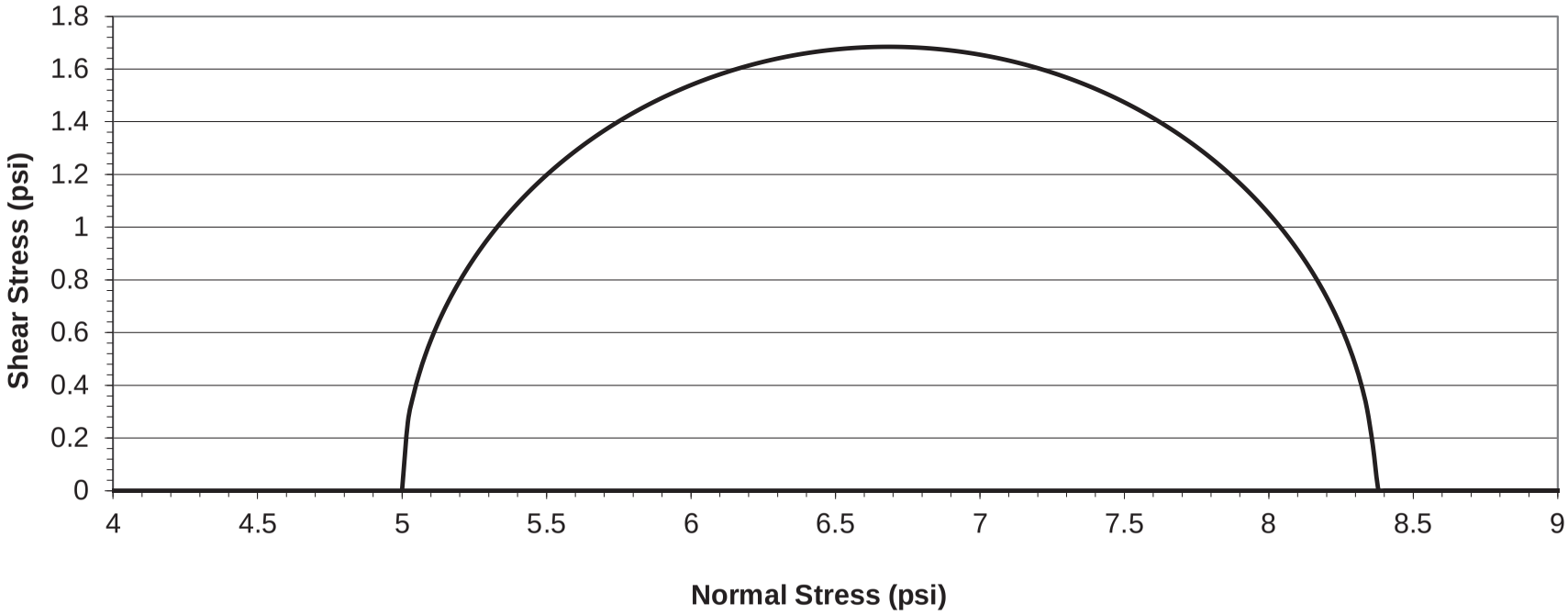


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

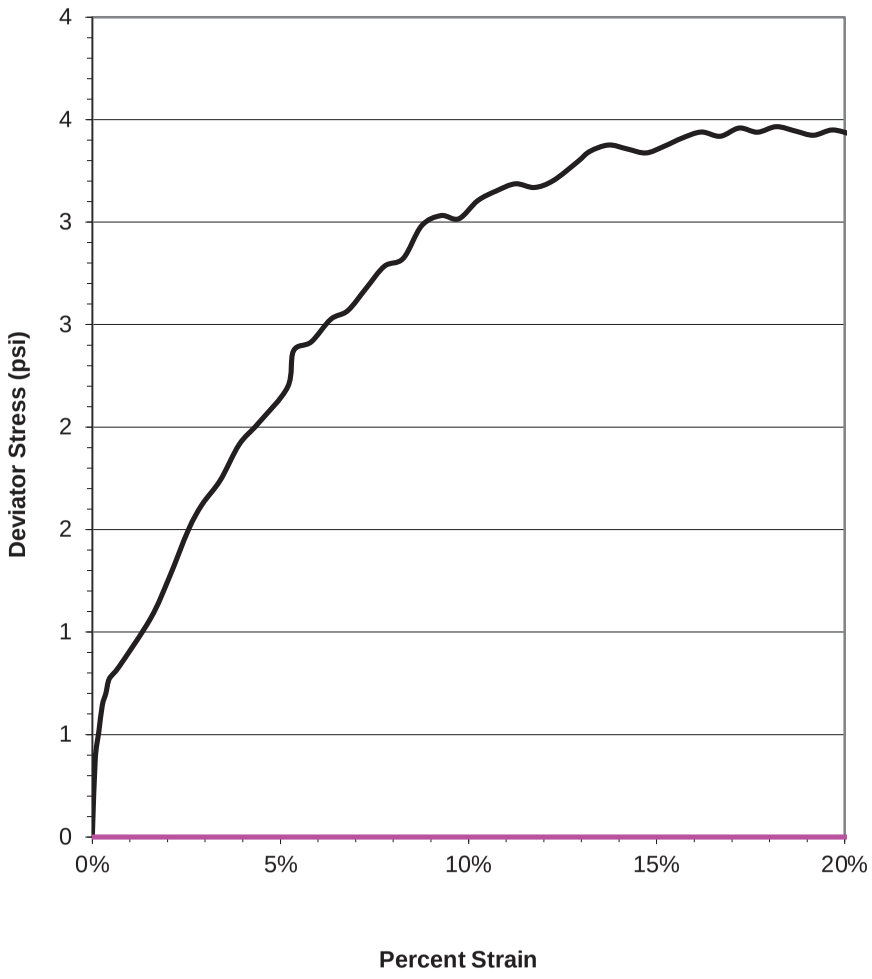
Project :	PND	Lab #	9	σ_3 =	5.0 psi	$\gamma\delta$ =	98.3 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-8						
Sample #	2						
Depth :	11.5'						
Date:	1/28/2013						

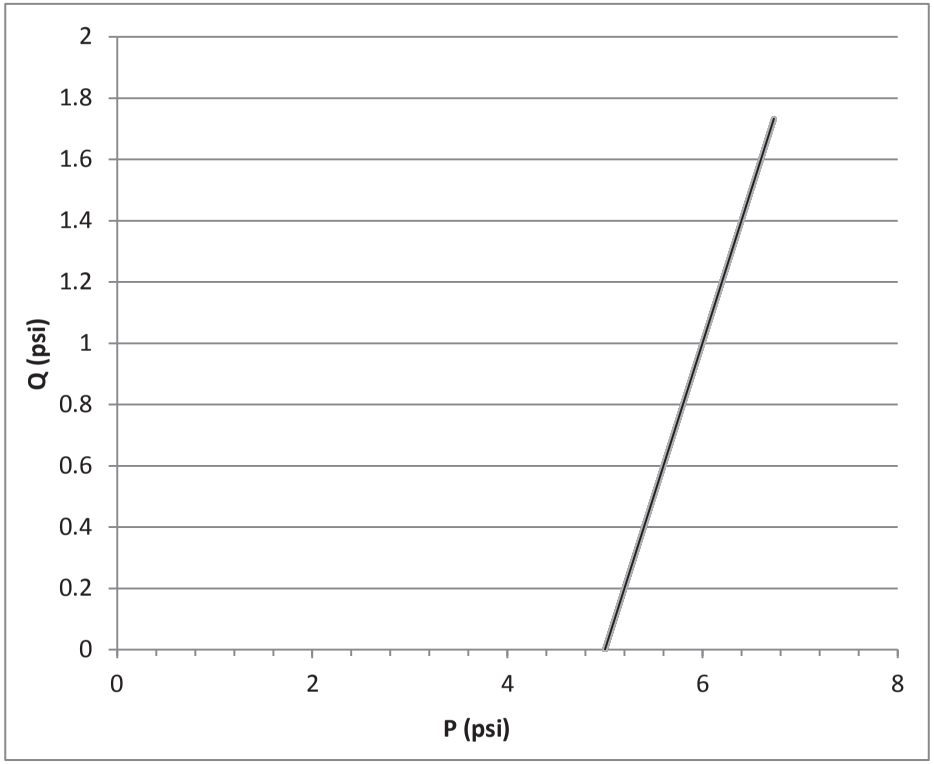


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND			
Client:	South Portage Cove			
WO #	A33608			
Boring #	BH-8	Depth	11.5'	ft
Sample #	2			
Initial Dry Density:		98.3 pcf		
Effective Confining Pressure :		5 psi		
Final Moisture Content:		28.6 %		
Laboratory #	9			
Date:	1/28/2013			



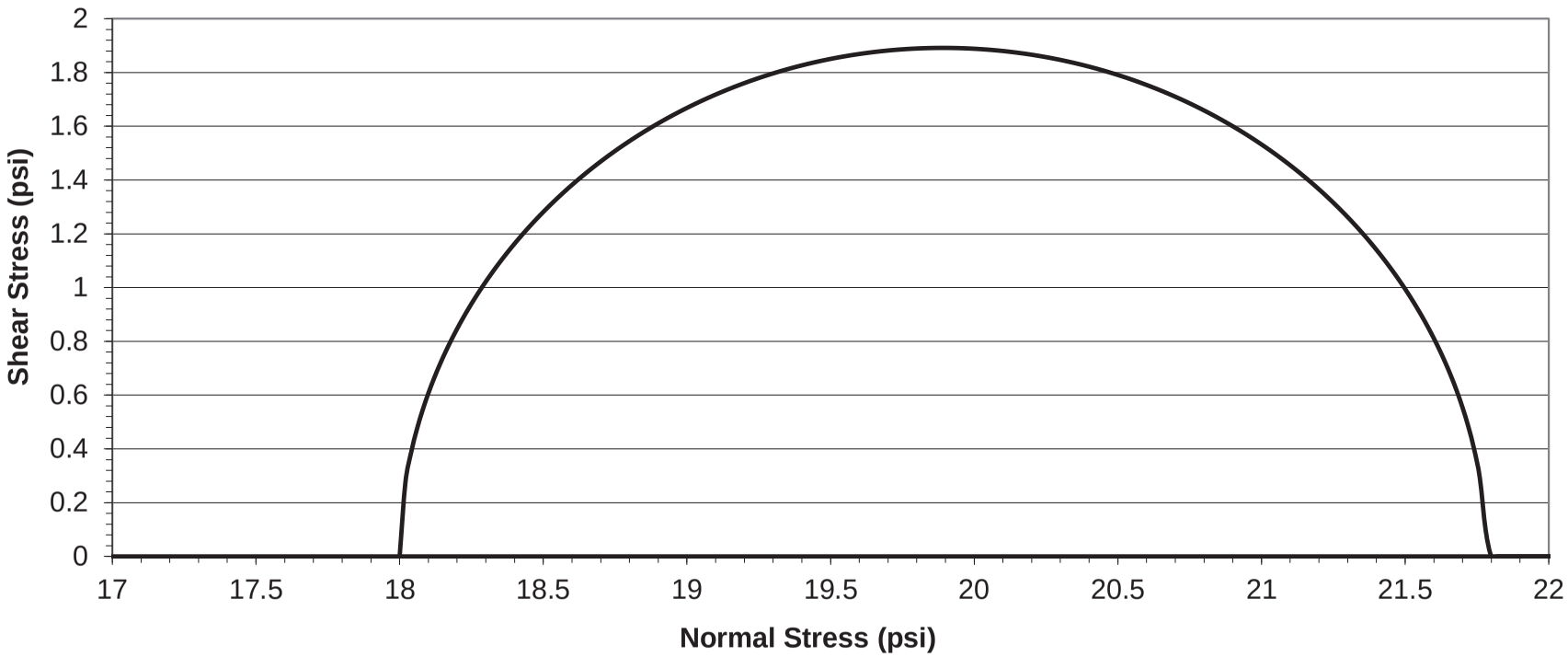


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

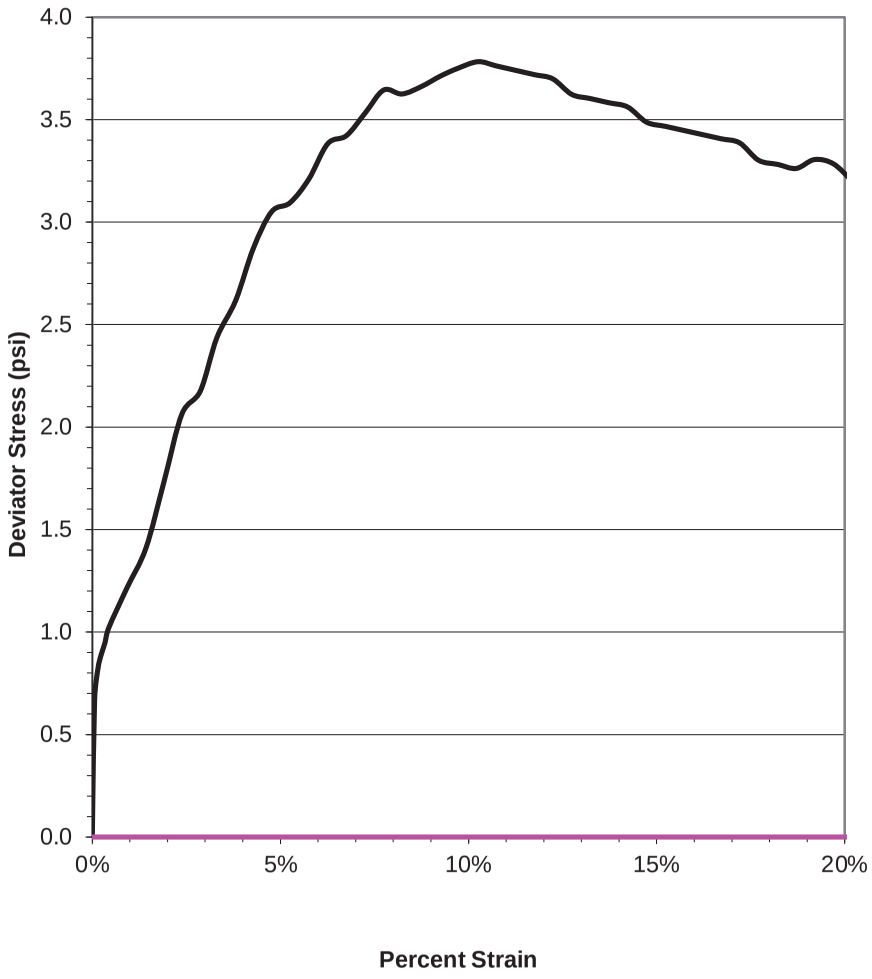
Project :	PND	Lab #	11	σ_3 =	18.0 psi	$\gamma\delta$ =	87.9 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-8						
Sample #	8						
Depth :	41.5'						
Date:	1/31/2013						

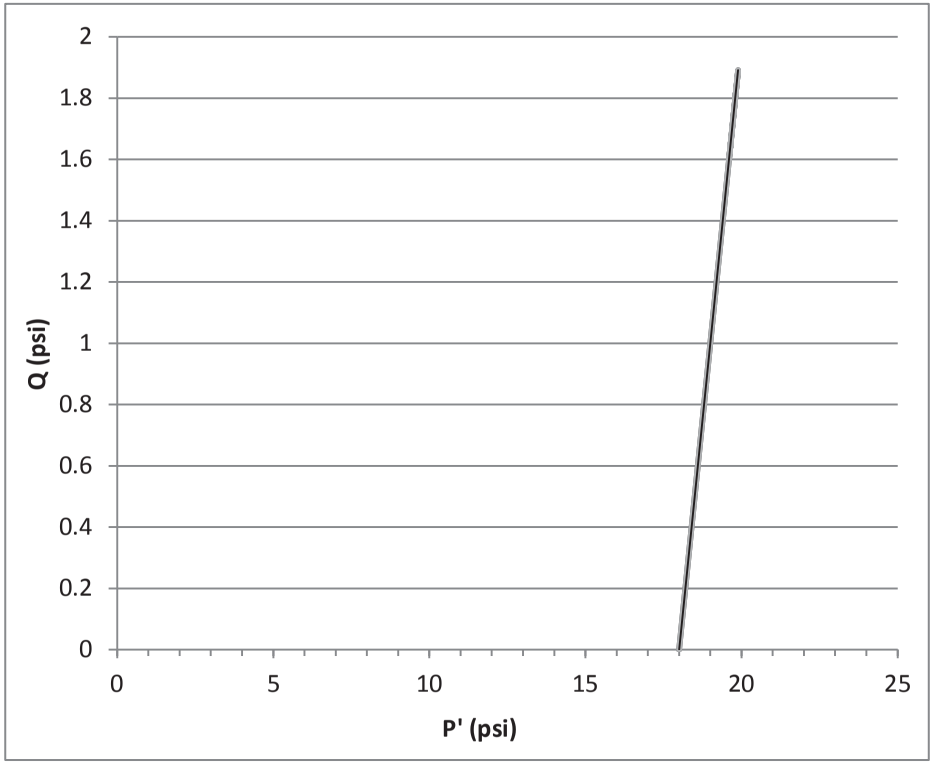


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND			
Client:	South Portage Cove			
WO #	A33608			
Boring #	BH-8	Depth	41.5'	ft
Sample #	8			
Initial Dry Density:		87.9 pcf		
Effective Confining Pressure :		18 psi		
Final Moisture Content:		35.4 %		
Laboratory #	11			
Date:	1/31/2013			



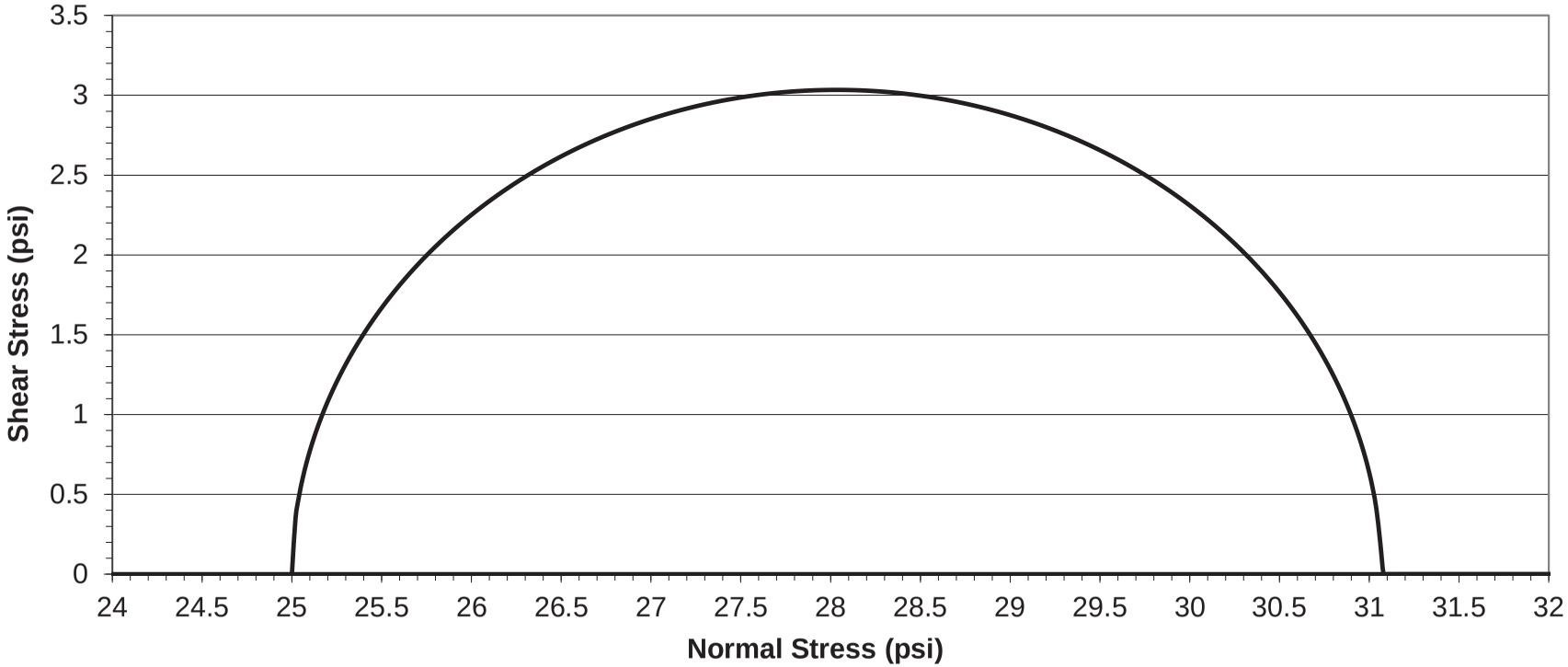


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

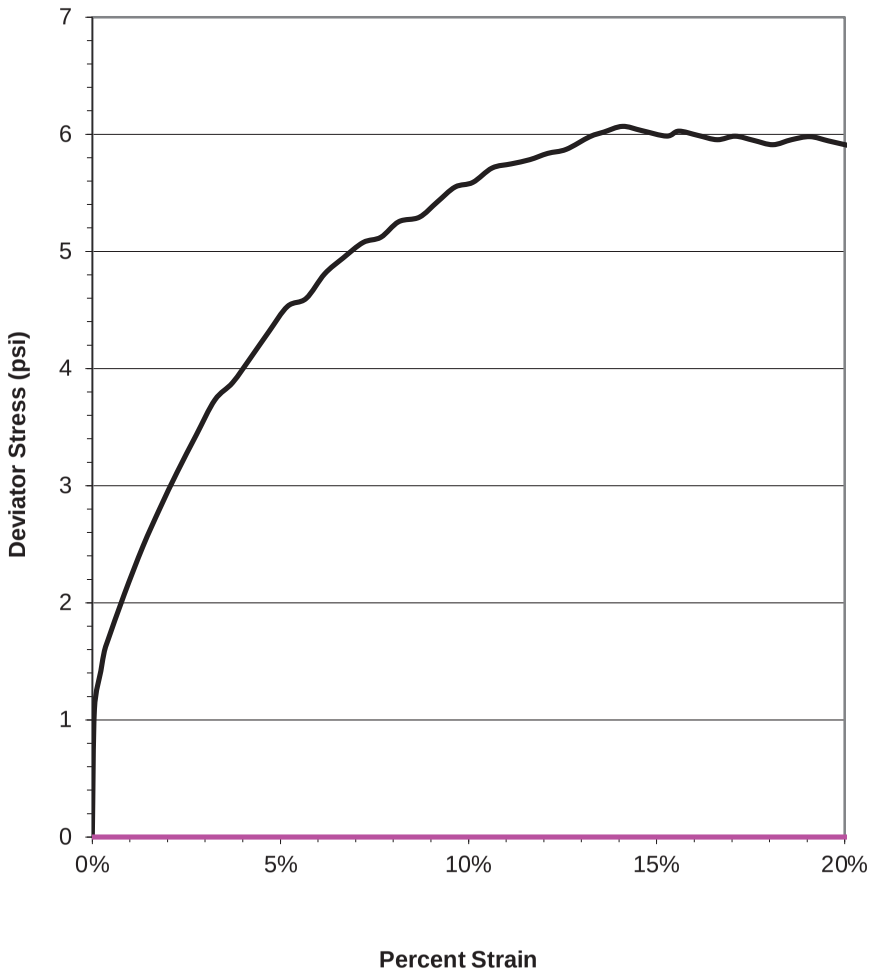
Project :	PND	Lab #	12	σ_3 =	25.0 psi	$\gamma\delta$ =	93.6 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-8						
Sample #	11						
Depth :	56.5						
Date:	1/31/2013						

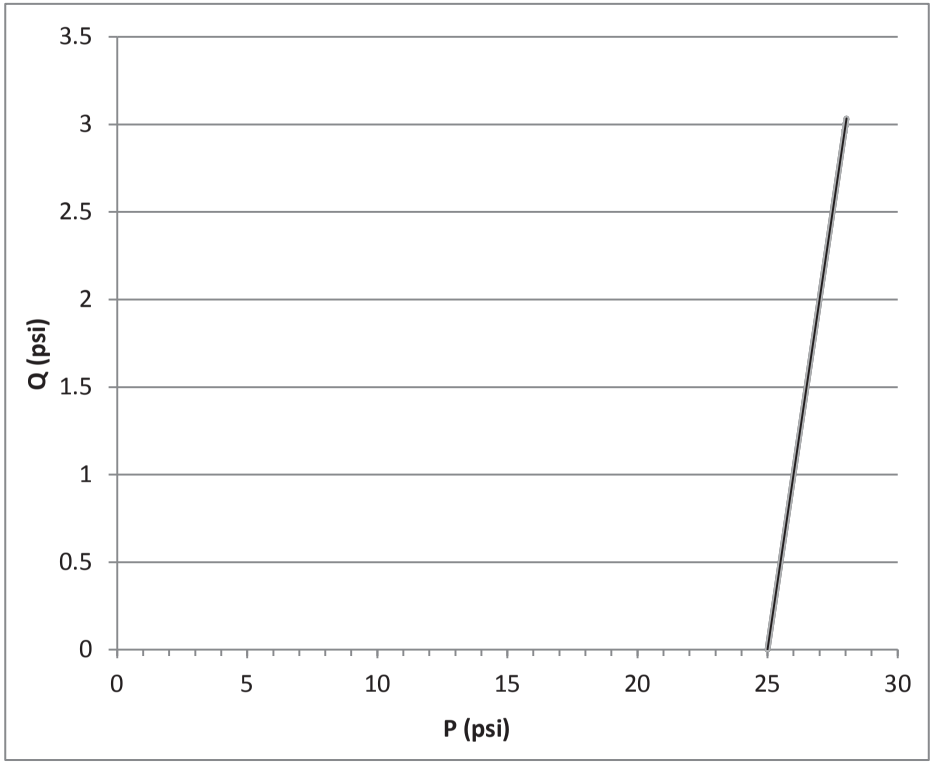


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND		
Client:	South Portage Cove		
WO #	A33608		
Boring #	BH-8	Depth	56.5 ft
Sample #	11		
Initial Dry Density:		93.6 pcf	
Effective Confining Pressure :		25 psi	
Final Moisture Content:		28.4 %	
Laboratory #	12		
Date:	1/31/2013		



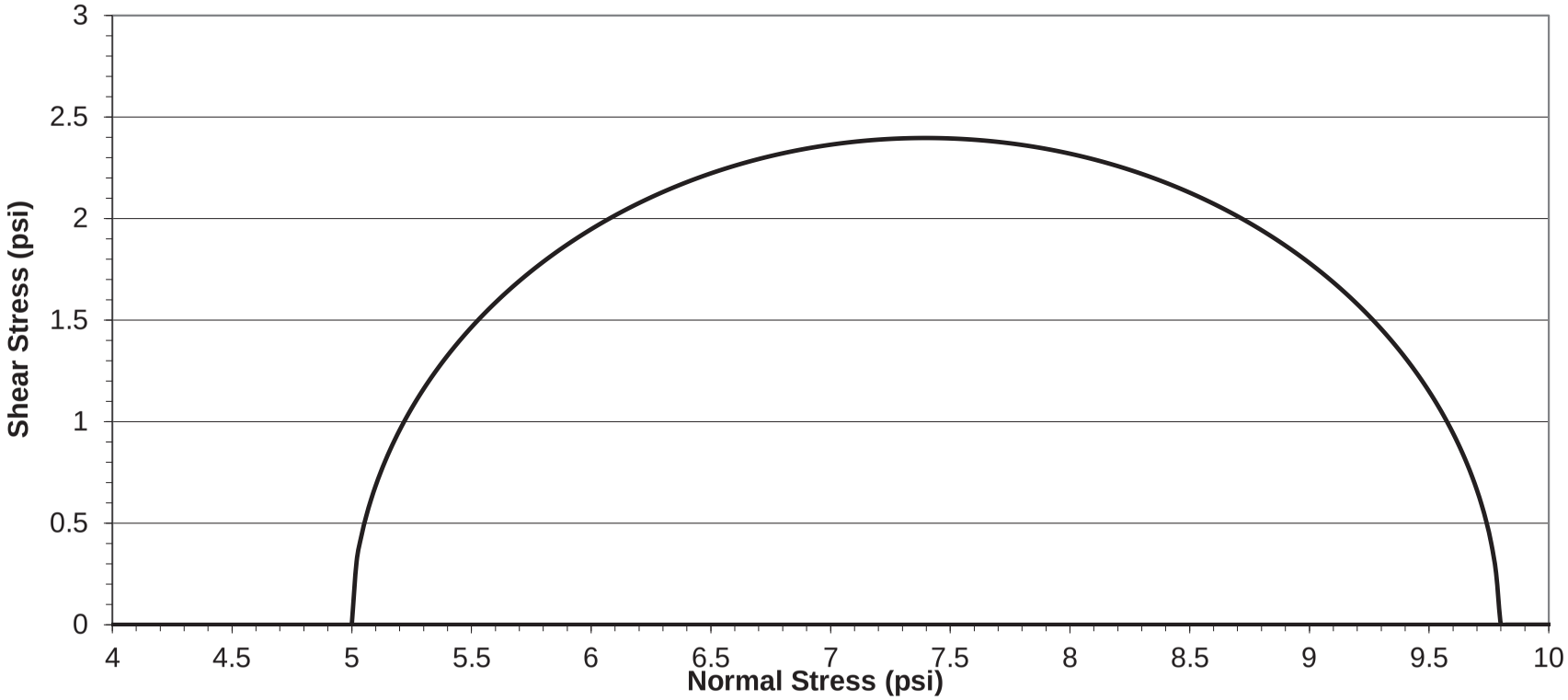


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

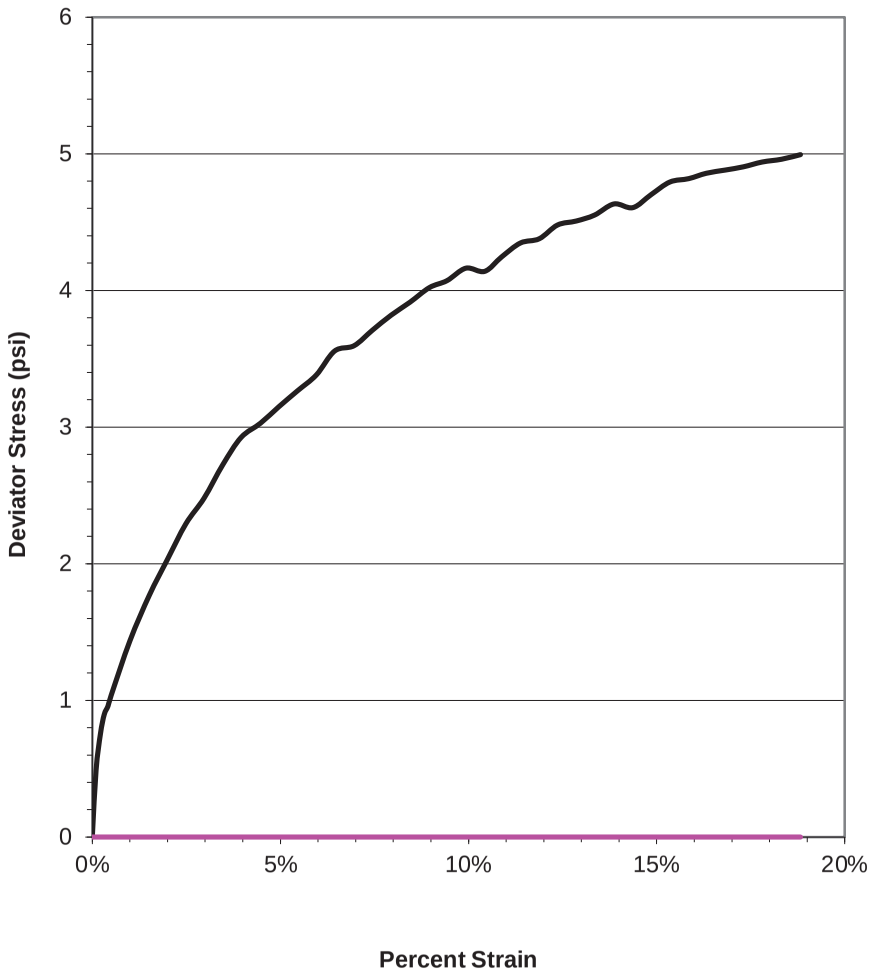
Project :	PND	Lab #	13	σ_3 =	5.0 psi	$\gamma\delta$ =	99.4 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-9						
Sample #	3						
Depth :	11.5'						
Date:	1/31/2013						

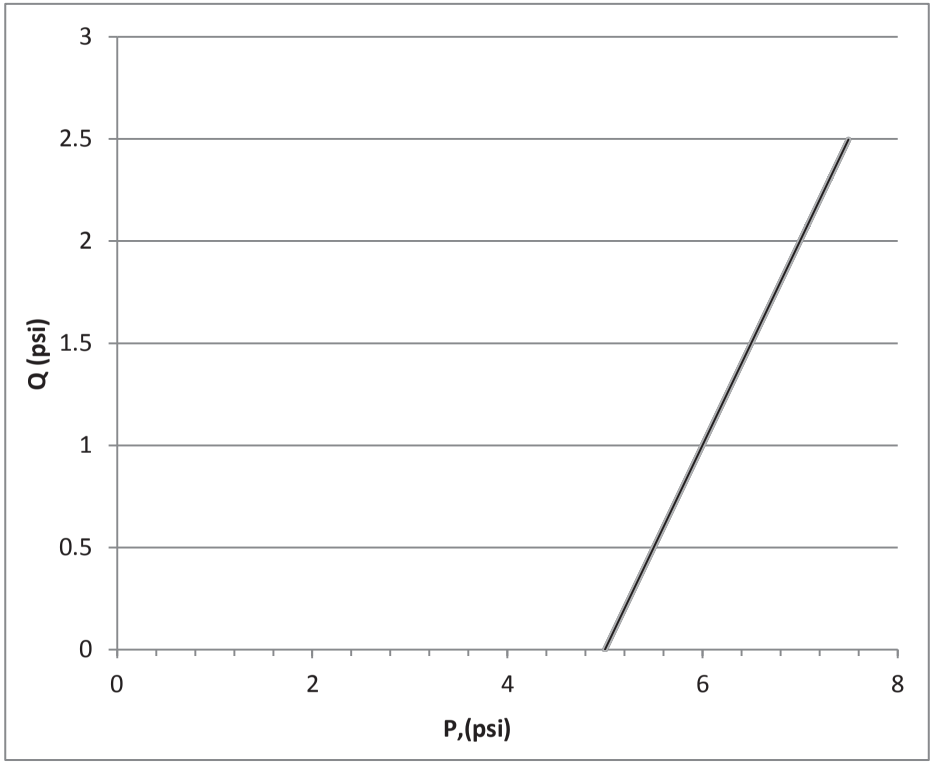


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND			
Client:	South Portage Cove			
WO #	A33608			
Boring #	BH-9	Depth	11.5'	ft
Sample #	3			
Initial Dry Density:		99.4 pcf		
Effective Confining Pressure :		5 psi		
Final Moisture Content:		26.5 %		
Laboratory #	13			
Date:	1/31/2013			



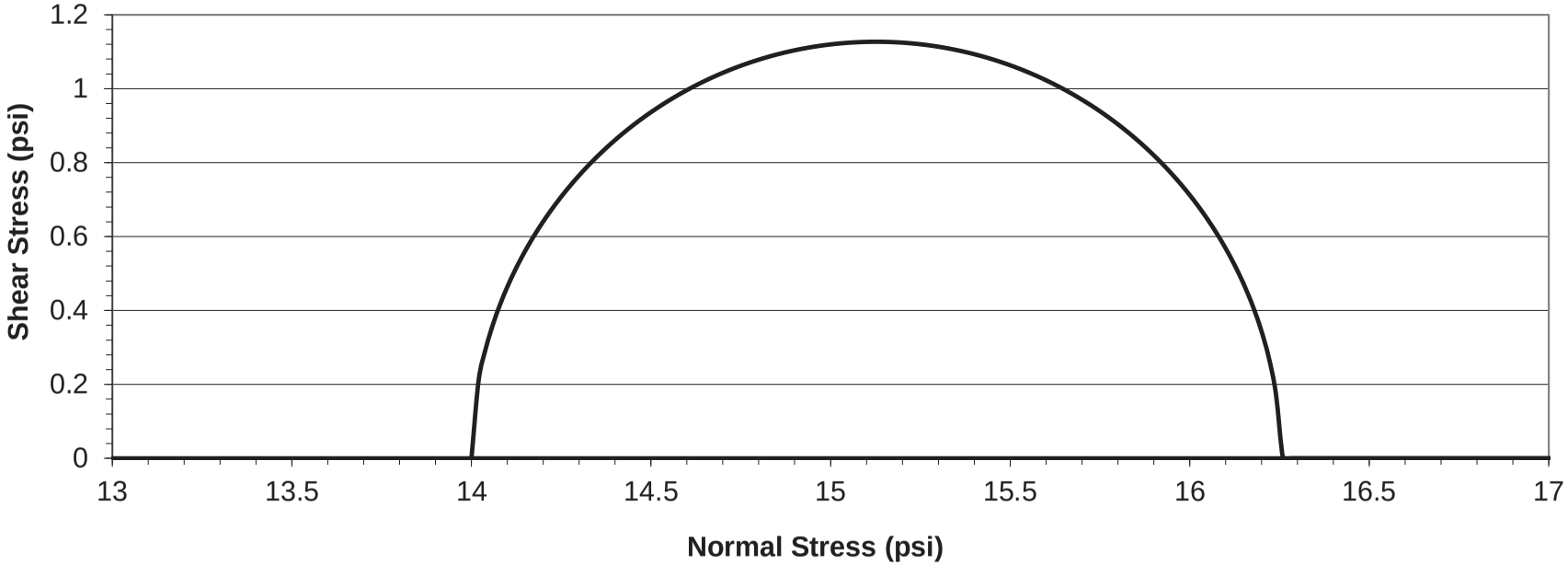


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

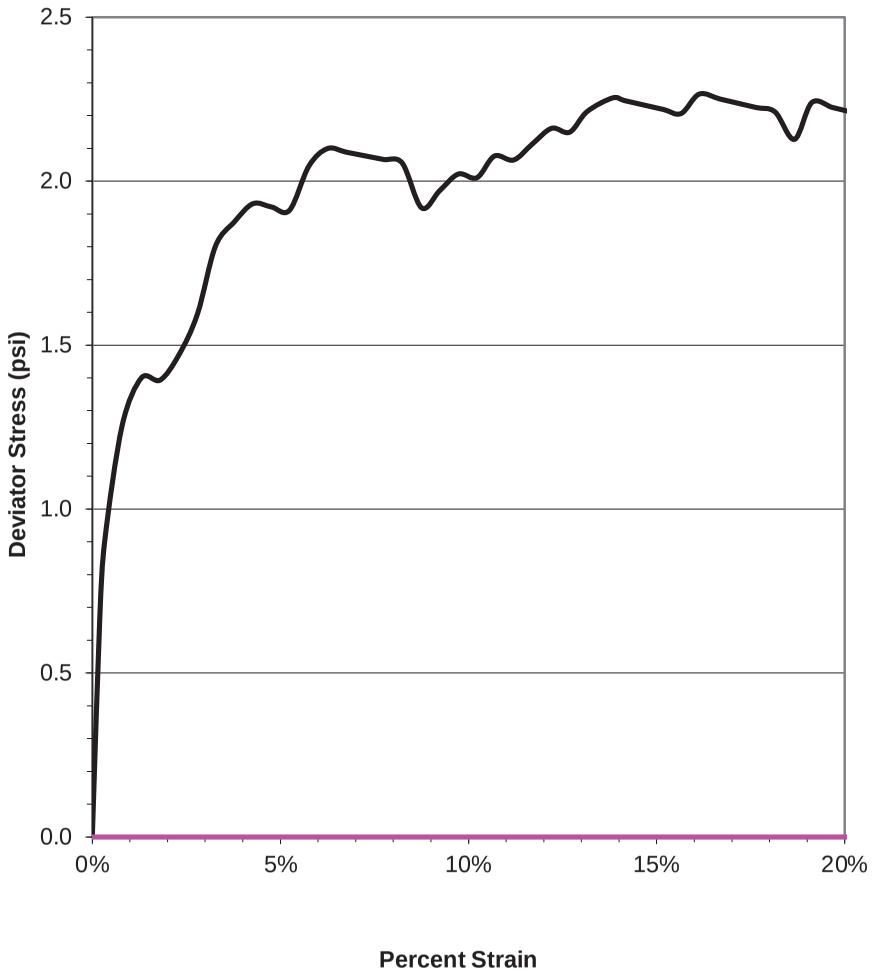
Project :	PND	Lab #	15	σ_3 =	14.0 psi	$\gamma\delta$ =	96.3 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-9						
Sample #	7						
Depth :	31.5						
Date:	2/1/2013						

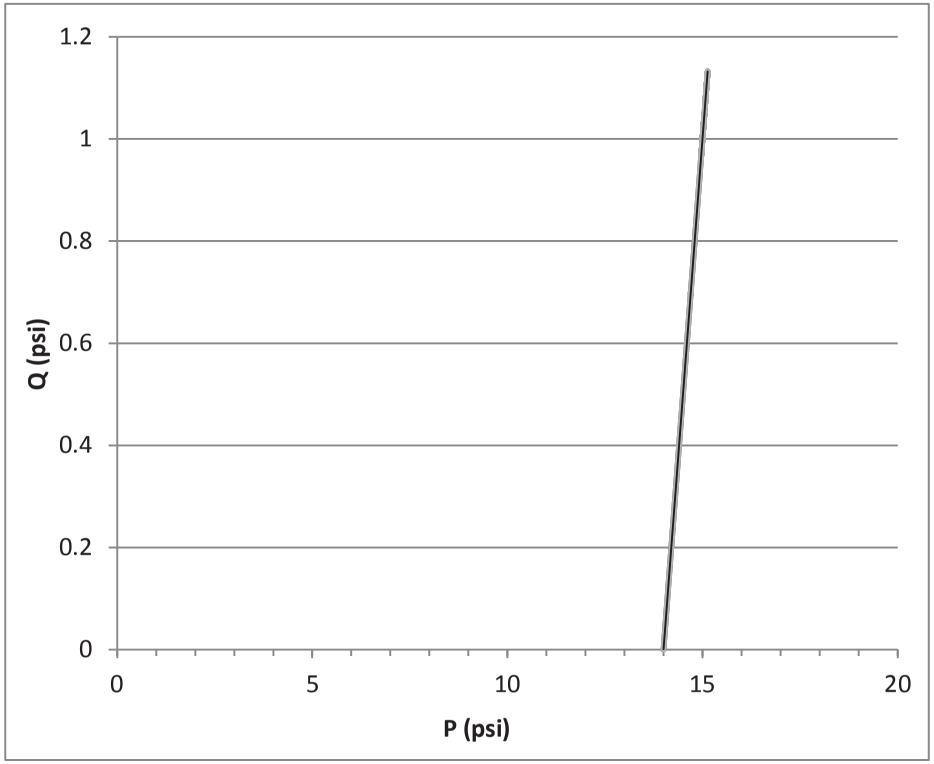


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND		
Client:	South Portage Cove		
WO #	A33608		
Boring #	BH-9	Depth	31.5 ft
Sample #	7		
Initial Dry Density:		96.3 pcf	
Effective Confining Pressure :		14 psi	
Final Moisture Content:		28.5 %	
Laboratory #	15		
Date:	2/1/2013		



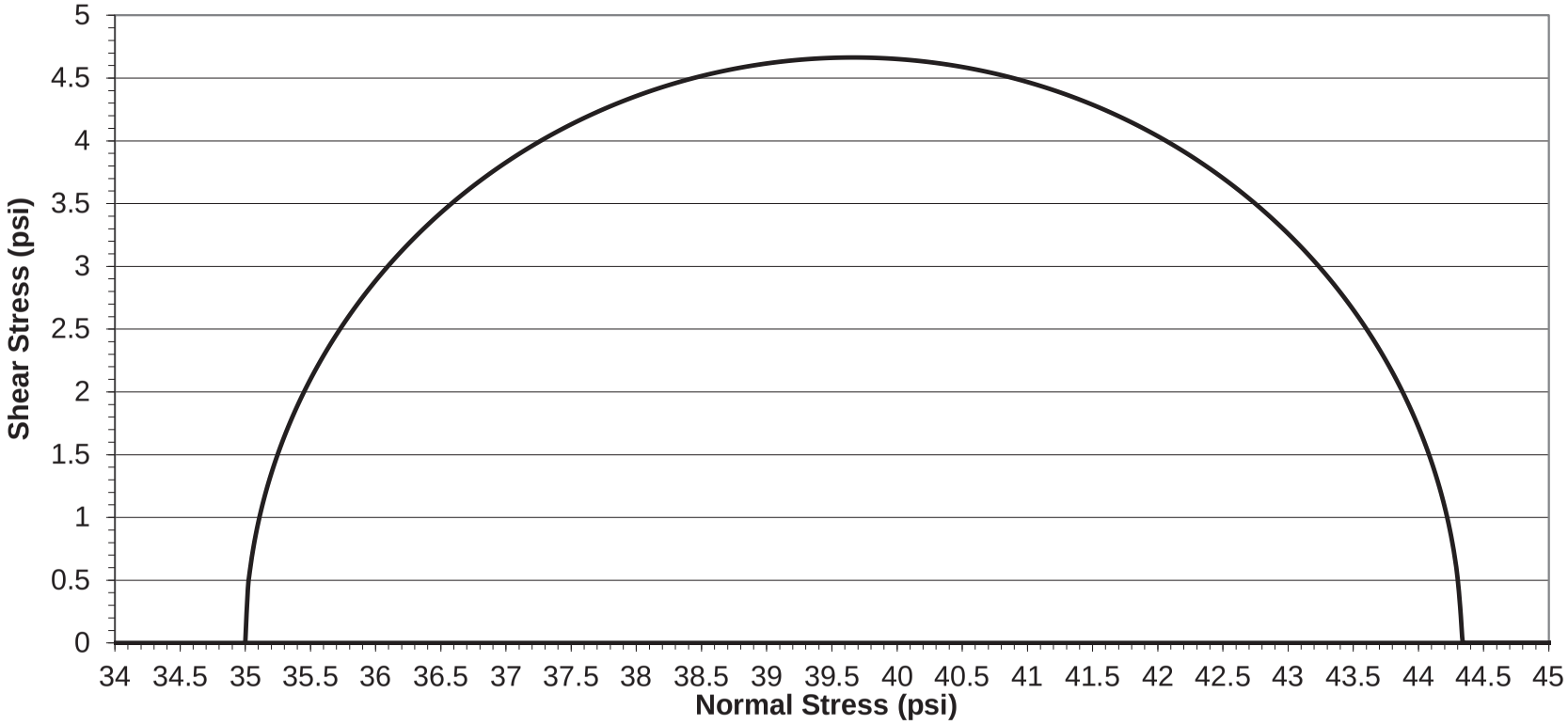


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

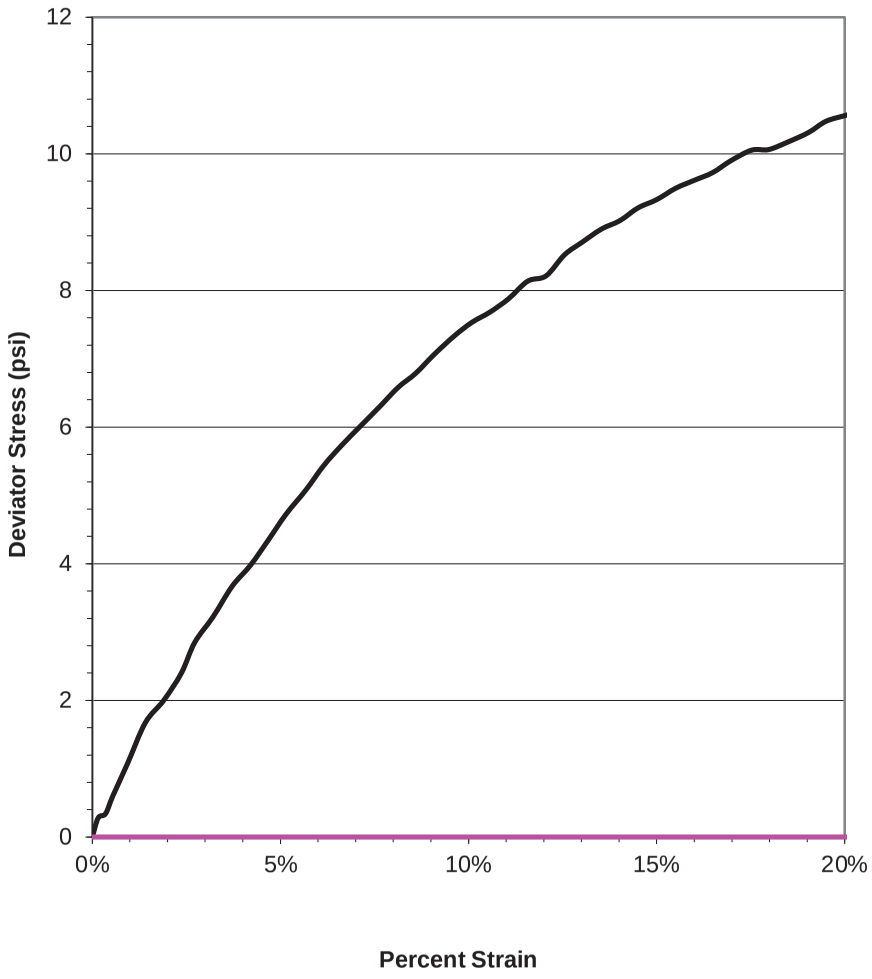
Project :	PND	Lab #	17	σ_3 =	35.0 psi	$\gamma\delta$ =	108.5 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-9						
Sample #	13						
Depth :	81.5						
Date:	2/1/2013						

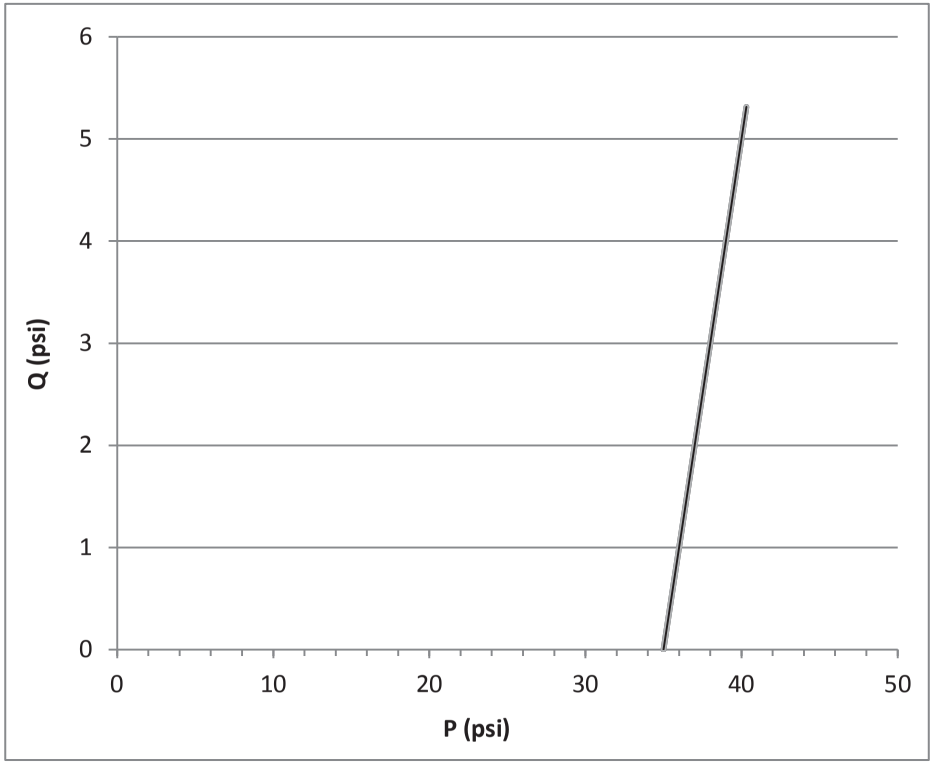


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND		
Client:	South Portage Cove		
WO #	A33608		
Boring #	BH-9	Depth	81.5 ft
Sample #	13		
Initial Dry Density:		108.5 pcf	
Effective Confining Pressure :		35 psi	
Final Moisture Content:		21.7 %	
Laboratory #	17		
Date:	2/1/2013		



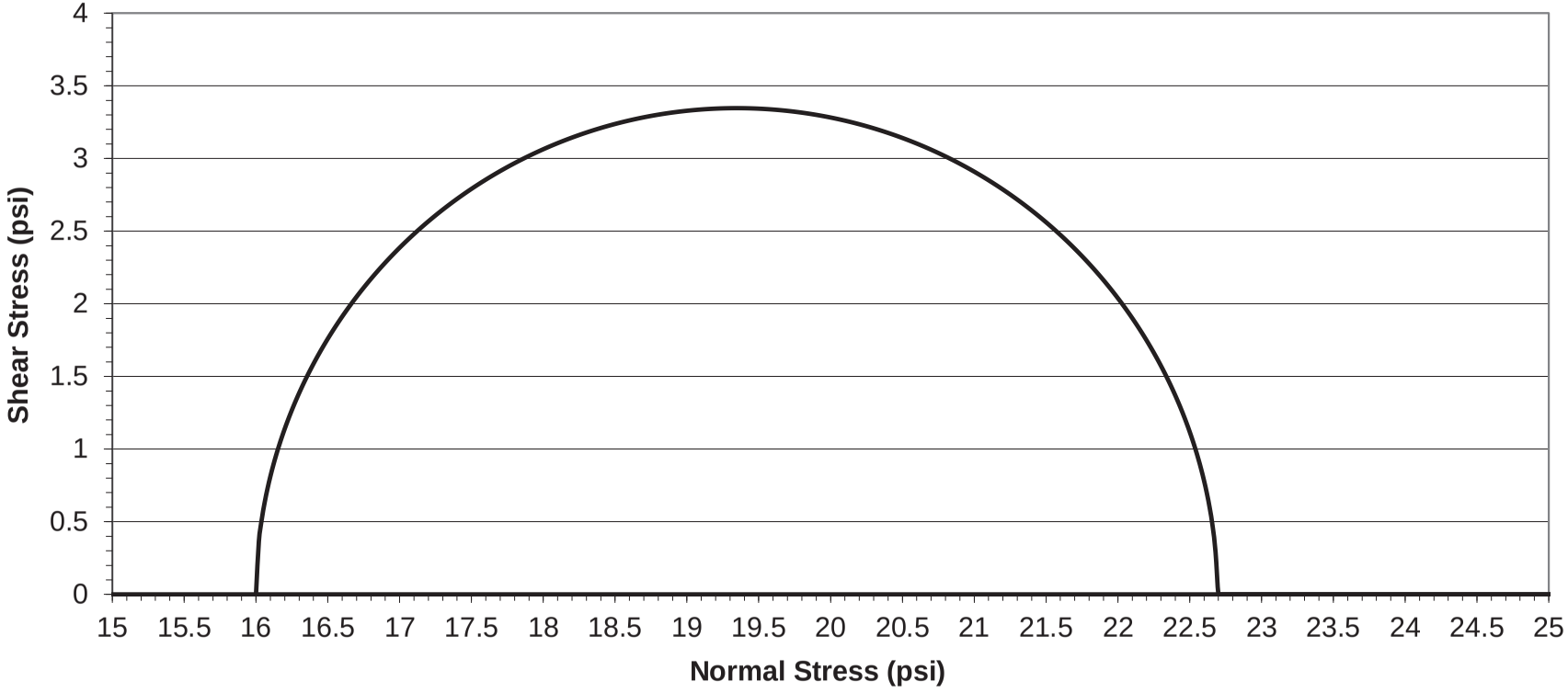


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

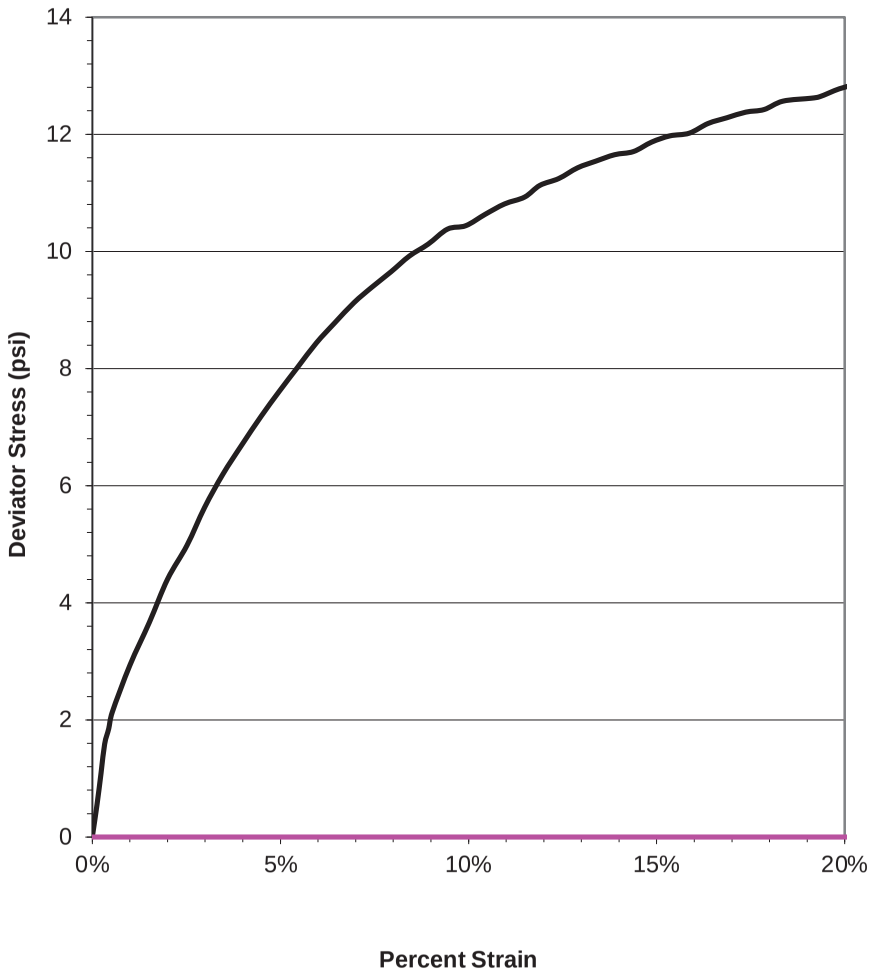
Project :	PND	Lab #	19	σ_3 =	16.0 psi	$\gamma\delta$ =	102.1 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-12						
Sample #	7						
Depth :	36.5'						
Date:	2/1/2013						

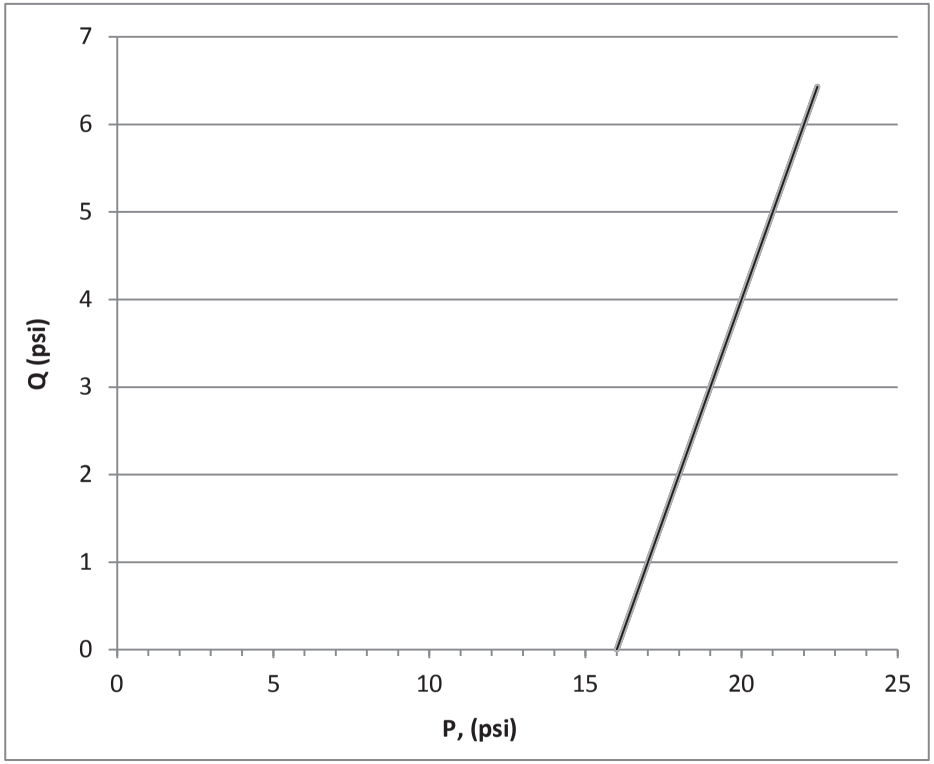


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND			
Client:	South Portage Cove			
WO #	A33608			
Boring #	BH-12	Depth	36.5'	ft
Sample #	7			
Initial Dry Density:	102.1 pcf			
Effective Confining Pressure :	16 psi			
Final Moisture Content:	22.4 %			
Laboratory #	19			
Date:	2/1/2013			



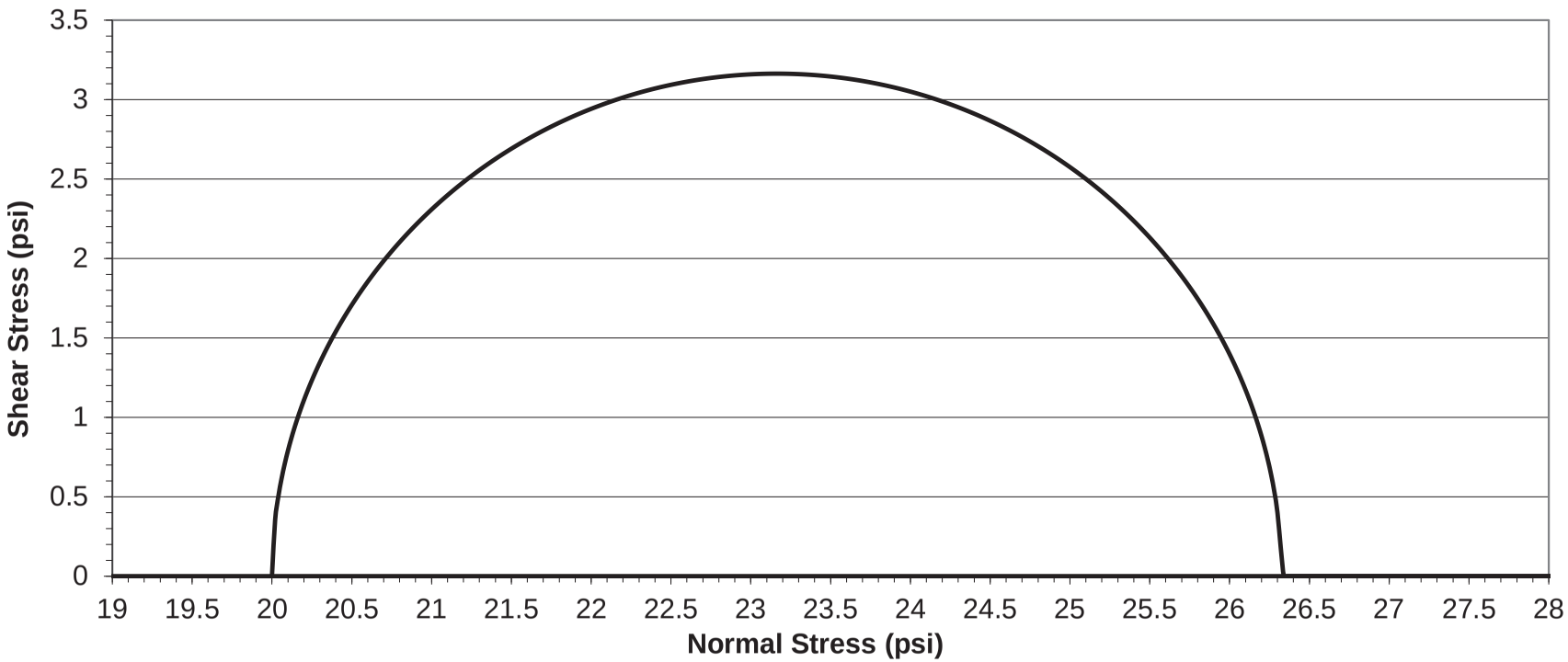


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

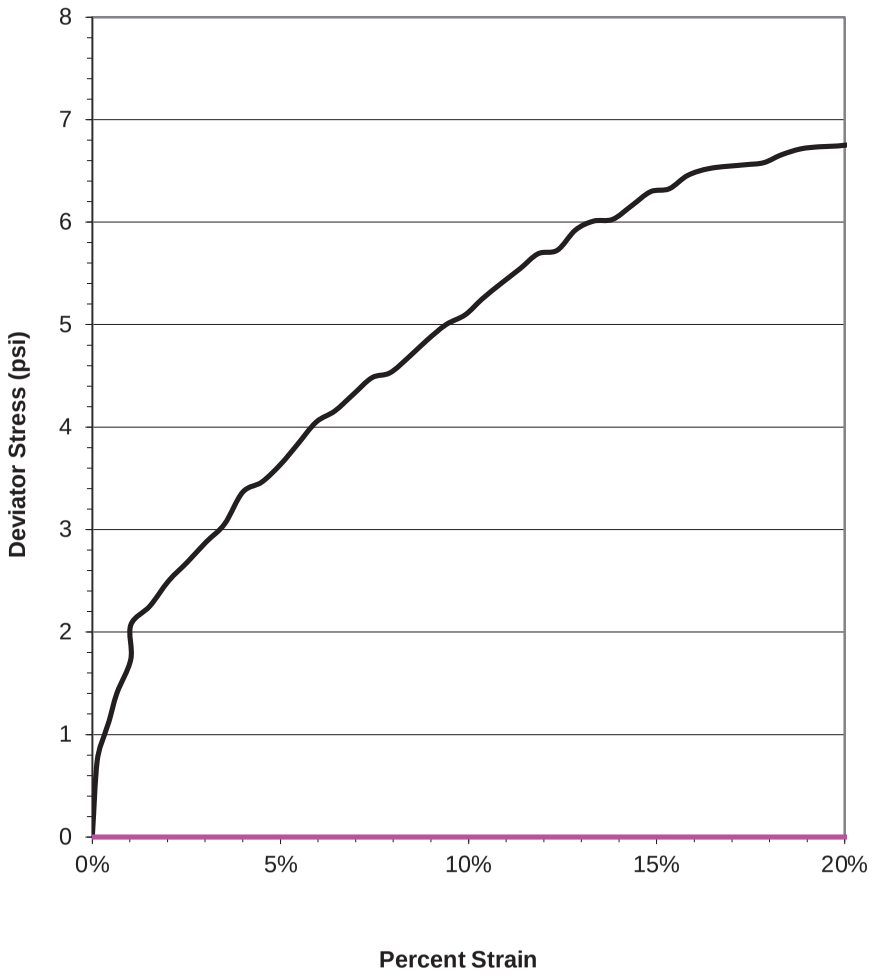
Project :	PND	Lab #	20	σ_3 =	20.0 psi	$\gamma\delta$ =	96.9 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-12						
Sample #	9						
Depth :	46.5						
Date:	2/1/2013						

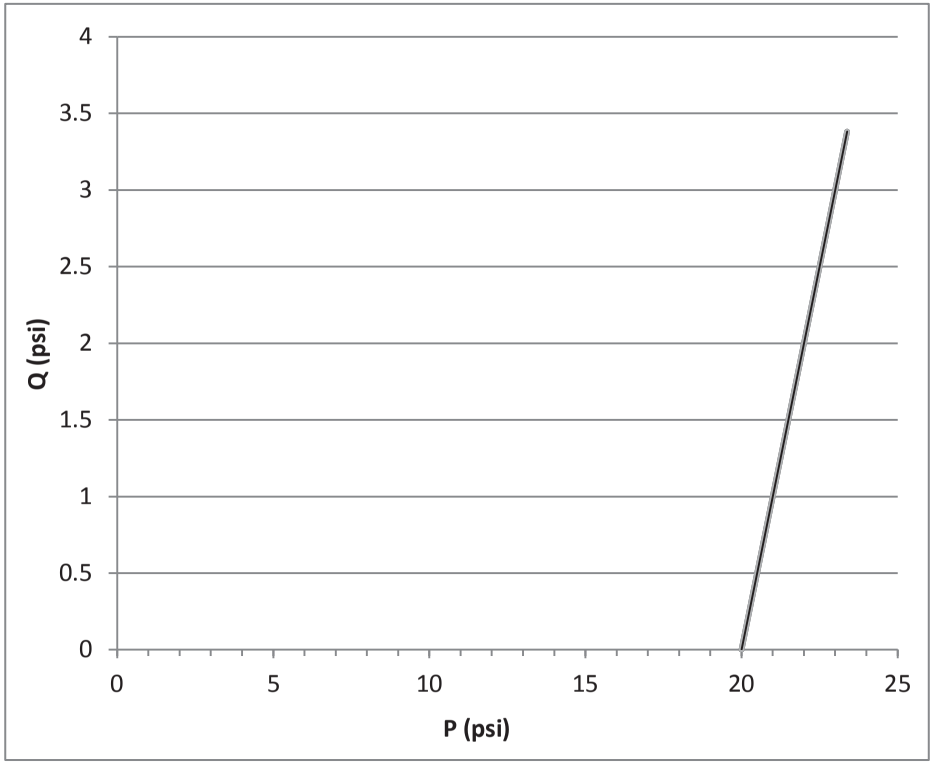


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND		
Client:	South Portage Cove		
WO #	A33608		
Boring #	BH-12	Depth	46.5 ft
Sample #	9		
Initial Dry Density:		96.9 pcf	
Effective Confining Pressure :		20 psi	
Final Moisture Content:		26.7 %	
Laboratory #	20		
Date:	2/1/2013		



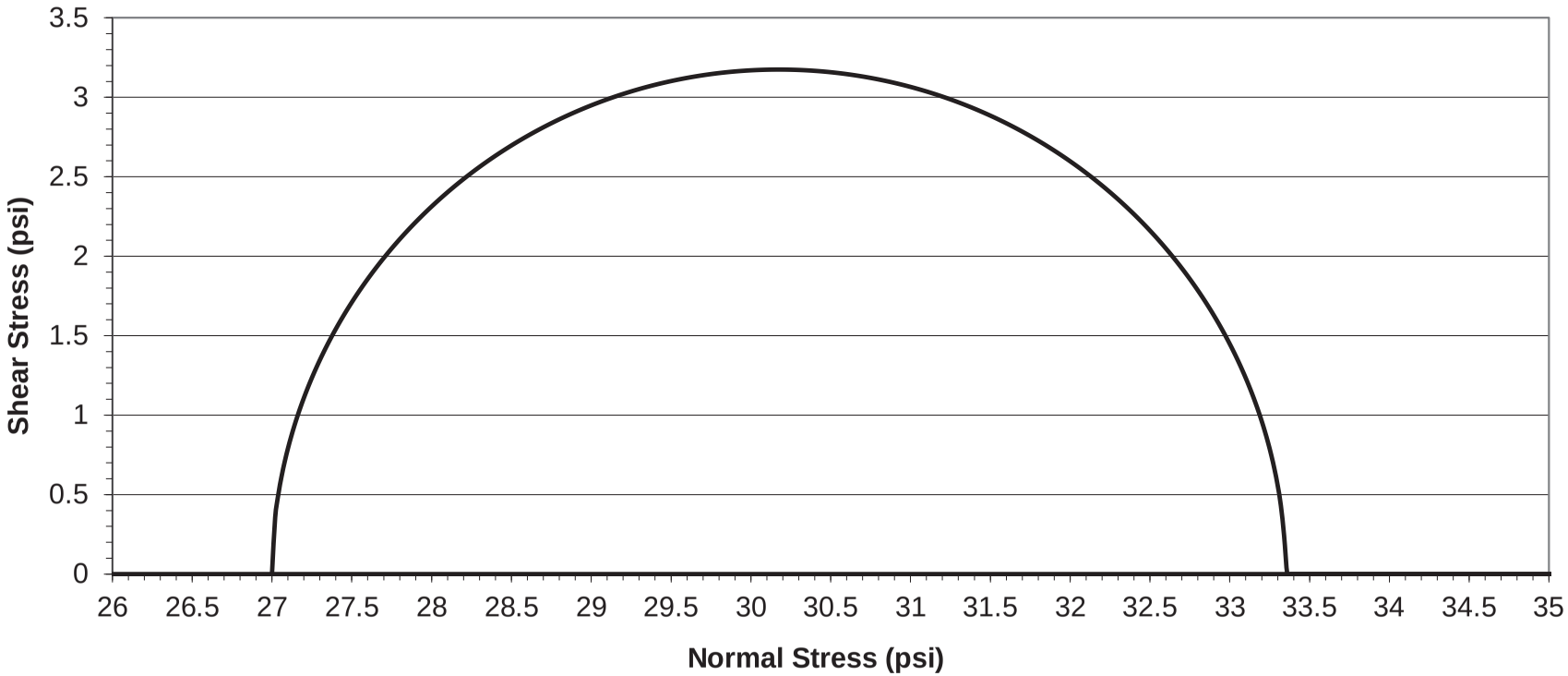


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

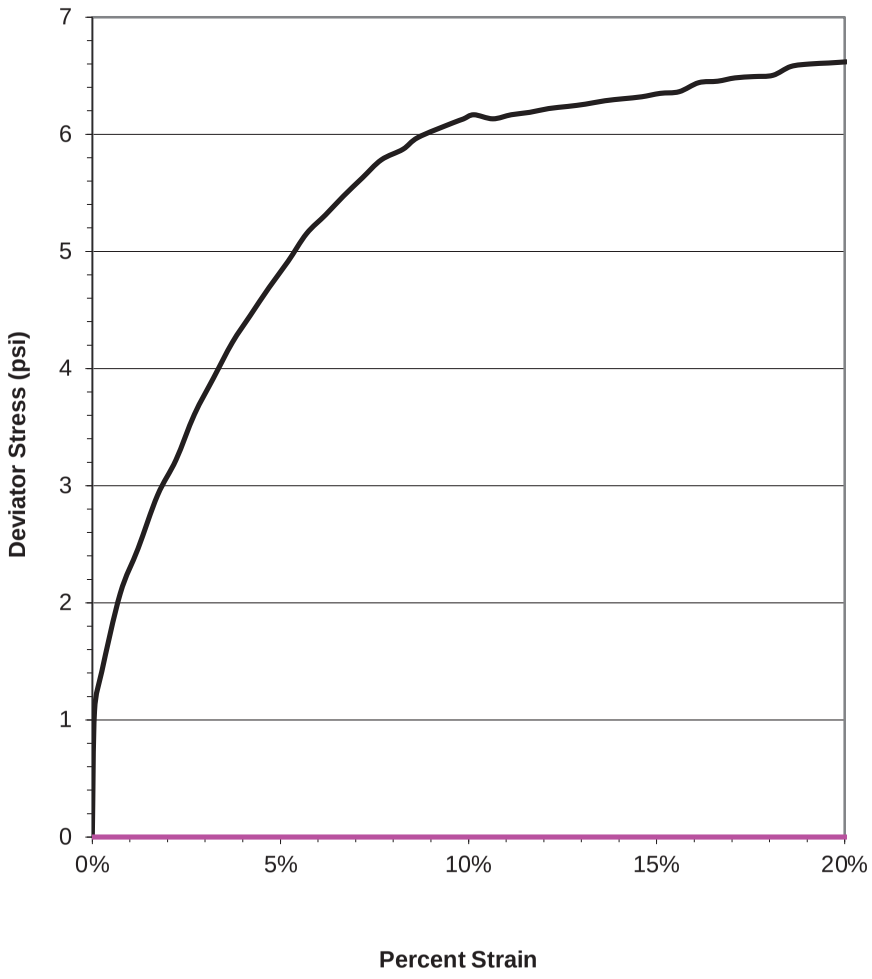
Project :	PND	Lab #	21	σ_3 =	27.0 psi	$\gamma\delta$ =	93.8 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-12						
Sample #	12						
Depth :	61.5'						
Date:	2/1/2013						

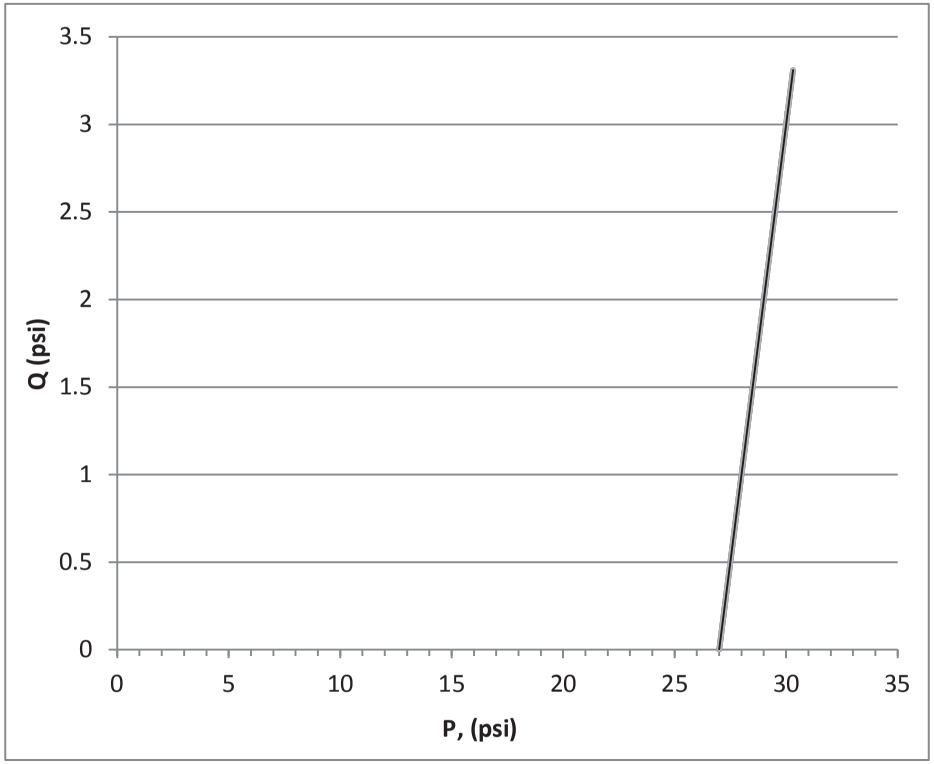


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND			
Client:	South Portage Cove			
WO #	A33608			
Boring #	BH-12	Depth	61.5'	ft
Sample #	12			
Initial Dry Density:		93.8	pcf	
Effective Confining Pressure :		27	psi	
Final Moisture Content:		32.2	%	
Laboratory #	21			
Date:	2/1/2013			



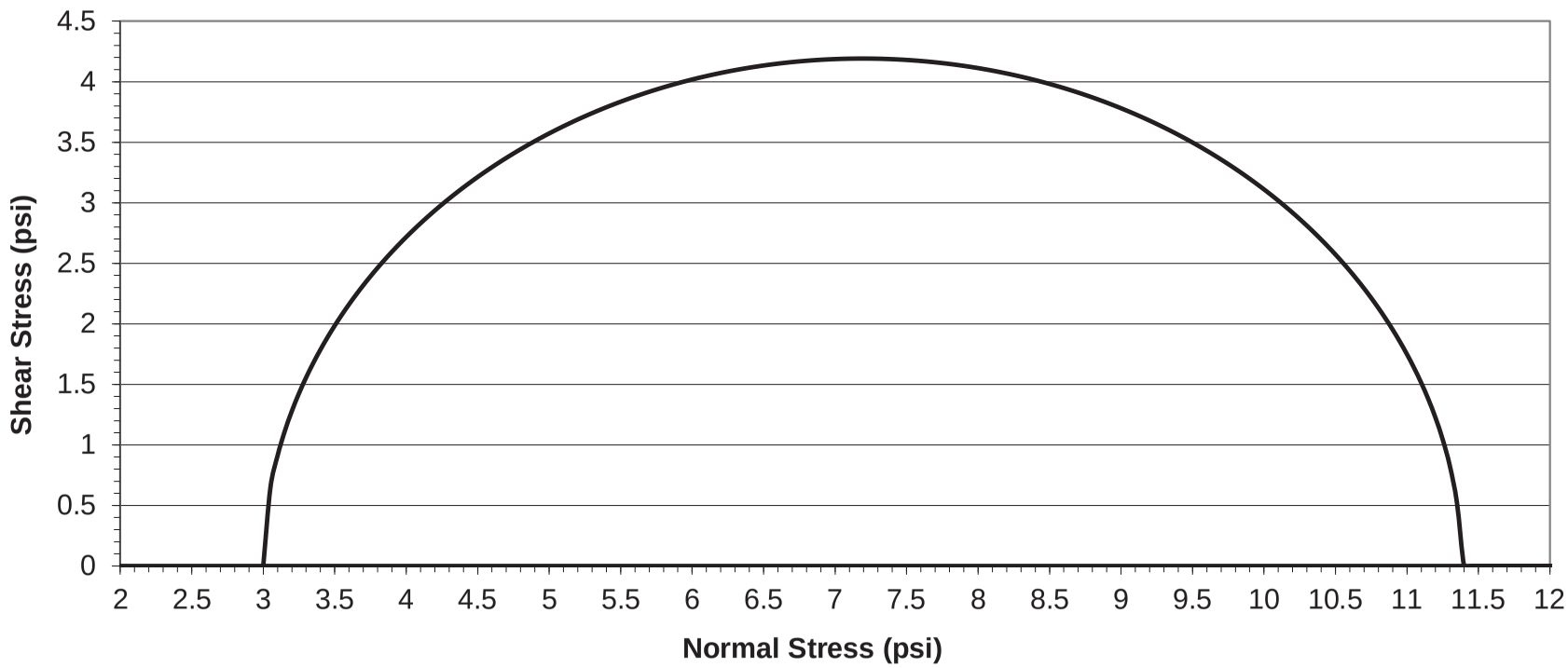


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

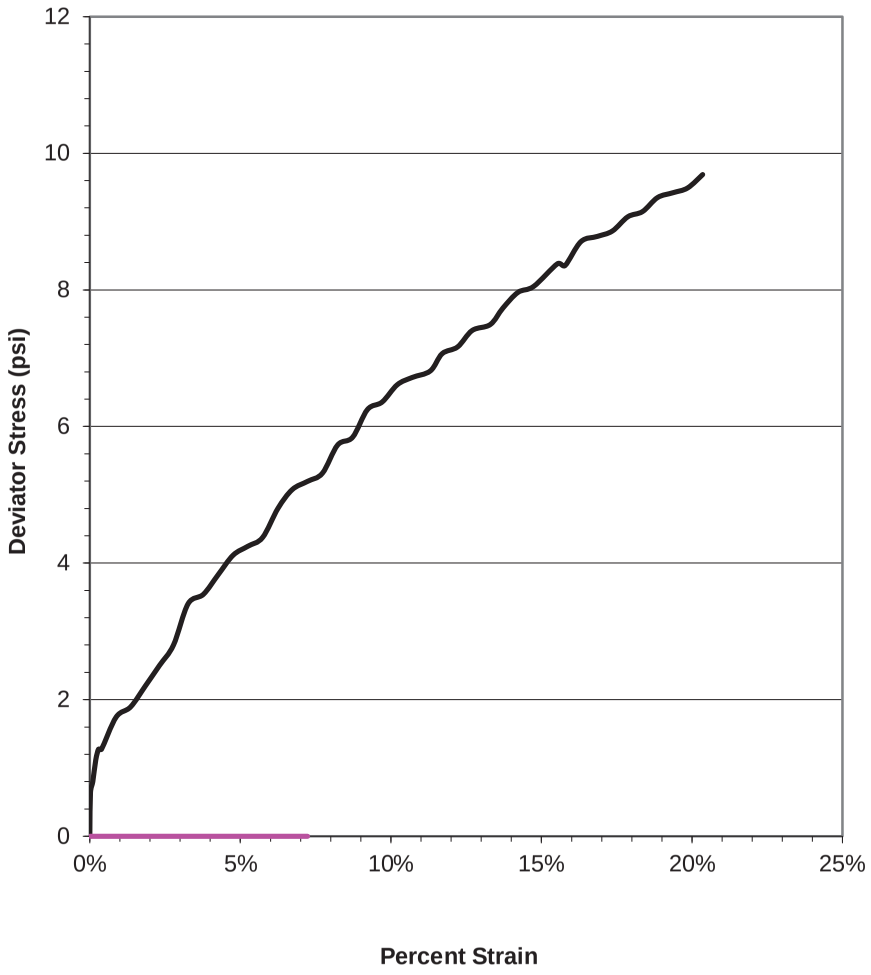
Project :	PND	Lab #	2013-22	σ_3 =	3.0 psi	$\gamma\delta$ =	103.6 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-13						
Sample #	2						
Depth :	5'-8'						
Date:	1/3/2013						

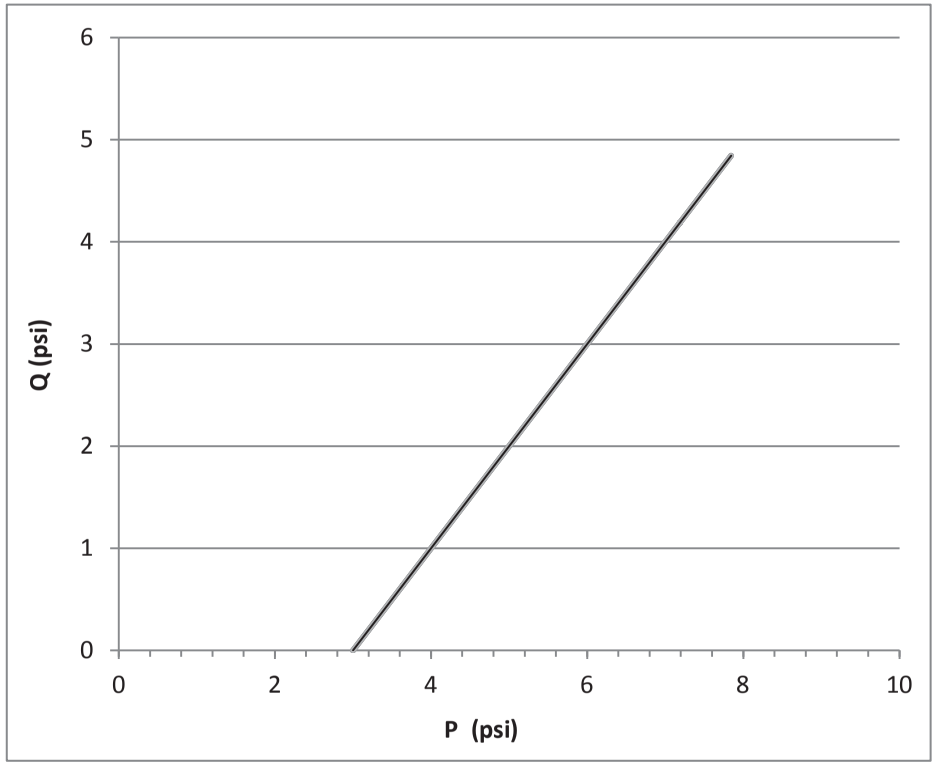


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND
Client:	South Portage Cove
WO #	A33608
Boring #	BH-13 Depth 5'-8'
Sample #	2
Initial Dry Density:	103.6 pcf
Effective Confining Pressure :	3 psi
Final Moisture Content:	25.6 %
Laboratory #	2013-22
Date:	1/3/2013





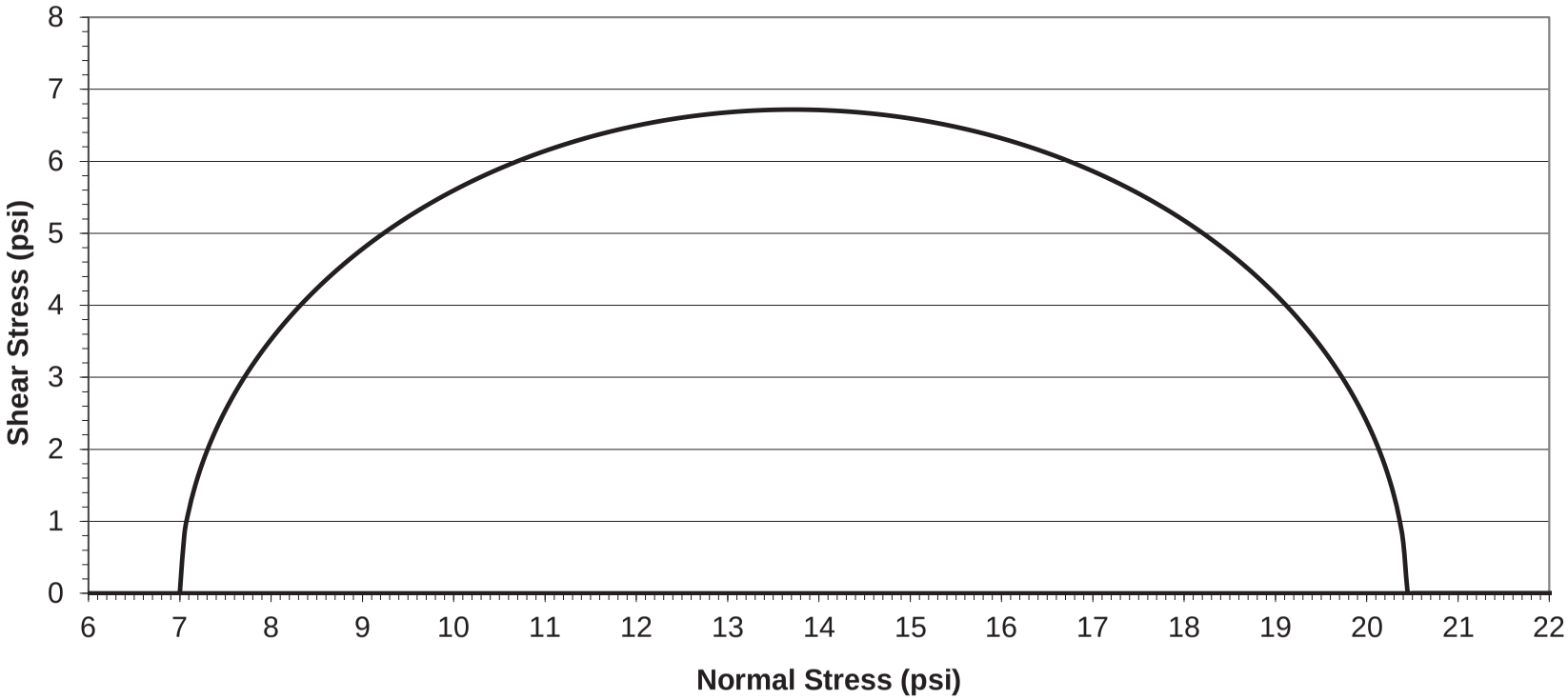
	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

Project : PND
Client: South Portage Cove
WO # A33608
Boring # BH-13
Sample # 4
Depth : 15'-18'
Date: 1/4/2013

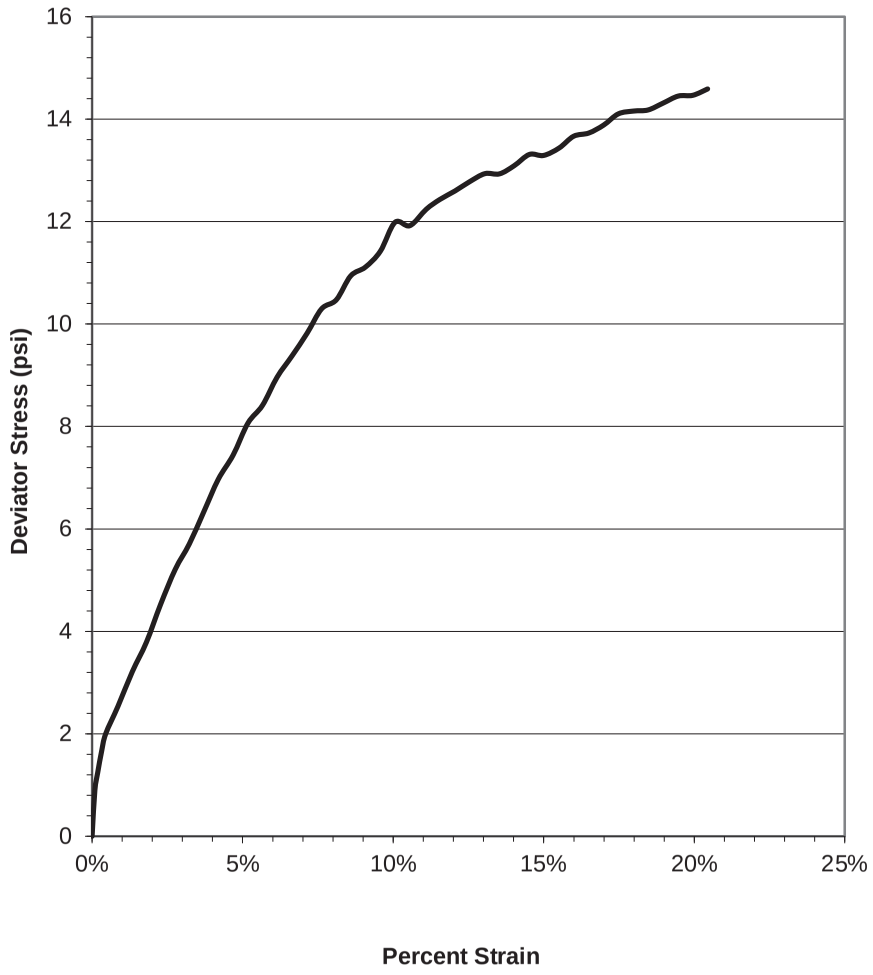
Lab # 23 σ_3 = 7.0 psi $\gamma\delta$ = 105.5 pcf

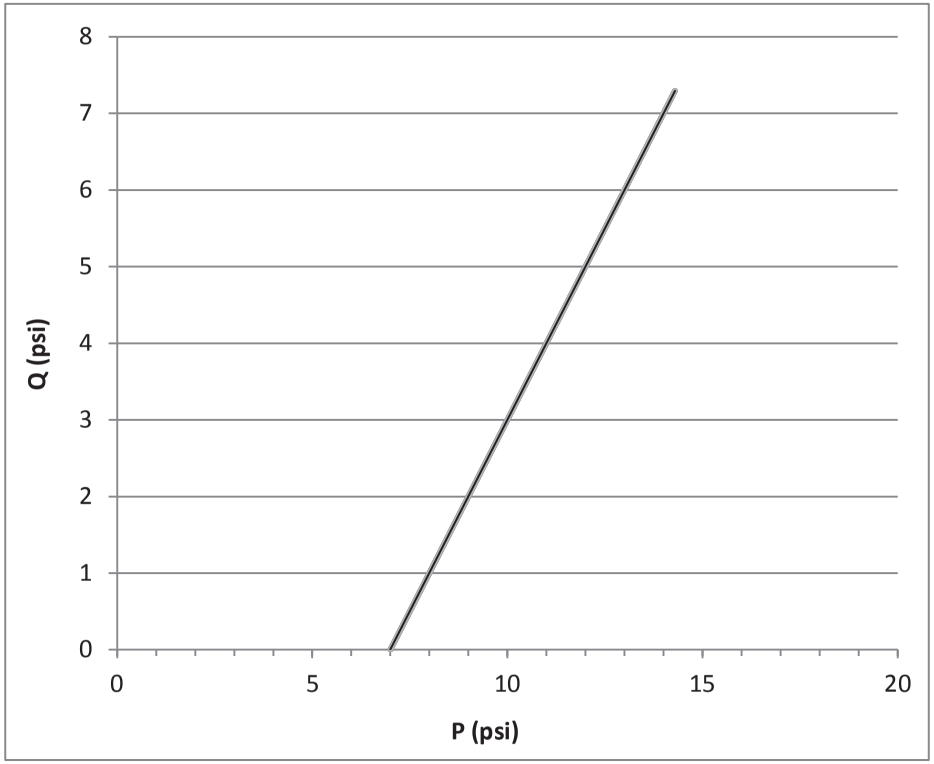


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND
Client:	South Portage Cove
WO #	A33608
Boring #	BH-13 Depth 15'-18'
Sample #	4
Initial Dry Density:	105.5 pcf
Effective Confining Pressure :	7 psi
Final Moisture Content:	23.3 %
Laboratory #	23
Date:	1/4/2013



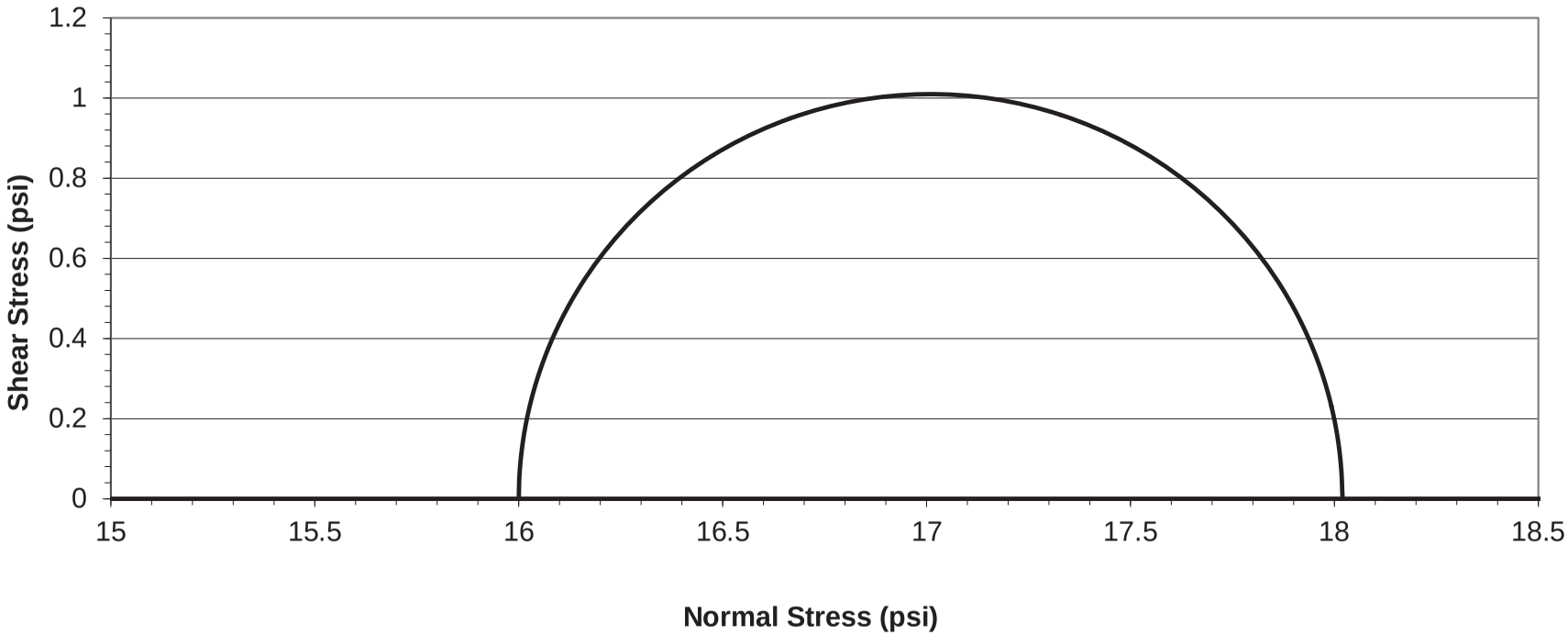


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

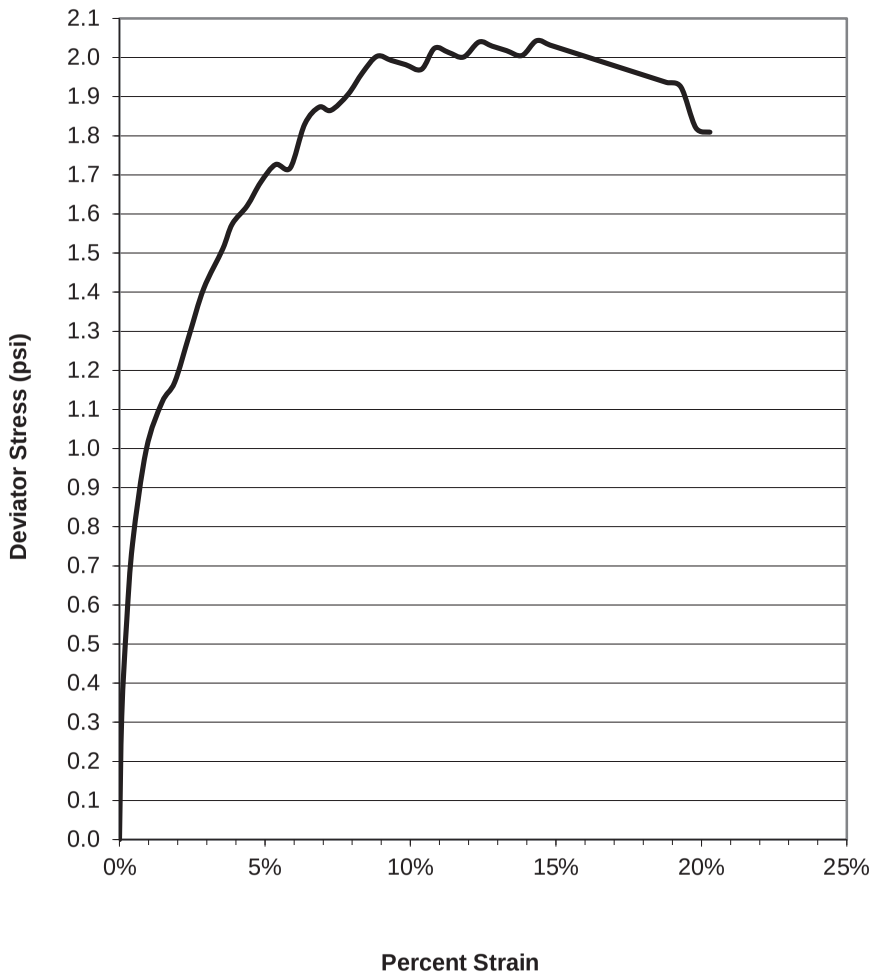
Project :	PND	Lab #	24	σ_3 =	16.0 psi	$\gamma\delta$ =	82.0 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-13						
Sample #	8						
Depth :	35' - 38'						
Date:	1/16/2013						

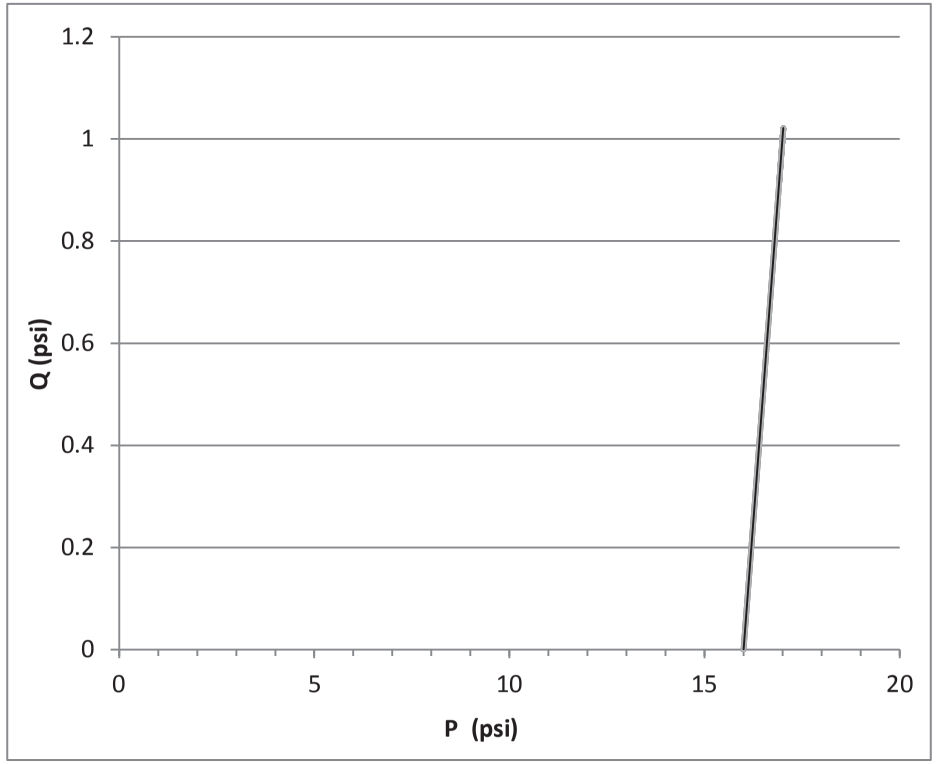


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND		
Client:	South Portage Cove		
WO #	A33608		
Boring #	BH-13	Depth	35' - 38' ft
Sample #	8		
Initial Dry Density:		82.0 pcf	
Effective Confining Pressure :		16 psi	
Final Moisture Content:		39.8 %	
Laboratory #	24		
Date:	1/16/2013		



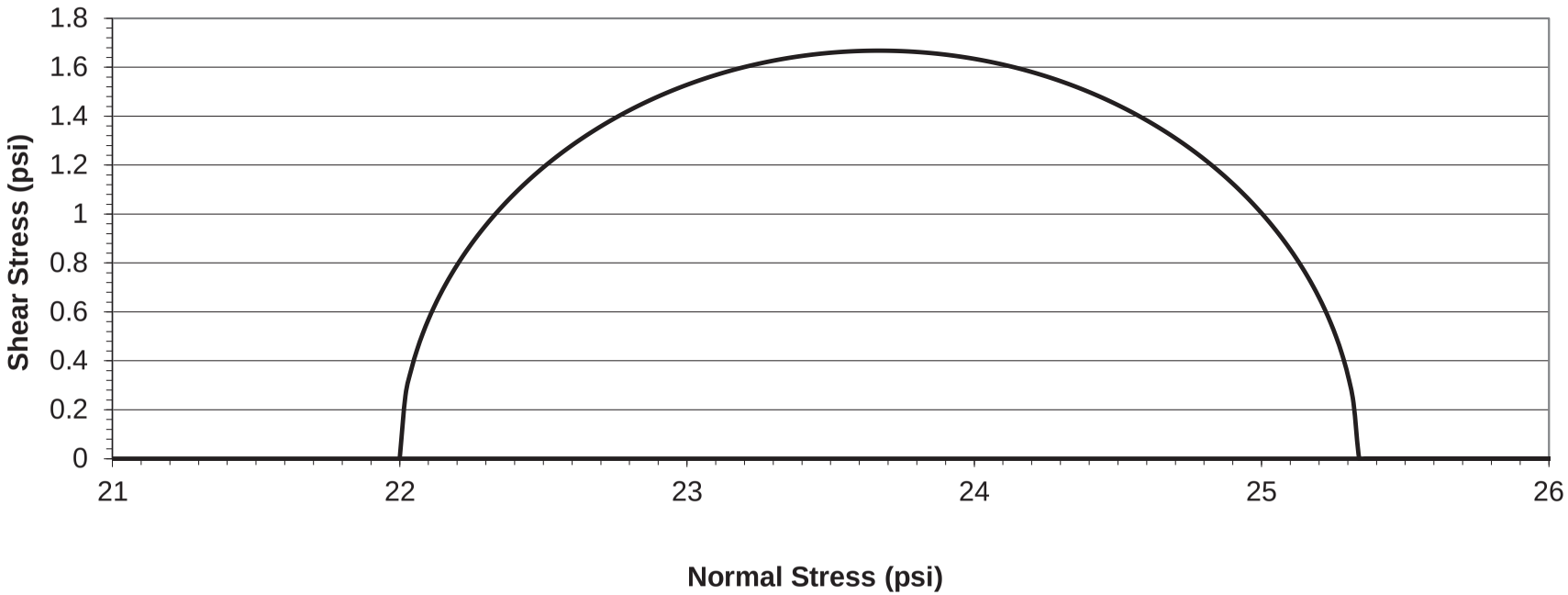


	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

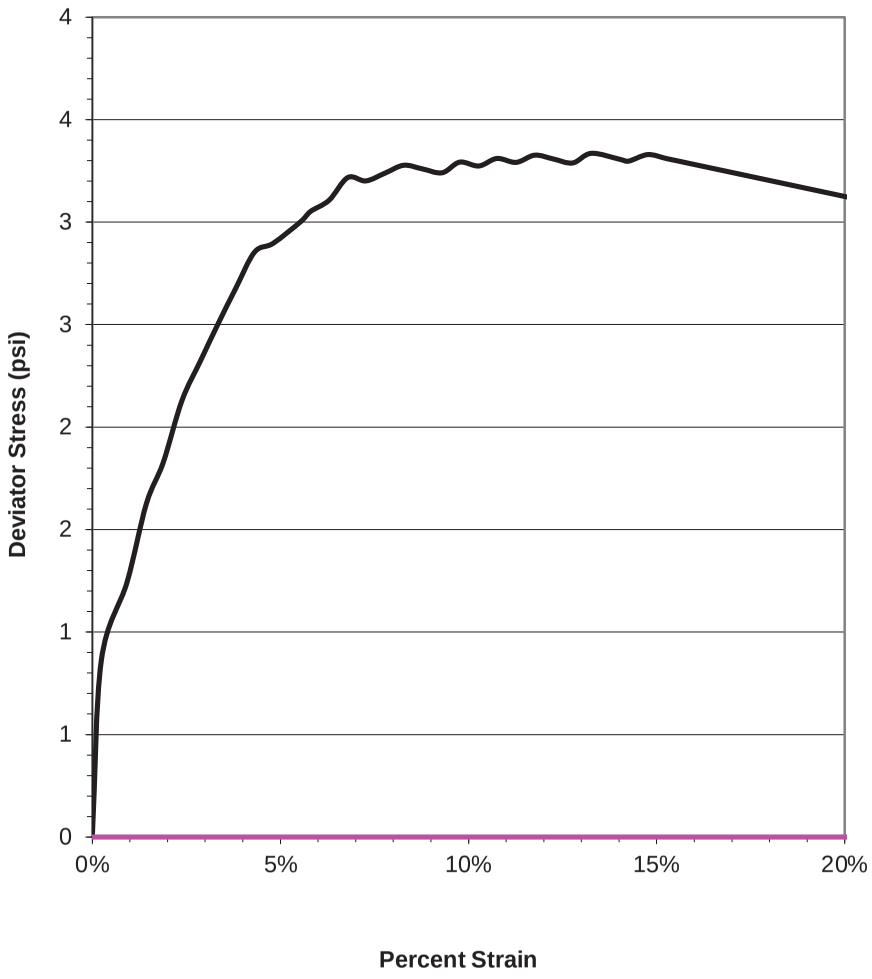
Project :	PND	Lab #	25	σ_3 =	22.0 psi	$\gamma\delta$ =	86.0 pcf
Client:	South Portage Cove						
WO #	A33608						
Boring #	BH-13						
Sample #	10						
Depth :	50' - 53'						
Date:	1/25/2013						

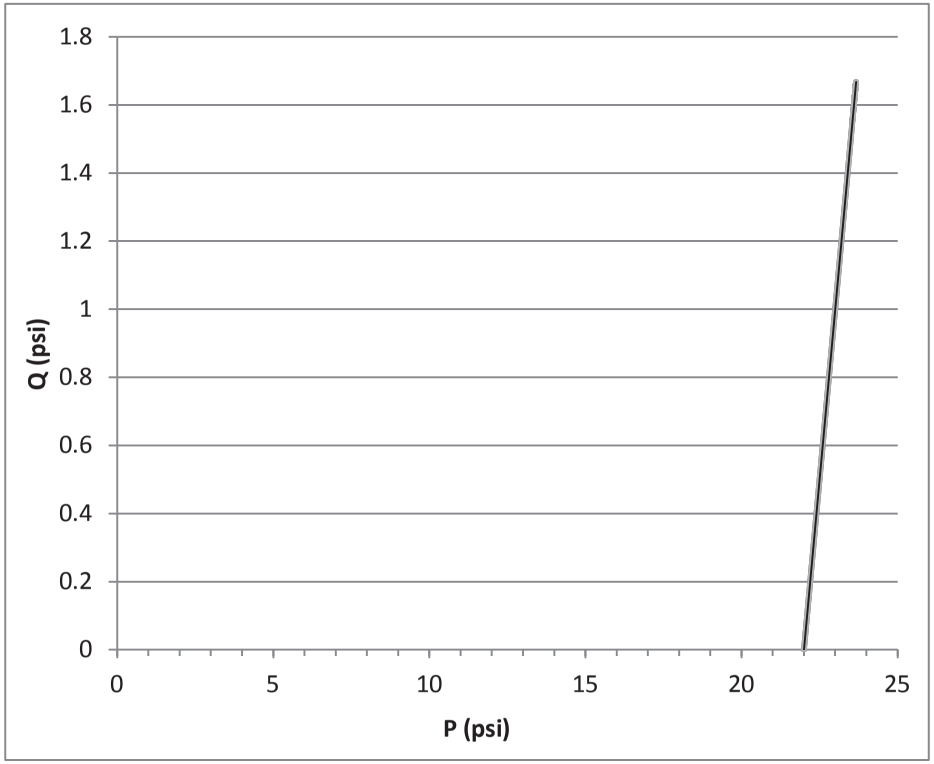


	Mohr Diagram - UU Tests	WO #	A33608
		Figure	1

DOWL HKM

Project :	PND		
Client:	South Portage Cove		
WO #	A33608		
Boring #	BH-13	Depth	50' - 53' ft
Sample #	10		
Initial Dry Density:		86.0 pcf	
Effective Confining Pressure :		22 psi	
Final Moisture Content:		36.6 %	
Laboratory #	25		
Date:	1/25/2013		



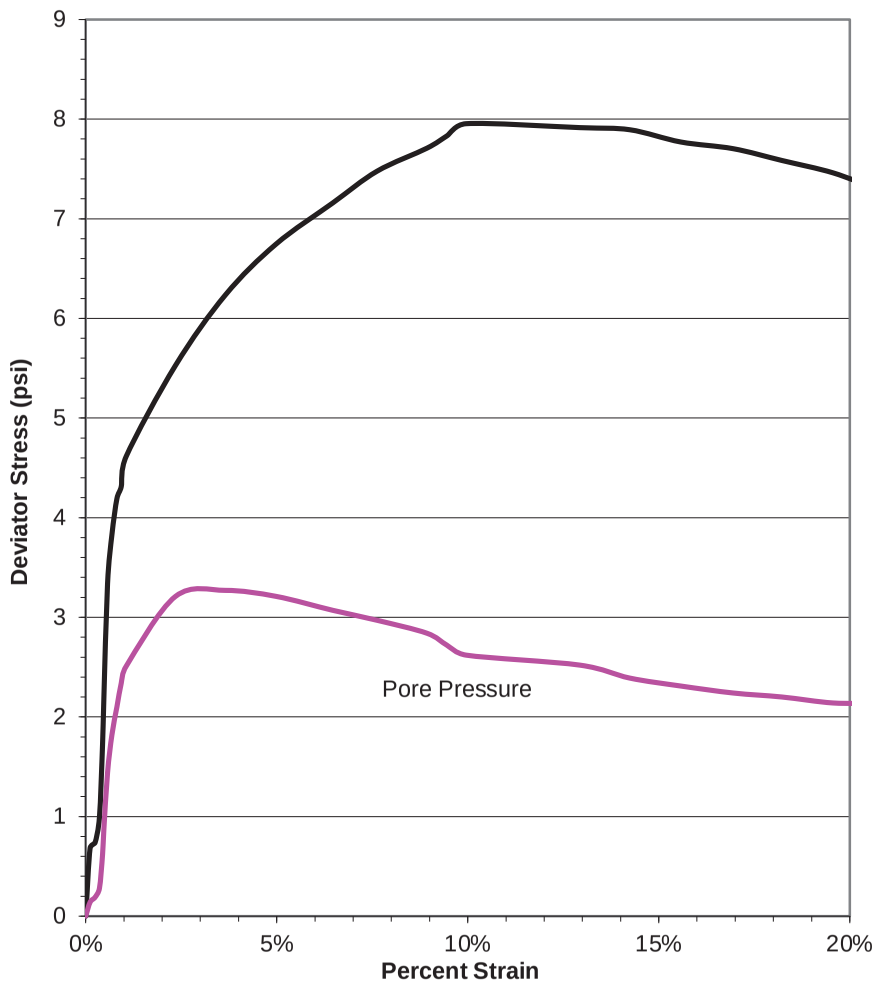


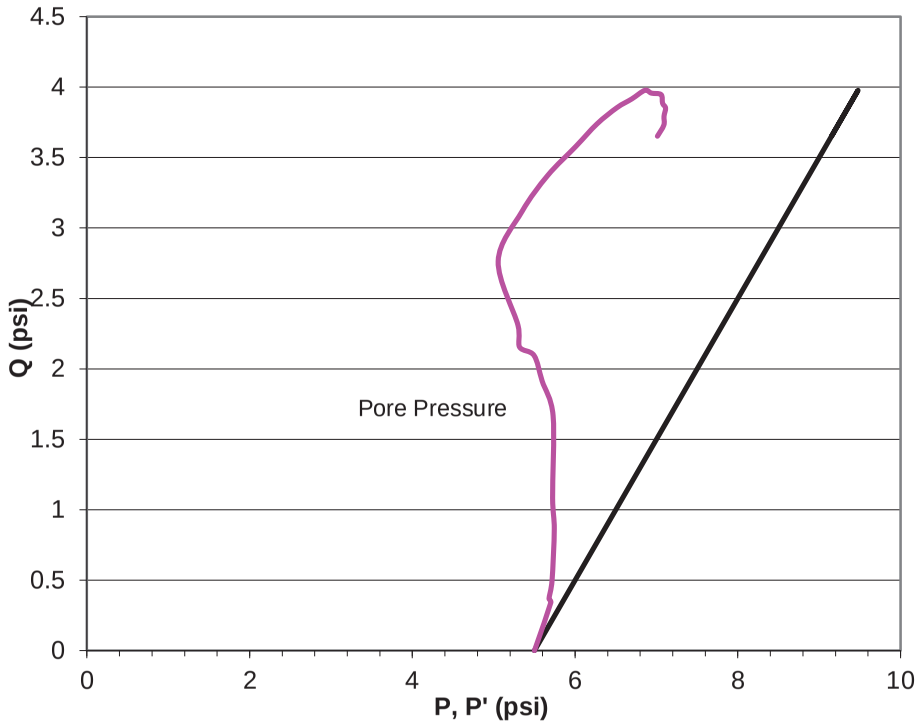
	Unconsolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

Project :	PND	
Client:	South Portage Cove	
WO #	A33608	
Boring #	BH-9	
Sample #	5	
Elevation	21.5'	
Initial Dry Density:		90.6 pcf
Effective Confining Pressure :		5.5 psi
Initical Moisture Content:		32.8 %
Laboratory #	2013-14A	
Date:	1/30/2013	



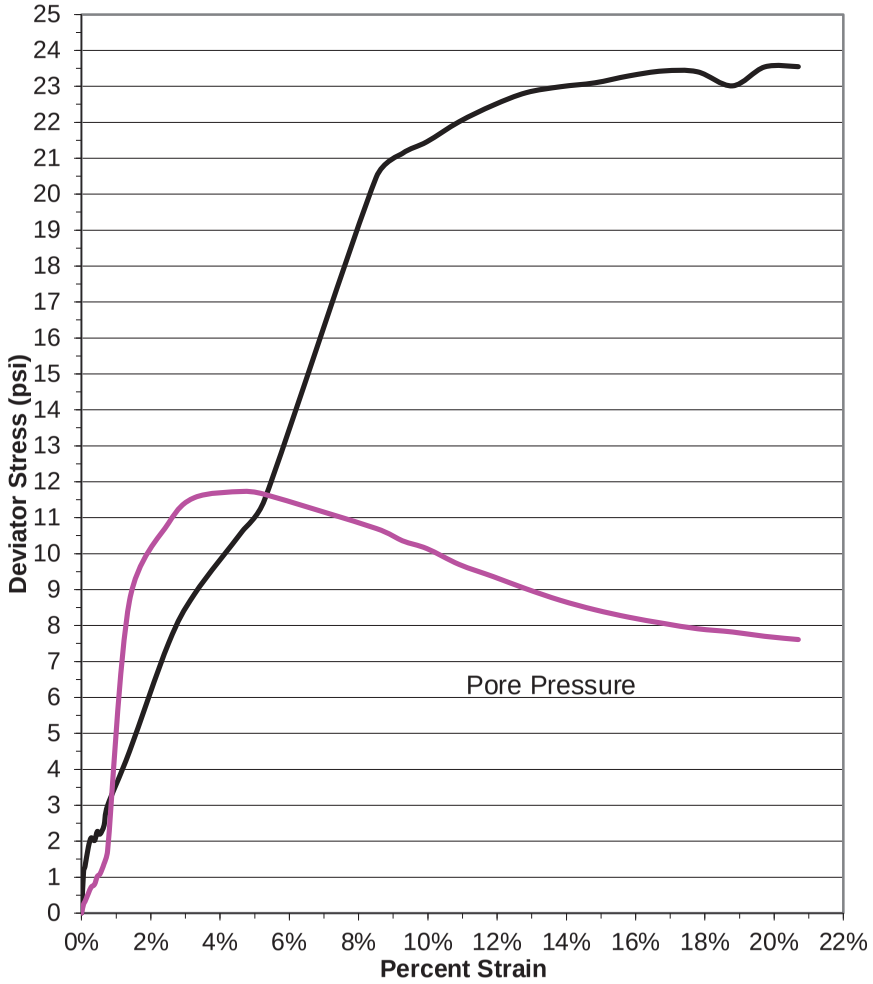


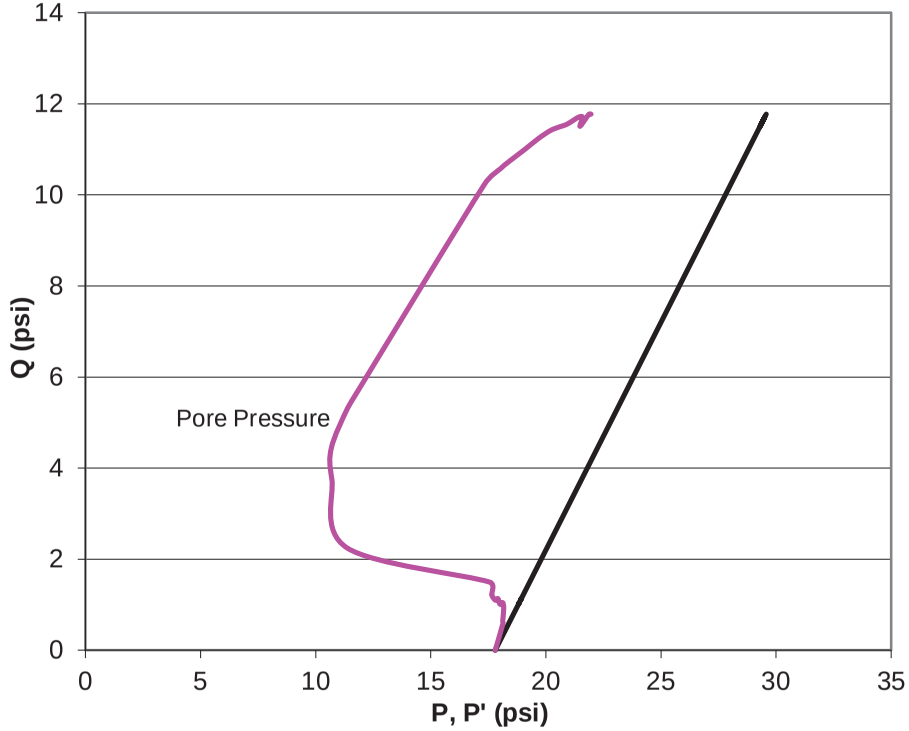
	Consolidated Undrained	WO #	A33608
		Figure	1

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

Project :	PND
Client:	South Portage Cove
WO #	A33608
Boring #	BH-9
Sample #	5
Elevation	21.5'
Initial Dry Density:	97.416 pcf
Effective Confining Pressure :	17.8 psi
Initial Moisture Content:	28.9 %
Laboratory #	2013-14B
Date:	2/4/2013



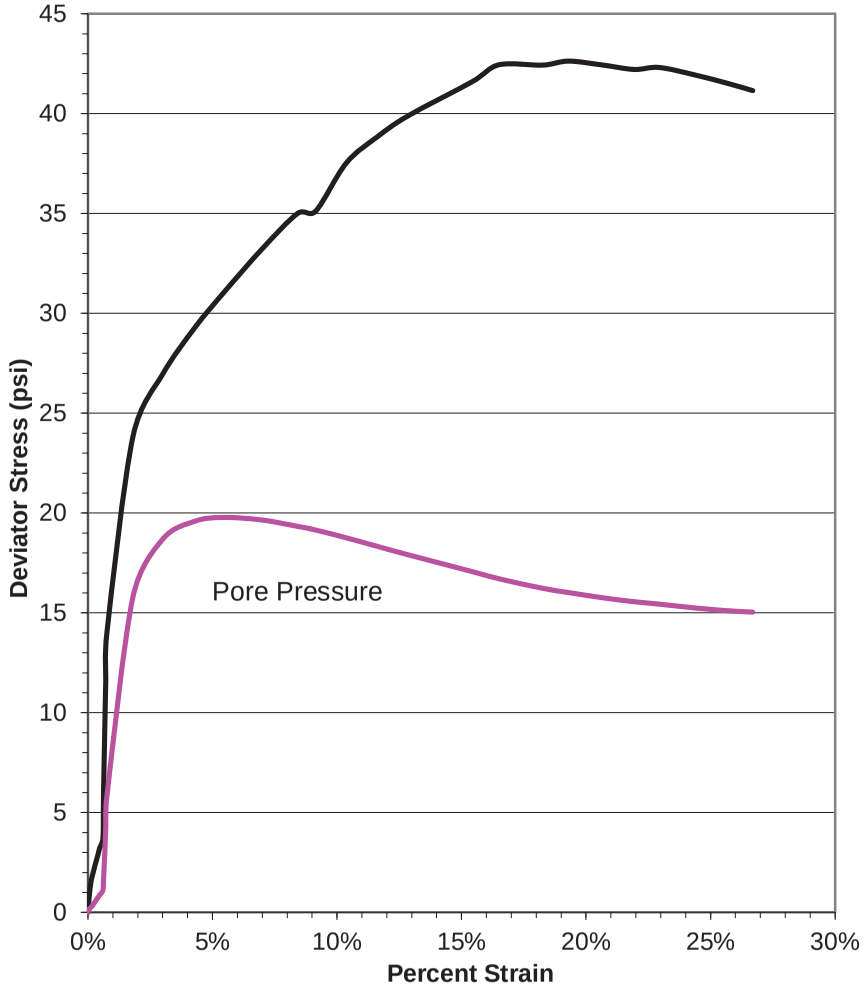


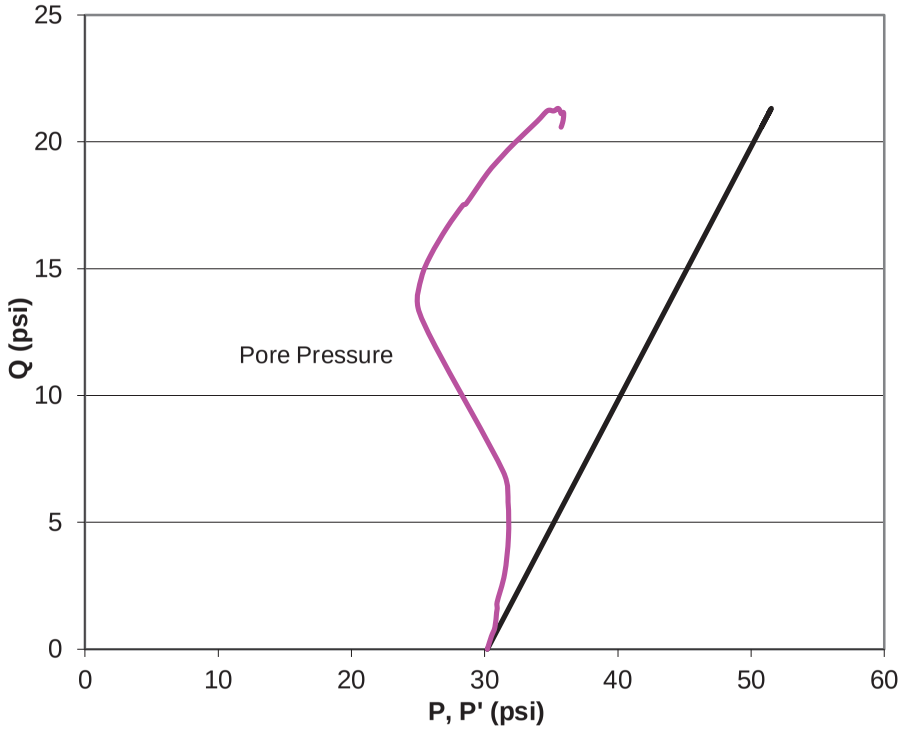
	Consolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

Project :	PND
Client:	South Portage Cove
WO #	A33608
Boring #	BH-9
Sample #	5
Evelvation	21.5'
Initial Dry Density:	98.1 pcf
Effective Confining Pressure :	30.2 psi
Final Moisture Content:	32.1 %
Laboratory #	2013-14C
Date:	2/8/2013



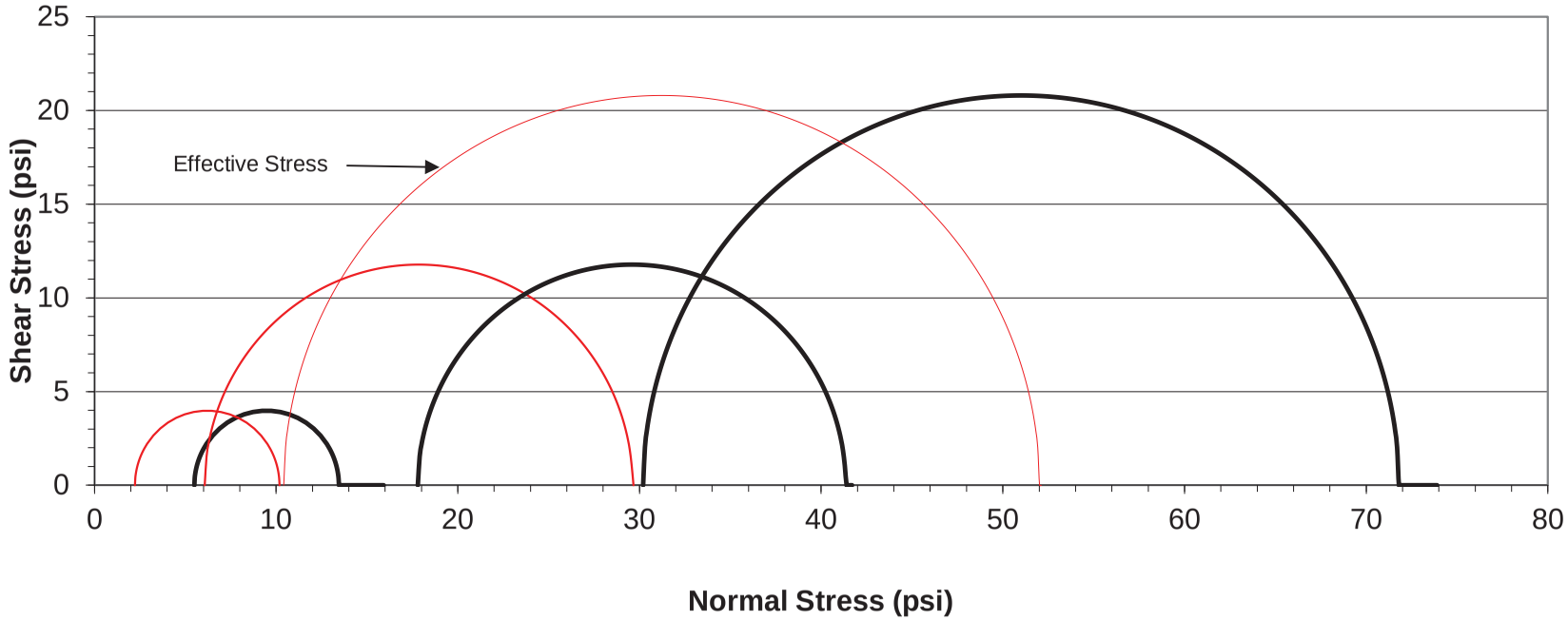


	Consolidated Undrained	WO #	A33608
		Figure	3

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

Project :	PND	Lab #	2013-14A	σ_3 =	5.5 psi	$\gamma\omega$ =	90.6 pcf
Client:	South Portage Cove	Lab #	14B	σ_3 =	17.8 psi	$\gamma\omega$ =	97.4 pcf
WO #	A33608	Lab #	14C	σ_3 =	30.2 psi	$\gamma\omega$ =	98.1 pcf
Boring #	BH-9						
Sample #	1,2,3						
Depth :	21.5'						
Date:	T2013-14						



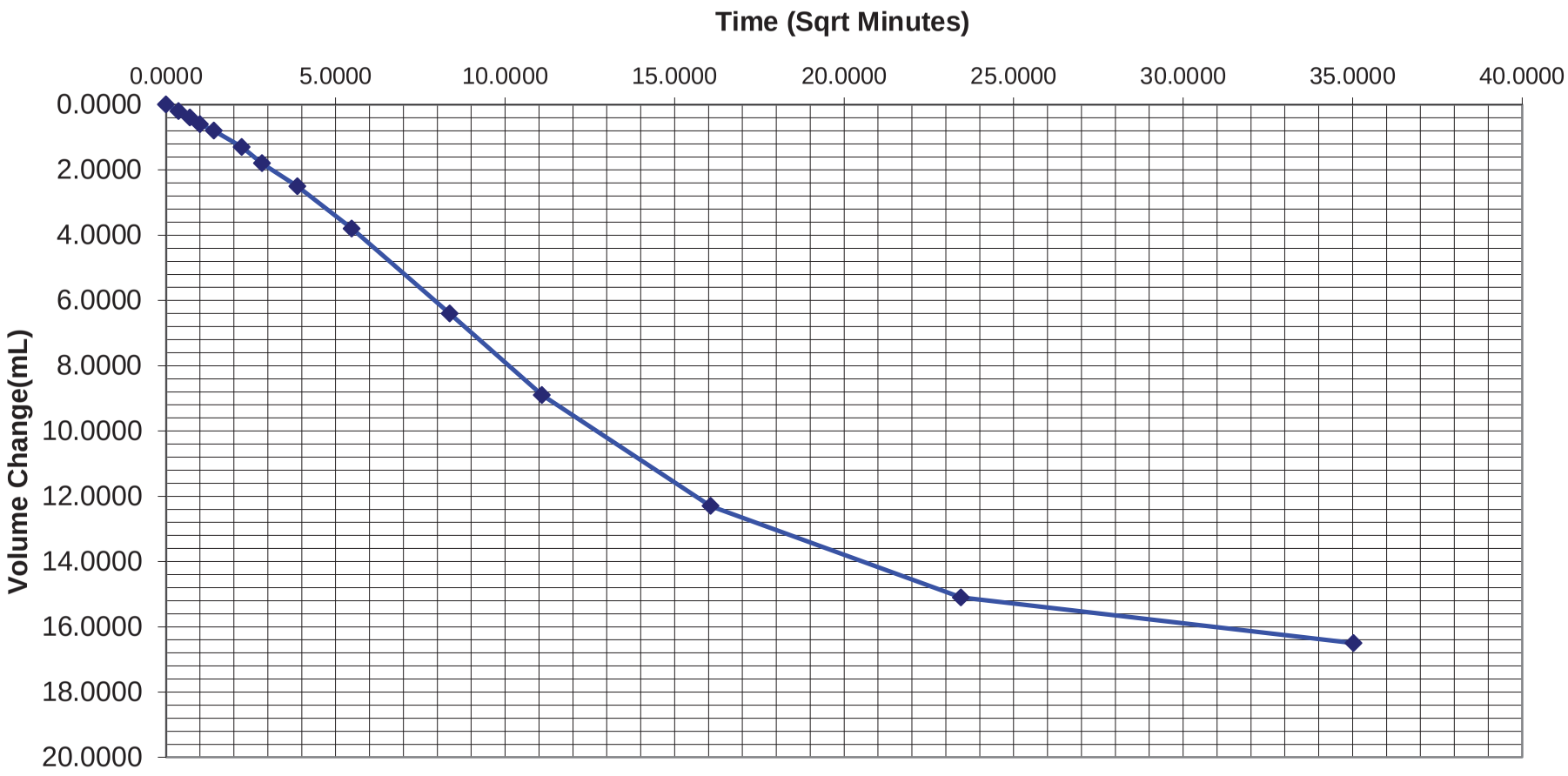
	Mohr Diagram - CU Tests	WO #	A33608
		Figure	4

DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	14A

Client : PND	Pressure: 5.5 psi	Boring : BH-9
Project : South Portage Cove		Sample # 5
Date: 1/30/2013		Depth : 21.5'

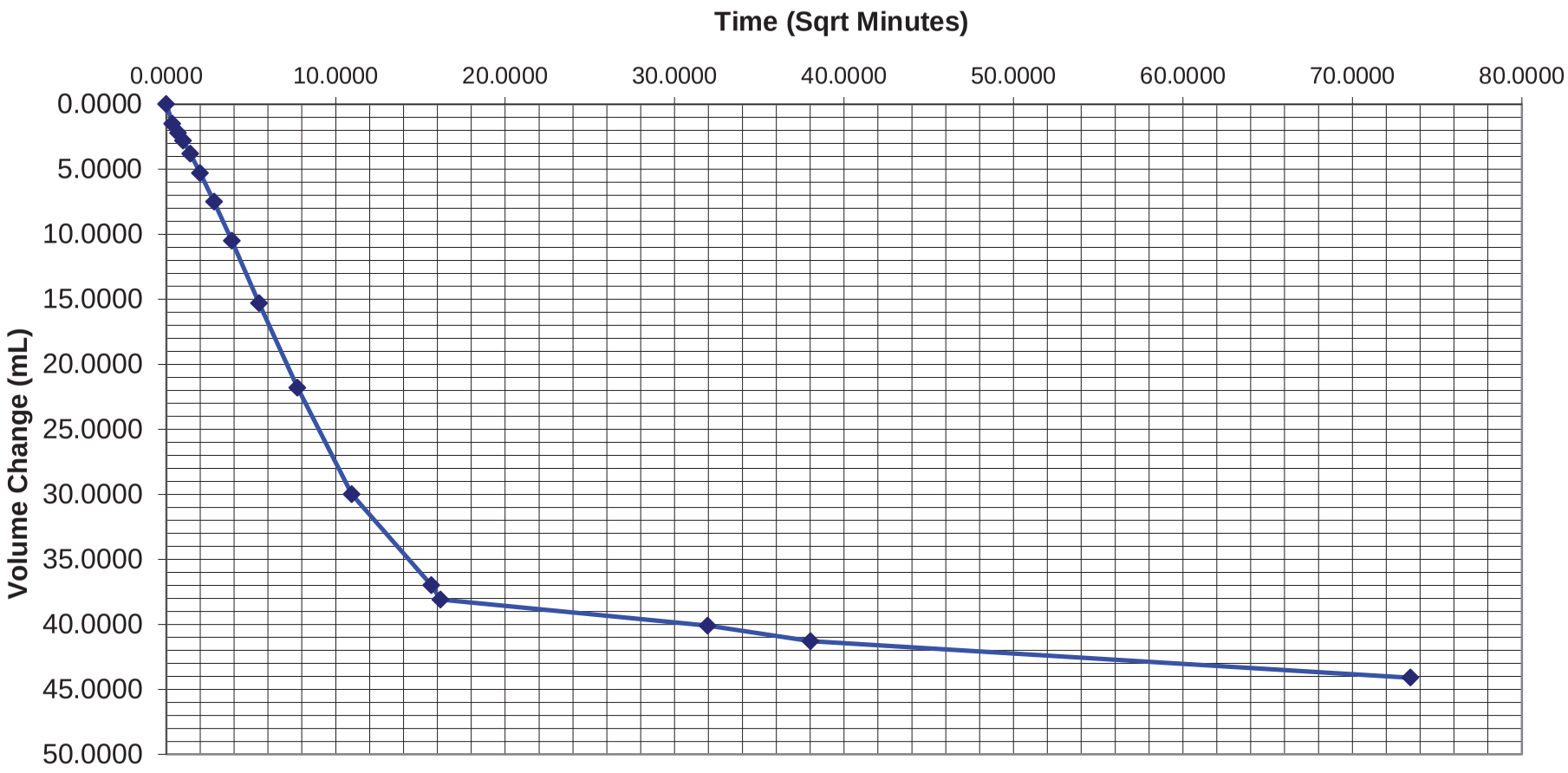


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	14A

Client : PND	Pressure: 17.8 psi	Boring : BH-9
Project : South Portage Cove		Sample # 5
Date: 1/30/2013		Depth : 21.5'



DOWL HKM

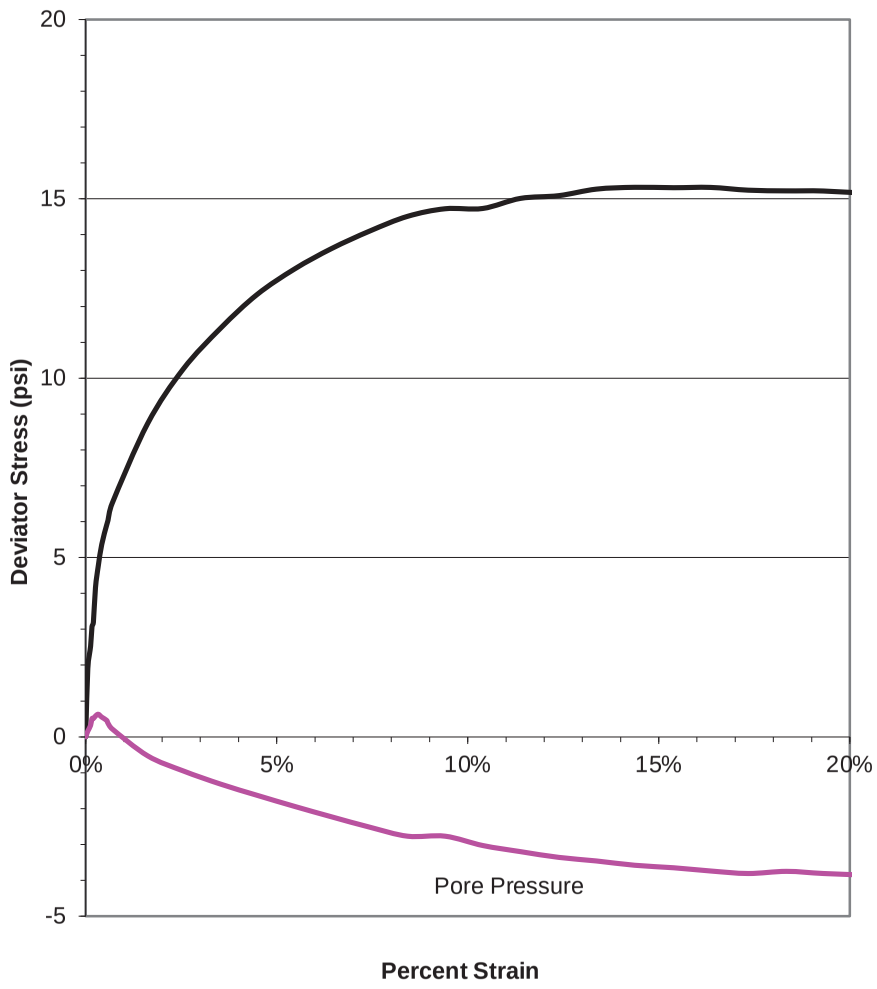
Time Rate of Consolidation

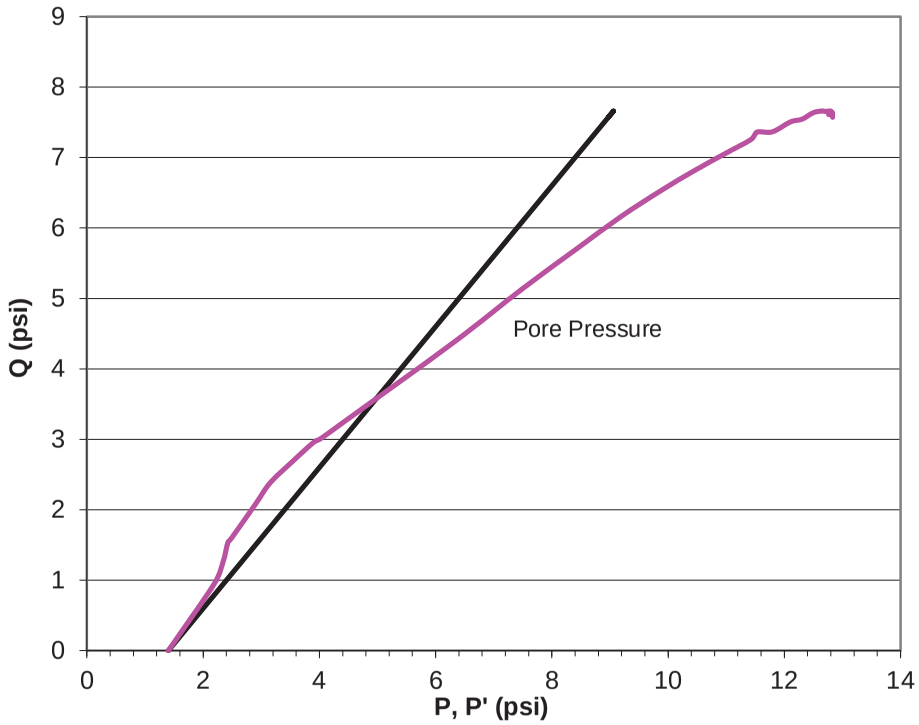
WO #	A33608
Lab #	14A

Client : PND	Pressure: 30.2 psi	Boring : BH-9
Project : South Portage Cove		Sample # 5
Date: 1/30/2013		Depth : 21.5'

DOWL HKM

Client:	PND
Project:	South Portage Cove
WO #	A32176
Boring #	BH-9
Sample #	9
Elevation	43.5'
Initial Dry Density:	100.7 pcf
Effective Confining Pressure :	1.4 psi
Initical Moisture Content:	23.7 %
Laboratory #	2013-16A
Date:	1/30/2013

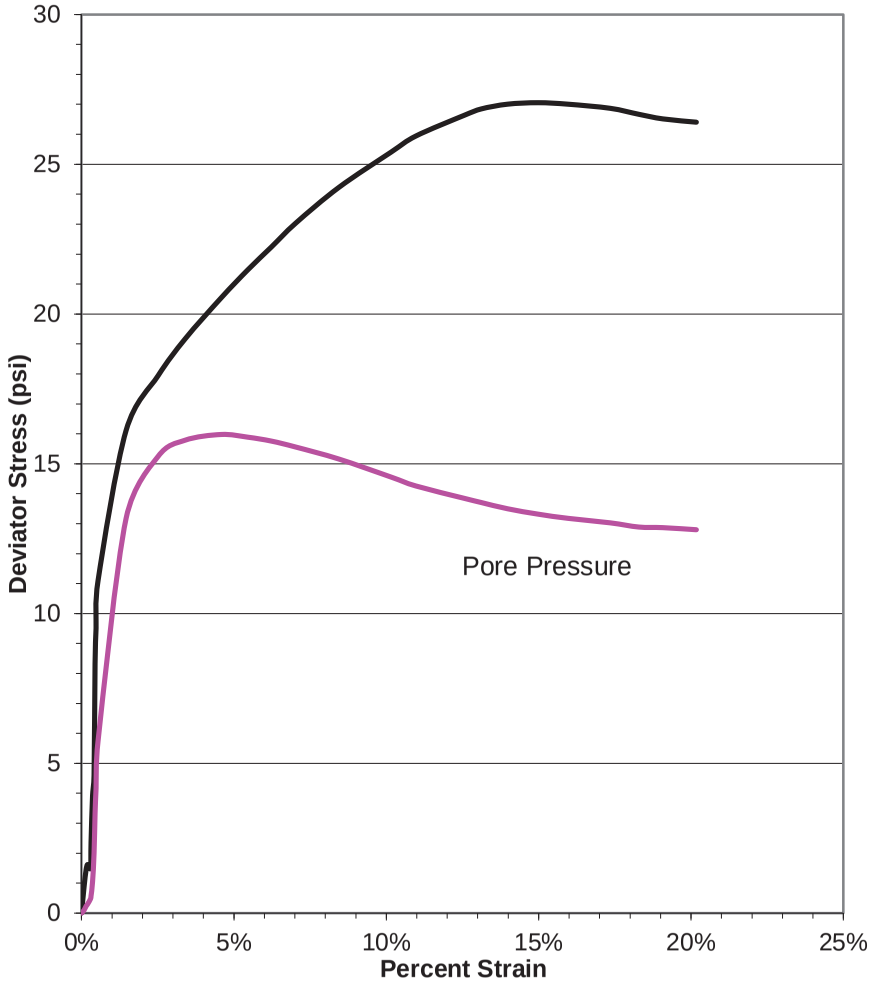


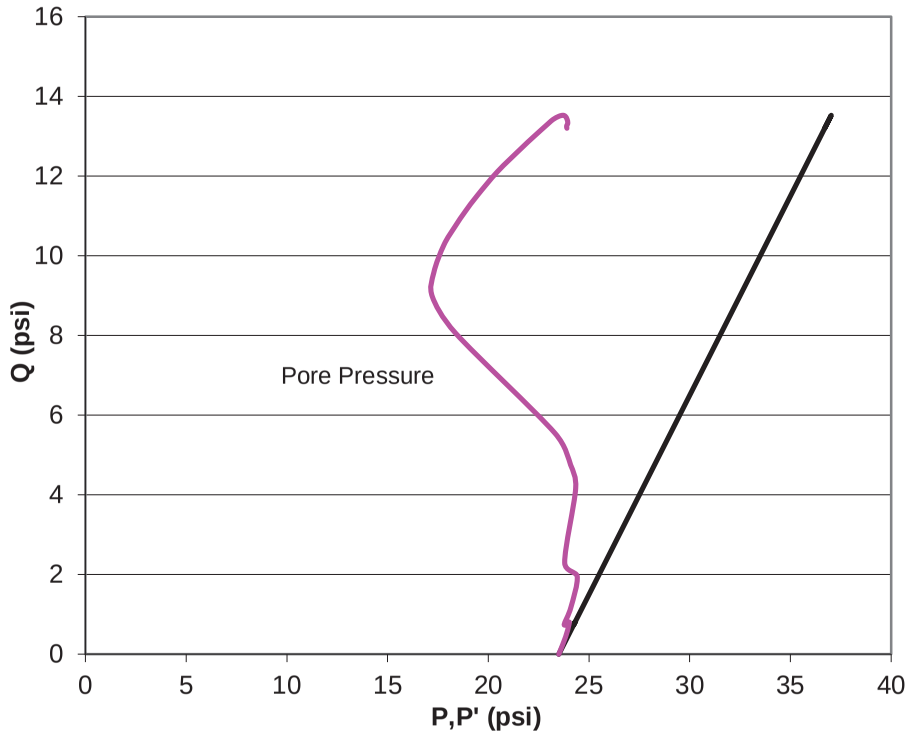


	Consolidated Undrained	WO #	A32176
		Figure	1

DOWL HKM

Client:	PND
Project:	South Portage Cove
WO #	A33608
Boring #	BH-9
Sample #	9
Elevation	43.5'
Initial Dry Density:	97.879 pcf
Effective Confining Pressure :	23.5 psi
Initial Moisture Content:	31.6 %
Laboratory #	2013-16B
Date:	2/6/2013



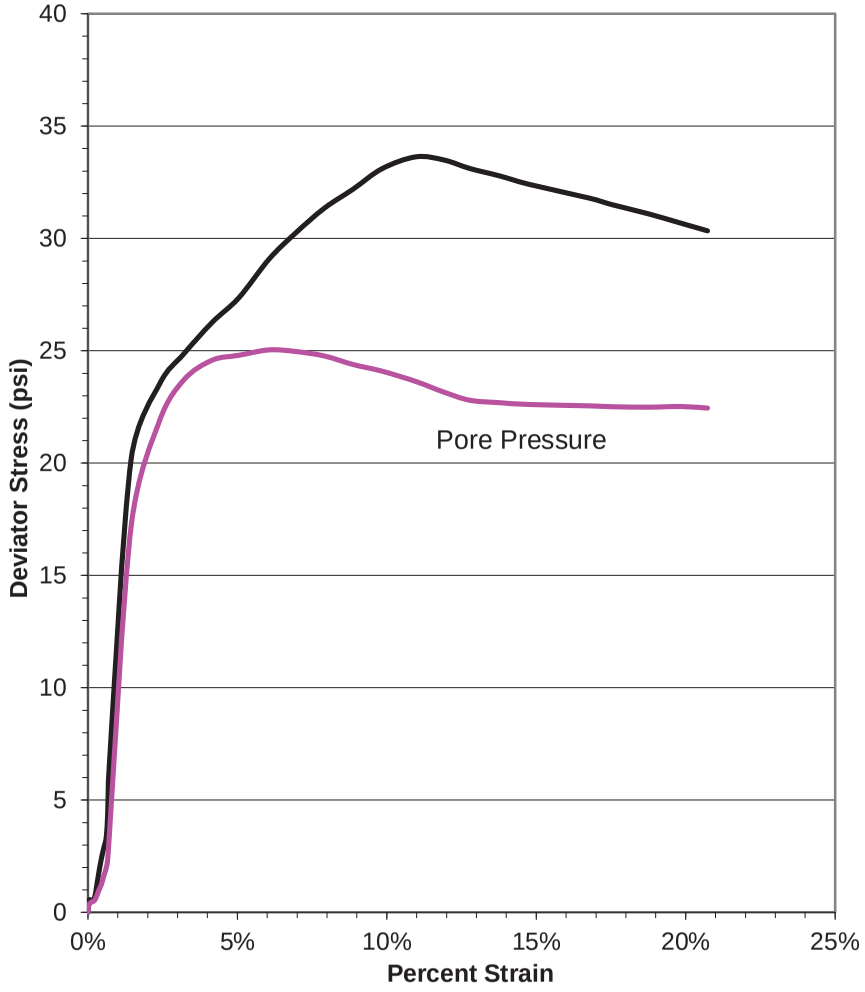


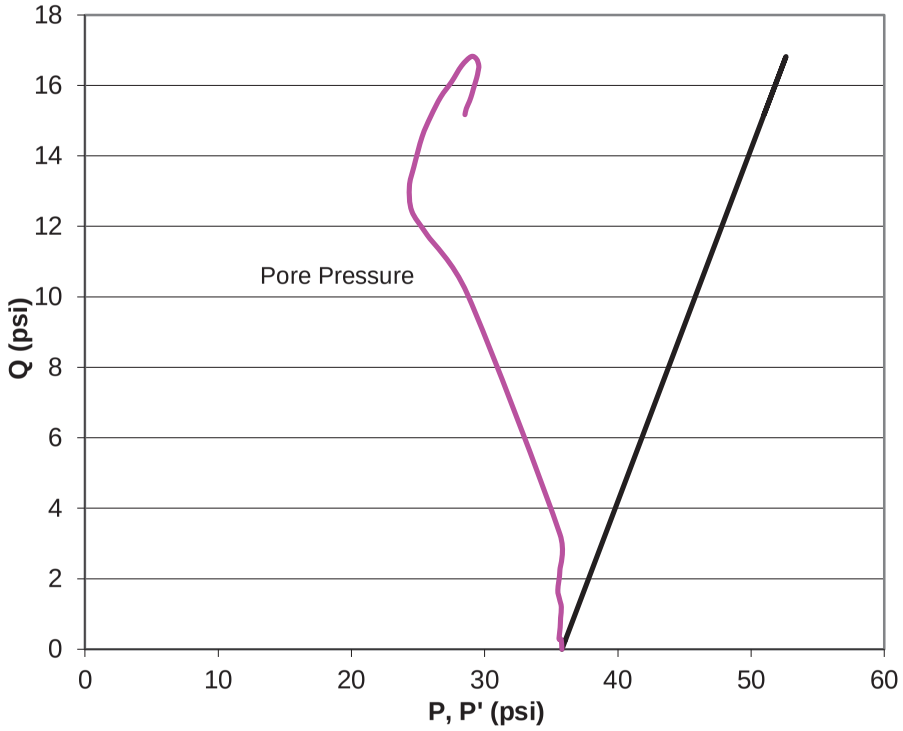
	Consolidated Undrained	WO #	A33608
		Figure	2

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

Client:	PND
Project:	South Portage Cove
WO #	A33608
Boring #	BH-9
Sample #	9
Evelvation	43.5'
Initial Dry Density:	94.8 pcf
Effective Confining Pressure :	35.8 psi
Final Moisture Content:	32 %
Laboratory #	2013-16C
Date:	2/15/2013



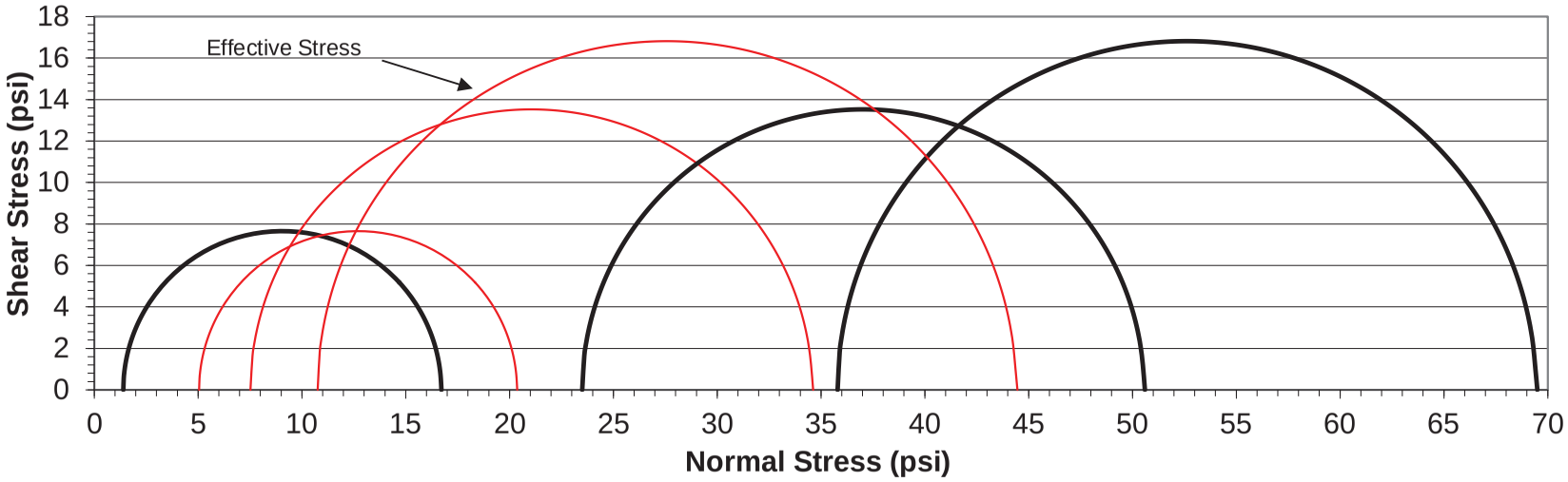


	Consolidated Undrained	WO #	A33608
		Figure	3

4041 B STREET - ANCHORAGE - ALASKA - 99503 - (907) 562-2000 - (907) 563-3953

DOWL HKM

Project :	PND	Lab #	2013-16A	σ_3 =	1.4 psi	$\gamma\omega$ =	100.7 pcf
Client:	South Portage Cove	Lab #	2013-16B	σ_3 =	23.5 psi	$\gamma\omega$ =	97.9 pcf
WO #	A32176	Lab #	2013-16C	σ_3 =	35.8 psi	$\gamma\omega$ =	94.8 pcf
Boring #	BH-9						
Sample #	1,2,3						
Depth :	43.5'						
Date:	2013-16C						



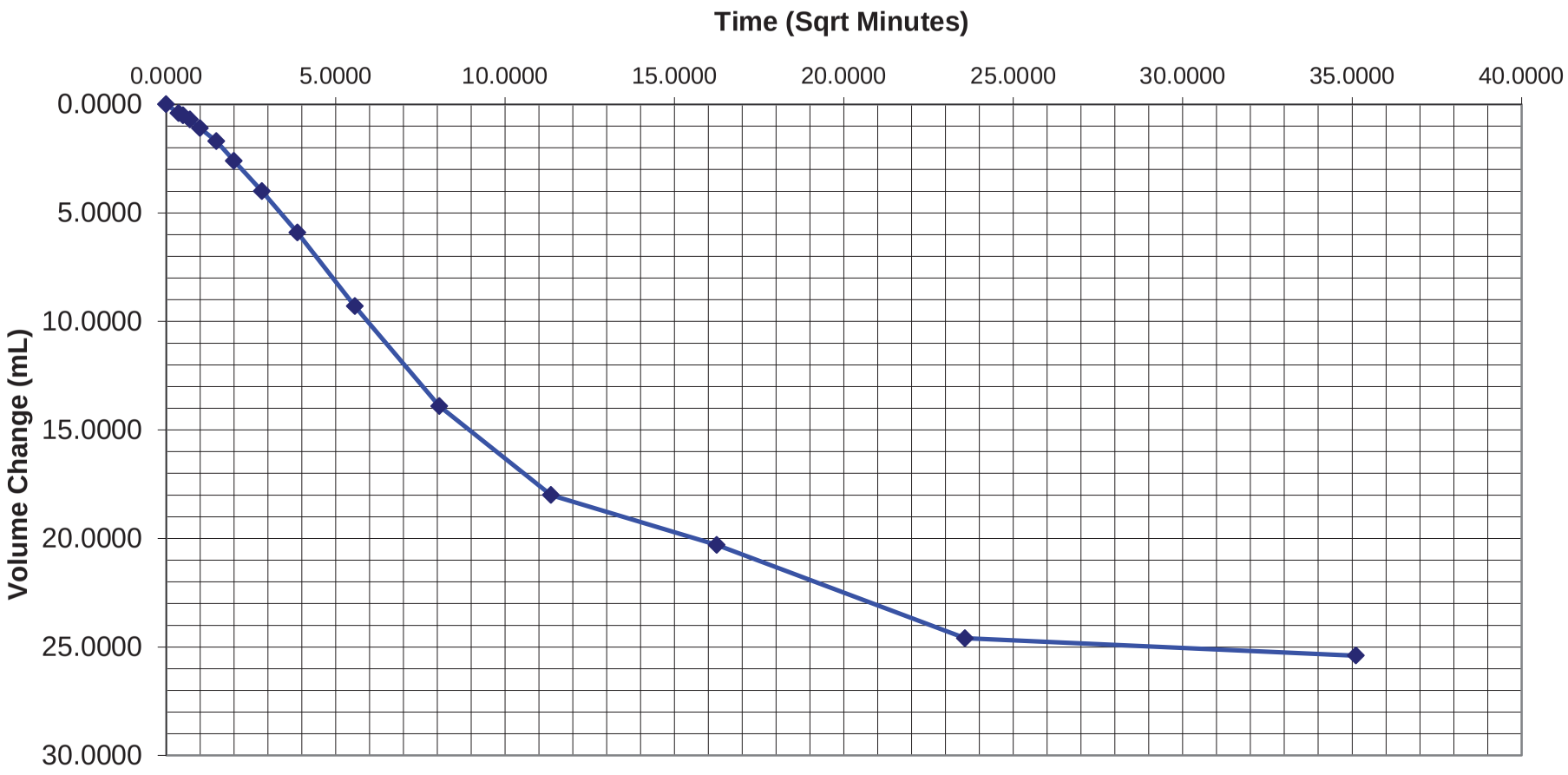
	Mohr Diagram - CU Tests	WO #	A32176
		Figure	4

DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-16A

Client : PND	Pressure: 11.2 psi	Boring : BH-9
Project : South Portage Cove		Sample # 9
Date: January 30, 2013		Depth : 43.5'

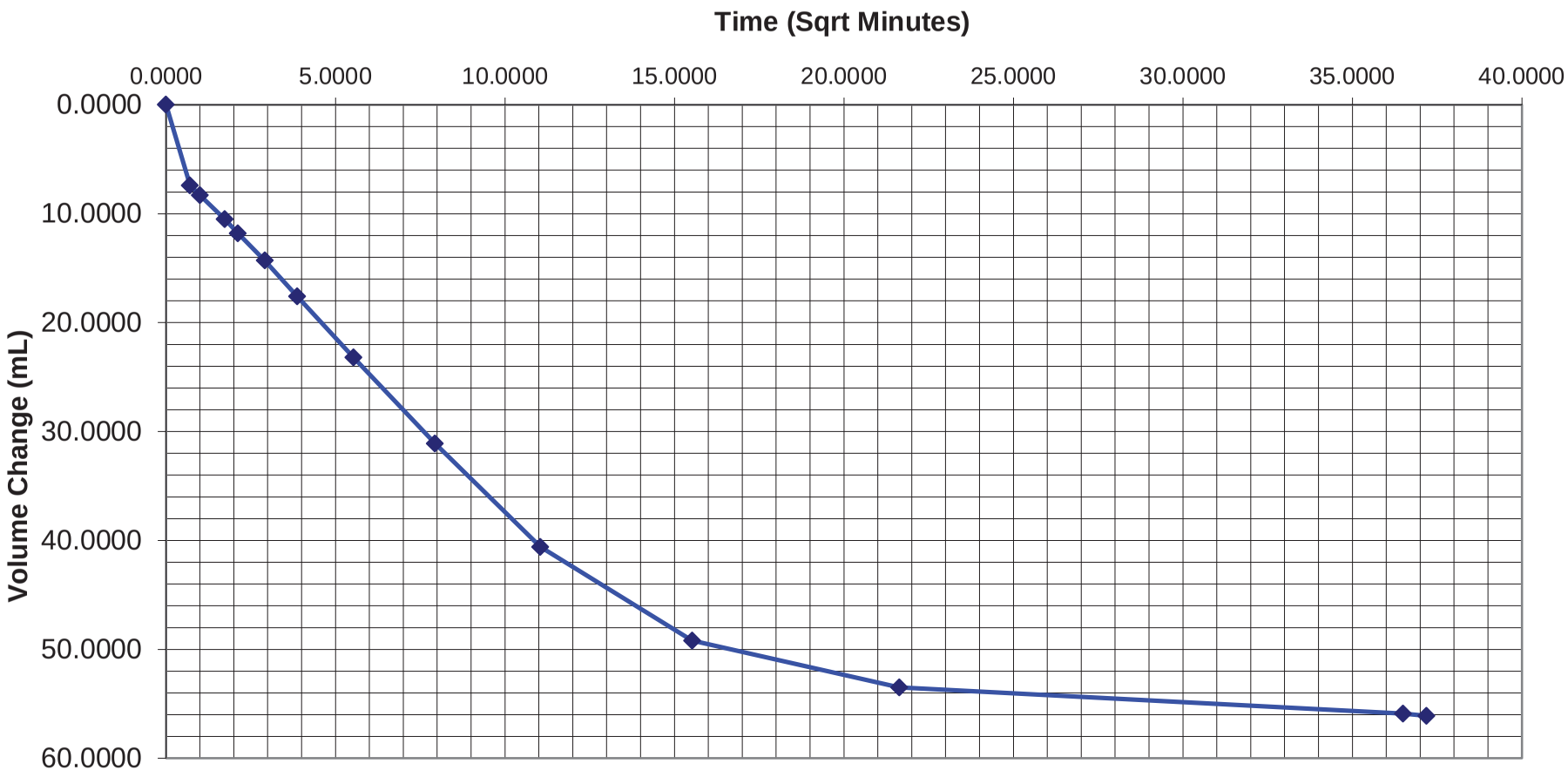


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-16A

Client : PND	Pressure: 23.5 psi	Boring : BH-9
Project : South Portage Cove		Sample # 9
Date: January 30, 2013		Depth : 43.5'

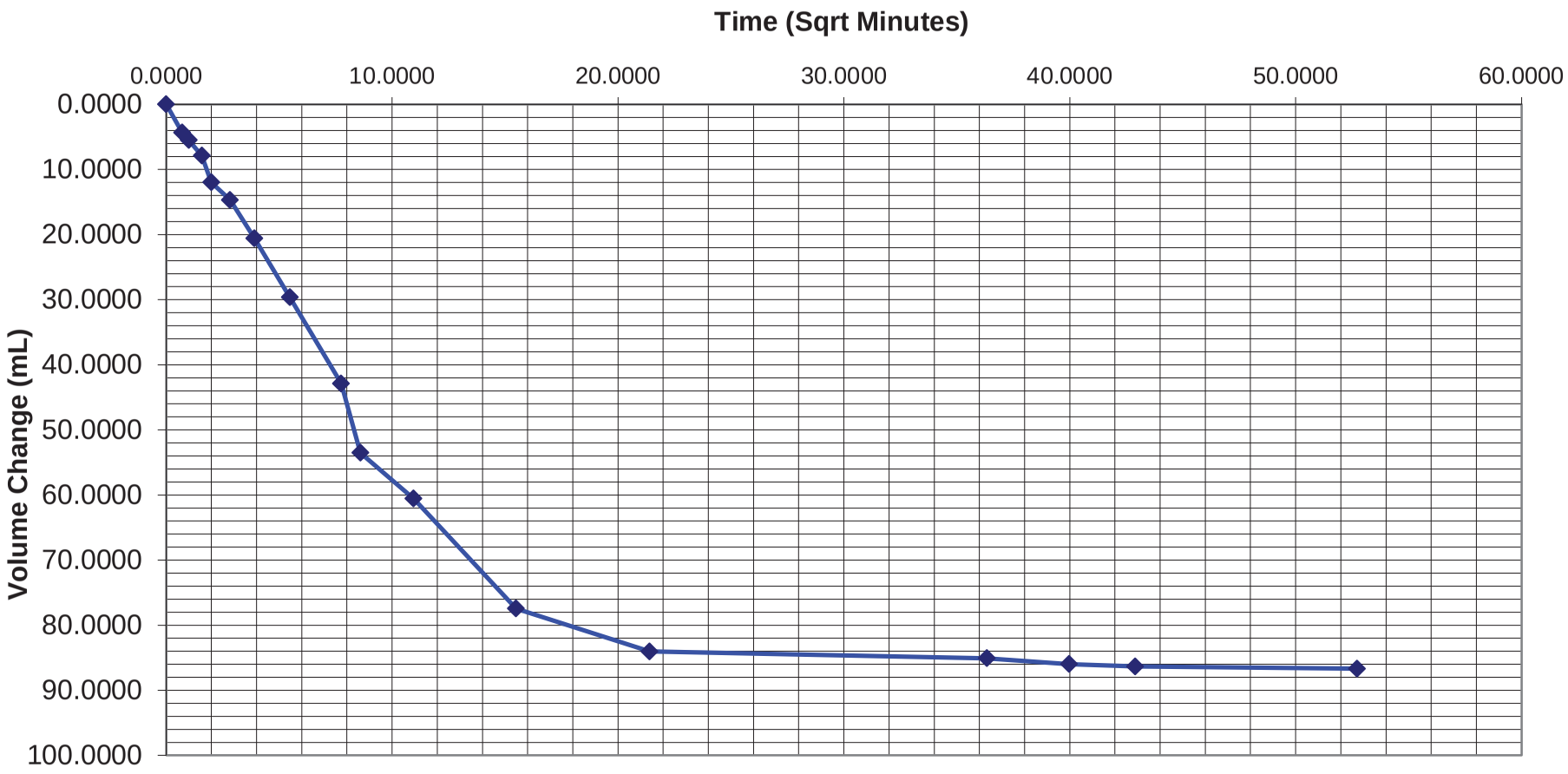


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-16A

Client : PND	Pressure: 35.8 psi	Boring : BH-9
Project : South Portage Cove		Sample # 9
Date: January 30, 2013		Depth : 43.5'

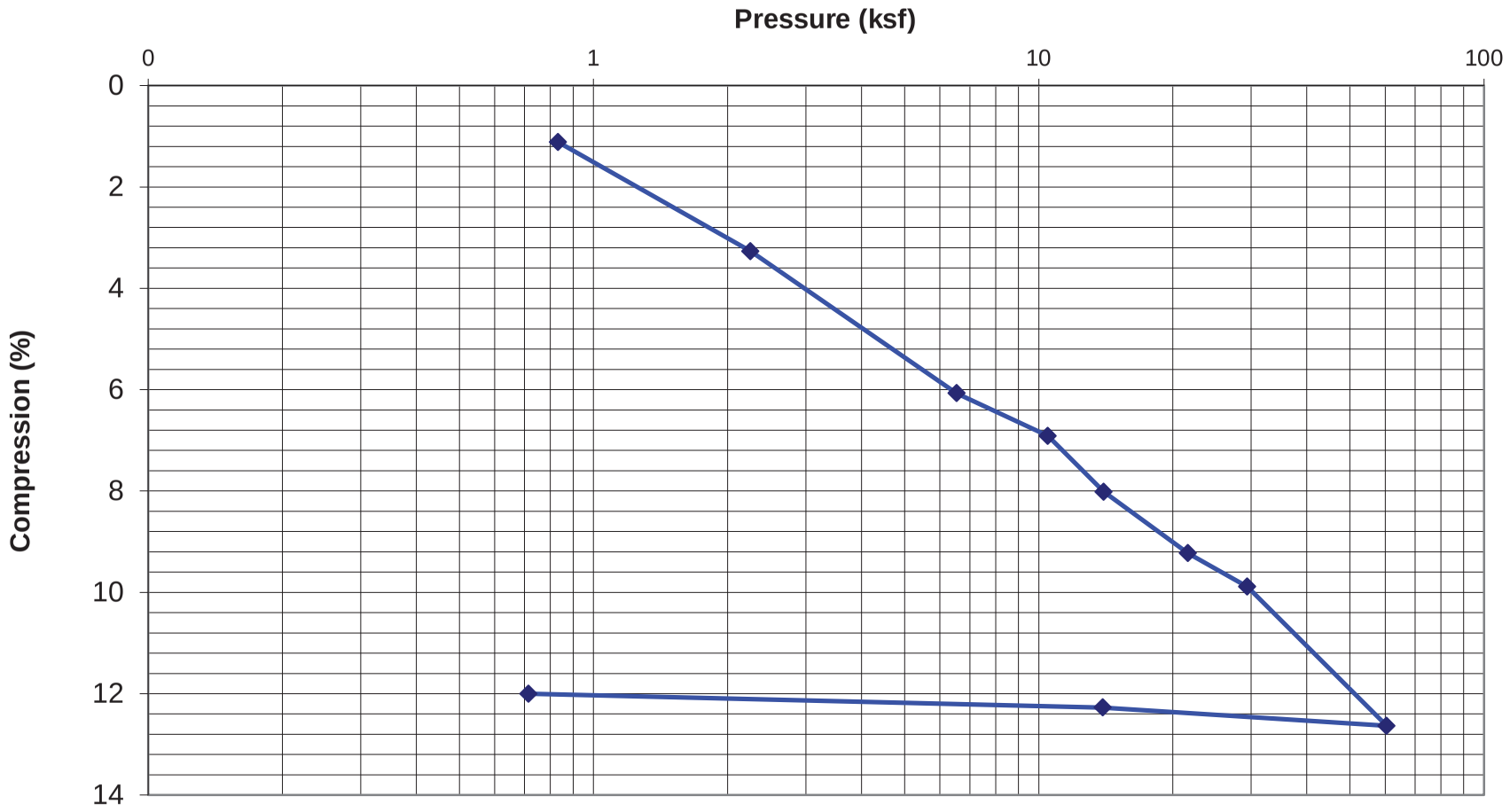


DOWL HKM

Compression Curve (% Comp. vs. Log P)

WO #	A33608
Lab #	2013-001

Client :	PND	Moisture Content =	23.0 %	Boring :	BH-4
Project :	South Portage Cove	Dry Unit Weight (pcf) =	104.8	Sample #	3
Date:	1/2/2013	Wet Unit Weight (pcf)=	128.9	Depth :	15'-18'



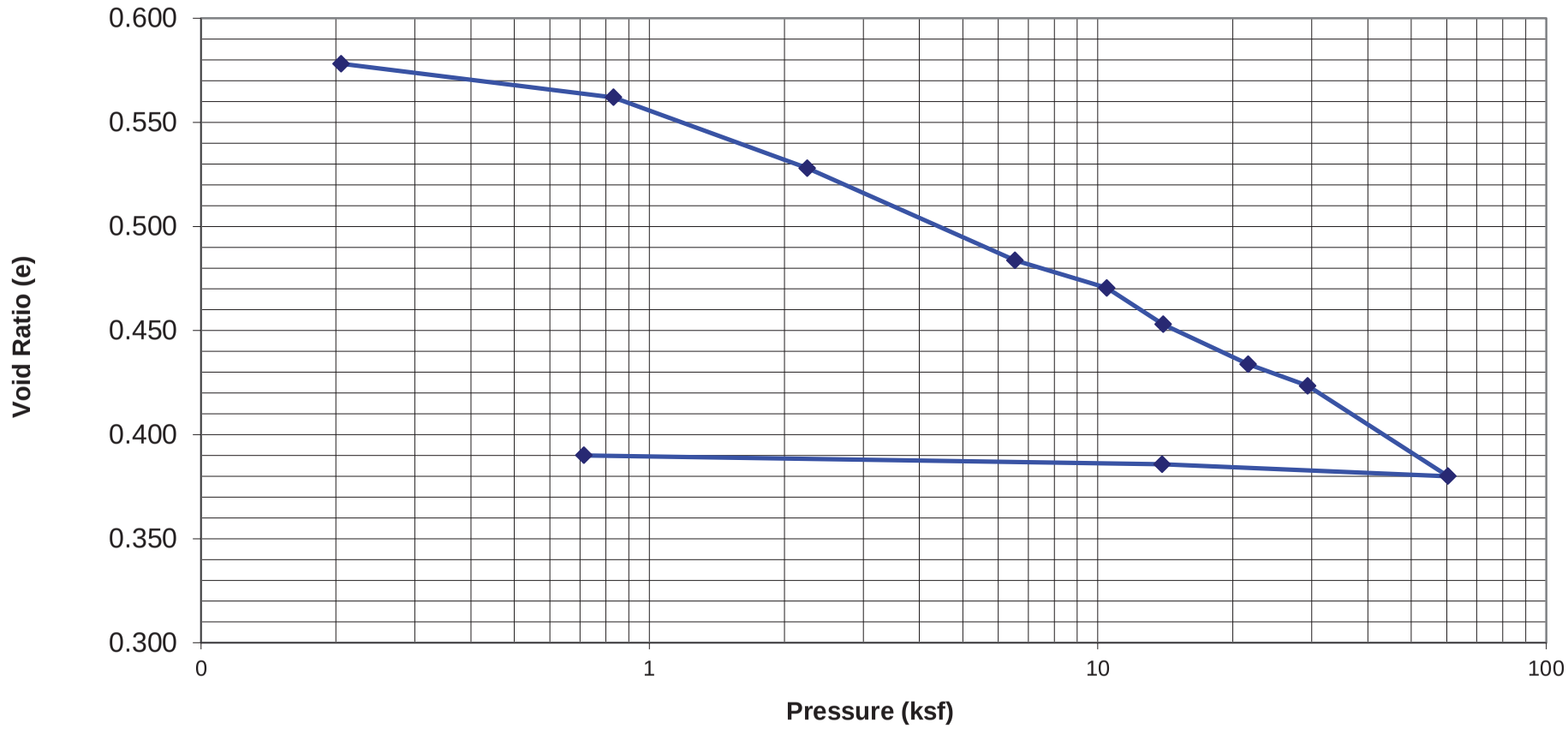
DOWL HKM

Compression Curve (e vs. Log P)

WO #	A33608
Lab #	2013-001

Client :	PND	Moisture Content =	23.0 %	Boring :	BH-4
Project :	South Portage Cove	Dry Unit Weight (pcf) =	104.8	Sample #	3
Date:	1/2/2013	Wet Unit Weight (pcf)=	128.9	Depth :	15'-18'

e_o = 0.578



DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-001

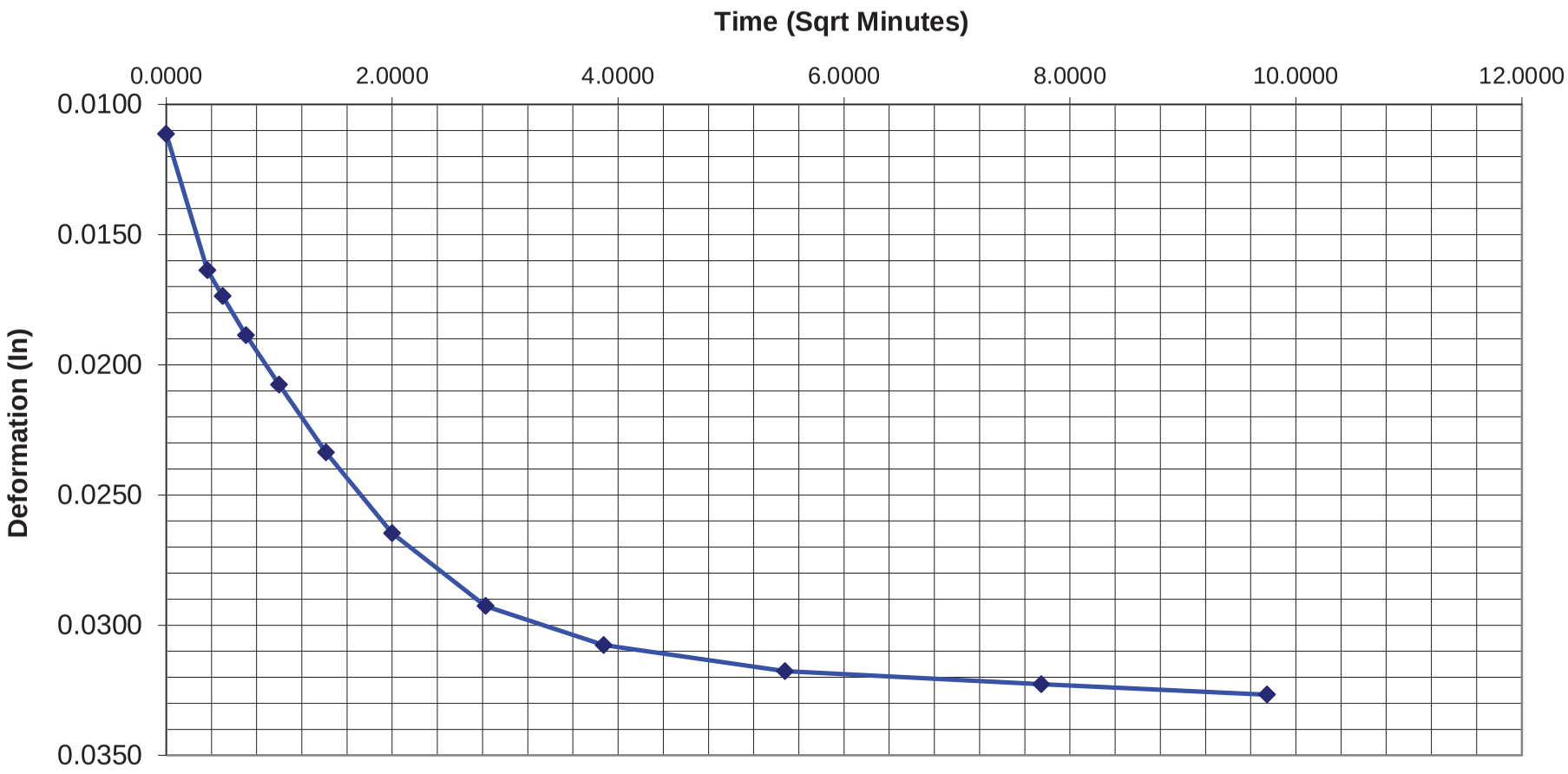
Client : PND	Pressure: 832 psf 2 psi	Boring :	BH-4
Project : South Portage Cove	Deformation Correction (in): 0.000567	Sample #	3
Date: 1/2/2013		Depth :	15'-18'

DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-001

Client : PND	Pressure: 2252 psf	4 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.000933		Sample # 3
Date: 1/2/2013			Depth : 15'1-118'



DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-001

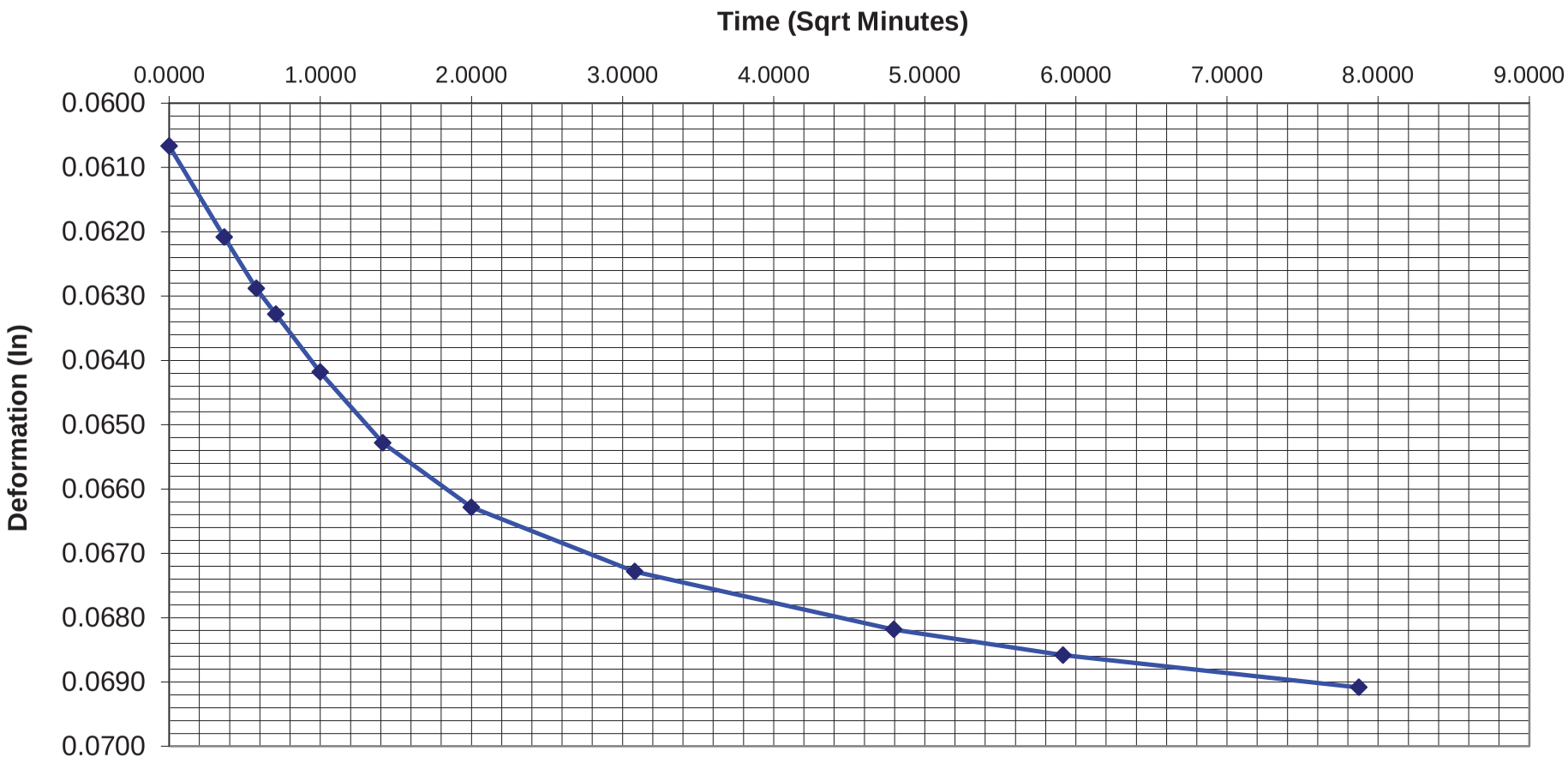
Client :	PND	Pressure:	6539 psf 10 psi	Boring :	BH-4
Project :	South Portage Cove	Deformation Correction (in):	0.001633	Sample #	3
Date:	1/2/2013			Depth :	15'-18'

DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-001

Client : PND	Pressure: 10484 psf 15 psi	Boring :	BH-4
Project : South Portage Cove	Deformation Correction (in): 0.001917	Sample #	3
Date: 1/2/2013		Depth :	15'-18'

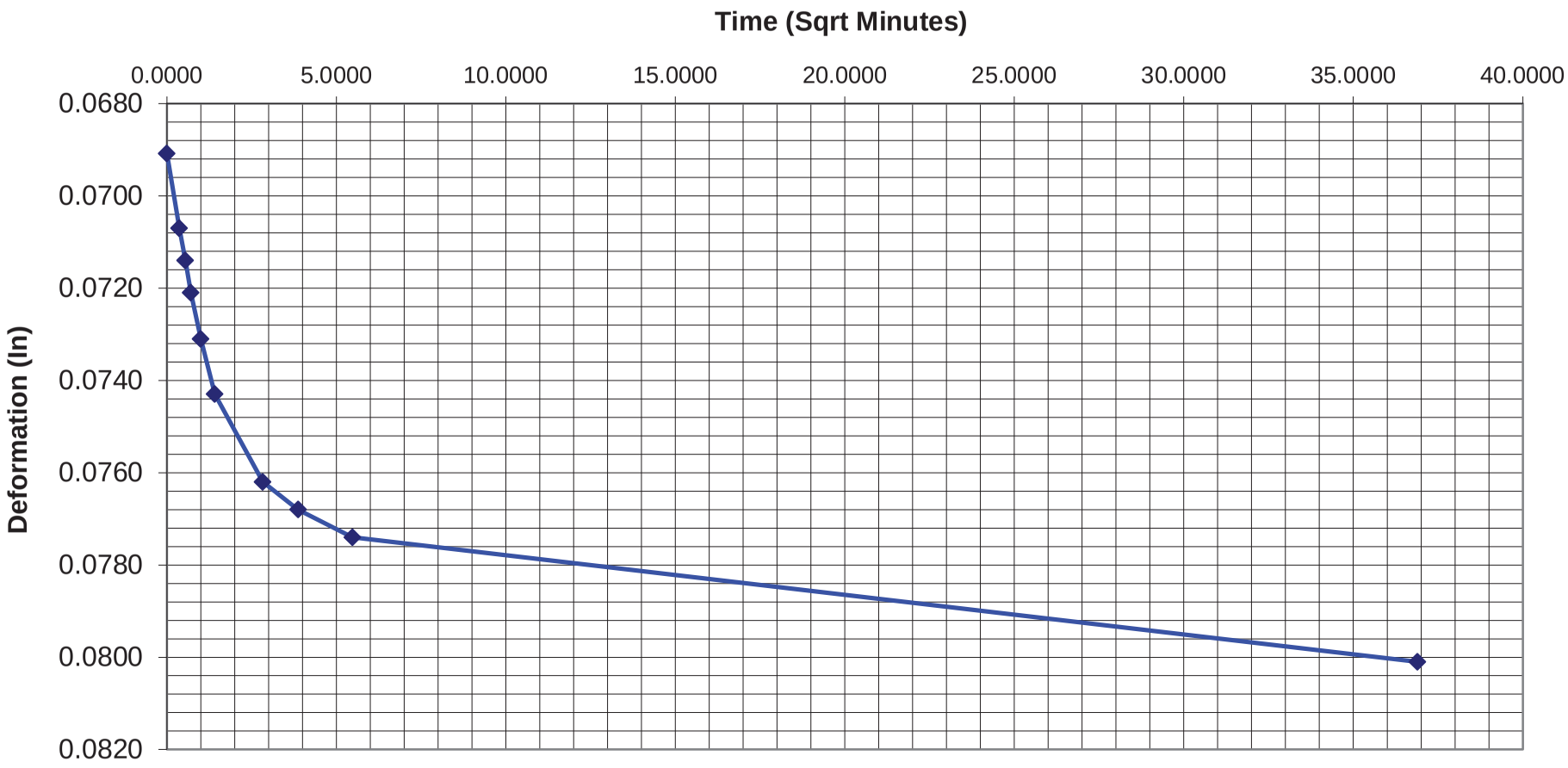


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-001

Client : PND	Pressure: 13999 psf 20 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.0022	Sample # 3
Date: 1/2/2013		Depth : 15'-18'

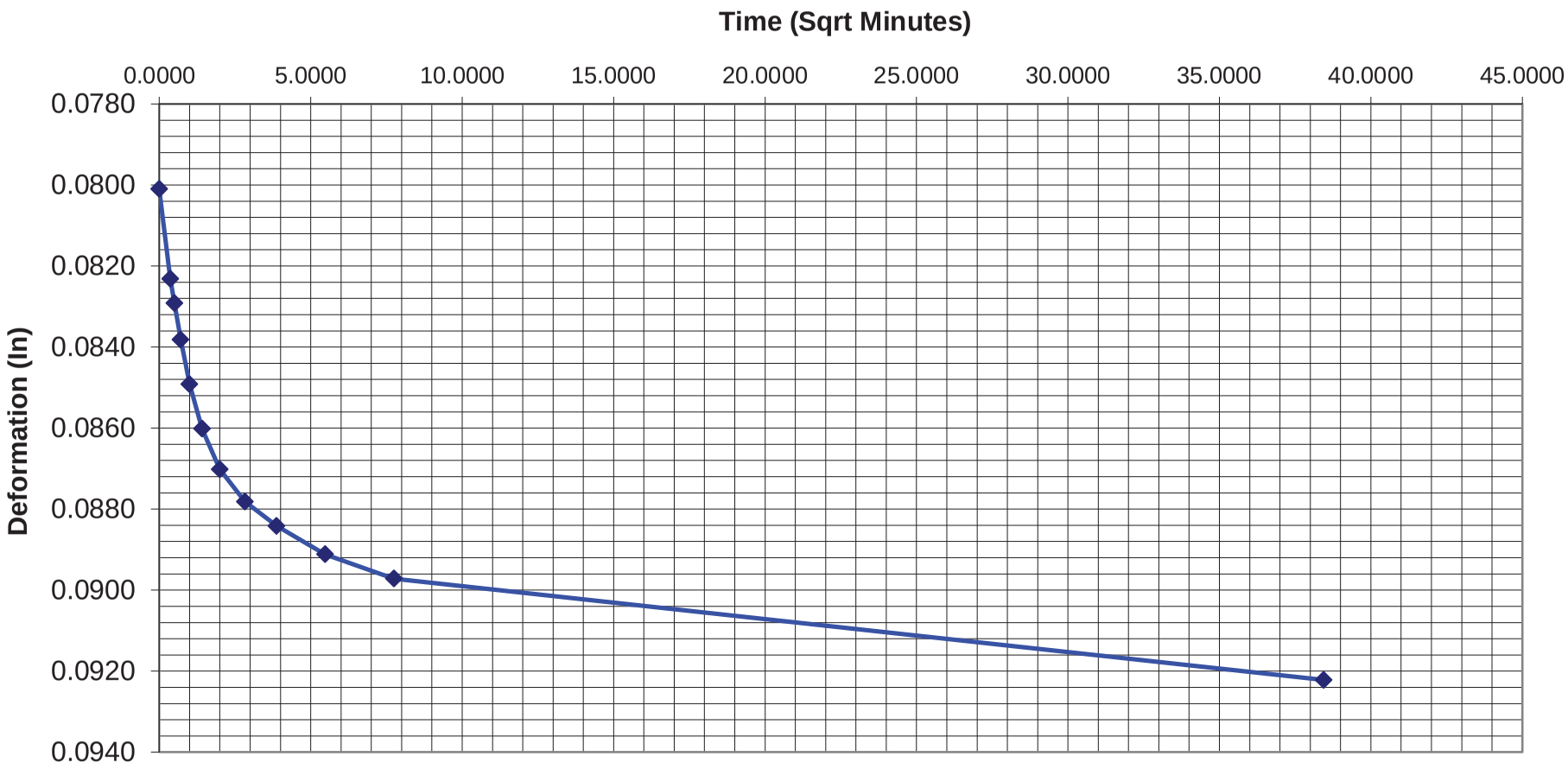


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-001

Client : PND	Pressure: 21644 psf 30 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.002583	Sample # 3
Date: 1/2/2013		Depth : 15'-18'

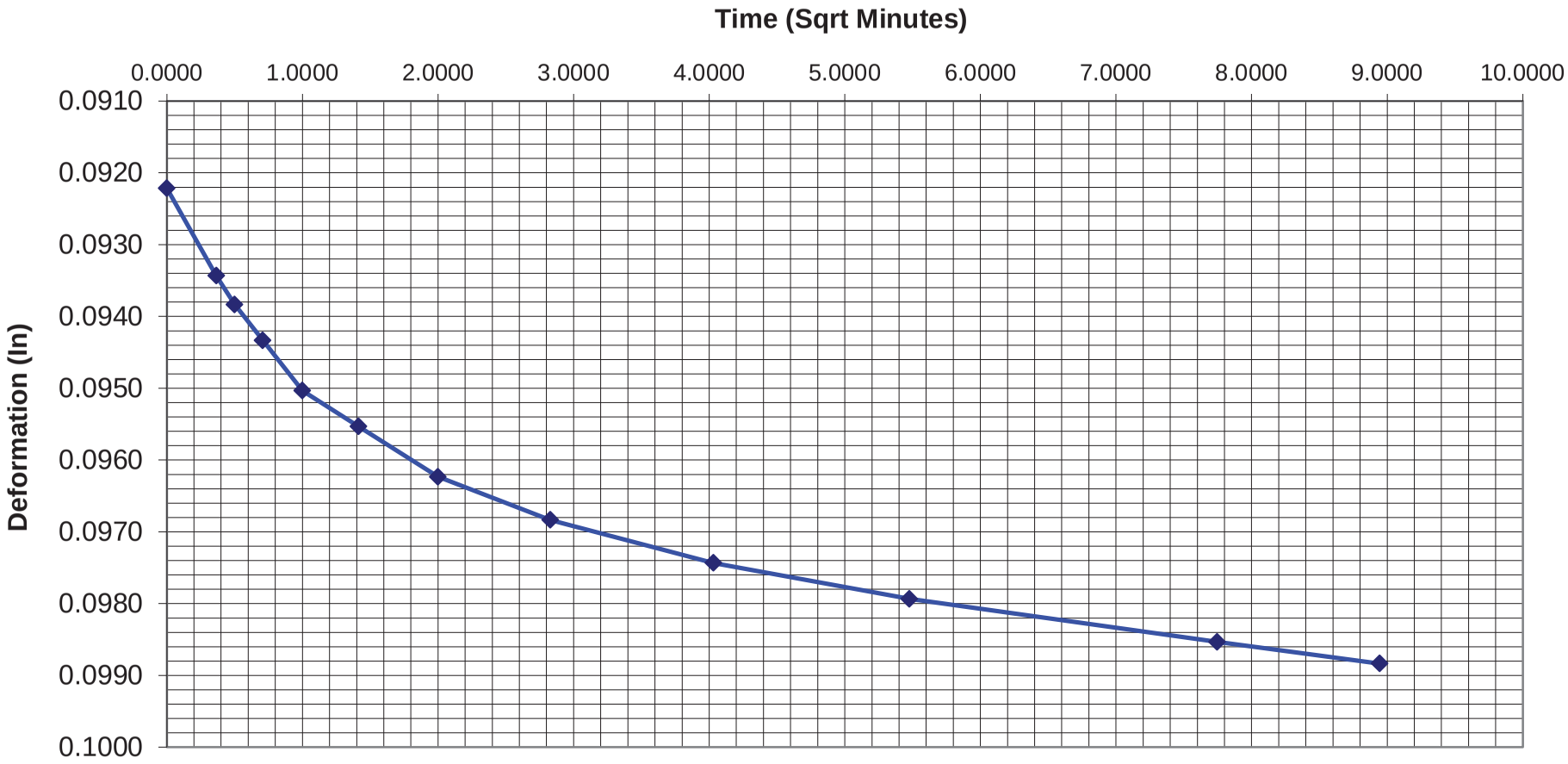


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-001

Client : PND	Pressure: 29407 psf 40 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.002967	Sample # 3
Date: 1/2/2013		Depth : 15'-18'

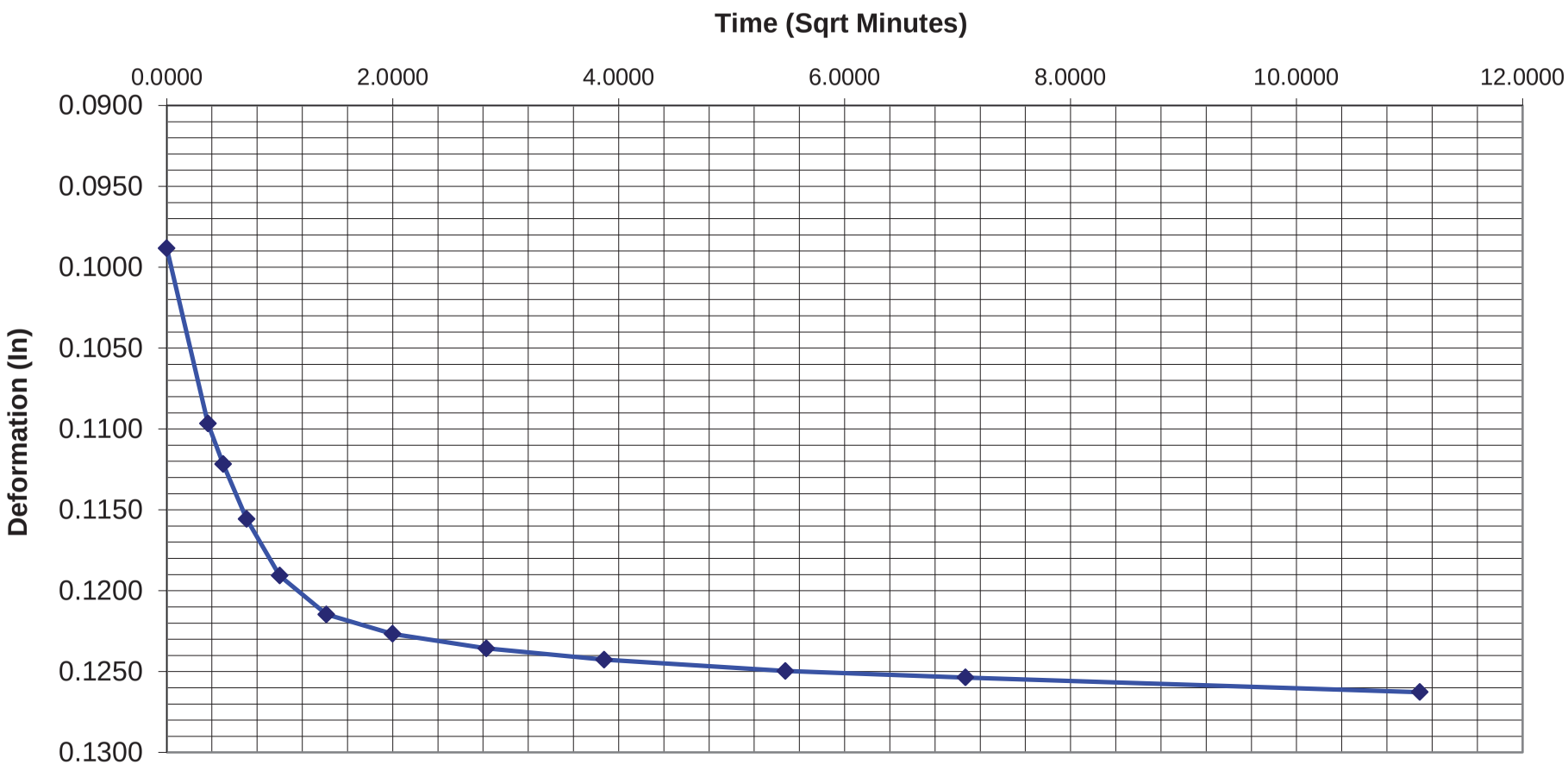


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-001

Client : PND	Pressure: 60429 psf 80 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.004033	Sample # 3
Date: 1/2/2013		Depth : 15'-18'

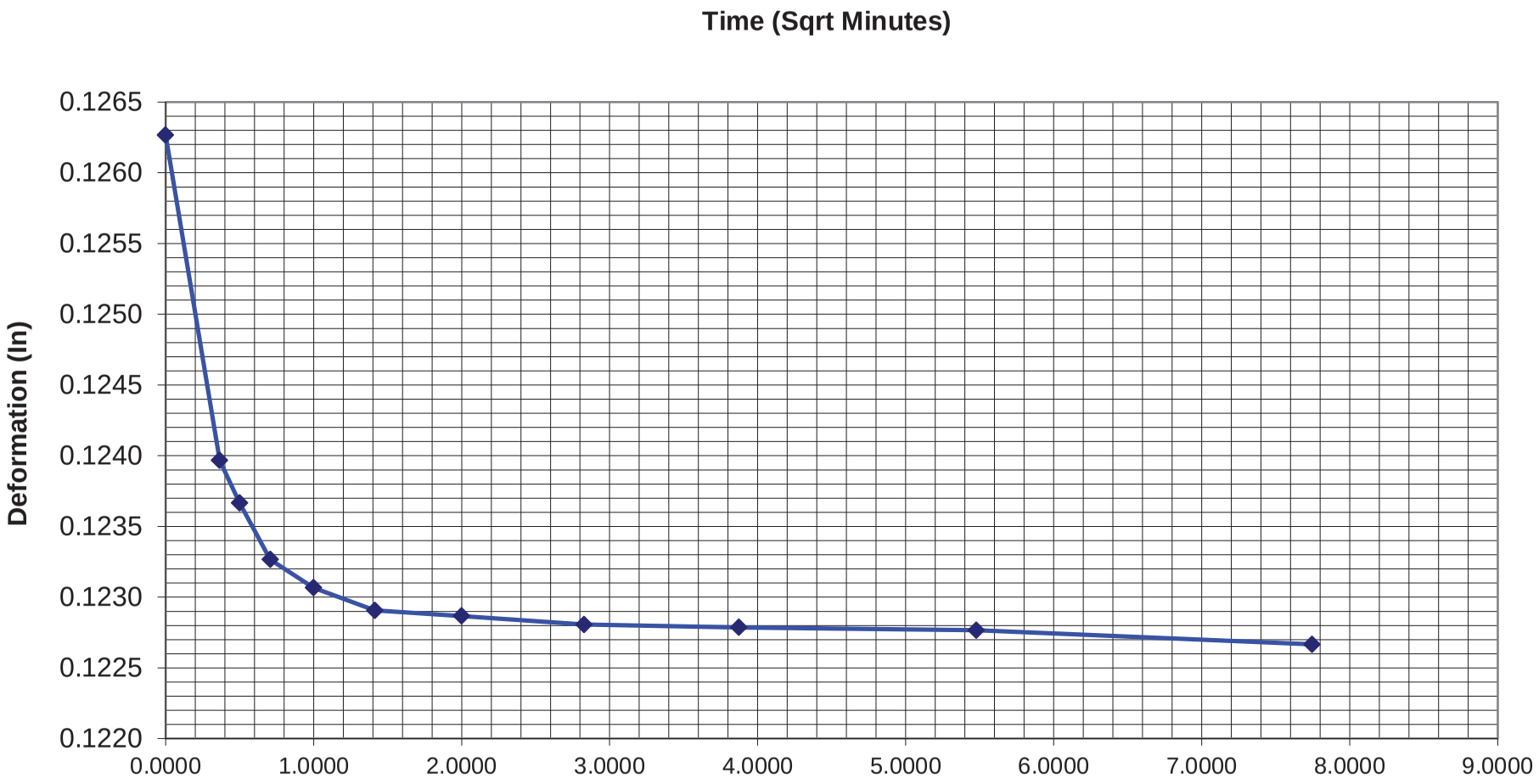


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-001

Client : PND	Pressure: 13920 psf 20 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.002733	Sample # 3
Date: 1/2/2013	Rebound Load	Depth : 15'-18'

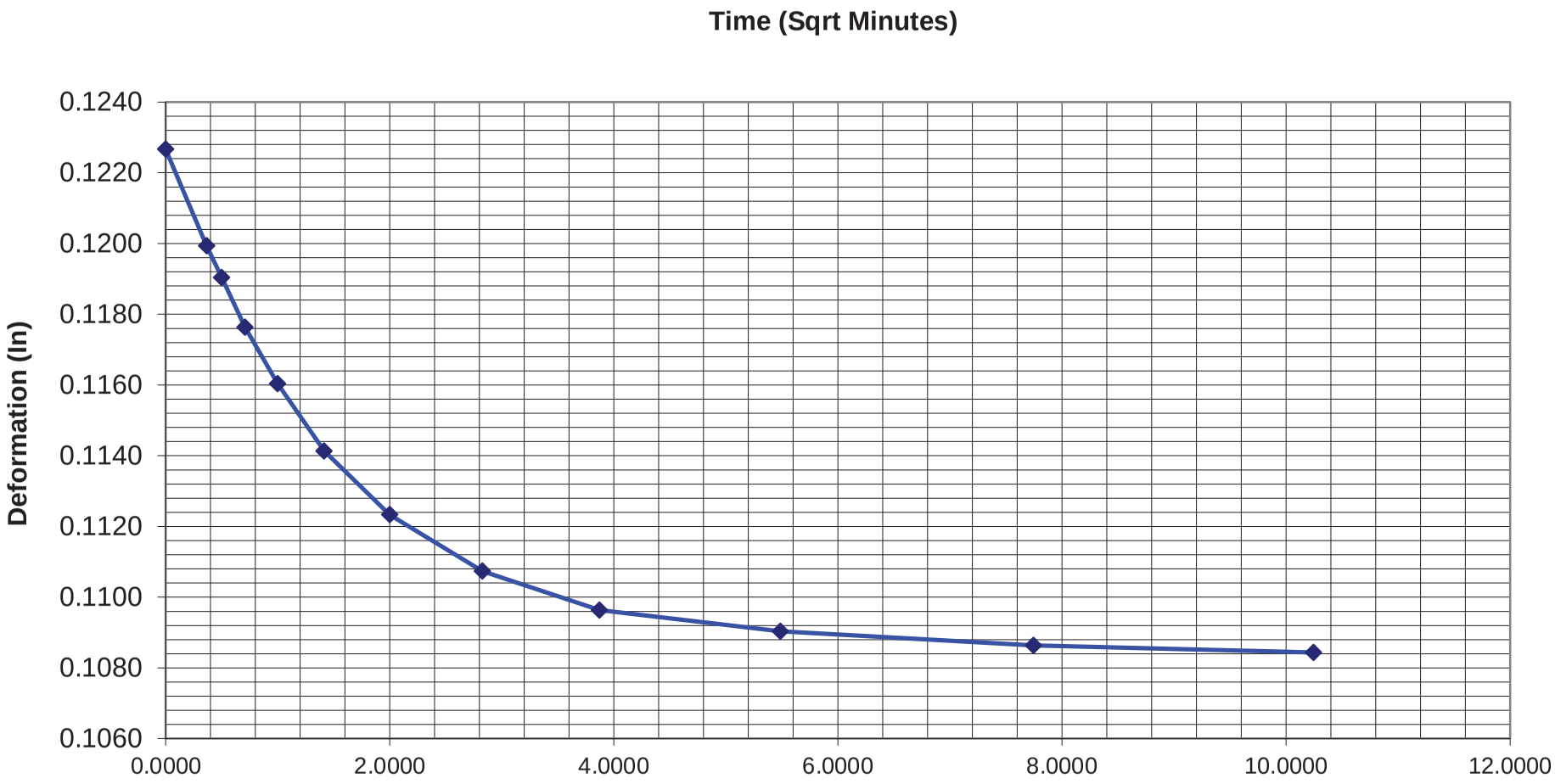


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-001

Client :	PND	Pressure:	715 psf 2 psi	Boring :	BH-4
Project :	South Portage Cove	Deformation Correction (in):	0.001567	Sample #	3
Date:	1/2/2013	Rebound Load		Depth :	15'-18'



Consolidation Report

Client :	PND	WO #	A33608	Boring :	BH-4
Project :	South Portage Cove	Lab #	2013-001	Sample #	3
Date:	1/2/2013	Frame #	1	Depth :	15'-18'

Wet Sample Weight (g)	165.72
Dry Sample Weight (g)	134.72
Sample Height (in)	1.00
Ring Diameter (in)	2.50
Dry Density (lb/ft3)	104.78
Wet Density (lb/ft3)	128.90
Area of Sample (in2)	4.90
Volume of Sample (in3)	4.90
Volume of Solids (in3)	3.10
Height of Solids (in)	0.63
Initial Height of Voids (in)	0.37
Initial Volume of Voids (in3)	1.80
Volume of Water (in3)	1.89
Initial Degree of Saturation (%)	105.23
Initial Void Ratio, e0	0.58
0.42 e0	0.24
specific gravity	2.65
Volume of Solids	0.63
Volume of Voids	0.37

Load Number	Guage Pressure	Load (lb)	Pressure (ksf)	Δ Height (in)	Void Ratio	% Change
Seating	1	7.00	0.206	0.000	0.578	0.00
1	2	28.33	0.832	0.011	0.562	1.11%
2	4	76.67	2.252	0.033	0.528	3.27%
3	10	222.67	6.539	0.061	0.484	6.07%
4	15	357.00	10.484	0.069	0.470	6.91%
5	20	476.67	13.999	0.080	0.453	8.02%
6	30	737.00	21.644	0.092	0.434	9.23%
7	40	1001.33	29.407	0.099	0.423	9.89%
8	80	2057.67	60.429	0.126	0.380	12.63%
9	20	474.00	13.920	0.123	0.386	12.27%
10	2	24.33	0.715	0.120	0.390	12.00%

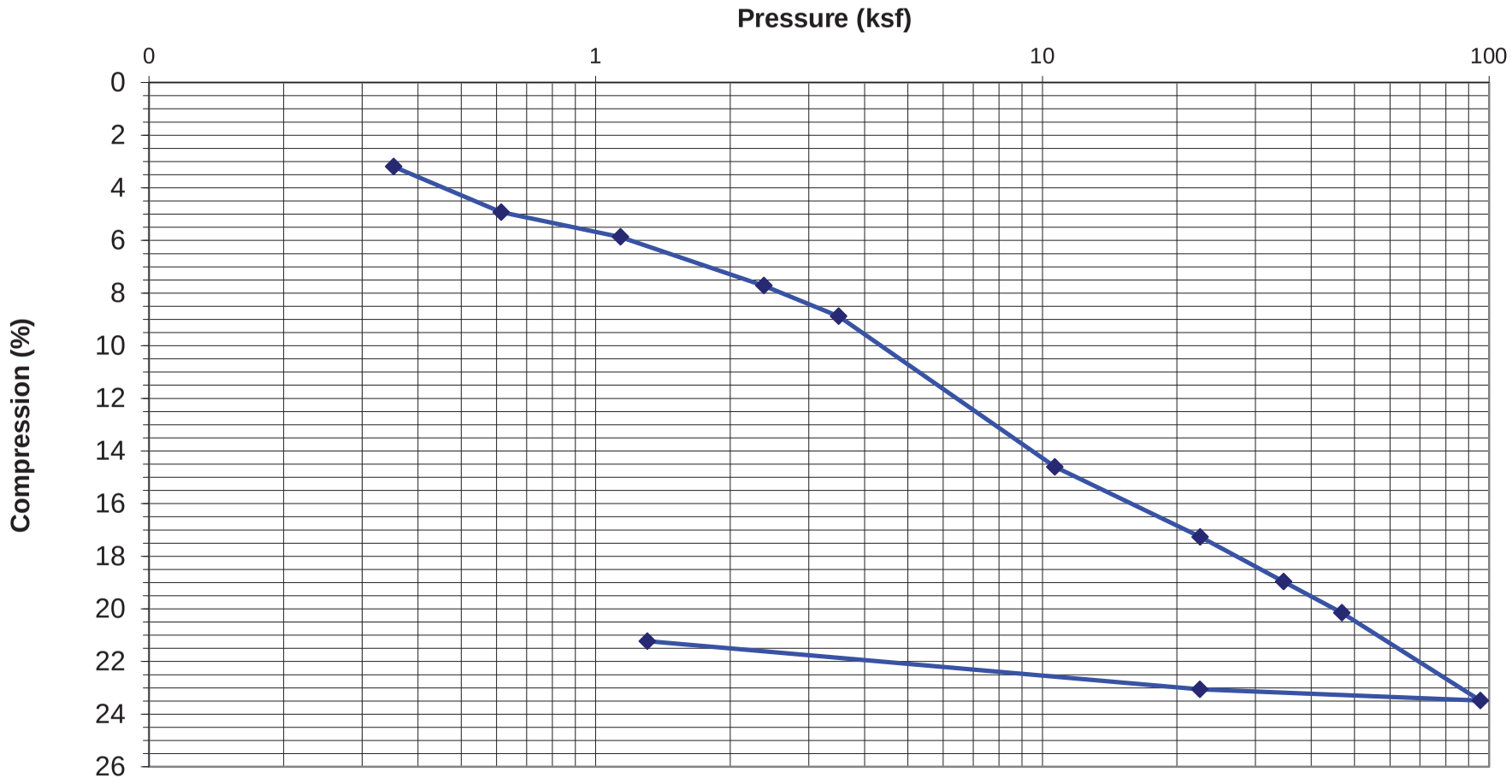
Moisture Content			
	Trimmings	Initial	Final
Wet + Tare	624.20		624.27
Dry + Tare	601.22		590.56
Tare	501.37		467.75
Wet Weight	122.83	165.72	156.52
Wt. Water	22.98		33.71
Wt. Dry Soil	99.85		122.81
% Moisture	23.0		27

DOWL HKM

Compression Curve (% Comp. vs. Log P)

WO #	A33608
Lab #	2013-003U

Client :	PND	Moisture Content =	29.6 %	Boring :	BH-4
Project :	South Portage Cove	Dry Unit Weight (pcf) =	70.8	Sample #	7
Date:	1/11/2013	Wet Unit Weight (pcf)=	91.8	Depth :	35' - 38'



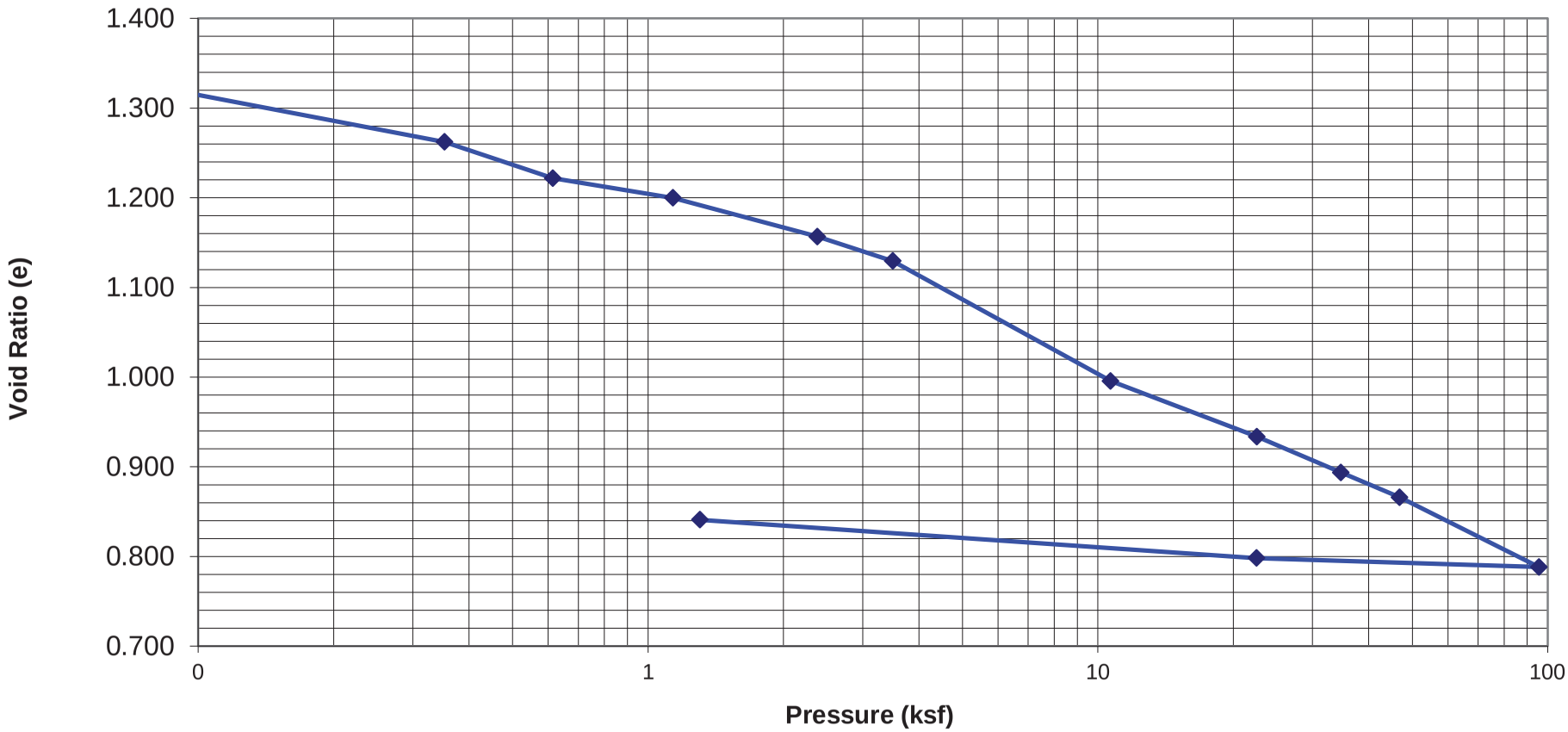
DOWL HKM

Compression Curve (e vs. Log P)

WO #	A33608
Lab #	2013-003U

Client :	PND	Moisture Content =	29.6 %	Boring :	BH-4
Project :	South Portage Cove	Dry Unit Weight (pcf) =	70.8	Sample #	7
Date:	1/11/2013	Wet Unit Weight (pcf)=	91.8	Depth :	35' - 38'

e_o = 1.335

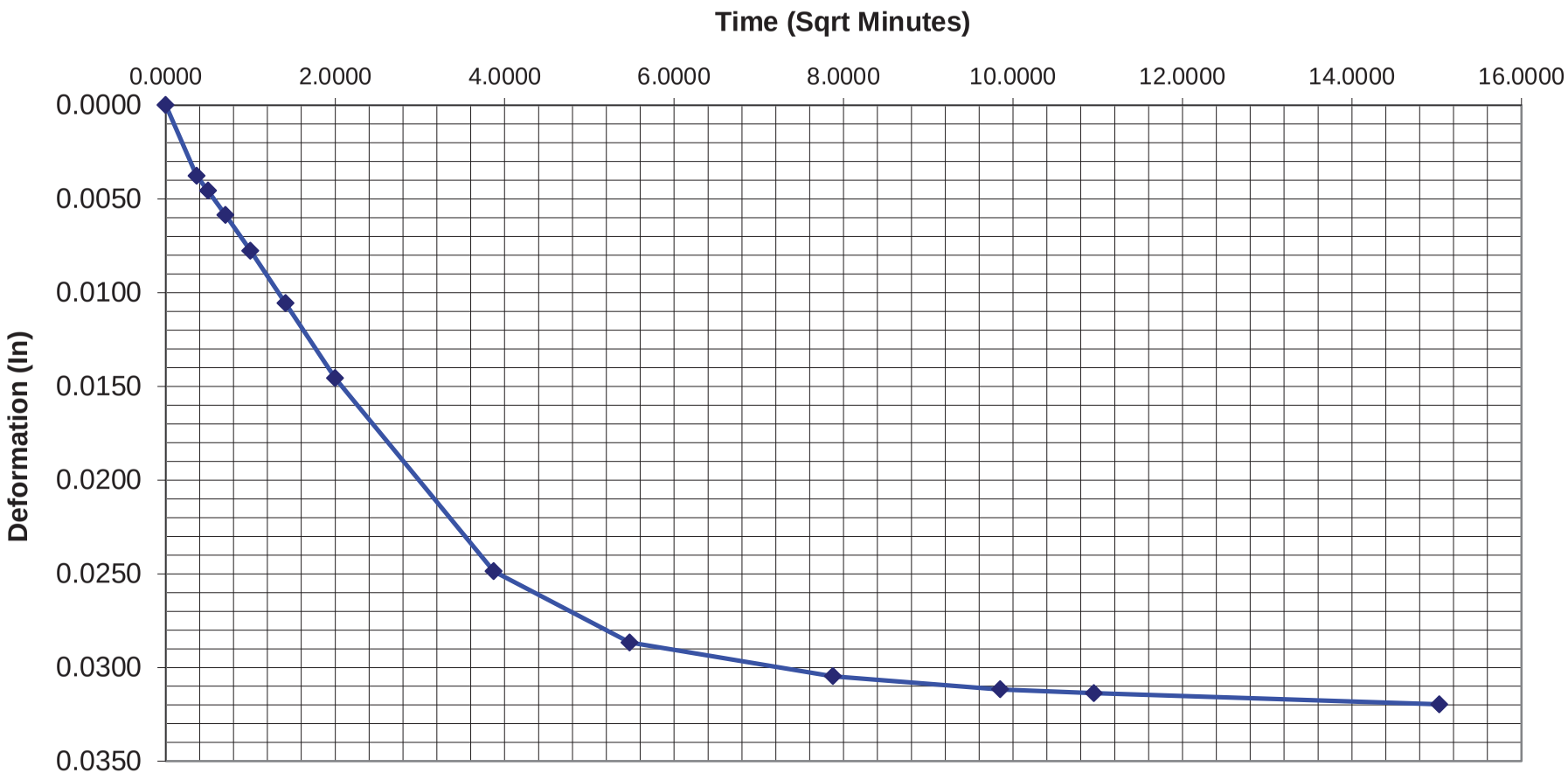


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-003U

Client : PND	Pressure: 353 psf 1.25 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.00013	Sample # 7
Date: 1/11/2013		Depth : 35' - 38'

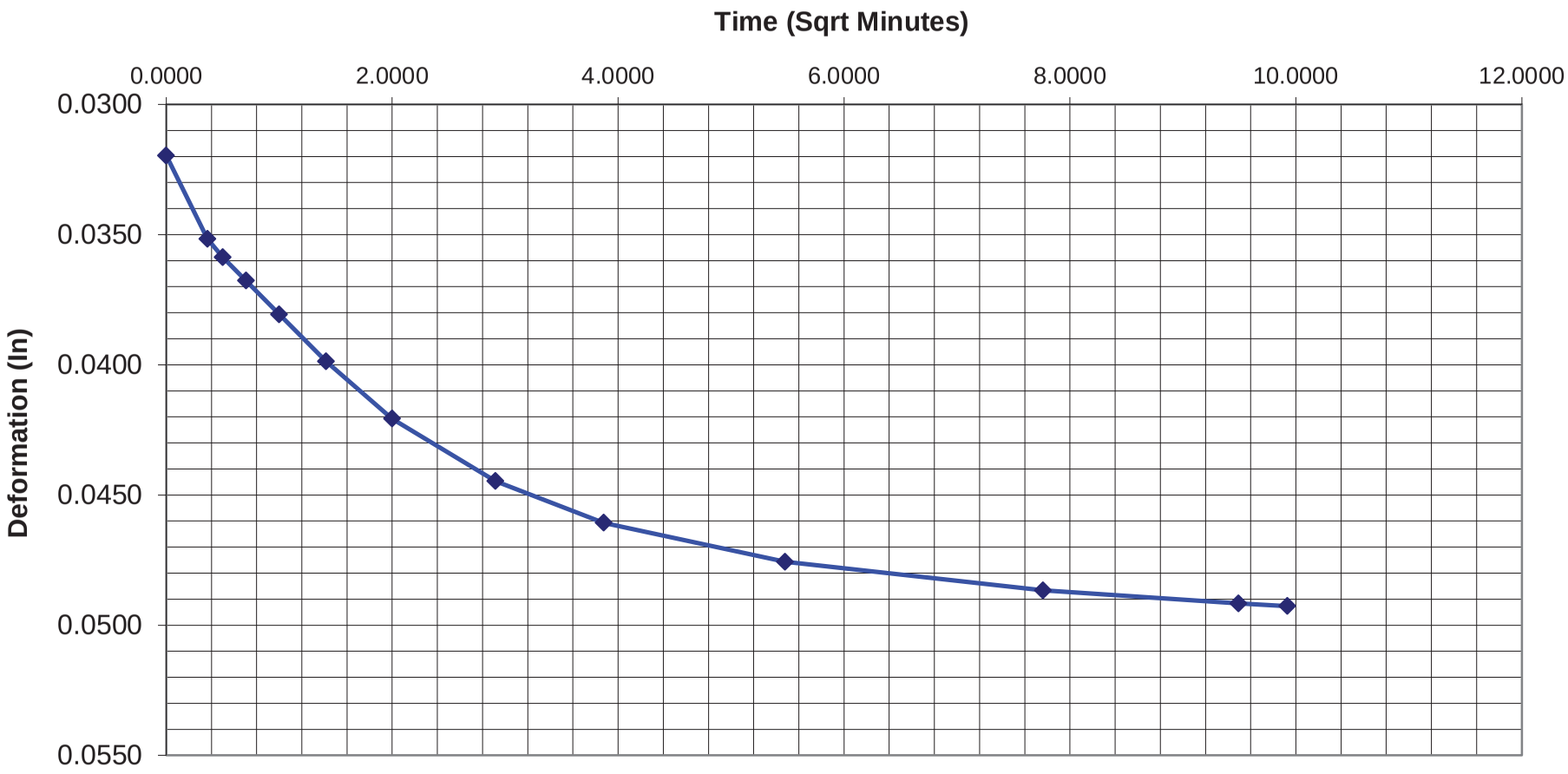


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-003U

Client : PND	Pressure: 614 psf 1.75 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.00013	Sample # 7
Date: 1/11/2013		Depth : 35' - 38'



DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-003U

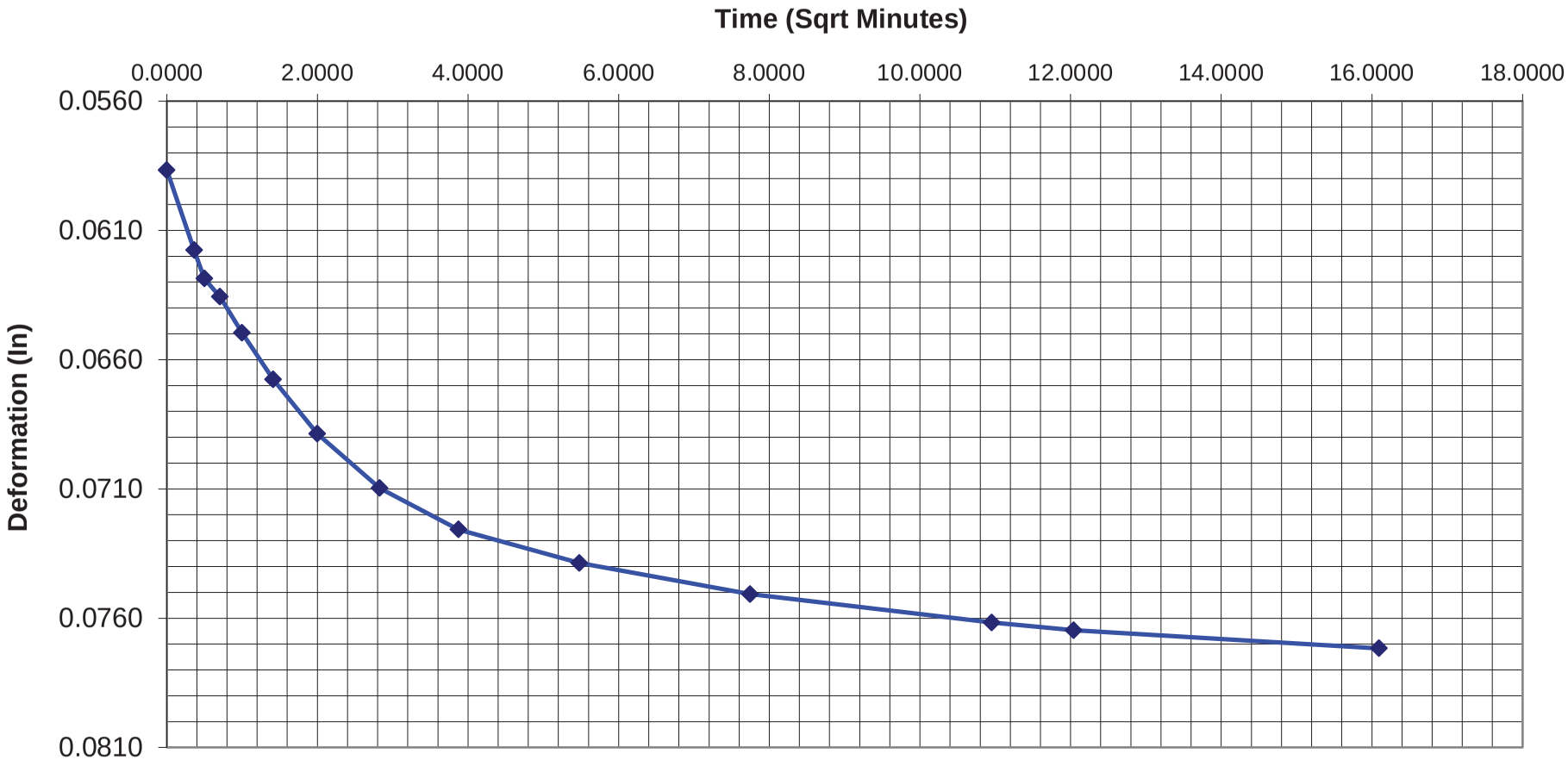
Client : PND	Pressure: 1137 psf 2 psi	Boring : BH4
Project : South Portage Cove	Deformation Correction (in): 0.00023	Sample # 7
Date: 1/11/2013		Depth : 35' - 38'

DOWL HKM

Time Rate of Consolidation

WO # A33608
Lab # 2013-003U

Client : PND	Pressure: 2381 psf 3 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.00083	Sample # 7
Date: 1/11/2013		Depth : 35' - 38'

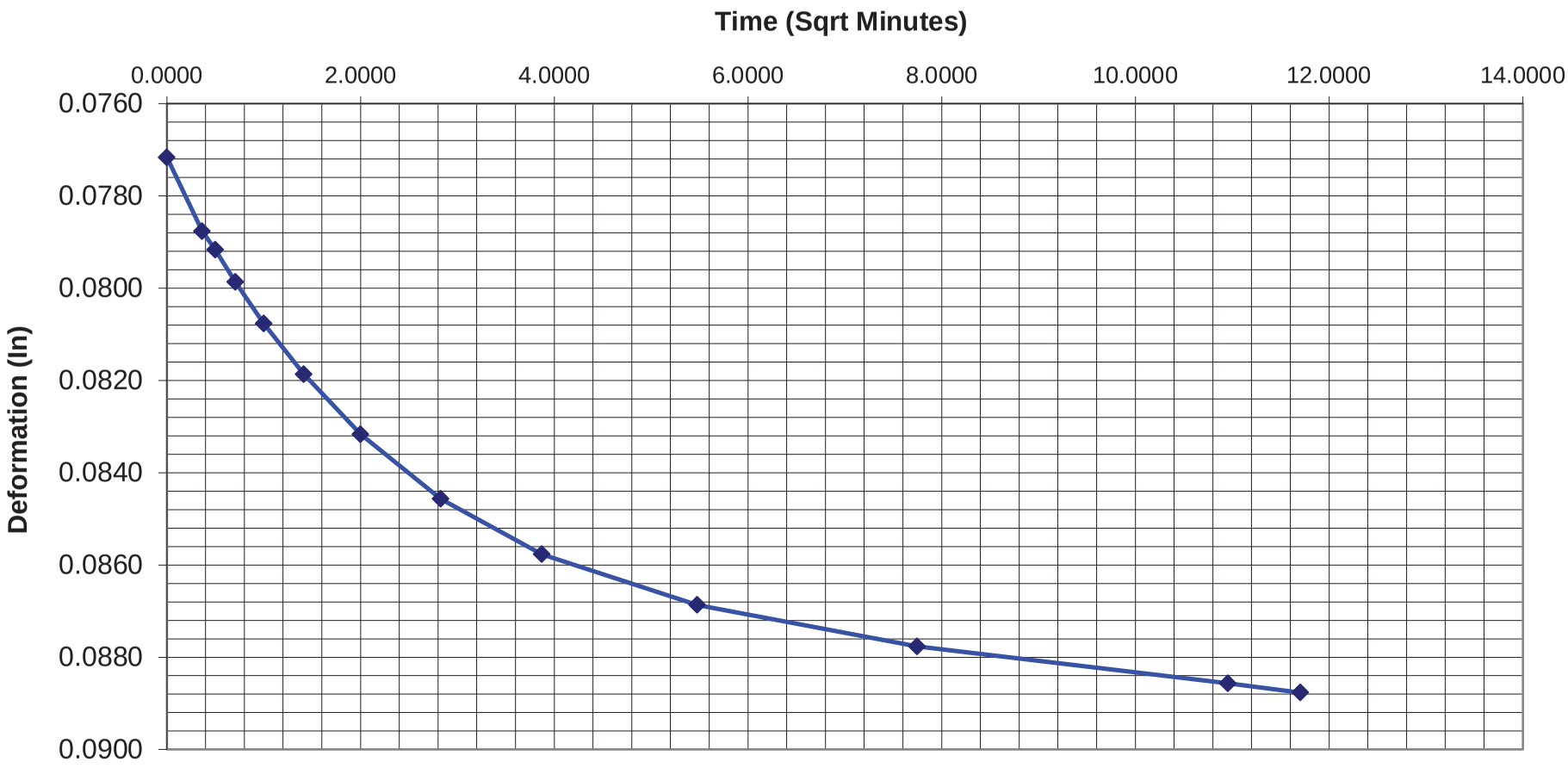


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-003U

Client : PND	Pressure: 3502 psf 4 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.00103	Sample # 7
Date: 1/11/2013		Depth : 35' - 38'

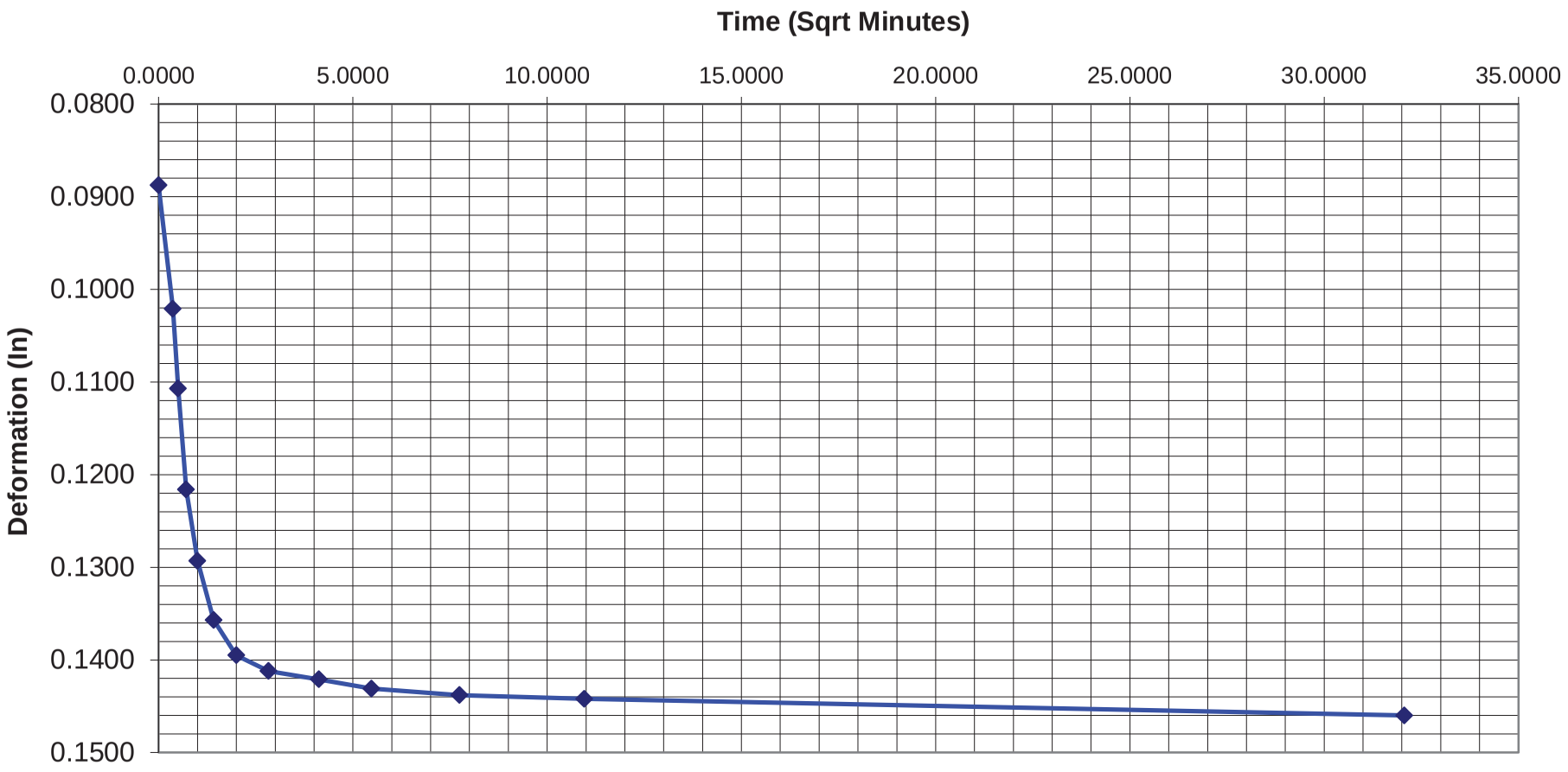


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-003U

Client : PND	Pressure: 10676 psf 10 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.0017	Sample # 7
Date: 1/11/2013		Depth : 35' - 38'

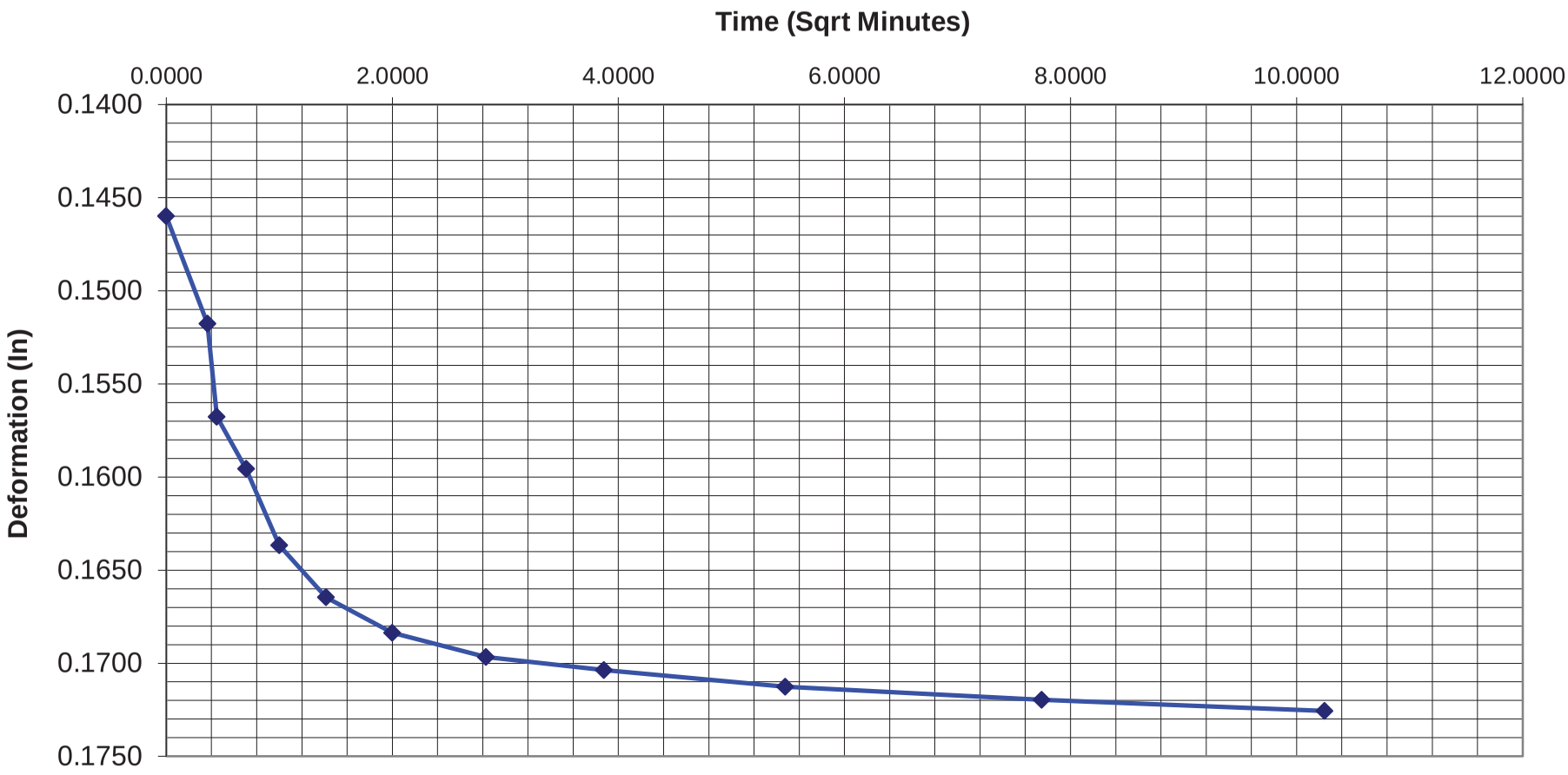


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-003U

Client : PND	Pressure: 22581 psf 20 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.00223	Sample # 7
Date: 1/11/2013		Depth : 35' - 38'

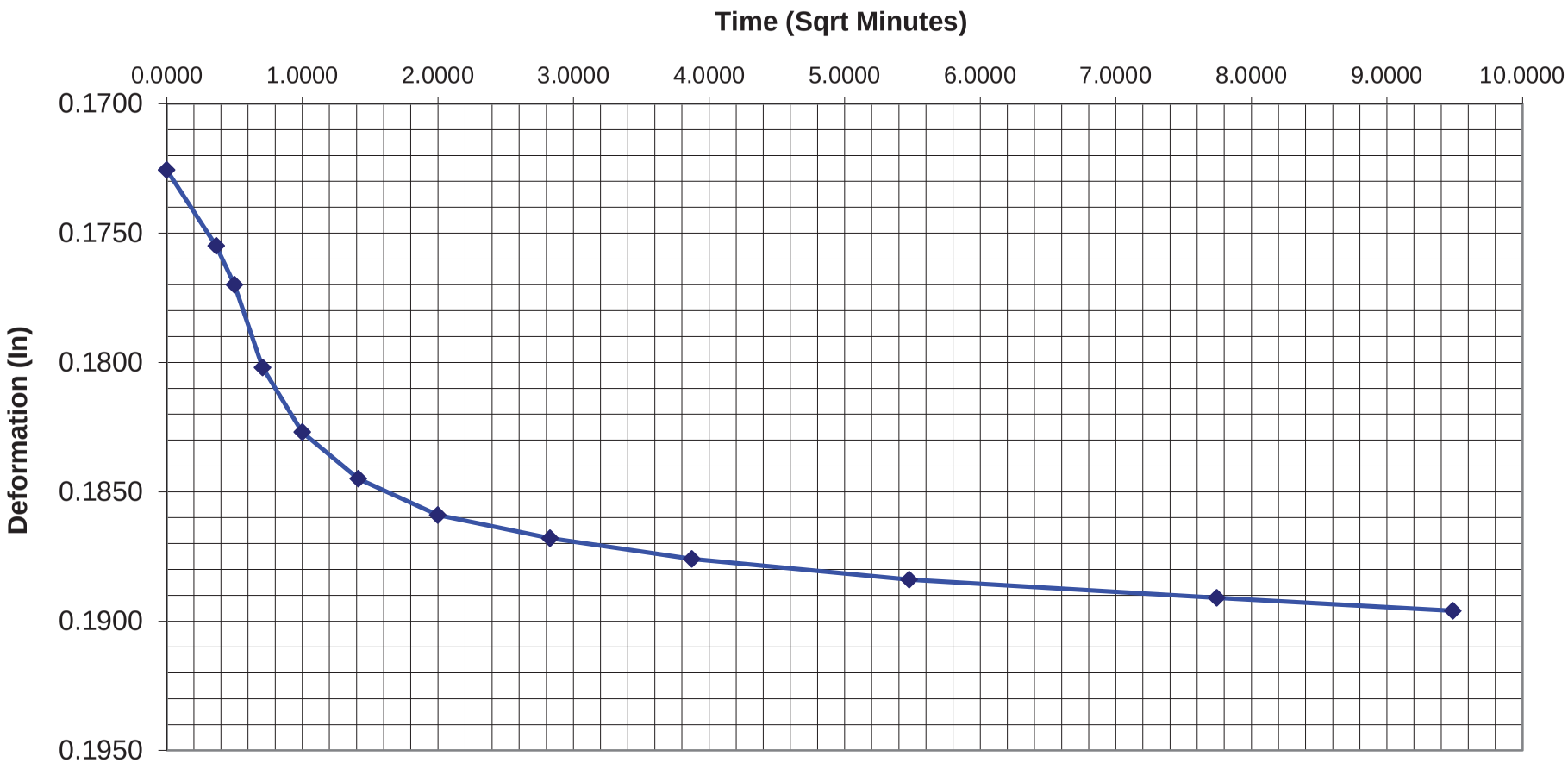


DOWL HKM

Time Rate of Consolidation

WO # A33608
Lab # 2013-003U

Client : PND	Pressure: 34717 psf 30 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.0025	Sample # 7
Date: 1/11/2013		Depth : 35' - 38'

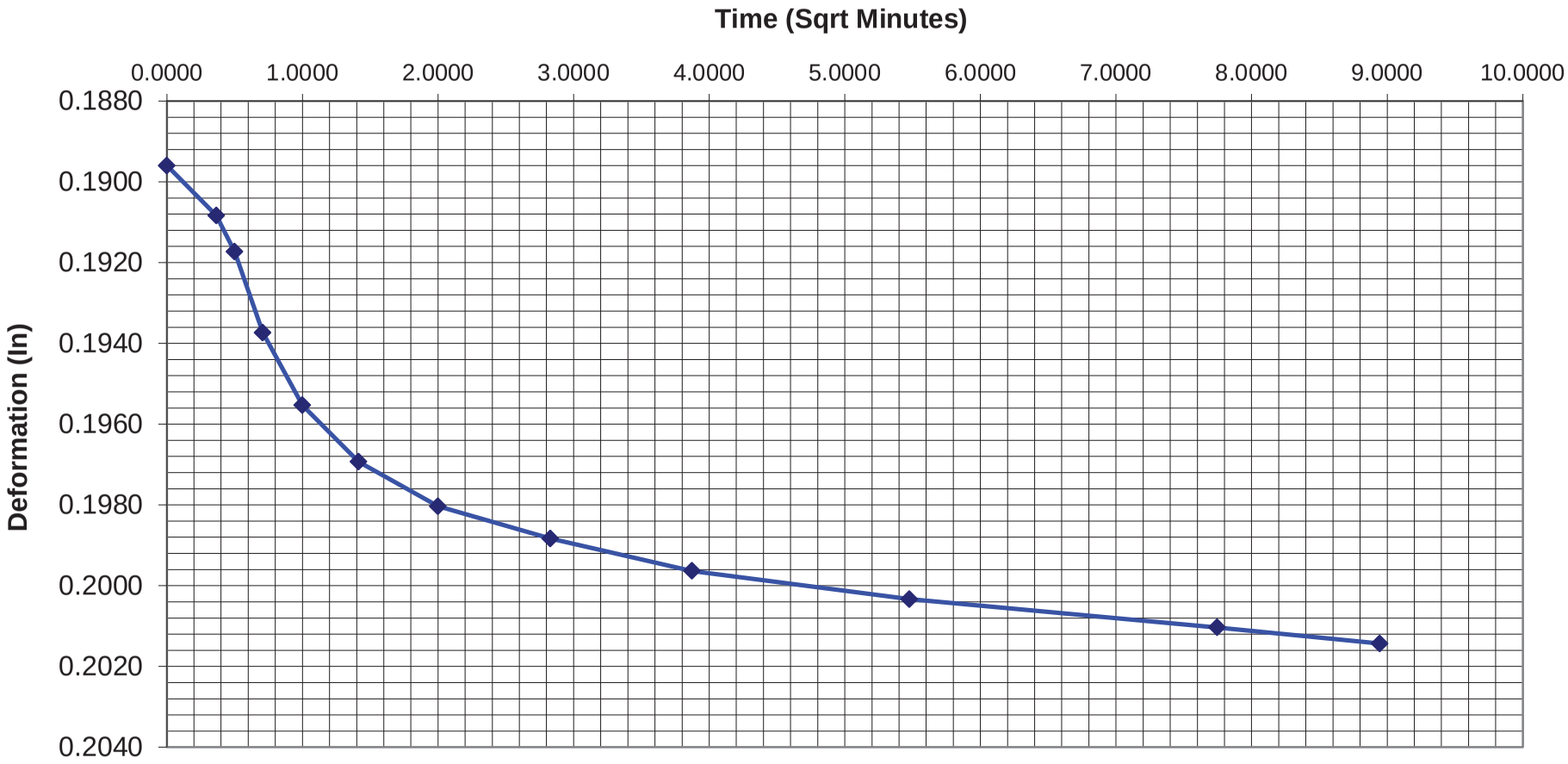


DOWL HKM

Time Rate of Consolidation

WO # A33608
Lab # 2013-003U

Client : PND	Pressure: 46867 psf 40 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.00277	Sample # 7
Date: 1/11/2013		Depth : 35' - 38'

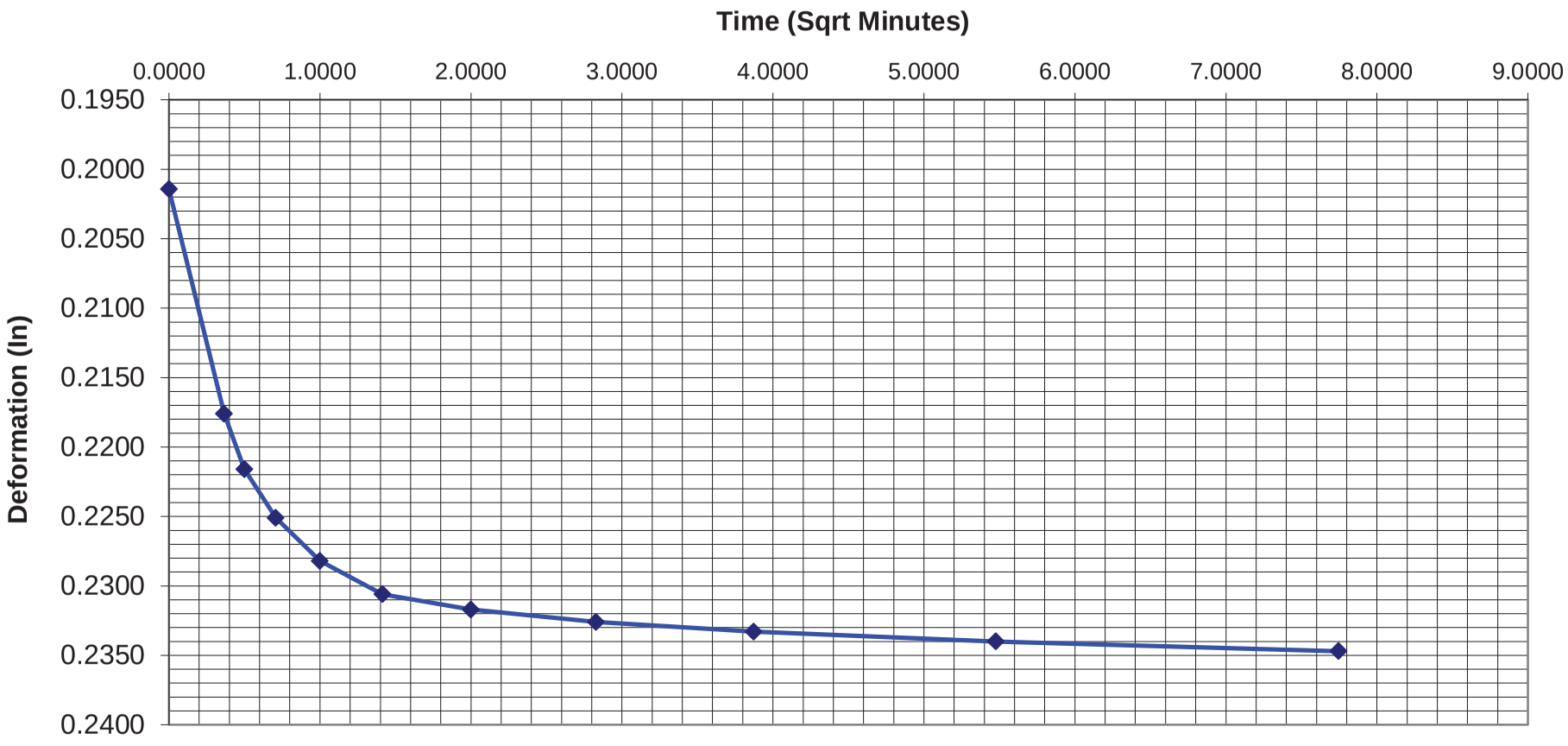


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-003U

Client : PND	Pressure: 95655 psf 80 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.0034	Sample # 7
Date: 1/11/2013		Depth : 35' - 38'

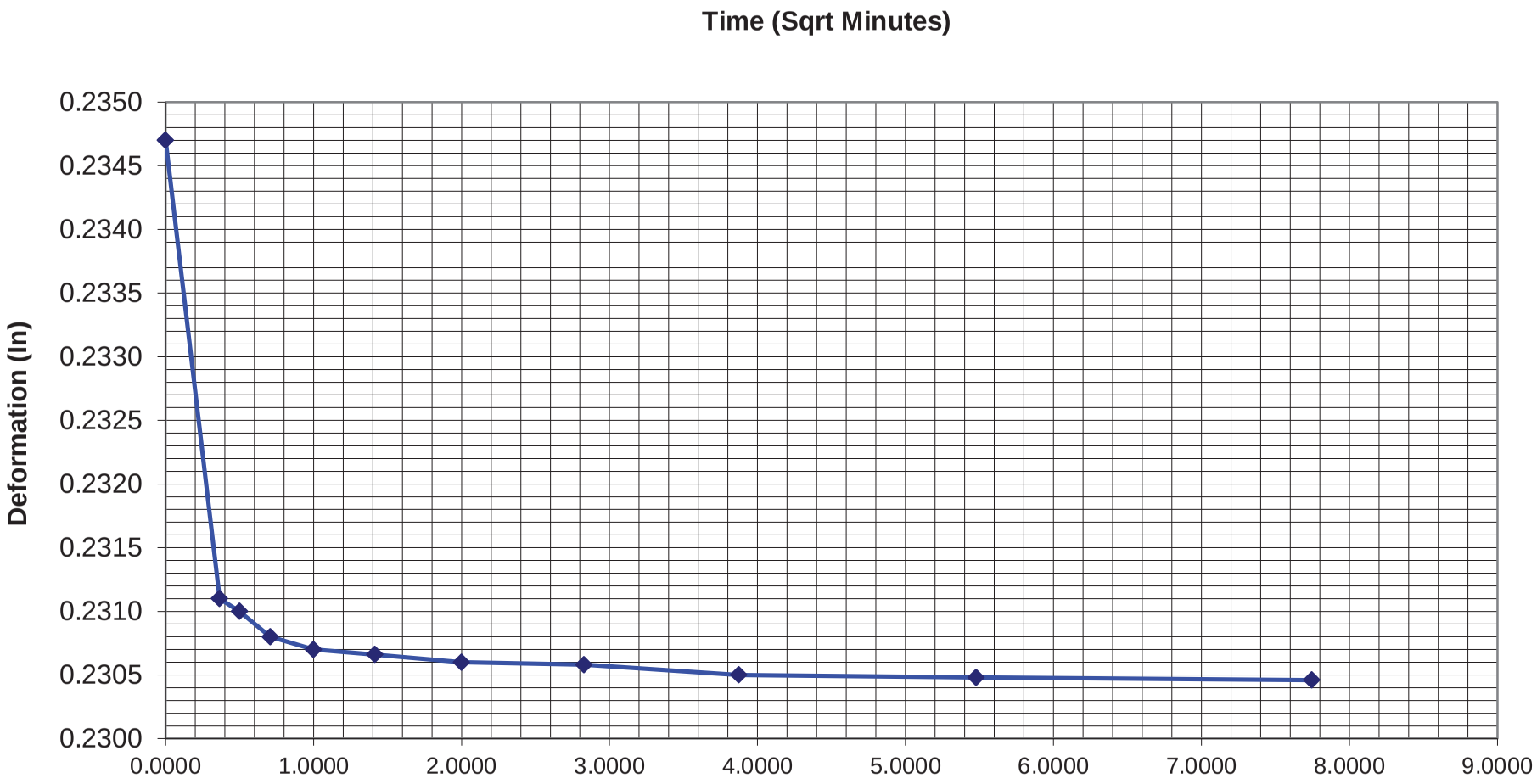


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-003U

Client : PND	Pressure: 22535 psf 20 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.0025	Sample # 7
Date: 1/11/2013	Rebound Load	Depth : 35' - 38'

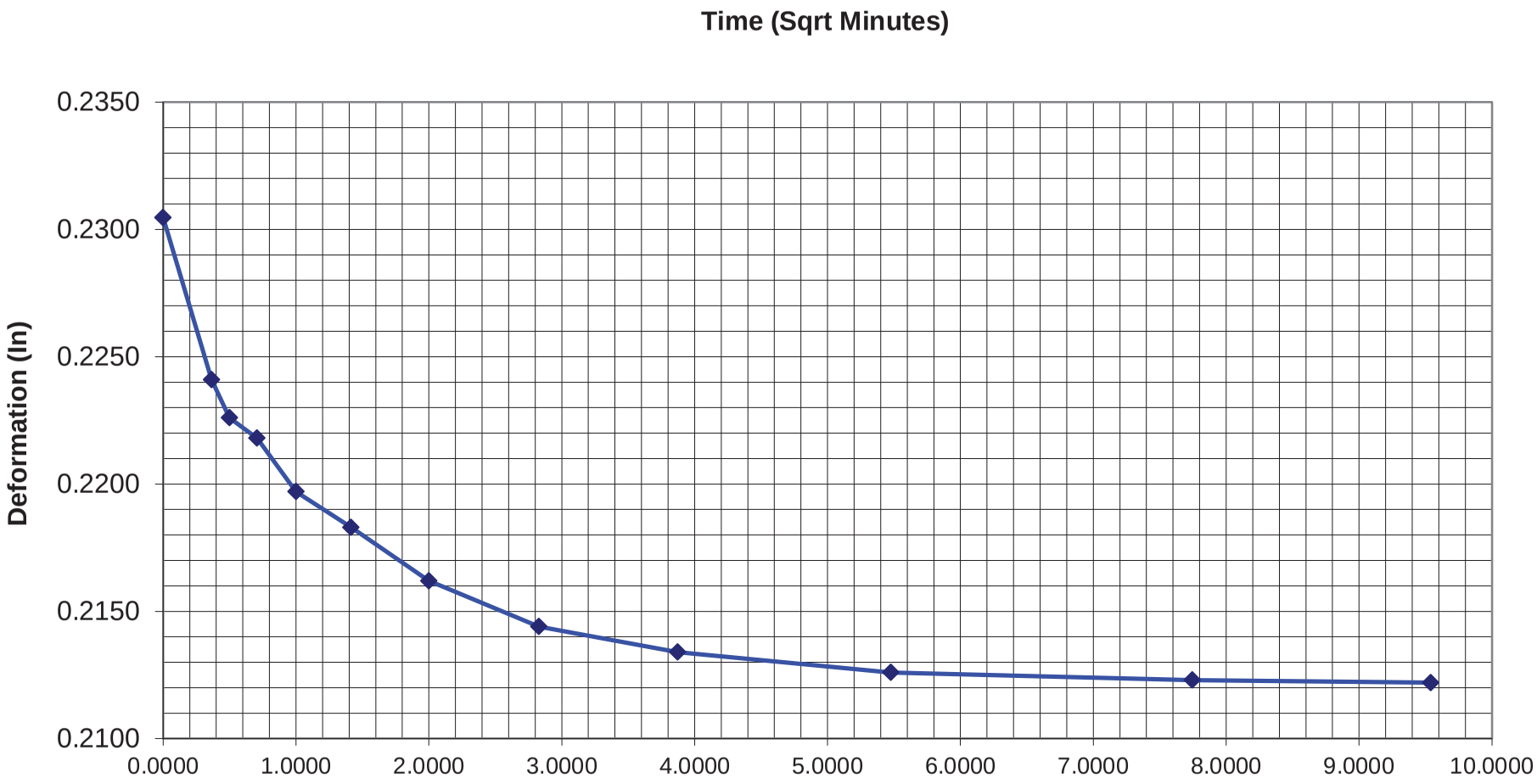


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-003U

Client : PND	Pressure: 1306 psf 2 psi	Boring : BH-4
Project : South Portage Cove	Deformation Correction (in): 0.0009	Sample # 7
Date: 1/11/2013	Rebound Load	Depth : 35' - 38'



Consolidation Report

Client :	PND	WO #	A33608	Boring :	BH-4
Project :	South Portage Cove	Lab #	2013-003U Undisturbed	Sample #	7
Date:	1/11/2013	Frame #	1	Depth :	35' - 38'

Wet Sample Weight (g)	75.22
Dry Sample Weight (g)	58.03
Sample Height (in)	1.00
Ring Diameter (in)	1.99
Dry Density (lb/ft3)	70.82
Wet Density (lb/ft3)	91.80
Area of Sample (in2)	3.12
Volume of Sample (in3)	3.12
Volume of Solids (in3)	1.34
Height of Solids (in)	0.43
Initial Height of Voids (in)	0.57
Initial Volume of Voids (in3)	1.79
Volume of Water (in3)	1.05
Initial Degree of Saturation (%)	58.70
Initial Void Ratio, e0	1.33
0.42 e0	0.56
specific gravity	2.65
Volume of Solids	0.43
Volume of Voids	0.57

Load Number	Guage Pressure	Load (lb)	Pressure (ksf)	Δ Height (in)	Void Ratio	% Change
Seating	1	1.333	0.061	0.000	1.335	0.00
1	1.25	7.667	0.353	0.032	1.262	3.20%
2	1.75	13.333	0.614	0.049	1.222	4.93%
3	2	24.667	1.137	0.059	1.200	5.87%
4	3	51.667	2.381	0.077	1.157	7.72%
5	4	76.000	3.502	0.089	1.129	8.88%
6	10	231.667	10.676	0.146	0.996	14.61%
7	20	490.000	22.581	0.173	0.934	17.27%
8	30	753.333	34.717	0.190	0.894	18.97%
9	40	1017.000	46.867	0.201	0.866	20.15%
10	80	2075.667	95.655	0.235	0.788	23.48%
11	20	489.000	22.535	0.230	0.798	23.06%
12	2	28.333	1.306	0.212	0.841	21.23%

Moisture Content

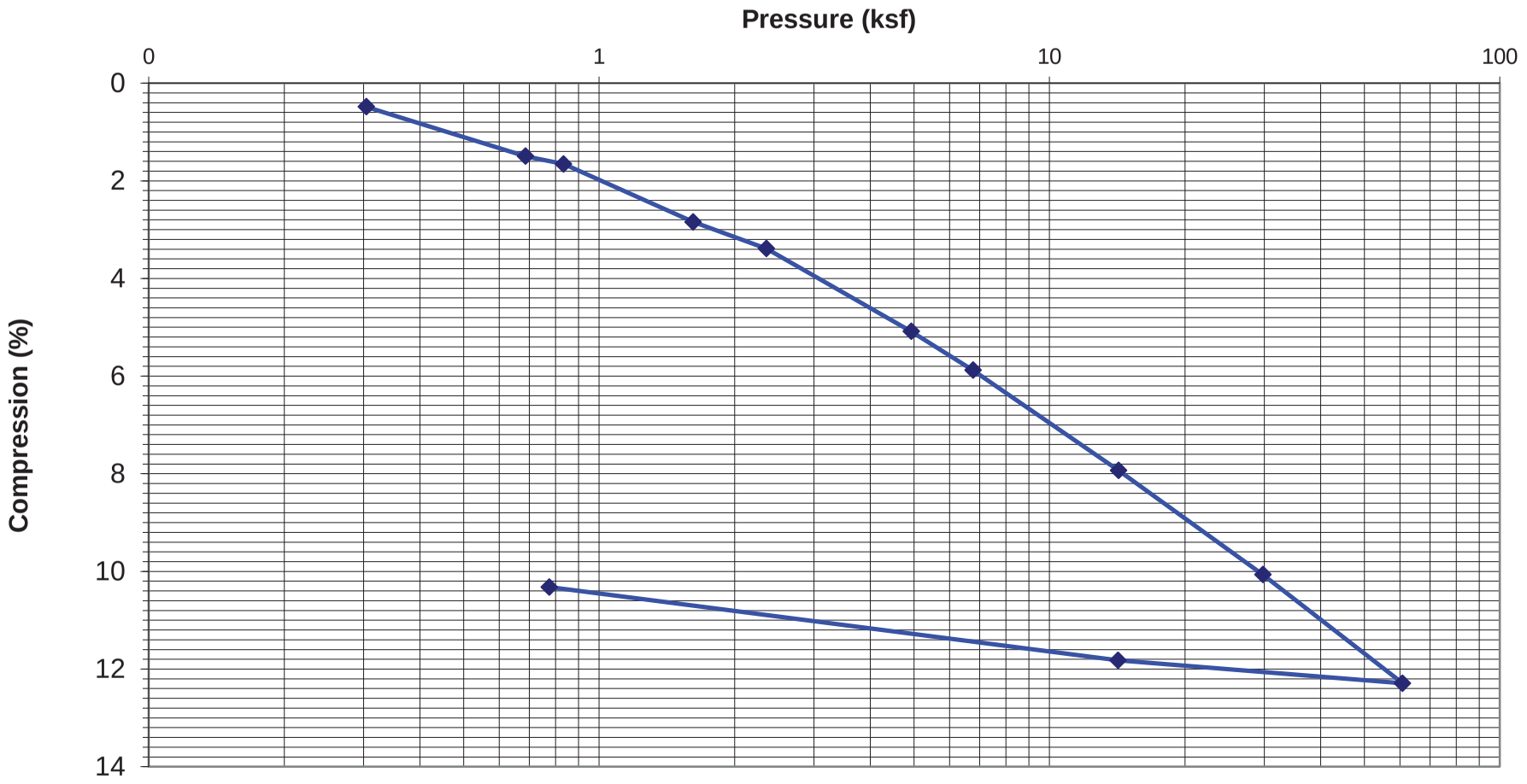
	Trimmings	Initial	Final
Wet + Tare	17.21		590.02
Dry + Tare	13.52		574.21
Tare	1.06		497.75
Wet Weight	16.15	75.22	92.27
Wt. Water	3.69		15.81
Wt. Dry Soil	12.46		76.46
% Moisture	29.6		21

DOWL HKM

Compression Curve (% Comp. vs. Log P)

WO #	A33608
Lab #	2013-005

Client :	PND	Moisture Content =	22.5 %	Boring :	BH-5
Project :	South Portage Cove	Dry Unit Weight (pcf) =	107.0	Sample #	4
Date:	1/18/2013	Wet Unit Weight (pcf)=	131.1	Depth :	20' - 23'



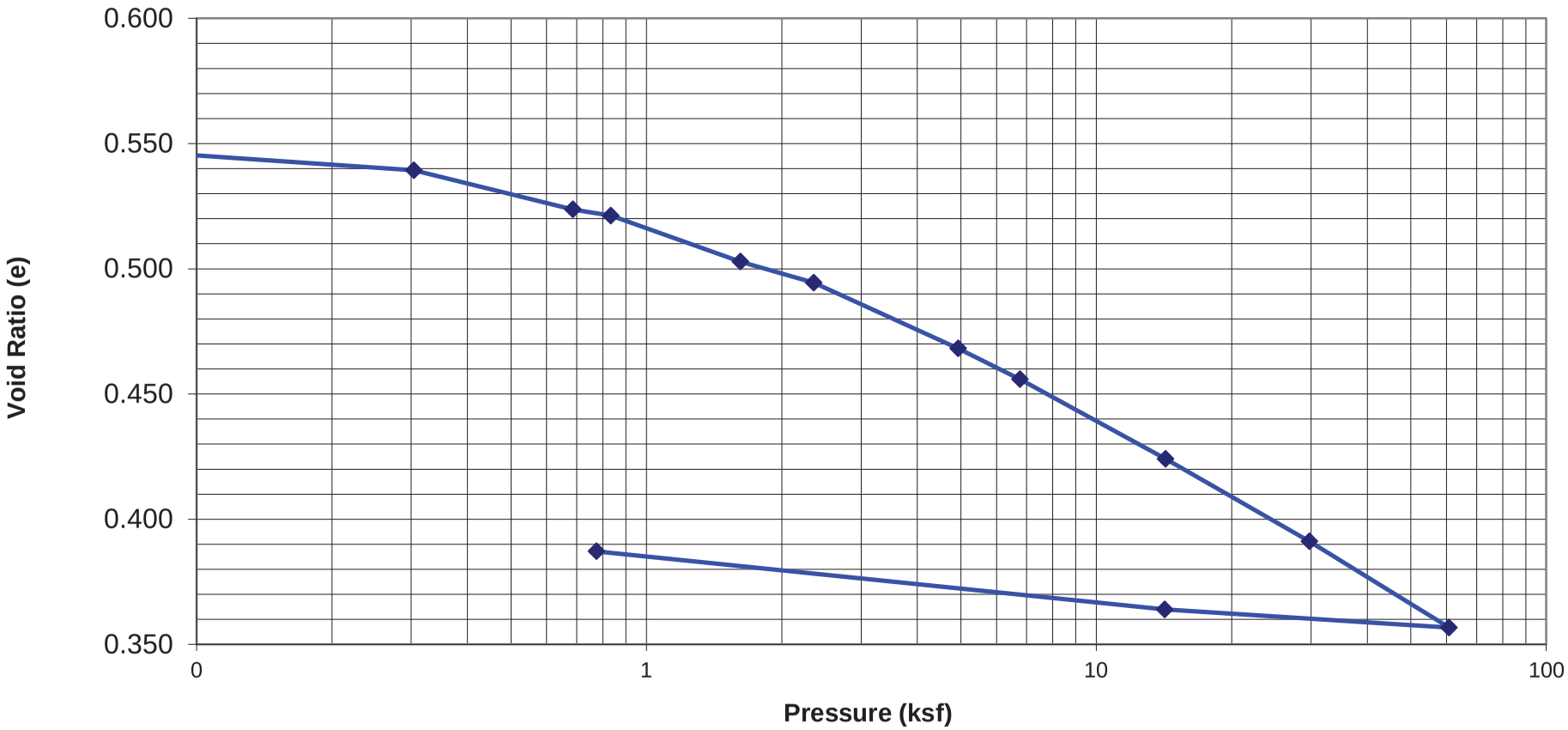
DOWL HKM

Compression Curve (e vs. Log P)

WO #	A33608
Lab #	2013-005

Client :	PND	Moisture Content =	22.5 %	Boring :	BH-5
Project :	South Portage Cove	Dry Unit Weight (pcf) =	107.0	Sample #	4
Date:	1/18/2013	Wet Unit Weight (pcf)=	131.1	Depth :	20' - 23'

e_o = 0.545

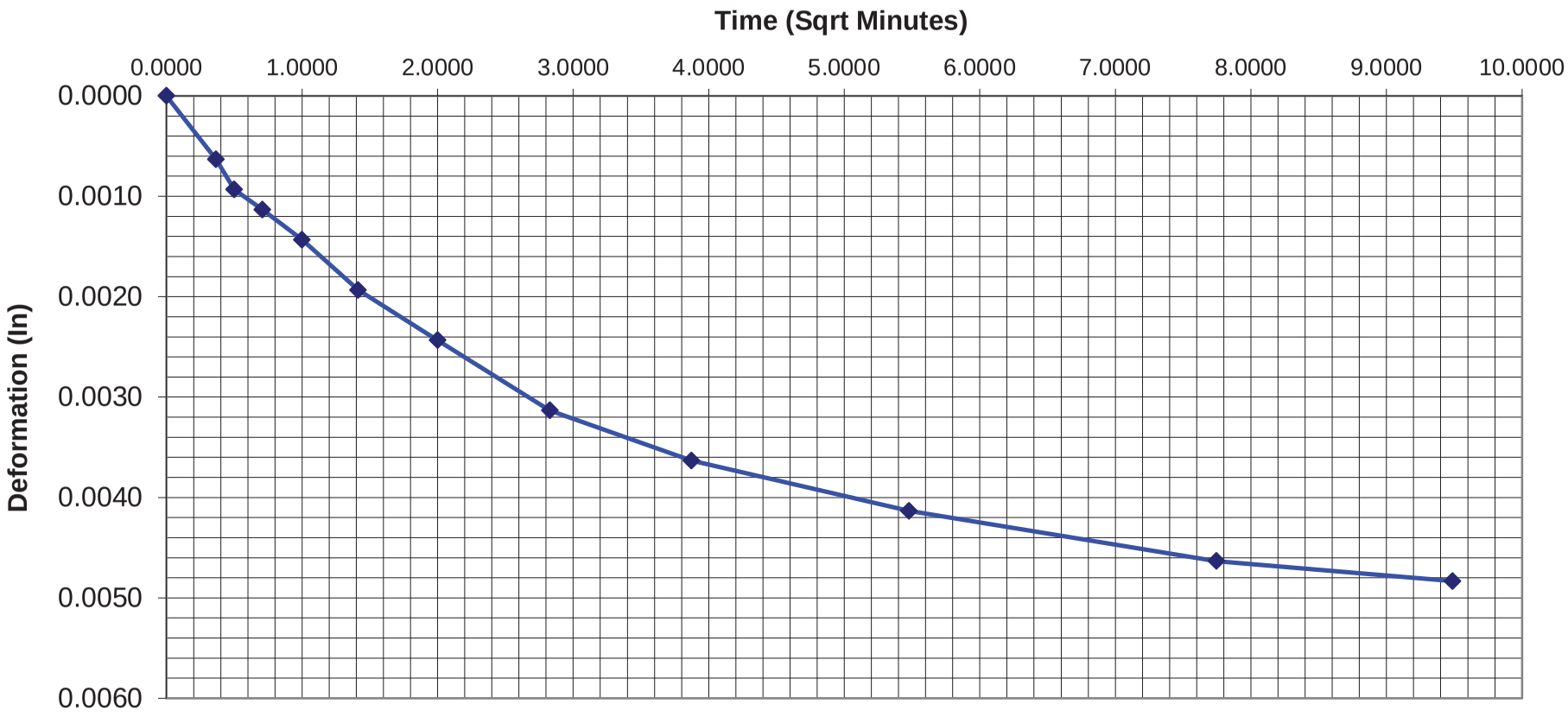


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-005

Client : PND	Pressure: 304 psf 1.25 psi	Boring : BH-5
Project : South Portage Cove	Deformation Correction (in): 0.00057	Sample # 4
Date: 1/18/2013		Depth : 20' - 23'

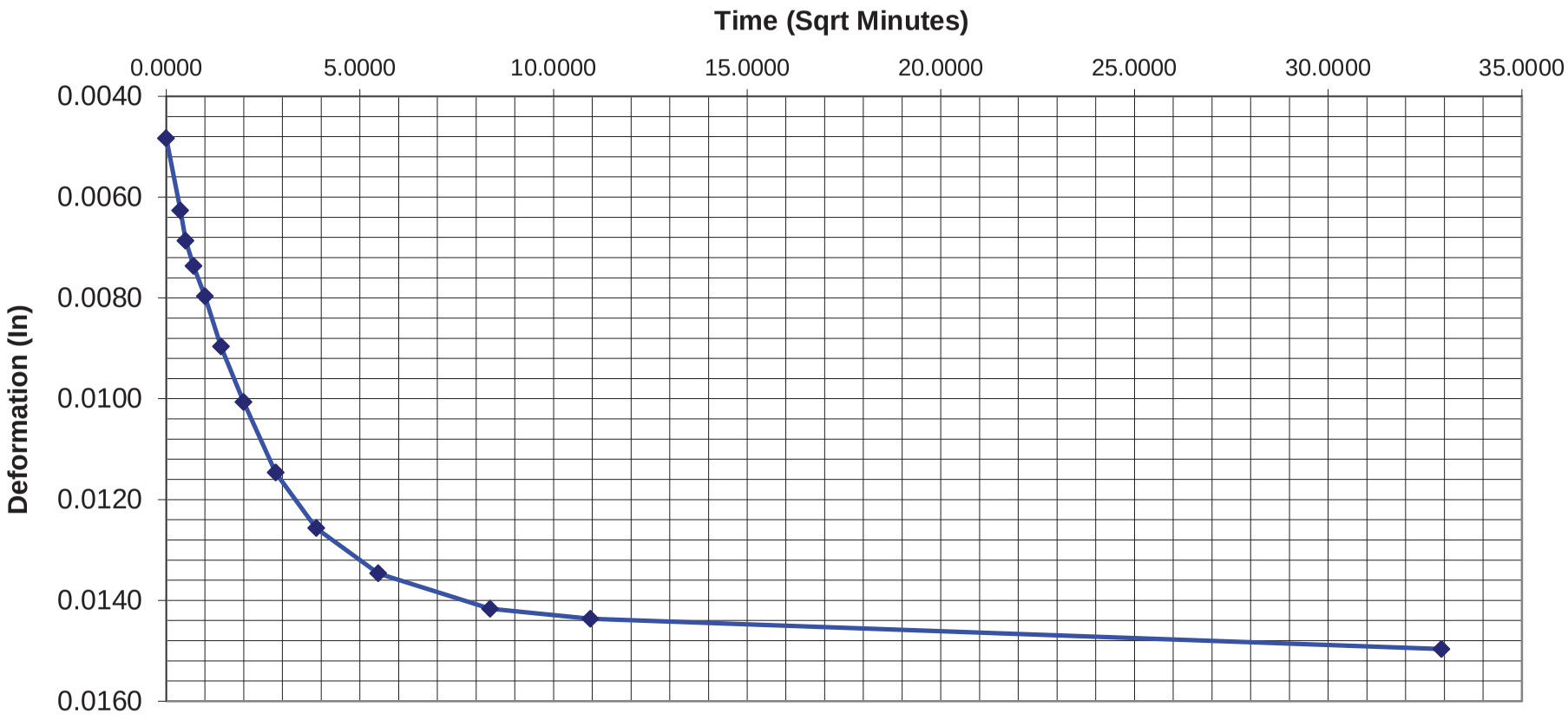


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-005

Client : PND	Pressure: 687 psf 1.75 psi	Boring : BH-5
Project : South Portage Cove	Deformation Correction (in): 0.00073	Sample # 4
Date: 1/18/2013		Depth : 20' - 23'



DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-005

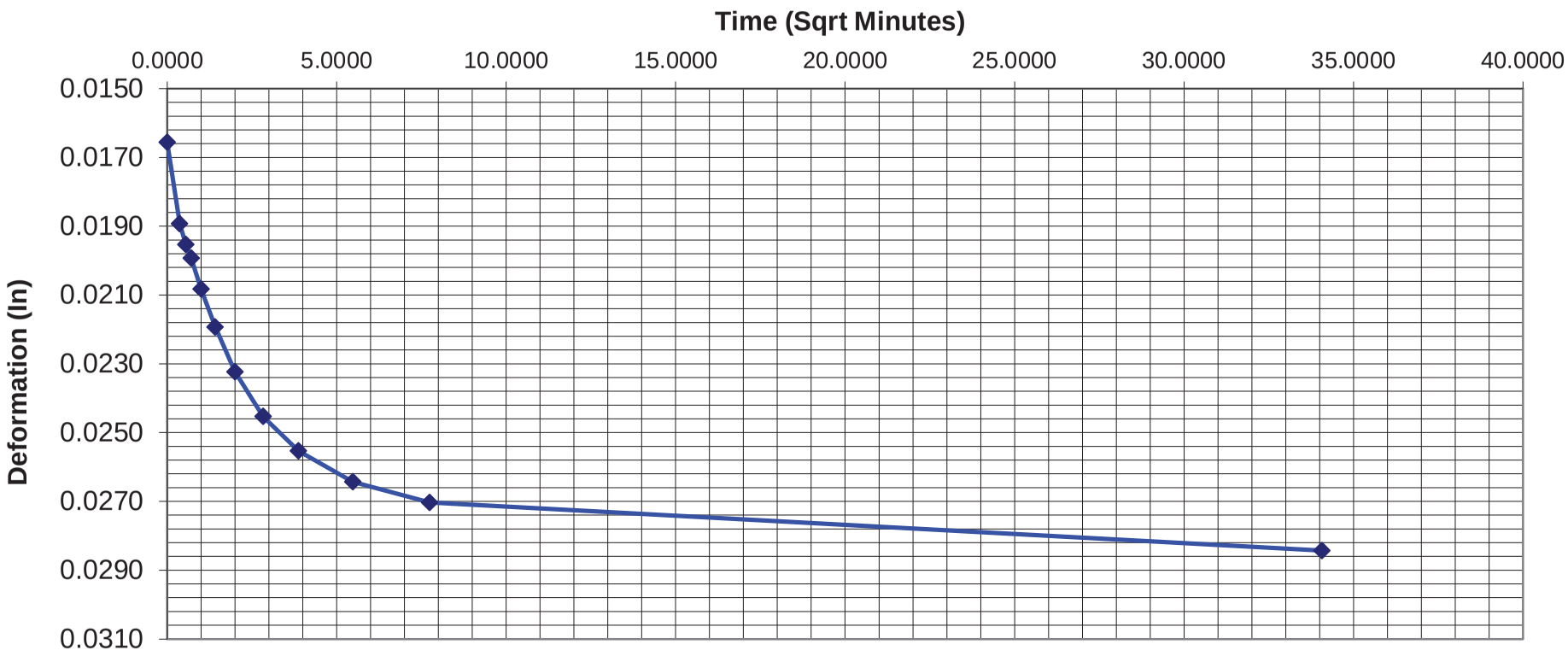
Client : PND	Pressure: 834 psf 2 psi	Boring : BH5
Project : South Portage Cove	Deformation Correction (in): 0.00077	Sample # 4
Date: 1/18/2013		Depth : 20' - 23'

DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-005

Client : PND	Pressure: 1619 psf 3 psi	Boring : 5
Project : South Portage Cove	Deformation Correction (in): 0.00077	Sample # 4
Date: 1/18/2013		Depth : 20' - 23'

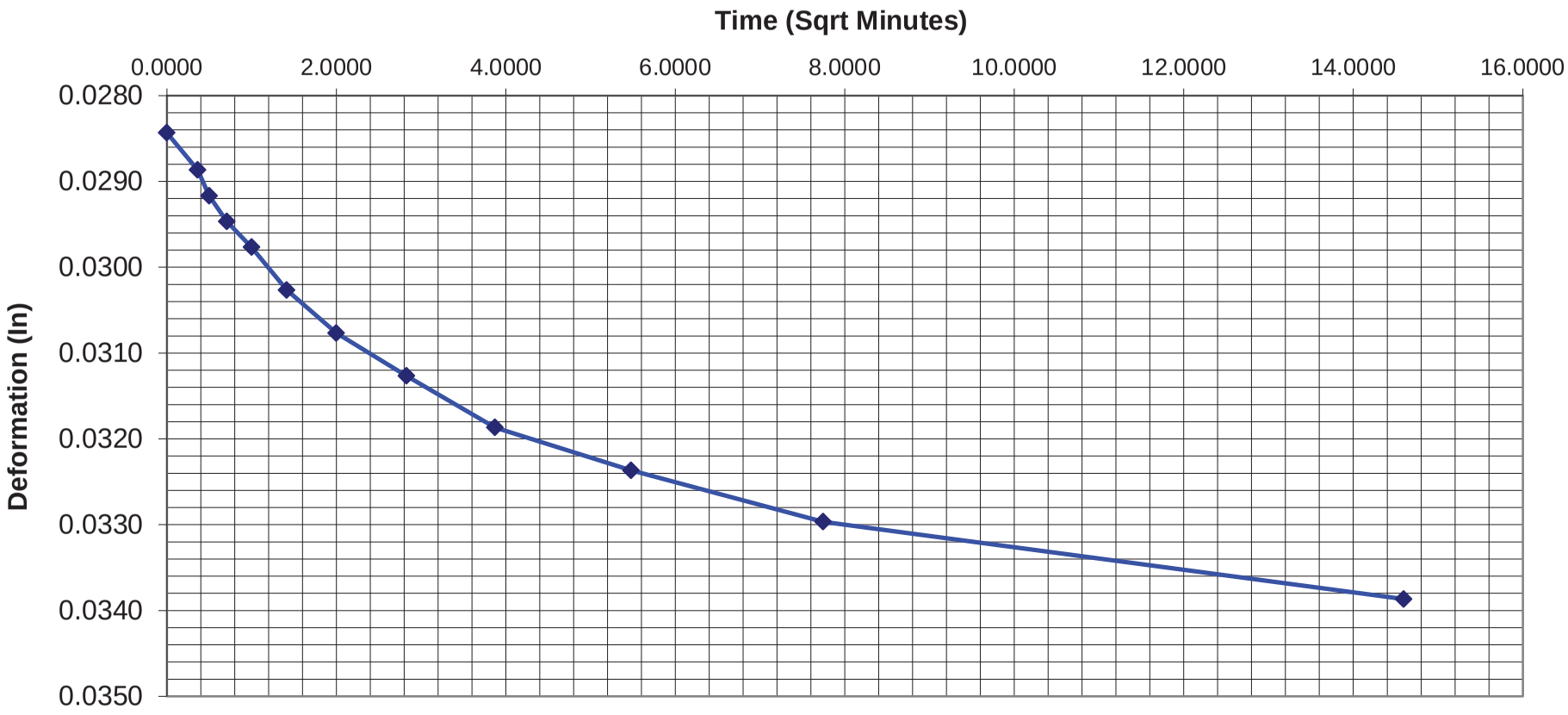


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-005

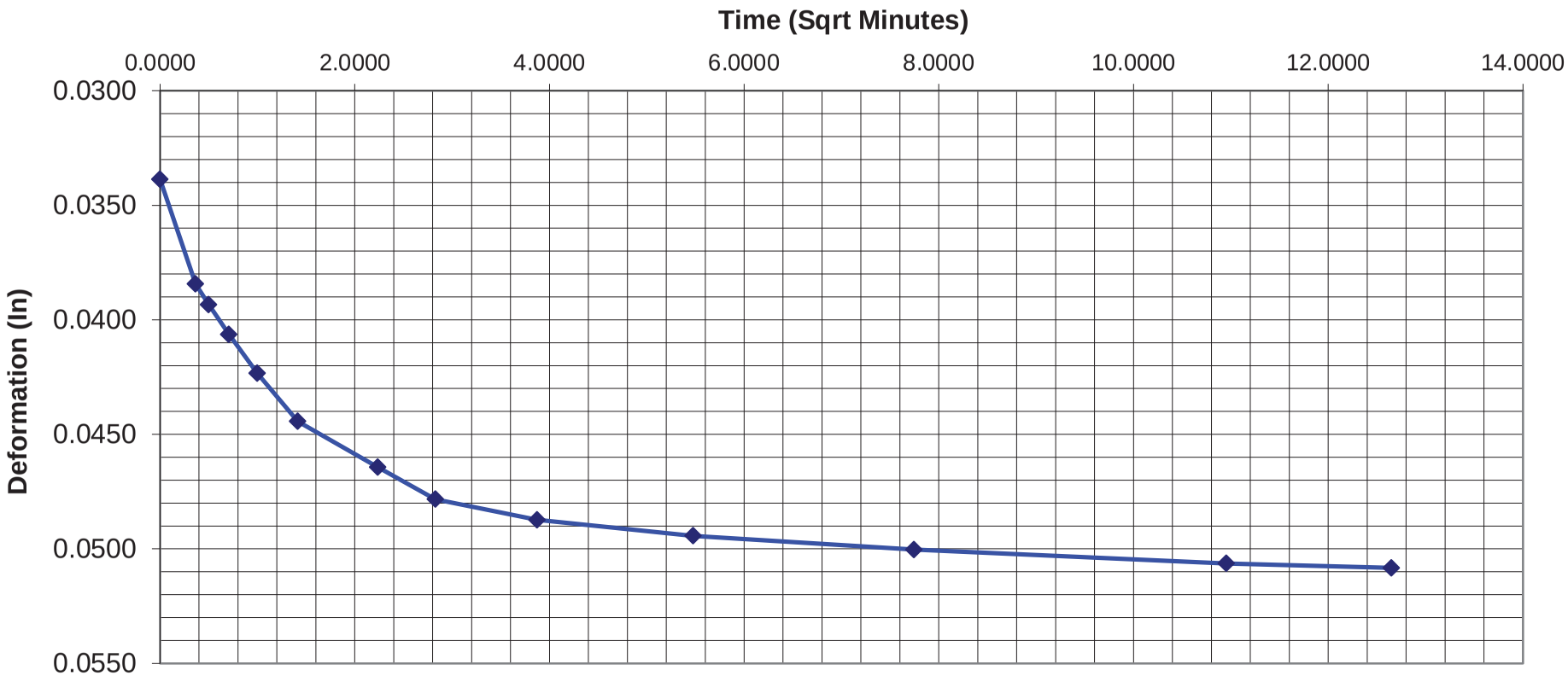
Client : PND	Pressure: 2355 psf 4 psi	Boring : BH-5
Project : South Portage Cove	Deformation Correction (in): 0.00093	Sample # 4
Date: 1/18/2013		Depth : 20' - 23'



Time Rate of Consolidation

WO #	A33608
Lab #	2013-005

Client : PND	Pressure: 4935 psf 7.5 psi	Boring : BH-5
Project : South Portage Cove	Deformation Correction (in): 0.00137	Sample # 4
Date: 1/18/2013		Depth : 20' - 23'

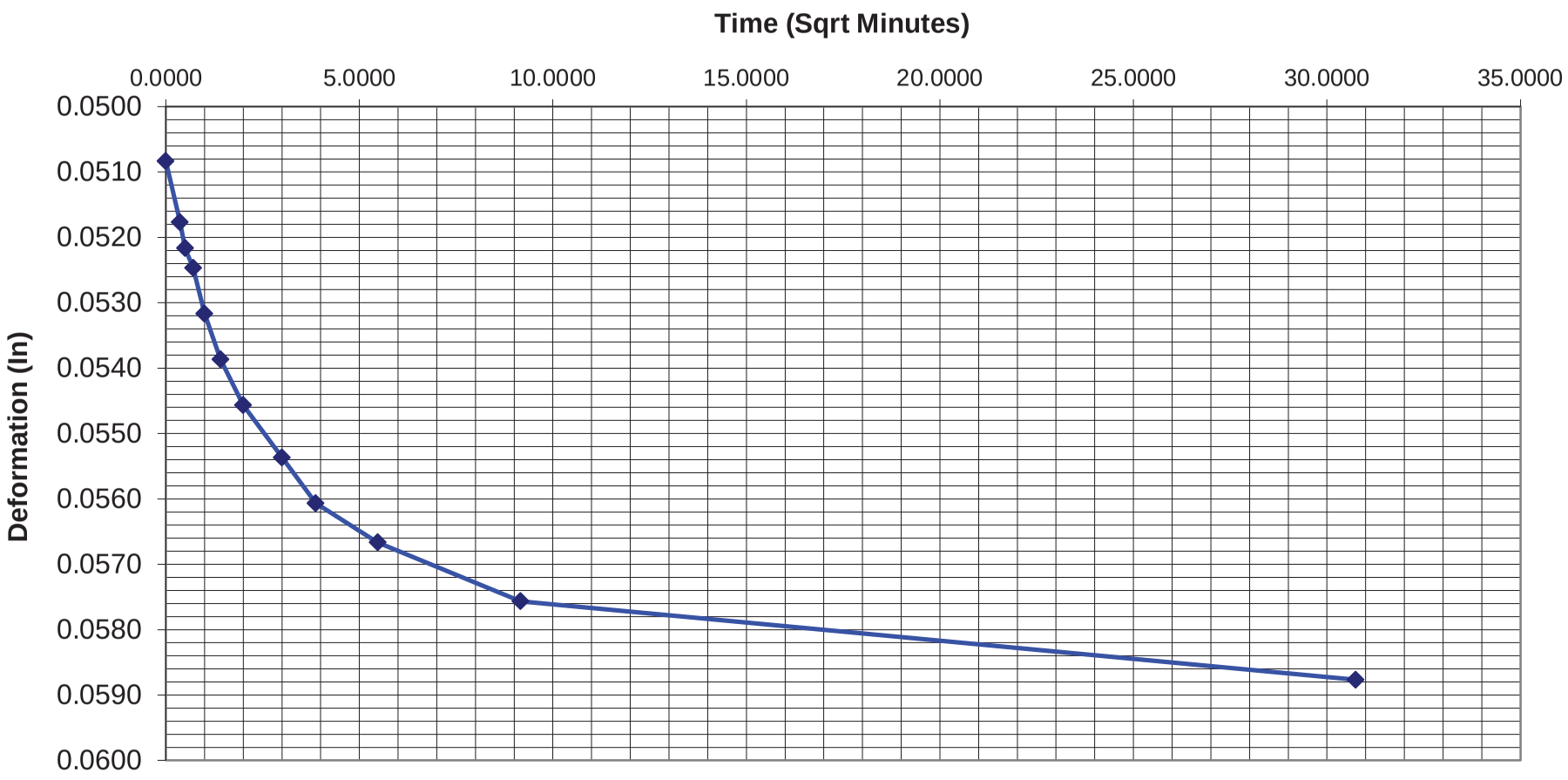


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-005

Client : PND	Pressure: 6769 psf 10 psi	Boring : BH-5
Project : South Portage Cove	Deformation Correction (in): 0.00163	Sample # 4
Date: 1/18/2013		Depth : 20' - 23'

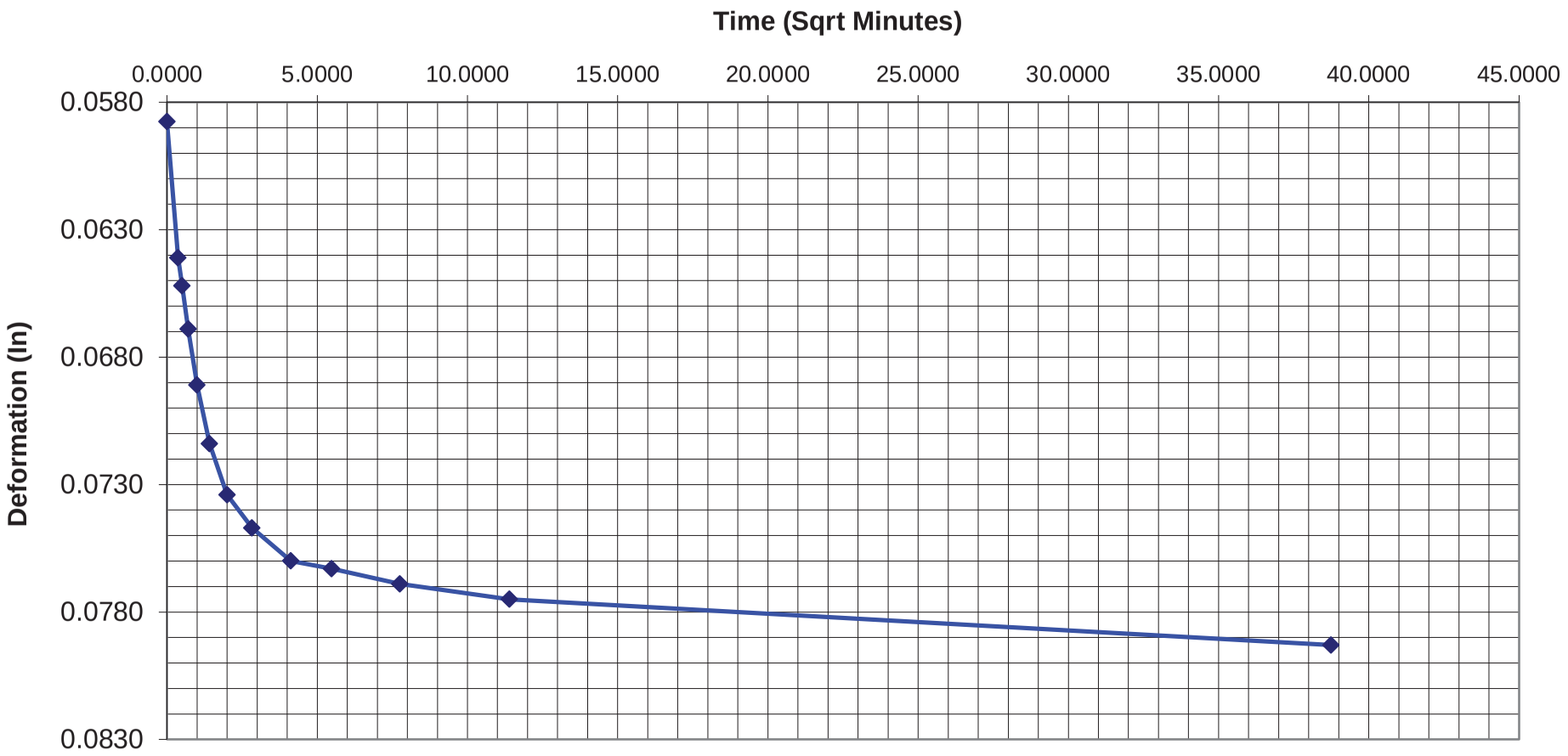


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-005

Client : PND	Pressure: 14255 psf 20 psi	Boring : BH-5
Project : South Portage Cove	Deformation Correction (in): 0.0022	Sample # 4
Date: 1/18/2013		Depth : 20' - 23'

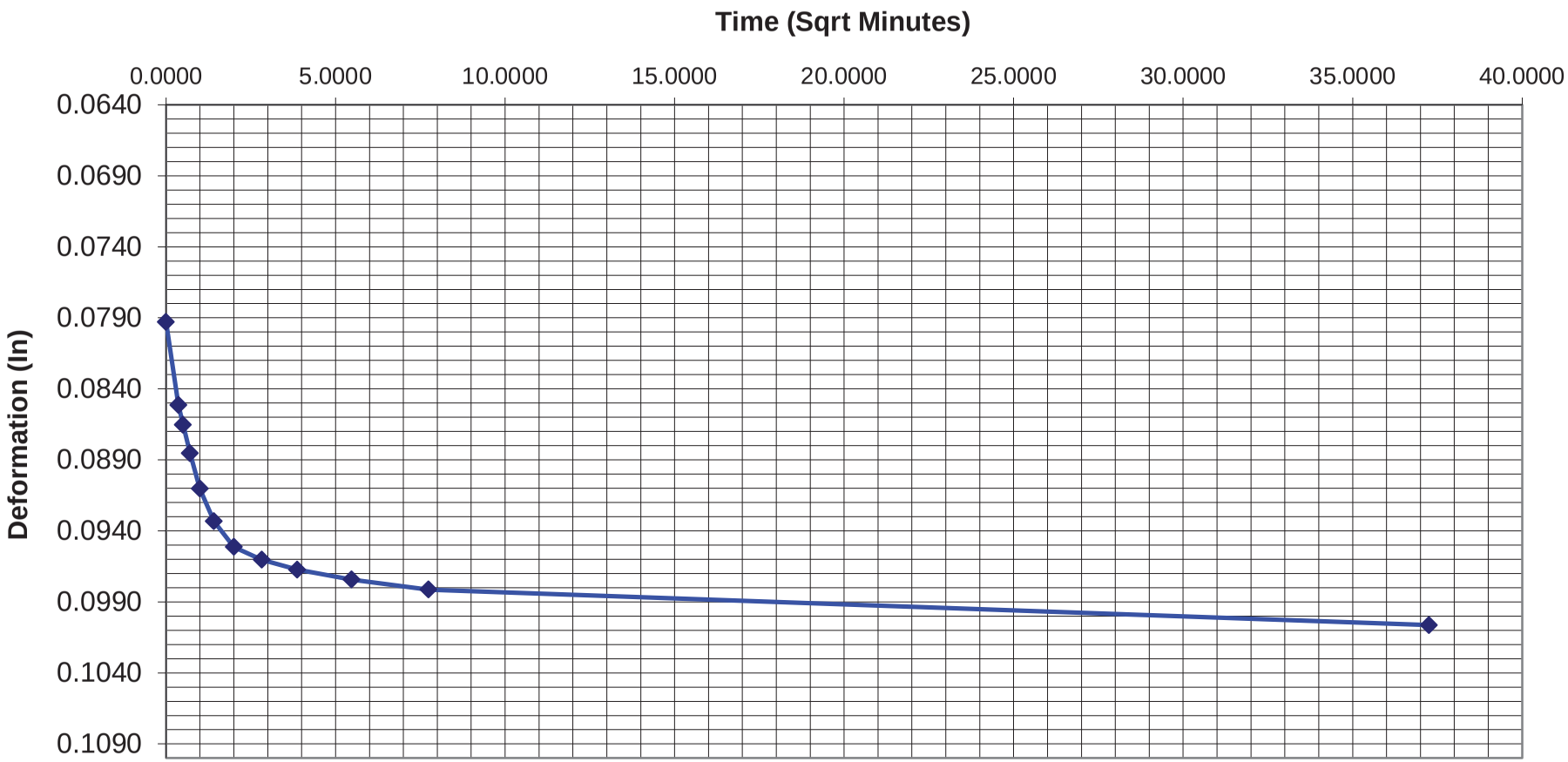


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-005

Client : PND	Pressure: 29795 psf 40 psi	Boring : BH-5
Project : South Portage Cove	Deformation Correction (in): 0.00297	Sample # 4
Date: 1/18/2013		Depth : 20' - 23'

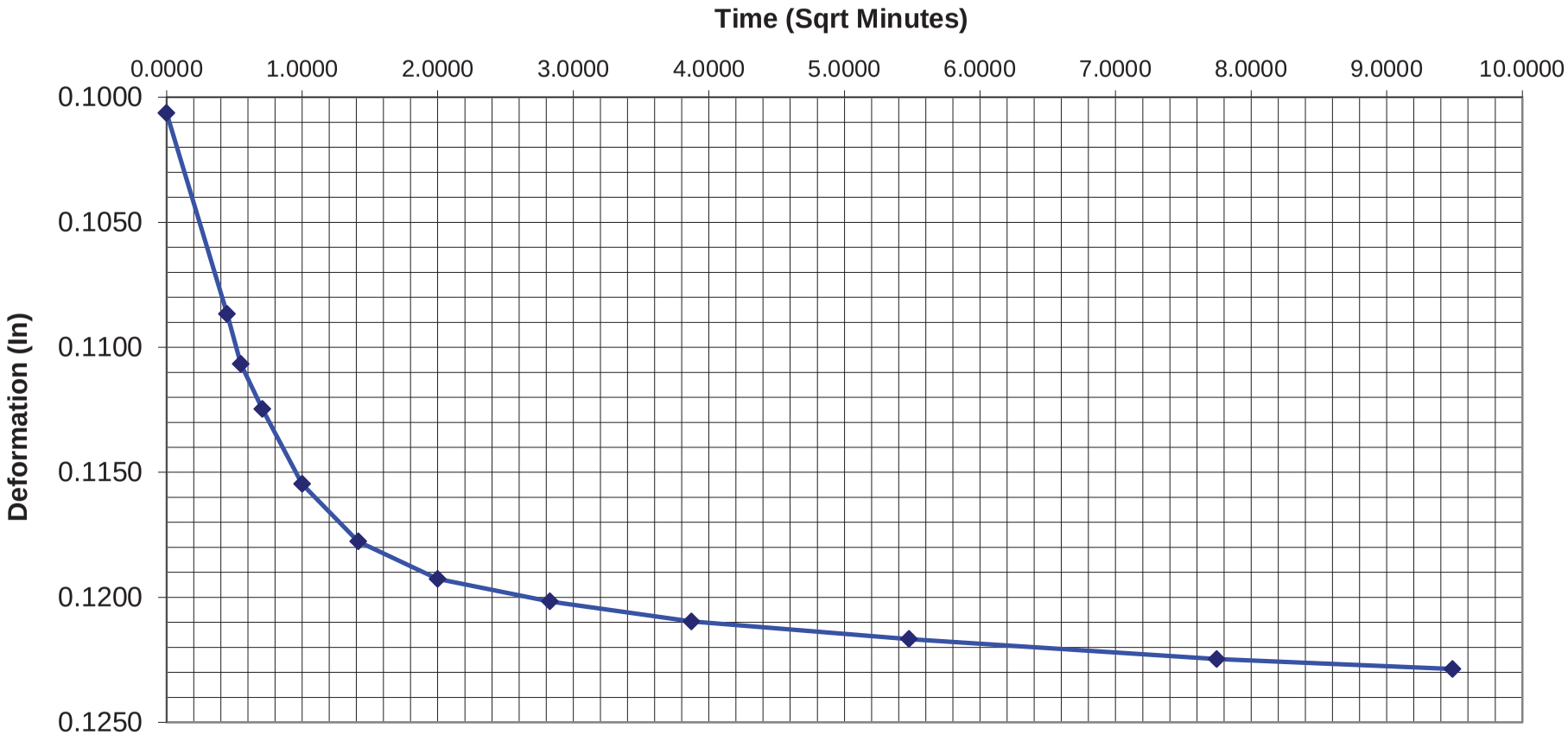


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-005

Client : PND	Pressure: 60817 psf 80 psi	Boring : BH-5
Project : South Portage Cove	Deformation Correction (in): 0.00403	Sample # 4
Date: 1/18/2013		Depth : 20' - 23'

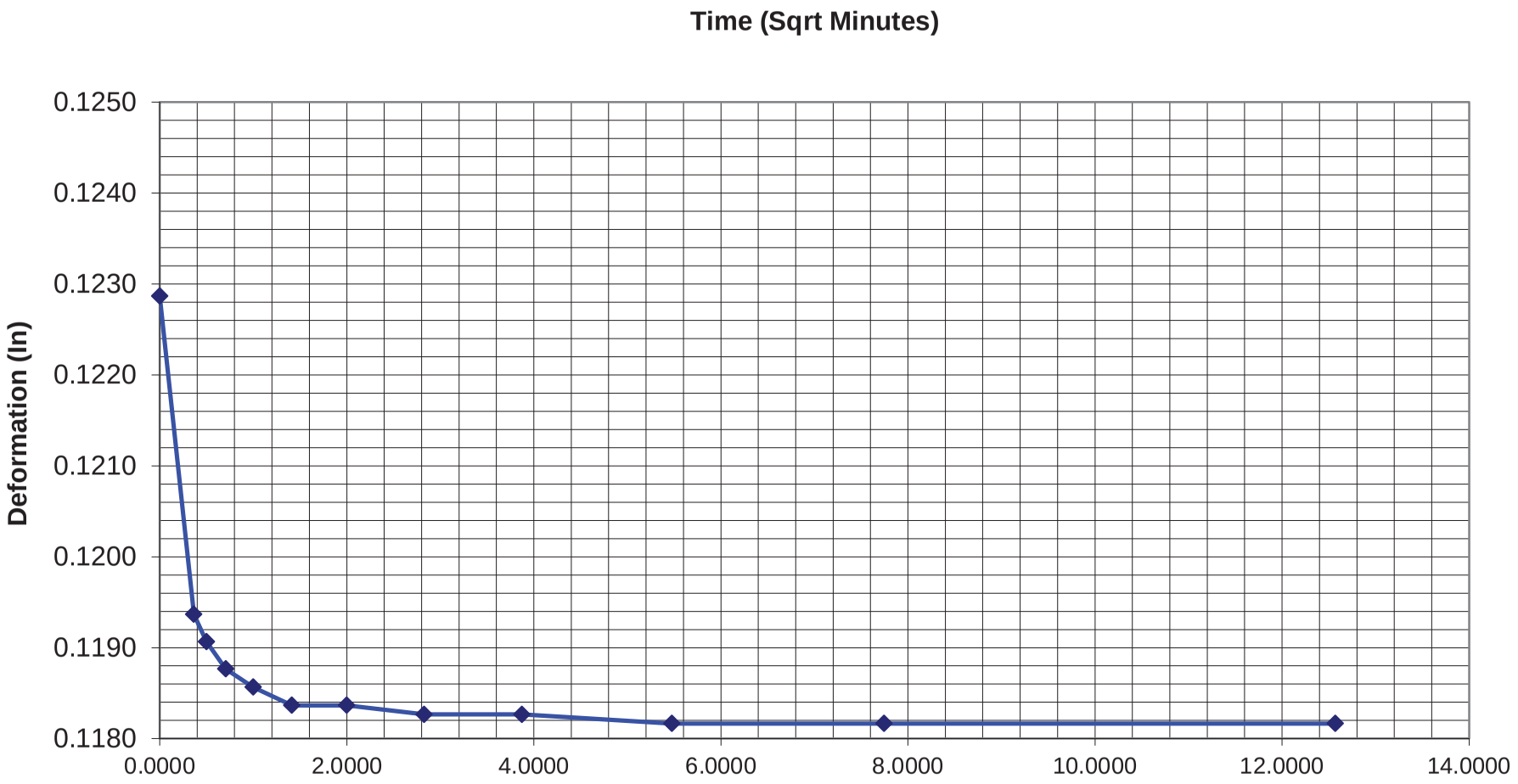


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-005

Client : PND	Pressure: 14206 psf 20 psi	Boring : BH-5
Project : South Portage Cove	Deformation Correction (in): 0.00273	Sample # 4
Date: 1/18/2013		Depth : 20' - 23'

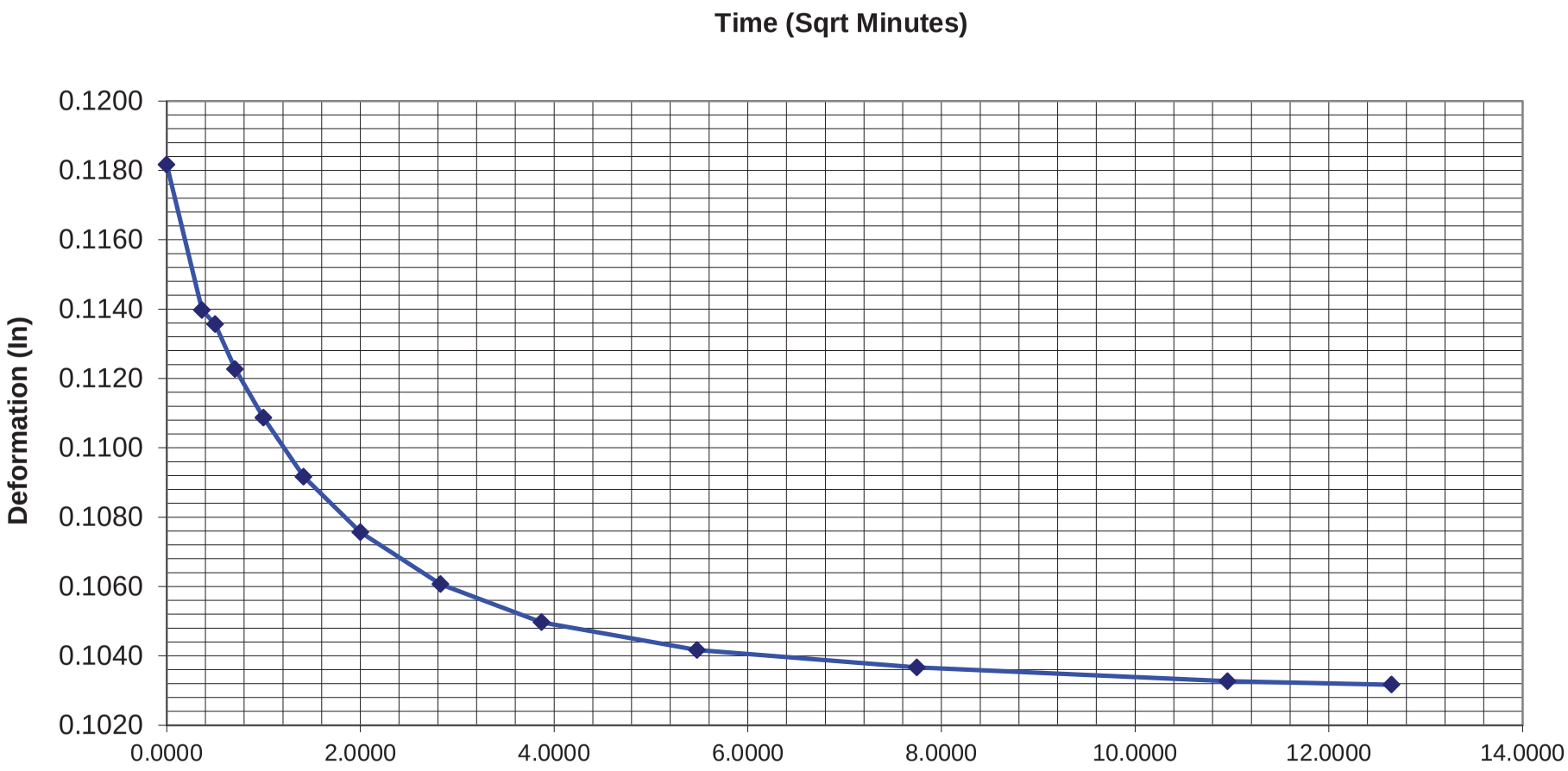


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-005

Client : PND	Pressure: 775 psf 2 psi	Boring : BH-5
Project : South Portage Cove	Deformation Correction (in): 0.00157	Sample # 4
Date: 1/18/2013	0	Depth : 20' - 23'



Consolidation Report

Client :	PND	WO #	A33608	Boring :	BH-5
Project :	South Portage Cove	Lab #	2013-005 Undisturbed	Sample #	4
Date:	1/18/2013	Frame #	1	Depth :	20' - 23'

Wet Sample Weight (g)	168.17
Dry Sample Weight (g)	137.29
Sample Height (in)	1.00
Ring Diameter (in)	2.50
Dry Density (lb/ft3)	107.00
Wet Density (lb/ft3)	131.07
Area of Sample (in2)	4.89
Volume of Sample (in3)	4.89
Volume of Solids (in3)	3.16
Height of Solids (in)	0.65
Initial Height of Voids (in)	0.35
Initial Volume of Voids (in3)	1.73
Volume of Water (in3)	1.88
Initial Degree of Saturation (%)	108.99
Initial Void Ratio, e0	0.55
0.42 e0	0.23
specific gravity	2.65
Volume of Solids	0.65
Volume of Voids	0.35

Load Number	Guage Pressure	Load (lb)	Pressure (ksf)	Δ Height (in)	Void Ratio	% Change
Seating	1	3.33	0.098	0.000	0.545	0.00
1	1.25	10.33	0.304	0.005	0.539	0.48%
2	1.75	23.33	0.687	0.015	0.524	1.50%
3	2	28.33	0.834	0.017	0.521	1.66%
4	3	55.00	1.619	0.028	0.503	2.84%
5	4	80.00	2.355	0.034	0.494	3.39%
6	7.5	167.67	4.935	0.051	0.468	5.09%
7	10	230.00	6.769	0.059	0.456	5.88%
8	20	484.33	14.255	0.079	0.424	7.93%
9	40	1012.33	29.795	0.101	0.391	10.07%
10	80	2066.33	60.817	0.123	0.357	12.29%
11	20	482.67	14.206	0.118	0.364	11.82%
12	2	26.33	0.775	0.103	0.387	10.32%

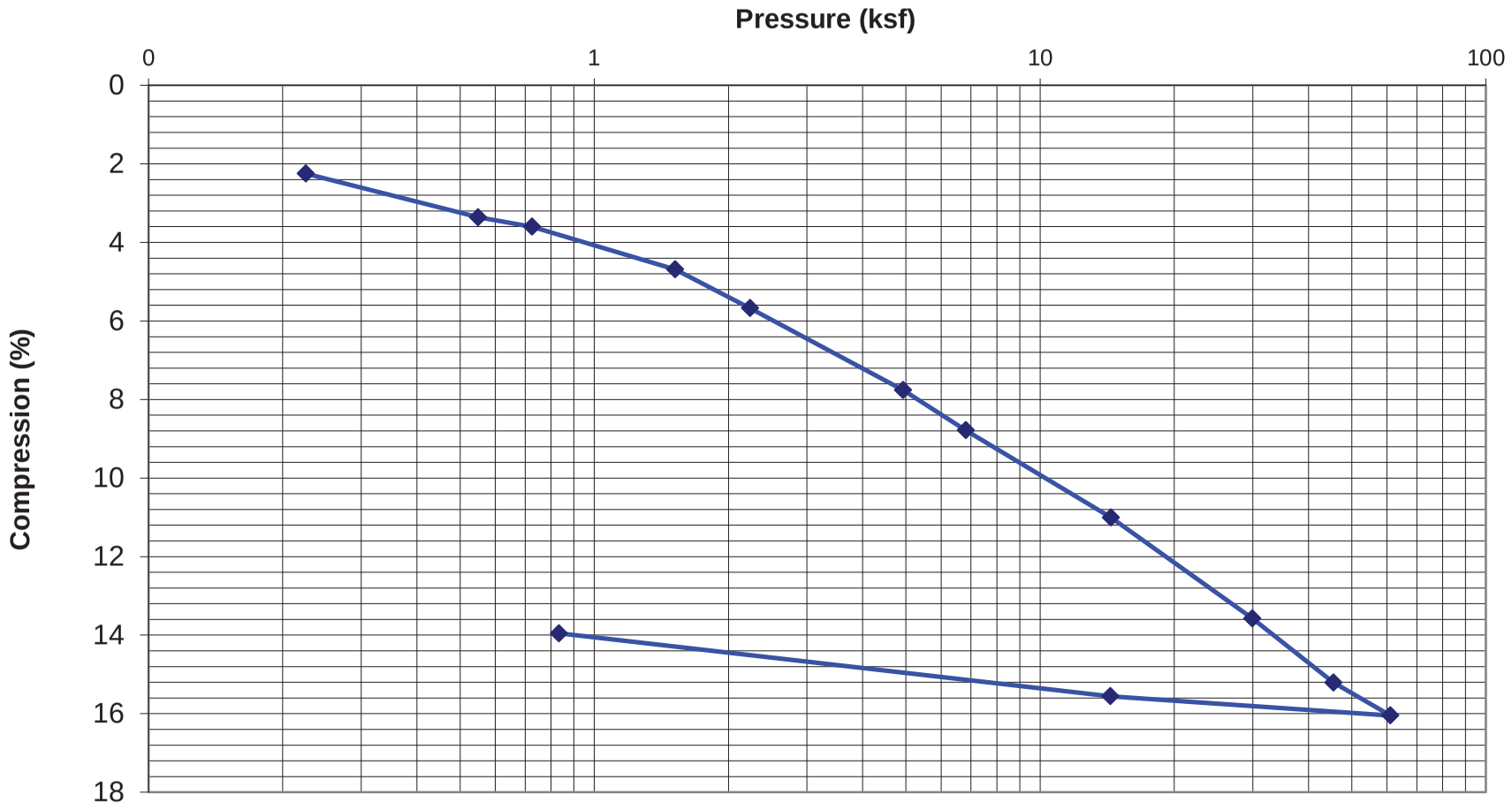
Moisture Content			
	Trimmings	Initial	Final
Wet + Tare	26.92		642.44
Dry + Tare	22.17		617.40
Tare	1.05		481.44
Wet Weight	25.87	168.17	161
Wt. Water	4.75		25.04
Wt. Dry Soil	21.12		135.96
% Moisture	22.5		18

DOWL HKM

Compression Curve (% Comp. vs. Log P)

WO #	A33608
Lab #	2013-006

Client :	PND	Moisture Content =	23.2 %	Boring :	BH-7
Project :	South Portage Cove	Dry Unit Weight (pcf) =	106.4	Sample #	3
Date:	1/18/2013	Wet Unit Weight (pcf)=	131.1	Depth :	15' - 18'



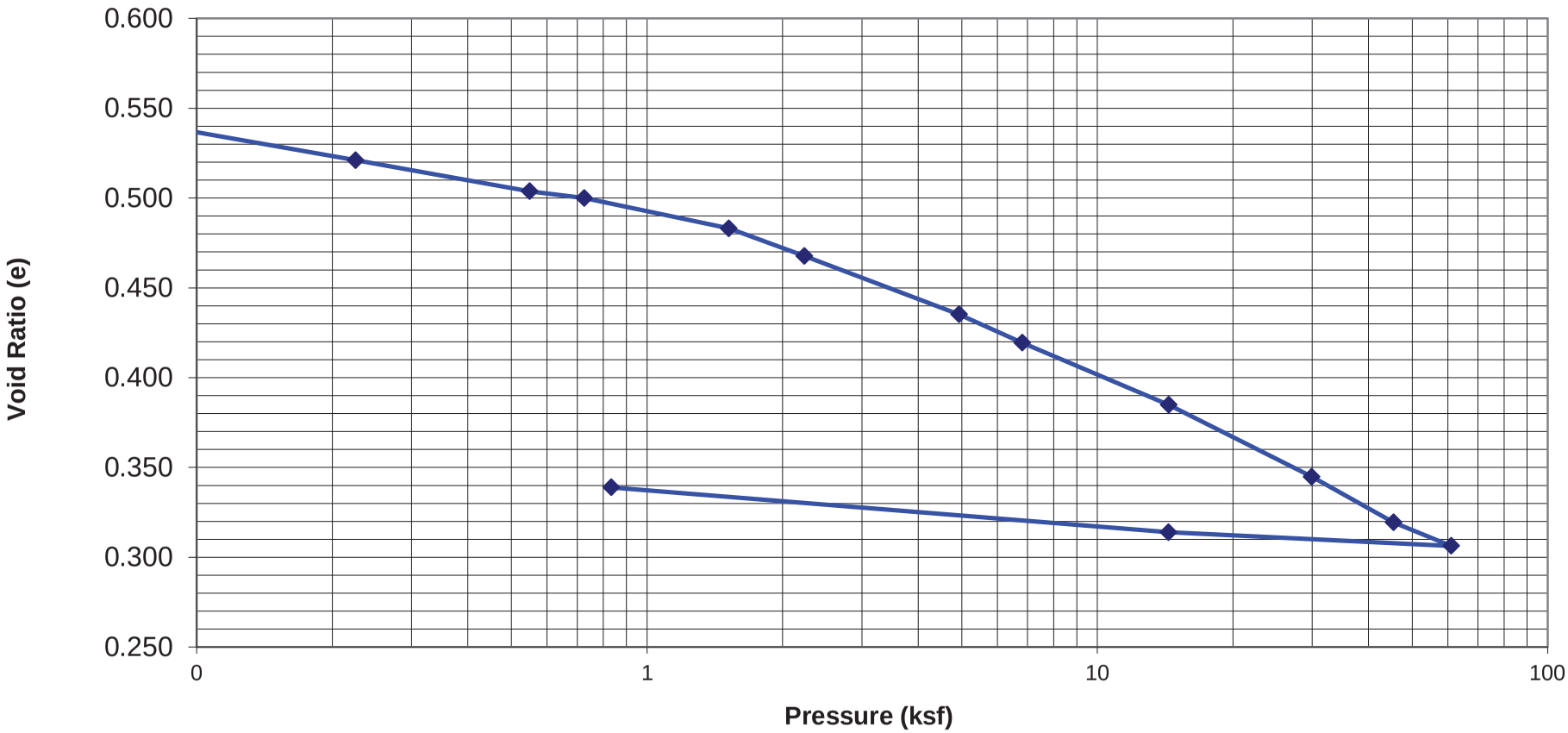
DOWL HKM

Compression Curve (e vs. Log P)

WO #	A33608
Lab #	2013-006

Client :	PND	Moisture Content =	23.2 %	Boring :	BH-7
Project :	South Portage Cove	Dry Unit Weight (pcf) =	106.4	Sample #	3
Date:	1/18/2013	Wet Unit Weight (pcf)=	131.1	Depth :	15' - 18'

e_o = 0.555

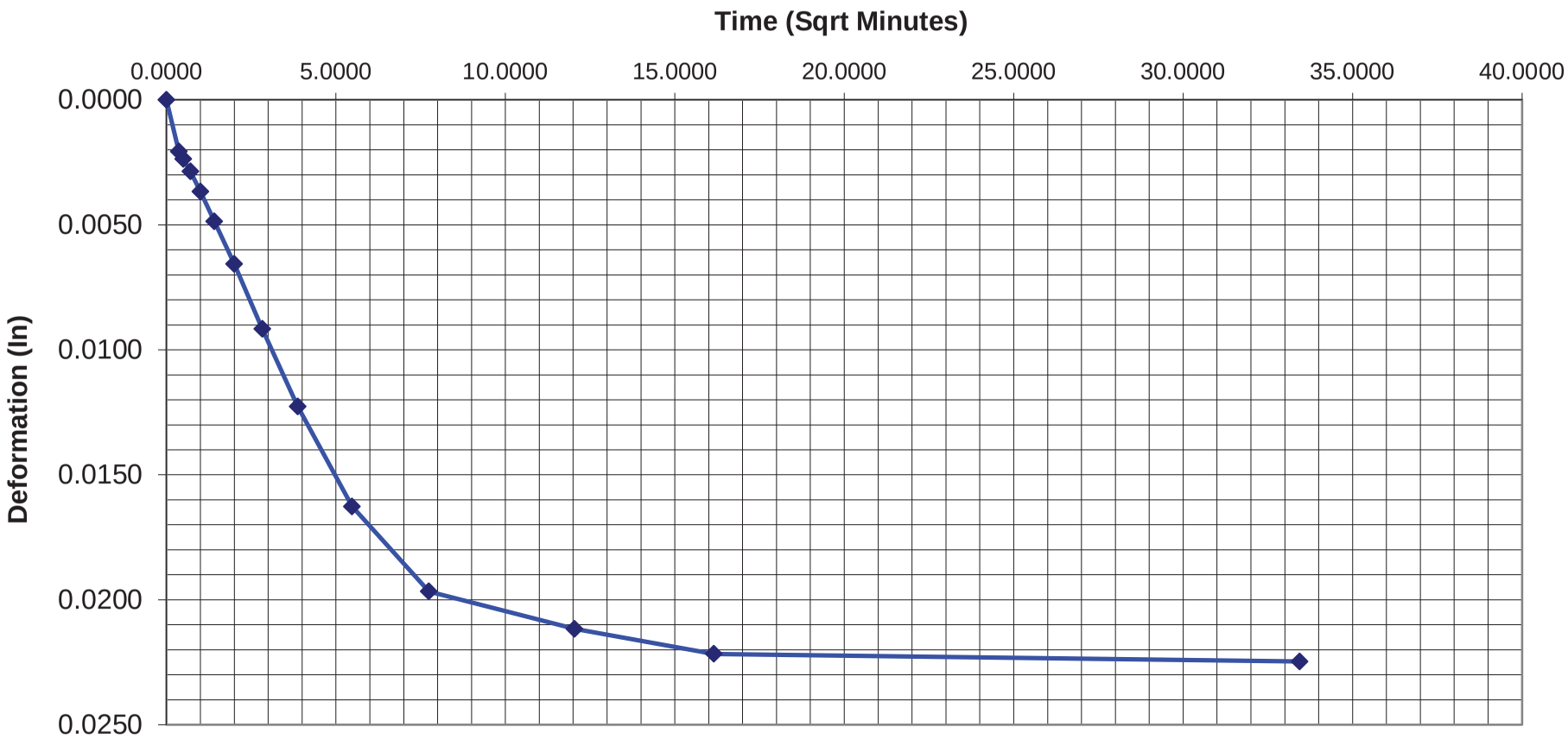


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-006

Client : PND	Pressure: 226 psf 1.25 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00013	Sample # 3
Date: 1/18/2013		Depth : 15' - 18'

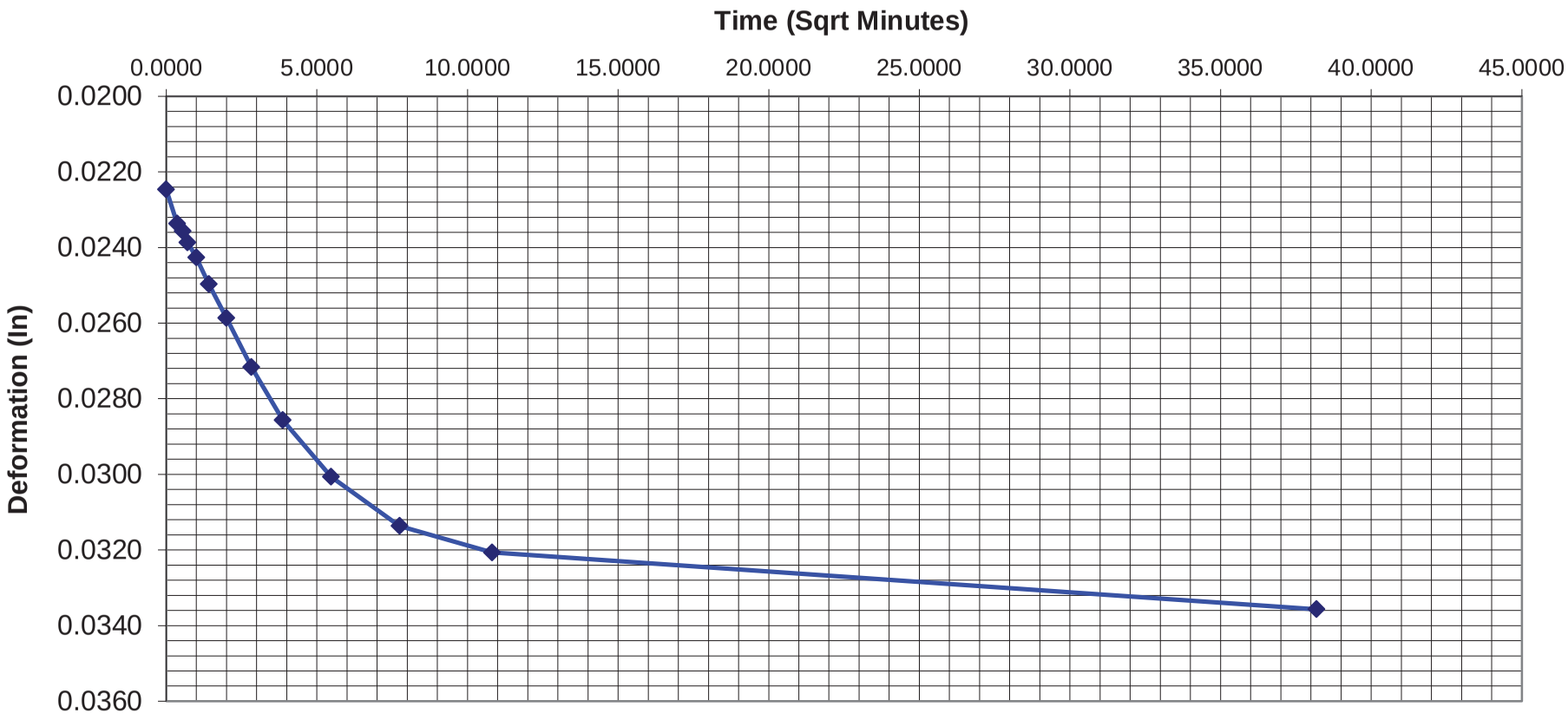


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-006

Client : PND	Pressure: 549 psf 1.75 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00013	Sample # 3
Date: 1/18/2013		Depth : 15' - 18'

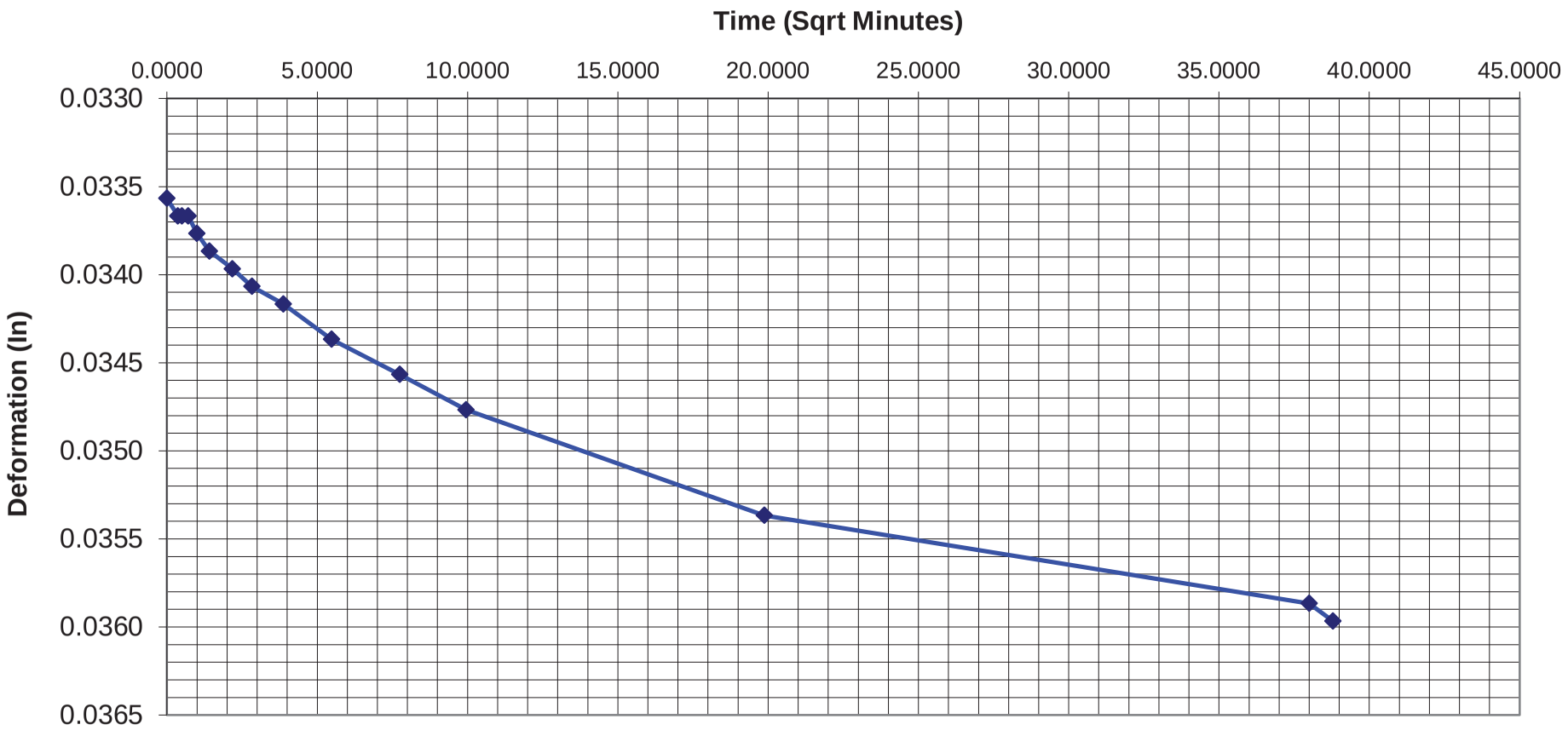


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-006

Client : PND	Pressure: 726 psf 2 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00023	Sample # 3
Date: 1/18/2013		Depth : 15' - 18'

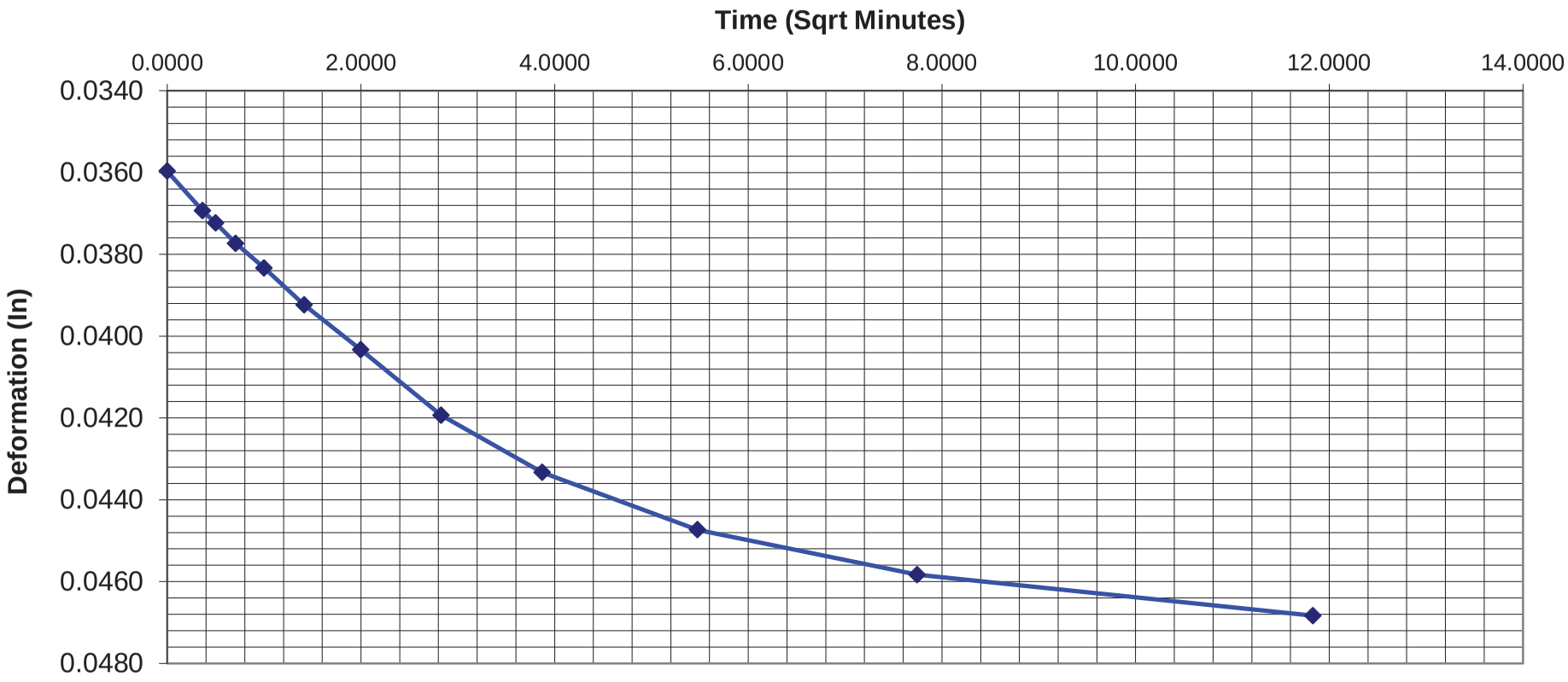


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-006

Client : PND	Pressure: 1520 psf 3 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00067	Sample # 3
Date: 1/18/2013		Depth : 15' - 18'

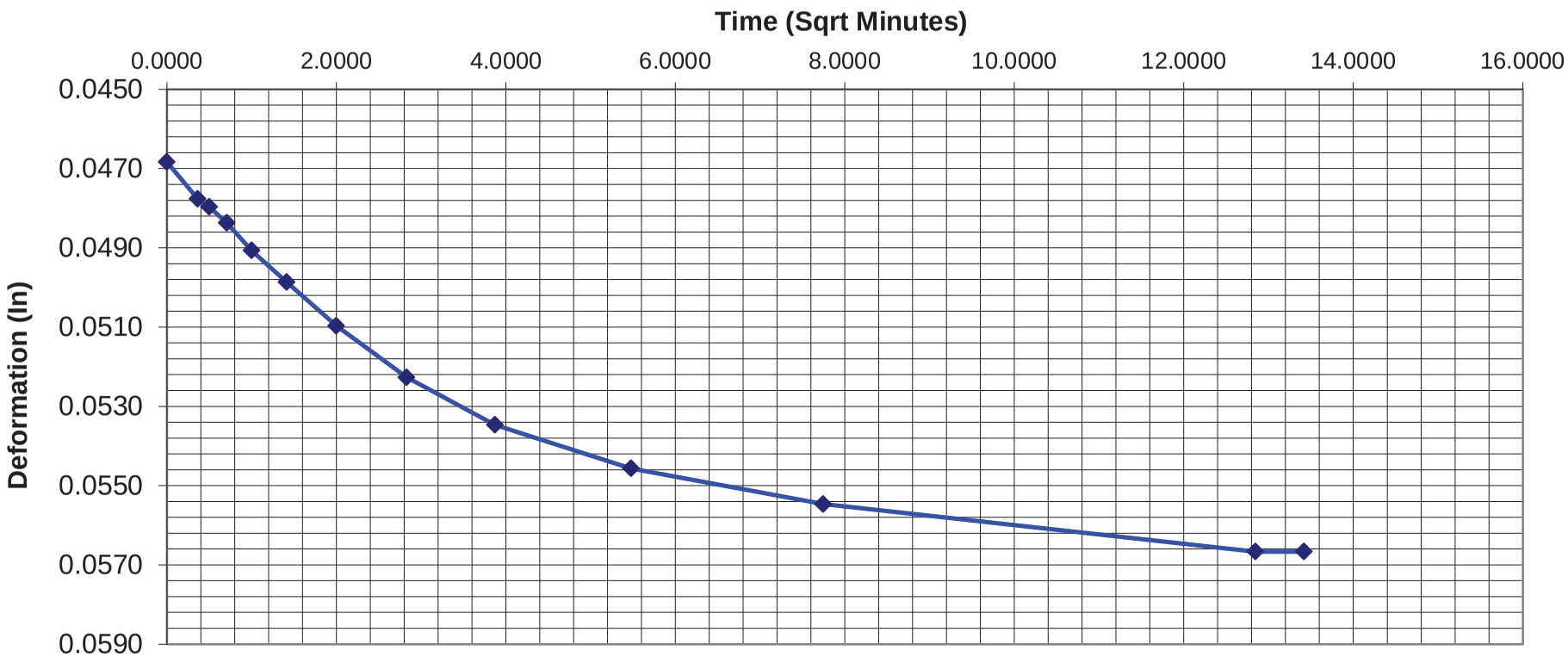


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-006

Client : PND	Pressure: 2236 psf 4 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00103	Sample # 3
Date: 1/18/2013		Depth : 15' - 18'

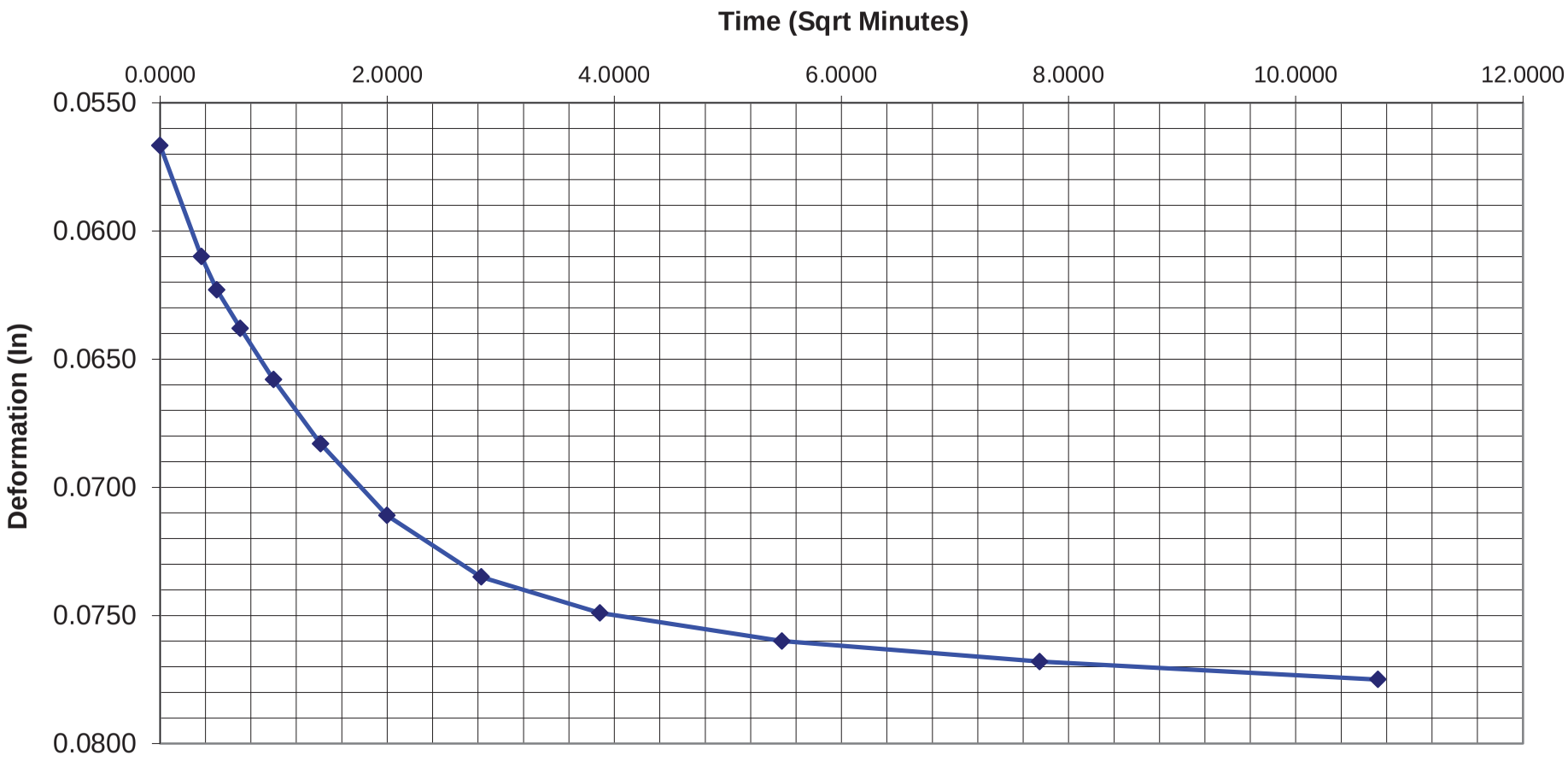


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-006

Client : PND	Pressure: 4933 psf 7.5 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.0015	Sample # 3
Date: 1/18/2013		Depth : 15' - 18'



DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-006

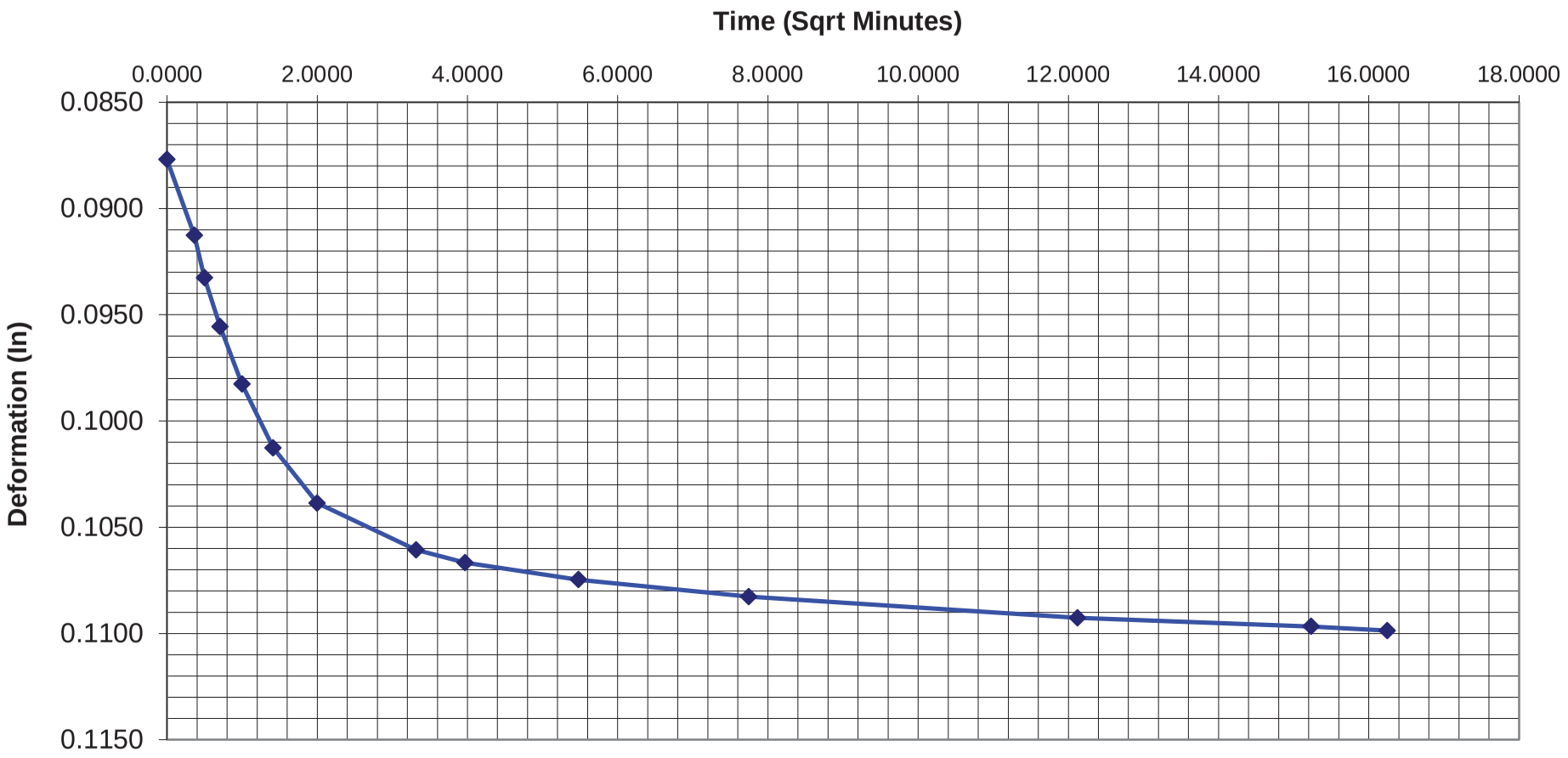
Client : PND	Pressure: 6816 psf 10 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.0017	Sample # 3
Date: 1/18/2013		Depth : 15' - 18'

DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-006

Client : PND	Pressure: 14418 psf 20 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00223	Sample # 3
Date: 1/18/2013		Depth : 15' - 18'

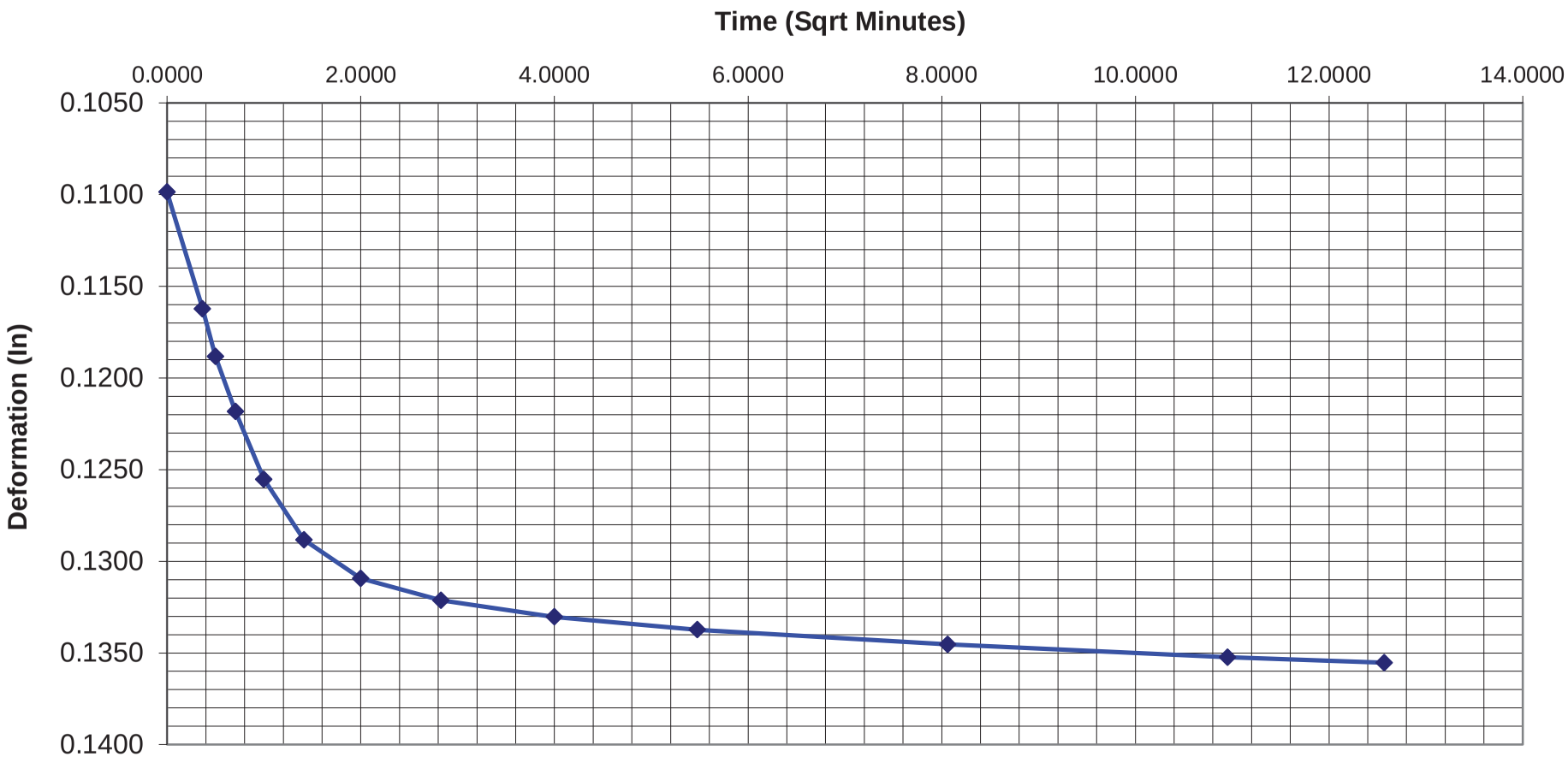


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-006

Client : PND	Pressure: 29924 psf 40 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00277	Sample # 3
Date: 1/18/2013		Depth : 15' - 18'



DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-006

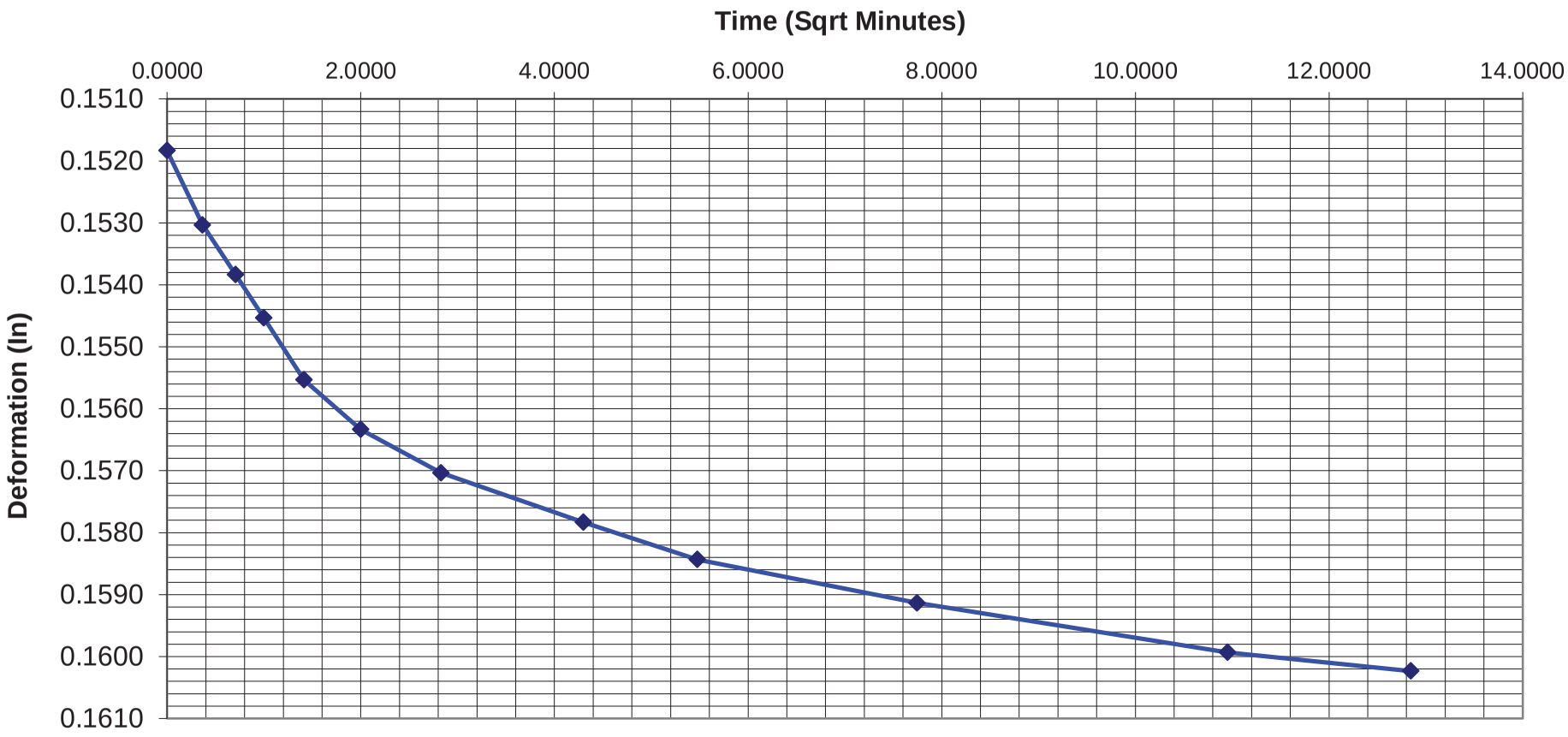
Client : PND	Pressure: 45518 psf 60 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00317	Sample # 3
Date: 1/18/2013		Depth : 15' - 18'

DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-006

Client : PND	Pressure: 61074 psf 80 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.0034	Sample # 3
Date: 1/18/2013		Depth : 15' - 18'

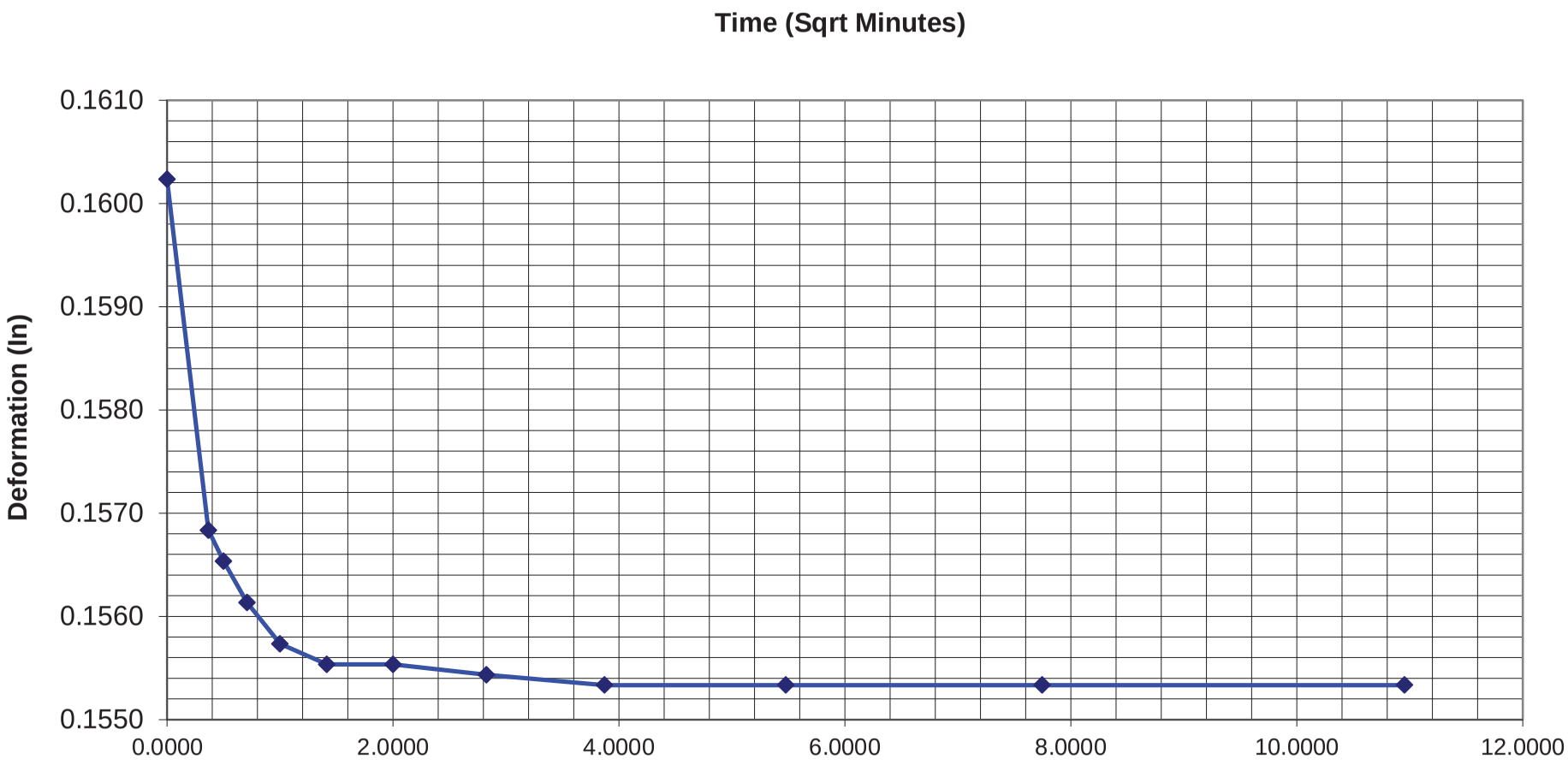


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-006

Client : PND	Pressure: 14388 psf 20 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.0025	Sample # 3
Date: 1/18/2013	Rebound Load	Depth : 15' - 18'

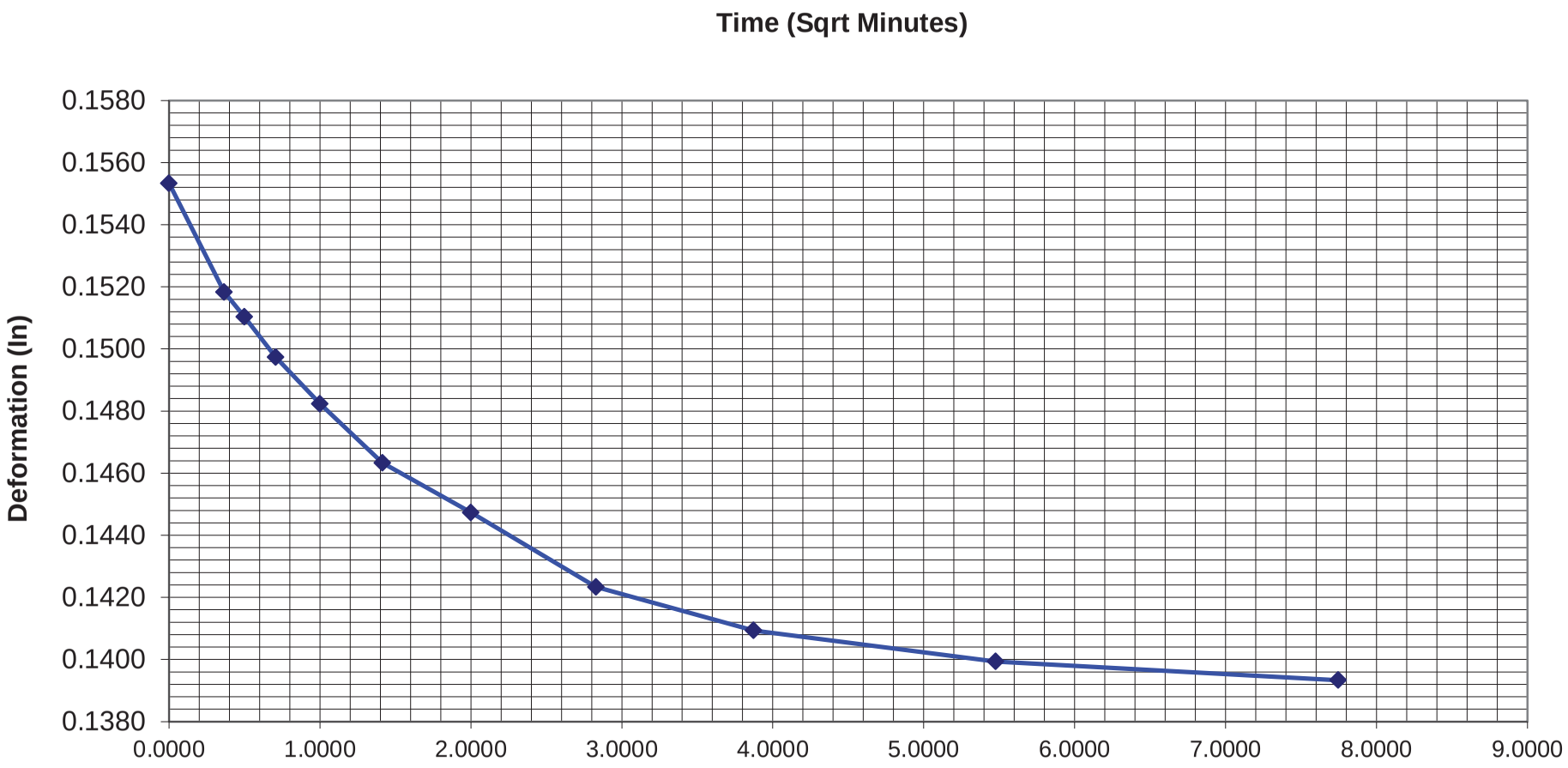


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-006

Client : PND	Pressure: 834 psf 2 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.0009	Sample # 3
Date: 1/18/2013	Rebound Load	Depth : 15' - 18'



Consolidation Report

Client :	PND	WO #	A33608	Boring :	BH-7
Project :	South Portage Cove	Lab #	2013-006 Remolded	Sample #	3
Date:	1/18/2013	Frame #	2	Depth :	15' - 18'

Wet Sample Weight (g)	168.03
Dry Sample Weight (g)	136.38
Sample Height (in)	1.00
Ring Diameter (in)	2.50
Dry Density (lb/ft3)	106.37
Wet Density (lb/ft3)	131.06
Area of Sample (in2)	4.89
Volume of Sample (in3)	4.89
Volume of Solids (in3)	3.14
Height of Solids (in)	0.64
Initial Height of Voids (in)	0.36
Initial Volume of Voids (in3)	1.75
Volume of Water (in3)	1.93
Initial Degree of Saturation (%)	110.62
Initial Void Ratio, e0	0.55
0.42 e0	0.23
specific gravity	2.65
Volume of Solids	0.64
Volume of Voids	0.36

Load Number	Guage Pressure	Load (lb)	Pressure (ksf)	Δ Height (in)	Void Ratio	% Change
Seating	1	1.33	0.039	0.000	0.555	0.00%
1	1.25	7.67	0.226	0.022	0.521	2.25%
2	1.75	18.67	0.549	0.034	0.504	3.36%
3	2	24.67	0.726	0.036	0.500	3.60%
4	3	51.67	1.520	0.047	0.483	4.69%
5	4	76.00	2.236	0.057	0.468	5.68%
6	10	167.67	4.933	0.078	0.435	7.76%
7	15	231.67	6.816	0.088	0.419	8.78%
8	20	490.00	14.418	0.110	0.385	11.00%
9	30	1017.00	29.924	0.136	0.345	13.57%
10	40	1547.00	45.518	0.152	0.319	15.21%
11	80	2075.67	61.074	0.160	0.306	16.05%
12	20	489.00	14.388	0.155	0.314	15.56%
13	2	28.33	0.834	0.139	0.339	13.95%

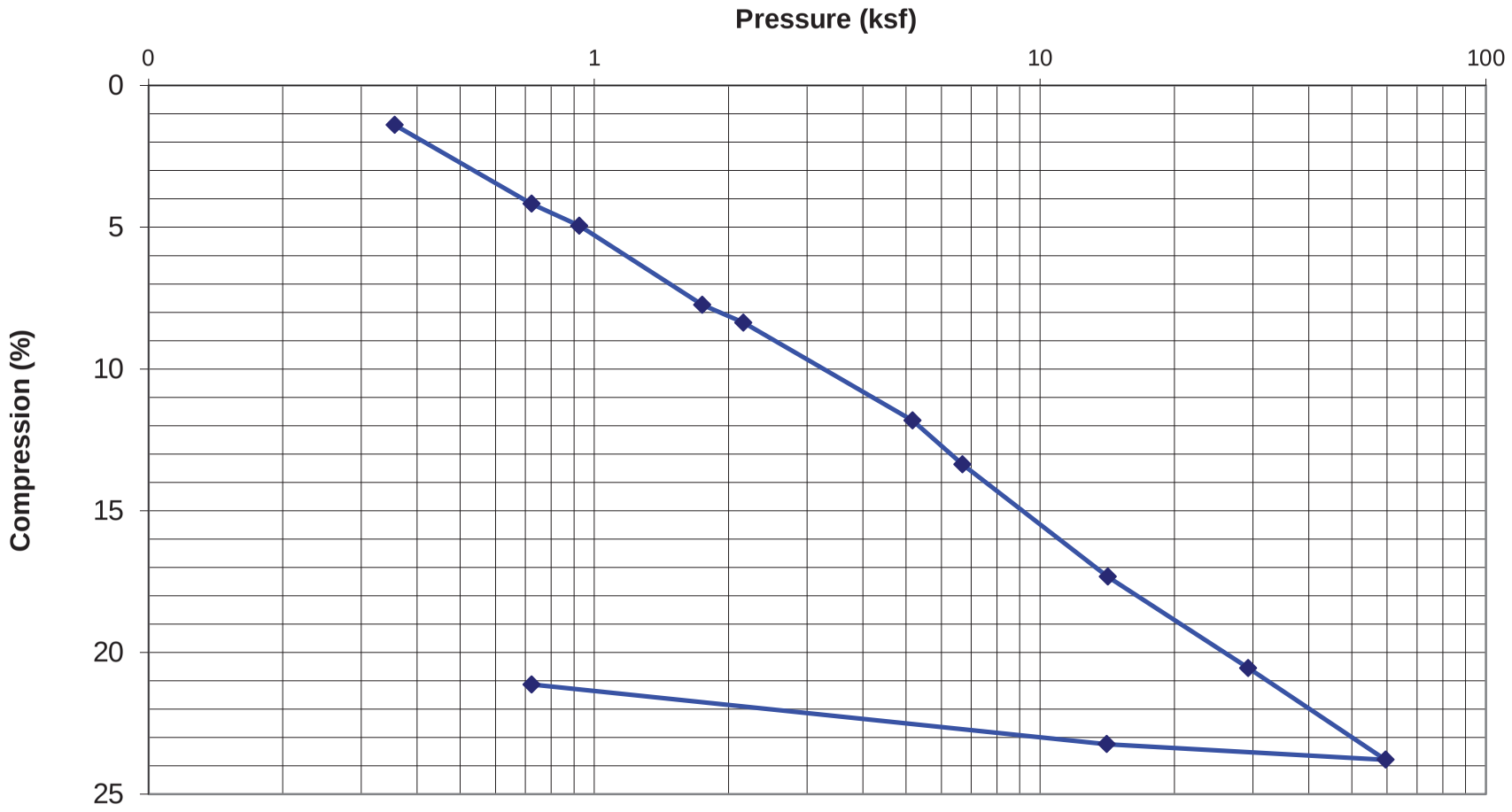
Moisture Content			
	Trimmings	Initial	Final
Wet + Tare	45.80		638.11
Dry + Tare	37.37		613.80
Tare	1.05		481.42
Wet Weight	44.75	168.03	156.69
Wt. Water	8.43		24.31
Wt. Dry Soil	36.32		132.38
% Moisture	23.2		18

DOWL HKM

Compression Curve (% Comp. vs. Log P)

WO #	A33608
Lab #	2013-008

Client :	PND	Moisture Content =	35.8 %	Boring :	BH-7
Project :	South Portage Cove	Dry Unit Weight (pcf) =	84.7	Sample #	7
Date:	1/21/2013	Wet Unit Weight (pcf)=	115.0	Depth :	36.5'



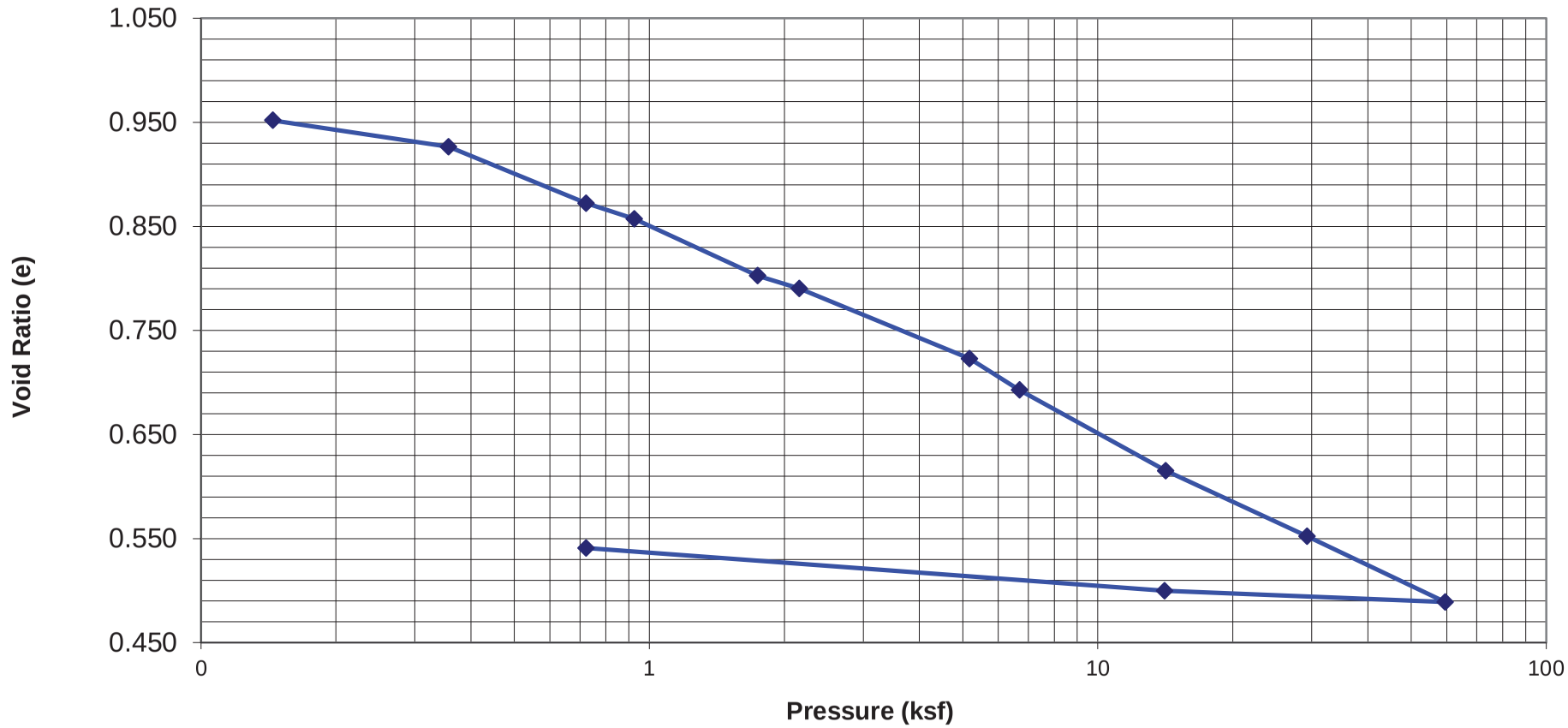
DOWL HKM

Compression Curve (e vs. Log P)

WO #	A33608
Lab #	2013-008

Client :	PND	Moisture Content =	35.8 %	Boring :	BH-7
Project :	South Portage Cove	Dry Unit Weight (pcf) =	84.7	Sample #	7
Date:	1/21/2013	Wet Unit Weight (pcf)=	115.0	Depth :	36.5'

e_o = 0.952

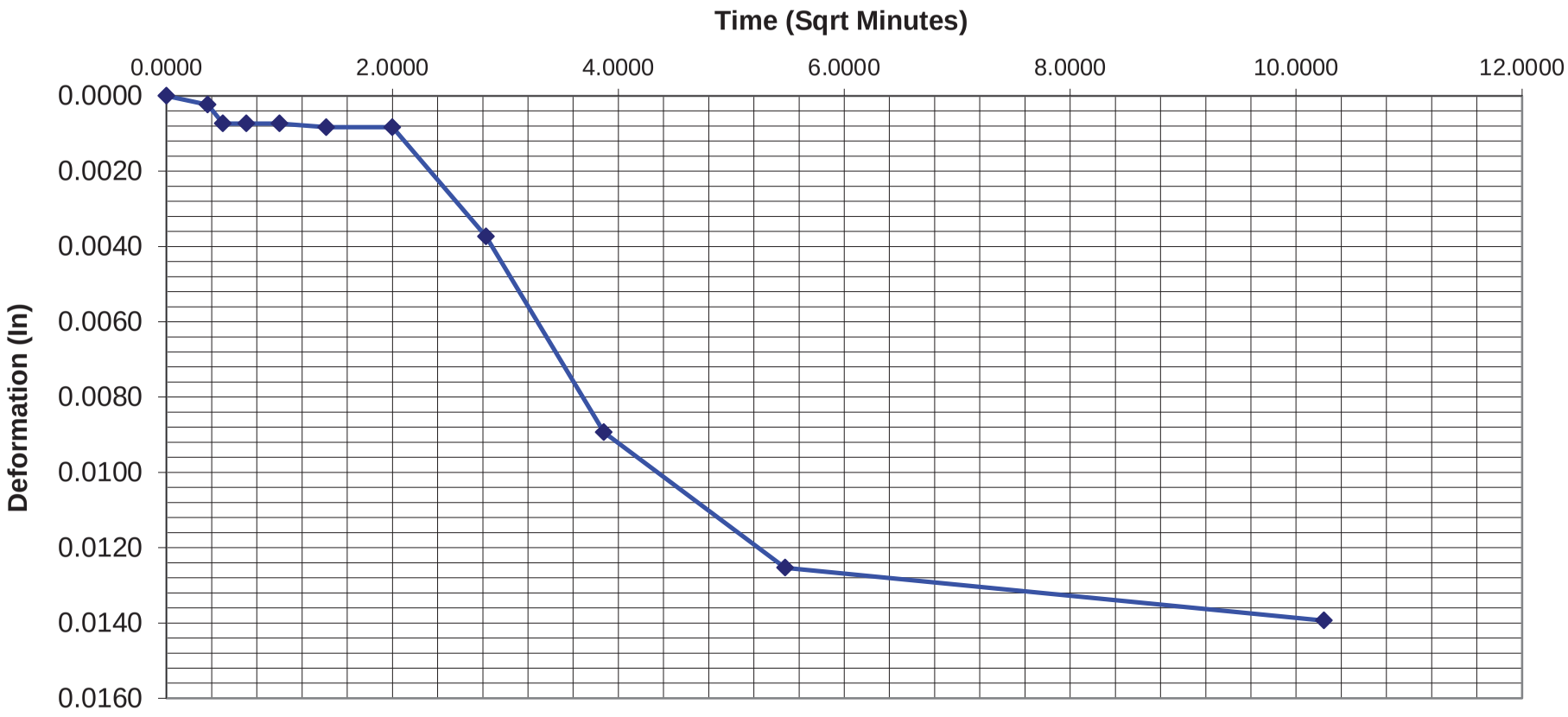


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-008

Client : PND	Pressure: 357 psf 1.25 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00047	Sample # 7
Date: 1/21/2013		Depth : 36.5'

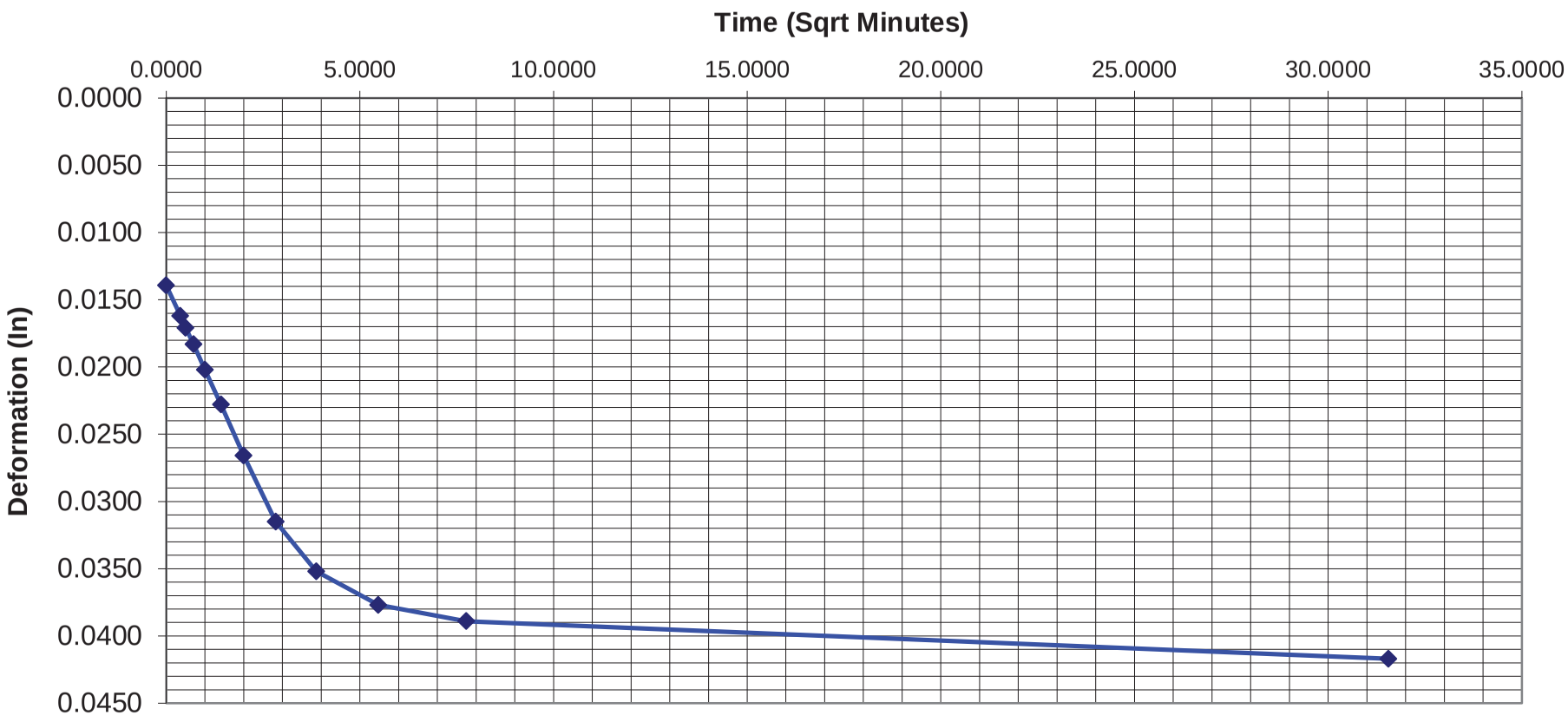


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-008

Client : PND	Pressure: 723 psf 1.75 psi	Boring :	BH-7
Project : South Portage Cove	Deformation Correction (in): 0.0008	Sample #	7
Date: 1/21/2013		Depth :	36.5'

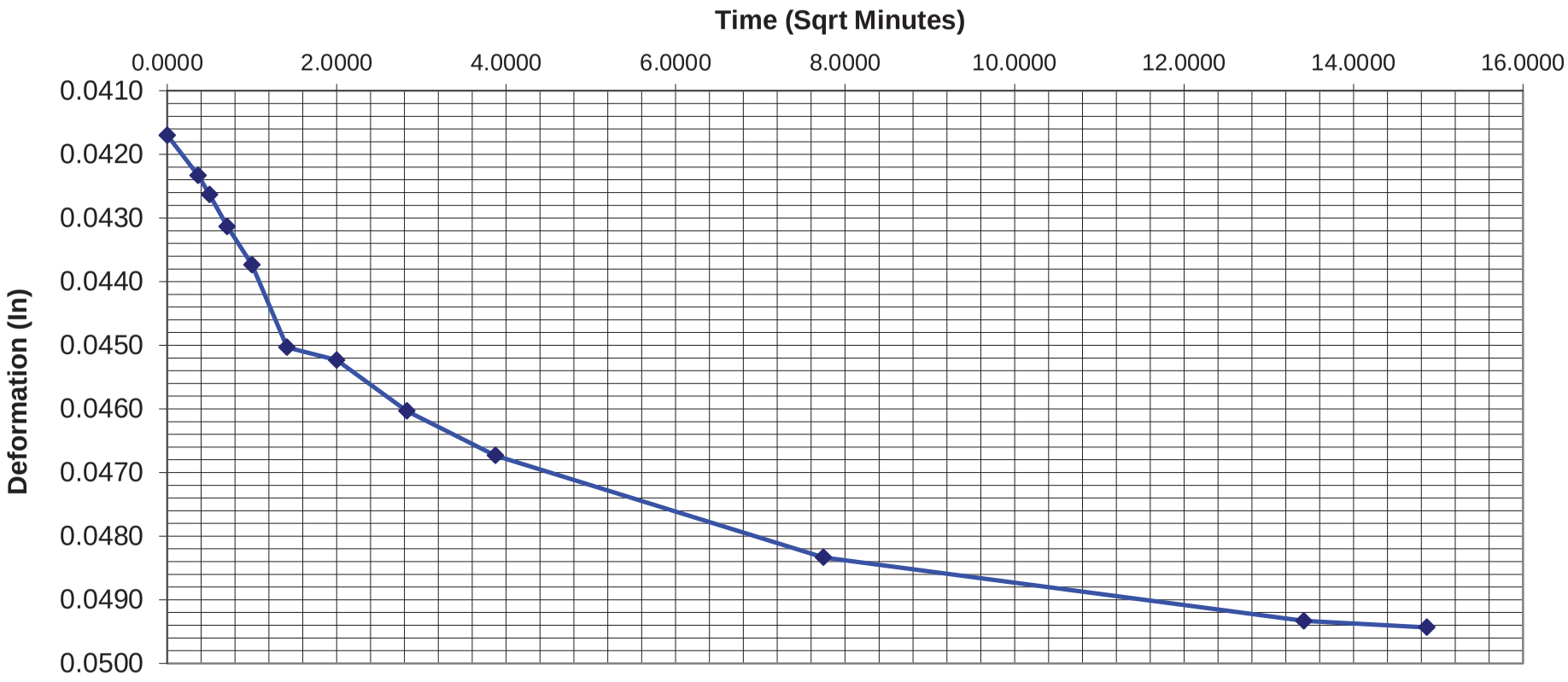


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-008

Client : PND	Pressure: 926 psf 2 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00087	Sample # 7
Date: 1/21/2013		Depth : 36.5'

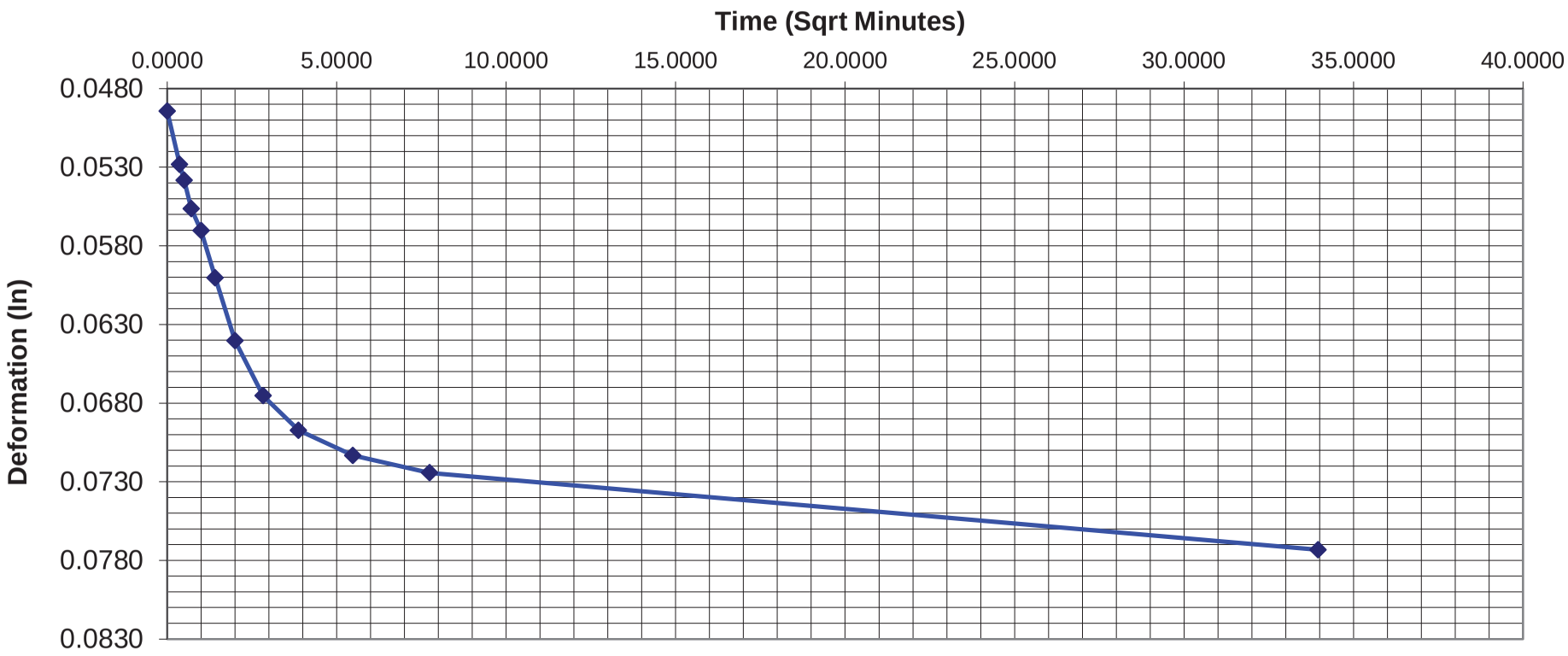


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-008

Client : PND	Pressure: 1746 psf 3 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00107	Sample # 7
Date: 1/21/2013		Depth : 36.5'

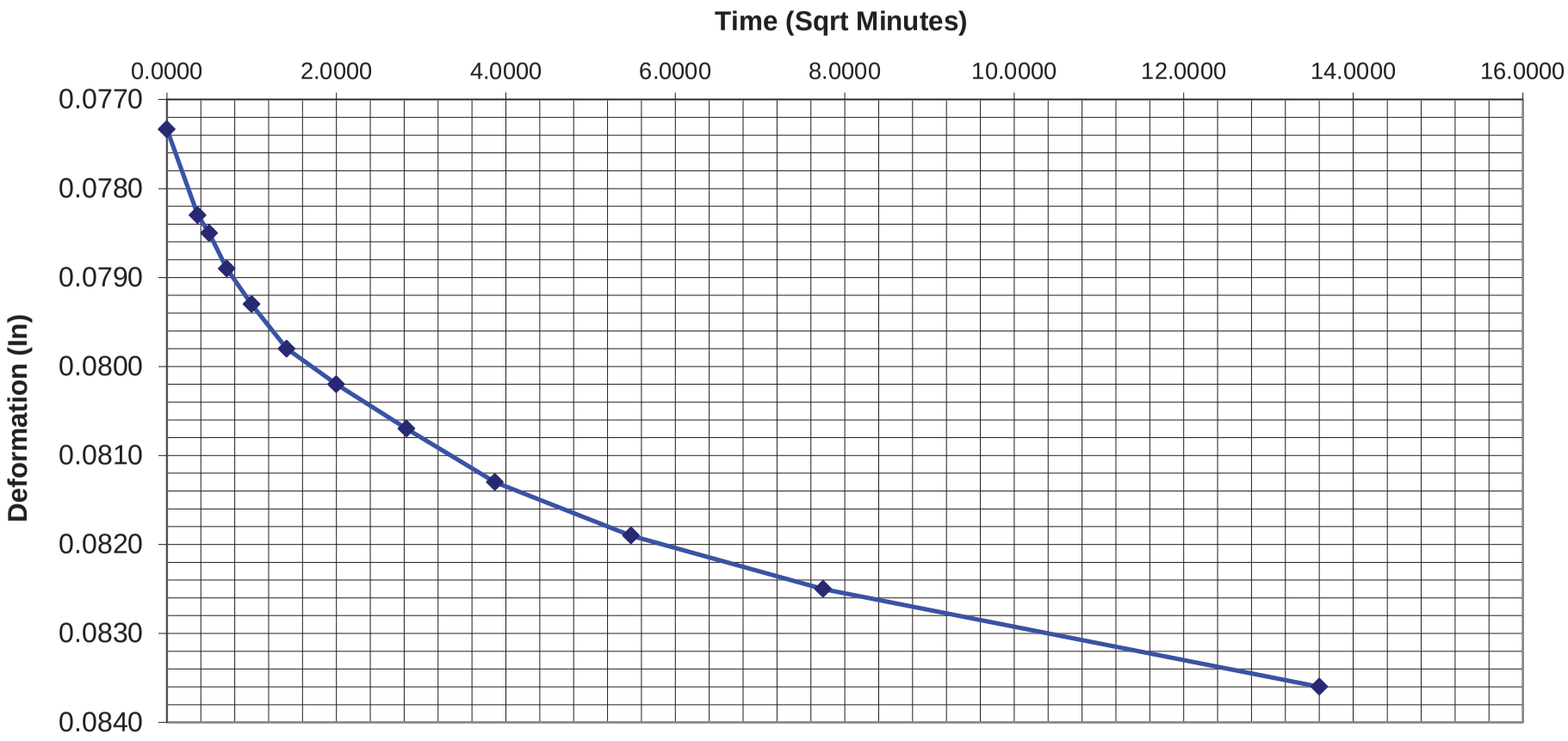


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-008

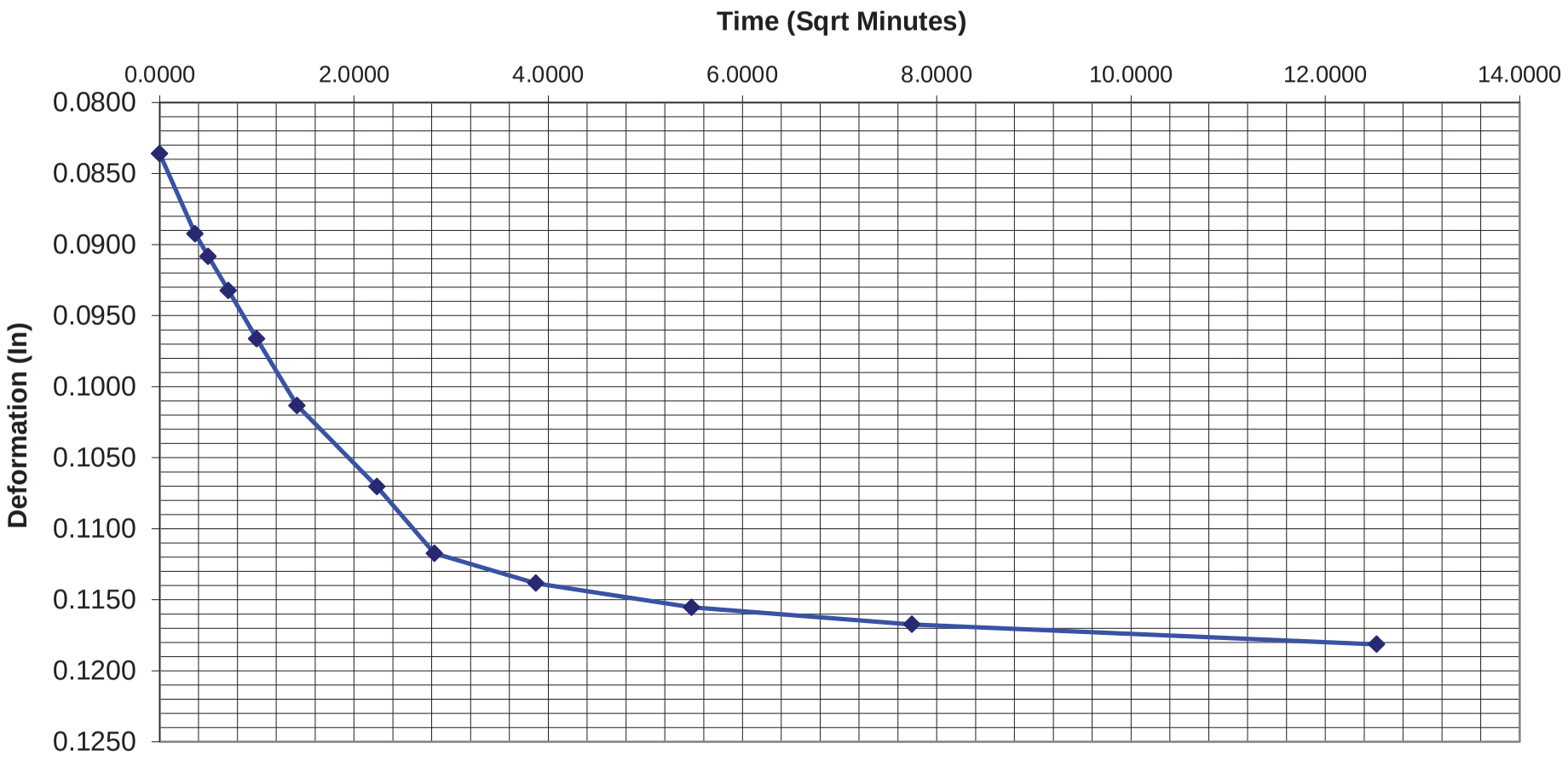
Client : PND	Pressure: 2160 psf 4 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.001	Sample # 7
Date: 1/21/2013		Depth : 36.5'



Time Rate of Consolidation

WO #	A33608
Lab #	2013-008

Client : PND	Pressure: 5179 psf 7.5 psi	Boring :	BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00117	Sample #	7
Date: 1/21/2013		Depth :	36.5'

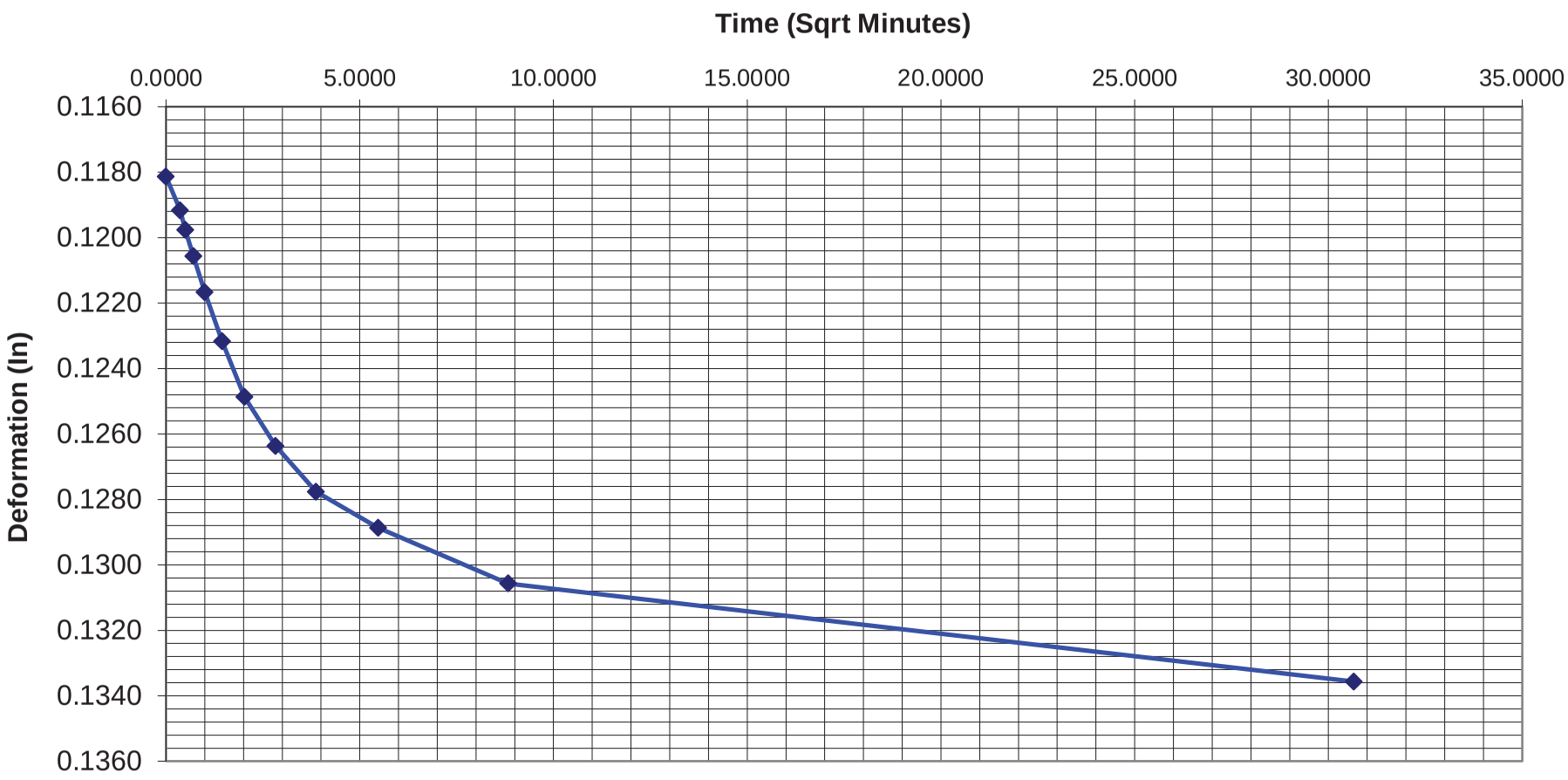


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-008

Client : PND	Pressure: 6693 psf 10 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00183	Sample # 7
Date: 1/21/2013		Depth : 36.5'

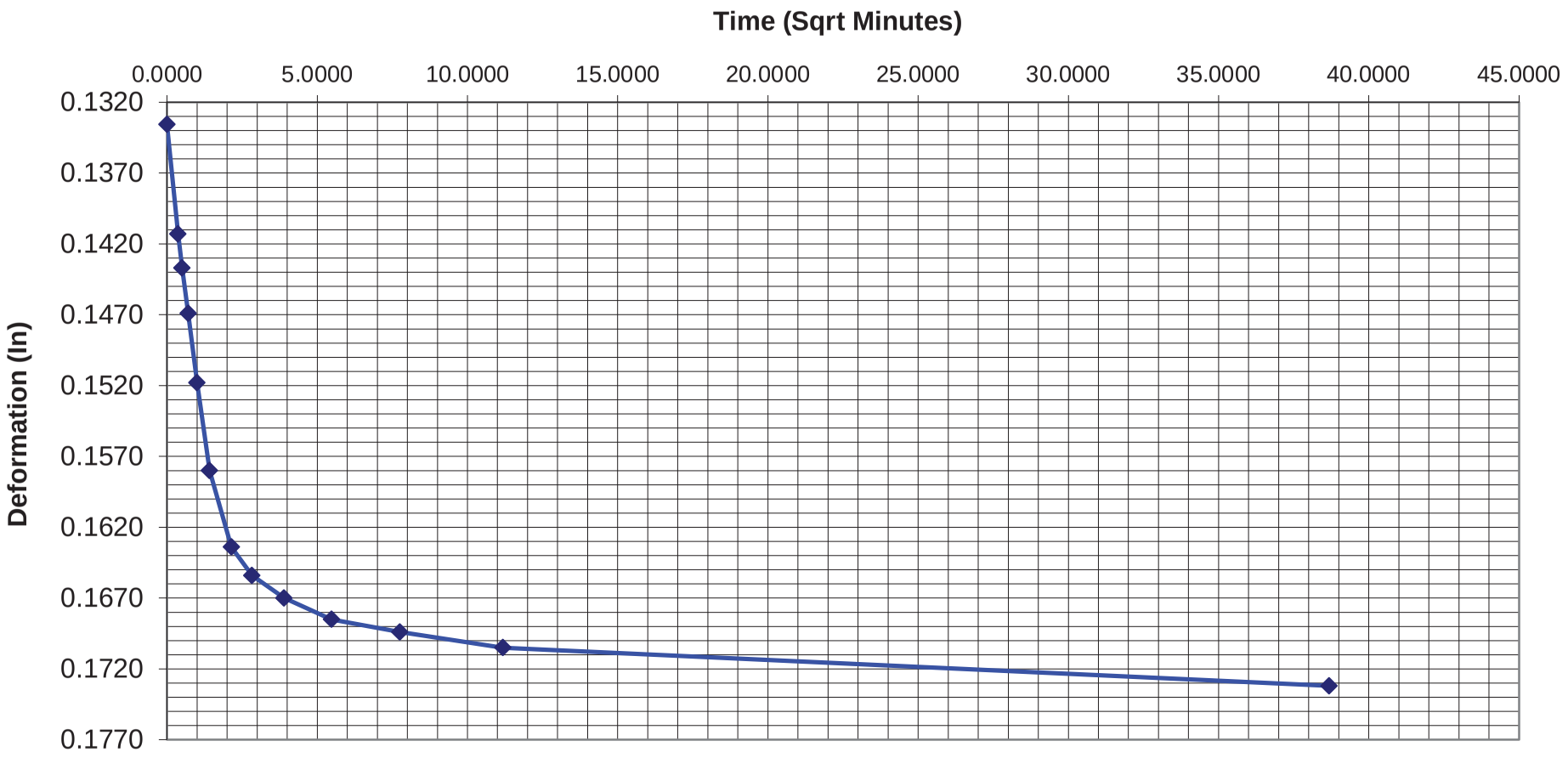


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-008

Client : PND	Pressure: 14186 psf 20 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.0026	Sample # 7
Date: 1/21/2013		Depth : 36.5'

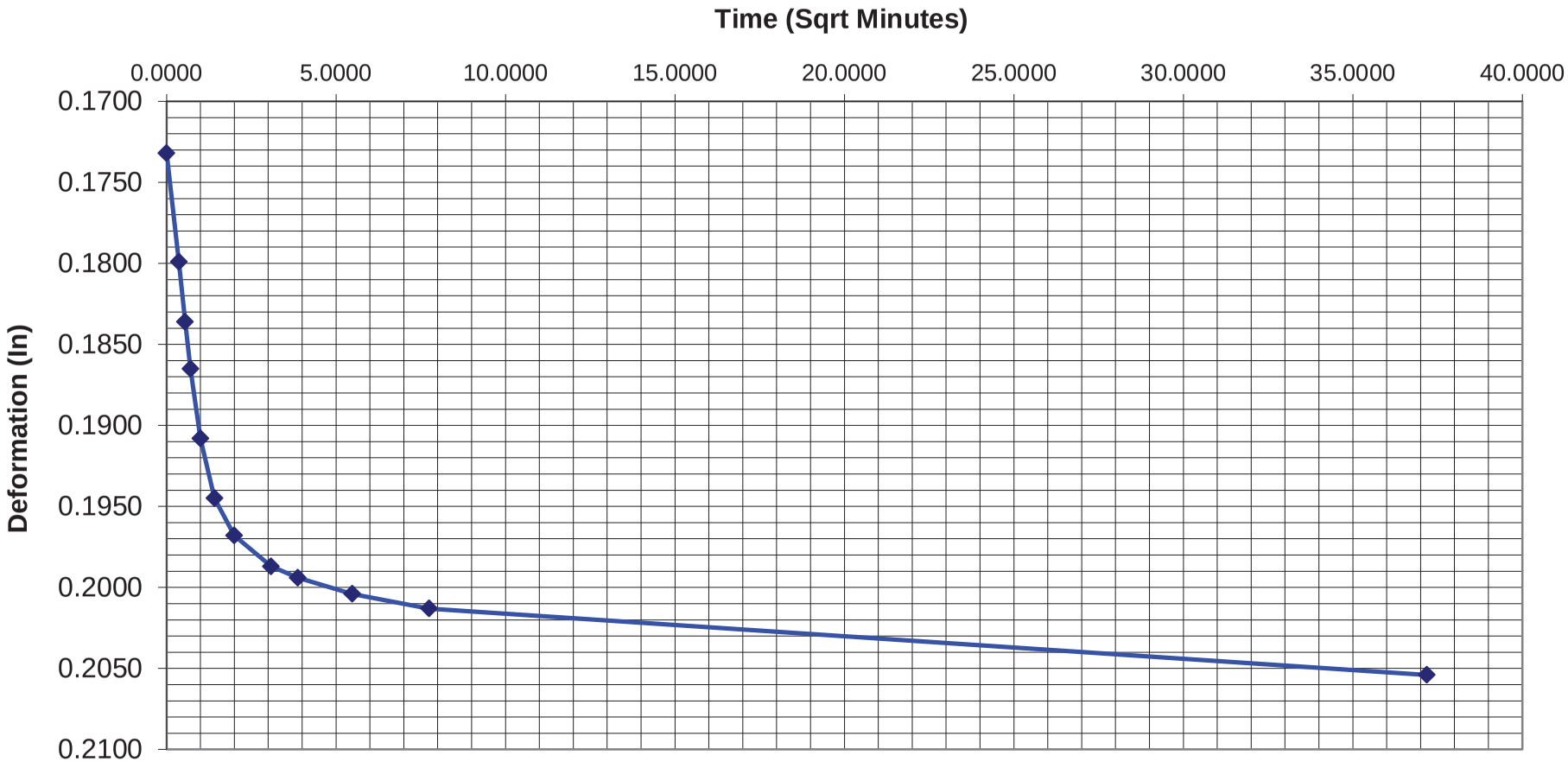


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-008

Client : PND	Pressure: 29289 psf 40 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.0036	Sample # 7
Date: 1/21/2013		Depth : 36.5'

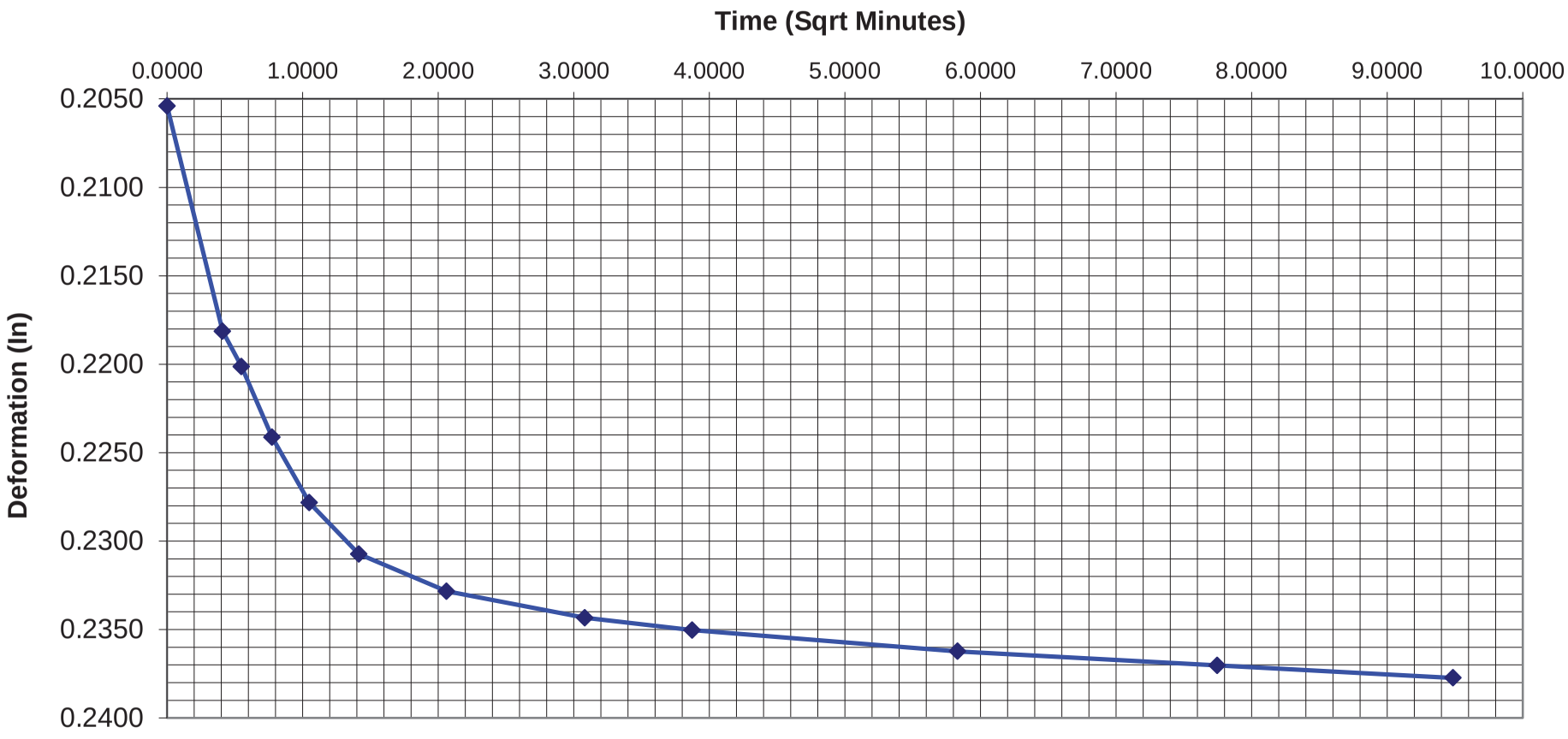


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-008

Client : PND	Pressure: 59561 psf 80 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00487	Sample # 7
Date: 1/21/2013		Depth : 36.5'

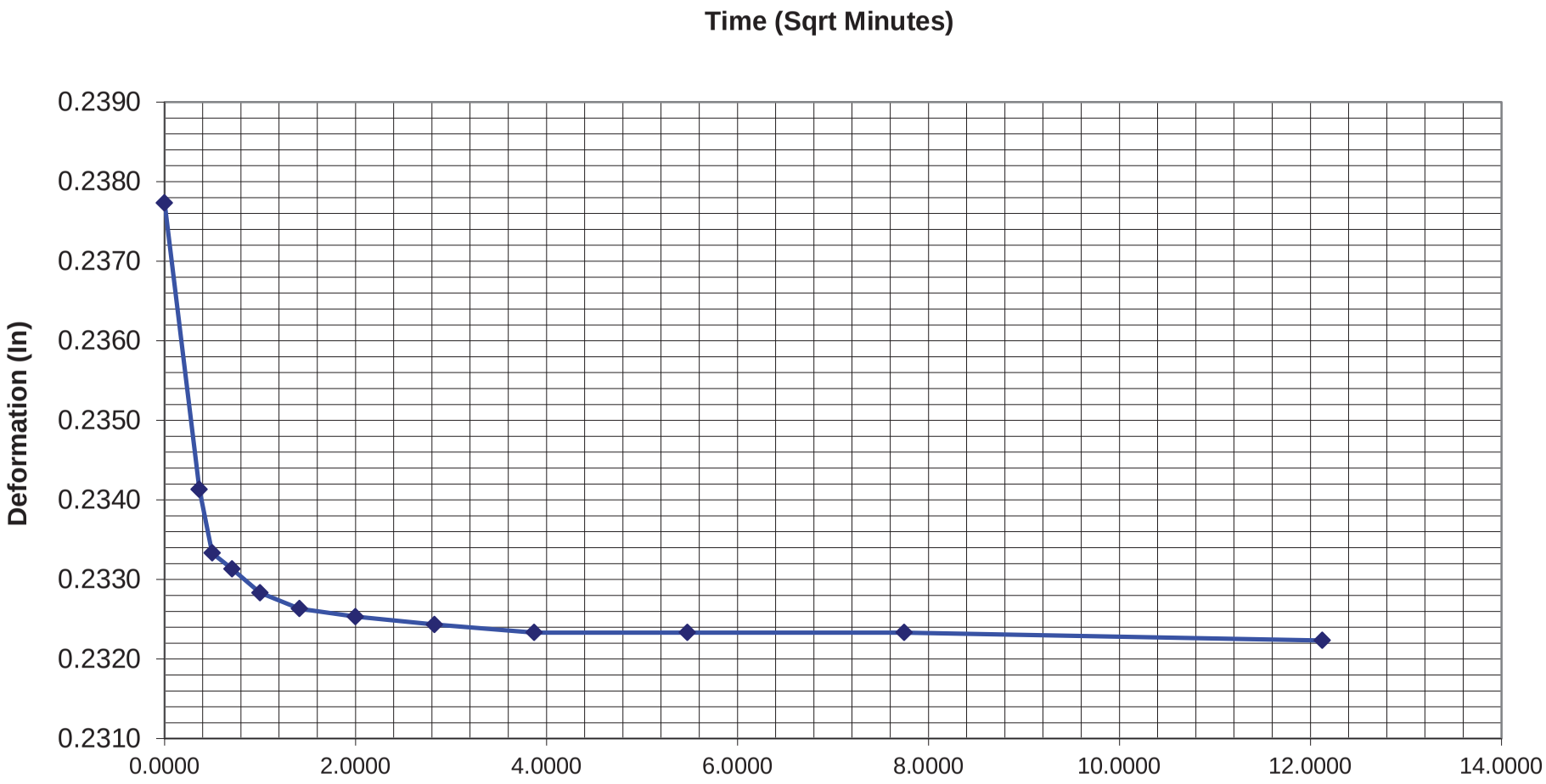


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-008

Client : PND	Pressure: 14109 psf 20 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.00307	Sample # 7
Date: 1/21/2013		Depth : 36.5'

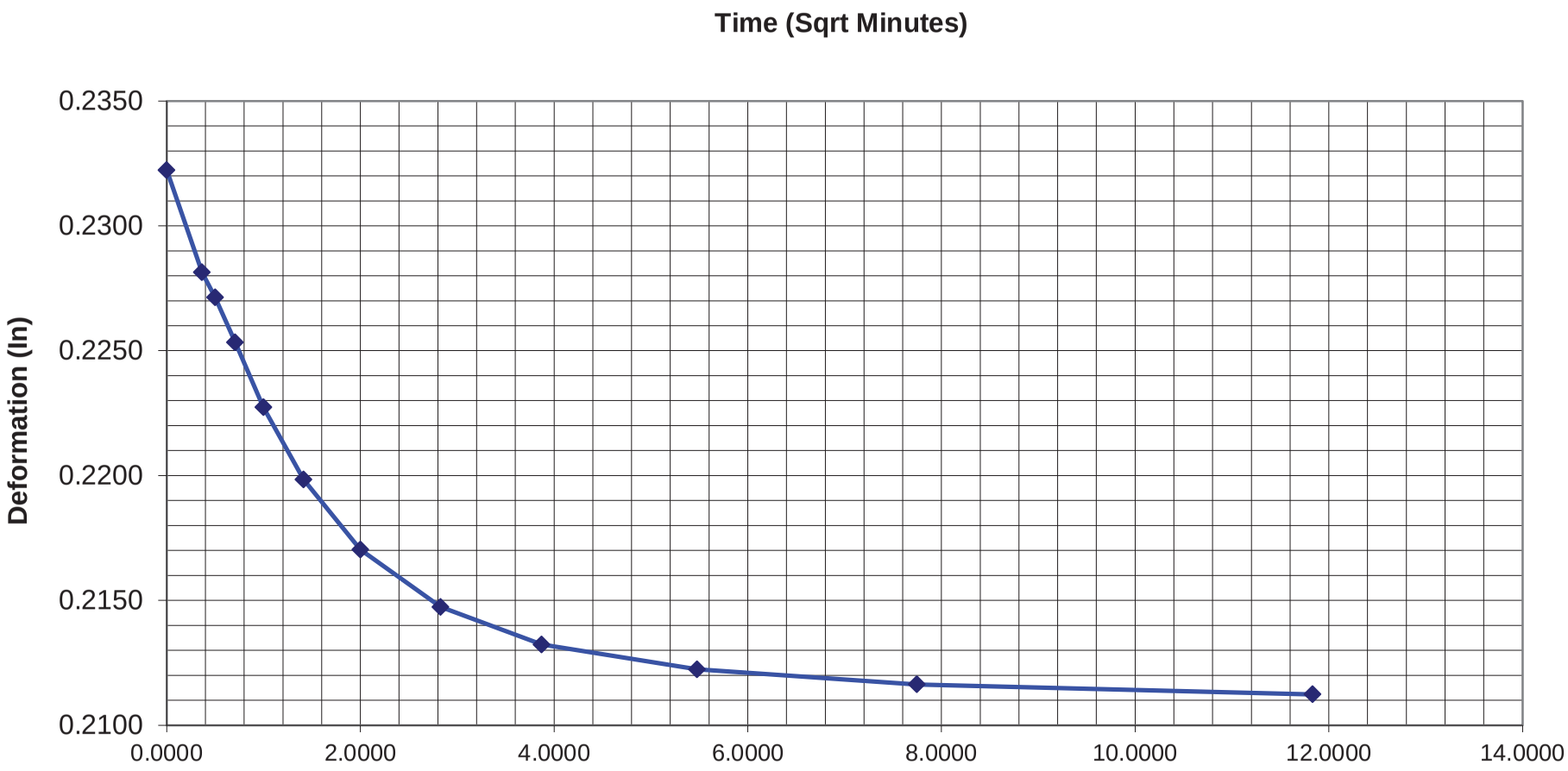


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-008

Client : PND	Pressure: 723 psf 2 psi	Boring : BH-7
Project : South Portage Cove	Deformation Correction (in): 0.001	Sample # 7
Date: 1/21/2013	0	Depth : 36.5'



Consolidation Report

Client :	PND	WO #	A33608	Boring :	BH-7
Project :	South Portage Cove	Lab #	2013-008 Undisturbed	Sample #	7
Date:	1/21/2013	Frame #	3	Depth :	36.5'

Wet Sample Weight (g)	150.10
Dry Sample Weight (g)	110.57
Sample Height (in)	1.00
Ring Diameter (in)	2.52
Dry Density (lb/ft3)	84.71
Wet Density (lb/ft3)	115.00
Area of Sample (in2)	4.98
Volume of Sample (in3)	4.97
Volume of Solids (in3)	2.55
Height of Solids (in)	0.51
Initial Height of Voids (in)	0.49
Initial Volume of Voids (in3)	2.43
Volume of Water (in3)	2.41
Initial Degree of Saturation (%)	99.33
Initial Void Ratio, e0	0.95
0.42 e0	0.40
specific gravity	2.65
Volume of Solids	0.51
Volume of Voids	0.49

Load Number	Guage Pressure	Load (lb)	Pressure (ksf)	Δ Height (in)	Void Ratio	% Change
Seating	1	5.00	0.145	0.000	0.952	0.00
1	1.25	12.33	0.357	0.014	0.927	1.39%
2	1.75	25.00	0.723	0.042	0.872	4.17%
3	2	32.00	0.926	0.049	0.857	4.95%
4	3	60.33	1.746	0.077	0.803	7.74%
5	4	74.67	2.160	0.084	0.790	8.36%
6	7.5	179.00	5.179	0.118	0.723	11.82%
7	10	231.33	6.693	0.134	0.693	13.36%
8	20	490.33	14.186	0.173	0.615	17.33%
9	40	1012.33	29.289	0.205	0.552	20.55%
10	80	2058.67	59.561	0.238	0.489	23.79%
11	20	487.67	14.109	0.232	0.500	23.23%
12	2	25.00	0.723	0.211	0.541	21.13%

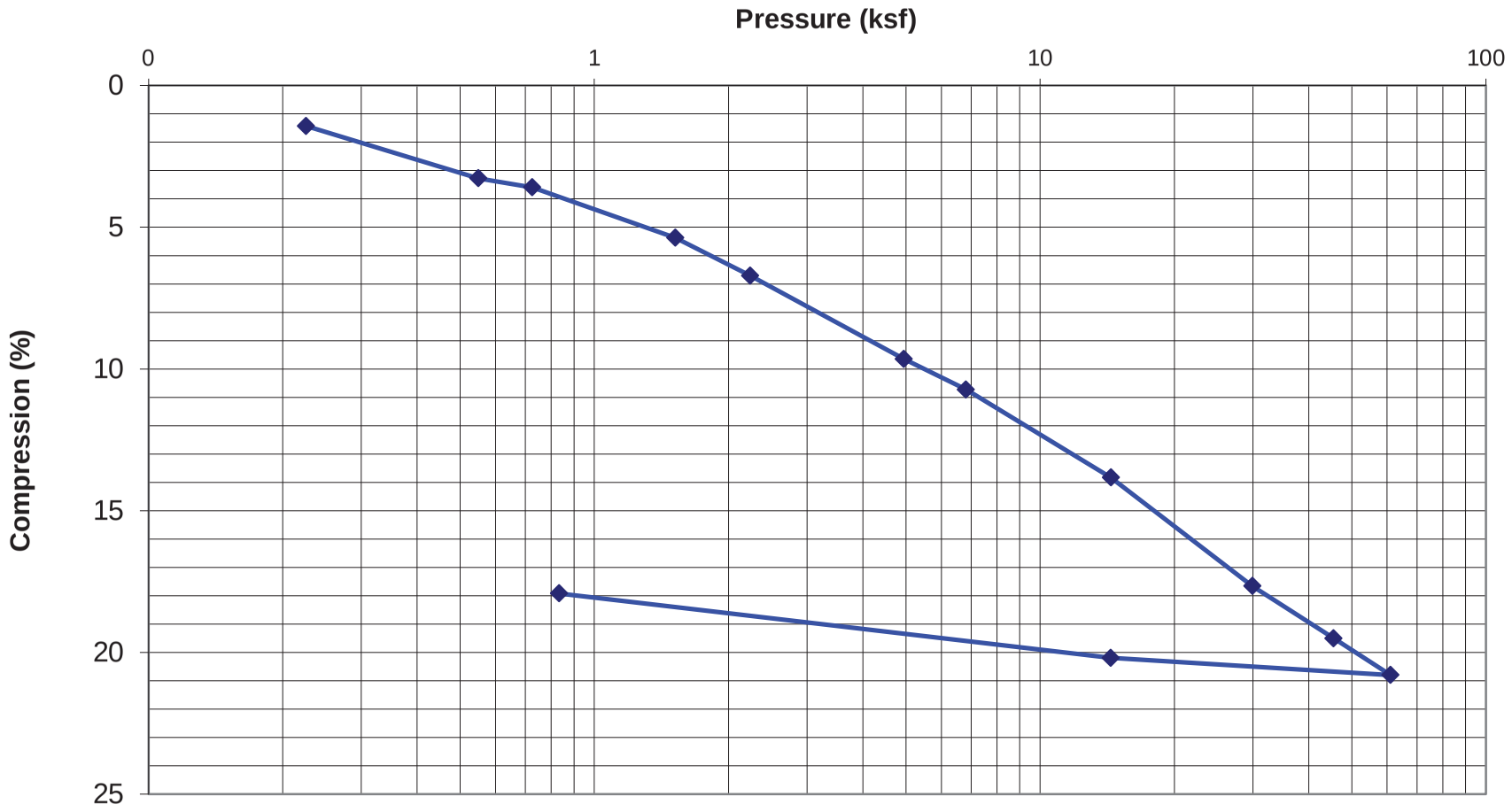
Moisture Content			
	Trimmings	Initial	Final
Wet + Tare	32.49		604.04
Dry + Tare	24.21		578.33
Tare	1.05		475.03
Wet Weight	31.44	150.10	129.01
Wt. Water	8.28		25.71
Wt. Dry Soil	23.16		103.3
% Moisture	35.8		25

DOWL HKM

Compression Curve (% Comp. vs. Log P)

WO #	A33608
Lab #	2013-010

Client :	PND	Moisture Content =	31.1 %	Boring :	BH-8
Project :	South Portage Cove	Dry Unit Weight (pcf) =	91.0	Sample #	6
Date:	1/21/2013	Wet Unit Weight (pcf)=	119.3	Depth :	30' - 33'



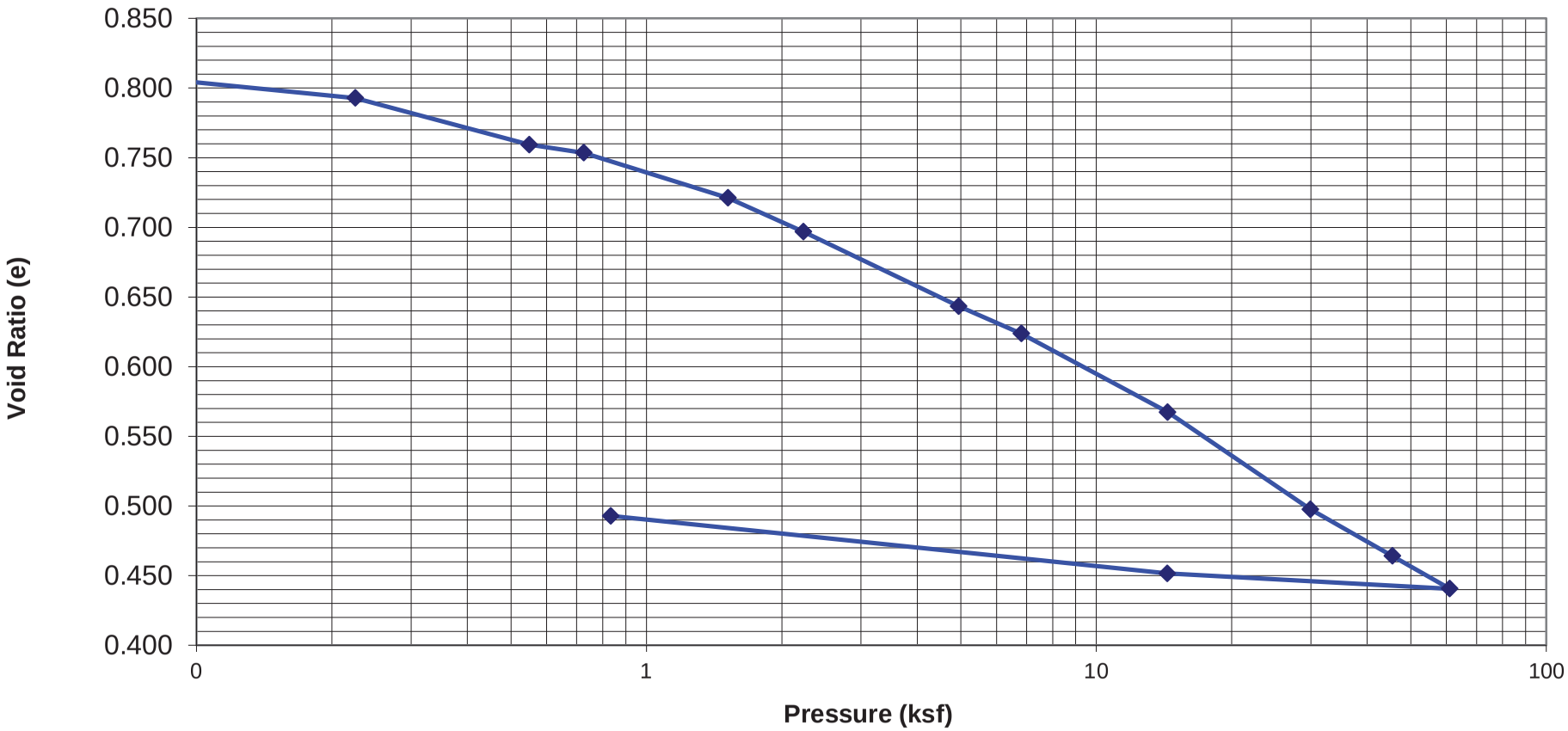
DOWL HKM

Compression Curve (e vs. Log P)

WO #	A33608
Lab #	2013-010

Client :	PND	Moisture Content =	31.1 %	Boring :	BH-8
Project :	South Portage Cove	Dry Unit Weight (pcf) =	91.0	Sample #	6
Date:	1/21/2013	Wet Unit Weight (pcf)=	119.3	Depth :	30' - 33'

e_o = 0.817

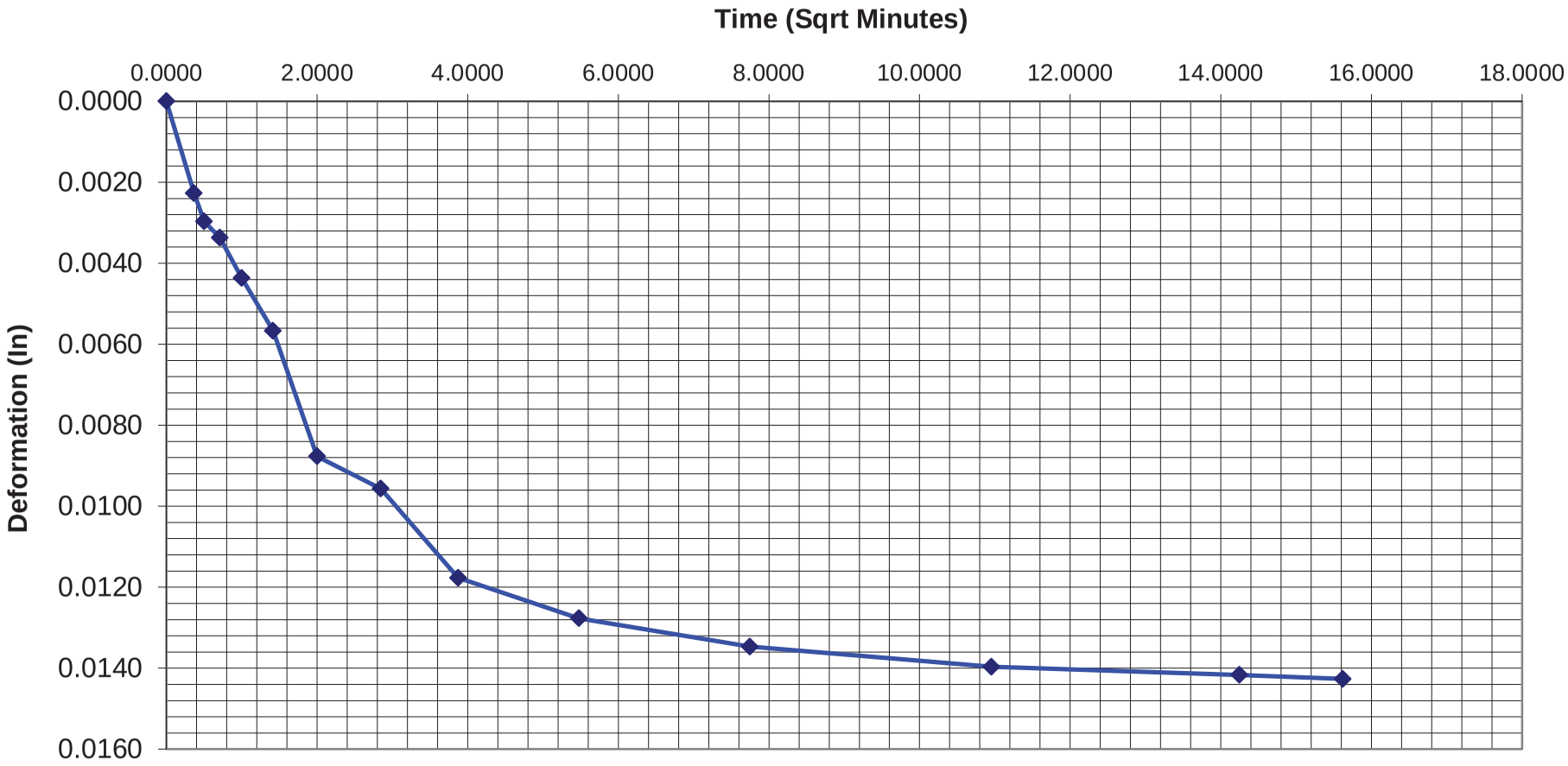


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-010

Client : PND	Pressure: 226 psf 1.25 psi	Boring : BH-8
Project : South Portage Cove	Deformation Correction (in): 0.00013	Sample # 6
Date: 1/21/2013		Depth : 30' - 33'

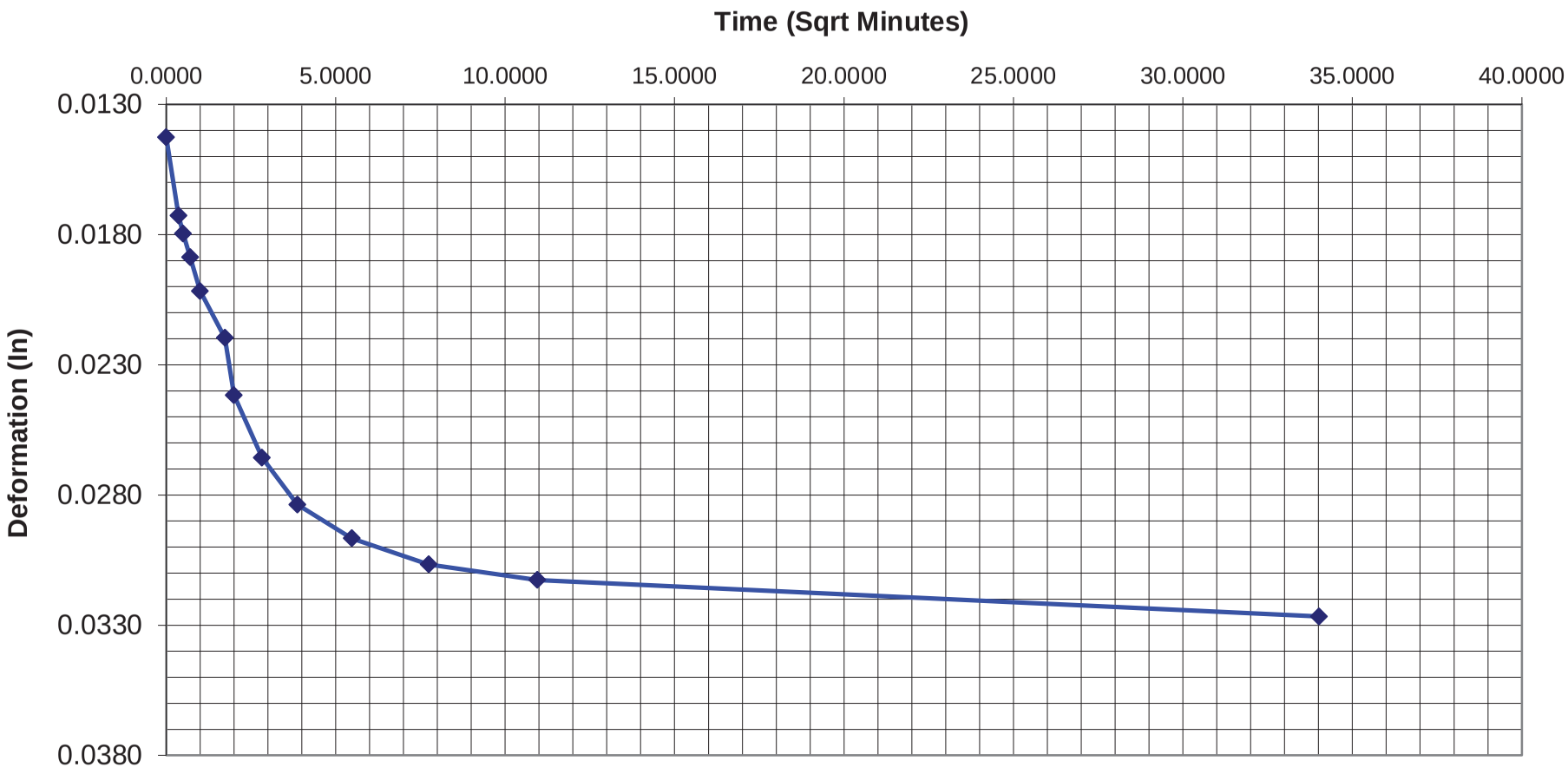


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-010

Client : PND	Pressure: 549 psf 1.75 psi	Boring : BH-8
Project : South Portage Cove	Deformation Correction (in): 0.00013	Sample # 6
Date: 1/21/2013		Depth : 30' - 33'

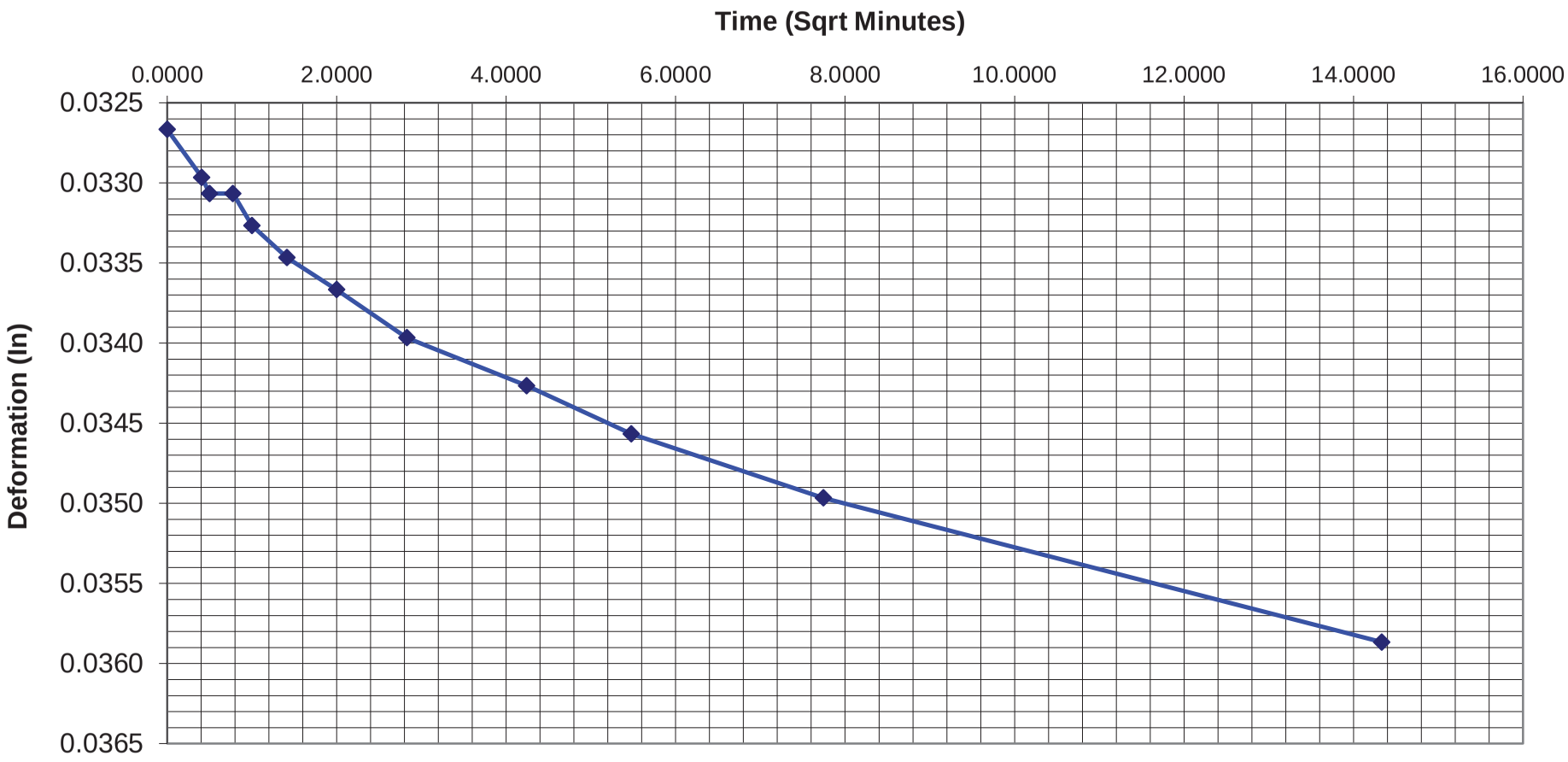


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-010

Client : PND	Pressure: 726 psf 2 psi	Boring : BH-8
Project : South Portage Cove	Deformation Correction (in): 0.00023	Sample # 6
Date: 1/21/2013		Depth : 30' - 33'

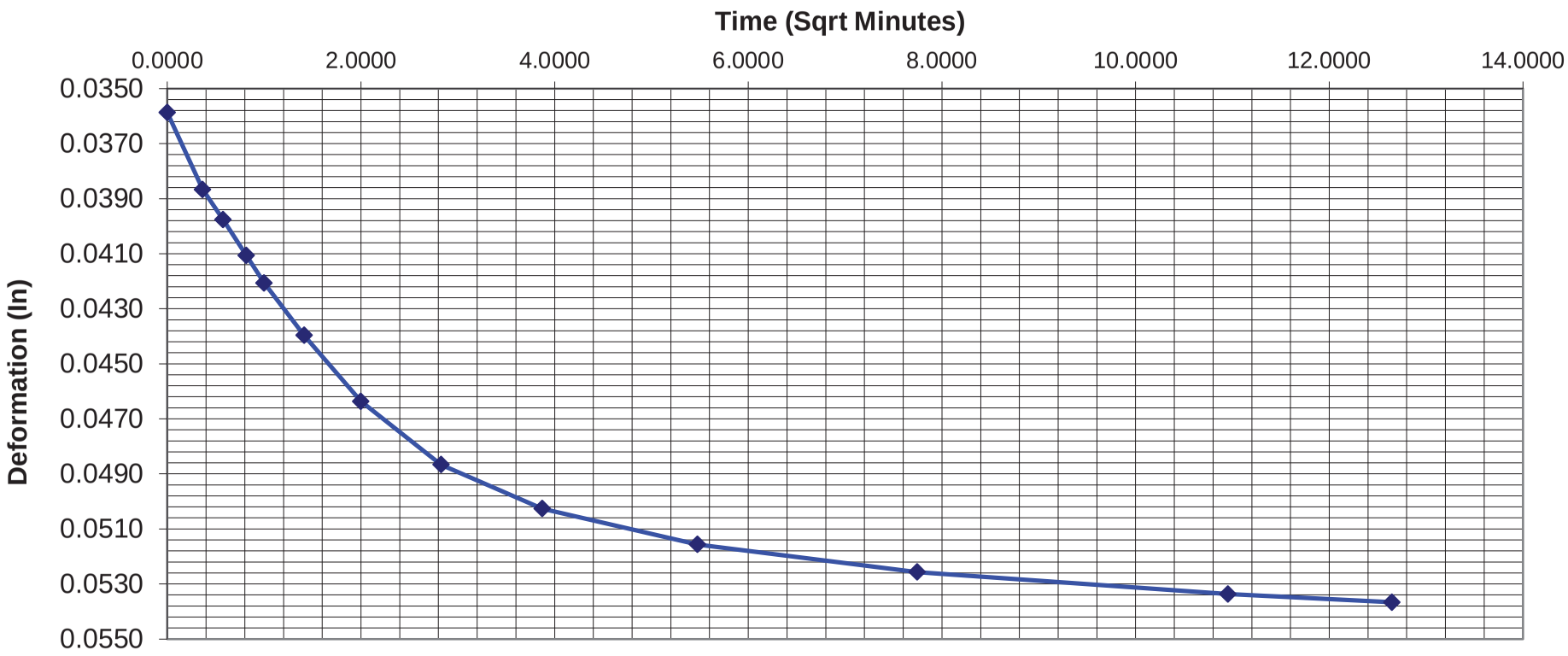


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-010

Client : PND	Pressure: 1520 psf 3 psi	Boring : BH-8
Project : South Portage Cove	Deformation Correction (in): 0.00083	Sample # 6
Date: 1/21/2013		Depth : 30' - 33'

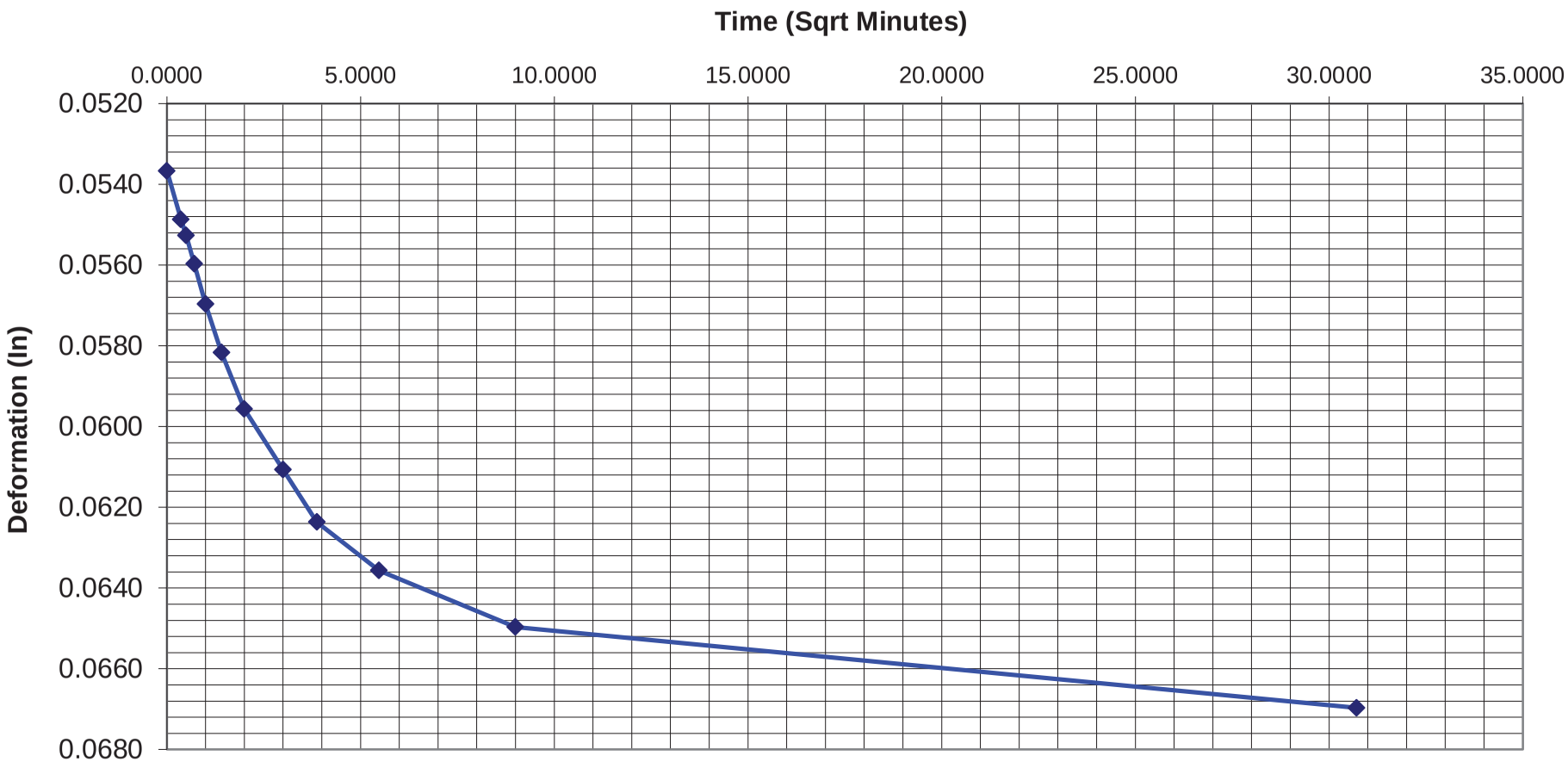


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-010

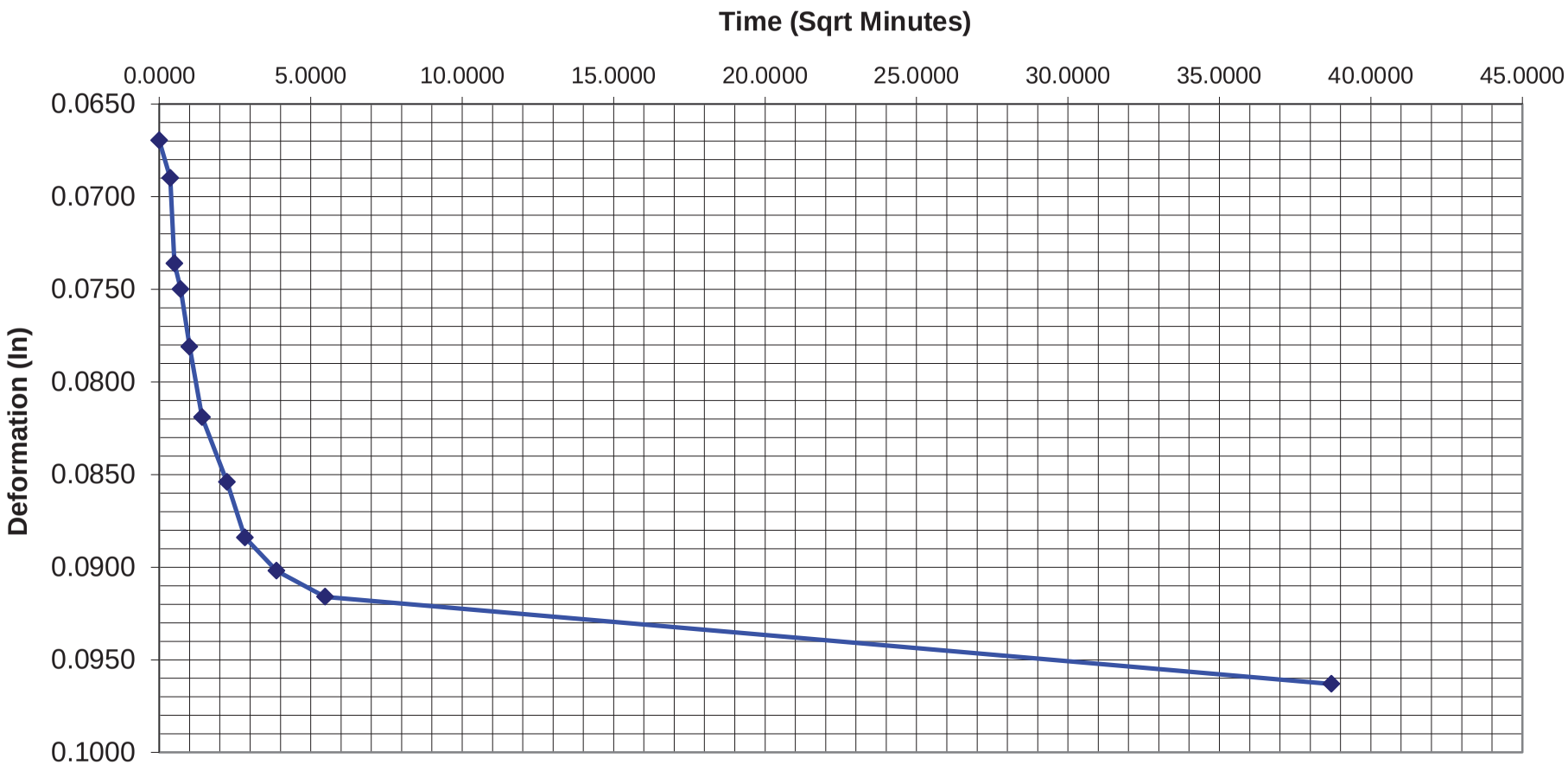
Client : PND	Pressure: 2236 psf 4 psi	Boring : BH-8
Project : South Portage Cove	Deformation Correction (in): 0.00103	Sample # 6
Date: 1/21/2013		Depth : 30' - 33'



Time Rate of Consolidation

WO #	A33608
Lab #	2013-010

Client : PND	Pressure: 4943 psf 7.5 psi	Boring : BH-8
Project : South Portage Cove	Deformation Correction (in): 0.0015	Sample # 6
Date: 1/21/2013		Depth : 30' - 33'

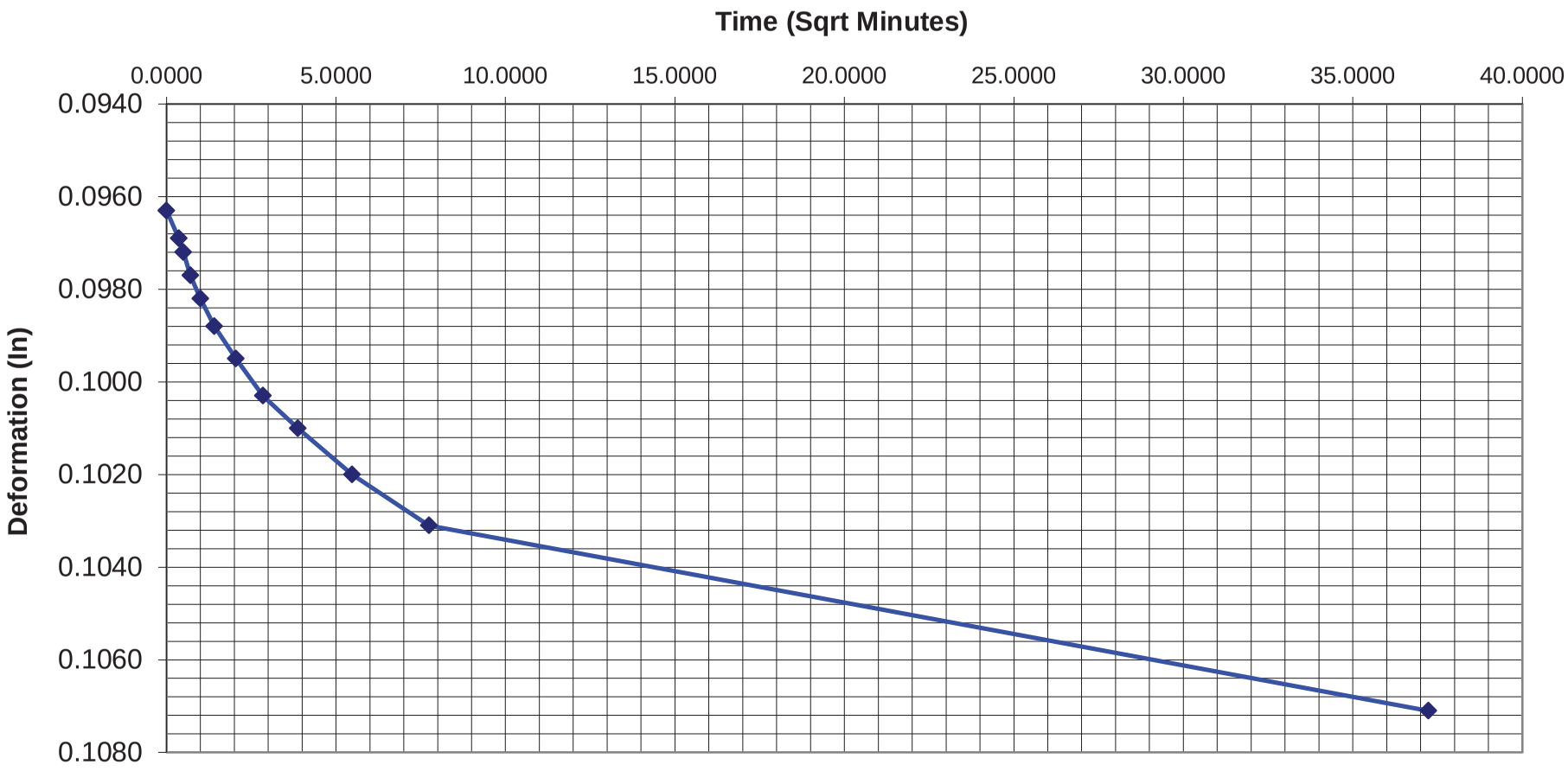


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-010

Client : PND	Pressure: 6816 psf 10 psi	Boring : BH-8
Project : South Portage Cove	Deformation Correction (in): 0.0017	Sample # 6
Date: 1/21/2013		Depth : 30' - 33'

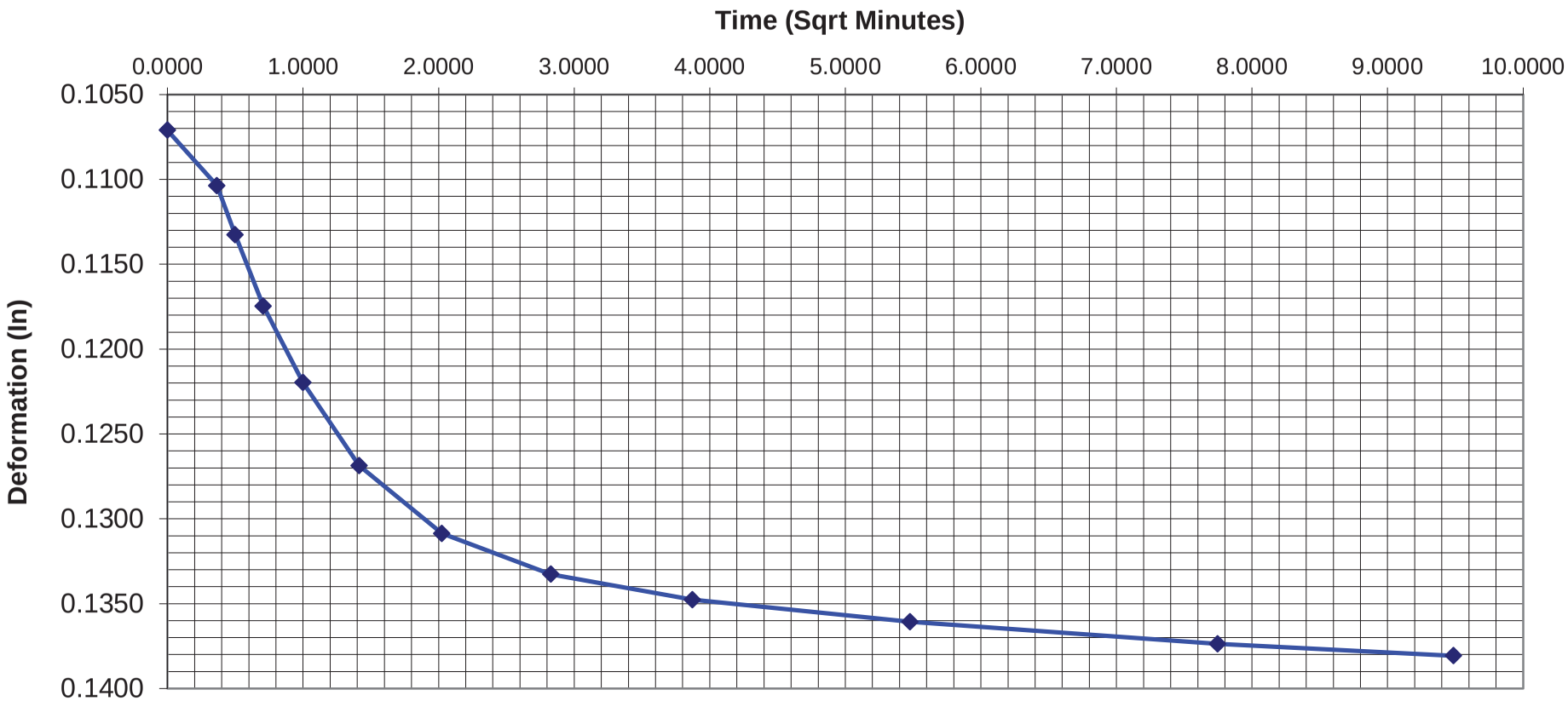


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-010

Client : PND	Pressure: 14418 psf 20 psi	Boring : BH-8
Project : South Portage Cove	Deformation Correction (in): 0.00223	Sample # 6
Date: 1/21/2013		Depth : 30' - 33'

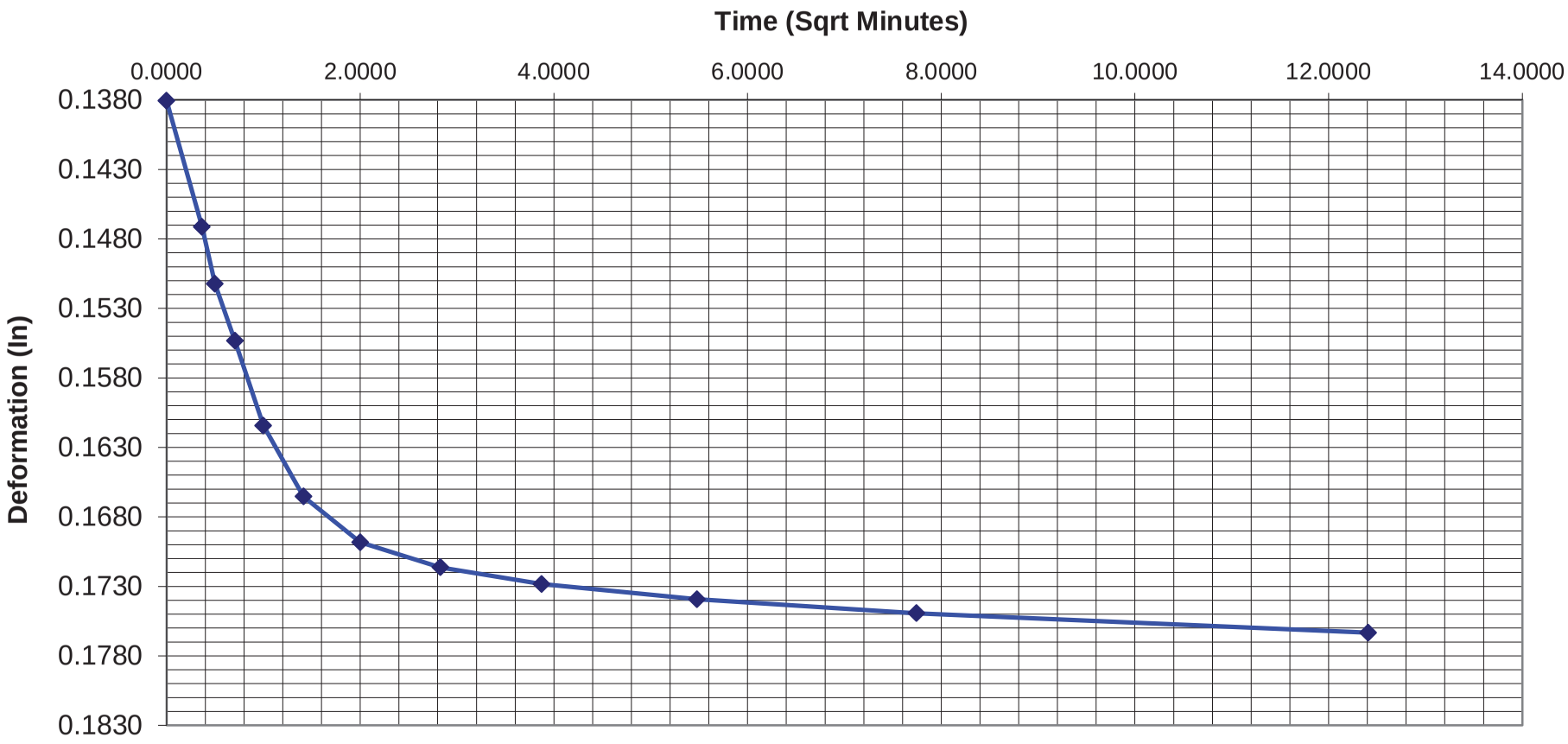


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-010

Client : PND	Pressure: 29924 psf 40 psi	Boring : BH-8
Project : South Portage Cove	Deformation Correction (in): 0.00277	Sample # 6
Date: 1/21/2013		Depth : 30' - 33'

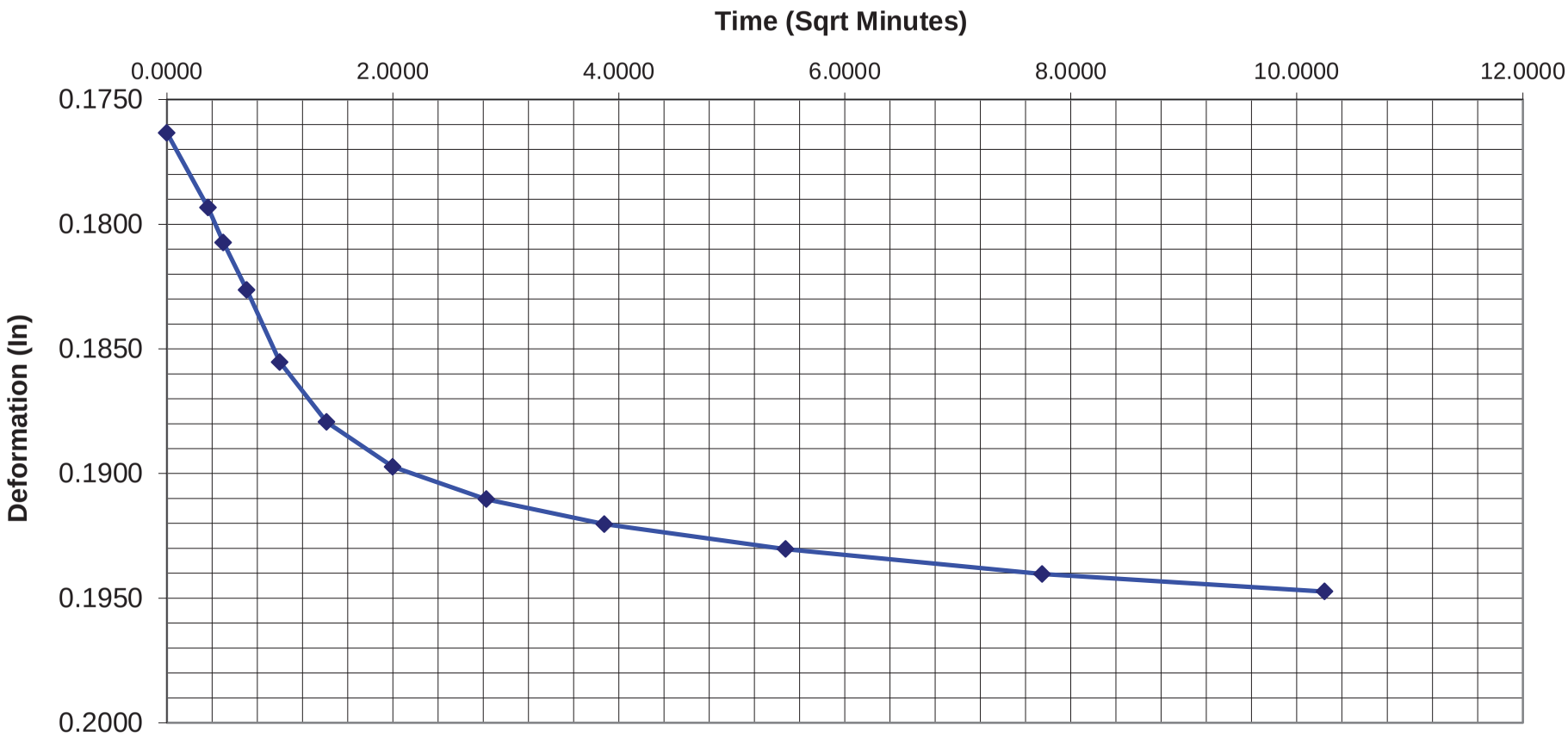


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-010

Client : PND	Pressure: 45518 psf 60 psi	Boring : BH-8
Project : South Portage Cove	Deformation Correction (in): 0.00317	Sample # 6
Date: 1/21/2013		Depth : 30' - 33'

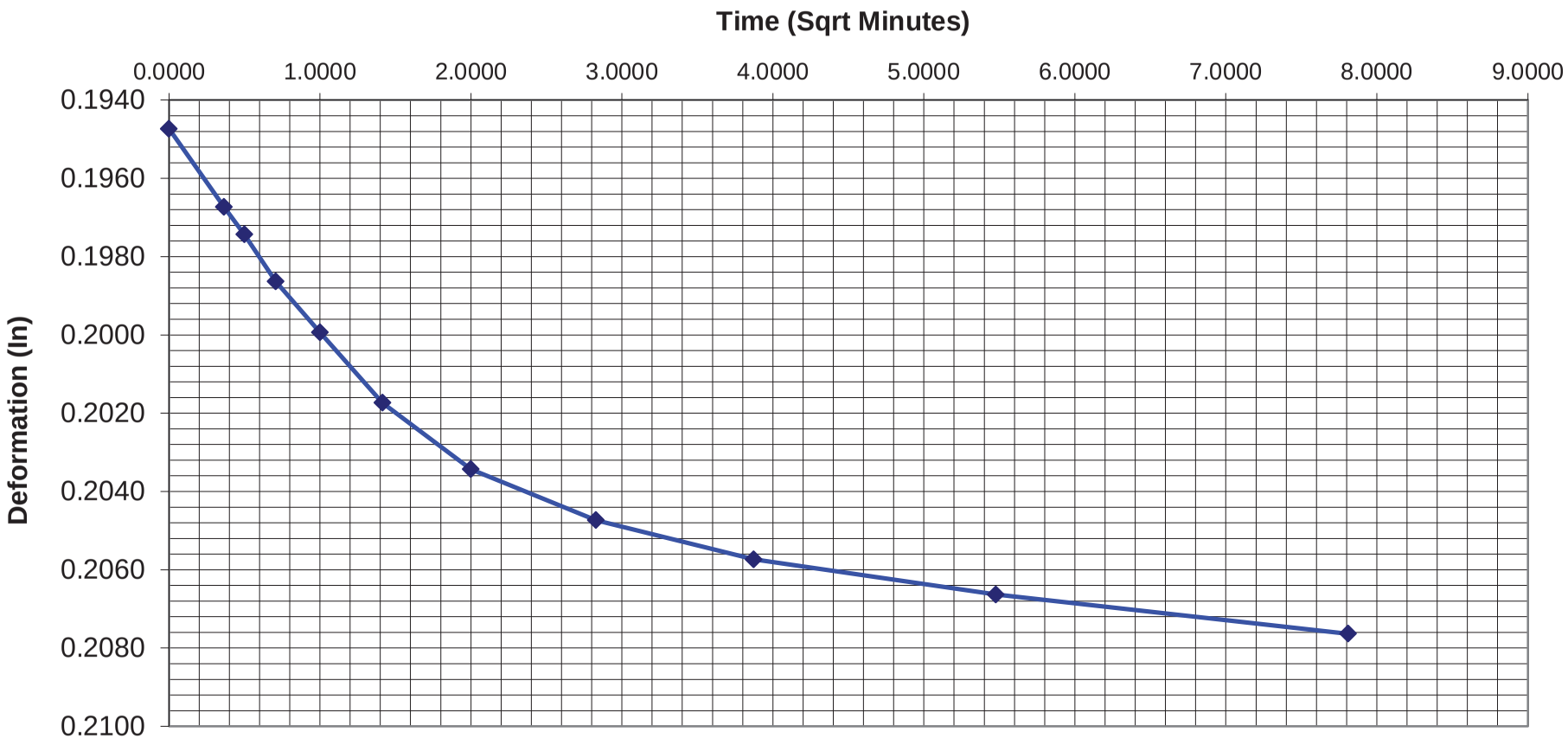


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-010

Client : PND	Pressure: 61074 psf 80 psi	Boring : BH-8
Project : South Portage Cove	Deformation Correction (in): 0.0034	Sample # 6
Date: 1/21/2013		Depth : 30' - 33'

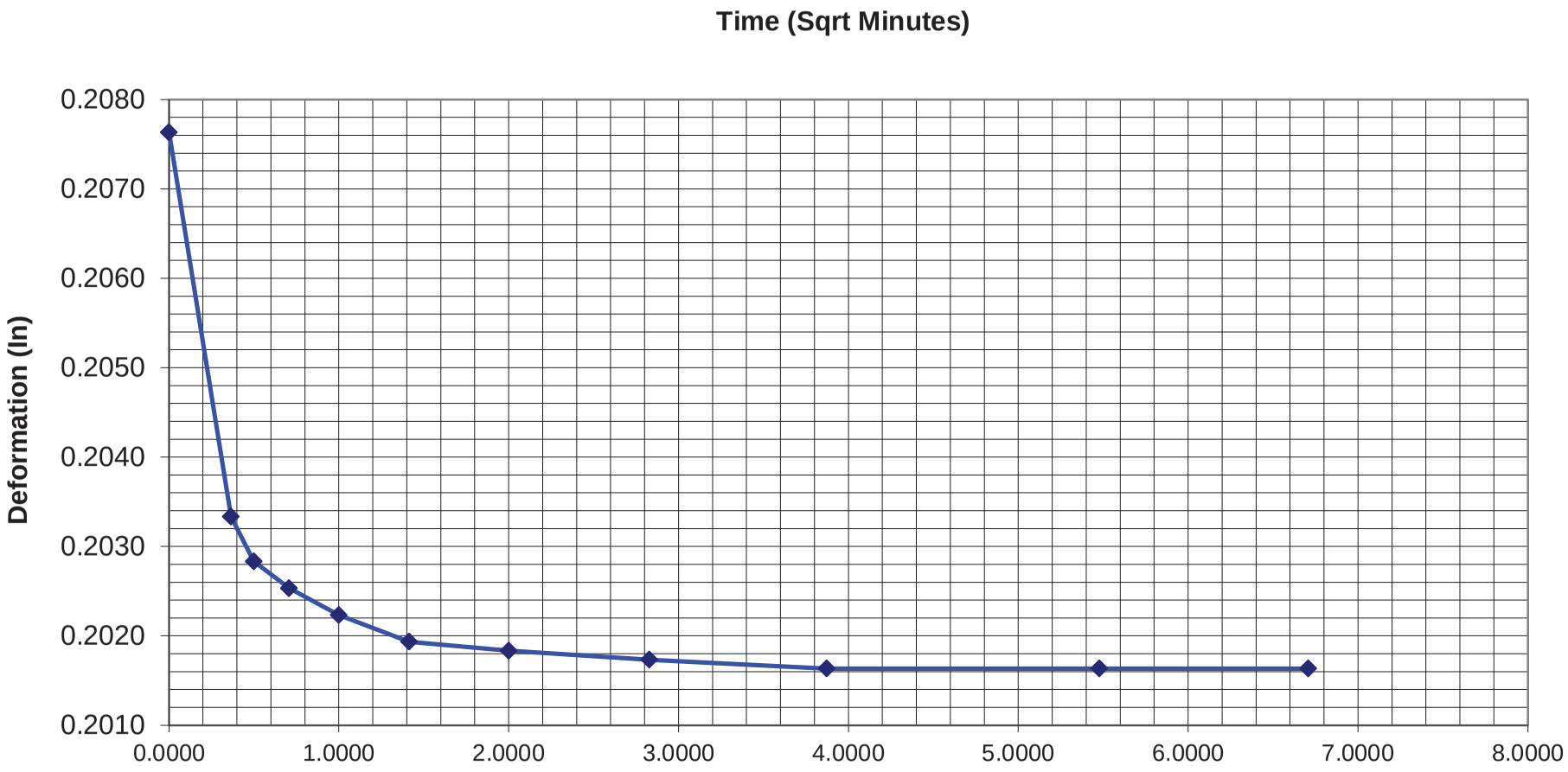


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-010

Client : PND	Pressure: 14388 psf 20 psi	Boring : BH-8
Project : South Portage Cove	Deformation Correction (in): 0.0025	Sample # 6
Date: 1/21/2013	Rebound Load	Depth : 30' - 33'

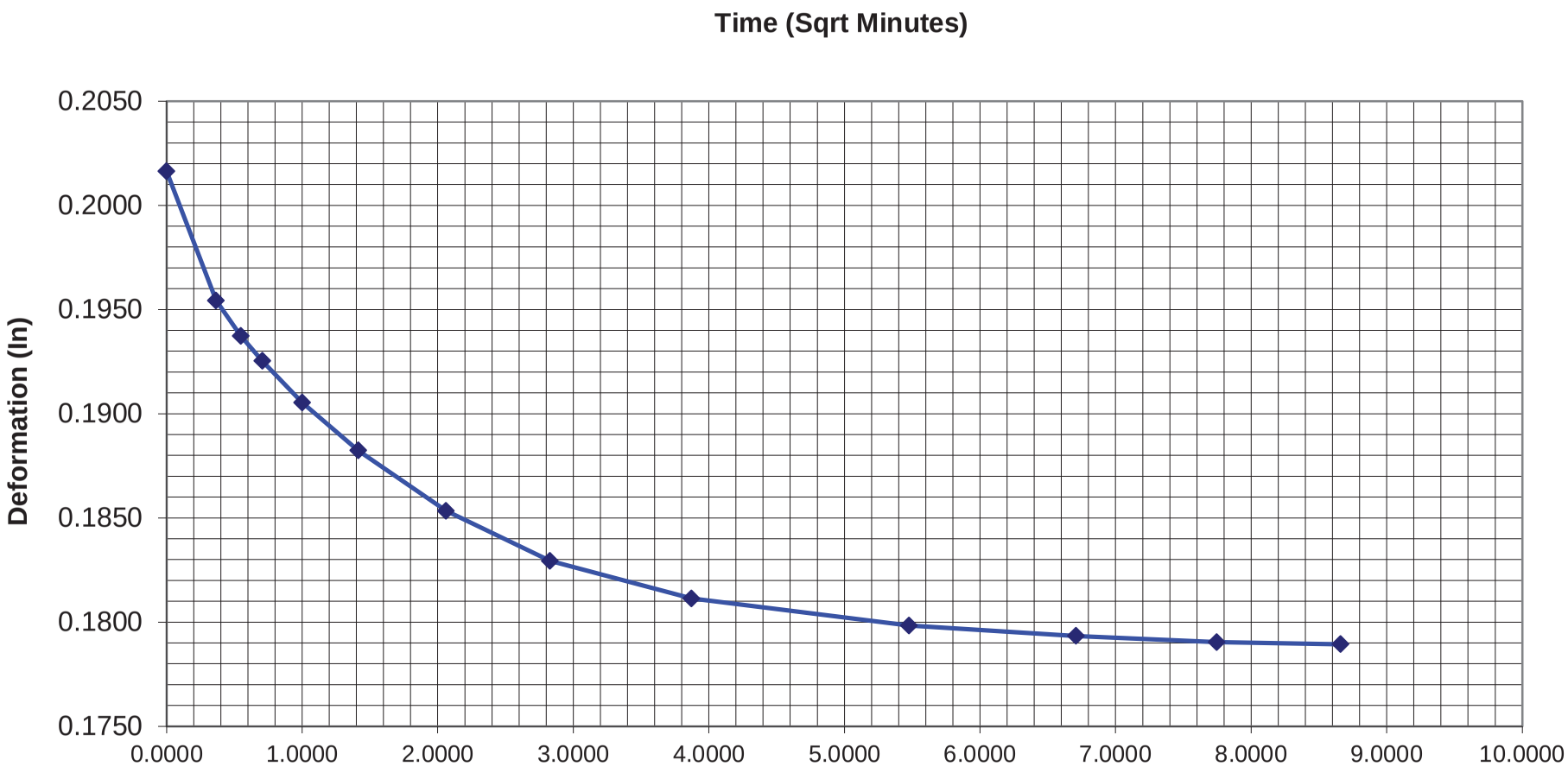


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-010

Client : PND	Pressure: 834 psf 2 psi	Boring : BH-8
Project : South Portage Cove	Deformation Correction (in): 0.0009	Sample # 6
Date: 1/21/2013	Rebound Load	Depth : 30' - 33'



Consolidation Report

Client :	PND	WO #	A33608	Boring :	BH-8
Project :	South Portage Cove	Lab #	2013-010 Remolded	Sample #	6
Date:	1/21/2013	Frame #	2	Depth :	30' - 33'

Wet Sample Weight (g)	152.98
Dry Sample Weight (g)	116.67
Sample Height (in)	1.00
Ring Diameter (in)	2.50
Dry Density (lb/ft3)	91.00
Wet Density (lb/ft3)	119.32
Area of Sample (in2)	4.89
Volume of Sample (in3)	4.89
Volume of Solids (in3)	2.69
Height of Solids (in)	0.55
Initial Height of Voids (in)	0.45
Initial Volume of Voids (in3)	2.20
Volume of Water (in3)	2.22
Initial Degree of Saturation (%)	100.71
Initial Void Ratio, e0	0.82
0.42 e0	0.34
specific gravity	2.65
Volume of Solids	0.55
Volume of Voids	0.45

Load Number	Guage Pressure	Load (lb)	Pressure (ksf)	Δ Height (in)	Void Ratio	% Change
Seating	1	1.33	0.039	0.000	0.817	0.00
1	1.25	7.67	0.226	0.014	0.793	1.43%
2	1.75	18.67	0.549	0.033	0.759	3.27%
3	2	24.67	0.726	0.036	0.753	3.59%
4	3	51.67	1.520	0.054	0.721	5.37%
5	4	76.00	2.236	0.067	0.697	6.71%
6	10	168.00	4.943	0.096	0.643	9.64%
7	15	231.67	6.816	0.107	0.624	10.73%
8	20	490.00	14.418	0.138	0.567	13.83%
9	30	1017.00	29.924	0.176	0.498	17.66%
10	40	1547.00	45.518	0.195	0.464	19.50%
11	80	2075.67	61.074	0.208	0.441	20.79%
12	20	489.00	14.388	0.202	0.452	20.19%
13	2	28.33	0.834	0.179	0.493	17.92%

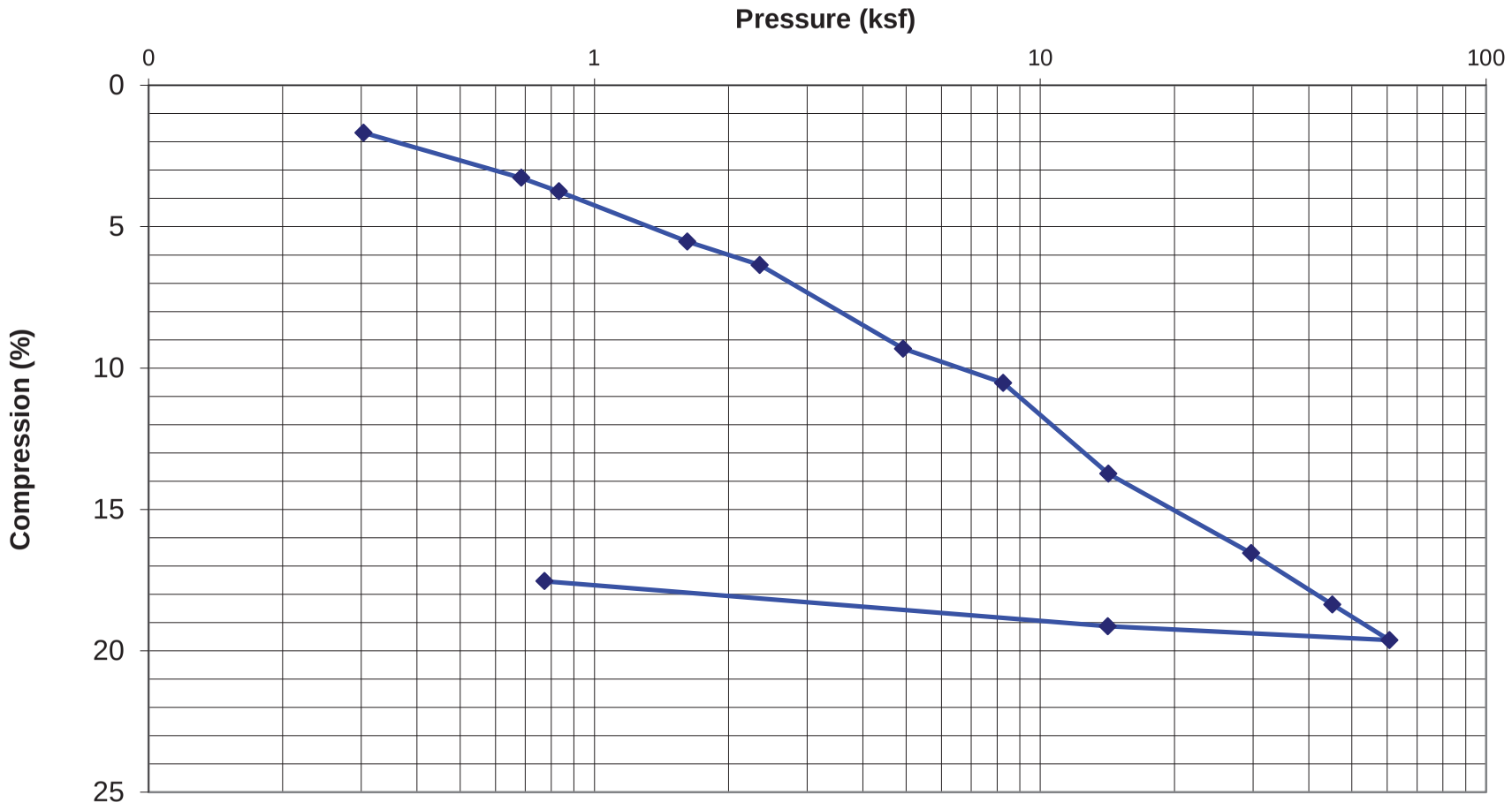
Moisture Content			
	Trimmings	Initial	Final
Wet + Tare	31.85		624.82
Dry + Tare	24.54		597.83
Tare	1.05		485.79
Wet Weight	30.8	152.98	139.03
Wt. Water	7.31		26.99
Wt. Dry Soil	23.49		112.04
% Moisture	31.1		24

DOWL HKM

Compression Curve (% Comp. vs. Log P)

WO #	A33608
Lab #	2013-018

Client :	PND	Moisture Content =	27.1 %	Boring :	BH-10
Project :	South Portage Cove	Dry Unit Weight (pcf) =	94.2	Sample #	7
Date:	1/29/2013	Wet Unit Weight (pcf)=	119.7	Depth :	35' - 38'



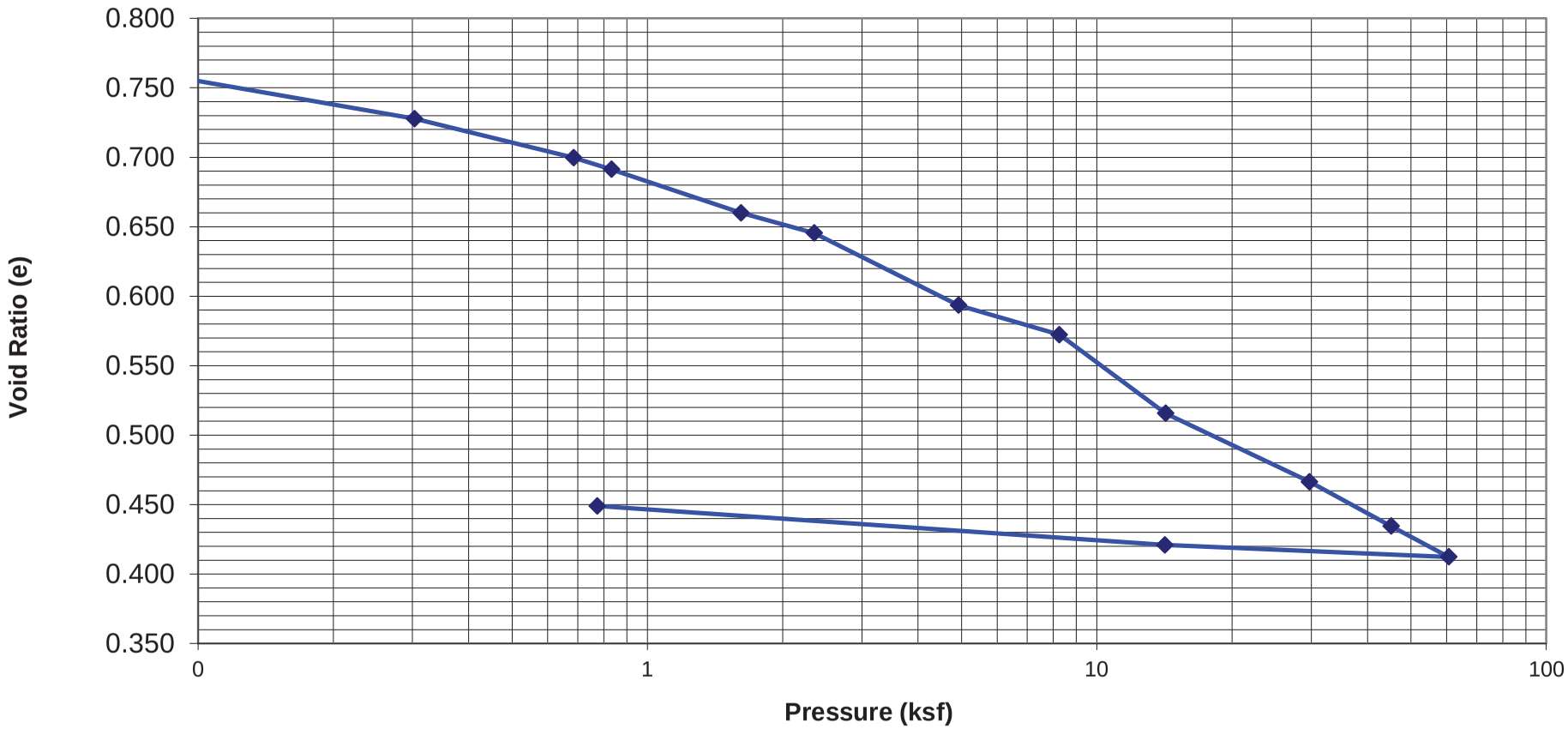
DOWL HKM

Compression Curve (e vs. Log P)

WO #	A33608
Lab #	2013-018

Client :	PND	Moisture Content =	27.1 %	Boring :	BH-10
Project :	South Portage Cove	Dry Unit Weight (pcf) =	94.2	Sample #	7
Date:	1/29/2013	Wet Unit Weight (pcf)=	119.7	Depth :	35' - 38'

e_o = 0.756

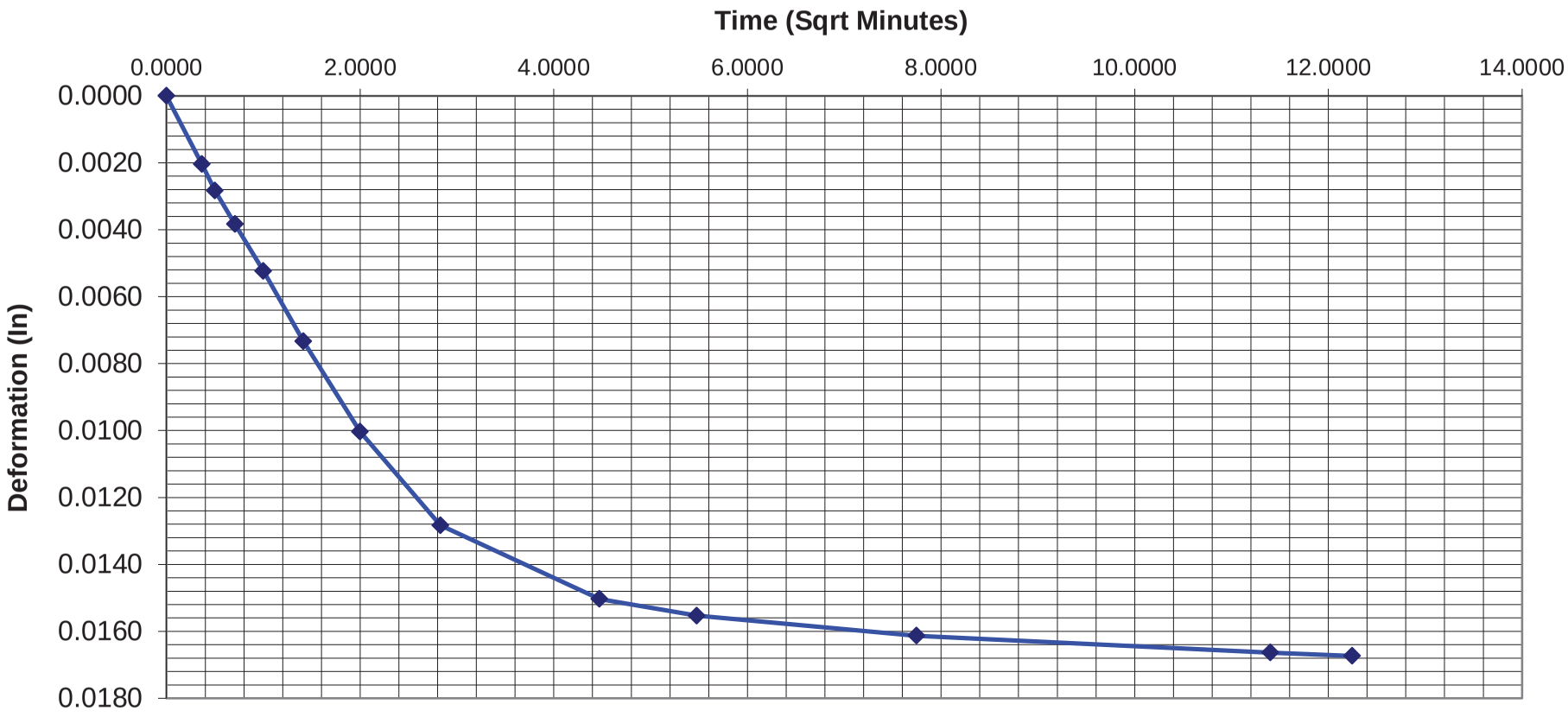


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-018

Client : PND	Pressure: 304 psf 1.25 psi	Boring : BH-10
Project : South Portage Cove	Deformation Correction (in): 0.00057	Sample # 7
Date: 1/29/2013		Depth : 35' - 38'

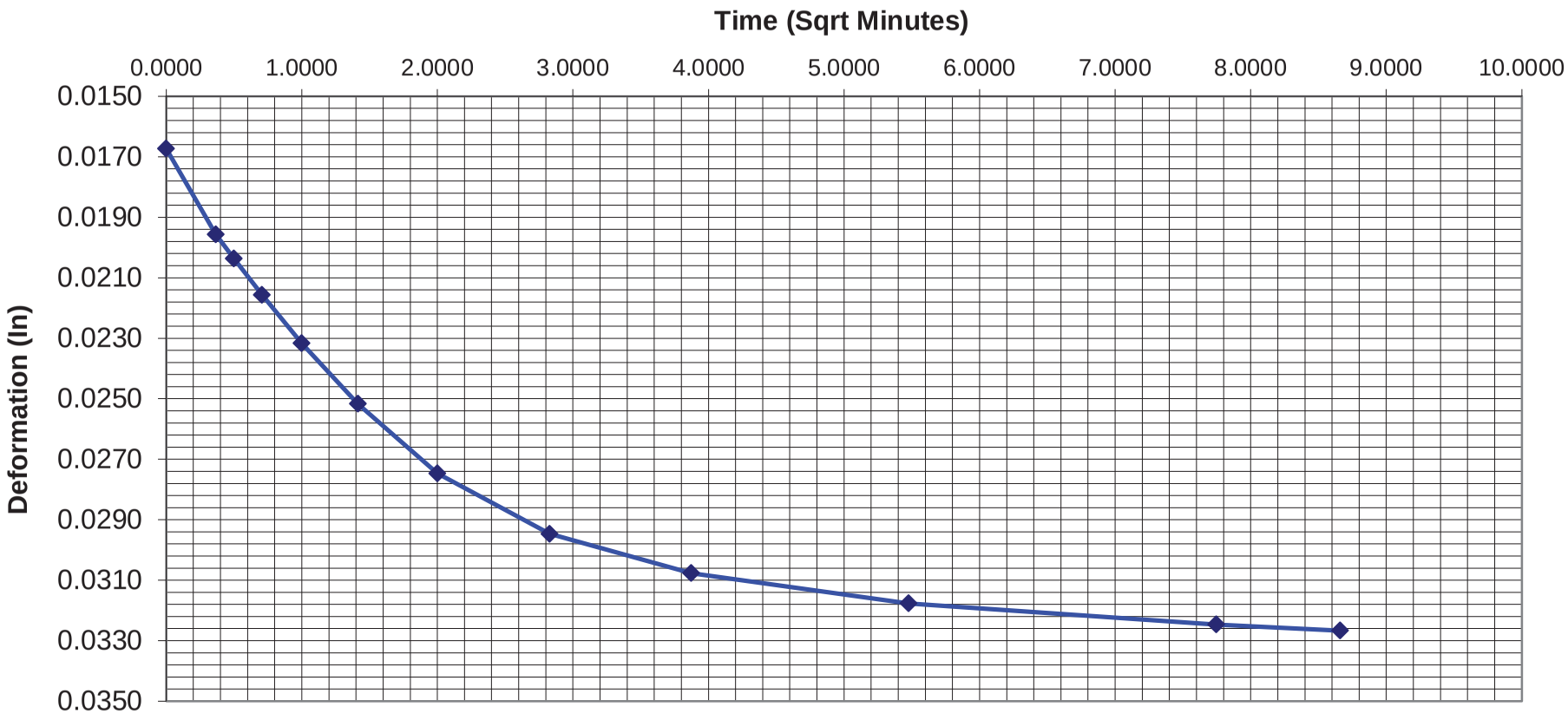


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-018

Client : PND	Pressure: 686 psf 1.75 psi	Boring : BH-10
Project : South Portage Cove	Deformation Correction (in): 0.00073	Sample # 7
Date: 1/29/2013		Depth : 35' - 38'

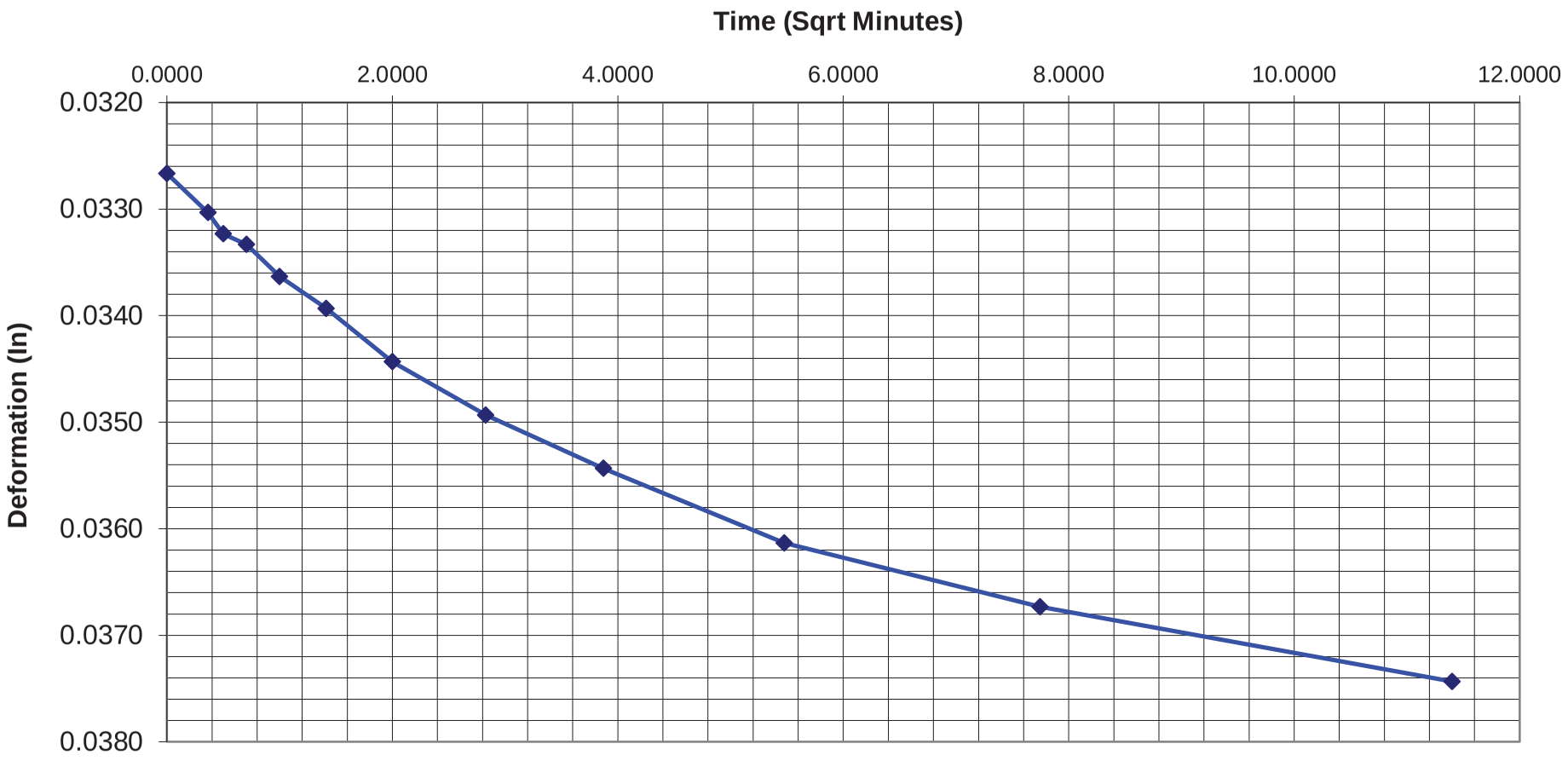


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-018

Client : PND	Pressure: 833 psf 2 psi	Boring : BH-10
Project : South Portage Cove	Deformation Correction (in): 0.00077	Sample # 7
Date: 1/29/2013		Depth : 35' - 38'

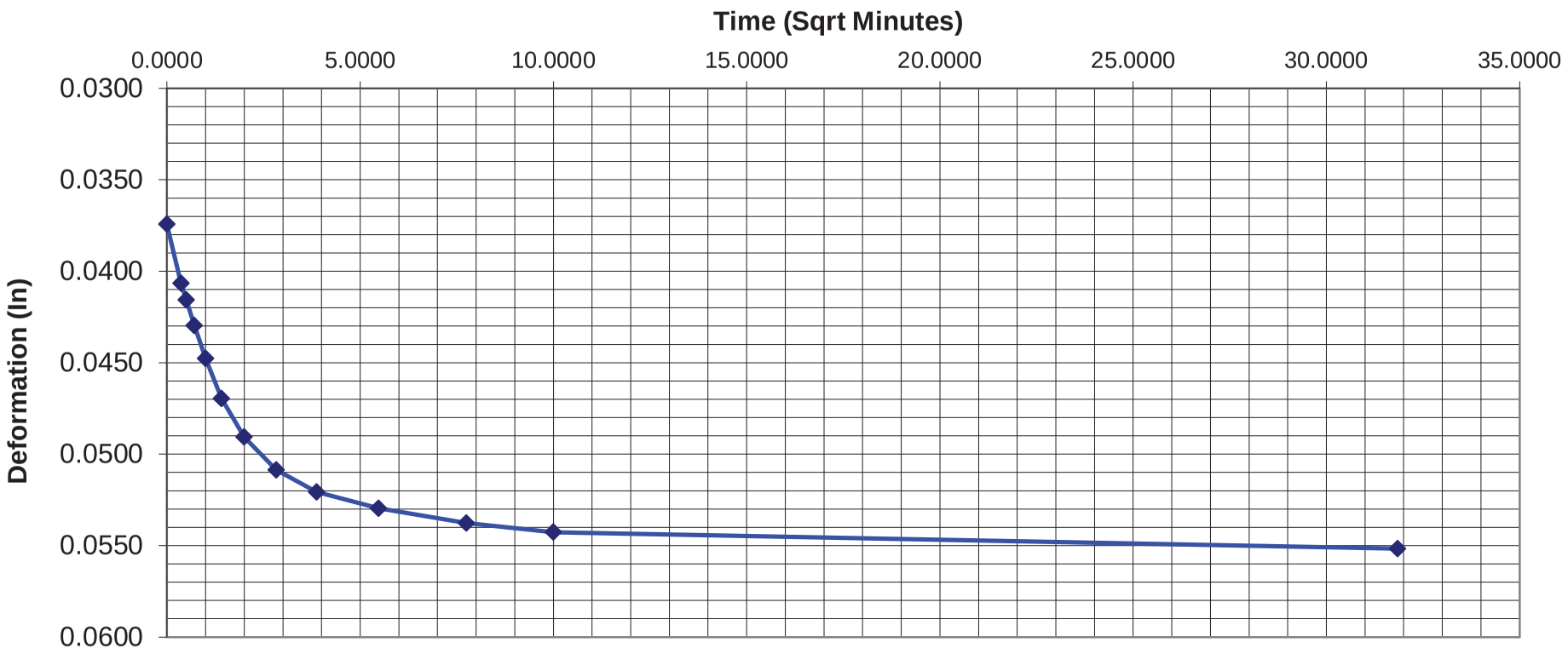


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-018

Client : PND	Pressure: 1616 psf 3 psi	Boring : BH-10
Project : South Portage Cove	Deformation Correction (in): 0.00103	Sample # 7
Date: 1/29/2013		Depth : 35' - 38'

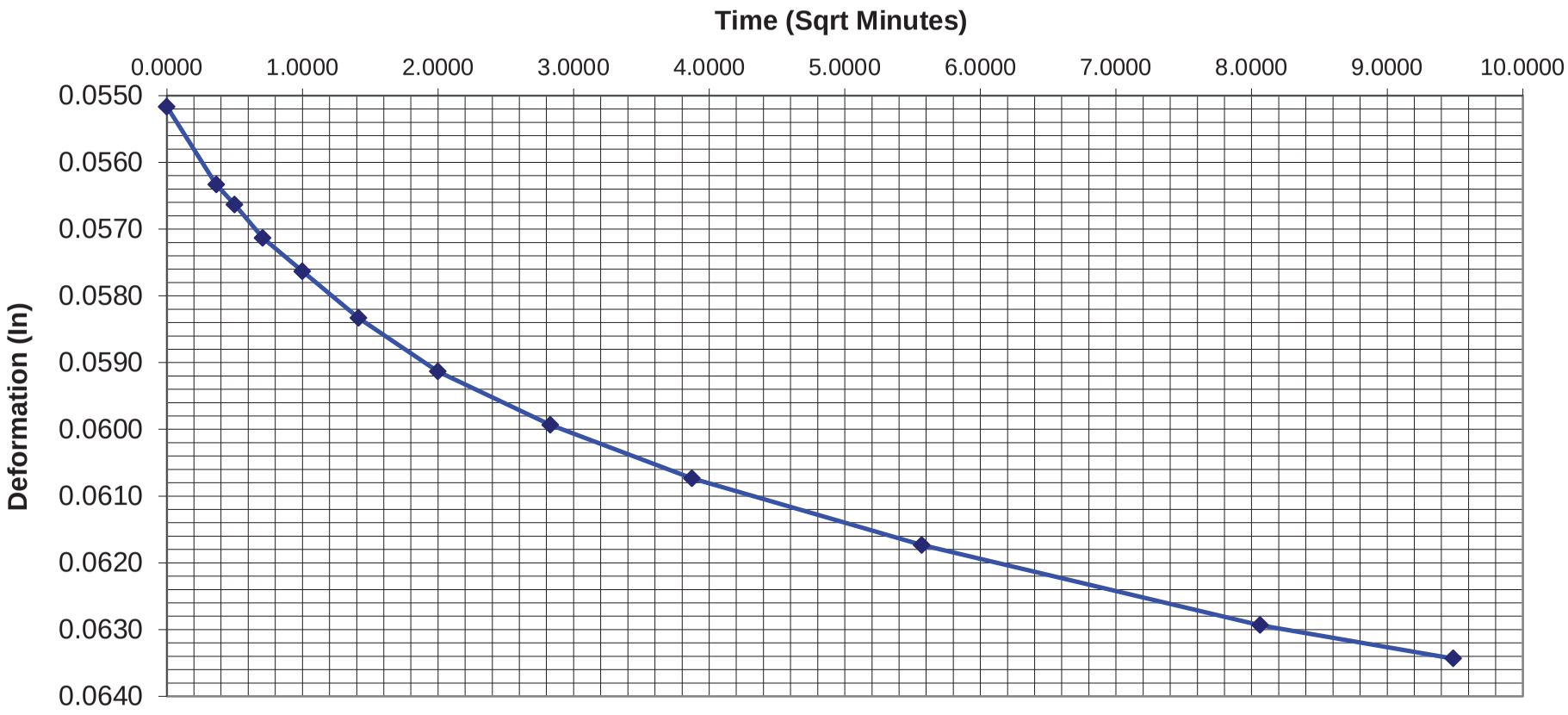


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-018

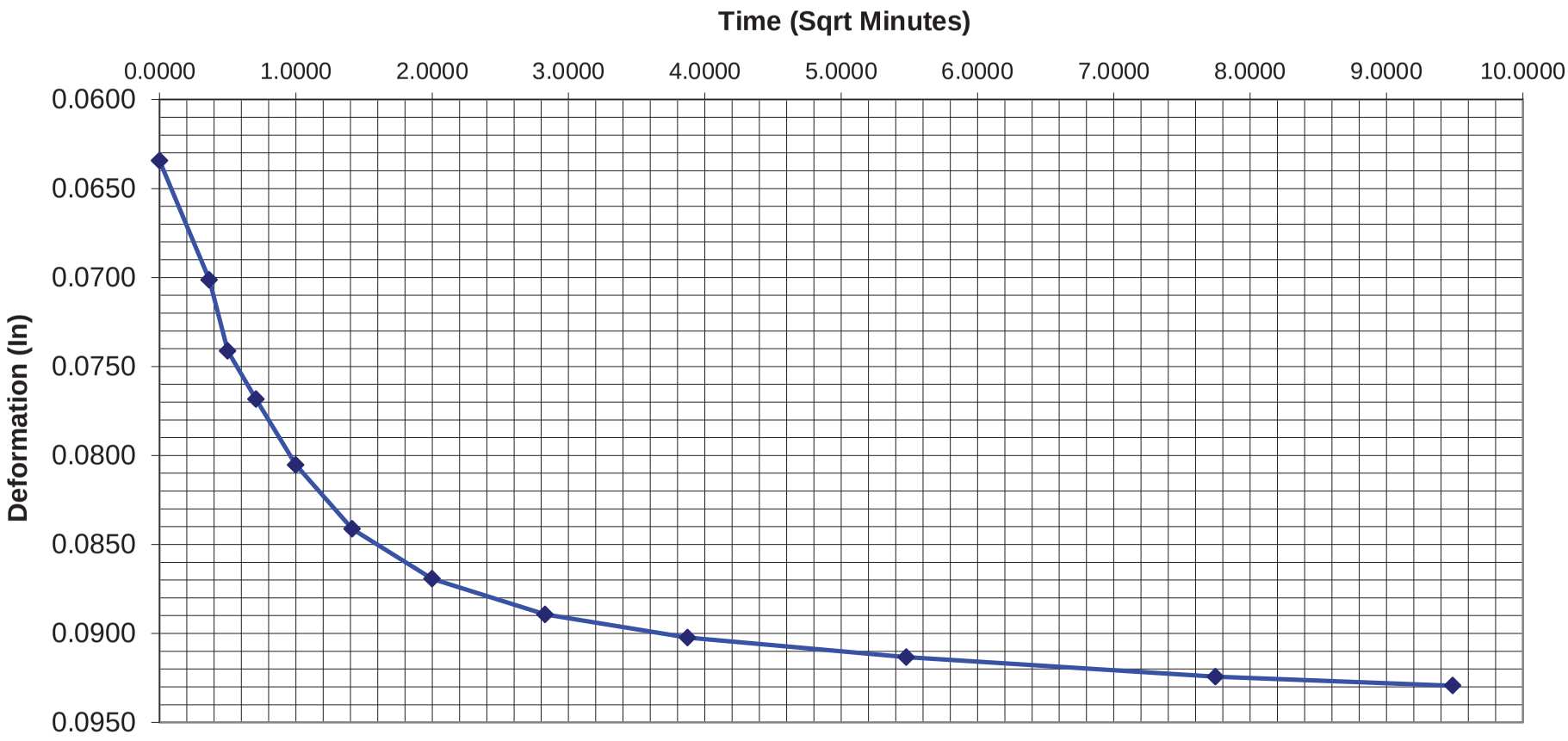
Client : PND	Pressure: 2351 psf 4 psi	Boring : BH-10
Project : South Portage Cove	Deformation Correction (in): 0.00127	Sample # 7
Date: 1/29/2013		Depth : 35' - 38'



Time Rate of Consolidation

WO #	A33608
Lab #	2013-018

Client : PND	Pressure: 4926 psf 7.5 psi	Boring : BH-10
Project : South Portage Cove	Deformation Correction (in): 0.00137	Sample # 7
Date: 1/29/2013		Depth : 35' - 38'

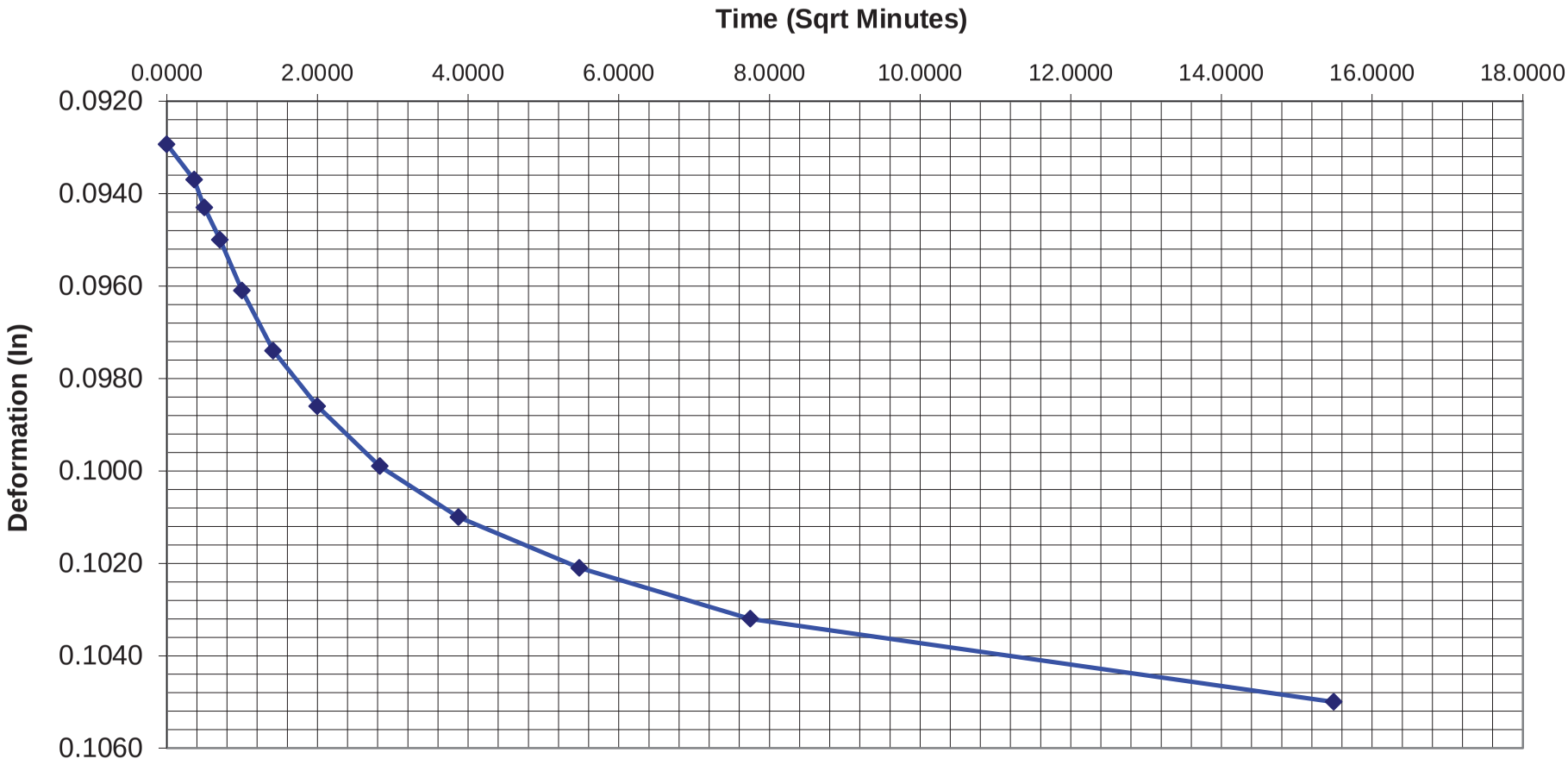


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-018

Client : PND	Pressure: 8256 psf 10 psi	Boring : BH-10
Project : South Portage Cove	Deformation Correction (in): 0.0021	Sample # 7
Date: 1/29/2013		Depth : 35' - 38'

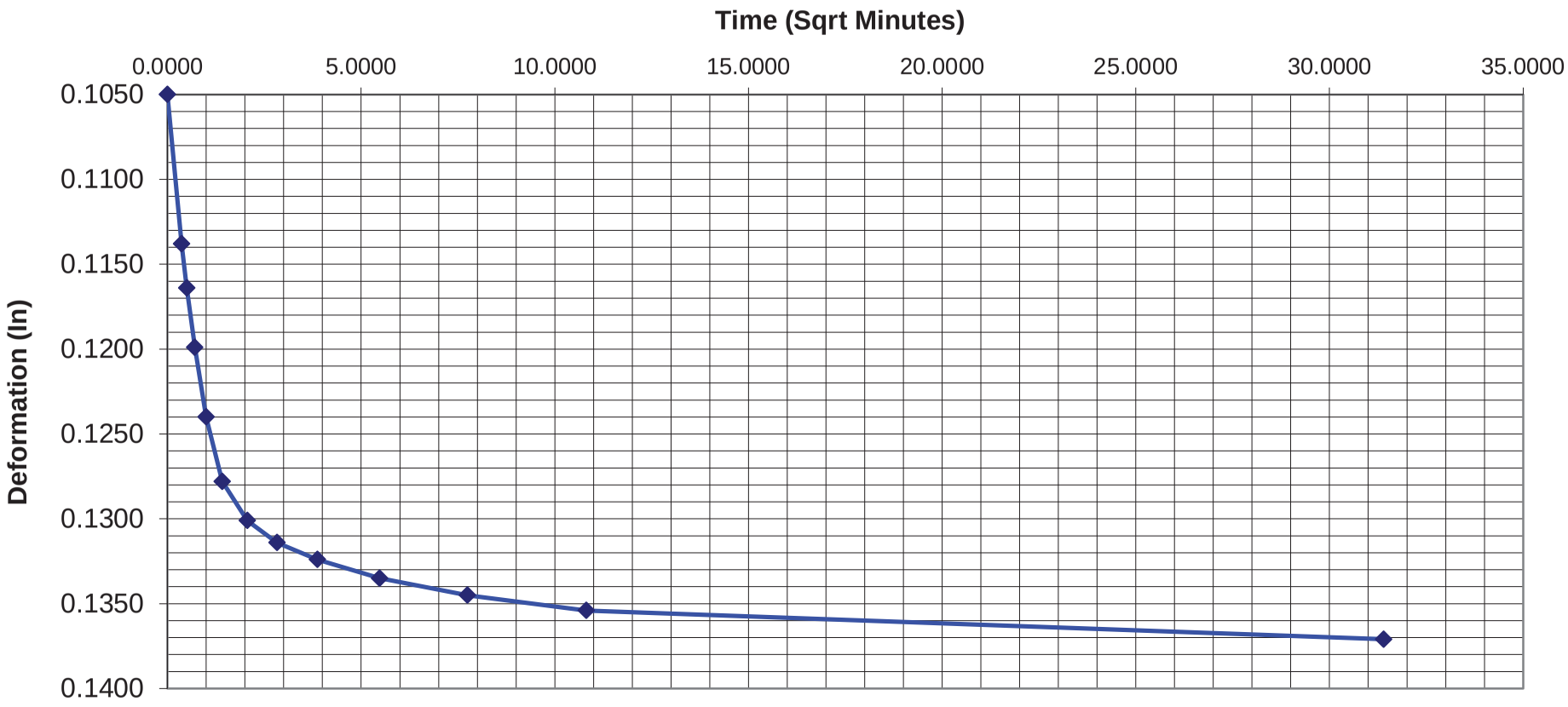


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-018

Client : PND	Pressure: 14231 psf 20 psi	Boring : BH-10
Project : South Portage Cove	Deformation Correction (in): 0.0027	Sample # 7
Date: 1/29/2013		Depth : 35' - 38'

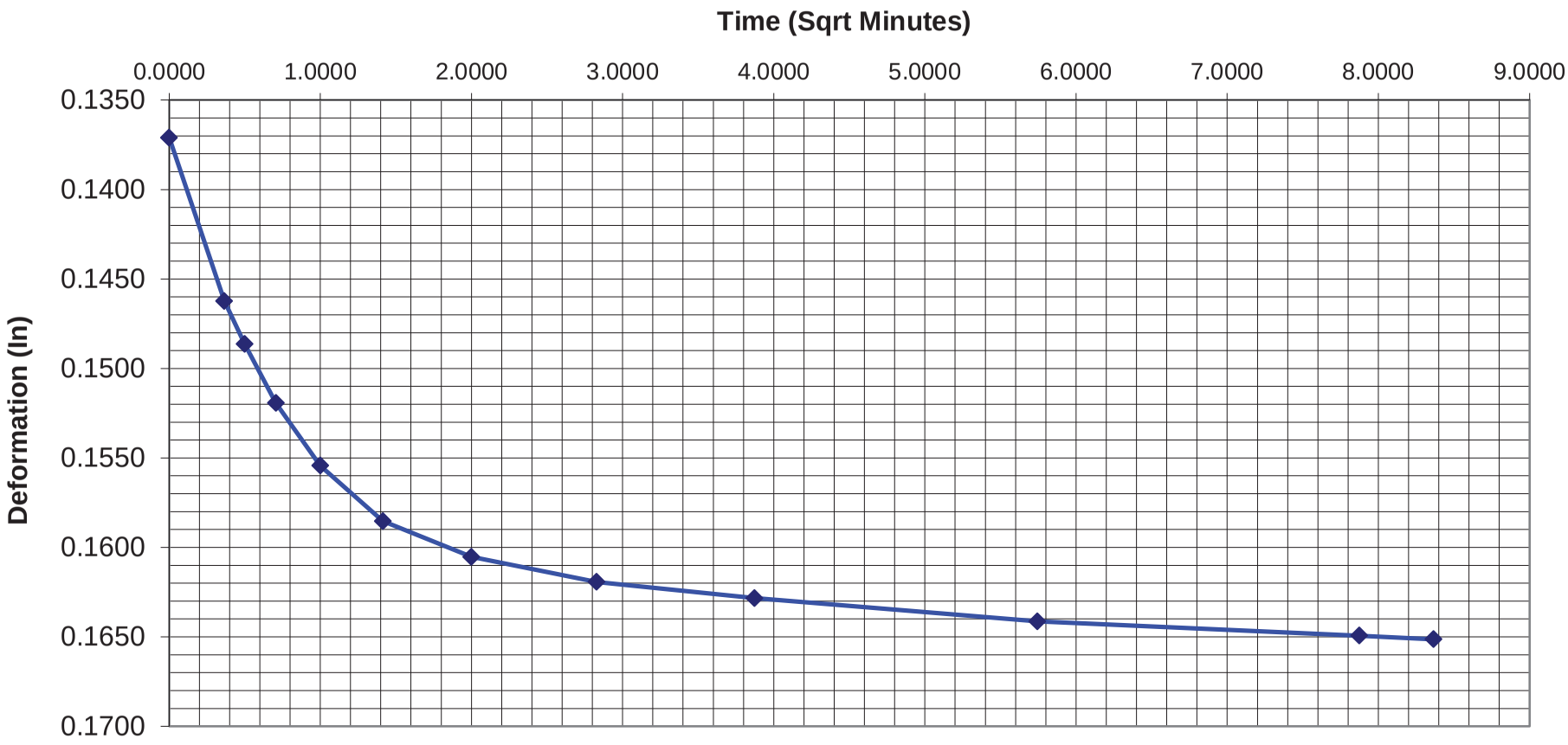


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-018

Client : PND	Pressure: 29745 psf 40 psi	Boring : BH-10
Project : South Portage Cove	Deformation Correction (in): 0.00337	Sample # 7
Date: 1/29/2013		Depth : 35' - 38'

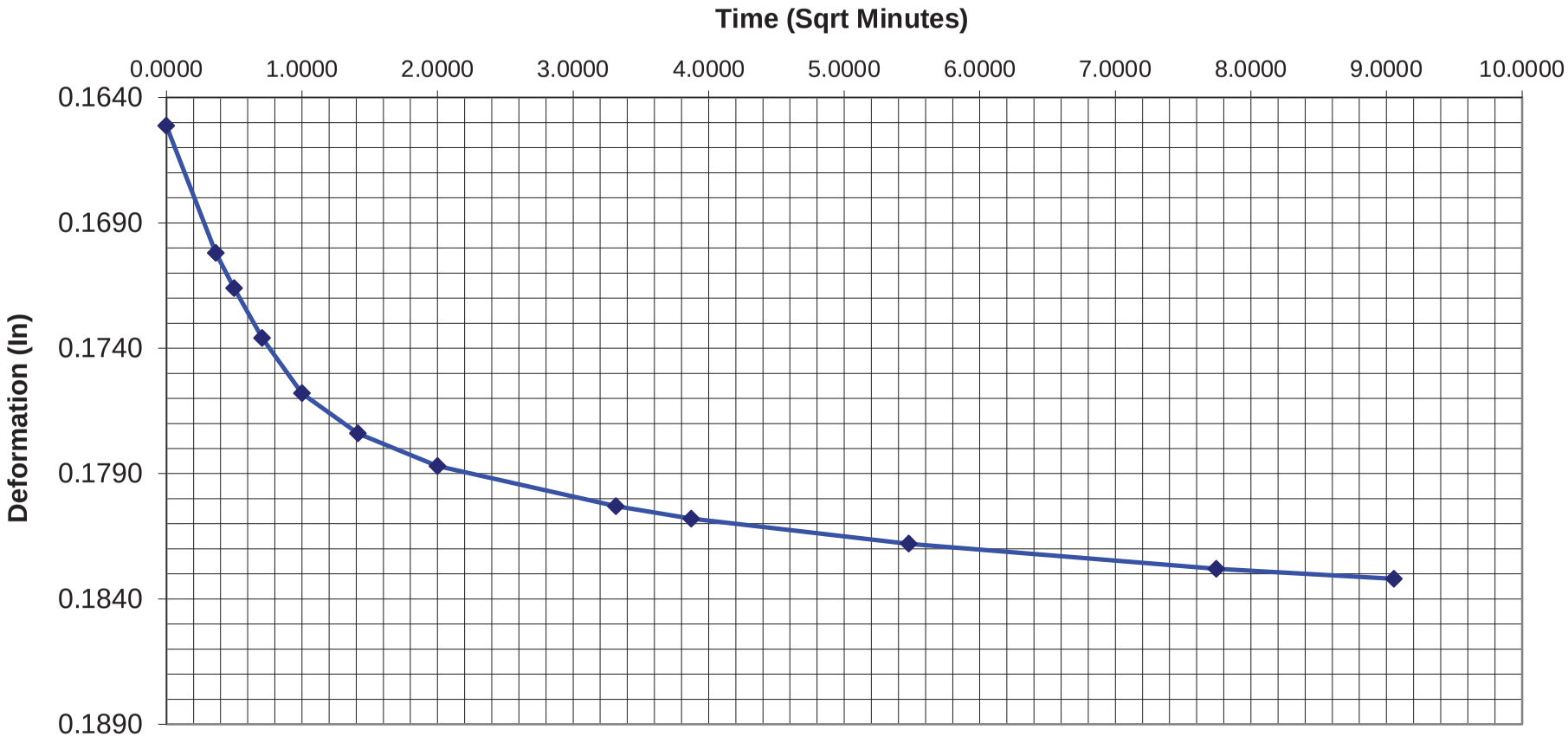


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-018

Client : PND	Pressure: 45200 psf 60 psi	Boring : BH-10
Project : South Portage Cove	Deformation Correction (in): 0.0038	Sample # 7
Date: 1/29/2013		Depth : 35' - 38'

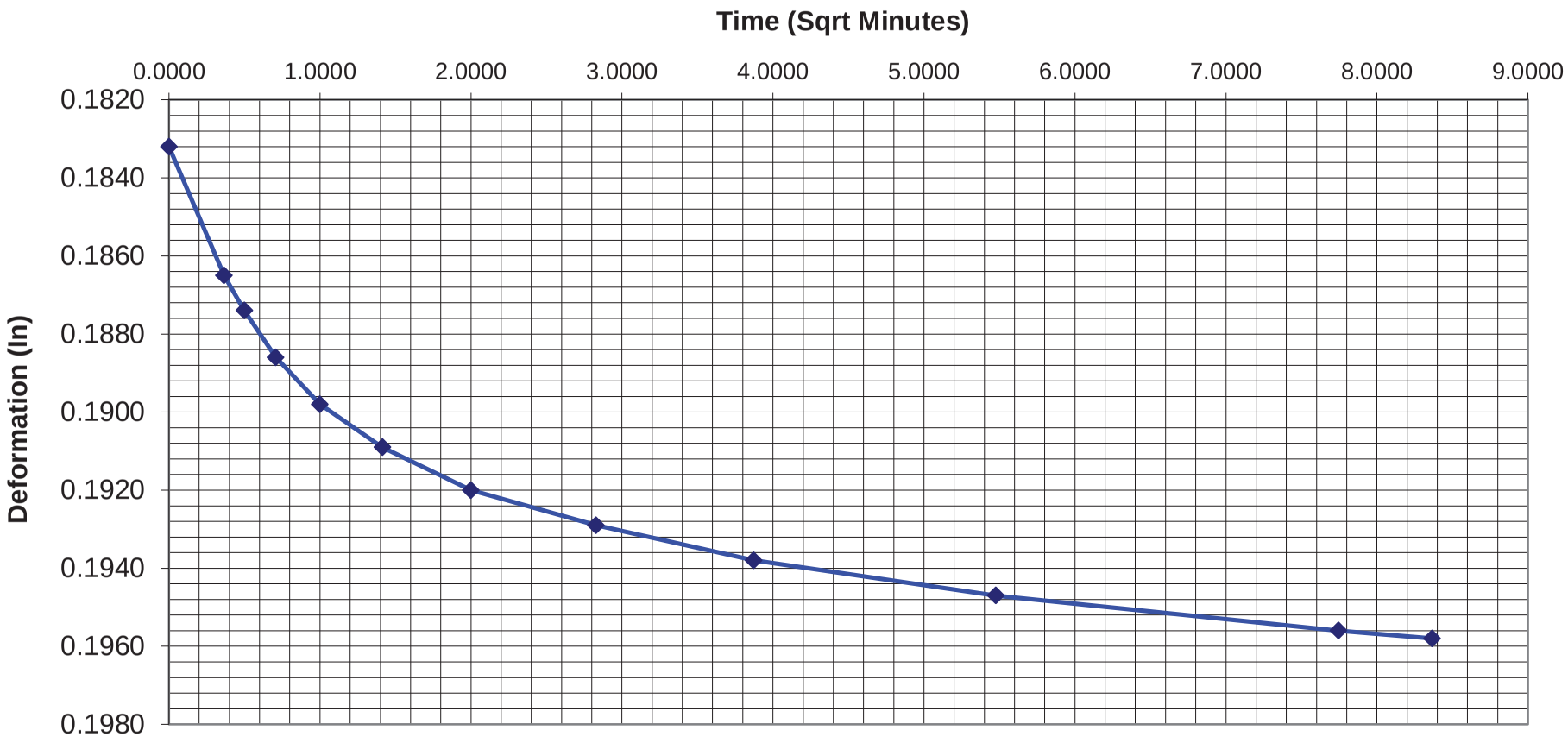


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-018

Client : PND	Pressure: 60714 psf 80 psi	Boring : BH-10
Project : South Portage Cove	Deformation Correction (in): 0.0042	Sample # 7
Date: 1/29/2013		Depth : 35' - 38'

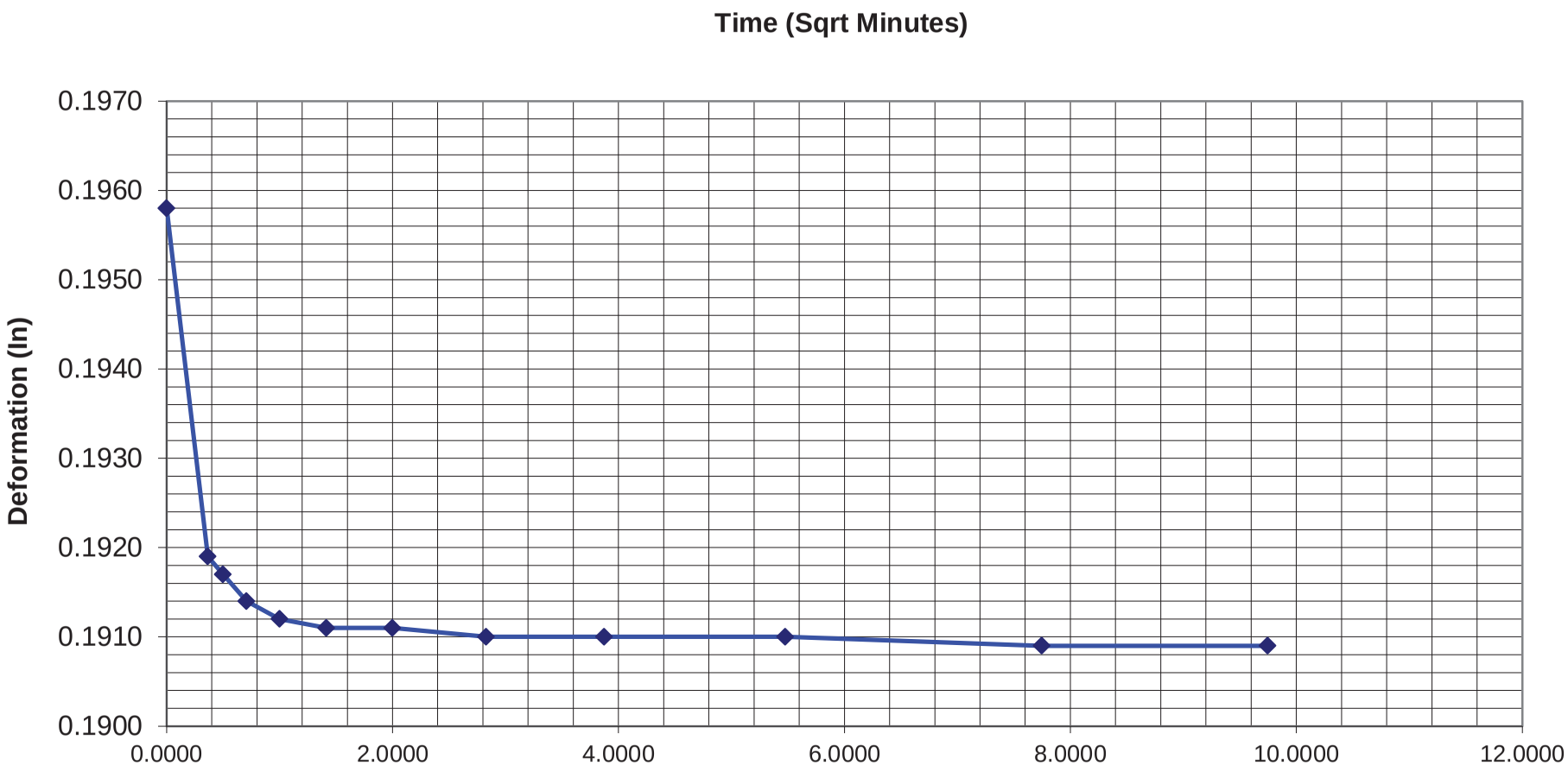


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-018

Client : PND	Pressure: 14182 psf 20 psi	Boring : BH-10
Project : South Portage Cove	Deformation Correction (in): 0.003	Sample # 7
Date: 1/29/2013	Rebound Load	Depth : 35' - 38'

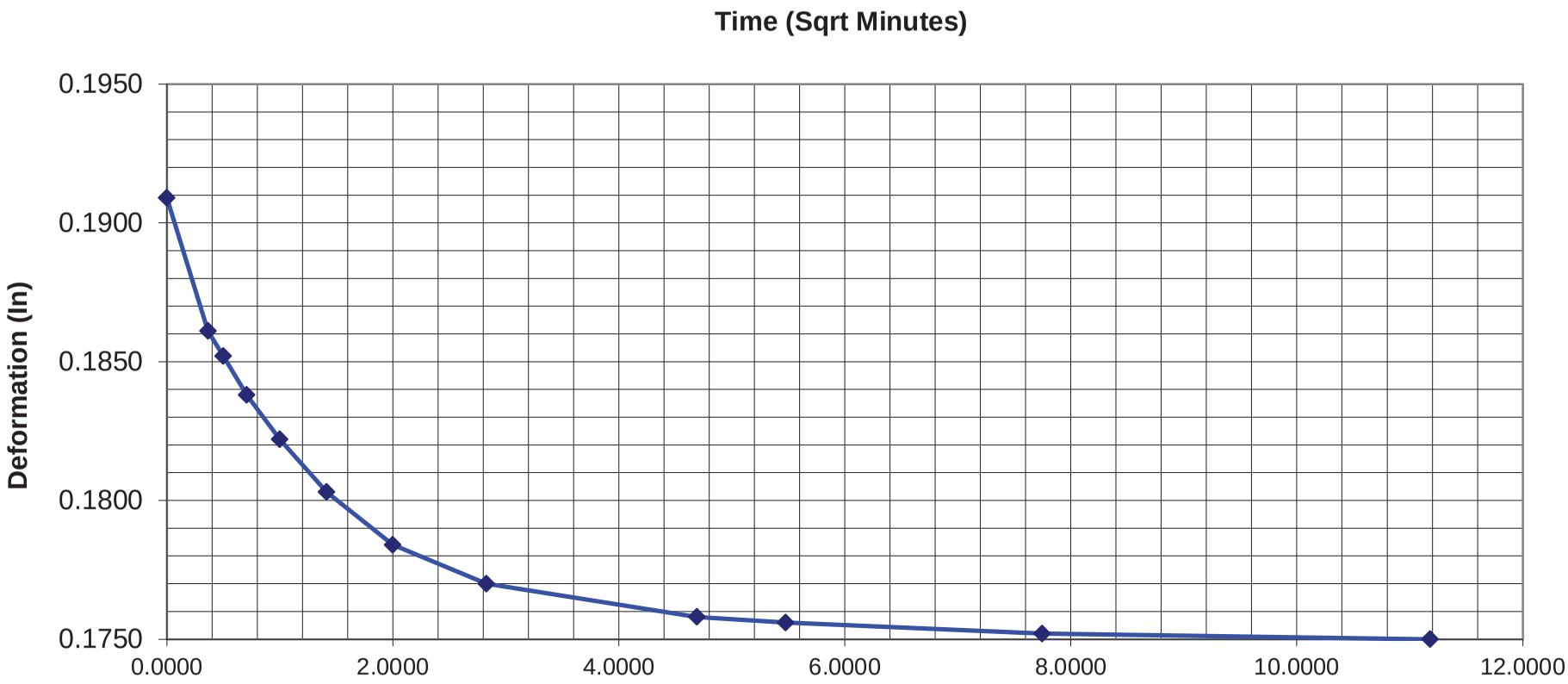


DOWL HKM

Time Rate of Consolidation

WO #	A33608
Lab #	2013-018

Client : PND	Pressure: 774 psf 2 psi	Boring : BH-10
Project : South Portage Cove	Deformation Correction (in): 0.00127	Sample # 7
Date: 1/29/2013	Rebound Load	Depth : 35' - 38'



Consolidation Report

Client :	PND	WO #	A33608	Boring :	BH-10
Project :	South Portage Cove	Lab #	2013-018 Remolded	Sample #	7
Date:	1/29/2013	Frame #	1	Depth :	35' - 38'

Wet Sample Weight (g)	153.54
Dry Sample Weight (g)	120.85
Sample Height (in)	1.00
Ring Diameter (in)	2.50
Dry Density (lb/ft3)	94.19
Wet Density (lb/ft3)	119.68
Area of Sample (in2)	4.90
Volume of Sample (in3)	4.89
Volume of Solids (in3)	2.78
Height of Solids (in)	0.57
Initial Height of Voids (in)	0.43
Initial Volume of Voids (in3)	2.11
Volume of Water (in3)	2.00
Initial Degree of Saturation (%)	94.69
Initial Void Ratio, e0	0.76
0.42 e0	0.32
specific gravity	2.65
Volume of Solids	0.57
Volume of Voids	0.43

Load Number	Guage Pressure	Load (lb)	Pressure (ksf)	Δ Height (in)	Void Ratio	% Change
Seating	1	3.33	0.098	0.000	0.756	0.00
1	1.25	10.33	0.304	0.017	0.728	1.68%
2	1.75	23.33	0.686	0.033	0.700	3.27%
3	2	28.33	0.833	0.037	0.691	3.75%
4	3	55.00	1.616	0.055	0.660	5.53%
5	4	80.00	2.351	0.063	0.645	6.36%
6	10	167.67	4.926	0.093	0.593	9.31%
7	15	281.00	8.256	0.105	0.572	10.52%
8	20	484.33	14.231	0.137	0.516	13.74%
9	30	1012.33	29.745	0.165	0.466	16.55%
10	40	1538.33	45.200	0.183	0.435	18.36%
11	80	2066.33	60.714	0.196	0.412	19.62%
12	20	482.67	14.182	0.191	0.421	19.13%
13	2	26.33	0.774	0.175	0.449	17.54%

Moisture Content			
	Trimmings	Initial	Final
Wet + Tare	50.69		1165.70
Dry + Tare	40.12		1141.10
Tare	1.05		1025.16
Wet Weight	49.64	153.54	140.54
Wt. Water	10.57		24.6
Wt. Dry Soil	39.07		115.94
% Moisture	27.1		21

APPENDIX F

Field Photographs

SOUTH PORTAGE COVE HARBOR EXPANSION
FIELD PHOTOGRAPHS – September 2014 Drilling

Photograph 1:
Drill rig staged aboard landing craft within harbor. Rubble mound breakwater is seen in the background and intertidal boulder field in foreground.

Photograph 2:
View of intertidal boulder field from the landing craft.

Photograph 3:
Existing rubble mound breakwater provides wave protection at harbor entrance.

Photograph 4:
Bentonite within tub was added to drilling fluid when encountering heaving sands.

Photograph 5:
Bentonite is seen surfacing within borehole casing during cleaning of borehole cuttings.

Photograph 6:
Borehole B-1 – Sample 3.

SOUTH PORTAGE COVE HARBOR EXPANSION
FIELD PHOTOGRAPHS – September 2014 Drilling

Photograph 7:
Borehole B-1 – Sample 4.

Photograph 8:
Borehole B-1 – Sample 6.

Photograph 9:
Borehole B-3 – Sample 4.

Photograph 10:
Borehole B-3 – Sample 6.

Photograph 11:
Borehole B-3 – Sample 7.

Photograph 12:
Borehole B-3 – Sample 8.

Photograph 13:
Borehole B-3 – Sample 9.

Photograph 14:
Borehole B-3 – Sample 10.

Photograph 15:
Borehole B-4 – Sample 3.

Photograph 16:
Borehole B-5 – Sample 5.

Photograph 17:
Borehole B-5 – Sample 6.

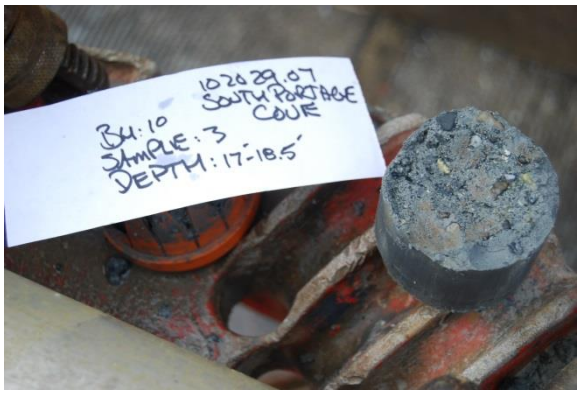
Photograph 18:
Borehole B-5 – Sample 8.

Photograph 19:
Borehole B-5 – Sample 9.

Photograph 20:
Borehole B-5 – Sample 11.

Photograph 21:
Borehole B-7 – Sample 2.

Photograph 22:
Borehole B-7 – Sample 3.



Photograph 23:
Borehole B-10 – Sample 3.

Photograph 24:
Borehole B-13 – Sample 7.

Photograph 25:
Borehole B-13 – Sample 8.

Photograph 26:
Borehole B-13 – Sample 9.

Photograph 27:
Borehole B-14A – Sample 2.

Photograph 28:
Borehole B-14A – Sample 3.

Photograph 29:
Borehole B-14A – Sample 4.

Photograph 30:
Borehole B-14B – Sample 1.

Photograph 31:
Borehole B-14B – Sample 3.

Photograph 32:
Borehole B-14B – Sample 4.

Photograph 33:
Borehole B-14B – sample 5.

Photograph 34:
Borehole B-16 – sample 1.

Photograph 35:
Borehole B-16 – Sample 2.

Photograph 36:
Boreholes were reinforced with 4-inch-diameter, steel casing. Driller is advancing the casing with a 340 lb. automatic hammer.

Photograph 37:
Drillers are preparing a core barrel with diamond drill bit to spot core an unexpected obstruction.

Photograph 38:
Water seen flowing from casing came up from 60.5 feet below mudline and at a rate of ½-gallon per minute.

Photograph 39:
Stand holding Shelby tube is to be sealed with wax.

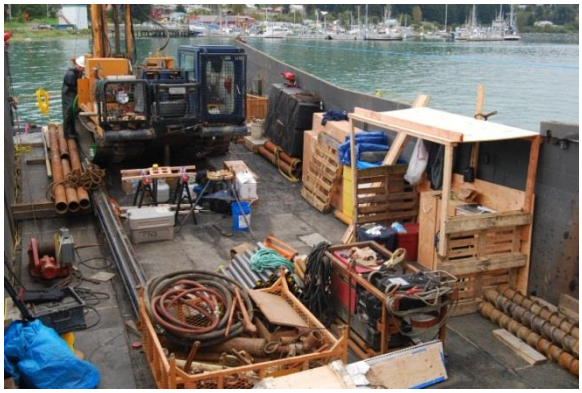
Photograph 40:
Standard size Shelby tubes stacked aboard deck.

Photograph 41:
A typically labeled and sealed Shelby tube.

Photograph 42:
Leadline used to measure the depth to mudline from aboard the landing craft.

Photograph 43:
Pipe stand is used for supporting the soil sampler when performing the soil logging activities.

Photograph 44:
The "shack" provides a sheltered area for logging the soil samples.



Photograph 45:
Equipment organized aboard the landing craft.

Photograph 46:
When cleaning out the borehole prior to sampling, water is flushed down hole and forces soil sediment (cuttings) to rise and settle aboard deck.

Photograph 47:
Drill rig aboard landing craft is positioned over borehole near the harbor breakwater.

Photograph 48:
Driving into Haines with the harbor breakwater in the foreground. Landing craft is seen positioned over borehole.

Photograph 49:
View towards the north end of Haines Harbor. USACE previously performed an investigation in the foreground area and found thick horizons of lean clay.

Photograph 50:
The landing craft with drill rig aboard is seen anchored in Portage Cove.

Photograph 51:
Boulder strewn bench upland from Portage Cove. Haines Harbor is seen in the background.

Photograph 52:
Glacier erratic boulders lying along the upland, intertidal zone. Port Chilkoot Trestle is seen in the background.

Photograph 53:
Bluish-gray, extremely compact, matrix supported sediments were found underlying the above bench surface.

Photograph 54:
Boulder-size clump of diamict composed of coarse-grained, near rounded gravel and sand-cemented within a finer grained matrix.

Photograph 55:
Mound of excavated diamict sediment. The excavated hole seen had a depth of near 14 feet before the incoming tide filled the hole; the walls held firm without collapsing.

Photograph 56:
The city of Haines, near the Deshu Isthmus is seen from across McClellan Flats at the head of Chilkat Inlet.

Photograph 57:
View looking Northwest up the Chilkat river valley.

Photograph 58:
View looking Southeast from the head of Chilkat Inlet and McClellan Flats.

Photograph 59:
Glacier transporting sediment onto an intertidal delta within Chilkat Inlet.

Photograph 60:
Elevated intertidal delta near the head of Chilkat Inlet. The land surface is rising relative to sea level due to glacial isostatic rebound.

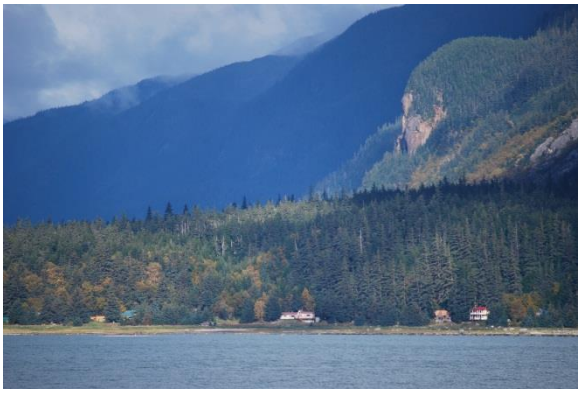
Photograph 61:
Takshanuk Mountains seen in background of Haines Harbor breakwater. Mount Kashagnak, a localized granitic pluton, is seen furthest left.

Photograph 62:
Basalt rock is exposed along the over-steepened Chilkat valley slopes.

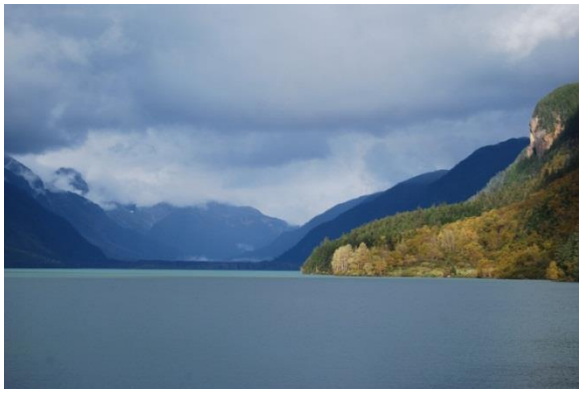
Photograph 63:
Sediment found deposited along the shoreline of the Chilkat Valley typically is green-colored, platy-shaped basalt eroded from the local bedrock.

Photograph 64:
Sub-angular, coarse-grained greenstone gravel and cobbles are intermixed with light-colored, sub-rounded, granitic gravels and cobbles.

Photograph 65:
View looking up the Chilkat River Valley – glacial erratic boulders are seen strewn about the intertidal shoreline. An elevated delta, due to isostatic rebound, is seen in the background.



Photograph 66:
View from the head of Chilkoot Inlet. The prominent over-steepened valley wall seen was scoured from past glacial ice.

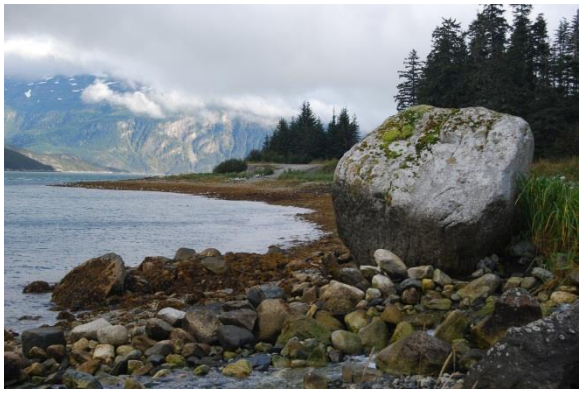


Photograph 67:
View looking up the Chilkoot River Valley. U-shaped valley walls resulted from past glacier scouring and give a perception of the past glacial ice thickness.

Photograph 68:
The boulders seen here at the mouth of Chilkoot Lake may have been flood deposited. Note the elongated axis of the boulders positioned perpendicular to the river's flow direction.

Photograph 69:
Coarse sediments blanket the Haines area and are transported within stream channels into Chilkoot Inlet.

Photograph 70:
Typical sediment found along the shoreline of Lutak Inlet are comprised of sub-angular to near rounded, granite sands, gravels, cobbles and boulders.



Photograph 71:
Large glacial erratic boulder lying along the shoreline of Lutak Inlet.

Photograph 72:
Someone made good use of this erratic boulder.

Photograph 73:
Colluvium shed from the over-steepened valley walls of Lutak Inlet are seen deposited at the midslope regions.

Photograph 74:
Glacially scoured over-steepened slopes, seen to the left foreground, are typical to the Haines region.

Photograph 75:
Glaciers eroding the regional mainland coastal mountains.

Photograph 76:
Borehole BH-2 - Sample 10.

Photograph 77:
Borehole BH-2 – Sample 11. Matrix-supported gravelly silt.

Photograph 78:
Bluish gray, matrix-supported gravelly silt.

Photograph 79:
Borehole BH-2 – Sample 12. Fining upward sequence of sub-rounded gravels to coarse-grained sand to finer-grained sand and silt.

Photograph 80:
Borehole BH-3 – Sample 5. Fining upward sequence.

Photograph 81:
Borehole BH-3 – Sample 6. Gravels and sands overlying matrix-supported sediment.

Photograph 82:
Bluish gray, compact, matrix-supported sediment found at the bottom of Sample 6.

Photograph 83:
Borehole BH-3 – Sample 8.

Photograph 84:
Borehole BH-3 – Sample 9.

Photograph 85:
Borehole BH-3 – Sample 10.

Photograph 86:
Borehole BH-3 – Sample 11. Fining upward sequence of sub-rounded coarse gravel to finer-grained sands.

Photograph 87:
Fining upward sequence found in Sample 11.

Photograph 88:
Borehole BH-5 – Sample 9.

Photograph 89:
Borehole BH-5 – Sample 10. Fining upward sequence overlying matrix-supported sediments.

Photograph 90:
Matrix-supported sediment found in Sample 10.

Photograph 91:
Borehole BH-6 – Sample 3.

Photograph 92:
Borehole BH-6 – Sample 7. Fining upward gravel and sand, note 3" piece of granite stuck in catcher.

Photograph 93:
Borehole BH-6 – Sample 7. Granite rock stuck in sampler catcher.

Photograph 94:
Borehole BH-7 – Sample 2. Greenish gray, lean clay.

Photograph 95:
Borehole BH-8 – Sample 3.

Photograph 96:
Borehole BH-8 – Sample 9.

Photograph 97:
Borehole BH-9 – Sample 1. Silty sand overlying poorly-graded sand.

Photograph 98:
Borehole BH-10 – Sample 11. Well-graded gravel with sand.

Photograph 99:
Borehole BH-10 – Sample 12. Fining upward gravel to silty sand.

Photograph 100:
Borehole BH-12 – Sample 4. Greenish gray lean clay

Photograph 101:
Borehole BH-12 – Sample 6.

Photograph 102:
Borehole BH-13 – Sample 7.

Photograph 103:
Borehole BH-13 – Sample 12.

Photograph 104:
Borehole BH-13 – Sample 12.

Photograph 105:
Shelby tube filled with cohesive sediment is being prepared for sealing.

APPENDIX G

Engineering Analysis

Excerpts from "Draft Final Geotechnical Report" dated April 2013.

4 GEOTECHNICAL ANALYSIS AND DESIGN RECOMMENDATIONS

4.2 Rubble-Mound Breakwater

Extension of the existing rubble-mound breakwater and construction of a southern rubble-mound breakwater are being considered. The locations of these structures are shown on the Site Plans in Appendix A. Breakwater construction would likely consist of quarry spall core rock covered with larger under layer rock and armor rock.

Rubble-mound breakwaters should be designed to take into account long-term settlement of the structure. Options to mitigate long-terms settlement include overbuilding the structure and monitoring settlement during construction and adding core rock to ensure final crest elevation is met. Surcharging is not recommended due to potential instability of the underlying weak marine soils.

The alignment of the proposed breakwater structure overlies very soft marine sediments. Construction on these soils will present several engineering challenges, namely, potential settlement, submarine slope instability, and inadequate bearing capacity. The weak soil conditions require special engineering consideration in order to account for these factors. The sequence and timing of construction must take into account the pore pressure increases within the very soft marine sediments to successfully build a rubble mound breakwater.

4.2.1 Stability

The soils that underlie the proposed rubble-mound breakwater alignment are composed primarily of sloping, very soft to stiff clay. These soils have very low permeability and when loaded by an approximately 55-foot-high rubble-mound breakwater will build up pore pressures in the clay that will take a long time to fully dissipate (many years). The development of excess pore water pressure in the ground results in relatively low shear strength during and immediately after rubble-mound breakwater construction. Over time, as the excess pore pressure water dissipates the strength of the clay increases. Therefore, the most critical time for stability of the rubble-mound breakwater is during and just after construction. The primary failure mechanism for this project is a bearing capacity type failure where the new rubble-mound breakwater fill essentially plunges into the ground while the adjacent ground surface pushes upward/outward, if the stresses caused by rubble-mound breakwater construction exceed the soil strength. The factor of safety against a bearing capacity failure depends on the undrained soil shear strength, s_u, the height and width (hence the slope), speed of construction and other factors.

The preliminary "typical" configuration of proposed breakwater extension (Section A-A' in Appendix A) was analyzed for slope stability as a screening tool to evaluate the feasibility of the concept. The results of the slope stability analysis are presented in Appendix F and discussed in the following sections.

4.2.1.1 Analysis Methodology

Slope stability analyses were completed to identify potential critical slope failure surfaces and to screen for potential static and seismic stability problems for the planned rubble-mound breakwater. The approach methodology is generally consistent with the procedures outlined by the United States Army Corps of Engineers (Perla and Beaty 2010 and EM-1110-2-1902). The available survey and bathymetry data was used to generate the topographic information and to develop the cross-section for the analyses, Section A-A' (refer to site plans in Appendix A for the location of Section A-A'). The stability analyses were completed with the computer software SLOPE/W version 8.0 (GeoStudio 2012) using the Spencer limit equilibrium method (Spencer 1967). This method compares the ratio of forces driving slope movement with forces resisting

slope movement for each trial failure surface and presents the result as the factor of safety (Fs). Trial failure surfaces are then sorted to identify the surface with the lowest Fs, or the "critical" failure surface.

4.2.1.2 Soil Models

Table 4-1 presents the soil parameters used in the slope stability analyses. Soil shear strength parameters based on SPT "N" values for the sand and gravel deposits were estimated by the correlations proposed by Meyerhof (1956). Shear strength parameters for the clay were determined based on results of the laboratory and field testing. Consolidated-undrained (CU) triaxial test results were used to develop the shear strength parameters of the clay. The undrained shear strength of the clay, s_u, was measured in the field using the Geonor vane shear tester and in the laboratory through unconsolidated-undrained (UU) and CU triaxial tests. The results of the field vane tests are included on the borehole logs in Appendix B and the results of the triaxial shear tests are included in Appendix D. From these various tests, we developed a summary of estimated and calculated s_u values for the clay deposit at the site and developed undrained shear strength profiles which are presented in Appendix F, Figures F-1 and F-2 that were used as an input for the undrained shear strength of the clay in our slope stability models.

Table 4-1. Slope Stability Analysis Parameters

Soil Layer		Total Unit Weight (pcf)	Internal Angle of Friction, φ' (degrees)	Cohesion, c' (psf)	Undrained Shear Strength, s_u (psf)
Rubble-Mound		145	46	0	n/a
Upper Sand		125	30	0	n/a
Clay	Drained	120	32	500	n/a
	Undrained	120	n/a	n/a	Strength Profile[1]
Lower Sand		125	36	0	n/a

Note: [1]Refer to Figures F-1 and F-2 in Appendix F for undrained shear strength profiles

4.2.1.3 Slope Stability Results

The analyses include evaluations of various failure modes including; global (short-term), global (long-term), pseudo-static, post-earthquake stability and "Staged" construction. Included are evaluations of seismic hazards including liquefaction and seismically induced landsliding. Table 4-2 summarizes the results of the slope stability analyses.

Table 4-2. Summary of Rubble-Mound Breakwater Slope Stability Analyses

Potential Failure Mode	Factor of Safety	Remarks	Figure (Appendix F)
Global (Long-Term)	> 1.5	Long-Term Stability of Breakwater	F-3
Pseudostatic	> 1.1	"Seismic" Stability of Breakwater for CLE Event	F-4
Post-Earthquake	> 1.1	Stability of Breakwater for Liquefaction	F-5
Global (Short-Term)	< 1.0	Represents Unstable Mass Fill Construction	F-6
Global (Short-Term) "Staged"	≈ 1.0	Immediately Following Staged Construction	F-7
Global (Long-Term) "Staged"	> 1.5	Represents Stage or Slow Construction	F-8
Global Stability (removal of clay)	> 1.1	Represents Minimum Temporary Cut Slope	F-9

Global Stability

The slope stability results indicate that the proposed rubble-mound breakwater extension does not have an adequate factor of safety against short-term global stability failure where the breakwater is hypothetically instantaneously constructed (i.e. the short-term global factor of safety is less than unity, $F_s<1$, which indicates that stability failure of the structure is imminent). This case represents the worst-case condition where the maximum load is applied (entire breakwater) and maximum excess porewater pressure exists in the clay resulting in the weakest shear strength for the clay (undrained conditions). Conversely, for the long-term condition, where excess porewater pressures developed from the applied breakwater load have fully dissipated, the proposed rubble-mound breakwater has an adequate factor of safety (i.e. the long-term global factor of safety is greater than 1.5, which indicates a stable condition).

If rubble-mound breakwater structures are chosen to be constructed at the site, it will be necessary to use one of the following three techniques for construction: 1) Construct in stages to allow partial consolidation between stages, 2) Construct slow enough to permit partial consolidation during construction to avoid failure, or 3) Dredge removal of soft to very soft silts and clays to provide stability.

Other options exist to improve stability. Stability may be improved by the incorporation of structural elements to support embankment toes (sheet piles, armor rock buttressing, etc.) and/or ground improvement (stone columns); however. We anticipate some of these options will be cost prohibitive, however, may be considered during through a cost-benefit in working with the design engineer. Wick drains are not recommended at this site to speed up consolidation of the clay based on the variable soil types encountered and the likelihood they would be difficult to install without being damaged, and therefore would not perform as anticipated.

Staged Construction

Slope stability analysis for the evaluation of staged construction is highly uncertain because of the difficulty in estimating actual pore pressure in the field and inherent variability of the consolidation behavior (magnitude and time for consolidation) of clays and the methodology for completing such analyses is not well established. Based on analyses that oversimplify the actual consolidation behavior of the site soils, we have developed some guideline recommendation for rubble mound construction for planning purposes. We recommend that no more than 14 feet of breakwater (measured from the center line) be constructed during a given "stage" prior to adequate consolidation of the underlying compressible clay. The time necessary between stages is highly dependent on the thickness of the underlying compressible clay and the actual rate of consolidation. Because the thickness of clay is highly variable beneath the proposed rubble-mound breakwater, this time period can range significantly, on the order of months and in the thickest sections several years (rates of settlement are discussed below). However, for practical purposes, it has been our experience that rate of consolidation of clay during construction is commonly fast enough that substantial dissipation of excess porewater pressure occurs during construction allowing construction to commence with minimal interruption provided careful instrumentation of pore pressure generation is tracked and evaluated during construction. Instrumentation should consist of an array of piezometers, inclinometers, and settlement measurements (settlement plates and survey) to track pore pressures and movements, horizontal and vertical. In addition, on similar project we have recommended that "higher order" finite element analysis be completed to evaluate stability just after construction and to develop more refined guidance for staged construction. Finite element computer models, such as PLAXIS, have the capability of accounting for the partial strength increases due to consolidation during construction. The advantage of this approach is that the model modifies the soil properties until the model converges to equilibrium due to the applied load which in turn identifies critical shear strength states (failure) which are functions of the loading and soil response. In comparison, the limit-equilibrium approach (Slope/W) calculates safety factors based on pre-determined soil shear strengths and

failure surfaces. The finite element models also provide important deformation information which can be used to predict ground movement and settlement during and after construction.

Seismic Stability – Liquefaction and Permanent Displacements

The pseudostatic screening analysis is a procedure to identify whether development of large permanent seismically induced displacements would result under the design level of shaking. The design level of shaking used for this analysis corresponds to the contingency level earthquake (CLE) ground motions, 10% probability of exceedance within a 50-year period (475-year return period). The analysis indicates that for the CLE event, permanent seismically induced displacements greater than 3 feet are not expected.

The post-earthquake condition was evaluated where soils classified as liquefiable (i.e. the upper sand/gravel deposits) will experience a partial loss of strength when subjected to design seismic shaking. To estimate the reduced strength of the potentially liquefiable soils, residual strengths were used as recommended by Idriss and Boulanger (2008) based on Seed (1987), Seed and Harder (1990), and Olsen and Stark (2002). It is our opinion that there is a potential for post-earthquake slope instability of the proposed rubble-mound breakwater as indicated by the calculated factor of safety.

Removal of Clay

Another option for construction of the rubble-mound breakwater would be to excavate the clay beneath the alignment and replace with competent material. This option would mitigate the construction and performance issues associated with construction of a breakwater on top of the clay soils including both the long-term settlement potential of the breakwater and slope instability. We evaluated the geometry required to construct and support the breakwater for this option using the slope stability analysis as described above. The results are presented on Figure F-9 in Appendix F. The minimum excavation of clay and replacement with competent material should extend out from the base of the breakwater at an inclination of 1H:1V. In order to achieve this, it will be necessary to excavate beyond this breakwater prism to maintain stable temporary cut slopes during the excavation and fill placement. For planning purposes, our analysis indicates that temporary cut slopes in the clay may be inclined no steeper than 1¾H:1V (horizontal to vertical) during construction. Shallower slopes may be required due to localized instability during construction and therefore the Contractor should be responsible for maintaining stable temporary slopes during construction and determining the appropriate temporary cut slope inclinations during construction.

4.2.2 Settlement

As the rubble-mound breakwater is constructed, the excess pore water pressure in the underlying softy clay will slowly flow outward and upward and the soil will begin to consolidate (settle). The process of settlement is complicated and dependent on several factors including applied load, mineralogy, stratigraphy, permeability, and time.

Three modes of settlement are expected for the clay soils resulting from the rubble-mound breakwater construction; immediate, primary consolidation, and secondary compression. The immediate settlement occurs rapidly as the load is applied and is analyzed simplistically using elastic theory. In other words, this is the initial squeezing of the soil mass under the load similar to the behavior of a spring being pressed. The primary consolidation settlement is the time-dependent volume change of the soil mass as the water is slowly squeezed out of the voids within the soil and as the soil mass is compressed into a denser configuration. This is synonymous to squeezing a wet sponge. The third mode is secondary compression which is the ongoing, long-term settlement that occurs due to the gradual volume decrease of the soil mass where there is no increase in stress and no change in pore pressure. For the purpose of estimating settlement behavior, the immediate settlement is ignored as it occurs rapidly as the load is applied, and settlement predictions are based on the primary and secondary settlements.

Typically, the rate of primary consolidation is quite fast relative to secondary compression but may take months to years depending on several factors. Besides material properties, the rate is governed by the thickness of the clay layer and whether sand lenses are present in the clay. Sand lenses, if continuous over the site, will dramatically increase the rate of consolidation. At this site, it does not appear that there are continuous sand layers within the clay that would facilitate drainage, and therefore, the entire thickness of the clay is conservatively assumed when estimating drainage path lengths for our time of consolidation estimates.

The consolidation parameters presented in Table 4-3 were used for the analysis and representative average values as determined from the consolidation testing, empirical relationships, and our experience. Estimates of the time-rate of consolidation settlement are presented in Section 4.2.2.1.

Table 4-3. Consolidation Parameters for South Portage Cove Clay

Parameter	Value
Modified Compression Index, C_{cc}	0.11
Modified Recompression Index, C_{rc}	0.017
Secondary Compression Index, C_{ac}	0.003
Coefficient of Consolidation, c_v	278 ft^2/year

4.2.2.1 Time Rate of Consolidation Settlement

Based on consolidation tests and other soil information from the boreholes, our analysis indicate that the primary consolidation along the rubble-mound breakwater alignment will be essentially complete (i.e. 95%) in approximately 1 to 2 years after the rubble-mound construction is completed, assuming construction duration of 6 months. It should be noted that longer durations, up to 3 years, are possible where thicker clay deposits underlie the site, for example along the east margin of the rubble-mound alignment where clay deposits approach 60 feet in thickness. Conversely, where thinner deposits of clay are present, primary consolidation will be essentially complete within the 6 months assumed construction duration where the clay deposit is on the order of 20 feet or less as observed along the west margin of the proposed rubble-mound alignment. Secondary compression is estimated to continue for 10 years or more after construction.

4.2.2.2 Estimated Consolidation Settlement

The total settlement of a 10 year period (including what occurs during construction is estimated to be on the order of 3 feet along the centerline of the breakwater as calculated along Soil Profile A-A' (See Appendix A for location). Our settlement calculations were divided into two phases: the first phase is equal to the time of construction (~6 months). The second phase is the 10 years following construction. As discussed above the "Time Rate of Consolidation Settlement" section, the primary consolidation will not be largely completed for much of the breakwater by the time construction is completed. Therefore, the second phase of settlement (from 6 weeks to 10 years) includes both some primary consolidation and all the secondary compression. Of the total 3 feet of settlement along the centerline, we estimate the amount of settlement that may occur during construction (phase 1) will be about 1½ to 2 feet. The amount of settlement estimated to occur in the 10 years following construction is about an additional 1 to 1½ feet.

The settlement estimates, both time rates and maximum amounts, presented above are based on limited laboratory data and field testing. It is common for actual ground settlement to differ from calculated settlement, with respect to time and location, because of natural variations in soil properties and soil stratigraphy, sample disturbance effects on laboratory tests and limitations of consolidation theory.

In particular, at this site, the clay layer appears to thicken to the east and depending on where the actual breakwater is constructed these settlement estimates may need to be revised. The impact on the rate of

ground settlement, during and after construction, is high as demonstrated in the settlement estimates above. Therefore, we recommend that the values for time rate and magnitude of settlement be considered approximate and that some provisions be made to add material several years after completion of construction. It is recommended consideration be given to over widening the top of the breakwater to accommodate future settlement and maintain a minimum crest elevation in the long-term.

4.2.3 Summary of Viable Breakwater Construction Alternatives

It is our opinion that breakwater construction is feasible at the site, however, it is appropriate to conduct additional studies to verify the most cost effective approach. As discussed above, the near surface soils (mudline) are expected to consist of soft marine clay. We have proposed three options for constructing the breakwater on these soils: Staged Construction, Slow Construction or Removal of Clay. Table 4-4 presents comparisons of the key considerations for each option.

Table 4-4. Matrix of Key Considerations for Rubble-Mound Breakwater Construction Options

Option	Description	Future Maintenance (long term settlement)	Relative Total Construction Duration	Uncertainty In Construction Duration	Relative Construction Cost	Uncertainty Of Stability During construction	Additional Considerations
1	Staged Construction	Highest	Longest	Highest	Potentially Least Expensive	Low	- Instrumentation during construction - Finite element modeling recommended
2	Slow Construction	Potentially Highest	Potentially Shortest	Low	Likely Least Expensive	Highest	- Instrumentation during construction - Finite element modeling recommended
3	Removal of Clay	Lowest	Likely Shortest	Lowest	Most Expensive	Lowest	- Large amount of excavated material to dispose of and increased armor quantities to construct breakwater

In summary:

Option 1 – Staged Construction: This option would construct the breakwater in stages where no more than 14 feet (estimate) of breakwater (measured from the center line) be constructed during a given "stage" prior to adequate consolidation of the underlying compressible clay (Figure 4-1). The time necessary between stages is highly dependent on the thickness of the underlying compressible clay and the actual rate of consolidation. Finite element modeling should be completed to estimate the time required to safely construct subsequent lifts. It will also be necessary to monitoring pore pressure and settlement during construction to verify the rate and degree of consolidation to maintain stable conditions during construction. Instrumentation should consist of an array of piezometers, inclinometers, and settlement measurements (settlement plates and survey) to track pore pressures and movements, horizontal and vertical.

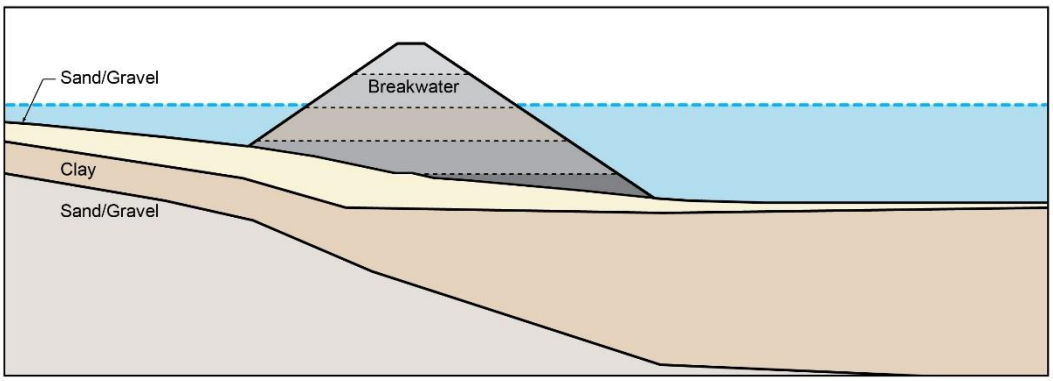


Figure 4-1. Staged Construction of Breakwater

Option 2 – Slow Construction: This option would construct the breakwater slow enough where destabilizing excess porewater pressures are not developed during construction (Figure 4-2). The time required for construction is highly dependent on the thickness of the underlying compressible clay and the actual rate of consolidation. Finite element modeling should be completed to estimate the time required to safely construct the breakwater and without developing destabilizing excess porewater pressures. It will also be necessary to monitoring pore pressure and settlement during construction to verify the rate and degree of consolidation to maintain stable conditions during construction. Instrumentation should consist of an array of piezometers, inclinometers, and settlement measurements (settlement plates and survey) to track pore pressures and movements, horizontal and vertical.

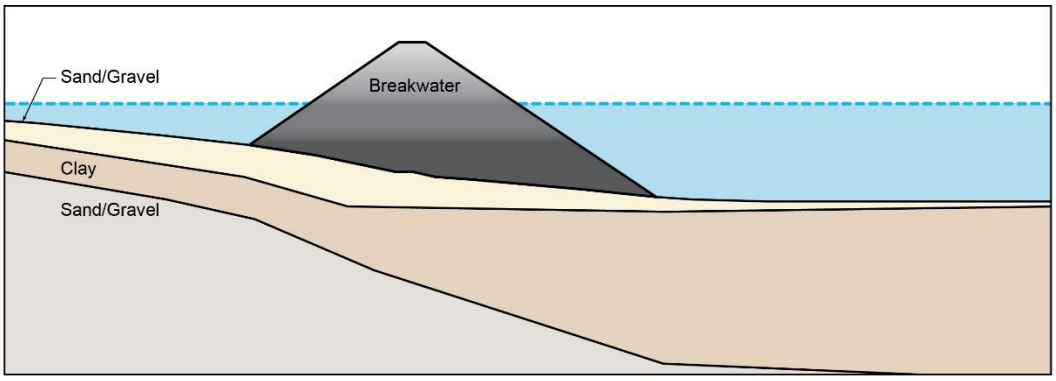


Figure 4-2. Slow Construction of Breakwater

Option 3: Removal of Clay: This option would remove the clay beneath the footprint of the breakwater prior to construction (Figure 4-3). The minimum excavation of clay and replacement with competent material should extend out from the base of the breakwater at an inclination of 1H:1V. In order to achieve this, it will be necessary to excavate a beyond this prism to maintain stable temporary cut slopes during the excavation and fill placement. For planning purposes, the temporary cut slopes in the clay may should be inclined no steeper than 1¾H:1V during construction. A key consideration for this option is that large volumes of material would need to be excavated and imported to the site to replace dredged materials beneath the breakwater raising costs significantly.

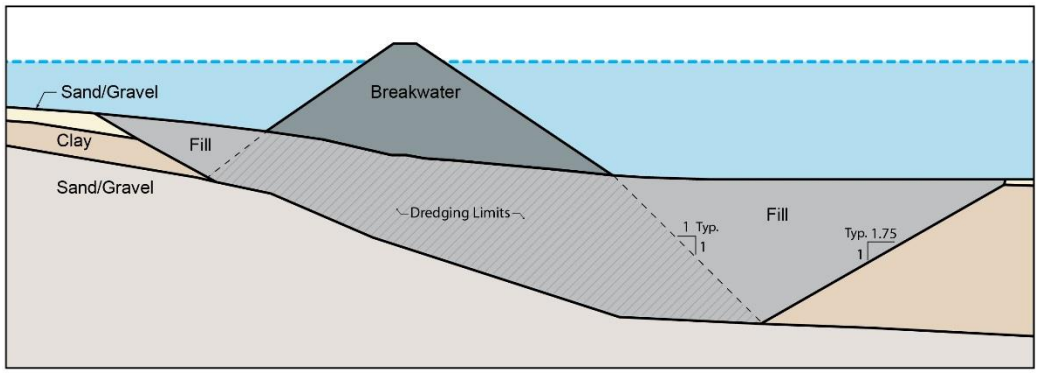


Figure 4-3. Removal of Clay

Two cross sections within the proposed dredge areas, B-B' and C-C' (see Appendix A) were analyzed for global slope stability as a screening tool to evaluate the feasibility of the dredge and potential impacts to the upslope breakwaters/jetties and to determine guideline recommendations for safe dredge separation distances and slope inclination. The results of the slope stability analyses are presented in Appendix F, Figures F-15 through F-17 and F-18 through F-20, for Section B-B' and C-C', respectively. The analyses were completed using the computer software SLOPE/W version 8.0 (GeoStudio 2012) using the Spencer limit equilibrium method (Spencer 1967). This method compares the ratio of forces driving slope movement with forces resisting slope movement for each trial failure surface and presents the result as the factor of safety (Fs). Trial failure surfaces are then sorted to identify the surface with the lowest Fs, or the "critical" failure surface. Soil parameters for the clay were "back calculated" for the current condition to establish the soil parameters appropriate for the current stable condition (factor of safety, Fs≈1.5). Subsequent analysis were completed to calculate the minimum dredge slope inclinations and separation distance required to maintain the stable configuration following dredging as (factor of safety, Fs≈1.5). In other words, the slope inclinations and separation distance recommendations were determined using criteria for dredge operations to minimize any impact to the current stability of the existing breakwater and jetty structures.

4.4 Basin Dredging

Two cross sections within the proposed dredge areas, B-B' and C-C' (see Appendix A) were analyzed for global slope stability as a screening tool to evaluate the feasibility of the dredge and potential impacts to the upslope breakwaters/jetties and to determine guideline recommendations for safe dredge separation distances and slope inclination. The results of the slope stability analyses are presented in Appendix F, Figures F-15 through F-17 and F-18 through F-20, for Section B-B' and C-C', respectively. The analyses were completed using the computer software SLOPE/W version 8.0 (GeoStudio 2012) using the Spencer limit equilibrium method (Spencer 1967). This method compares the ratio of forces driving slope movement with forces resisting slope movement for each trial failure surface and presents the result as the factor of safety (Fs). Trial failure surfaces are then sorted to identify the surface with the lowest Fs, or the "critical" failure surface. Soil parameters for the clay were "back calculated" for the current condition to establish the soil parameters appropriate for the current stable condition (factor of safety, Fs≈1.5). Subsequent analysis were completed to calculate the minimum dredge slope inclinations and separation distance required to maintain the stable configuration following dredging as (factor of safety, Fs≈1.5). In other words, the slope inclinations and separation distance recommendations were determined using criteria for dredge operations to minimize any impact to the current stability of the existing breakwater and jetty structures. p

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REVISIONS

REV.	DATE	DESCRIPTION	DWN.	CKD.	APP.

P N D ENGINEERS, INC.
9360 Glacier Highway Ste 100
Juneau, Alaska 99801
Phone: 907-586-2093
Fax: 907-586-2099
www.pnd-anc.com

DESIGN: PND CHECKED: MH
DRAWN: PJD APPROVED: MH
SCALE: SCALE IN FEET 0 60 120 FT.
DATE: February 2013

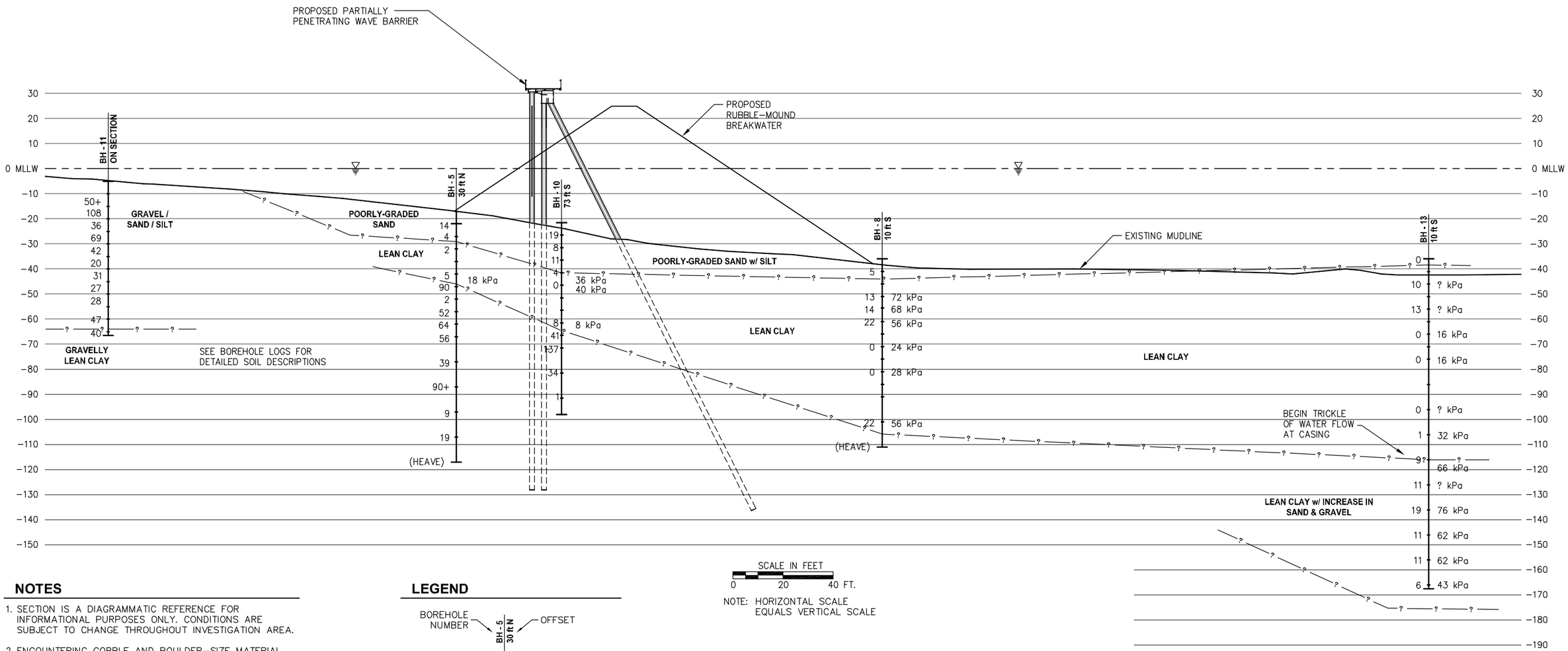
HAINES BOROUGH
SOUTH PORTAGE COVE HARBOR EXPANSION

SHEET TITLE: SITE PLAN WITH PROPOSED RUBBLE MOUND BREAKWATER

PND PROJECT NO.: 102029.04 DWG. FILE:

A

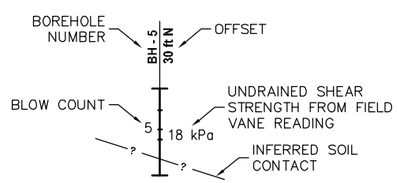
SHEET 3 OF 5



NOTES

1. SECTION IS A DIAGRAMMATIC REFERENCE FOR INFORMATIONAL PURPOSES ONLY. CONDITIONS ARE SUBJECT TO CHANGE THROUGHOUT INVESTIGATION AREA.
2. ENCOUNTERING COBBLE AND BOULDER-SIZE MATERIAL SHOULD BE ANTICIPATED WITHIN ANY OF THE REPRESENTED SOIL HORIZONS.
3. VARIATION IN MUDLINE ELEVATIONS WERE OBSERVED BETWEEN BATHYMETRIC SURVEY DATA AND LEADLINE MEASUREMENTS TAKEN AT BOREHOLE COLLARS.

LEGEND



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PND ENGINEERS, INC.
9360 Glacier Highway Ste 100
Juneau, Alaska 99801
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www.pnd-anc.com

DESIGN: PND CHECKED: MH
DRAWN: PJD APPROVED: MH
SCALE: AS SHOWN
DATE: February 2013

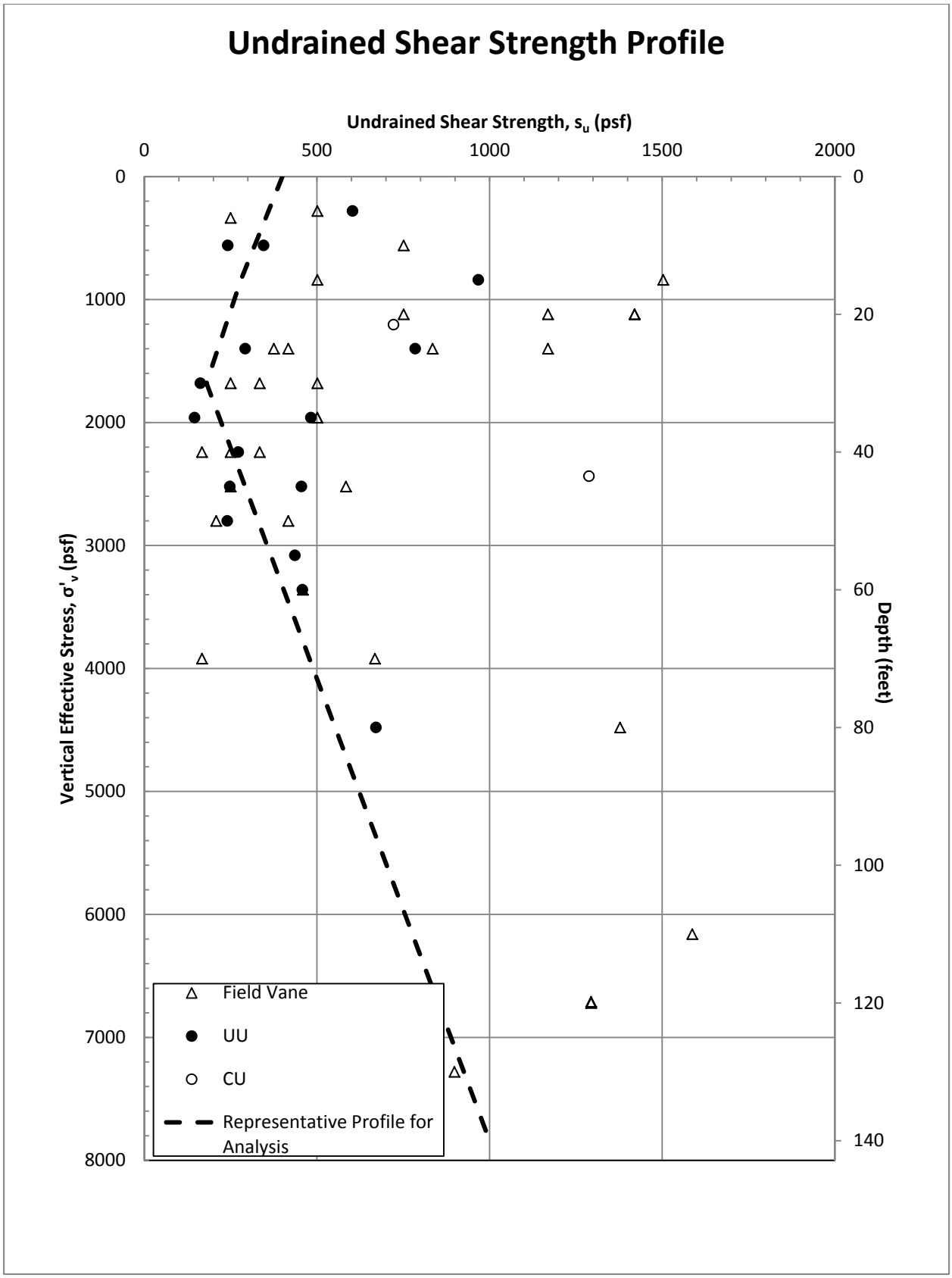
HAINES BOROUGH
SOUTH PORTAGE COVE HARBOR EXPANSION

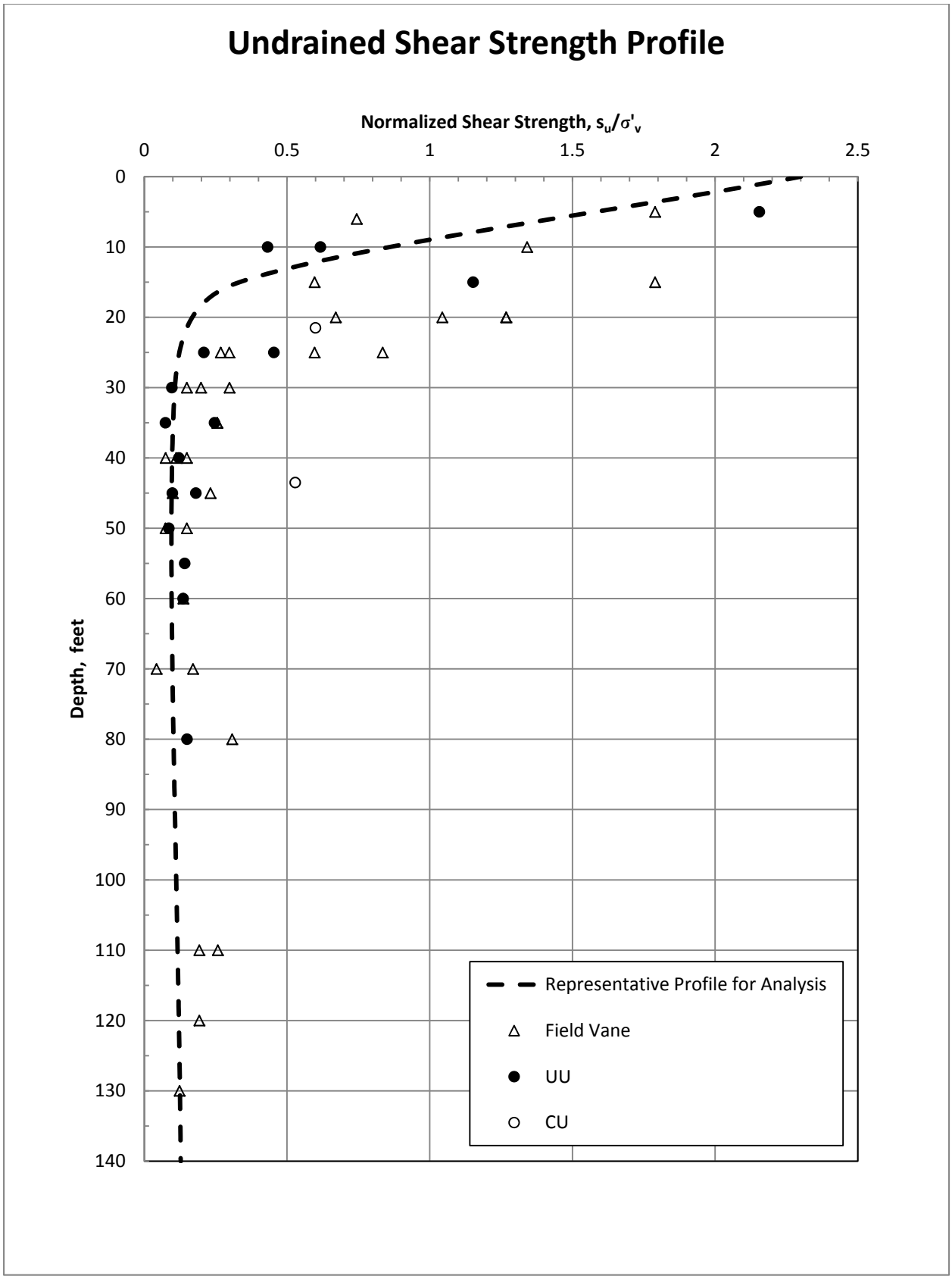
SHEET TITLE: **GENERALIZED SUBSURFACE PROFILE SECTION A-A'**

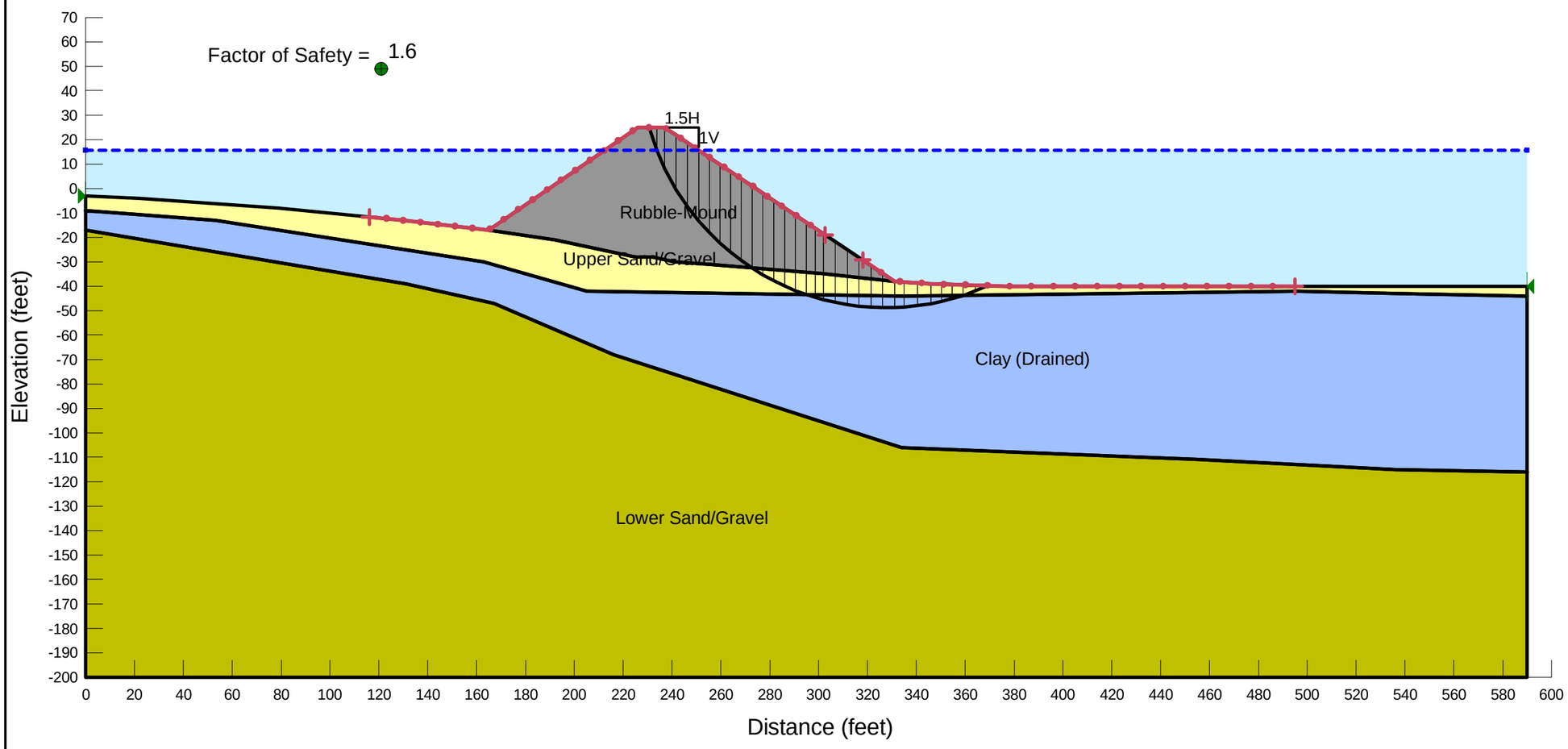
PND PROJECT NO.: 102029.04 DWG. FILE: 102029.04.DWG

A

SHEET 5 OF 5


Undrained Shear Strength Profile
Undrained Shear Strength, s_u (psf)
0
500
1000
1500
2000
Vertical Effective Stress, σ'_v (psf)
0
1000
2000
3000
4000
5000
6000
7000
8000
Depth (feet)
0
20
40
60
80
100
120
140
Field Vane
UU
CU
Representative Profile for Analysis


Undrained Shear Strength Profile
Normalized Shear Strength, s_u/σ'_v
0
0.5
1
1.5
2
2.5
Depth, feet
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Representative Profile for Analysis
Field Vane
UU
CU



Soil Parameters:

Name: Rubble-Mound
Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 46 °

Name: Upper Sand/Gravel
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 34 °

Name: Clay (Drained)
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 30 °

Name: Lower Sand/Gravel
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 36 °

Method: Spencer
SLOPE/W Analysis - Rubble-Mound Breakwater - Section A-A' (Long Term - Drained)

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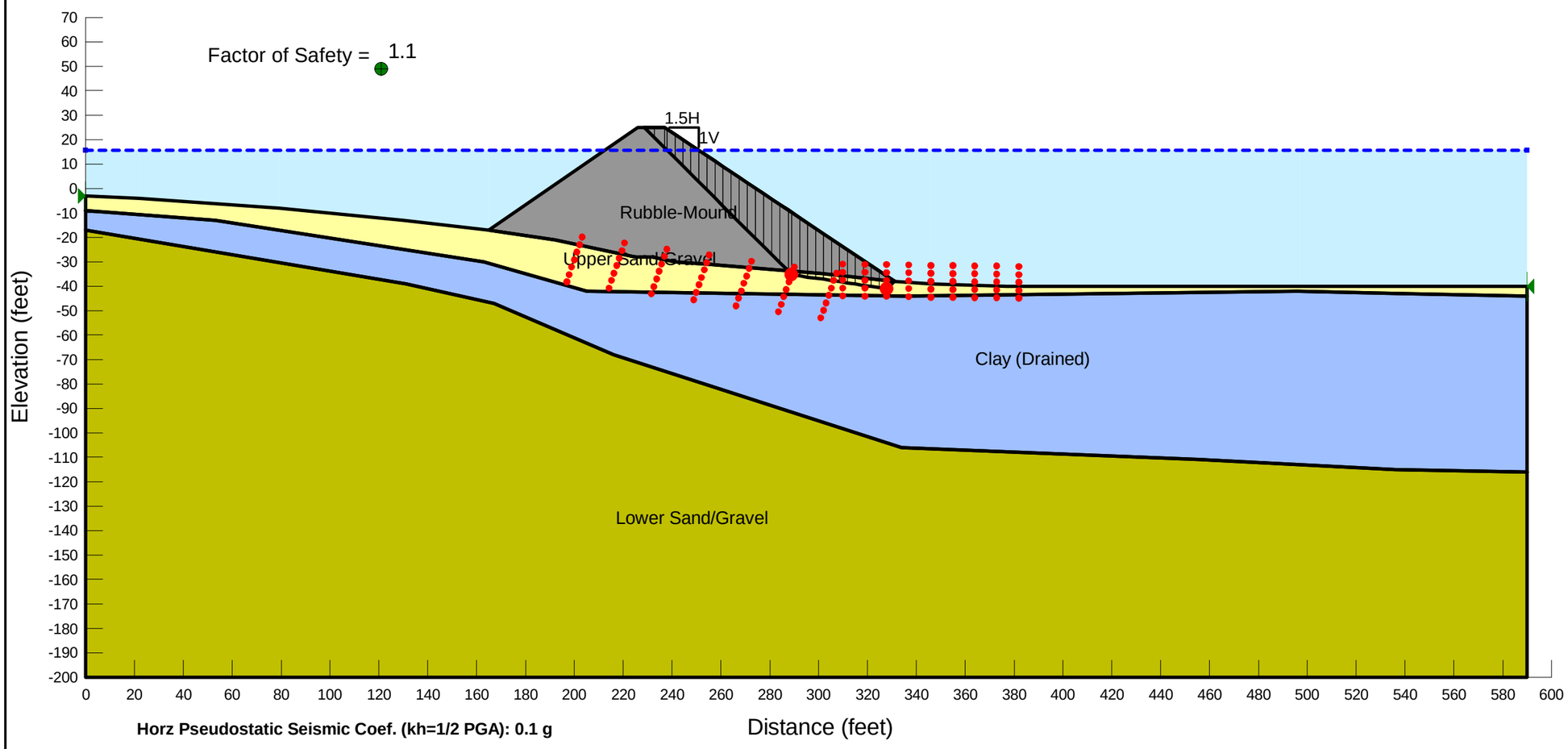
Figure F-3



Soil Parameters:

Name: Rubble-Mound
Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 46 °

Name: Upper Sand/Gravel
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 34 °

Name: Clay (Drained)
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 30 °

Name: Lower Sand/Gravel
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 36 °

Method: Spencer
SLOPE/W Analysis - Rubble-Mound Breakwater - Section A-A' (pseudo-static)

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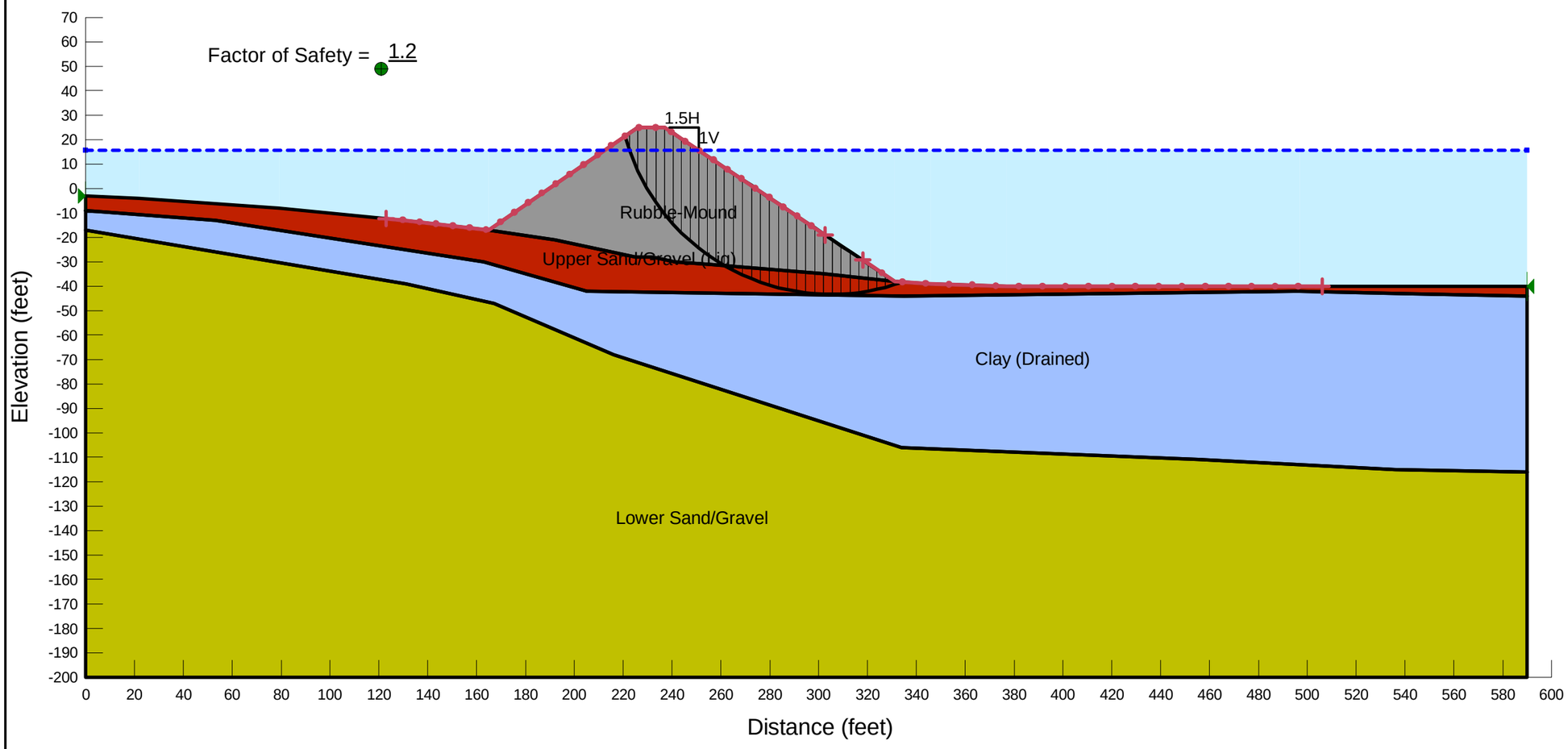
Figure F-4



Soil Parameters:

Name: Rubble-Mound
Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 46 °

Name: Upper Sand/Gravel (Liq)
Model: Undrained (Phi=0)
Unit Weight: 125 pcf
Cohesion': 630 psf

Name: Clay (Drained)
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 30 °

Name: Lower Sand/Gravel
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 36 °

Method: Spencer
SLOPE/W Analysis - Rubble-Mound Breakwater - Section A-A' (Post EQ)

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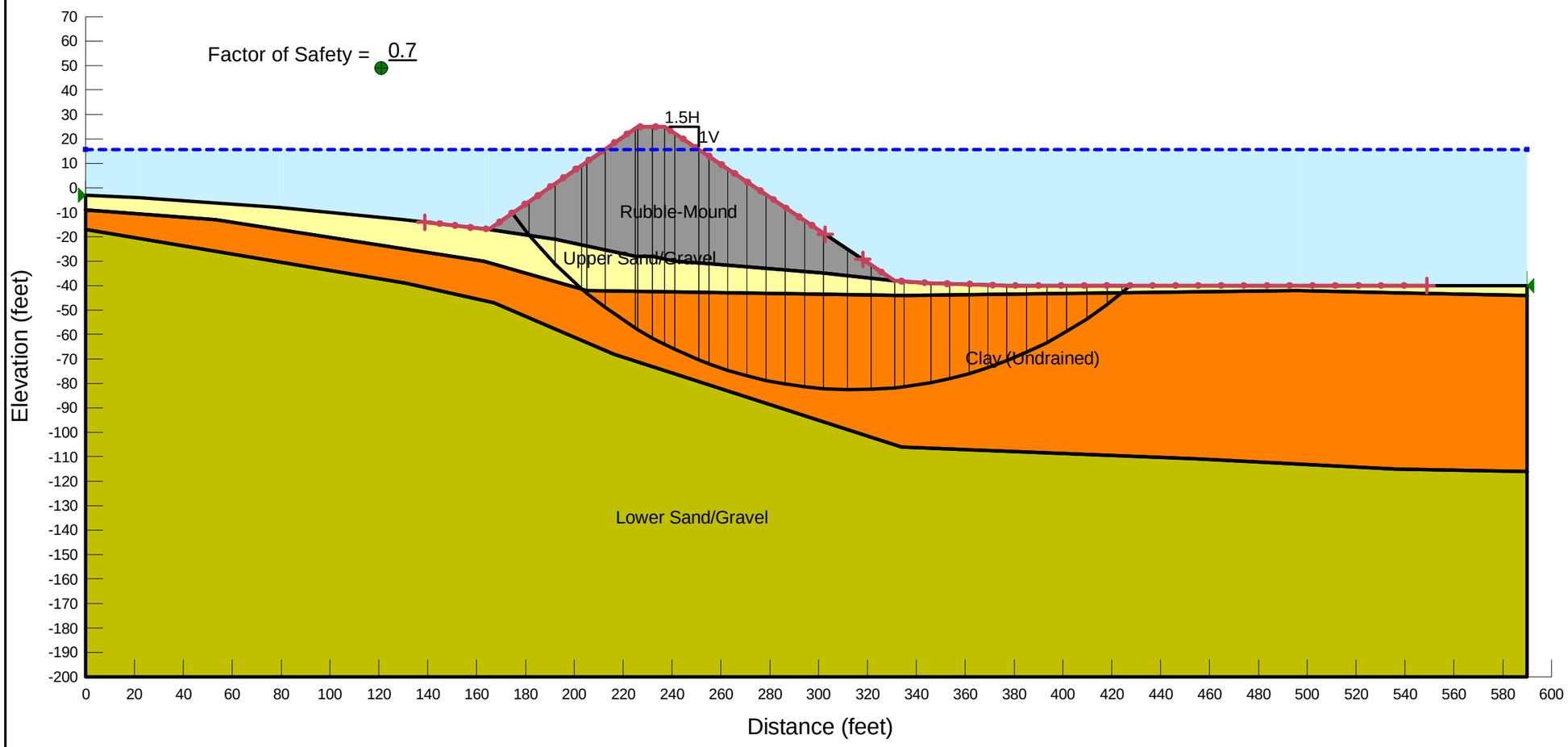
Figure F-5



Soil Parameters:

Name: Rubble-Mound
Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 46 °

Name: Upper Sand/Gravel
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 34 °

Name: Clay (Undrained)
Model: Shear/Normal Fn.
Unit Weight: 120 pcf
Strength Function: SPC Clay

Name: Lower Sand/Gravel
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 36 °

Method: Spencer
SLOPE/W Analysis - Rubble-Mound Breakwater - Section A-A' (Short Term - Undrained)

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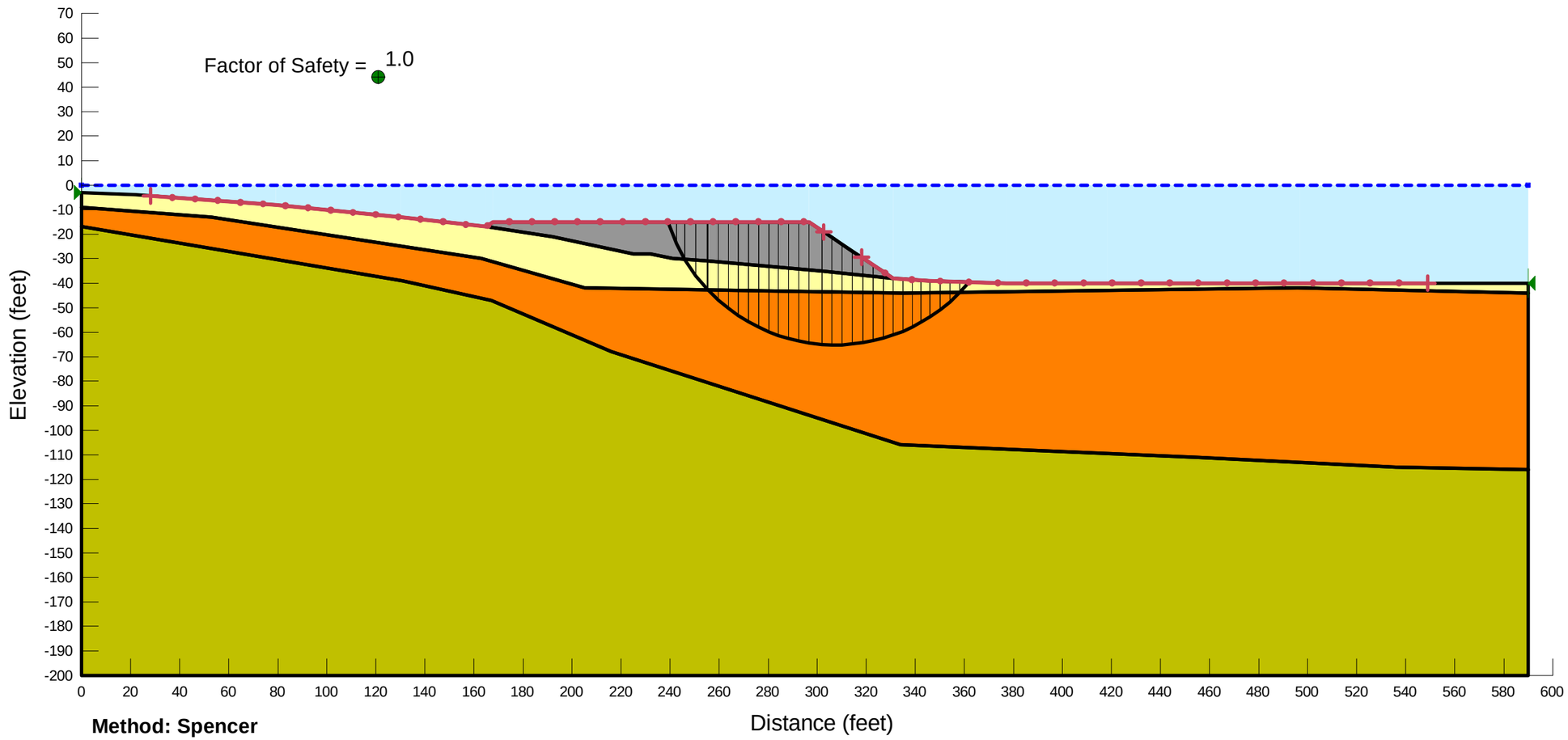
Figure F-6



Method: Spencer
SLOPE/W Analysis - Stage Const. (Short Term - Undrained)

Soil Parameters:

Name: Rubble-Mound
Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 46 °

Name: Upper Sand/Gravel
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 34 °

Name: Clay (Undrained)
Model: Shear/Normal Fn.
Unit Weight: 120 pcf
Strength Function: SPC Clay

Name: Lower Sand/Gravel
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 36 °

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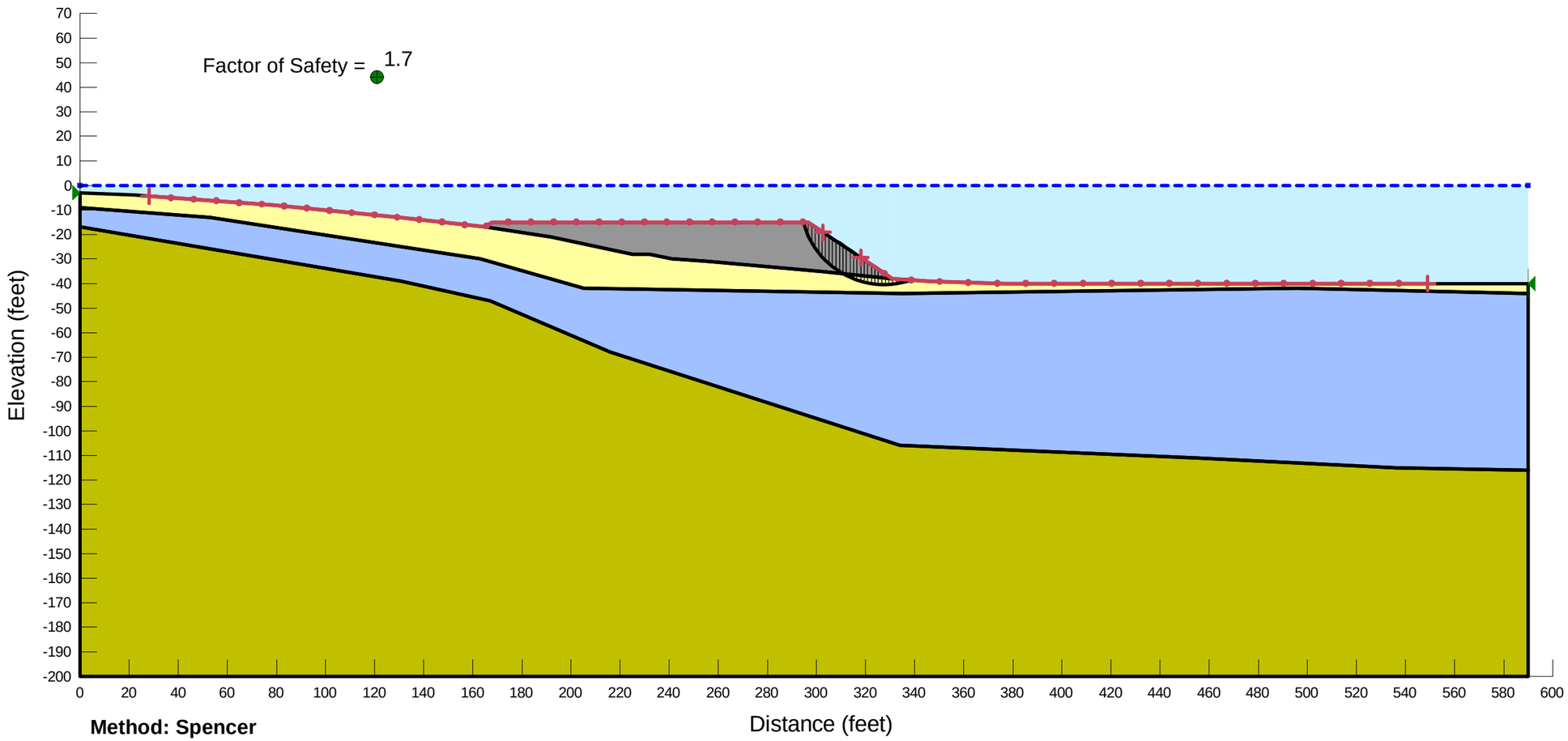
Figure F-7



Method: Spencer
SLOPE/W Analysis - Stage Const. (Long Term - Drained)

Soil Parameters:

Name: Rubble-Mound
Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 46 °

Name: Upper Sand/Gravel
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 34 °

Name: Clay (Drained)
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 30 °

Name: Lower Sand/Gravel
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 36 °

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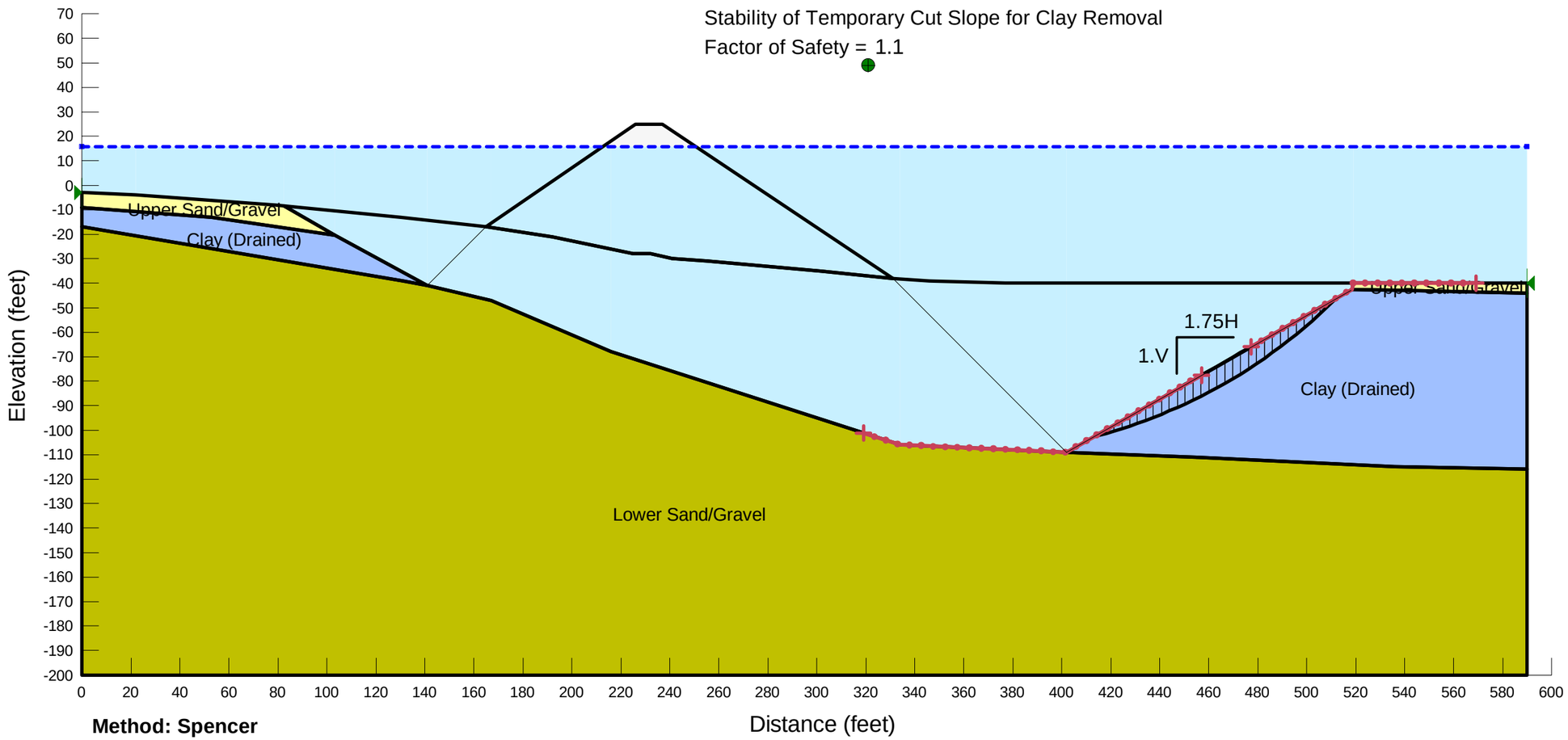
Figure F-8



Method: Spencer
SLOPE/W Analysis (overex clay)

Soil Parameters:

Name: Upper Sand/Gravel
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 34 °

Name: Clay (Drained)
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 30 °

Name: Lower Sand/Gravel
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 36 °

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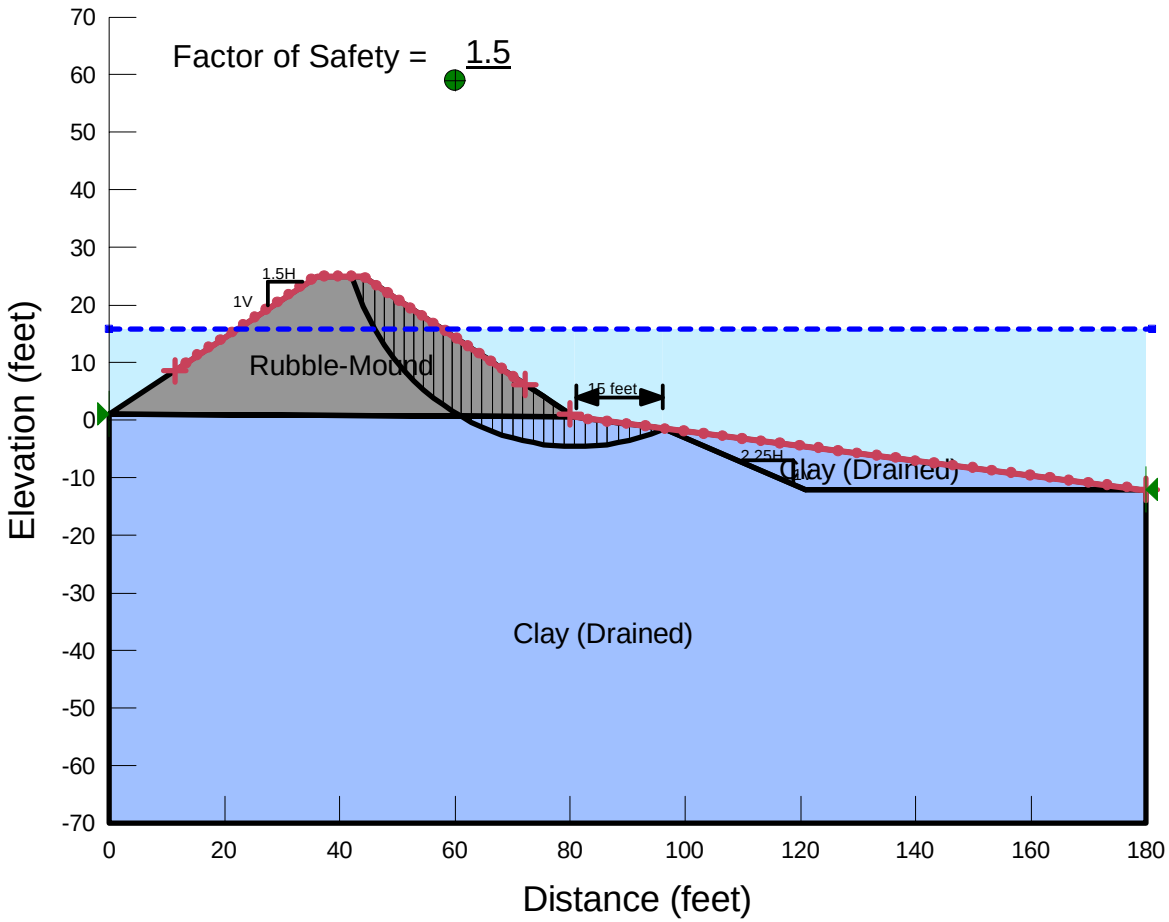
Figure F-9



Soil Parameters:

Name: Rubble-Mound
Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 46 °

Name: Clay (Drained)
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 30 °

Method: Spencer
SLOPE/W Analysis SECTION B-B' (Existing Condition)

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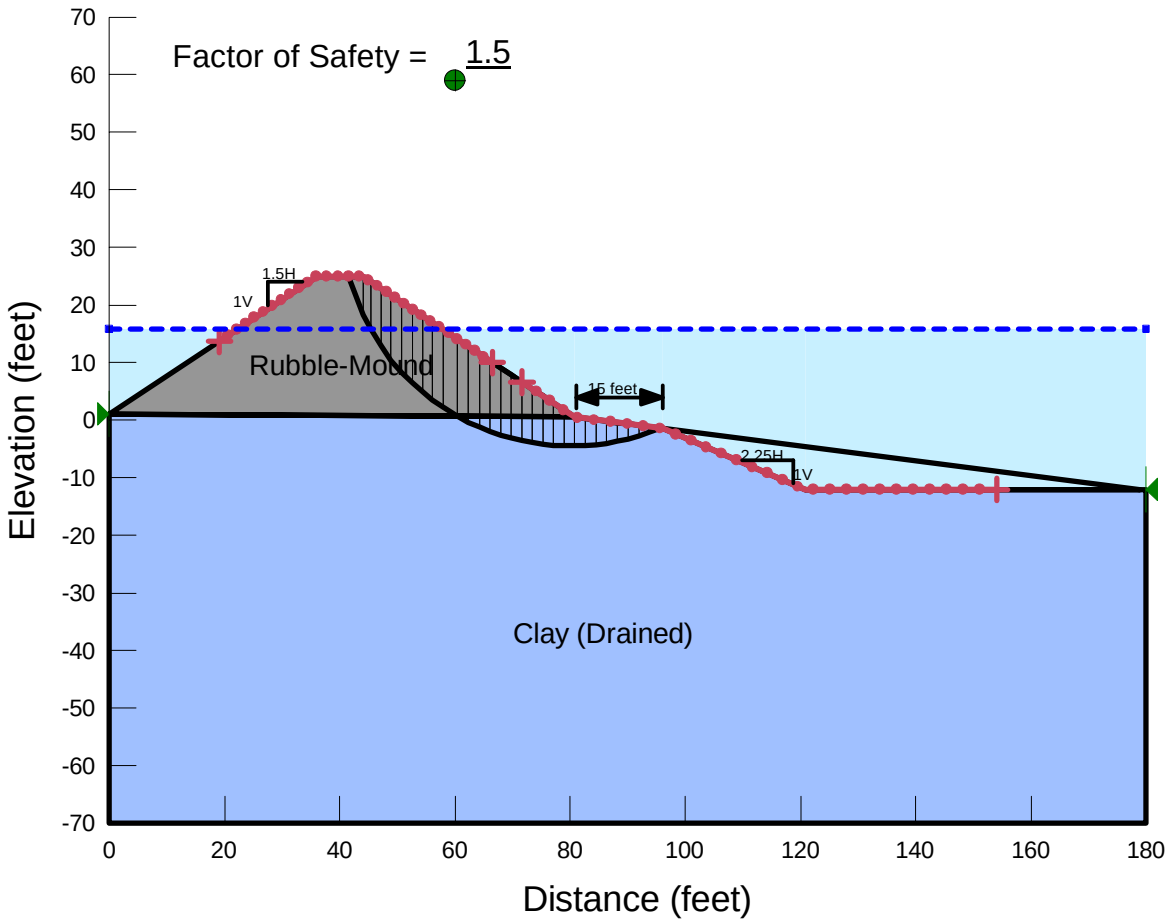
Figure F-15



Soil Parameters:

Name: Rubble-Mound
Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 46 °

Name: Clay (Drained)
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 30 °

Method: Spencer
SLOPE/W Analysis SECTION B-B' (Dredge)

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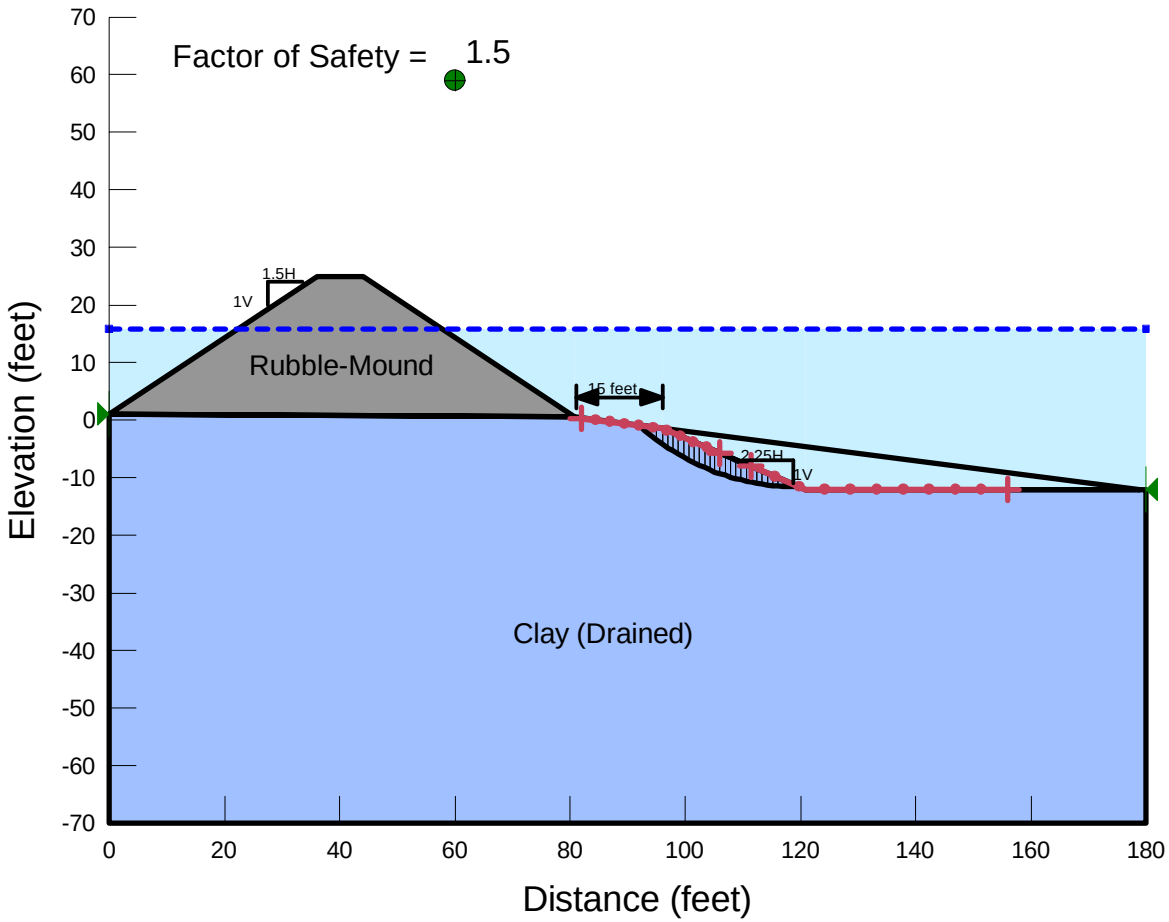
Figure F-16



Soil Parameters:

Name: Rubble-Mound
Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 46 °

Name: Clay (Drained)
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 30 °

Method: Spencer
SLOPE/W Analysis SECTION B-B' (Dredge Cut)

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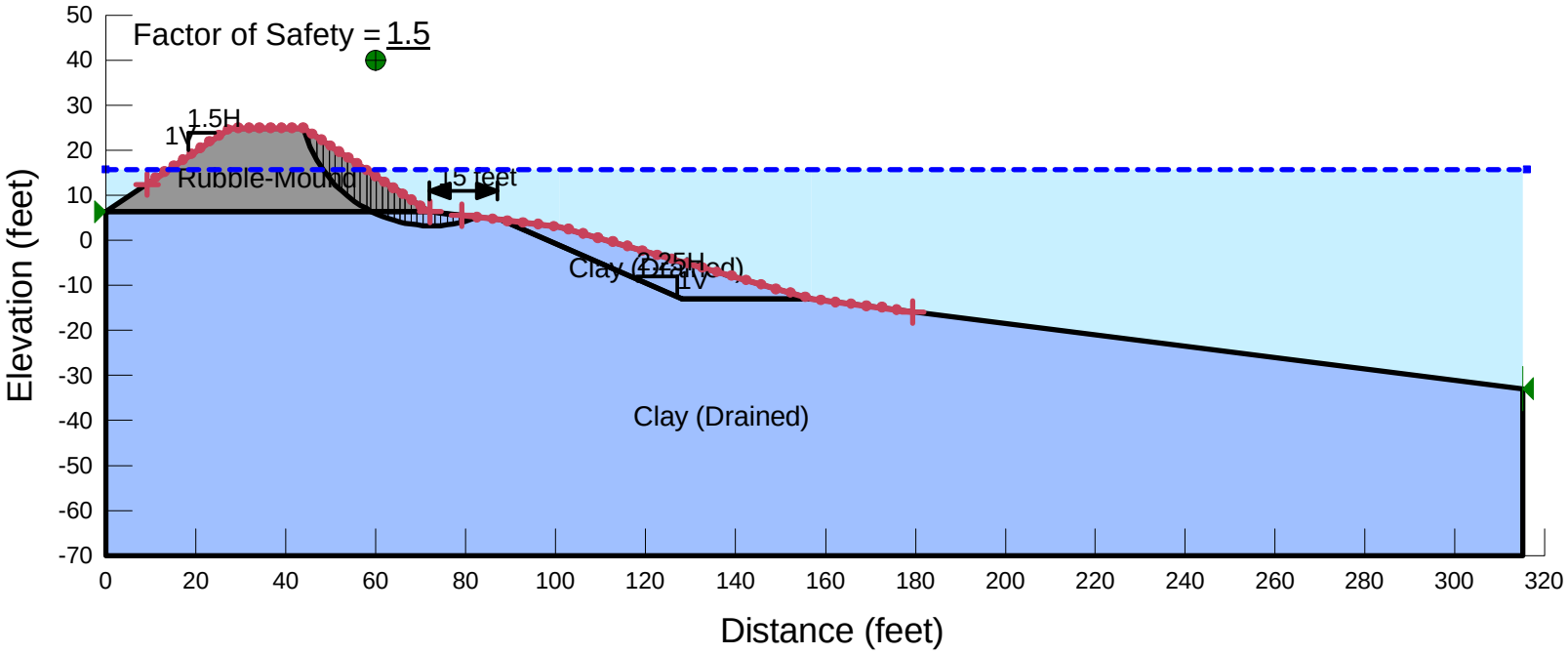
Figure F-17



Soil Parameters:

Name: Rubble-Mound
Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 46 °

Name: Clay (Drained)
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 30 °

Method: Spencer
SLOPE/W Analysis SECTION C-C' (Existing Condition)

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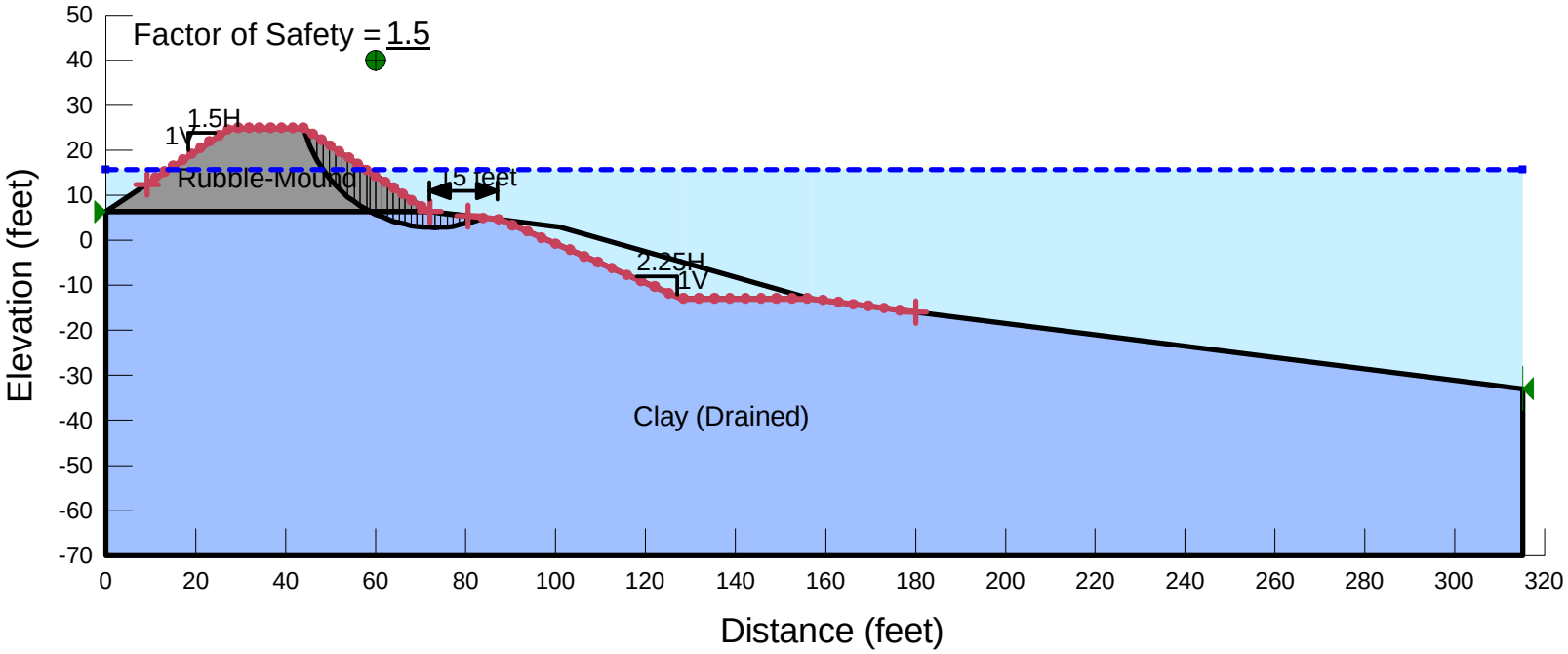
Figure F-18



Soil Parameters:

Name: Rubble-Mound
Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 46 °

Name: Clay (Drained)
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 30 °

Method: Spencer
SLOPE/W Analysis SECTION C-C' (Dredge)

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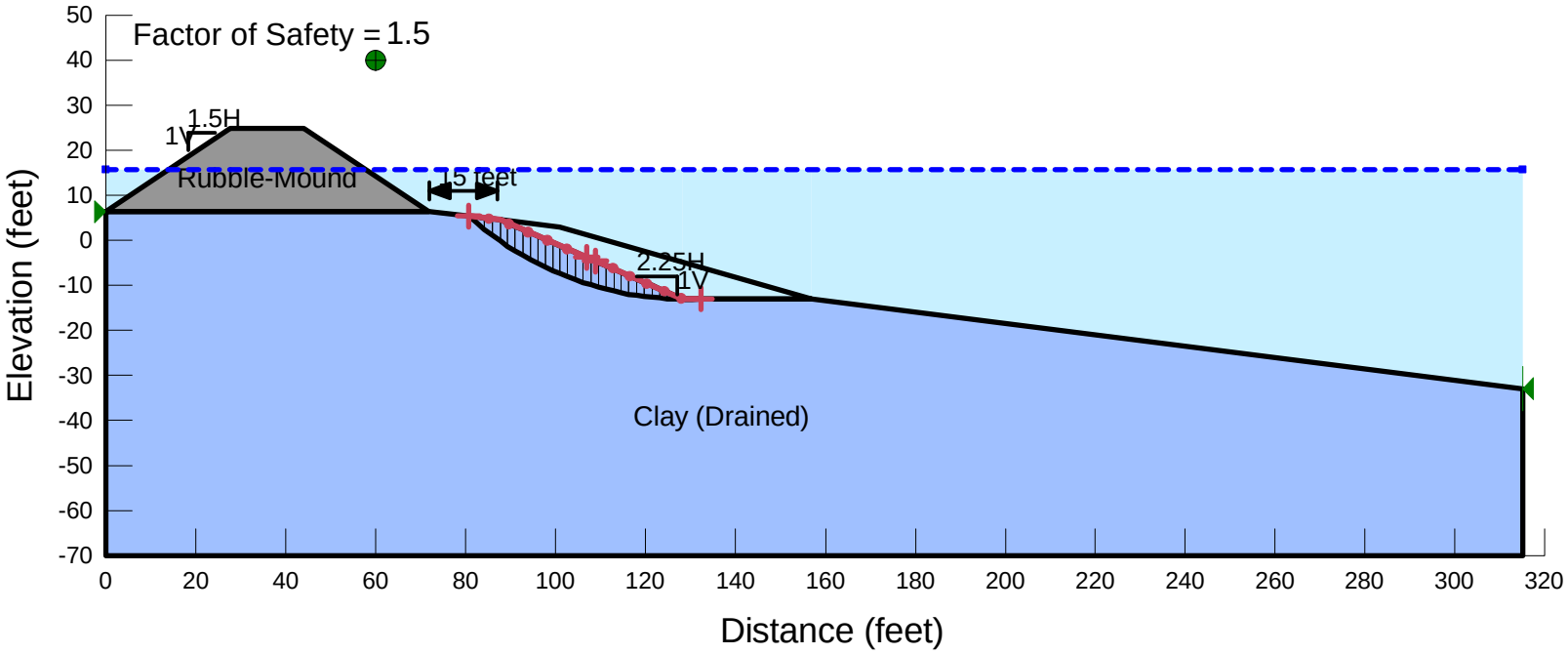
Figure F-19



Soil Parameters:

Name: Rubble-Mound
Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 46 °

Name: Clay (Drained)
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 30 °

Method: Spencer
SLOPE/W Analysis SECTION C-C' (Dredge Cut)

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Figure F-20

GeoEngineers

8410 154th Avenue NE, Redmond, WA 98052, Telephone: 425.861.6000, Fax: 425.861.6050 www.geoengineers.com

Memorandum

To:	Christopher Kokesh, PE; Steven Halcomb, PE; and Garth Howlett, PE – PND Engineers
From:	King H Chin, PE and Heidi P. Disla, PE
Date:	July 26, 2013
File:	21132-001-00
Subject:	Third Party Geotechnical Review Comments Proposed Rubble Mound Breakwater at South Portage Cove Harbor, Haine, Alaska

This memorandum presents a summary of the third party technical review comments on the geotechnical input parameters used in the design analyses completed by PND Engineers (PND) for a rubble mound breakwater at South Portage Cove Harbor in Haine, Alaska.

We understand that the project includes construction of a rubble mound breakwater on existing soft ground at the South Portage Cove Harbor in Haine, Alaska. Based on the results of the global stability analyses, PND concluded that the construction of the breakwater will need to be completed in phases to prevent subsoil failure during construction and that ground improvement technique using wick drain will be installed to speed up the construction of the breakwater. PND completed PLAXIS modeling to evaluate the required stage construction procedure, global factor of safety and deformation estimate at each construction stage identified for this project.

The objectives of our third party technical review services are to provide our opinions on the geotechnical input parameters for the soft foundations soils used in the global stability and PLAXIS analyses completed by PND. The review comments presented in this memorandum are based on our review of the pertinent sections of the draft final geotechnical report dated April 2013 and the PLAXIS soil input parameters provided by PND. We also completed limited engineering analyses to develop our comments presented in this memorandum.

SHORT TERM UNDRAINED SHEAR STRENGTH OF SOFT FOUNDATION SOILS

One of the most critical conditions to be considered in the design of embankment on soft foundation soils is the evaluation of rate of embankment construction to ensure that the construction-induced soil stress does not exceed the short term undrained shear strength (Su) of the soft foundations soils. Based on the soil data available for this project, PND developed a Su profile for use in the evaluation of embankment stability during construction, as presented in the attached Figure 1.

Based on our review of the consolidation and shear strength test data, it appears that the Su profile developed by PND did not account for the stress history of the soil. Since the undrained shear strength of clay is highly dependent of the stress history, it is our opinion that an alternate Su profile developed using the Stress History And Normalized Soil Engineering Properties (SHANSEP) method (Ladd and Foott, 1974) be developed and considered in the embankment stability analysis.

Based on the consolidation test data provided, we developed an interpretation of the stress history of the clay as presented in the attached Figures 2 and 3. As presented in Figure 3, the foundation soil within the top 30 feet is slightly to moderately over-consolidated with an over-consolidation ratio (OCR) ranges from 1.3 to 7.

Disclaimer: Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Figure 4 presents our interpreted Su profile that incorporated the stress history of the foundation soils using the SHANSEP method. The SHANSEP equation developed is $Su = 0.15 \times OCR^{0.80}$. Also shown on Figure 4 is the Su profile developed by PND for comparison purposes. The comparison shows that the undrained shear strength developed by PND has higher values within the top 20 feet of soils and lower values below depth of about 20 feet. It is our opinion that the global stability analyses during construction conditions be evaluated using both the PND Su profile and an alternate Su profile developed using the SHANSEP method.

SOIL INPUT PARAMETERS USED IN PLAXIS ANALYSIS

There were two questions posed by PND related to the soil input parameters used in the PLAXIS analysis: (1) the appropriate soil model for use in the analysis, and @2) drained versus undrained analysis.

Based on our experience, it is our opinion that the PLAXIS analysis be completed using both the Hardening Soil (HS) and the Soft Soil Creep (SSC) Models available in the PLAXIS program. It is also our opinion that the HS model would provide a better simulation of the undrained shear strength of the foundation soils for short term conditions but would likely underestimate the settlement induced by the embankment weight under long term conditions. To better evaluate the potential settlement of the foundation soils caused by the embankment, a SSC model can be used to estimate the long term settlement of the embankment.

For the temporary construction conditions, it is our opinion that an undrained analysis using the HS model be completed to evaluate the factor of safety of the embankment during construction. For long term conditions, it is our opinion that a drained analysis using the SSC model be completed to evaluate the factor of safety and the settlement of the embankment.

OTHER GEOTECHNICAL ISSUES FOR CONSIDERATIONS

Based on our cursory review of the geotechnical report, the following are the geotechnical issues identified for consideration by PND Engineers:

1. The report indicates that liquefiable soils present at the site. The stability analyses should consider the effects of liquefaction of these soil layers.
2. The site is located in a seismically active region. The effect of the ground shaking to the soft foundation soils (i.e. cyclic mobility) should be considered in the stability of the embankment.
3. The report indicates the site is underlain by a soil layer with artesian water. The effect of the presence of the artesian water should be considered in the stability of the embankment.

Please call if you have any questions or wish to discuss the opinions and review comments presented in this memorandum.

The opinions and comments expressed herein are intended as an independent review of the geotechnical input parameters used in the analyses completed by PND Engineers for the South Portage Cove Harbor Project in Haine, Alaska. The opinions presented herein are only provided for consideration by the PND Engineers and should not be used as design information. The responsibility for producing a design in accordance with industry standards and the Haine Borough's requirements under separate Agreement shall reside solely with PND Engineers. GeoEngineers disclaims any liability for claims, losses, or damages arising from the performance of the breakwater design implemented for this project.

KHC:nld:lc

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Attachments:

Figure 1. Undrained Shear Strength Profile

Figure 2. Pre-Consolidation Pressure Profile

Figure 3. OCR Profile

Figure 4. GeoEngineers Interpreted Undrained Shear Strength Profile

Undrained Shear Strength Profile

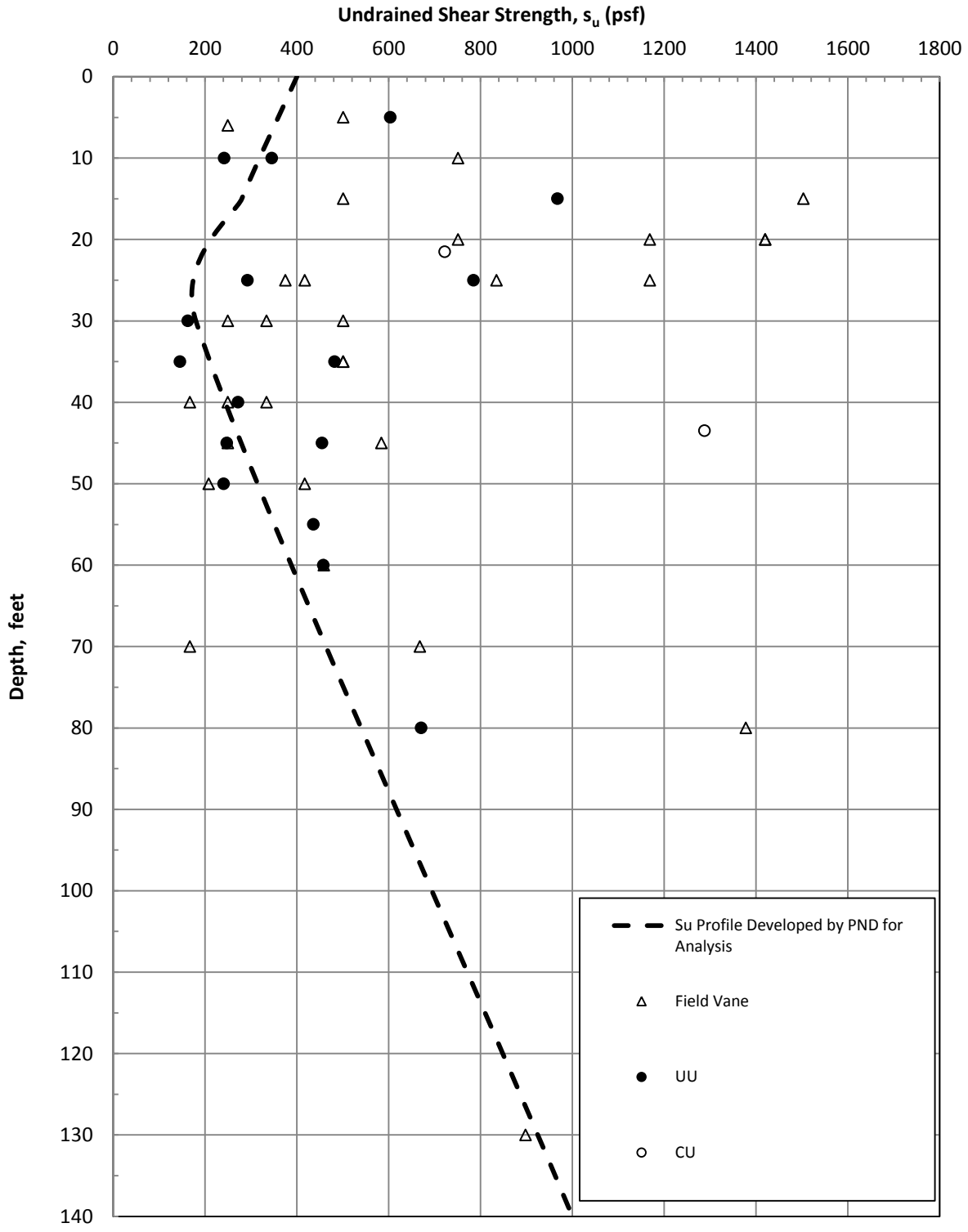

Figure 1

Pre-Consolidation Pressure Profile

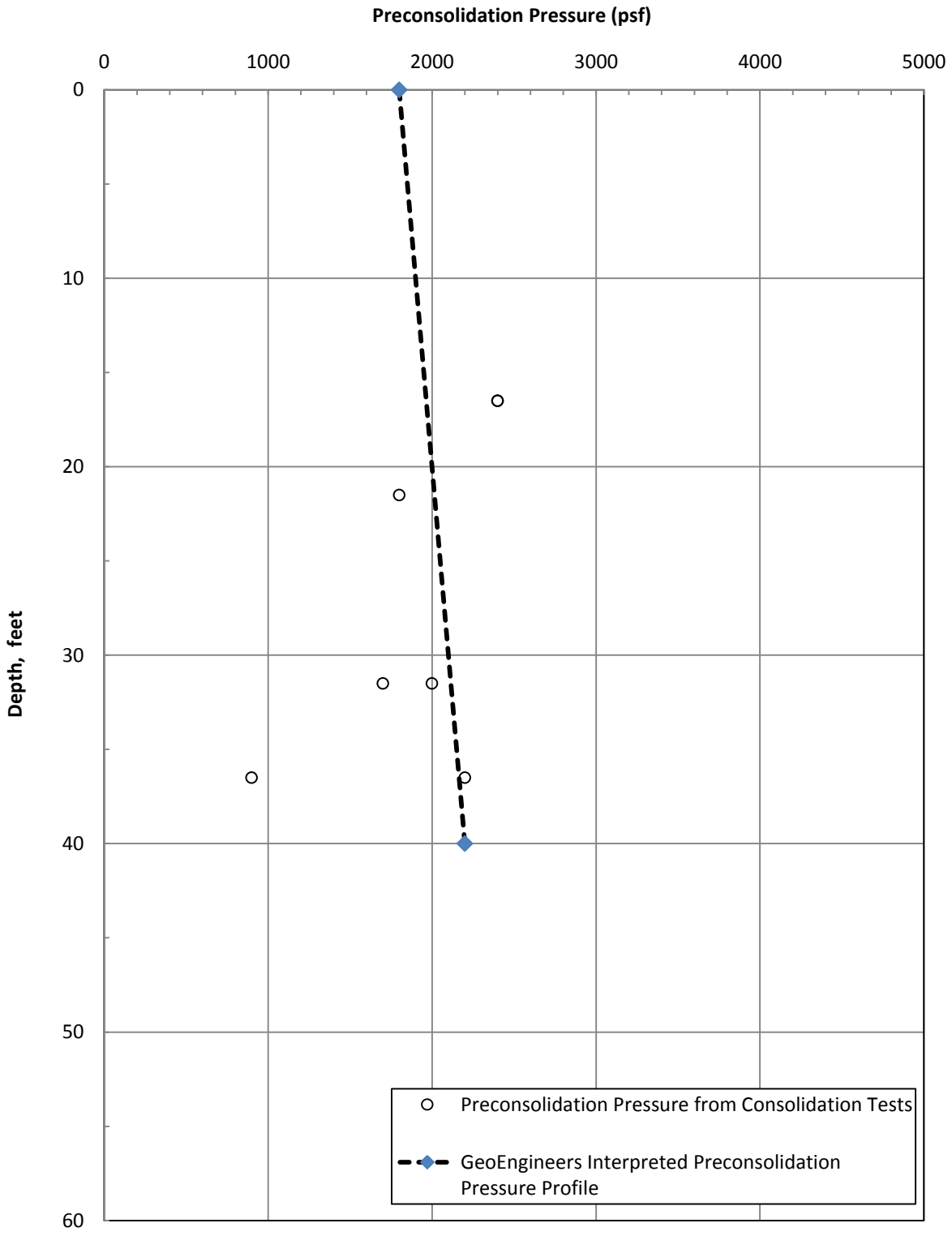

Figure 2

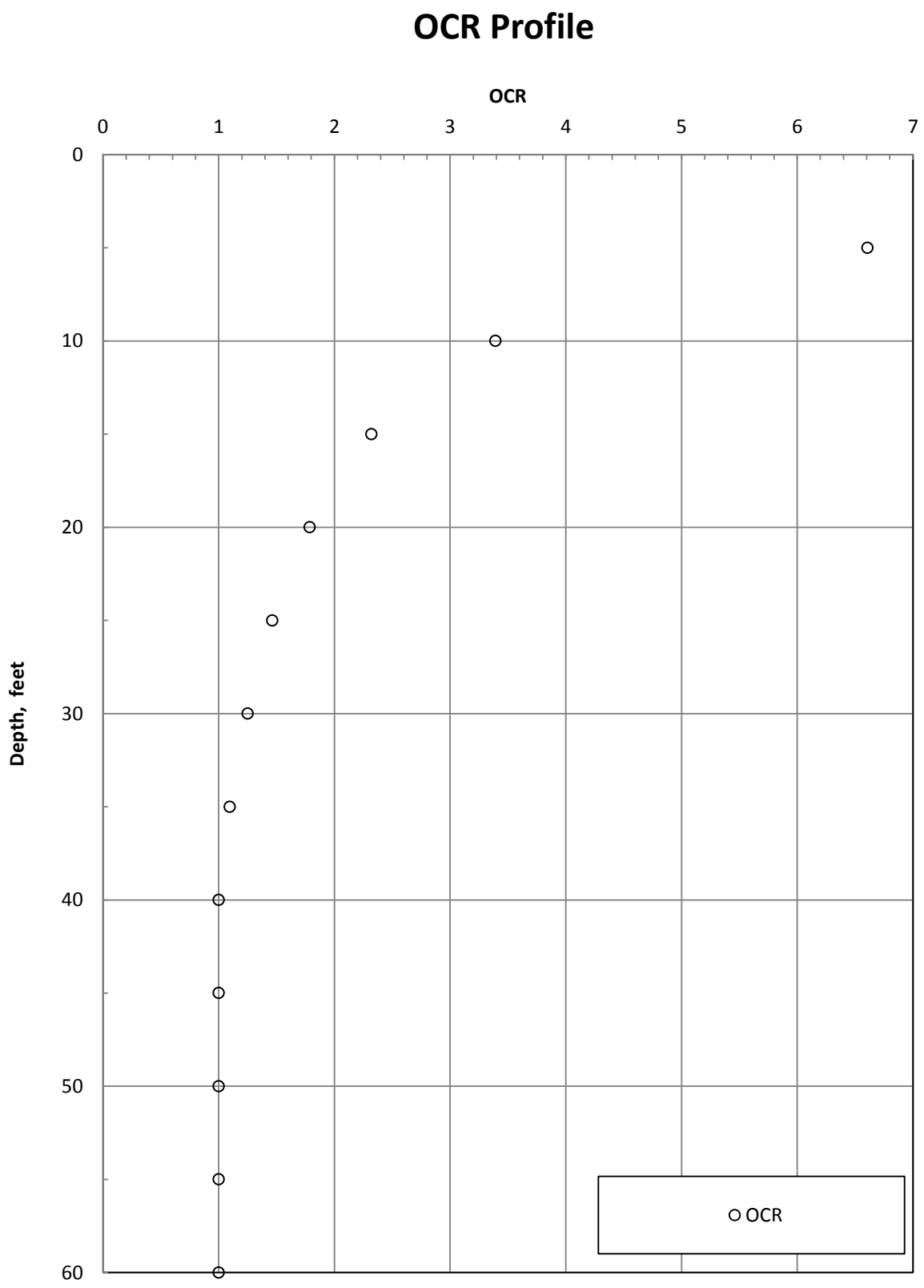

Figure 3

Undrained Shear Strength Profile

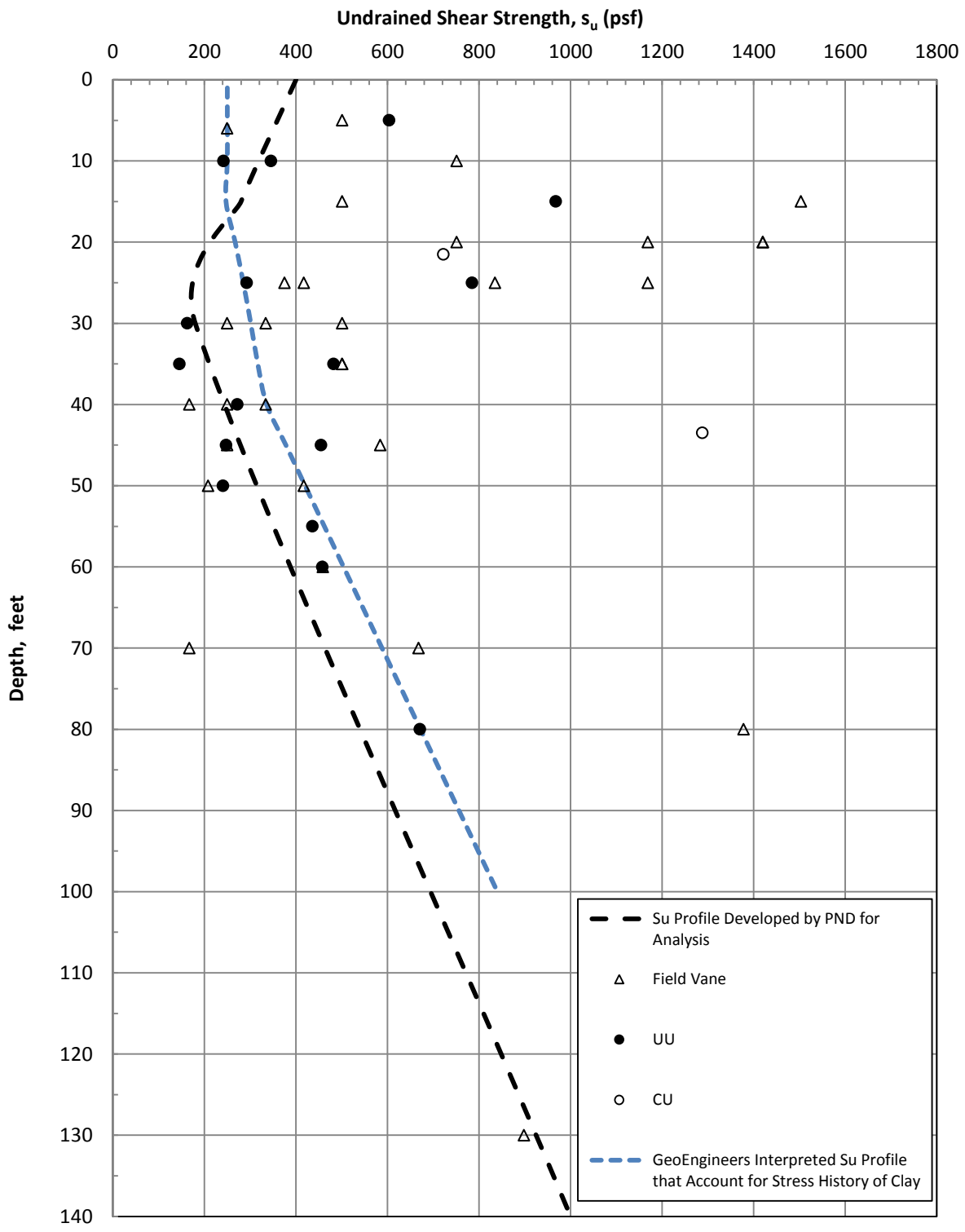

Figure 4

APPENDIX H

GBA Publication: "Important Information about your Geotechnical-Engineering Report"

Important Information about Your

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical-Engineering Report Is Based on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical-engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical-engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold-prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical-engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold-prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your GBA-Member Geotechncial Engineer for Additional Assistance

Membership in the GEOPROFESSIONAL BUSINESS ASSOCIATION exposes geotechnical engineers to a wide array of risk confrontaton techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your GBA-member geotechnical engineer for more information.

GEOPROFESSIONAL BUSINESS ASSOCIATION

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