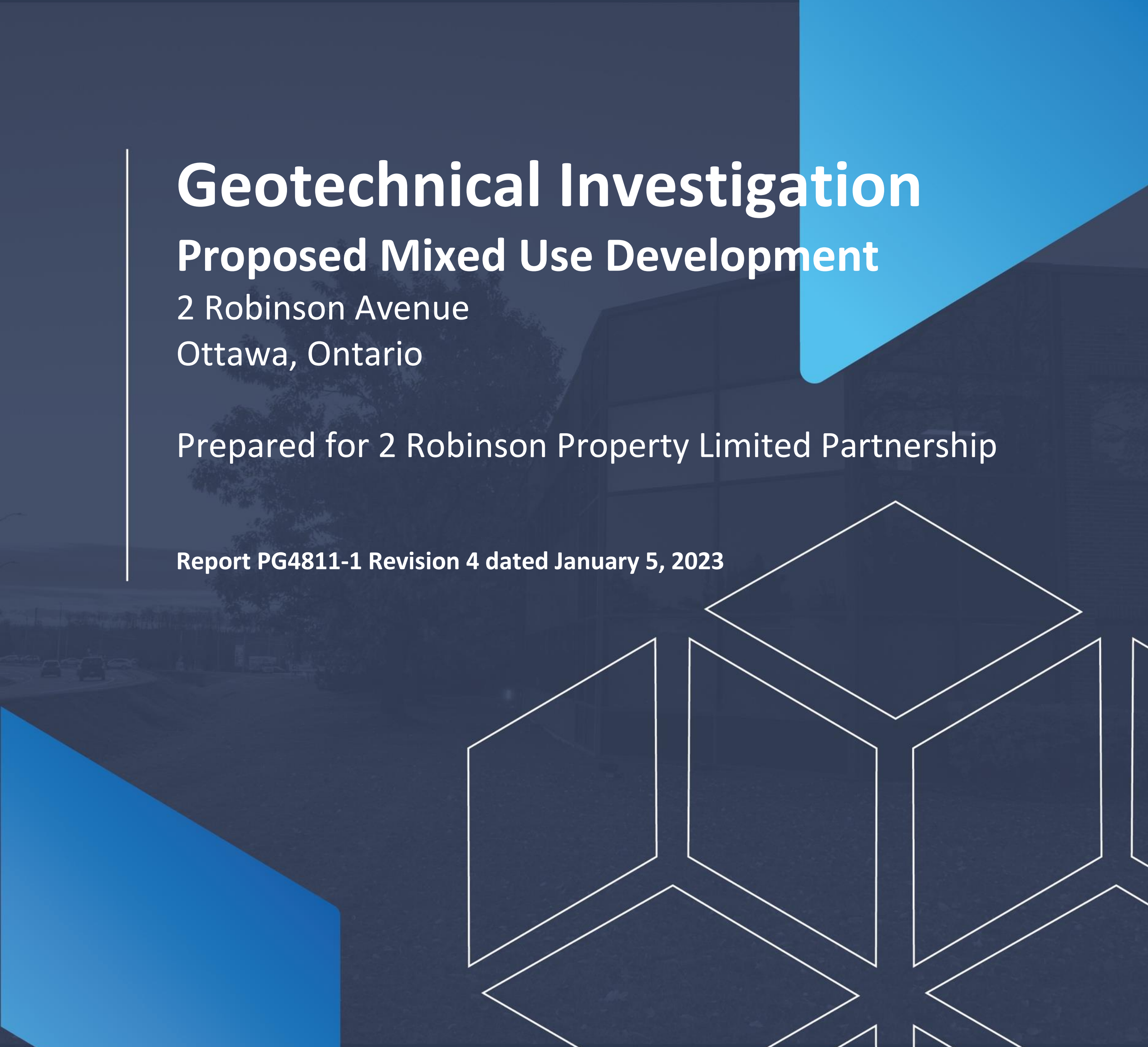


Geotechnical Investigation

Proposed Mixed Use Development

2 Robinson Avenue
Ottawa, Ontario

Prepared for 2 Robinson Property Limited Partnership

Report PG4811-1 Revision 4 dated January 5, 2023

Table of Contents

Appendices

Appendix 1	Soil Profile and Test Data Sheets Symbols and Terms Analytical Testing Results Hydraulic Conductivity Results
Appendix 2	Figure 1 - Key Plan Figure 2 - Section A - Static Conditions Figure 3 - Section A - Seismic Conditions Drawing PG4811-1 - Test Hole Location Plan

1.0 Introduction

Paterson Group (Paterson) was commissioned by 2 Robinson Property Limited Partnership to conduct a geotechnical investigation for the proposed mixed use redevelopment to be located at 2 Robinson Avenue in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the investigation were to:

- ☐ Determine the subsoil and groundwater conditions at this site by means of boreholes.
- ☐ Provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect the design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as they are understood at the time of writing this report.

2.0 Proposed Development

Based our current understanding, the proposed development will consist of four multi-storey buildings constructed over a common one and/or two levels of underground parking along with at grade parking areas and access lanes. It is further understood that the existing building will be demolished as part of the proposed redevelopment. It’s expected that the site will be municipally serviced.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The initial field program for the geotechncial investigation was carried out between February 7 and February 15, 2019. During that time, a total of 13 boreholes were advanced to a maximum depth of 11.6 m below existing ground surface for environmental purposes. A supplemental geotechnical and environmental investigation was carried out between February 15 to February 24, 2022. During that time, a total of 10 boreholes were advanced to a maximum depth of 19.5 m and a total of 7 test pits were advanced to a maximum depth of 5.2 m. Furthermore, on November 9 and 10, 2022, a total of 3 boreholes were advanced to a maximum depth of 13.6 m below the existing ground surface to further delineate the bedrock surface on the southwest portion of the site.

The borehole locations were determined in the field by Paterson personnel and distributed in a manner to provide general coverage of the proposed development taking into consideration of existing site features and underground services. The locations of the boreholes are presented in Drawing PG4811-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were drilled using a track-mounted auger drill rig operated by a two person crew. The test pits were excavated using a hydraulic excavator. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer from our geotechnical department. The drilling procedure consisted of augering to the required depths at the selected locations and sampling the overburden.

Sampling and In Situ Testing

Soil samples from the boreholes were recovered from the auger flights, using a 50 mm diameter split-spoon sampler or using 47.6 mm inside diameter coring equipment. Grab samples of the soil were obtained from the test pits. All soil samples were initially classified on site, placed in sealed plastic bags and transported to our laboratory. The depths at which the auger, split spoon, rock core, and grab samples were recovered from the test holes are shown as, AU, SS, RC, and G, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

The Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split spoon samples. The SPT results are recorded as “N” values on the Soil Profile and Test Data sheets. The “N” value is the number of blows required to drive the split spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

Dynamic cone penetration testing (DCPT) was conducted at BH 2A, BH 5 and BH 11 during our field investigation. The DCPT consists of driving a steel rod, equipped with a 50 mm diameter cone at its tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment of penetration.

The recovery value and a Rock Quality Designation (RQD) value were calculated for each drilled section of bedrock and are presented on the borehole logs. The recovery value is the length of the bedrock sample recovered over the length of the drilled section. The RQD value is the total length of intact rock pieces longer than 100 mm over the length of the core run. The values indicate the bedrock quality.

The subsurface conditions observed in the boreholes were recorded in detail in the field. The soil profiles are logged on the Soil Profile and Test Data sheets presented in Appendix 1 of this report.

Groundwater

Groundwater monitoring wells consisting of 51 mm diameter PVC were installed in BH 2A, BH 4, BH 6, BH 10, BH 11 and BH 12 to permit monitoring of the groundwater levels subsequent to the completion of the sampling program. Groundwater monitoring wells were installed in boreholes BH 1-22, BH 2-22, BH 3-22, BH 6-22, BH 7A-22, BH 8-22, BH 9-22, and BH 10-22 during the supplemental investigation. Furthermore, polytube piezometers were installed in BH 11-22, BH 12-22, and BH 13-22 during the most recent investigation.

3.2 Field Survey

The test hole locations were determined in the field by Paterson personnel with consideration of underground utilities and existing site features. The location each borehole location are presented on Drawing PG4811-1 - Test Hole Location Plan in Appendix 2.

Borehole surface elevations were extrapolated from an existing topographical survey during the initial investigation. Borehole and test pit locations and ground surface elevations at each test hole location were surveyed by Paterson using a handheld GPS and referenced to a geodetic datum for the current investigation.

3.3 Laboratory Testing

All samples from the current investigation will be stored in the laboratory for a period of one month after issuance of this report. They will then be discarded unless we are otherwise directed.

4.0 Observations

4.1 Surface Conditions

The west portion of the site along Lees Avenue is flat and was previously occupied by a vacant two storey building and an unpaved parking lot with associated access lanes and lighting. The building was recently demolished. The parking lot is slightly below grade from Lees Avenue.

The east portion of the site is significantly elevated along Chapel Street and slopes down towards Lees Avenue and the existing building. This portion is landscaped and has a treed area in front of the existing building. Also, a paved access lane from Lees Avenue borders the front of the building.

4.2 Subsurface Profile

Overburden

Generally, the subsoil profile encountered at the borehole locations consists of a brown sandy silty fill overlying a native silty sand or glacial till layer. The fill layer was found to extend as deep as 11.7 m below existing ground surface. The fine matrix of the glacial till deposit was noted to consist of a brown silty sand with clay, gravel, cobbles and boulders. A layer of coal was found underlying the sandy fill in the east portion of the site in Boreholes BH1, BH2A, BH3, BH4 and BH5. A layer of peat was found underlying the fill in boreholes BH10 and BH11.

Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for the details of the soil profiles encountered at each borehole location.

Bedrock

Practical refusal to DCPT was encountered at depths varying between 10.2 m to 11.6 m depth at BH 2A, BH 5, and BH 11. During the 2022 investigations, a fair to excellent quality shale interbedded with limestone bedrock was encountered at depths ranging from 10.1 to 18.0 m depth below the existing ground surface.

Based on available geological mapping, bedrock in the area of the subject site consists of shale of the Carlsbad Formation. The overburden drift thickness is estimated to be between 10 and 15 m depth.

4.3 Groundwater

Groundwater levels were measured in the monitoring wells installed in the boreholes upon completion of the sampling program. The groundwater level readings are presented in Table 1.

The long term groundwater level is estimated to be within the silty sand deposit or within the glacial till. The elevated embankment is contributing to a localized elevated groundwater which is most likely perched in the fill layer. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could be higher at the time of construction.

Table 1 - Summary of Groundwater Levels

Borehole Number	Measured Groundwater Depth (m)	Recording Date
BH 2A	3.40	February 22. 2019
BH 4	9.60	February 22. 2019
BH 6	7.40	February 22. 2019
BH 10	3.10	February 22. 2019
BH 11	3.60	February 22. 2019
BH 12	3.50	February 22. 2019
BH 1-22	7.56	March 8, 2022
BH 2-22	10.67	March 8, 2022
BH 3-22	2.77	March 8, 2022
BH 6-22	Dry	March 3, 2022
BH 7A-22	7.51	March 3, 2022
BH 8-22	8.77	March 2, 2022
BH 9-22	3.93	March 3, 2022
BH 10-22	6.85	March 8, 2022
BH 11-22	4.65	November 18, 2022
BH 12-22	4.94	November 18, 2022
BH 13-22	4.16	November 18, 2022

Notes:
Monitoring wells installed with 51 mm tubing for sampling in BH 1-22 to BH 3-22, BH 6-22 to BH 10-22.
Polytube piezometers installed in BH11-22, BH 12-22, and BH 13-22.

Hydraulic Conductivity Testing

Following the completion of the slug testing, the test data was analyzed as per the method set out by Hvorslev (1951). Assumptions inherent in the Hvorslev method include a homogeneous and isotropic aquifer of infinite extent with zero-storage assumption, and a screen length significantly greater than the monitoring well diameter. The assumption regarding aquifer storage is considered to be appropriate for groundwater flow through the overburden aquifer. The assumption regarding screen length and well diameter is considered to be met based on a screen length of 1.5 to 3 m and a diameter of 0.03 to 0.05 m.

While the idealized assumptions regarding aquifer extent, homogeneity, and isotropy are not strictly met in this case (or in any real-world situation), it has been our experience that the Hvorslev method produces effective point estimates of hydraulic conductivity in conditions similar to those encountered at the subject site. Hvorslev analysis is based on the line of best fit through the field data (hydraulic head recovery vs. time), plotted on a semi-logarithmic scale. In cases where the initial hydraulic head displacement is known with relative certainty, such as in this case where a physical slug has been introduced, the line of best fit is considered to pass through the origin.

Based on the above test methods, the glacial till yielded hydraulic conductivity values ranging between **1.3×10^{-8} and 3.3×10^{-4} m/sec**, while silty sand ranged between **1×10^{-6} and 1.5×10^{-6} m/sec**. Hydraulic conductivity testing of the bedrock varied between **1.1×10^{-6} and 5.9×10^{-7} m/sec**. The values measured within the monitoring wells are generally consistent with similar material, Paterson has encountered on other sites and typical published values for glacial till, silty sand and bedrock. These values typically range from 1×10^{-5} to 1×10^{-10} m/sec for glacial till, 1×10^{-4} to 1×10^{-6} m/sec for silty sand and 1×10^{-6} to 1×10^{-10} m/sec for bedrock. The range in hydraulic conductivity values is due to the variability in the composition and compactness of the glacial till as well as silty sand, and quality of the bedrock. The results of the hydraulic conductivity testing are presented in Appendix 1.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered satisfactory for the proposed redevelopment. It is expected that lighter structures will be founded on conventional shallow foundations placed on native undisturbed compact to dense glacial till or silty sand. The foundation for higher and heavier buildings is expected to consist of either:

- ☐ a raft foundation placed on native undisturbed compact to dense glacial till, or
- ☐ footings founded directly or indirectly on the bedrock. The garage structure extending beyond the building footprint can be founded on spread footings, or
- ☐ a deep foundation, such as end-bearing piles, which extends to the bedrock surface.

The foundations will require the excavation to extend below the fill layer since portions of the fill is environmentally impacted due to the former operations. The layer of peat below the fill will have to be removed below building footprints. Consideration should be given for two levels of underground parking due to the thickness of the fill layer and should extend to bedrock for the heavier structures.

The above and other considerations are further discussed in the following sections.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil, asphalt, organic, unapproved fill and all deleterious material should be removed from within the perimeter of the proposed building and other settlement sensitive structures. Foundation walls, underground services, and other construction debris should be entirely removed from within the perimeter of the buildings. Under paved areas, existing construction remnants, such as foundation walls, pipe ducts, etc., should be excavated to a minimum depth of 1 m below final grade.

Compacted Granular Fill Working Platform (Pile Foundation)

Should the proposed high-rise building be supported on a driven pile foundation, the use of heavy equipment would be required to install the piles (i.e. pile driving crane). It is conventional practice to install a compacted granular fill layer, at a convenient elevation, to allow the equipment to access the site without getting stuck and causing significant disturbance.

A typical working platform could consist of 0.6 m of OPSS Granular B, Type II crushed stone which is placed and compacted to a minimum of 98% of its standard Proctor maximum dry density (SPMDD) in lifts not exceeding 300 mm in thickness.

Once the piles have been driven and cut off, the working platform can be regraded, and soil tracked in, or soil pumping up from the pile installation locations, can be bladed off and the surface can be topped up, if necessary, and re-compacted to act as the substrate for further fill placement for the basement slab.

Protection of Subgrade (Raft Foundation)

Where a raft foundation is utilized, it is recommended that a minimum 50 mm thick lean concrete mud slab be placed on the undisturbed glacial till subgrade shortly after the completion of the excavation. The main purpose of the mud slab is to reduce the risk of disturbance of the subgrade under the traffic of workers and equipment.

The final excavation to the raft bearing surface level and the placing of the mud slab should be done in smaller sections to avoid exposing large areas of the glacial till to potential disturbance due to drying.

Fill Placement

Fill used for grading beneath the proposed building, should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building and paved areas should be compacted to at least 98% of the material's standard Proctor maximum dry density (SPMDD).

Clean non-specified existing fill, along with clean site-excavated soil, can be used as general landscaping fill where settlement of the ground surface is of minor concern. This material should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If this material is to be used to build up the subgrade level for areas to be paved, it should be compacted in thin lifts to at least 95% of the material's SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless used in conjunction with a composite drainage membrane.

5.3 Foundation Design

Conventional Shallow Foundation

The bearing resistance values are provided on the assumption that the footings will be placed on bearing surfaces consisting of native undisturbed soil. The bearing surfaces should be free of fill, topsoil, surface water and deleterious materials, such as loose, frozen or disturbed soil prior to placing concrete.

Table 2 - Bearing Resistance Values at Limit States

Founding Layer	Bearing Resistance Value at SLS (kPa)	Factored Bearing Resistance Value at ULS (kPa)
Compact silty sand	125	200
Compact glacial till	250	400
Dense glacial till	300	500
Weathered bedrock surface	1500	3000

Note:
- SLS – Serviceability Limit States
- ULS – Ultimate Limit States
- A geotechnical resistance factor of 0.5 was applied to the bearing resistance value at ULS.

The SLS values are based on a total settlement of 25 mm, and a differential settlement of 20 mm between adjacent footings, both founded on a similar bearing medium.

For areas where fill is encountered below design underside of footing level, lean concrete (minimum 15 MPa) in-filled trenches could be used to extend footings to an approved bearing surface. Near vertical, zero entry trenches extending at least 150 mm wider than the proposed footing face should be extended through the fill to an approved bearing surface. The bearing surface should be inspected by Paterson personnel and in-filled with a lean concrete to design underside of footing level.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a stiff silty clay or glacial till bearing medium when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V, passes only through in situ soil or engineered fill of the same or higher capacity as the soil.

Raft Foundation

Alternatively, consideration can be given to a raft foundation if the building loads exceed the bearing resistance values provided for a conventional shallow footing foundation. For preliminary design purposes, the following parameters may be used for the raft design, which will dependent on the founding elevation.

The amount of settlement of the raft slab will be dependent on the sustained raft contact pressure. The bearing resistance value at SLS (contact pressure) of **250 kPa** can be used for design purposes on the glacial till deposit. The loading conditions for the contact pressure are based on sustained loads, that are generally taken to be 100% Dead Load and 50% Live Load. The contact pressure provided considers the stress relief associated with the soil removal associated with one underground parking level. The factored bearing resistance (contact pressure) at ULS can be taken as **500 kPa**. A geotechnical resistance factor of 0.5 was applied to the bearing resistance value at ULS.

Based on the following assumptions for the raft foundation, the proposed building can be designed using the above parameters with a total and differential settlement of 25 and 15 mm, respectively.

Modulus of Subgrade Reaction

Typical values of subgrade modulus for a compact and dense glacial till are provided in Table 3.

Table 3 - Modulus of Subgrade Reaction

Soil Type	Modulus of Soil Reaction (MPa/m)
Compact glacial till	30
Dense glacial till	40

End Bearing Pile Foundation

If the raft slab bearing resistance values are insufficient for the proposed high-rise buildings, a deep foundation system driven to refusal in the bedrock will be recommended for foundation support of the proposed buildings. For deep foundations, concrete-filled steel pipe piles are generally utilized in the Ottawa area. Applicable pile resistance values at SLS and ULS are given in Table 4. A resistance factor of 0.4 has been incorporated into the factored ULS values. Note that these are all geotechnical axial resistance values.

The geotechnical pile resistance values were estimated using the Hiley dynamic formula, to be confirmed during pile installation with a program of dynamic monitoring. Re-striking of all piles at least once will also be required after at least 48 hours have elapsed since initial driving.

Table 4 - Pile Foundation Design Data

Pile Outside Diameter (mm)	Pile Wall Thickness (mm)	Geotechnical Axial Resistance		Final Set (blows/12 mm)	Transferred Hammer Energy (kJ)
		SLS (kN)	Factored at ULS (kN)		
245	9	940	1130	10	29
245	11	1175	1410	10	35
245	13	1375	1650	10	42

The minimum centre-to-centre pile spacing is 2.5 times the pile diameter. The closer the piles are spaced, however, the more potential that the driving of subsequent piles in a group could have influence on piles in the group that have already been driven. These effects, primarily consisting of uplift of previously driven piles, are checked as part of the field review of the pile driving operations.

Prior to the commencement of production pile driving, a limited number of indicator piles should be installed across the site. It is recommended that each indicator pile be dynamically load tested to evaluate pile stresses, hammer efficiency, pile load transfer, and end-of-driving criteria for end-bearing in the bedrock.

Buildings founded on piles driven to refusal in the bedrock will have negligible post-construction settlement.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class C or Class D** based on the founding elevation for the foundations considered at this site. Buildings founded directly on bedrock (conventional footings) can use a **Class A** seismic site classification. If a higher seismic site class is required, a site specific shear wave velocity test may be completed to accurately determine the applicable seismic site classification for foundation design of the proposed building, as presented in Table 4.1.8.4.A of the Ontario Building Code (OBC) 2012.

The subsoil at the subject site is not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code 2012 for a full discussion of the earthquake design requirements.

5.5 Basement Floor Slab

The native soil or approved fill surface will be considered to be an acceptable subgrade surface on which to commence backfilling for floor slab construction. Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular B Type II is recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-slab fill consist of 19 mm clear crushed stone for the basement floor slab used for finished space. In consideration of the groundwater conditions encountered during the investigation, a subfloor drainage system, consisting of lines of perforated drainage pipe subdrains connected to a positive outlet, should be provided in the clear stone backfill under the lower basement floor.

5.6 Basement Wall

There are several combinations of backfill materials and retained soils that could be applicable for the basement walls of the subject structure. However, the conditions can be well-represented by assuming the retained soil consists of a material with an angle of internal friction 30 degrees and a bulk (drained) unit weight of 20 kN/m^3.

However, undrained conditions are anticipated (i.e. below the groundwater level). Therefore, the applicable effective (undrained) unit weight of the retained soil can be taken as 13 kN/m^3, where applicable. A hydrostatic pressure should be added to the total static earth pressure when using the effective unit weight.

Lateral Earth Pressures

The static horizontal earth pressure (p_o) can be calculated using a triangular earth pressure distribution equal to $K_o \cdot \gamma \cdot H$ where:

K_o = at-rest earth pressure coefficient of the applicable retained soil (0.5)
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m)

An additional pressure having a magnitude equal to $K_o \cdot q$ and acting on the entire height of the wall should be added to the above diagram for any surcharge loading, q (kPa), that may be placed at ground surface adjacent to the wall. The surcharge pressure will only be applicable for static analyses and should not be used in conjunction with the seismic loading case.

Actual earth pressures could be higher than the “at-rest” case if care is not exercised during the compaction of the backfill materials to maintain a minimum separation of 0.3 m from the walls with the compaction equipment.

Seismic Earth Pressures

The total seismic force (P_{AE}) includes both the earth force component (P_o) and the seismic component (ΔP_{AE}). The seismic earth force (ΔP_{AE}) can be calculated using $0.375 \cdot a_c \cdot \gamma \cdot H^2/g$ where:

a_c = $(1.45 - a_{max}/g)a_{max}$
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m)
g = gravity, 9.81 m/s^2

The peak ground acceleration, (a_{max}), for the Ottawa area is 0.32g according to OBC 2012. Note that the vertical seismic coefficient is assumed to be zero. The earth force component (P_o) under seismic conditions can be calculated using $P_o = 0.5\ K_o\ \gamma\ H^2$, where $K_o = 0.5$ for the soil conditions noted above.

The total earth force (P_{AE}) is considered to act at a height, h (m), from the base of the wall, where:

$$h = \{P_o \cdot (H/3) + \Delta P_{AE} \cdot (0.6 \cdot H)\}/P_{AE}$$

The earth forces calculated are unfactored. For the ULS case, the earth loads should be factored as live loads, as per OBC 2012.

5.7 Pavement Structure

Car only parking and heavy truck parking areas, and access lanes may be required at this site. The proposed pavement structures are presented in Tables 6, 7, and 8.

Table 5 - Recommended Pavement Structure - Car Only Parking Areas

Thickness (mm)	Material Description
50	Wear Course - HL-3 or Superpave 12.5 Asphaltic Concrete
150	BASE - OPSS Granular A Crushed Stone
300	SUBBASE - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil, or OPSS Granular B Type I or II material placed over in situ soil or fill	

Table 6 - Recommended Pavement Structure - Access Lanes and Heavy Truck Parking Areas

Thickness (mm)	Material Description
40	Wear Course - HL-3 or Superpave 12.5 Asphaltic Concrete
50	Binder Course - HL-8 or Superpave 19.0 Asphaltic Concrete
150	BASE - OPSS Granular A Crushed Stone
450	SUBBASE - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil, or OPSS Granular B Type I or II material placed over in situ soil or fill	

Table 7 - Recommended Rigid Pavement Structure - Car Only Parking Areas

Thickness (mm)	Material Description
125	Wear Course **-** Concrete slab
300	BASE - OPSS Granular A Crushed Stone
SUBGRADE - Either fill, in situ soil, or OPSS Granular B Type I or II material placed over in situ soil or fill	

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project. If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the material’s SPMDD using suitable vibratory equipment.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

It is recommended that a perimeter foundation drainage system be provided for all the proposed structures. The system should consist of a 150 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 19 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer. A waterproofing system should be provided to the second basement level for the proposed buildings, if applicable, and elevator pit (pit bottom and walls). A composite drainage system is recommended to be installed against the proposed building foundation walls to provide an outlet for any water that by-passes the waterproofing membrane layer to be installed against the shoring face to limit dewatering of the supported soils.

Foundation Backfill

Backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should be used for this purpose. A composite drainage system should be applied to the exterior of the building foundation walls in order to minimize the risk of groundwater infiltration from the backfill materials.

Alternatively, where foundation walls are to be formed against a temporary shoring system, the following is recommended. A composite drainage system should be fastened to the shoring face or waterproofing membrane (second basement level only) to allow for a blind sided foundation wall pour. It is recommended that 150 mm diameter sleeves at 3 m centres be cast in the footing or at the foundation wall/footing interface to allow the infiltration of water to flow to the interior perimeter drainage pipe. An interior perimeter drainage consisting of a minimum 150 mm diameter perforated, corrugated PVC pipe be placed along the interior side of the exterior footing. The perimeter drainage pipe and underfloor drainage system should direct water to sump pit(s) within the lower basement area.

Underfloor Drainage

It is anticipated that underfloor drainage will be required to control water infiltration. For design purposes, we recommend that 150 mm diameter perforated pipes be placed at each bay. The spacing of the underfloor drainage system should be confirmed at the time of completing the excavation when water infiltration can be better assessed.

6.2 Protection of Footings Against Frost Action

Perimeter footings, pile caps and grade beams of heated structures are required to be insulated against the deleterious effect of frost action. A minimum of 1.5 m of soil cover alone, or a minimum of 0.6 m of soil cover, in conjunction with foundation insulation, should be provided in this regard.

Other exterior unheated footings, pile caps or grade beams, such as those for isolated exterior piers, are more prone to deleterious movement associated with frost action than the exterior walls of the structure proper and require additional protection, such as soil cover of 2.1 m or a combination of soil cover and foundation insulation.

6.3 Excavation Side Slopes

At this site, temporary shoring may be required to complete the required excavations. However, it is recommended that where sufficient room is available open cut excavation in combination with temporary shoring can be used.

Excavation Side Slopes

The subsoil at this site is considered to be mainly a Type 2 or 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects. The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below the groundwater level.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides. Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

It is recommended that a trench box be used at all times to protect personnel working in trenches with steep or vertical sides. It is expected that services will be installed by “cut and cover” methods and excavations will not be left open for extended periods of time.

Temporary Shoring

Temporary shoring may be required for the overburden soil to complete the required excavations where insufficient room is available for open cut methods. The shoring requirements will depend on the depth of the excavation, the proximity of the adjacent buildings and underground structures and the elevation of the adjacent building foundations and underground services.

The design and approval of the shoring system will be the responsibility of the shoring contractor and the shoring designer hired by the shoring contractor. It is the responsibility of the shoring contractor to ensure that the temporary shoring is in compliance with safety requirements, designed to avoid any damage to adjacent structures and include dewatering control measures. In the event that subsurface conditions differ from the approved design during the actual installation, it is the responsibility of the shoring contractor to commission the required experts to re-assess the design and implement the required changes. Furthermore, the design of the temporary shoring system should take into consideration, a full hydrostatic condition which can occur during significant precipitation events.

Due to the boulders and cobbles within the glacial till deposit, the temporary system could consist of soldier pile and lagging system. Any additional loading due to street traffic, construction equipment, adjacent structures and facilities, etc., should be included to the earth pressures described below. These systems could be cantilevered, anchored or braced. Generally, the shoring systems should be provided with tie-back rock anchors to ensure their stability. The shoring system is recommended to be adequately supported to resist toe failure, if required, by means of rock bolts or extending the piles into the bedrock through pre-augered holes if a soldier pile and lagging system is the preferred method.

The earth pressures acting on the shoring system may be calculated using the following parameters.

Table 8 - Soil Parameters for Shoring System Design

Parameters	Values
Active Earth Pressure Coefficient (K_a)	0.33
Passive Earth Pressure Coefficient (K_p)	3
At-Rest Earth Pressure Coefficient (K_o)	0.5
Unit Weight (γ), kN/m^3	20
Submerged Unit Weight (γ), kN/m^3	13

The geotechnical design of grouted rock anchors in sedimentary bedrock is based upon two possible failure modes. The anchor can fail either by shear failure along the grout/rock interface or by pullout of a 60 to 90 degree cone of rock with the apex of the cone near the middle of the bonded length of the anchor.

The anchor derives its capacity from the bonded portion, or fixed anchor length, at the base of the anchor. An unbonded portion, or free anchor length, is also usually provided between the rock surface and the start of the bonded length. A factored tensile grout to rock bond resistance value at ULS of **1.0 MPa**, incorporating a resistance factor of 0.3, can be used. A minimum grout strength of 40 MPa is recommended.

It is recommended that the anchor drill hole diameter be within 1.5 to 2 times the rock anchor tendon diameter and the anchor drill holes be inspected by geotechnical personnel and should be flushed clean prior to grouting. The use of a grout tube to place grout from the bottom up in the anchor holes is further recommended.

The geotechnical capacity of each rock anchor should be proof tested at the time of construction. More information on testing can be provided upon request. Compressive strength testing is recommended to be completed for the rock anchor grout. A set of grout cubes should be tested for each day grout is prepared.

Soldier Pile and Lagging System

The active earth pressure acting on a soldier pile and timber lagging shoring system can be calculated using a rectangular earth pressure distribution with a maximum pressure of 0.65 K γ H for strutted or anchored shoring or a triangular earth pressure distribution with a maximum value of K γ H for a cantilever shoring system. H is the height of the excavation.

The active earth pressure should be used where wall movements are permissible while the at-rest pressure should be used if no movement is permissible.

The total unit weight should be used above the groundwater level while the submerged unit weight should be used below the groundwater level.

The hydrostatic groundwater pressure should be added to the earth pressure distribution wherever the submerged unit weights are used for earth pressure calculations should the level on the groundwater not be lowered below the bottom of the excavation. If the groundwater level is lowered, the total unit weight for the soil should be used full weight, with no hydrostatic groundwater pressure component.

6.4 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance with the most recent Material Specifications and Standard Detail Drawings from the Department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa.

At least 150 mm of OPSS Granular A should be used for pipe bedding for sewer and water pipes. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe should consist of OPSS Granular A or Granular B Type II with a maximum size of 25 mm. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to 95% of the material's standard Proctor maximum dry density.

It should generally be possible to re-use the site materials above the cover material if the operations are carried out in dry weather conditions.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) and above the cover material should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 225 mm thick loose lifts and compacted to a minimum of 95% of the material standard Proctor maximum dry density.

6.5 Groundwater Control

Groundwater Control for Building Construction

It is anticipated that groundwater infiltration into the excavations should be moderate and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of the excavation. The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum 4 to 5 months should be allowed for completion of the Category 3 PTTW application package and issuance of the permit by the MECP.

For typical ground or surface water volumes being pumped during the construction phase, typically between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

Impacts on Neighbouring Properties

Based on the existing groundwater level, the extent of any significant groundwater lowering will take place within a limited range of the proposed building. Based on the proximity of neighbouring buildings and minimal zone impacted by the groundwater lowering, the proposed development will not negatively impact the neighbouring structures. It should be noted that no issues are expected with respect to groundwater lowering that would cause long term adverse effects to adjacent structures surrounding the proposed building.

6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project. The subsoil conditions at this site mostly consist of frost susceptible materials. In presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters and tarpaulins or other suitable means. In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

The trench excavations should be carried out in a manner to avoid the introduction of frozen materials, snow or ice into the trenches. Precaution must be taken where excavations are carried in proximity of existing structures which may be adversely affected due to the freezing conditions. In particular, it should be recognized that where a shoring system is used, the soil behind the shoring system will be subjected to freezing conditions and could result in heaving of the structure(s) placed within or above frozen soil. Provisions should be made in the contract document to protect the walls of the excavations from freezing, if applicable.

6.7 Slope Stability Assessment

A slope stability assessment has been conducted to determine the geotechnical stability for the current slope conditions within the subject site.

One slope cross-section (Section A) was studied for the slope at the site under static and seismic conditions based on existing grades presented on the provided site plan and borehole data collected from the geotechnical investigation. The cross-section location is presented on Drawing PG4811-1 - Test Hole Location Plan which is included in Appendix 2. The analysis is discussed further below.

Slope Stability Analysis

The analysis of the stability of the slope was carried out using SLIDE, a computer program which permits a two-dimensional slope stability analysis using several methods including the Bishop's simplified method, which is a widely used and accepted analysis method. The program calculates a factor of safety, which represents the ratio of the forces resisting failure to those favouring failure. Theoretically, a factor of safety of 1.0 represents a condition where the slope is marginally stable. However, due to intrinsic limitations of the calculation methods and the variability of the subsoil and groundwater conditions, a factor of safety greater than one is usually required to ascertain that the risks of failure are acceptable.

Static Loading Analysis

A minimum factor of safety of 1.5 is generally recommended for static conditions where the failure of the slope would endanger permanent structures.

The slope stability analysis for static conditions was completed at the slope cross-section under a conservative scenario.

The results of the static analysis at Section A are shown on the attached Figure 2 in Appendix 2. The results indicate that the factor of safety exceeds 1.5 and is considered acceptable from a geotechnical perspective.

Seismic Loading Analysis

An analysis considering seismic loading for the proposed site conditions was also completed at Section A. A horizontal seismic coefficient of 0.16 g was considered for the slope. A factor of safety of 1.1 is considered to be satisfactory for stability analyses including seismic loading.

The results of the seismic analysis for Section A is shown on Figure 3 in Appendix 2. The results indicate that the factor of safety exceeds 1.1 and is considered acceptable from a geotechnical perspective.

Slope Maintenance Recommendations

In order to maintain the slope against surficial erosion over the long run, it is recommended that the slope face be topped with a minimum 150 mm thick layer of topsoil with a mix of hardy grass seed. If a different finish is proposed for the slope face, it is highly recommended that a drainage outlet be allocated within the slope area to drain the surface water runoff away from the bottom of the slope.

6.8 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of an aggressive to very aggressive corrosive environment.

7.0 Recommendations

A materials testing and observation services program is a requirement for the provided foundation design data to be applicable. The following aspects of the program should be performed by the geotechnical consultant:

- ☐ Once the final design is available, Paterson would review the proposed foundations and determine if additional boreholes are required due to data gaps.
- ☐ Review of the geotechnical aspects of the excavating contractor's shoring design, prior to construction.
- ☐ Observation of all bearing surfaces prior to the placement of concrete.
- ☐ Review of all pile driving operations, where applicable.
- ☐ Sampling and testing of the concrete and fill materials used.
- ☐ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- ☐ Observation of all subgrades prior to backfilling.
- ☐ Field density tests to determine the level of compaction achieved.
- ☐ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued, upon request, following the completion of a satisfactory materials testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review the grading plan once available and our recommendations when the drawings and specifications are complete.

A preliminary geotechnical investigation of this nature is a limited sampling of a site. The recommendations are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around the test locations. The extent of the limited area depends on the soil, bedrock and groundwater conditions, as well the history of the site reflecting natural, construction, and other activities. Should any conditions at the site be encountered which differ from those at the test locations, we request notification immediately in order to permit reassessment of our recommendations.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than 2 Robinson Property Limited Partnership or their agent(s) is not authorized without review by Paterson Group for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
Jan. 5, 2023
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

Nicole R.L. Patey, B.Eng.

David J. Gilbert, P.Eng.

Report Distribution

- ❑ 2 Robinson Property Limited Partnership
- ❑ Paterson Group

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

HYDRAULIC CONDUCTIVITY RESULTS

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE February 16, 2022

FILE NO. PG4811

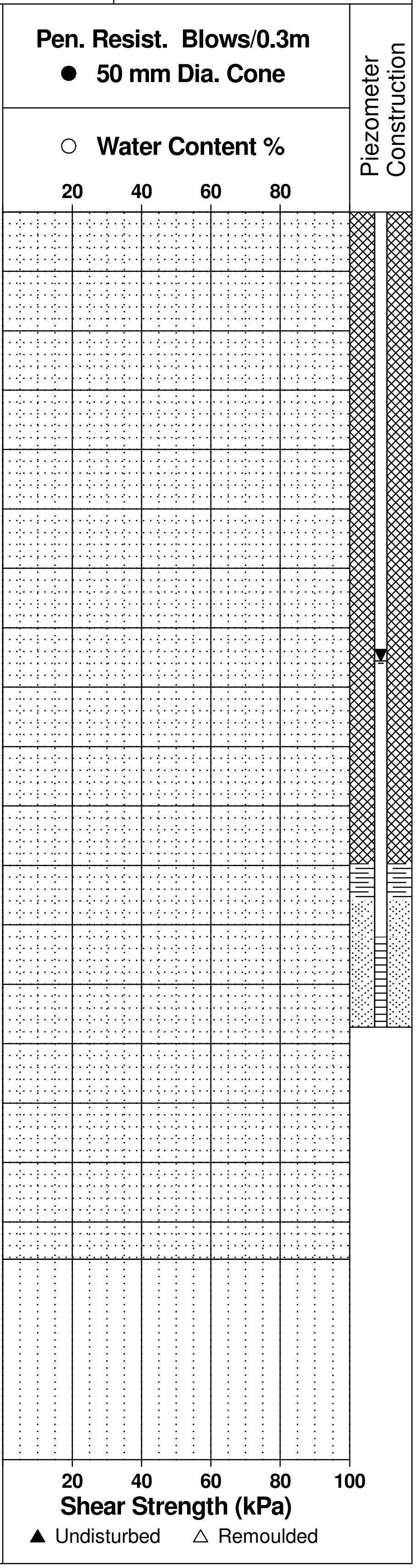
HOLE NO. BH 1-22

SOIL DESCRIPTION	Depth (m)
GROUND SURFACE	
FILL: Brown silty sand with gravel, trace clay	0.61
FILL: Dark brown silty sand to sandy silt with clay, gravel, trace cobbles	1.45
FILL: Grey silty clay, trace sand	1.83
FILL: Brown silty sand	2.29
FILL: Brown to grey silty sand to sandy silt some clay, gravel, trace cobbles	4.50
FILL: Brown silty sand with gravel, trace topsoil	6.40
FILL: Grey silty sand	7.92
Compact, grey **SILTY SAND** to **SANDY SILT**	10.67
GLACIAL TILL: Grey silty sand to sandy silt with gravel, cobbles and boulders	14.48
BEDROCK: Excellent quality, dark grey shale interbedded with grey limestone	17.63
End of Borehole	

(GWL @ 7.56m - March 8, 2022)

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	75	22
SS	3	75	18
G	4	96	29
SS	5	83	7
SS	6	83	22
SS	7	83	14
SS	8	88	31
SS	9	83	42
SS	10	83	33
SS	11	79	23
SS	12	92	39
SS	13	71	13
SS	14	71	22
SS	15	63	63
SS	16	67	50
SS	17	75	37
SS	18	83	71
SS	19	25	50
RC	1	100	100
RC	2	100	95
RC	3	100	95

DEPTH (m)	ELEV. (m)
0	65.49
1	64.49
2	63.49
3	62.49
4	61.49
5	60.49
6	59.49
7	58.49
8	57.49
9	56.49
10	55.49
11	54.49
12	53.49
13	52.49
14	51.49
15	50.49
16	49.49
17	48.49



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE February 16, 2022

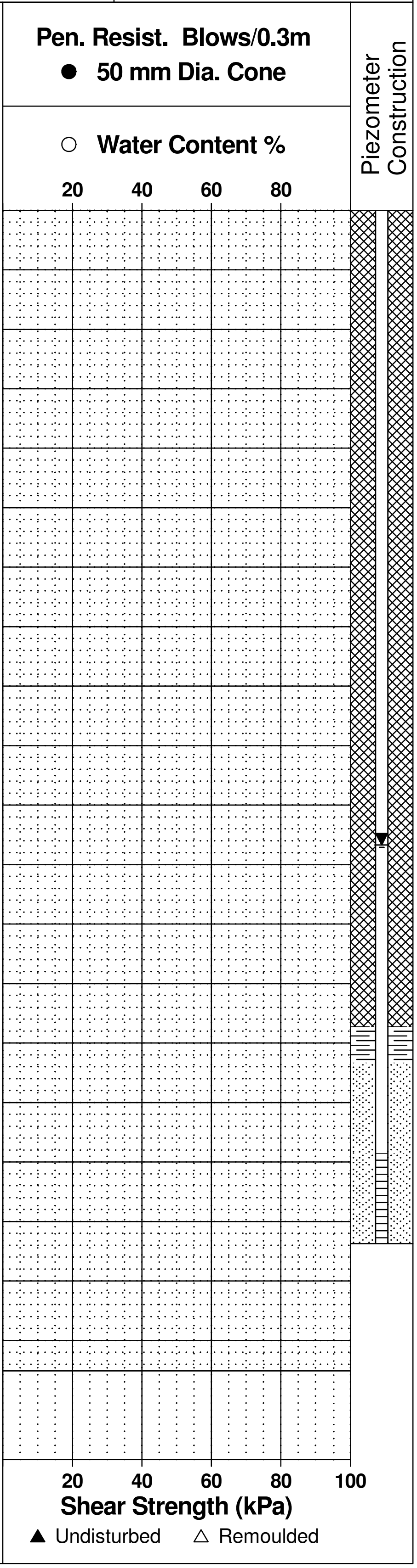
FILE NO. PG4811

HOLE NO. BH 2-22

SOIL DESCRIPTION	Depth (m)
GROUND SURFACE	
FILL: Brown silty sand trace organics	0.61
FILL: Brown silty clay some sand and gravel	4.11
FILL: Brown silty sand, some crushed stone and gravel	11.74
GLACIAL TILL: Very dense, grey silty sand to sandy silt with gravel, cobbles, rock fragments and boulders - shale fragments increasing with depth	17.98
BEDROCK: Fair to good quality dark grey interbedded shale with grey limestone	19.51
End of Borehole (GWL @ 10.67m - March 8, 2022)	

TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	58	9
SS	3	25	7
G	4	75	14
SS	5	75	35
SS	6	75	27
SS	7	63	50+
SS	8	75	69
SS	9	83	62
SS	10	42	50+
RC	1	76	
RC	2	50	
RC	3	100	47

DEPTH (m)	ELEV. (m)
0	68.66
1	67.66
2	66.66
3	65.66
4	64.66
5	63.66
6	62.66
7	61.66
8	60.66
9	59.66
10	58.66
11	57.66
12	56.66
13	55.66
14	54.66
15	53.66
16	52.66
17	51.66
18	50.66
19	49.66



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE February 17, 2022

FILE NO. PG4811

HOLE NO. BH 3-22

SOIL DESCRIPTION	
GROUND SURFACE	
FILL: Brown silty sand with crushed stone and gravel	0.91
FILL: Brown silty sand with gravel and trace clay	2.59
FILL: Compact brown to grey silty sand	3.81
Compact, grey **SILTY SAND** to **SANDY SILT**	7.16
GLACIAL TILL: Compact, grey silty sand to sandy silt with gravel, cobbles, boulders and trace clay	10.72
BEDROCK: Excellent quality, dark grey shale interbedded with grey limestone	13.11
End of Borehole	
(GWL @ 2.77m - March 8, 2022)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	8	9
SS	3	63	7
G	4	75	17
SS	5	83	28
SS	6	83	35
SS	7	83	54
SS	8	17	50+
RC	1	100	86
RC	2	100	93

DEPTH (m)	ELEV. (m)
0	62.44
1	61.44
2	60.44
3	59.44
4	58.44
5	57.44
6	56.44
7	55.44
8	54.44
9	53.44
10	52.44
11	51.44
12	50.44
13	49.44

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**

○ **Water Content %**

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

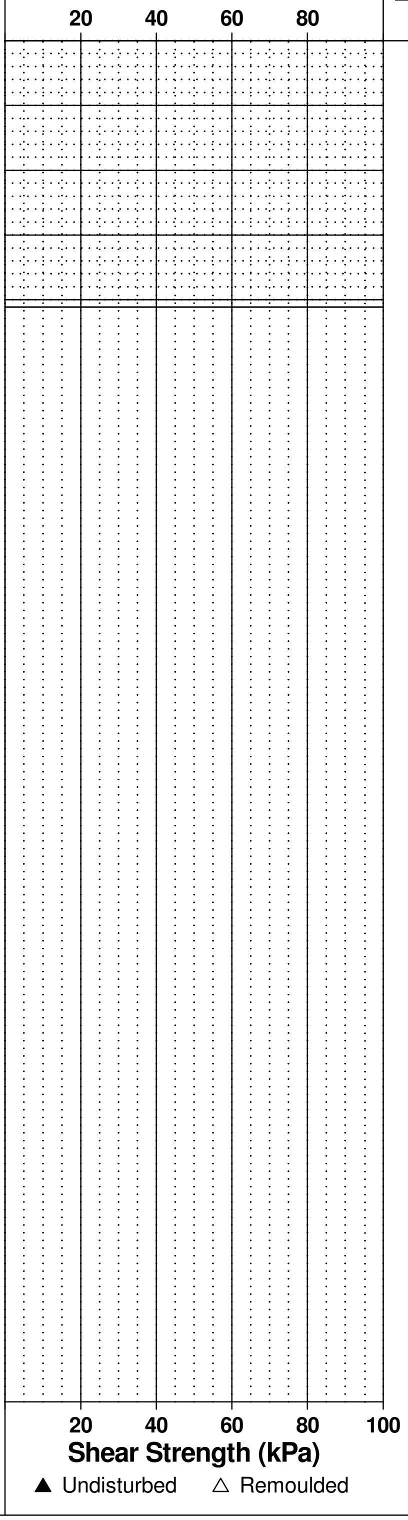
BORINGS BY CME-55 Low Clearance Drill

DATE February 22, 2022

FILE NO. PG4811

HOLE NO. BH 4-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	66.81		
TOPSOIL 0.20									
						1	65.81		
FILL: Brown silty sand with gravel, crushed stone some clay						2	64.81		
						3	63.81		
		SS	1	25	24				
4.11		SS	2	33	50+	4	62.81		
End of Borehole Practical refusal to augering at 4.11m depth									



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE February 22, 2022

FILE NO. PG4811

HOLE NO. BH 4A-22

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.20
FILL: Brown silty sand with gravel, crushed stone some clay - increasing clay content with depth	5.18
FILL: Brown silty sand with gravel, crushed stone, trace clay	6.02
Dense to compact, brown **SILTY SAND** - some gravel by 7.6 m depth	8.53
GLACIAL TILL: Dense grey silty sand to sandy silt with gravel, cobbles and boulders	9.45

End of Borehole

Practical refusal to augering at 9.45m depth

TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	42	23
SS	2	25	9
SS	3	75	13
SS	4	75	49
SS	5	75	47
SS	6	50	28
SS	7	58	25
SS	8	50	50+

DEPTH (m)	ELEV. (m)
0	67.18
1	66.18
2	65.18
3	64.18
4	63.18
5	62.18
6	61.18
7	60.18
8	59.18
9	58.18

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers
9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

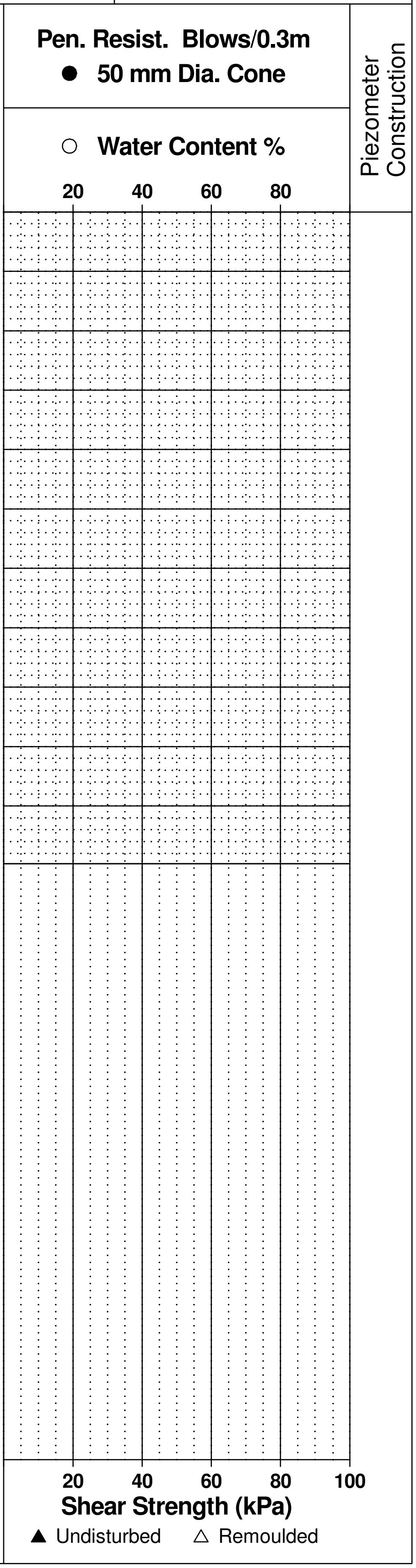
Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic
REMARKS
BORINGS BY CME-55 Low Clearance Drill
DATE February 22, 2022
FILE NO. PG4811
HOLE NO. BH 5-22

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.18
FILL: Brown silty sand with clay, gravel, some crushed stone - trace organics by 5.3m depth	6.02
Dense, brown **SILTY SAND** - trace gravel by 8.8 m depth	10.06
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders	10.97
End of Borehole Practical refusal to augering at 10.97m depth	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	50	14
SS	2	17	11
SS	3	8	12
SS	4	75	31
SS	5	50	31
SS	6	50	15
SS	7	63	31
SS	8	67	50+

DEPTH (m)	ELEV. (m)
0	68.67
1	67.67
2	66.67
3	65.67
4	64.67
5	63.67
6	62.67
7	61.67
8	60.67
9	59.67
10	58.67



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE February 22, 2022

FILE NO. PG4811

HOLE NO. BH 6-22

SOIL DESCRIPTION	
GROUND SURFACE	
TOPSOIL	0.18
FILL: Brown silty sand	5.18
FILL: Brown silty sand with gravel, trace concrete debris	7.54
Dense, grey **SILTY SAND** to **SANDY SILT** - some gravel and cobbles by 9.3 m depth	9.75
End of Borehole (BH dry - March 3, 2022)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	67	8
SS	2	75	6
SS	3	83	30
SS	4	67	27
SS	5	83	38
SS	6	75	80
SS	7	63	44
SS	8	67	45

DEPTH (m)	ELEV. (m)
0	68.61
1	67.61
2	66.61
3	65.61
4	64.61
5	63.61
6	62.61
7	61.61
8	60.61
9	59.61

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers
9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE February 23, 2022

FILE NO. PG4811

HOLE NO. BH 7-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	67.91		
TOPSOIL 0.30									
FILL: Grey silt clay with sand and gravel 2.49						1	66.91		
End of Borehole Practical refusal to augering at 2.49m depth						2	65.91		

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE February 23, 2022

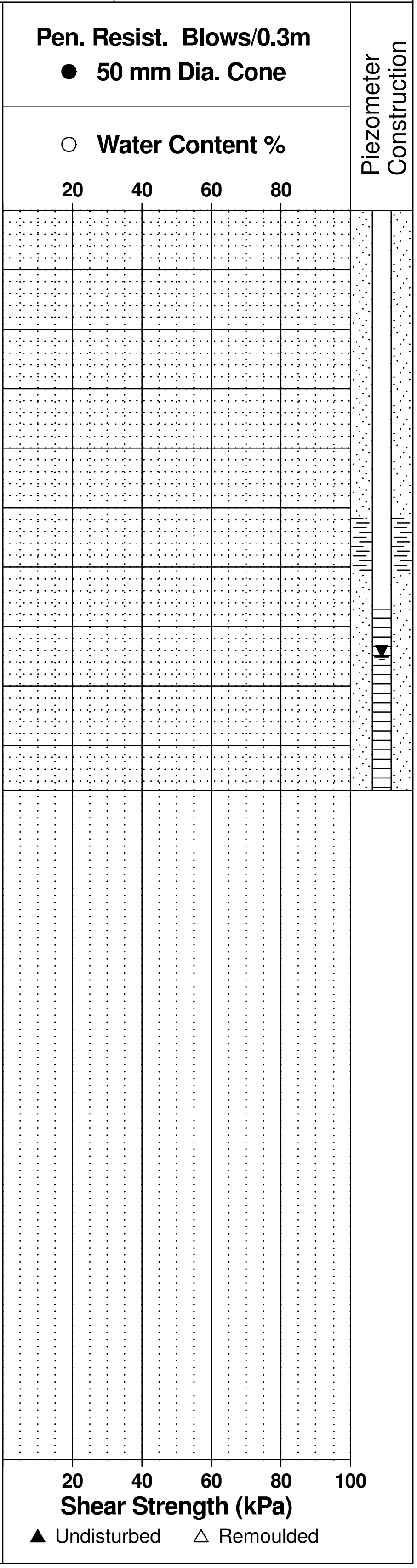
FILE NO. PG4811

HOLE NO. BH 7A-22

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.30
FILL: Grey silty clay with sand and gravel - increasing sand content with depth	5.33
FILL: Brown silty sand with gravel, trace clay	6.86
Very dense, brown **SILTY SAND,** trace gravel	7.62
Very dense, grey **SILTY SAND** to **SANDY SILT,** trace gravel	9.75
End of Borehole (GWL @ 7.51m - March 3, 2022)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	75	8
SS	2	67	8
SS	3	75	14
SS	4	75	39
SS	5	83	39
SS	6	83	50+
SS	7	83	53
SS	8	83	82
SS	9	83	58

DEPTH (m)	ELEV. (m)
0	67.56
1	66.56
2	65.56
3	64.56
4	63.56
5	62.56
6	61.56
7	60.56
8	59.56
9	58.56



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE February 23, 2022

FILE NO. PG4811

HOLE NO. BH 8-22

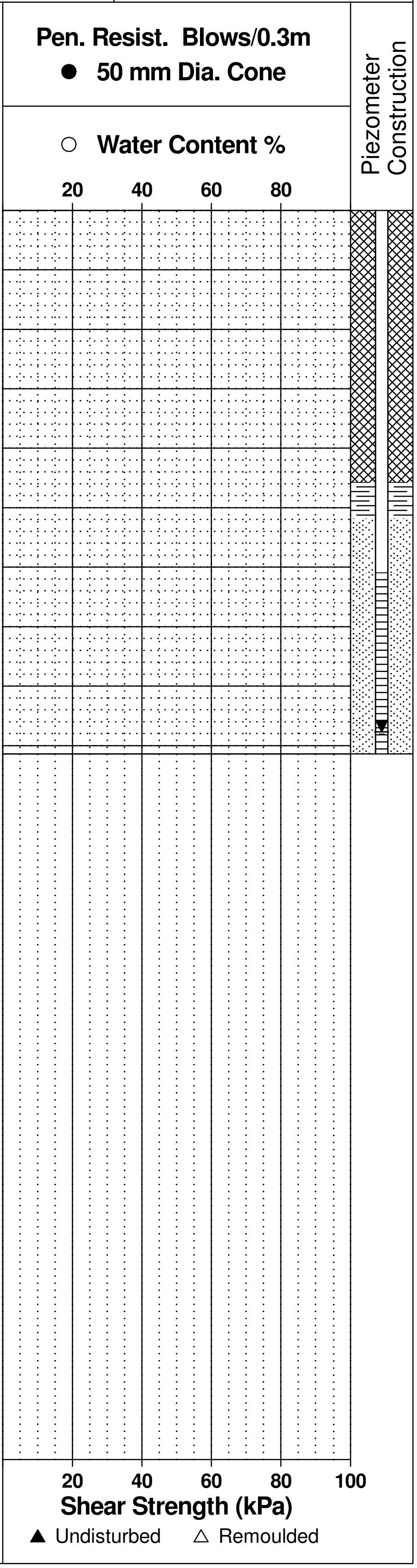
SOIL DESCRIPTION	DEPTH (m)
GROUND SURFACE	
FILL: Brown silty sand with gravel	4.57
FILL: Brown silty sand with coal and slag	5.18
FILL: Brown silty sand with gravel, trace cobbles and boulders	9.14
End of Borehole	

Practical refusal to augering at 9.14m depth

(GWL @ 8.77 m - March 2, 2022)

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	75	18
SS	2	25	25
SS	3	83	15
SS	4	50	25
SS	5	33	50
SS	6	0	50+
SS	7	0	50+
SS	8	67	50+

DEPTH (m)	ELEV. (m)
0	66.60
1	65.60
2	64.60
3	63.60
4	62.60
5	61.60
6	60.60
7	59.60
8	58.60
9	57.60



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

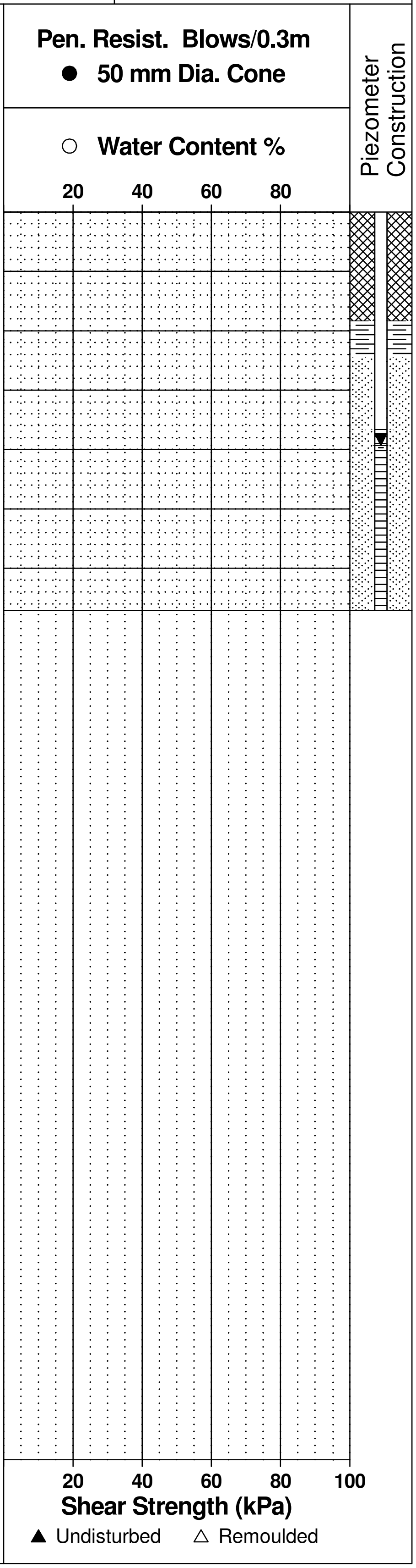
BORINGS BY CME-55 Low Clearance Drill

DATE February 24, 2022

FILE NO. PG4811

HOLE NO. BH 9-22

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	61.29
TOPSOIL 0.15						
FILL: Brown silty sand with gravel	AU	1				
	SS	2	75	34	1	60.29
- with crushed stone by 0.8m depth 1.83	SS	3	75	53		
FILL: Brown silty sand with clay and gravel	SS	4	71	28	2	59.29
	SS	5	83	29	3	58.29
3.81						
GLACIAL TILL: Compact, grey silty sand to sandy silt some clay, gravel, cobbles and boulders	SS	6	83	22	4	57.29
	SS	7	83	24	5	56.29
	SS	8	75	39	6	55.29
6.71	SS	9	83	22		
End of Borehole						
(GWL @ 3.93m - March 3, 2022)						



patersongroup Consulting Engineers
9 Auriga Drive, Ottawa, Ontario K2E 7T9

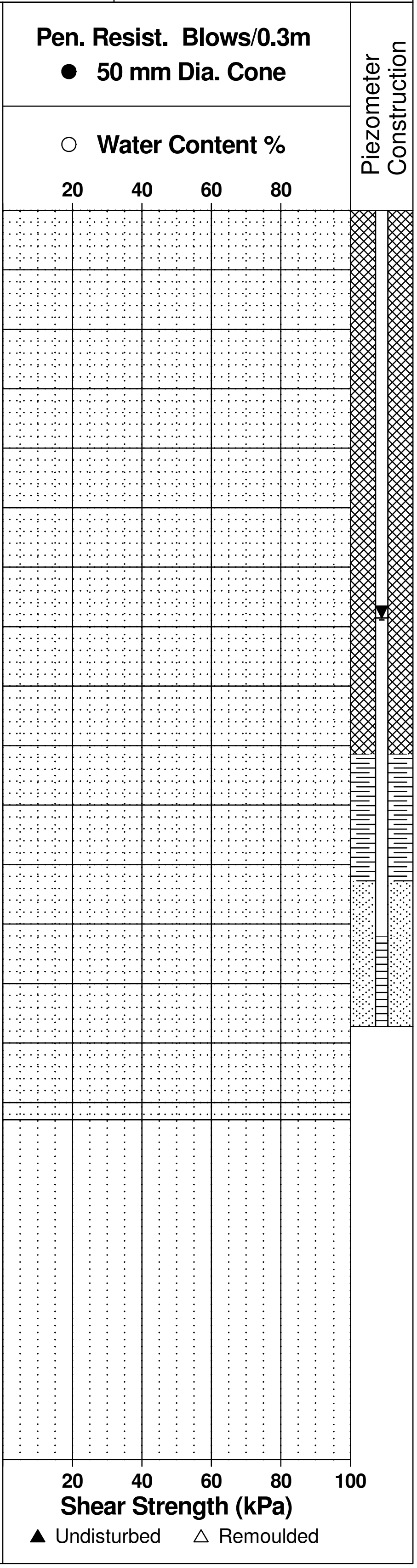
SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic
REMARKS
BORINGS BY CME-55 Low Clearance Drill
DATE February 24, 2022
FILE NO. PG4811
HOLE NO. BH10-22

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Grey silty clay with sand, gravel, trace cobbles, boulders and organics	SS	1	67	3
3.96				
GLACIAL TILL: Compact to very dense, grey silty sand to sandy silt some clay, gravel, cobles and boulders	SS	2	83	14
	SS	3	83	65
11.43				
BEDROCK: Excellent quality shale interbedded with grey limestone - 15mm thick mud seam at 12.3 m depth - 25mm thick mud seam at 12.9 m depth - 10mm thick mud seam at 13.5 m depth	RC	1	100	90
	RC	2	100	93
	RC	3	100	93
15.29				
End of Borehole (GWL @ 6.85m - March 8, 2022)				

DEPTH (m)	ELEV. (m)
0	61.13
1	60.13
2	59.13
3	58.13
4	57.13
5	56.13
6	55.13
7	54.13
8	53.13
9	52.13
10	51.13
11	50.13
12	49.13
13	48.13
14	47.13
15	46.13



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

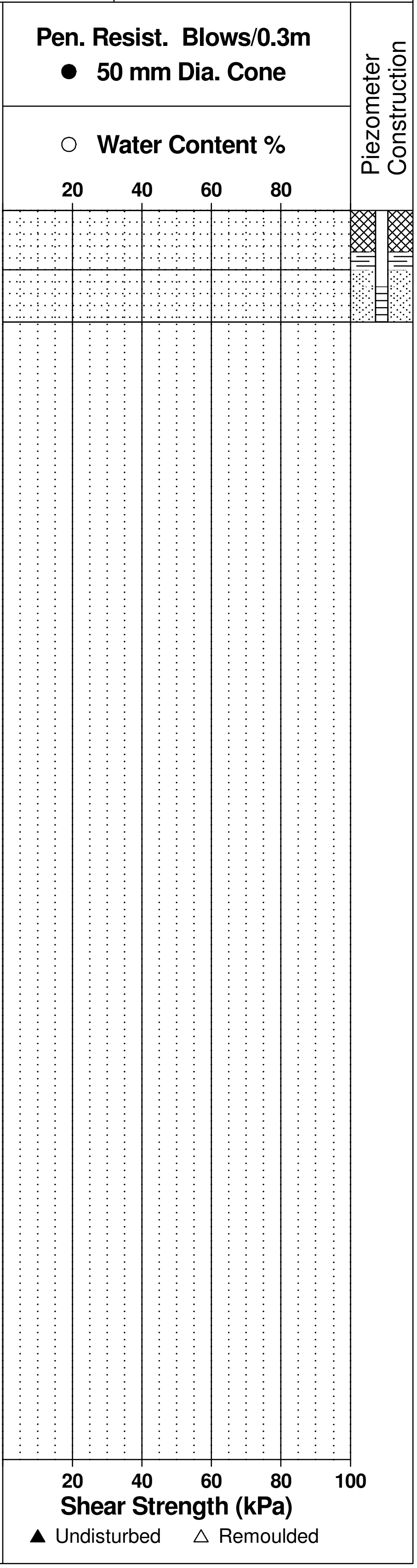
BORINGS BY CME-55 Low Clearance Drill

DATE November 9, 2022

FILE NO. PG4811

HOLE NO. BH11-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	60.80
OVERBURDEN						1	59.80
1.88							
End of Borehole Practical refusal to augering at 1.88m depth							



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

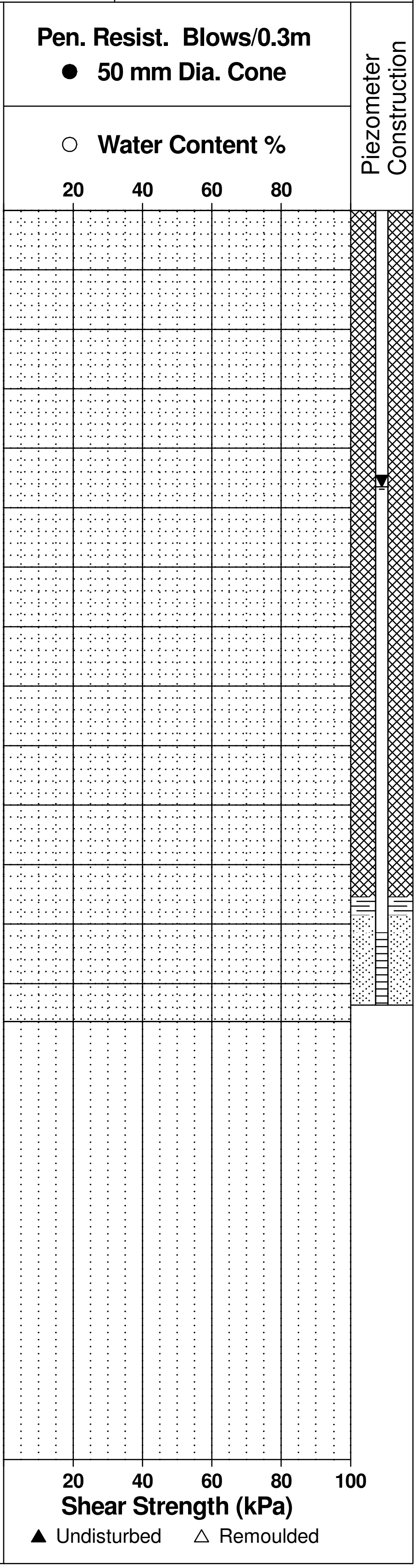
DATE November 9, 2022

FILE NO. PG4811

HOLE NO. BH11A-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
OVERBURDEN					
10.67					
BEDROCK: Excellent quality, black shale interbedded with grey limestone	▤	RC	1	100	93
	▤	RC	2	100	98
13.64					
End of Borehole (GWL @ 4.65m - Nov. 18, 2022)					

DEPTH (m)	ELEV. (m)
0	60.79
1	59.79
2	58.79
3	57.79
4	56.79
5	55.79
6	54.79
7	53.79
8	52.79
9	51.79
10	50.79
11	49.79
12	48.79
13	47.79



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

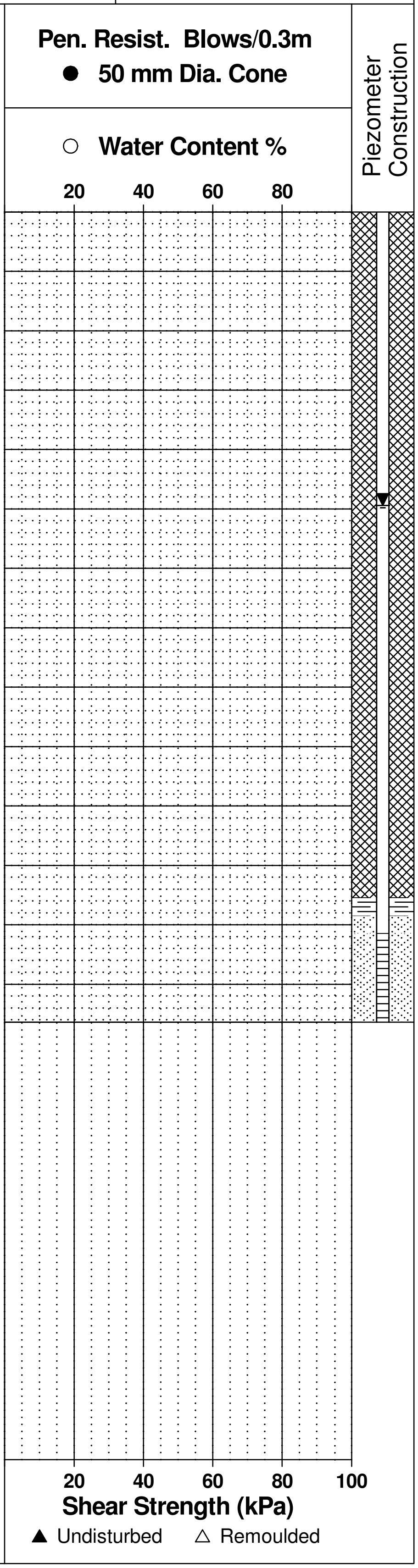
DATE November 9, 2022

FILE NO. PG4811

HOLE NO. BH12-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
OVERBURDEN					
10.08					
BEDROCK: Fair to excellent quality, black shale interbedded with grey limestone		RC	1	100	67
		RC	2	100	97
		RC	3	100	93
13.64					
End of Borehole (GWL @ 4.94m - Nov. 18, 2022)					

DEPTH (m)	ELEV. (m)
0	60.97
1	59.97
2	58.97
3	57.97
4	56.97
5	55.97
6	54.97
7	53.97
8	52.97
9	51.97
10	50.97
11	49.97
12	48.97
13	47.97



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE November 10, 2022

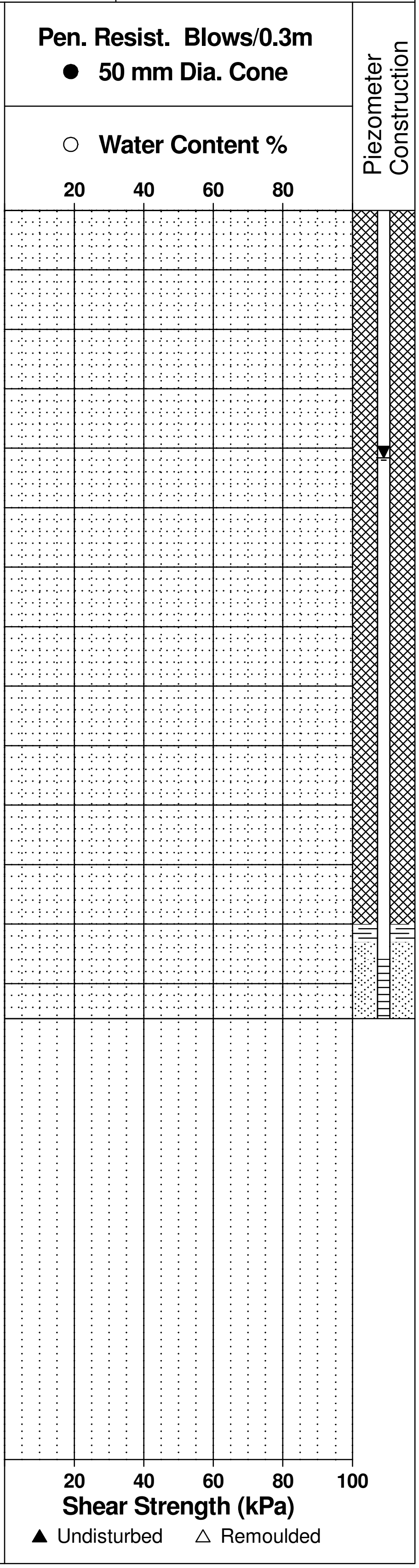
FILE NO. PG4811

HOLE NO. BH13-22

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	60.80
OVERBURDEN					1	59.80
					2	58.80
					3	57.80
					4	56.80
					5	55.80
					6	54.80
					7	53.80
					8	52.80
					9	51.80
10.06					10	50.80
BEDROCK: Good to excellent quality, black shale interbedded with grey limestone	RC	1	100	75		
	RC	2	100	93	11	49.80
					12	48.80
	RC	3	100	93	13	47.80
13.59						

End of Borehole

(GWL @ 4.16m - Nov. 18, 2022)



patersongroup Consulting Engineers
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

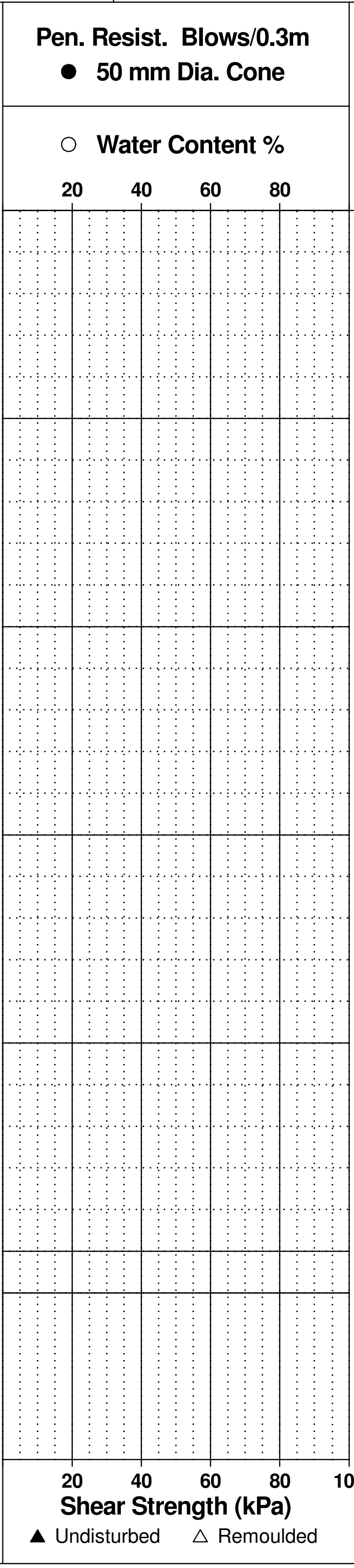
BORINGS BY Excavator

DATE February 15, 2022

FILE NO. PG4811

HOLE NO. TP 1-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	66.11	
TOPSOIL 0.30		G	1					
FILL: Brown silty clay with gravel, cobbles, some sand 2.10		G	2			1 2	65.11 64.11	
FILL: Grey to brown silty sand with gravel, cobbles and boulders 4.30		G G	3 4			3 4	63.11 62.11	
FILL: Brown to grey silty clay to clayey silt with gravel, cobbles and boulders 5.20		G	5			5	61.11	
End of Test Pit								



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Excavator

DATE February 15, 2022

FILE NO. PG4811

HOLE NO. TP 2-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	65.74		
Masonry Pavement 0.20									
FILL: Crushed stone with brown silty sand, some organics 0.50		G	1						
FILL: Brown silty sand, some gravel and cobbles 0.90		G	2						
						1	64.74		
		G	3						
						2	63.74		
		G	4						
FILL: Grey to brown silty clay to clayey sily with gravel, cobbles and boulders									
						3	62.74		
- concrete Footing									
						4	61.74		
		G	5			5	60.74		
5.10									
End of Test Pit									

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Excavator

DATE February 15, 2022

FILE NO. PG4811

HOLE NO. TP 3-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	62.01		
FILL: Crushed stone with brown silty sand	▨	G	1						
0.70									
FILL: Dark brown silty clay to clayey silt with gravel, cobbles and boulders	▨	G	2			1	61.01		
						2	60.01		
						3	59.01		
3.10		G	3						
End of Test Pit Practical refusal to excavation on inferred bedrock surface at 3.10m depth									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Excavator

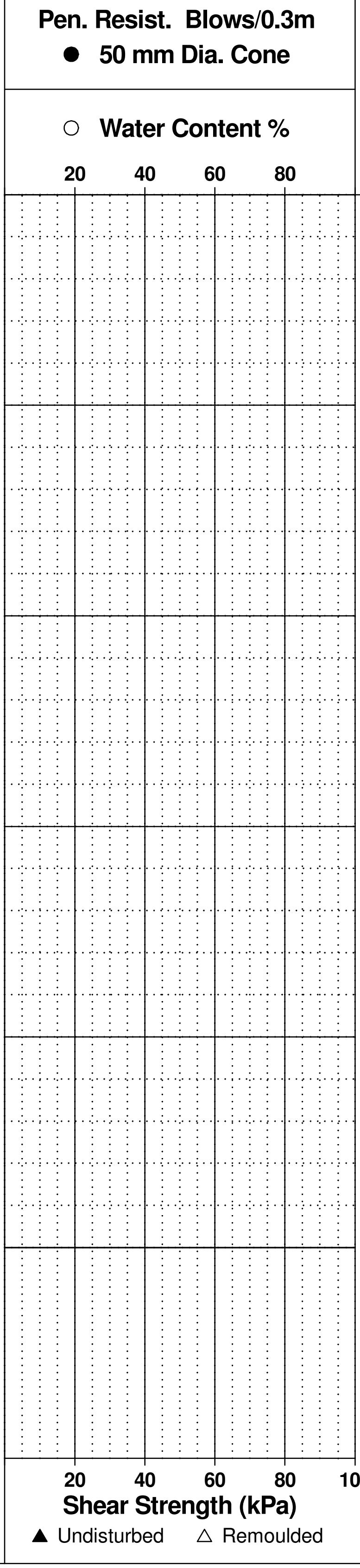
DATE February 16, 2022

FILE NO. PG4811

HOLE NO. TP 4-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
FILL: Brown silty sand with gravel, crushed stone and organics		G	1		
0.50					
FILL: Dark brown silty sand with gravel, crushed stone and trace clay		G	2		
0.76					
FILL: Brown silty sand with gravel		G	3		
0.95					
FILL: Black silty sand with crushed stone		G	4		
		G	5		
2.41					
FILL: Grey silty clay some sand with gravel, cobbles and boulders					
3.20					
TOPSOIL		G	6		
3.50					
GLACIAL TILL: Dense, grey silty sand to sandy silt with gravel, cobbles, boulders and trace clay		G	7		
- clay content increasing with depth		G	8		
5.00					
End of Test Pit					

DEPTH (m)	ELEV. (m)
0	61.92
1	60.92
2	59.92
3	58.92
4	57.92
5	56.92



Piezometer Construction

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

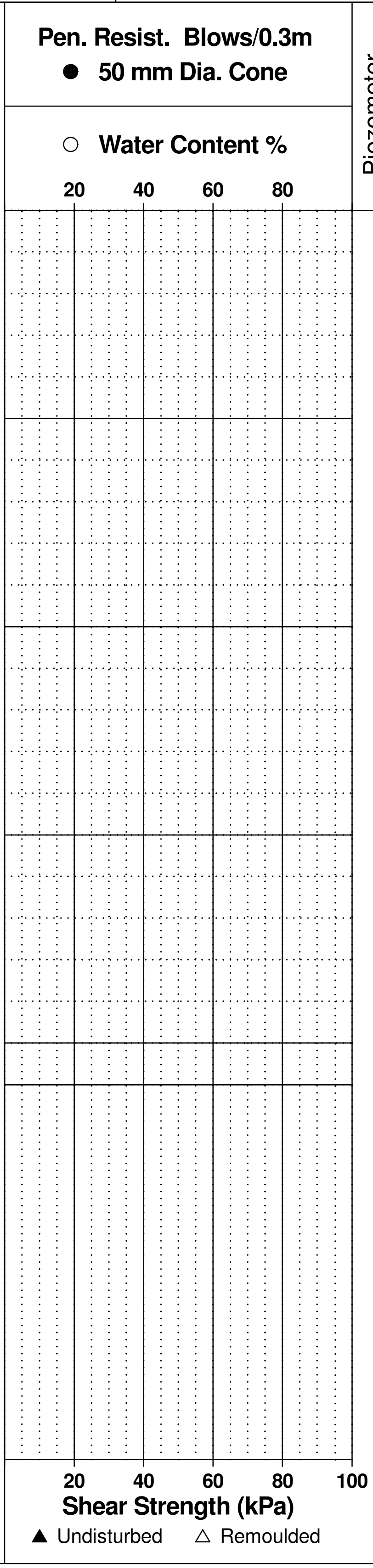
BORINGS BY Excavator

DATE February 16, 2022

FILE NO. PG4811

HOLE NO. TP 5-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	61.27	
TOPSOIL 0.10								
FILL: Brown silty sand with crushed stone and construction debris 1.30		G	1			1	60.27	
FILL: Grey sandy silt with gravel, trace clay 1.80		G	2					
FILL:: Black silty sand with gravel, crushed stone, some coal, trace clay - cobbles, boulders and organics present by 2.9 m depth 3.50		G G	3 4			2 3	59.27 58.27	
GLACIAL TILL: Compact to dense, grey silty sand to sandy silt with gravel, cobbles, boulders and clay 4.20		G	5			4	57.27	
End of Test Pit								



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Excavator

DATE February 16, 2022

FILE NO. PG4811

HOLE NO. TP 6-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD			20 40 60 80	
GROUND SURFACE						0	62.06		
FILL: Brown silty sand with crushed stone and gravel 0.60	▨	G	1						
FILL: Brown silty sand with gravel, cobbles and boulders, some construction debris 1.25	▨	G	2			1	61.06		
FILL: Dark brown silty sand with clay, gravel, cobbles, trace boulders 2.10	▨	G	3			2	60.06		
End of Test Pit Refusal to excavation on inferred concrete slab at 2.1 m depth									

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Development
2 Robinson Ave. & 320 Lees Ave., Ottawa, Ontario

DATUM Geodetic

FILE NO. PG4811

REMARKS

HOLE NO. TP 7-22

BORINGS BY Excavator

DATE February 16, 2022

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	62.06		
FILL: Brown silty sand with crushed stone									
0.60									
FILL: Dark brown silty clay with sand, gravel, trace cobbles						1	61.06		
						2	60.06		
2.30									
FILL: Dark brown to black sandy silt with gravel, some clay, topsoil, trace cobbles and coal						3	59.06		
		G	1						
						4	58.06		
4.10									
GLACIAL TILL: Brown silty sand with gravel, rock fragments, cobbles and boulders		G	2						
4.30									
End of Test Pit Refusal to excavation on inferred bedrock surface 4.3 m depth									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
2 Robinson Avenue
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 75 Power Auger

DATE February 7, 2019

FILE NO. PG4811

HOLE NO. BH 1

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
FILL: Brown sandy silty with gravel. - some cobbles by 1.5m depth	6.25
FILL: Black sand with coal, some organics	6.86
Compact, brown **SAND**	8.69
Compact, brown **SILTY SAND**	9.60
GLACIAL TILL: Silty sand, some gravel and clay	9.75
End of Borehole	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	25	7
SS	3	83	8
SS	4	17	6
SS	5	46	50+
SS	6	25	12
SS	7	58	15
SS	8	58	20
SS	9	83	29
SS	10	92	25
SS	11	92	27
SS	12	100	29
SS	13	92	41

DEPTH (m)	ELEV. (m)
0	67.50
1	66.50
2	65.50
3	64.50
4	63.50
5	62.50
6	61.50
7	60.50
8	59.50
9	58.50

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Monitoring Well Construction

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
2 Robinson Avenue
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 75 Power Auger

DATE February 7, 2019

FILE NO. PG4811

HOLE NO. BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Monitoring Well Construction
GROUND SURFACE						0	67.25	
FILL : Brown sand some silt, gravel and clay	▨	AU	1					
	▨	SS	2	67	3	1	66.25	
	▨	SS	3	42	5	2	65.25	
	▨	SS	4	58	22	3	64.25	
3.20	▨	SS	5	0	50+			
End of Borehole Practical refusal to augering @ 3.20m depth.								

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %
20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
2 Robinson Avenue
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 75 Power Auger

DATE February 7, 2019

FILE NO. PG4811

HOLE NO. BH 2A

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	67.20
					1	66.20
					2	65.20
FILL: Brown sand with silt, clay and gravel					3	64.20
	SS	1		6		
	SS	2	25	11	4	63.20
	SS	3	83	22	5	62.20
5.33						
FILL: Coal 5.49						
FILL: Brown sand 6.10	SS	4	17	26	6	61.20
FILL: Brown clayey silt with sand, some gravel 6.70	SS	5	46	48		
	SS	6	25	50+	7	60.20
	SS	7	58	73	8	59.20
GLACIAL TILL: Very dense, brown silty sand to sandy silt, some gravel, trace clay	SS	8	58	59	9	58.20
	SS	9	83	50+		
	SS	10	92	95	10	57.20
10.67						
Dynamic Cone Penetration Test commenced at 10.67m depth. Inferred **GLACIAL TILL** 11.48					11	56.20

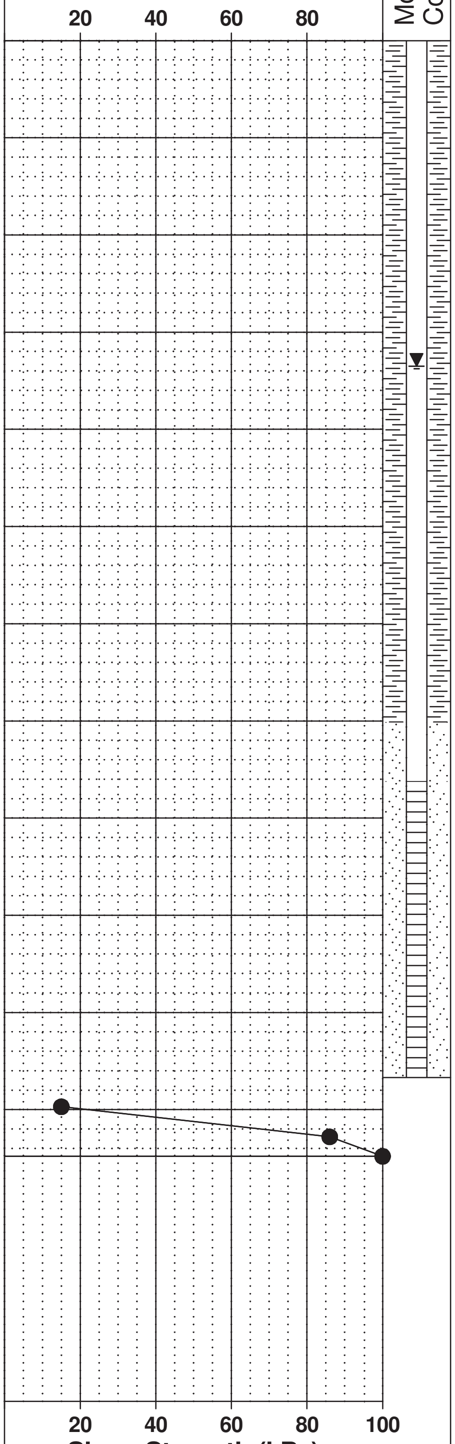
End of Borehole

Practical DCPT refusal at 11.48m depth

(GWL @ 3.35m - Feb. 22, 2019)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
2 Robinson Avenue
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 75 Power Auger

DATE February 7, 2019

FILE NO. PG4811

HOLE NO. BH 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Monitoring Well Construction
GROUND SURFACE						0	69.30		
FILL: Brown silty sand, some gravel, trace clay	▨	AU	1						
		SS	2	92	25	1	68.30		
		SS	3	100	19	2	67.30		
		SS	4	75	5				
		SS	5	67	8	3	66.30		
		SS	6	67	4	4	65.30		
		SS	7	75	5	5	64.30		
		SS	8	75	38	6	63.30		
6.65		SS	9	92	27				
FILL: Coal 6.70									
FILL: Brown sand, silt and gravel	▨	SS	10	83	51	7	62.30		
8.38		SS	11	108	28	8	61.30		
GLACIAL TILL: Dense, brown silty sand, some gravel, trace clay	^	SS	12	83	48	9	60.30		
9.75		SS	13	92	38				
End of Borehole									

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
2 Robinson Avenue
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 75 Power Auger

DATE February 7, 2019

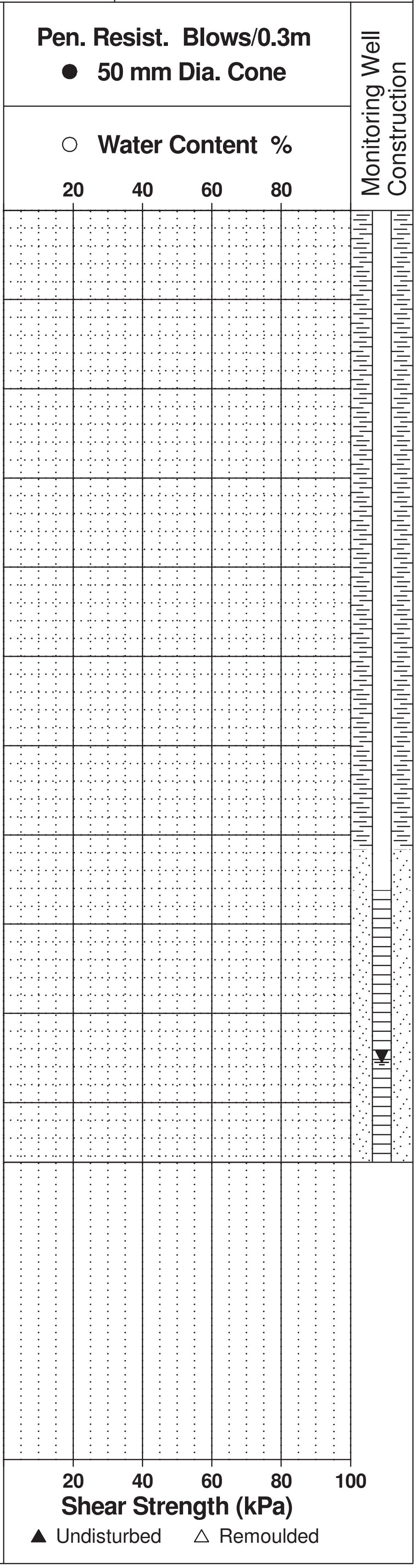
FILE NO. PG4811

HOLE NO. BH 4

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.15
FILL: Brown silty clay, some sand and gravel	5.33
FILL: Coal	5.79
FILL: Brown sand	5.94
FILL: Coal	6.70
GLACIAL TILL: Very dense to dense, brown silty sand with gravel, cobbles and boulders	10.67
End of Borehole	
(GWL @ 9.55m - Feb. 22, 2019)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	58	10
SS	3	75	5
SS	4	33	5
SS	5	25	7
SS	6	25	5
SS	7	58	9
SS	8	100	16
SS	9	100	56
SS	10	8	23
SS	11	60	50+
SS	12	83	87
SS	13	75	54
SS	14	83	40

DEPTH (m)	ELEV. (m)
0	67.80
1	66.80
2	65.80
3	64.80
4	63.80
5	62.80
6	61.80
7	60.80
8	59.80
9	58.80
10	57.80



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
2 Robinson Avenue
Ottawa, Ontario

DATUM

REMARKS

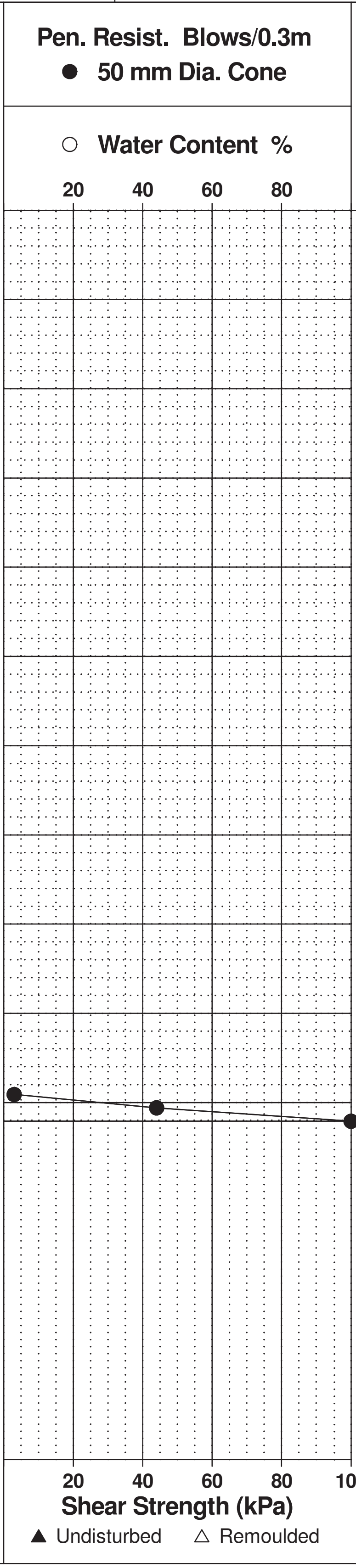
BORINGS BY CME 75 Power Auger

DATE February 7, 2019

FILE NO. PG4811

HOLE NO. BH 5

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	66.60
FILL: Brown silty clay, some sand and gravel	AU	1				
	SS	2	75	7	1	65.60
	SS	3	75	6	2	64.60
3.05	SS	4	67	11	3	63.60
FILL: Brown sand with silt, clay and gravel 3.81	SS	5	58	10		
FILL: Brown silty clay 4.11	SS	6	67	7	4	62.60
FILL: Coal 4.98	SS	7	75	24	5	61.60
Compact to very dense, brown **SILTY SAND to SANDY SILT**	SS	8	83	18	6	60.60
	SS	9	83	53		
	SS	10	78	85	7	59.60
	SS	11	100	41	8	58.60
	SS	12	92	67	9	57.60
9.75	SS	13	75	29		
Dynamic Cone Penetration Test commenced at 9.75m depth. 10.21					10	56.60
End of Borehole Practical DCPT refusal at 10.21m depth						



Monitoring Well Construction

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
2 Robinson Avenue
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 75 Power Auger

DATE February 7, 2019

FILE NO. PG4811

HOLE NO. BH 6

SOIL DESCRIPTION	Layer bottom (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	66.00
Asphaltic concrete	0.08						
FILL: Crushed stone	0.46	AU	1				
FILL: Sand and silty clay, some gravel and cobbles	6.86	SS	2	50	10	1	65.00
		SS	3	67	15	2	64.00
		SS	4	83	5	3	63.00
		SS	5	50	38		
		SS	6	75	13	4	62.00
		SS	7	67	24	5	61.00
		SS	8	96	50	6	60.00
		SS	9	71	65		
Very dense to dense, brown **SILTY SAND,** some gravel, trace black sand	9.75	SS	10	79	53	7	59.00
		SS	11	83	32	8	58.00
		SS	12	79	31	9	57.00
		SS	13	100	45		
End of Borehole							

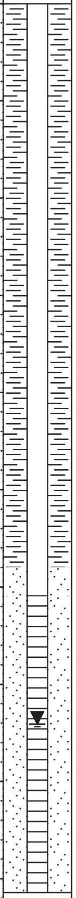
(GWL @ 7.41m - Feb. 22, 2019)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content % (20, 40, 60, 80)

Shear Strength (kPa) (20, 40, 60, 80, 100)
▲ Undisturbed △ Remoulded

Monitoring Well Construction



patersongroup Consulting Engineers
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
2 Robinson Avenue
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 75 Power Auger

DATE February 12, 2019

FILE NO. PG4811

HOLE NO. BH 7

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
Asphaltic concrete	0.10
FILL: Brown silty sand with gravel	3.10
FILL: Brown silty sand, trace black sand and gravel	7.47
Compact, brown **SILTY SAND**	9.75
End of Borehole	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	54	7
SS	3	58	6
SS	4	46	18
SS	5	54	3
SS	6	88	10
SS	7	83	11
SS	8	79	25
SS	9	92	31
SS	10	83	26
SS	11	88	30
SS	12	88	29
SS	13	0	29

DEPTH (m)	ELEV. (m)
0	65.50
1	64.50
2	63.50
3	62.50
4	61.50
5	60.50
6	59.50
7	58.50
8	57.50
9	56.50

STRATA PLOT

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Monitoring Well Construction

patersongroup Consulting Engineers
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
2 Robinson Avenue
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 75 Power Auger

DATE February 14, 2019

FILE NO. PG4811

HOLE NO. BH 8

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % (20 40 60 80)	Monitoring Well Construction
GROUND SURFACE						0	62.75		
FILL: Brown silty sand, trace organics 0.18		AU	1						
FILL: Brown silty sand		SS	2	42	18	1	61.75		
2.13		SS	3	83	18	2	60.75		
Compact, brown **SILTY SAND,** trace clay		SS	4	92	10	3	59.75		
		SS	5	63	12	4	58.75		
		SS	6	96	19	5	57.75		
5.18		SS	7	100	29				
End of Borehole									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
2 Robinson Avenue
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 75 Power Auger

DATE February 14, 2019

FILE NO. PG4811

HOLE NO. BH 9

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Brown silty sand with gravel	AU	1		
	SS	2	46	12
2.18	SS	3	63	19
FILL: Brown silty sand with organics	SS	4	8	13
3.68	SS	5	17	8
Compact to very dense, brown **SILTY SAND** with gravel	SS	6	50	11
	SS	7	38	11
	SS	8	75	22
	SS	9	83	21
	SS	10	38	15
	SS	11	33	18
	SS	12	21	37
9.75	SS	13	33	54
End of Borehole				

DEPTH (m)	ELEV. (m)
0	61.40
1	60.40
2	59.40
3	58.40
4	57.40
5	56.40
6	55.40
7	54.40
8	53.40
9	52.40

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

Monitoring Well Construction

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
2 Robinson Avenue
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 75 Power Auger

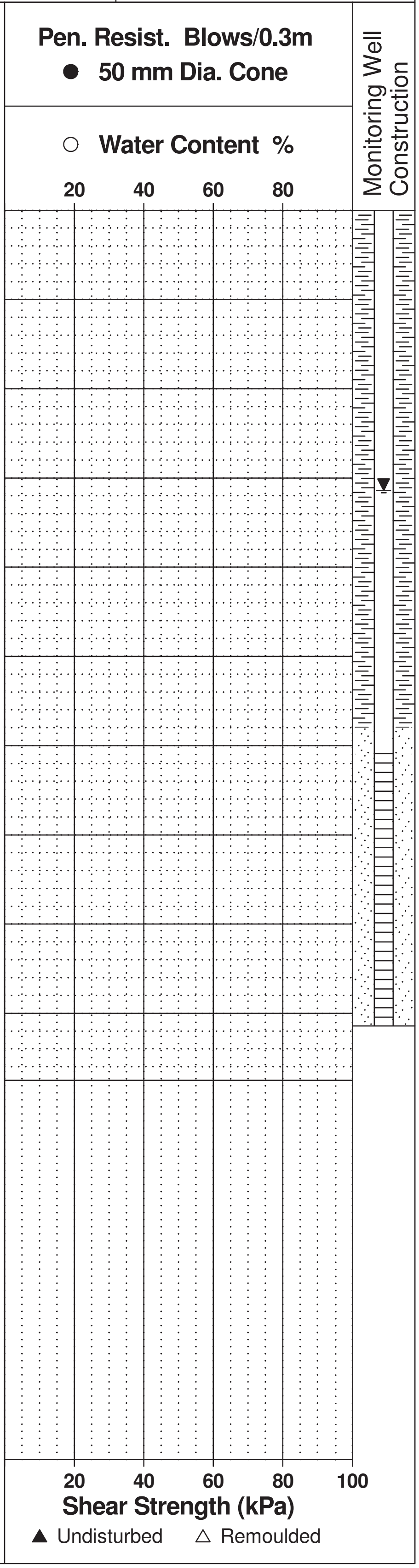
DATE February 15, 2019

FILE NO. PG4811

HOLE NO. BH10

SOIL DESCRIPTION		SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
FILL: Brown silty sand with gravel		AU	1		
		SS	2	58	28
		SS	3	75	13
		SS	4	88	7
	3.66	SS	5	75	2
PEAT		SS	6	71	6
		SS	7	38	46
	6.10	SS	8		27
Compact to very dense, brown **SANDY SILT**		SS	9	83	25
		SS	10	88	31
		SS	11	83	26
- some gravel by 8.4m depth		SS	12	96	59
	9.75	SS	13	88	50
End of Borehole (GWL @ 3.14m - Feb. 22, 2019)					

DEPTH (m)	ELEV. (m)
0	62.40
1	61.40
2	60.40
3	59.40
4	58.40
5	57.40
6	56.40
7	55.40
8	54.40
9	53.40



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
2 Robinson Avenue
Ottawa, Ontario

DATUM

REMARKS

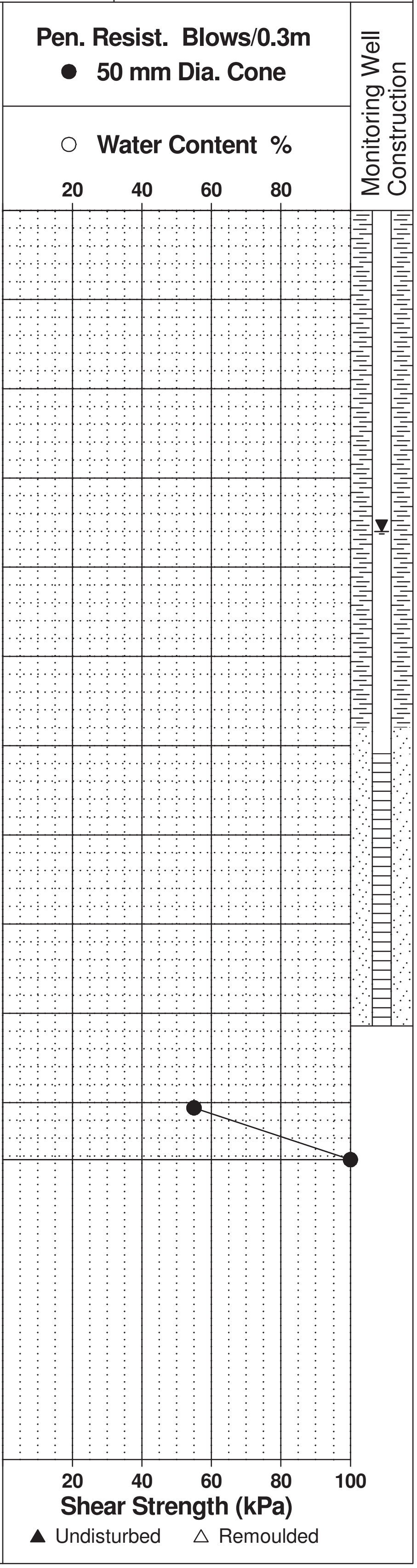
BORINGS BY CME 75 Power Auger

DATE February 15, 2019

FILE NO. PG4811

HOLE NO. BH11

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	62.00
FILL: Brown silty sand, some gravel, trace clay, occasional cobbles and boulders		AU	1				
		SS	2	67	50+	1	61.00
1.52							
FILL: Grey silty clay, trace sand and gravel		SS	3	88	7	2	60.00
2.29							
FILL: Brown silty sand, some gravel		SS	4	79	39		
- trace organics by 3.0m depth						3	59.00
		SS	5	83	24		
3.81							
PEAT		SS	6	75	6	4	58.00
4.57							
Compact, brown **SILTY SAND to SANDY SILT,** trace gravel and clay		SS	7	13	24	5	57.00
		SS	8	83	50		
6.10						6	56.00
Compact, brown **SANDY SILT**		SS	9	92	29		
		SS	10	88	15	7	55.00
		SS	11	83	23	8	54.00
- dense to very dense with some gravel by 8.4m depth		SS	12	79	34	9	53.00
		SS	13	96	56		
9.75							
Dynamic Cone Penetration Test commenced at 9.75m depth.						10	52.00
10.64							
End of Borehole							
Practical refusal to DCPT @ 10.64m depth							
(GWL @ 3.60m - Feb. 22, 2019)							



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
2 Robinson Avenue
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 75 Power Auger

DATE February 15, 2019

FILE NO. PG4811

HOLE NO. BH12

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Brown silty sand, trace gravel, occasional cobbles and boulders	AU	1		
	SS	2	100	50+
2.29	SS	3	88	25
FILL: Brown silty sand, some gravel, trace clay	SS	4	25	16
3.81	SS	5	83	8
GLACIAL TILL: Brown silty clay, trace sand and gravel	SS	6	100	10
	SS	7	92	10
	SS	8	92	11
	SS	9	83	10
	SS	10	88	9
	SS	11	83	10
8.99	SS	12	58	16
End of Borehole				
(GWL @ 3.48m - Feb. 22, 2019)				

DEPTH (m)	ELEV. (m)
0	61.25
1	60.25
2	59.25
3	58.25
4	57.25
5	56.25
6	55.25
7	54.25
8	53.25

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Monitoring Well Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the relative strength of cohesionless soils is the compactness condition, usually inferred from the results of the Standard Penetration Test (SPT) ‘N’ value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm. An SPT N value of “P” denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

Compactness Condition	‘N’ Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

Consistency	Undrained Shear Strength (kPa)	‘N’ Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity, S_t, is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

Low Sensitivity: $S_t < 2$
Medium Sensitivity: $2 < S_t < 4$
Sensitive: $4 < S_t < 8$
Extra Sensitive: $8 < S_t < 16$
Quick Clay: $S_t > 16$

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NQ or larger size core. However, it can be used on smaller core sizes, such as BQ, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	**ROCK QUALITY**
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS - Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW - Thin wall tube or Shelby tube, generally recovered using a piston sampler
G - "Grab" sample from test pit or surface materials
AU - Auger sample or bulk sample
WS - Wash sample
RC - Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

WC% - Natural water content or water content of sample, %
LL - Liquid Limit, % (water content above which soil behaves as a liquid)
PL - Plastic Limit, % (water content above which soil behaves plastically)
PI - Plasticity Index, % (difference between LL and PL)

Dxx - Grain size at which xx% of the soil, by weight, is of finer grain sizes
These grain size descriptions are not used below 0.075 mm grain size
D10 - Grain size at which 10% of the soil is finer (effective grain size)
D60 - Grain size at which 60% of the soil is finer

Cc - Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu - Uniformity coefficient = $D60 / D10$

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay
(more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

p'_o - Present effective overburden pressure at sample depth
p'_c - Preconsolidation pressure of (maximum past pressure on) sample
Ccr - Recompression index (in effect at pressures below p'_c)
Cc - Compression index (in effect at pressures above p'_c)

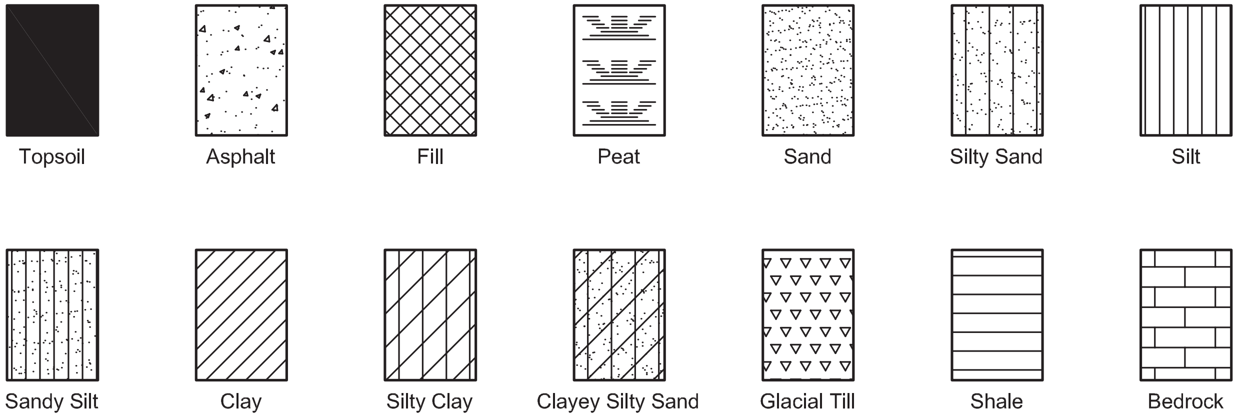
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

PERMEABILITY TEST

k - Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

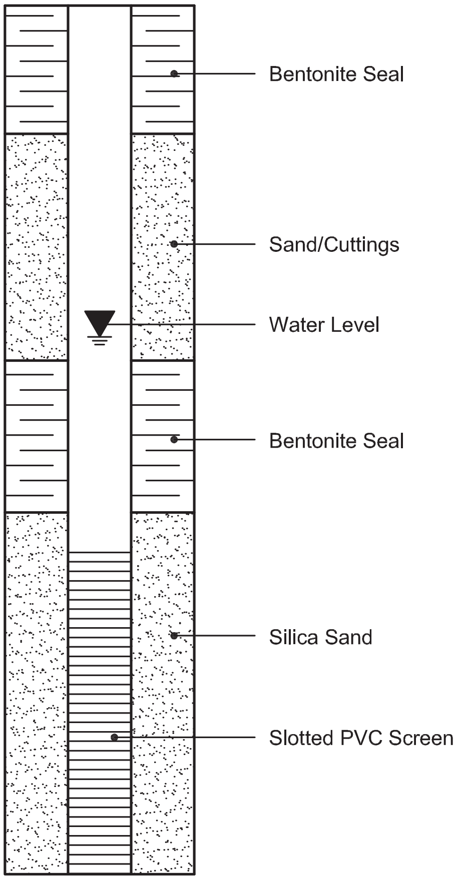
SYMBOLS AND TERMS (continued)

STRATA PLOT

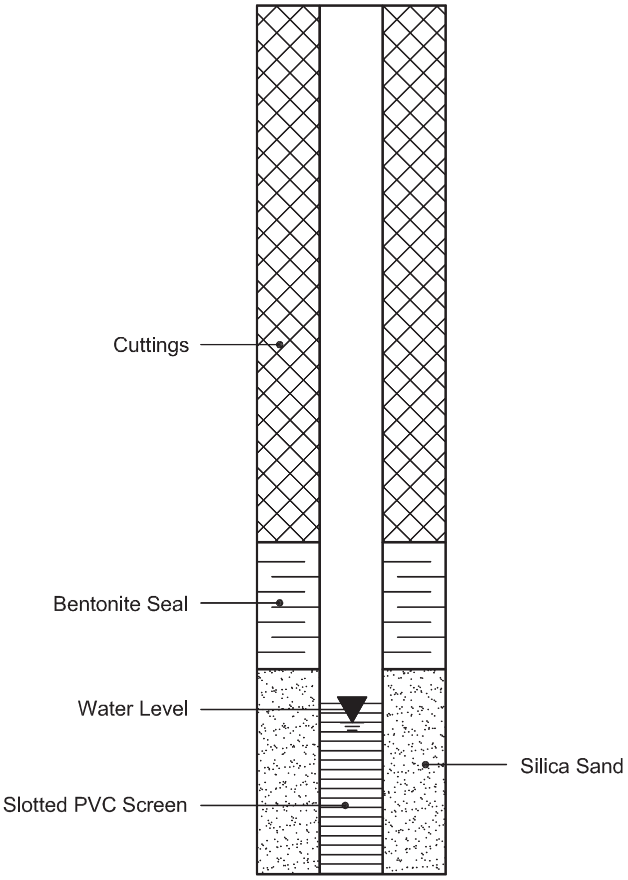


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION

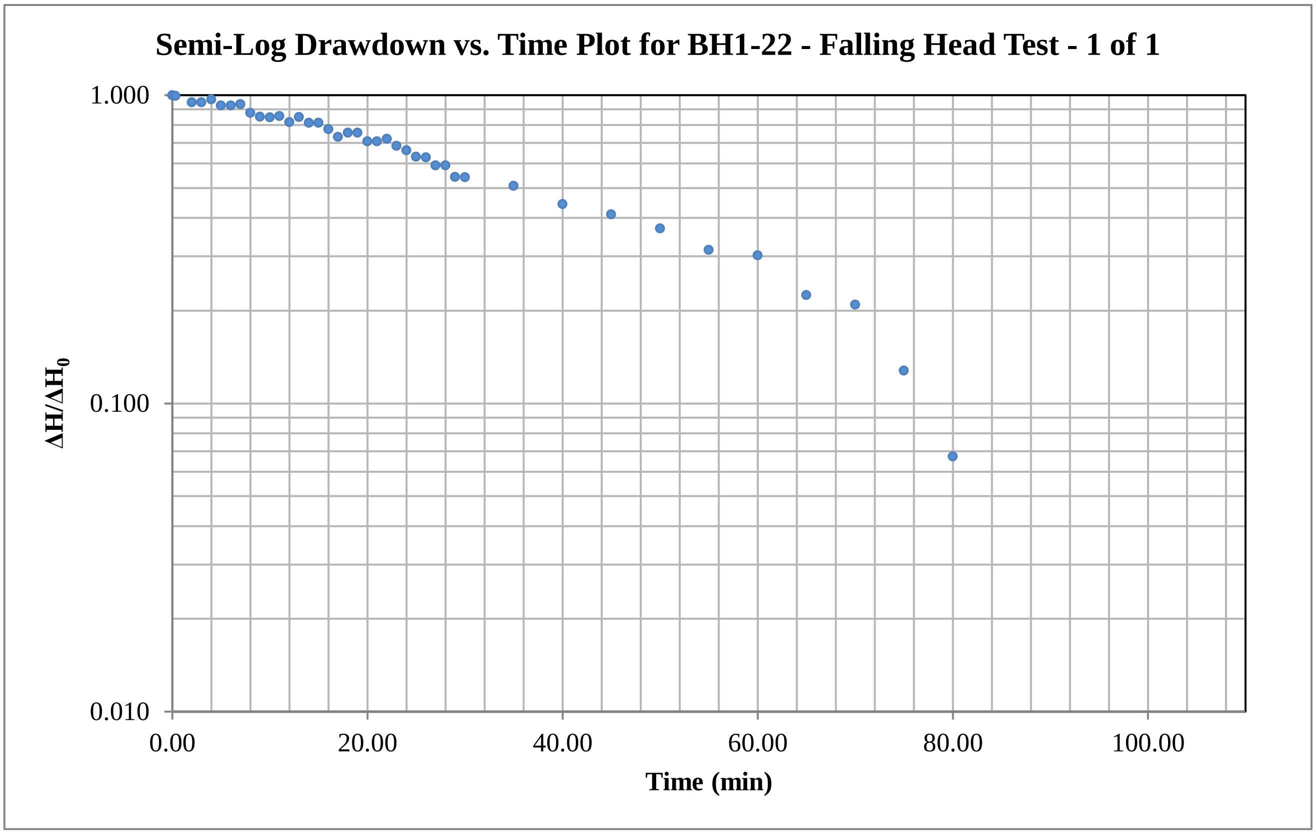


PIEZOMETER CONSTRUCTION



Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH1-22
Test: Falling Head - 1 of 1
Date: March 8, 2022



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 2.3019

Well Parameters:

L	1.5	m	Saturated length of screen or open hole
D	0.05	m	Diameter of well
r_c	0.025	m	Radius of well

Data Points (from plot):

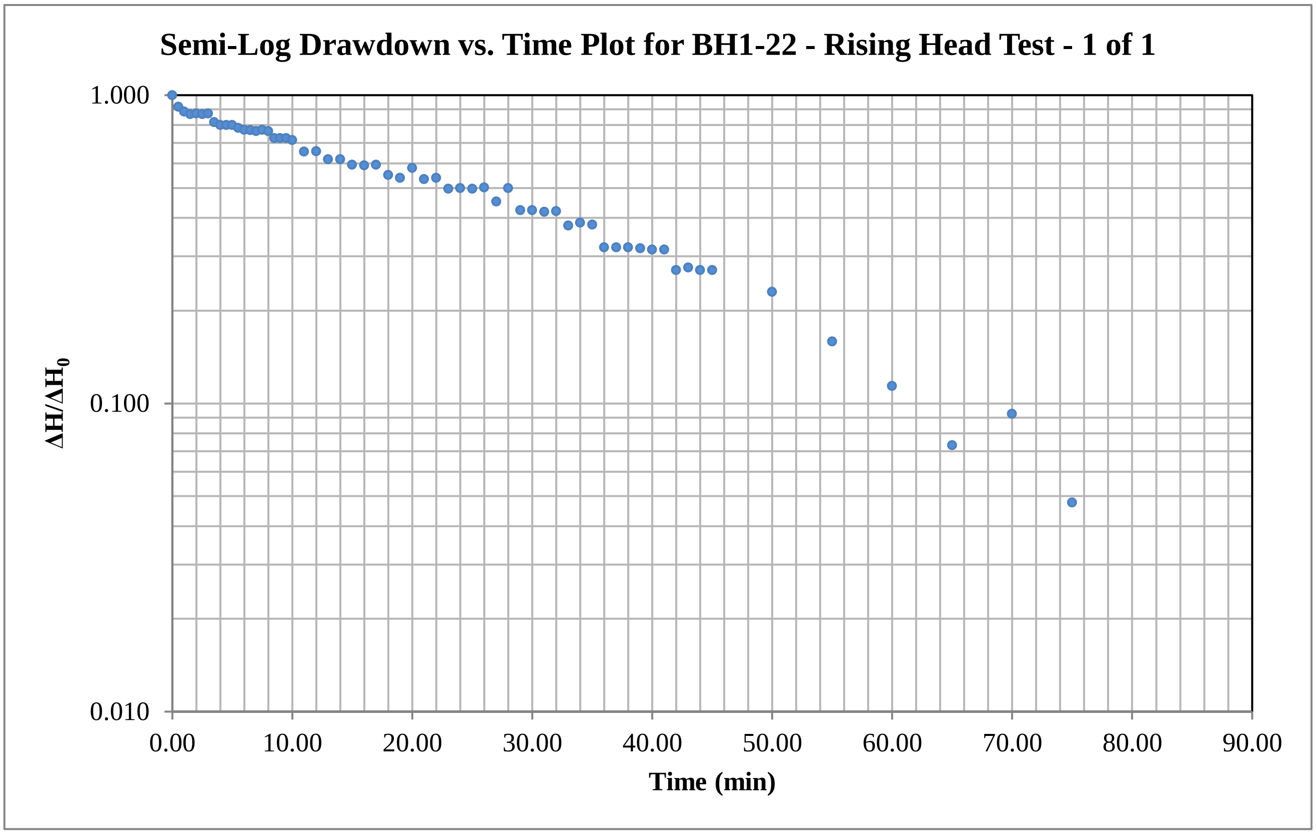
t*: 49.239 minutes

$\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 2.87E-07 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH1-22
Test: Rising Head - 1 of 1
Date: March 8, 2022



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 2.3019

Well Parameters:

L	1.5	m	Saturated length of screen or open hole
D	0.05	m	Diameter of well
r_c	0.025	m	Radius of well

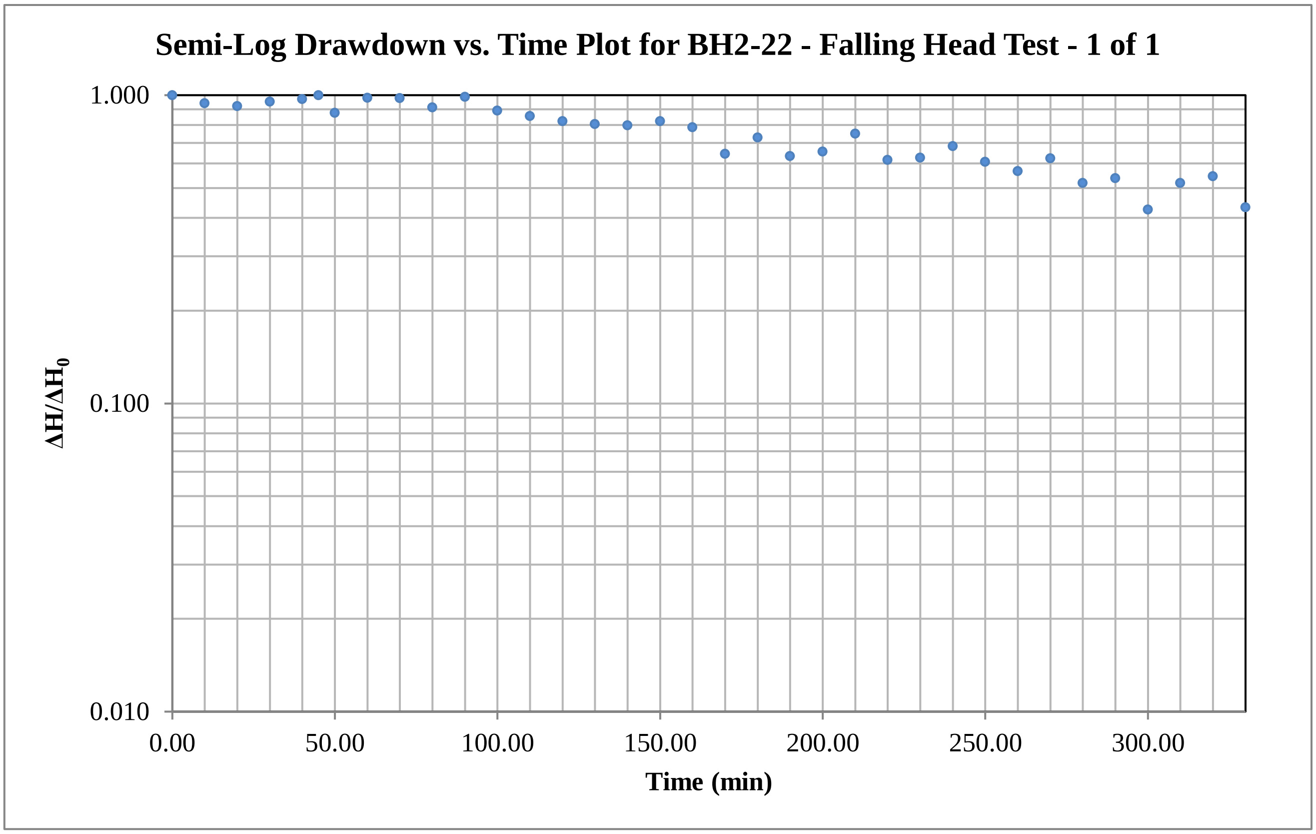
Data Points (from plot):

t*: 35.177 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 4.02E-07 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH2-22
Test: Falling Head - 1 of 1
Date: March 8, 2022



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F}\frac{1}{t*}\ln\left(\frac{\Delta H*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 2.06124

Well Parameters:

L	1.5	m	Saturated length of screen or open hole
D	0.031	m	Diameter of well
r_c	0.0155	m	Radius of well

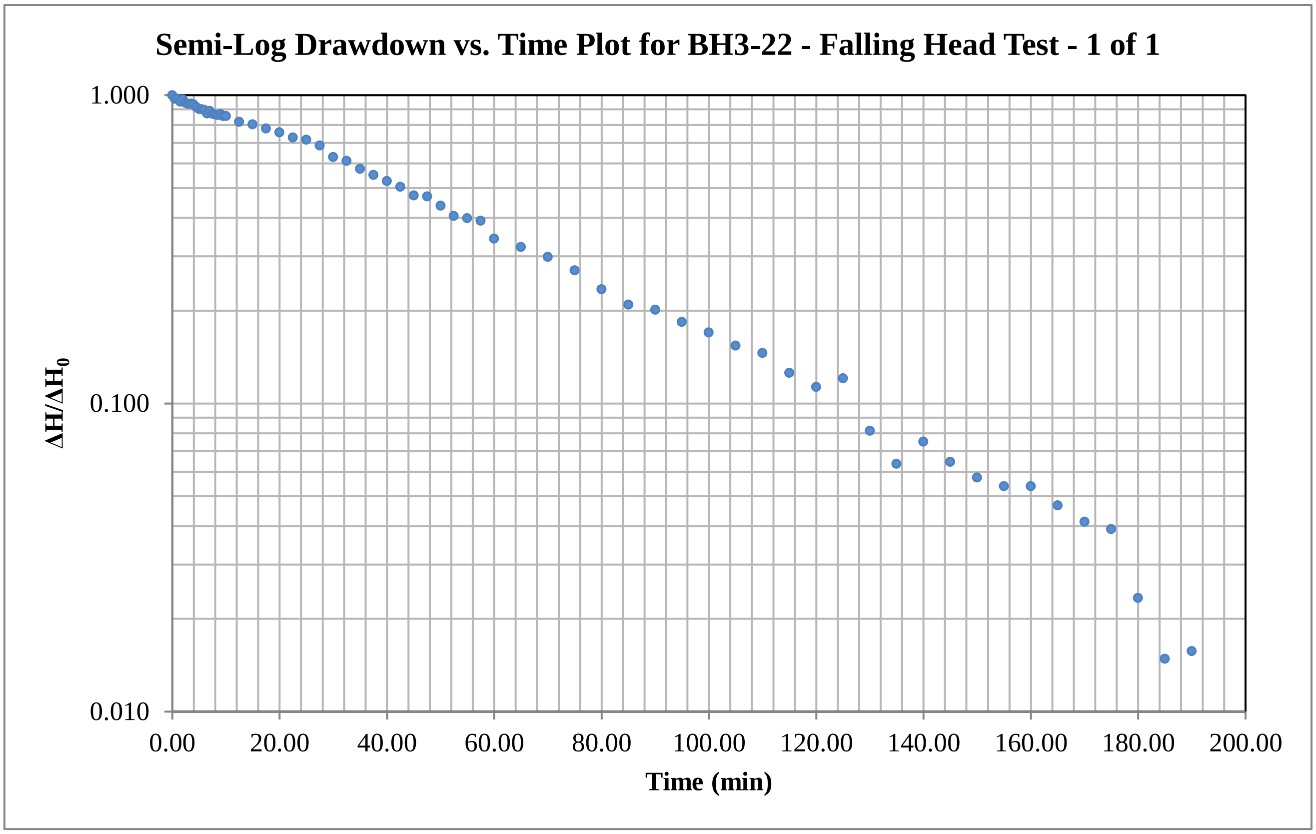
Data Points (from plot):

t*: 476.825 minutes $\Delta H*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 1.27E-08 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH3-22
Test: Falling Head - 1 of 1
Date: March 8, 2022



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 2.3019

Well Parameters:

L	1.5	m	Saturated length of screen or open hole
D	0.05	m	Diameter of well
r_c	0.025	m	Radius of well

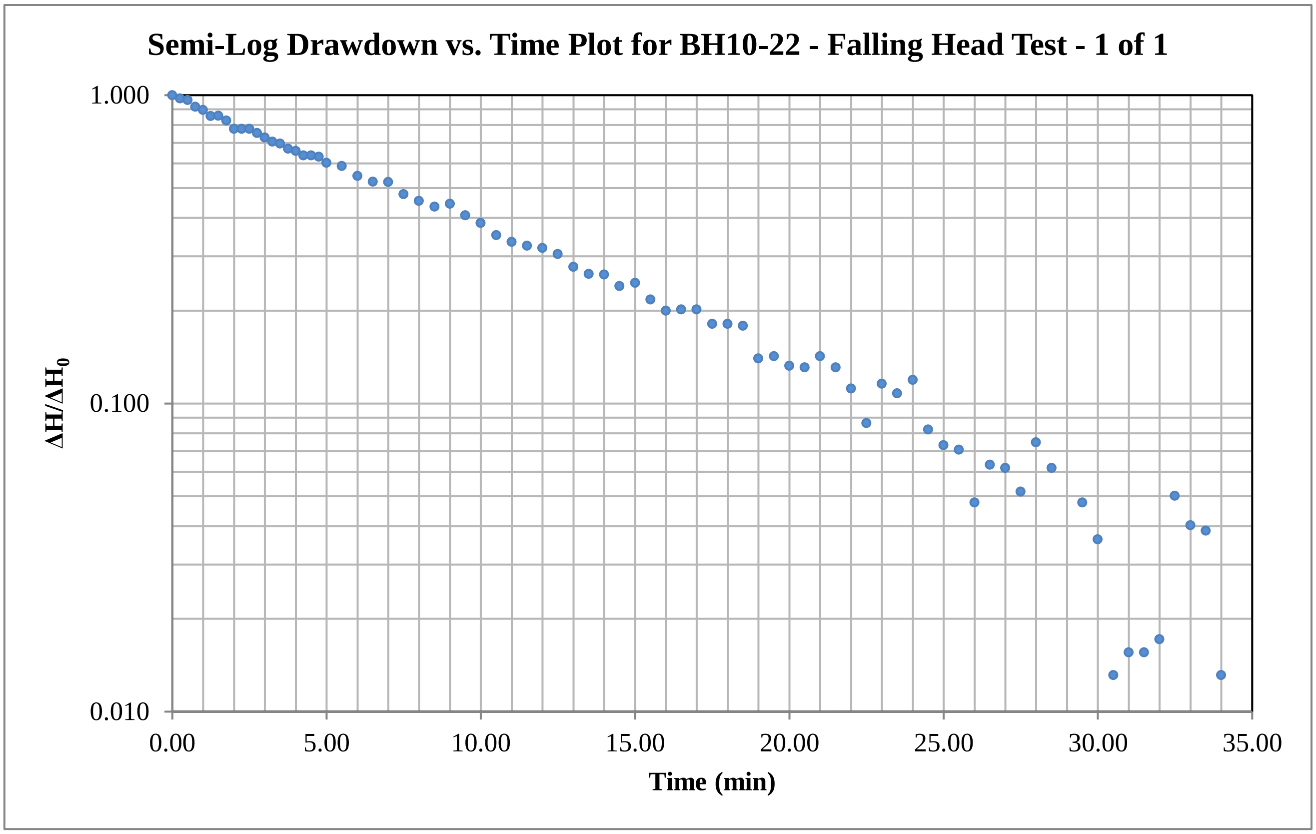
Data Points (from plot):

t*: 58.801 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 2.40E-07 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH10-22
Test: Falling Head - 1 of 1
Date: March 8, 2022


Semi-Log Drawdown vs. Time Plot for BH10-22 - Falling Head Test - 1 of 1

Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 2.06124

Well Parameters:

L	1.5	m	Saturated length of screen or open hole
D	0.031	m	Diameter of well
r_c	0.0155	m	Radius of well

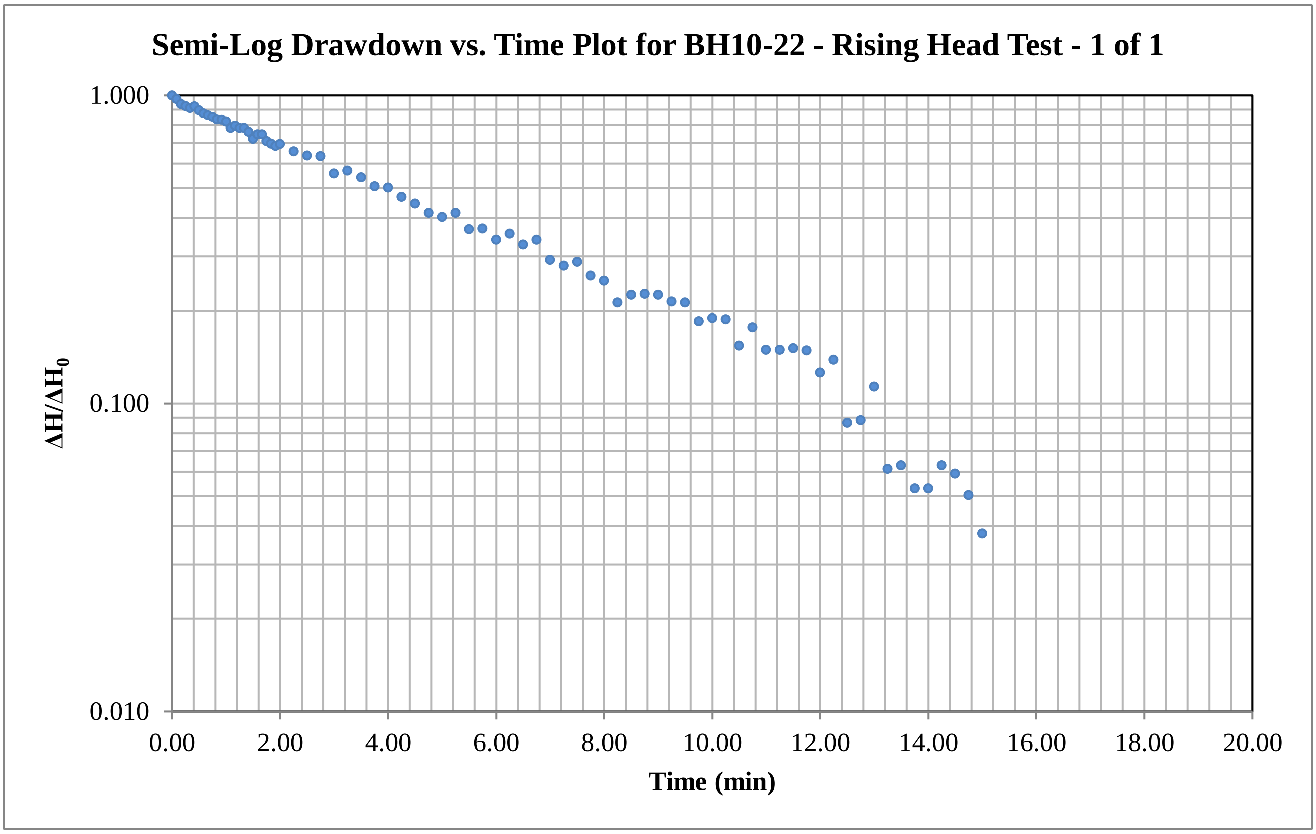
Data Points (from plot):

t*: 10.301 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 5.89E-07 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH10-22
Test: Rising Head - 1 of 1
Date: March 8, 2022



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 2.06124

Well Parameters:

L	1.5	m	Saturated length of screen or open hole
D	0.031	m	Diameter of well
r_c	0.0155	m	Radius of well

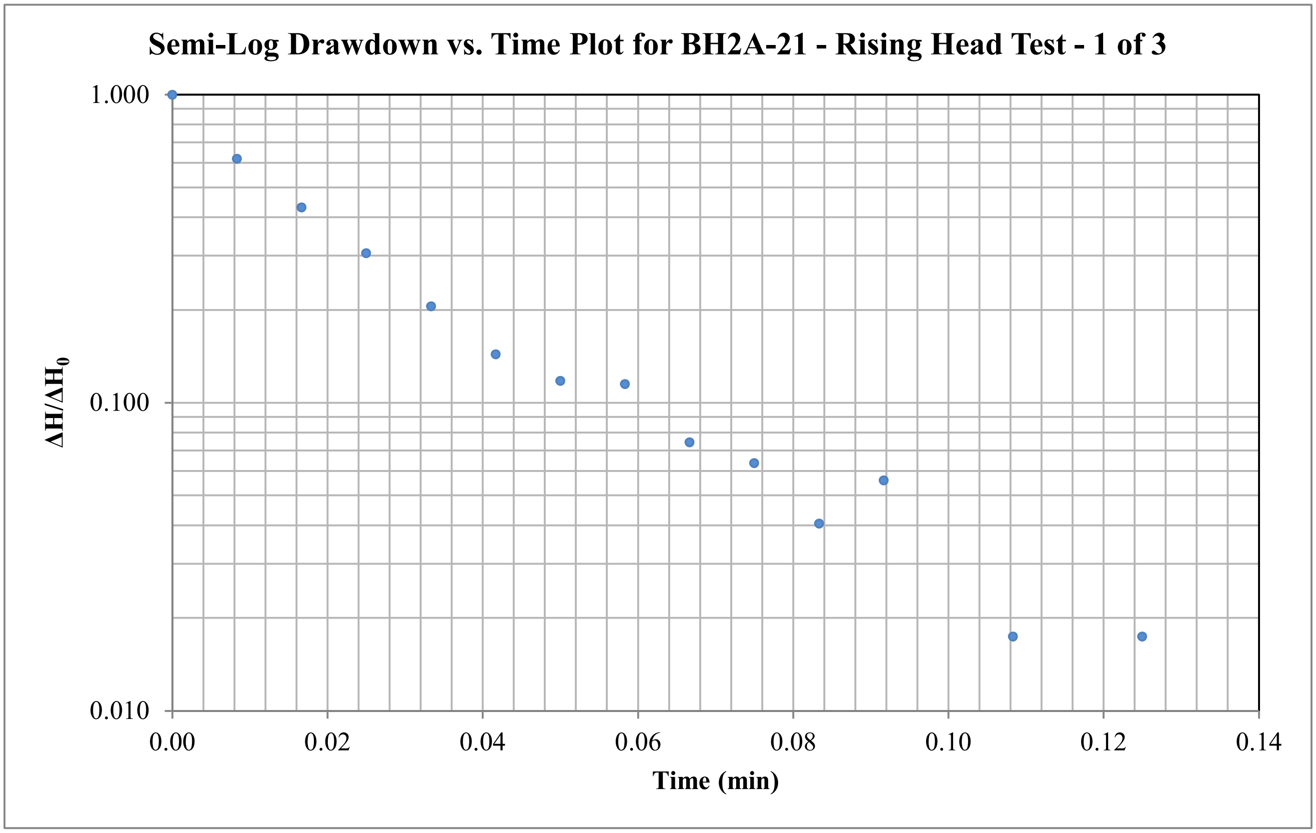
Data Points (from plot):

t*: 5.750 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 1.06E-06 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH2A-21
Test: Rising Head - 1 of 3
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3 m	Saturated length of screen or open hole
D	0.05 m	Diameter of well
r_c	0.025 m	Radius of well

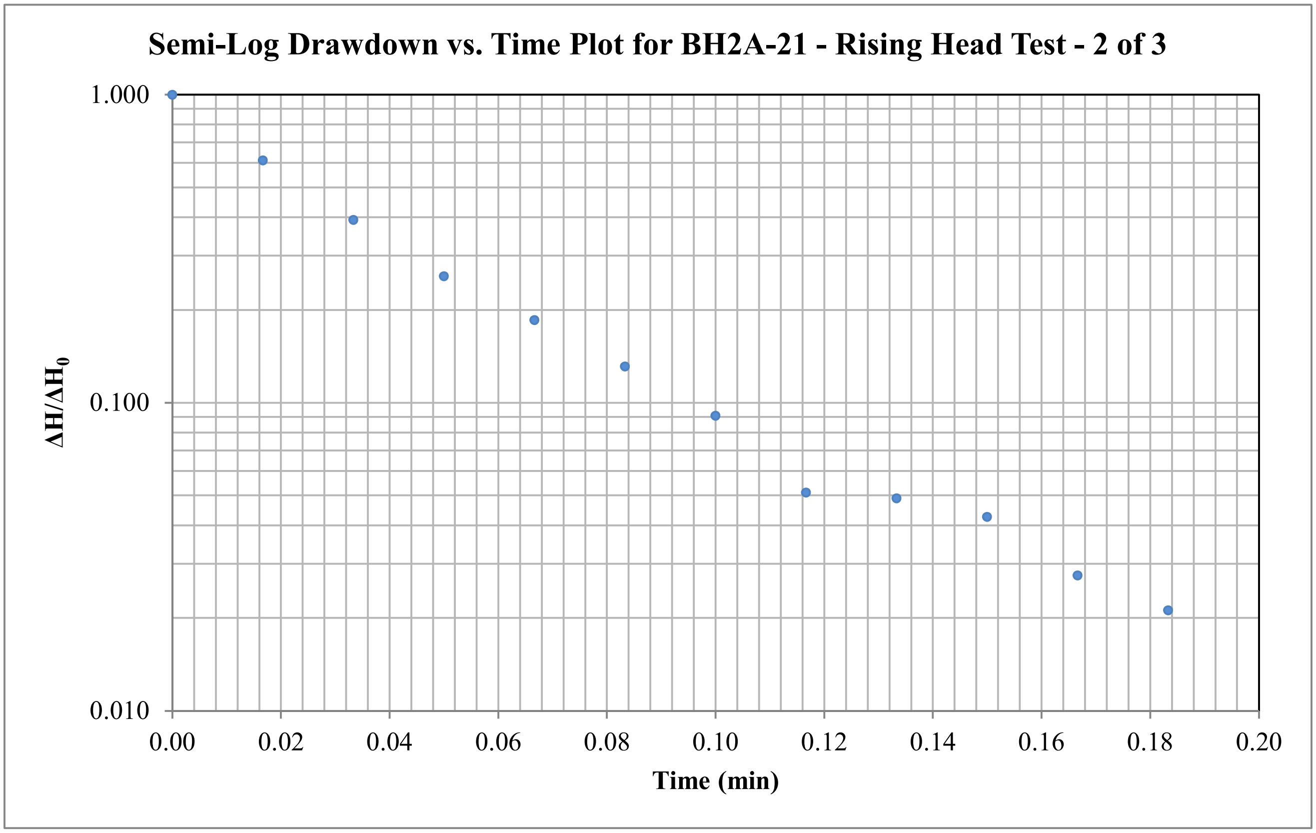
Data Points (from plot):

t*: 0.025 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 3.33E-04 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH2A-21
Test: Rising Head - 2 of 3
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3	m	Saturated length of screen or open hole
D	0.05	m	Diameter of well
r_c	0.025	m	Radius of well

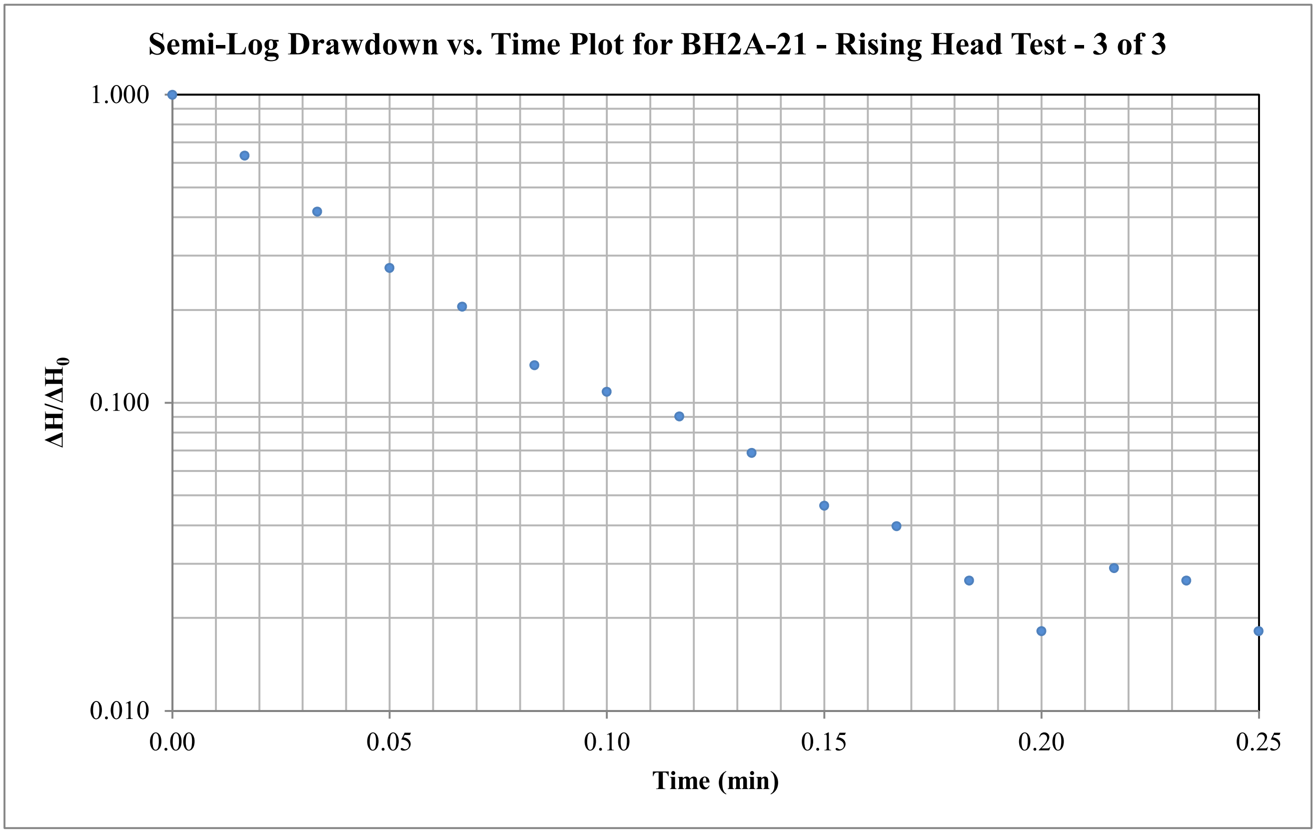
Data Points (from plot):

t*: 0.036 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 2.29E-04 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH2A-21
Test: Rising Head - 3 of 3
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t*} \ln\left(\frac{\Delta H *}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3 m	Saturated length of screen or open hole
D	0.05 m	Diameter of well
r_c	0.025 m	Radius of well

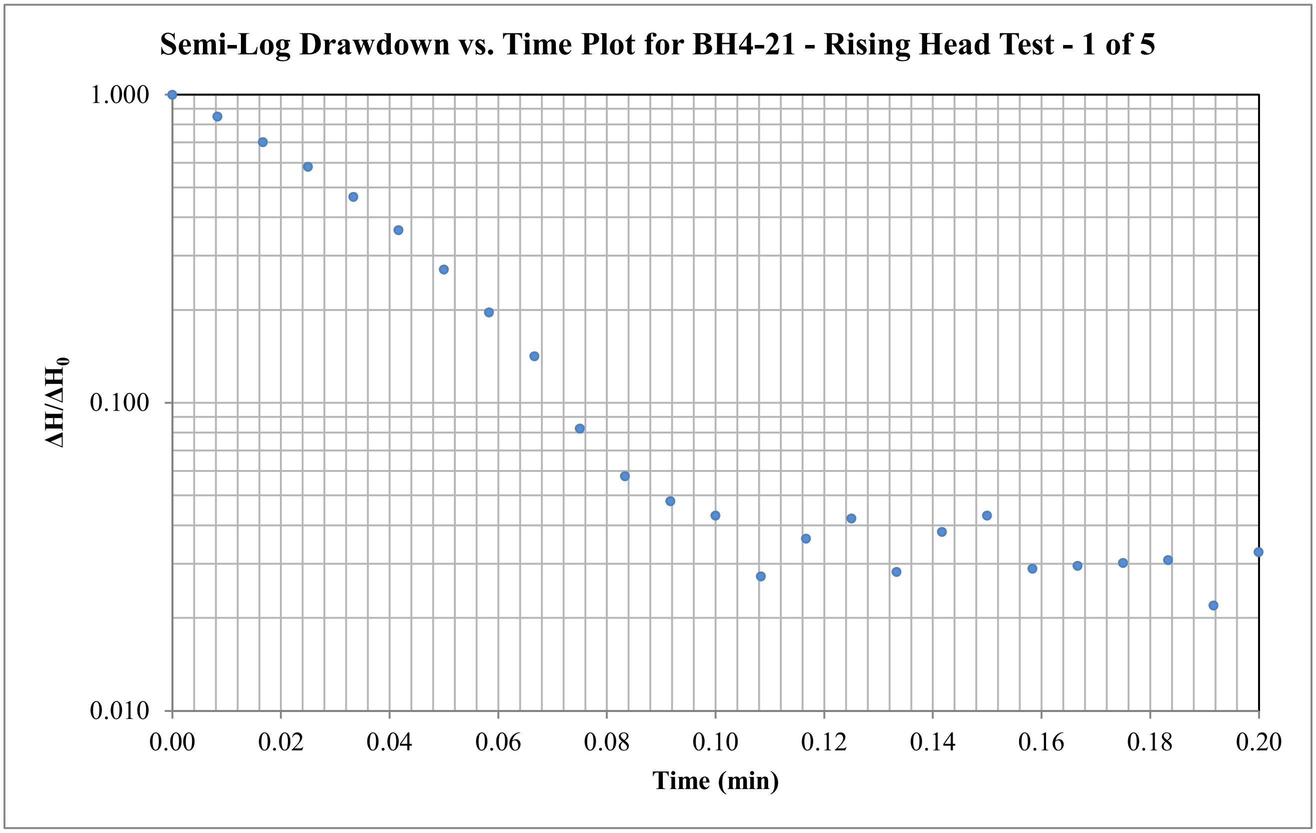
Data Points (from plot):

t*: 0.039 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 2.13E-04 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH4-21
Test: Rising Head - 1 of 5
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3	m	Saturated length of screen or open hole
D	0.05	m	Diameter of well
r_c	0.025	m	Radius of well

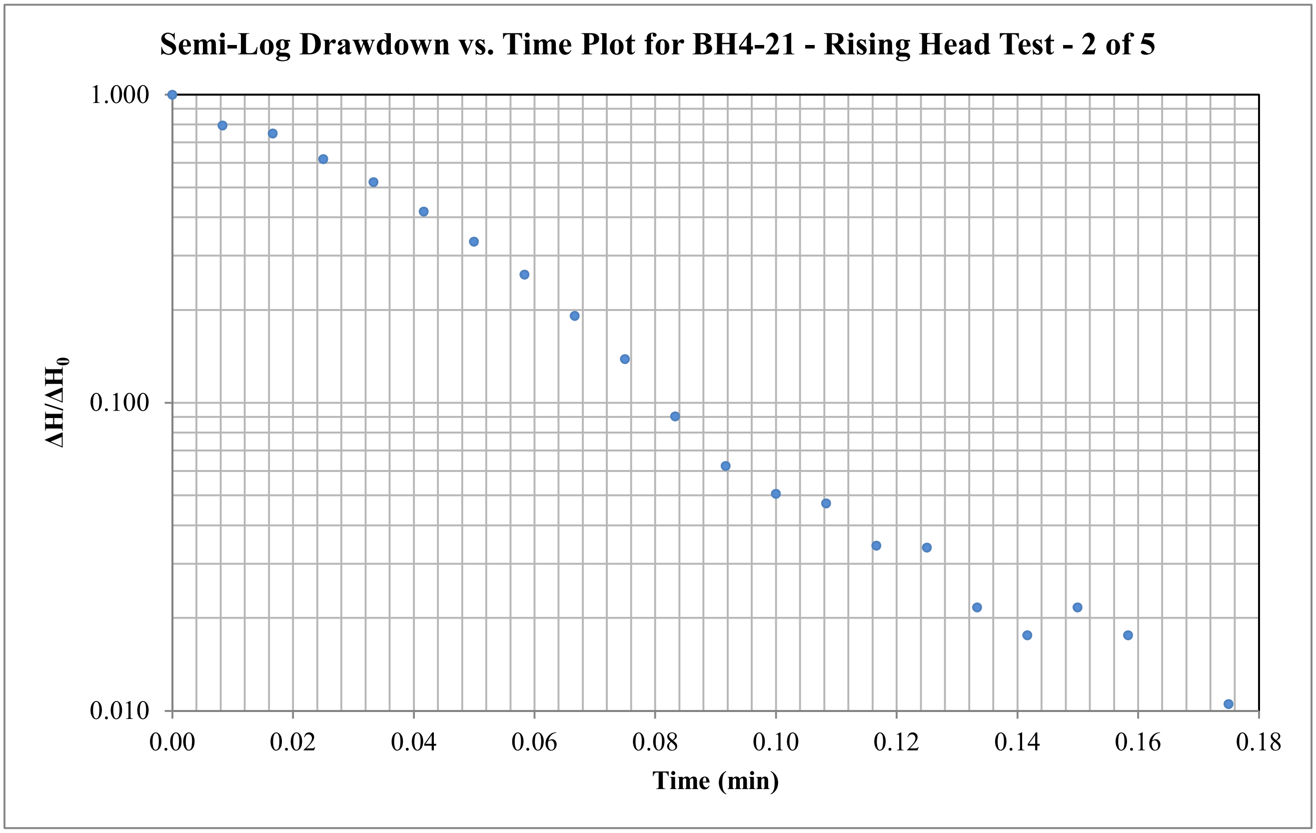
Data Points (from plot):

t*: 0.041 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 2.01E-04 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH4-21
Test: Rising Head - 2 of 5
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3 m	Saturated length of screen or open hole
D	0.05 m	Diagonal of well
r_c	0.025 m	Radius of well

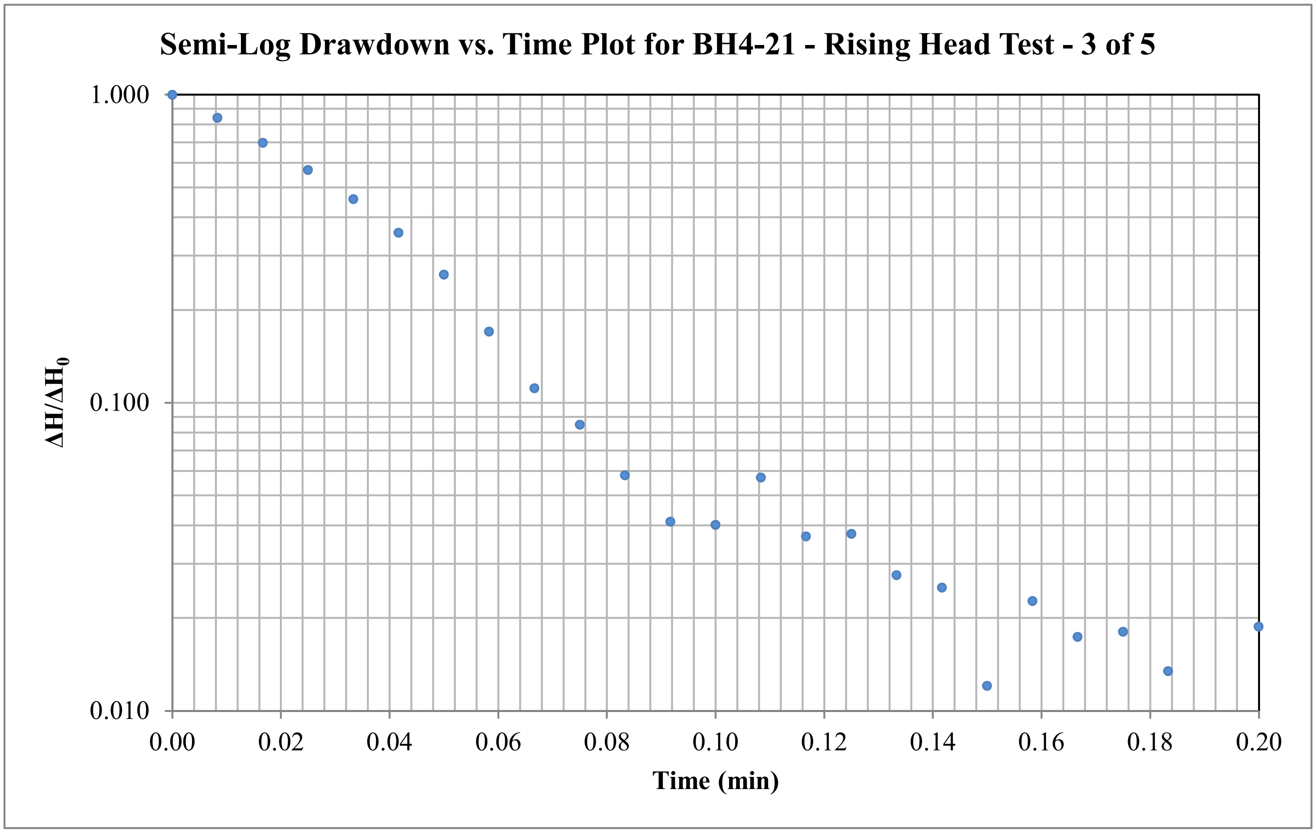
Data Points (from plot):

t*: 0.046 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 1.78E-04 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH4-21
Test: Rising Head - 3 of 5
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3 m	Saturated length of screen or open hole
D	0.05 m	Diameter of well
r_c	0.025 m	Radius of well

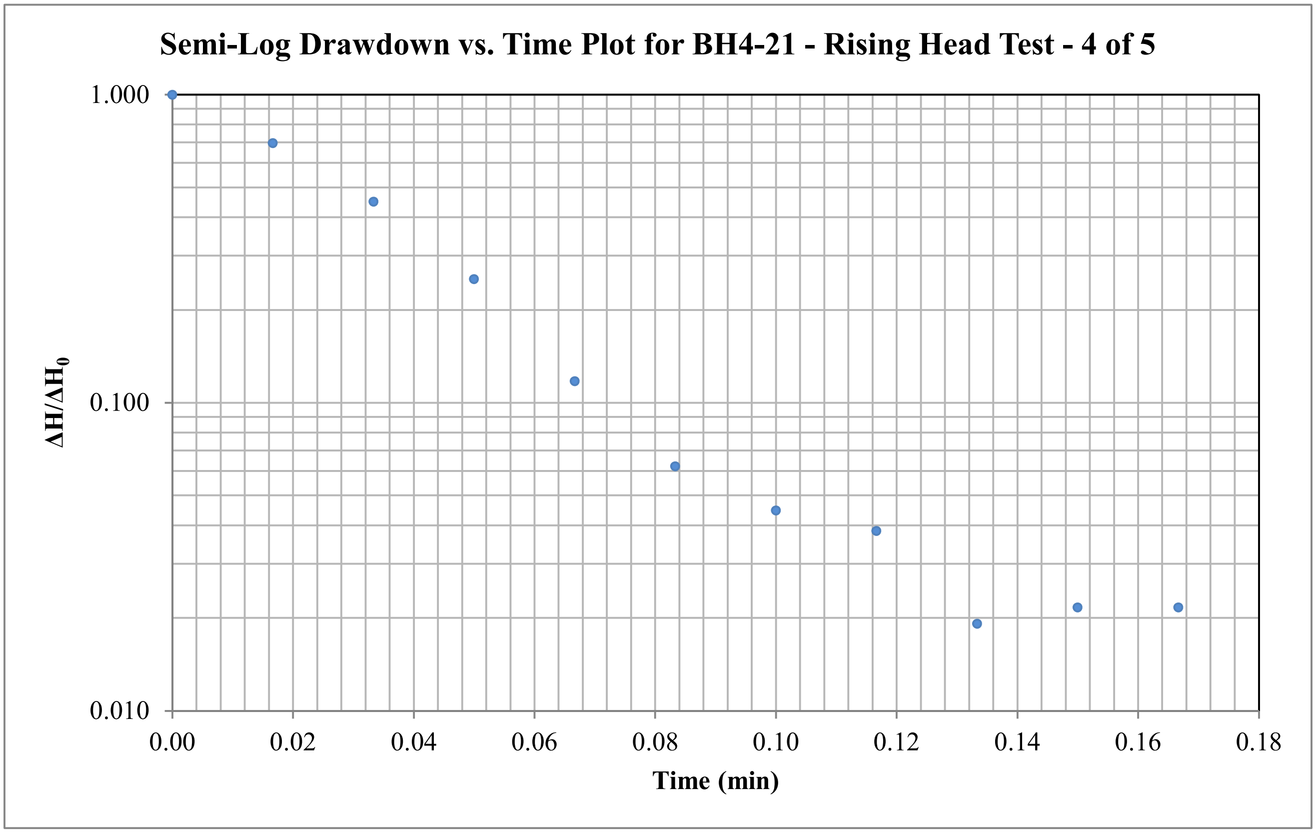
Data Points (from plot):

t*: 0.041 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 2.04E-04 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH4-21
Test: Rising Head - 4 of 5
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3 m	Saturated length of screen or open hole
D	0.05 m	Diameter of well
r_c	0.025 m	Radius of well

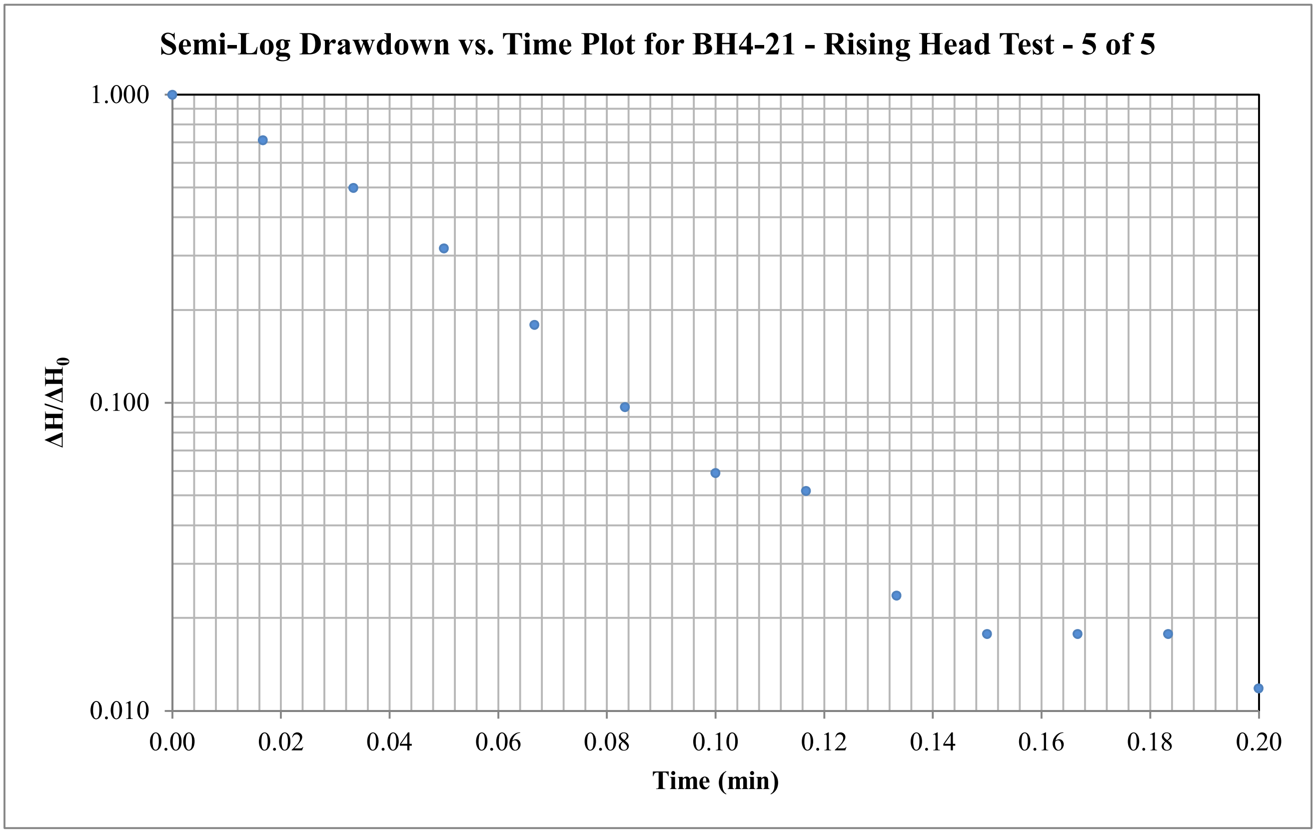
Data Points (from plot):

t*: 0.040 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 2.06E-04 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH4-21
Test: Rising Head - 5 of 5
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3	m	Saturated length of screen or open hole
D	0.05	m	Diameter of well
r_c	0.025	m	Radius of well

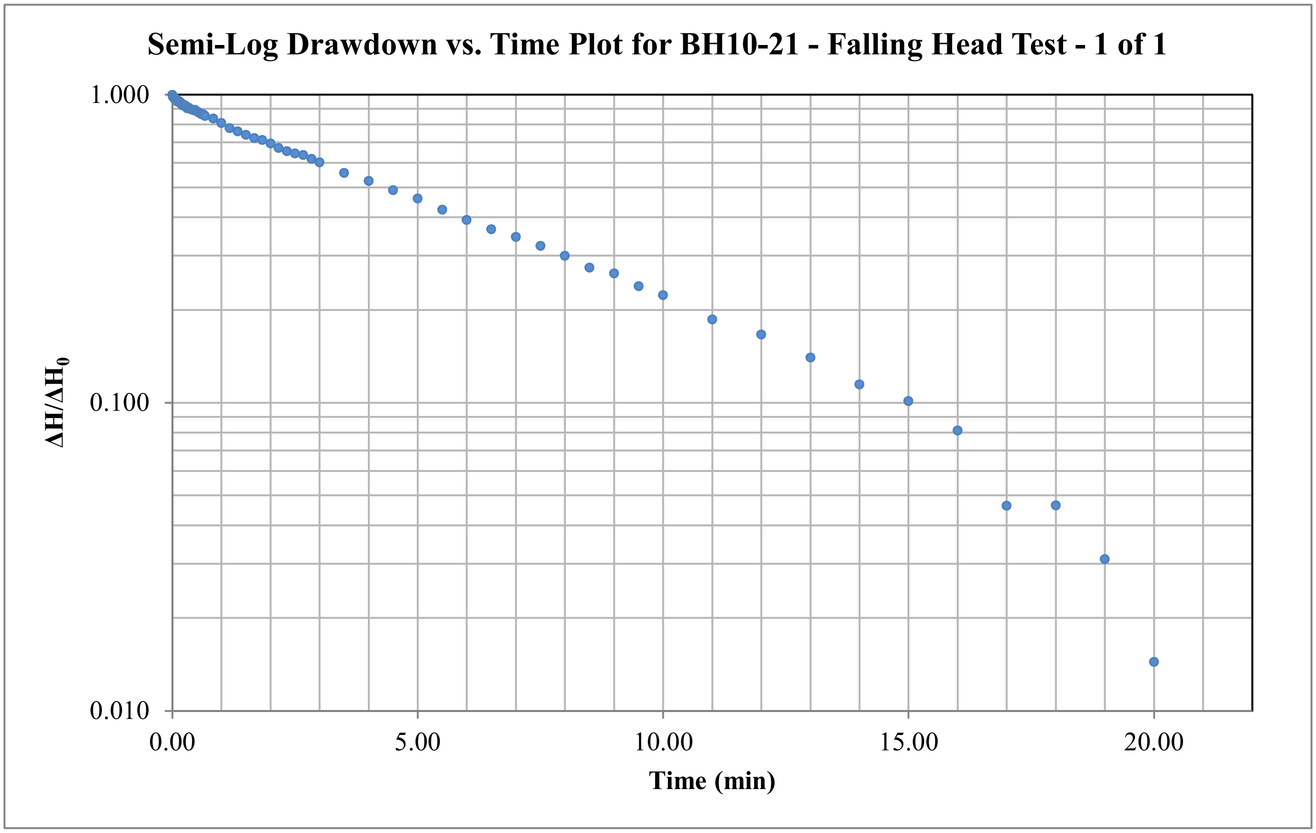
Data Points (from plot):

t*: 0.045 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 1.83E-04 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH10-21
Test: Falling Head - 1 of 1
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$\boxed{K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)}$$

Hvorslev Shape Factor

$$\boxed{F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3	m	Saturated length of screen or open hole
D	0.05	m	Diameter of well
r_c	0.025	m	Radius of well

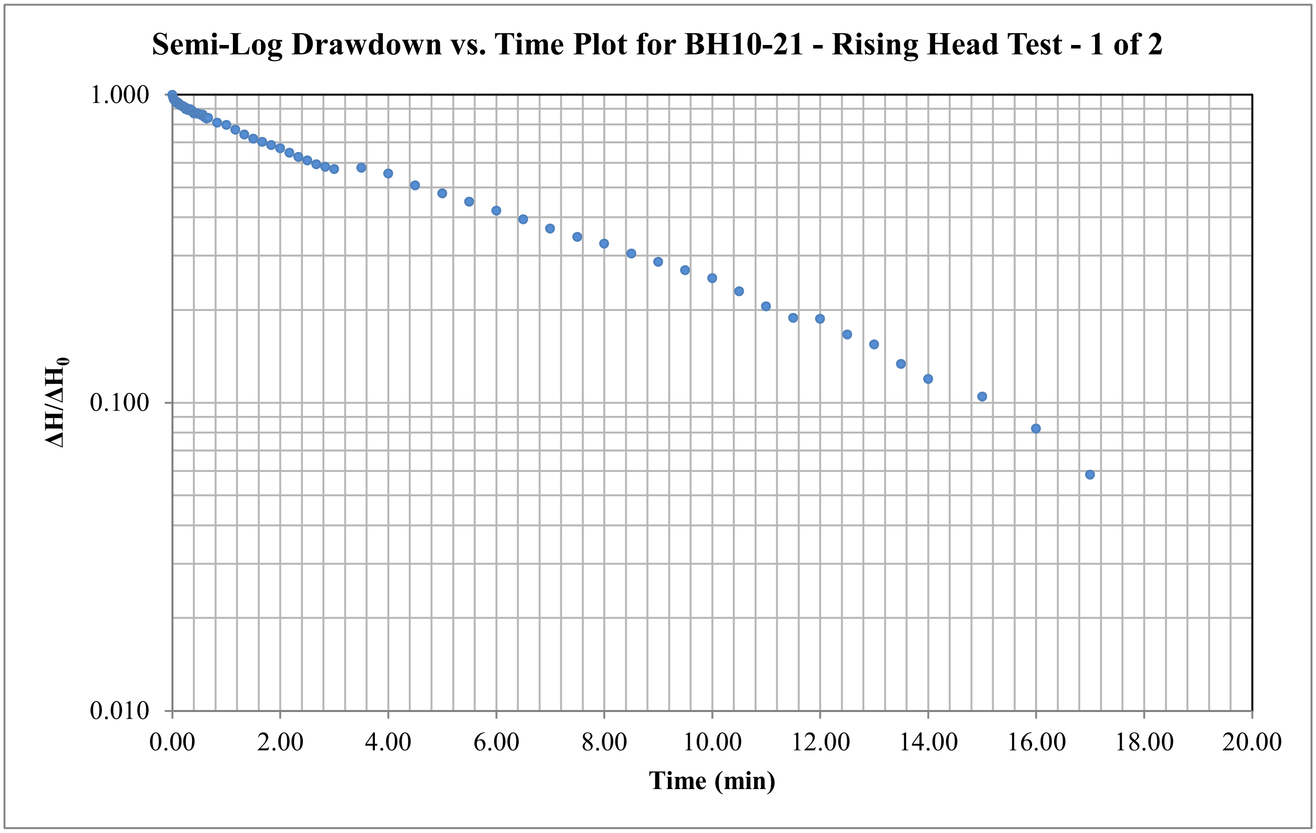
Data Points (from plot):

t*: 6.430 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 1.29E-06 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH10-21
Test: Rising Head - 1 of 2
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3 m	Saturated length of screen or open hole
D	0.05 m	Diameter of well
r_c	0.025 m	Radius of well

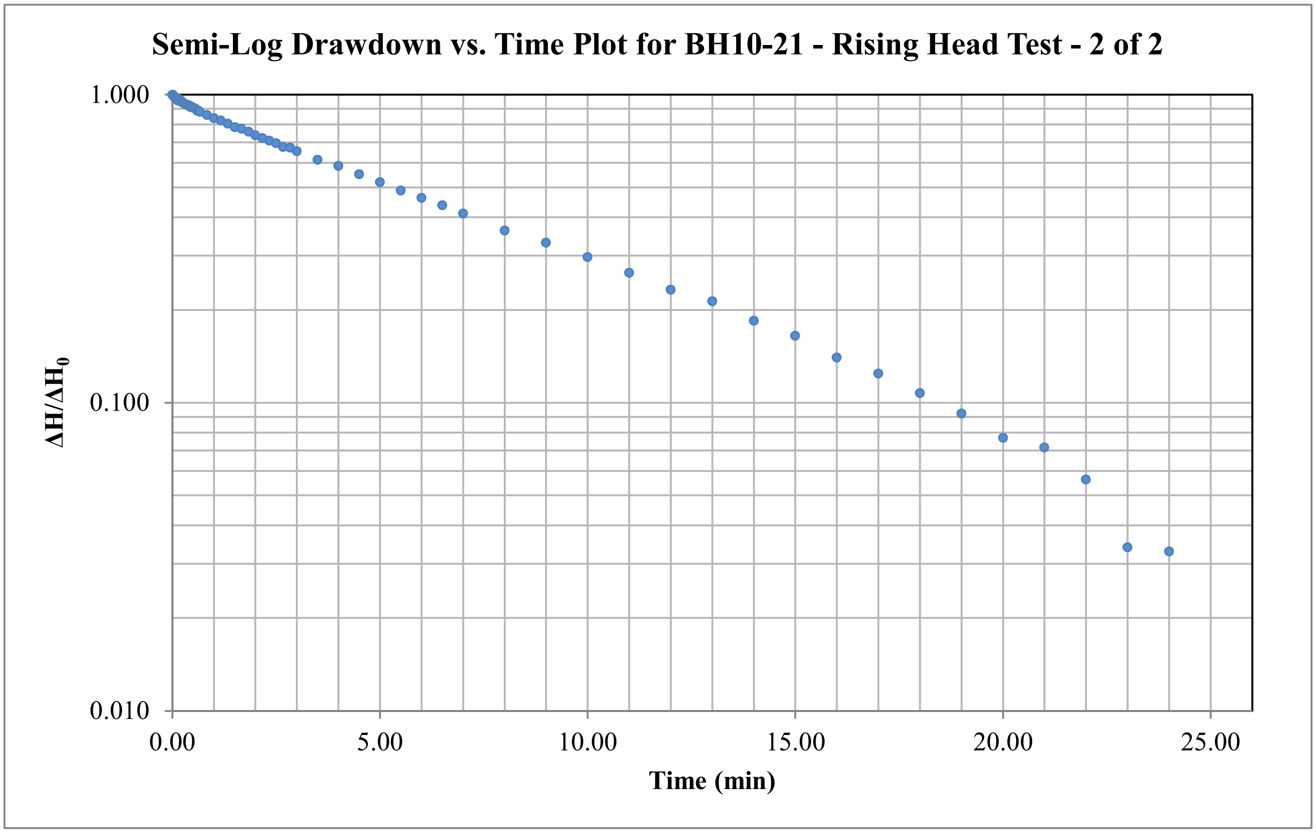
Data Points (from plot):

t*: 6.977 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 1.18E-06 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH10-21
Test: Rising Head - 2 of 2
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3	m	Saturated length of screen or open hole
D	0.05	m	Diameter of well
r_c	0.025	m	Radius of well

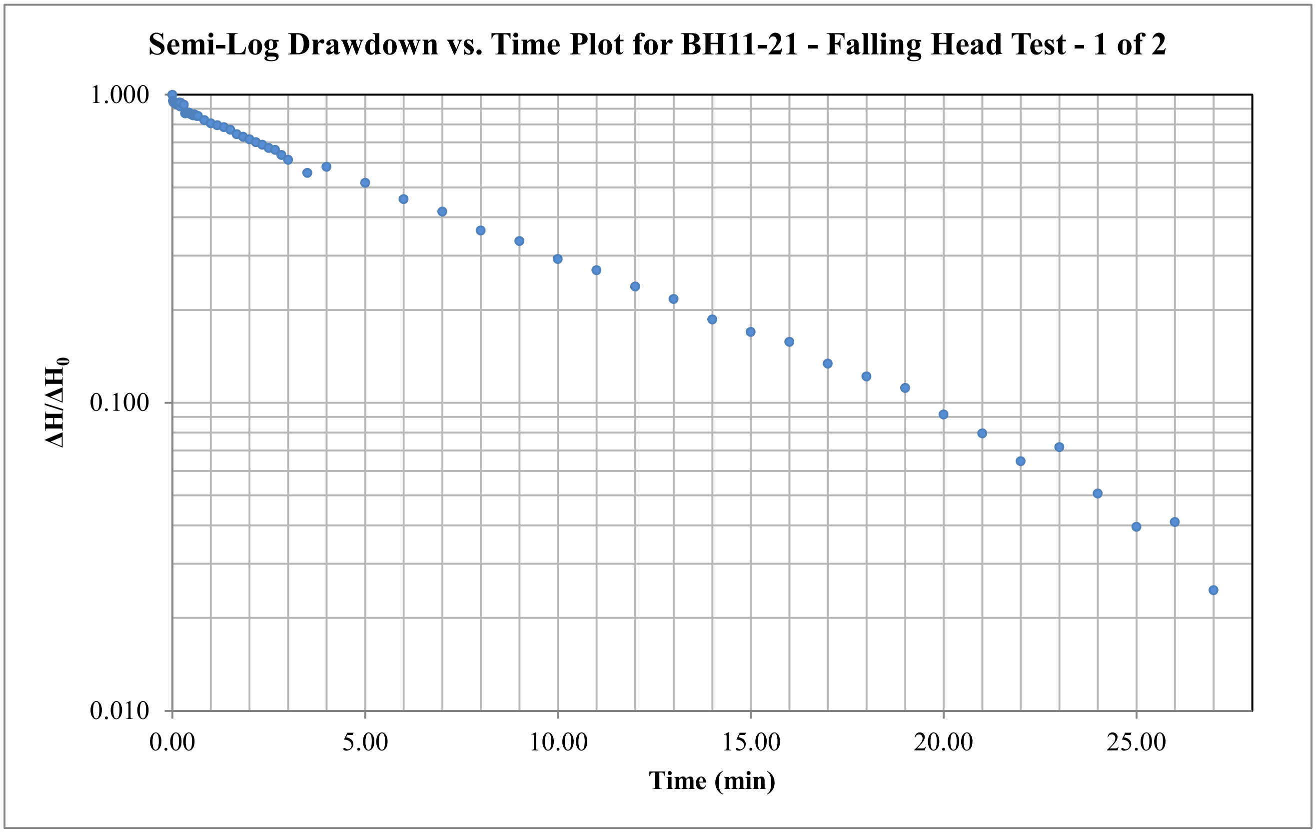
Data Points (from plot):

t*: 7.869 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 1.05E-06 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH11-21
Test: Falling Head - 1 of 2
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3 m	Saturated length of screen or open hole
D	0.05 m	Diameter of well
r_c	0.025 m	Radius of well

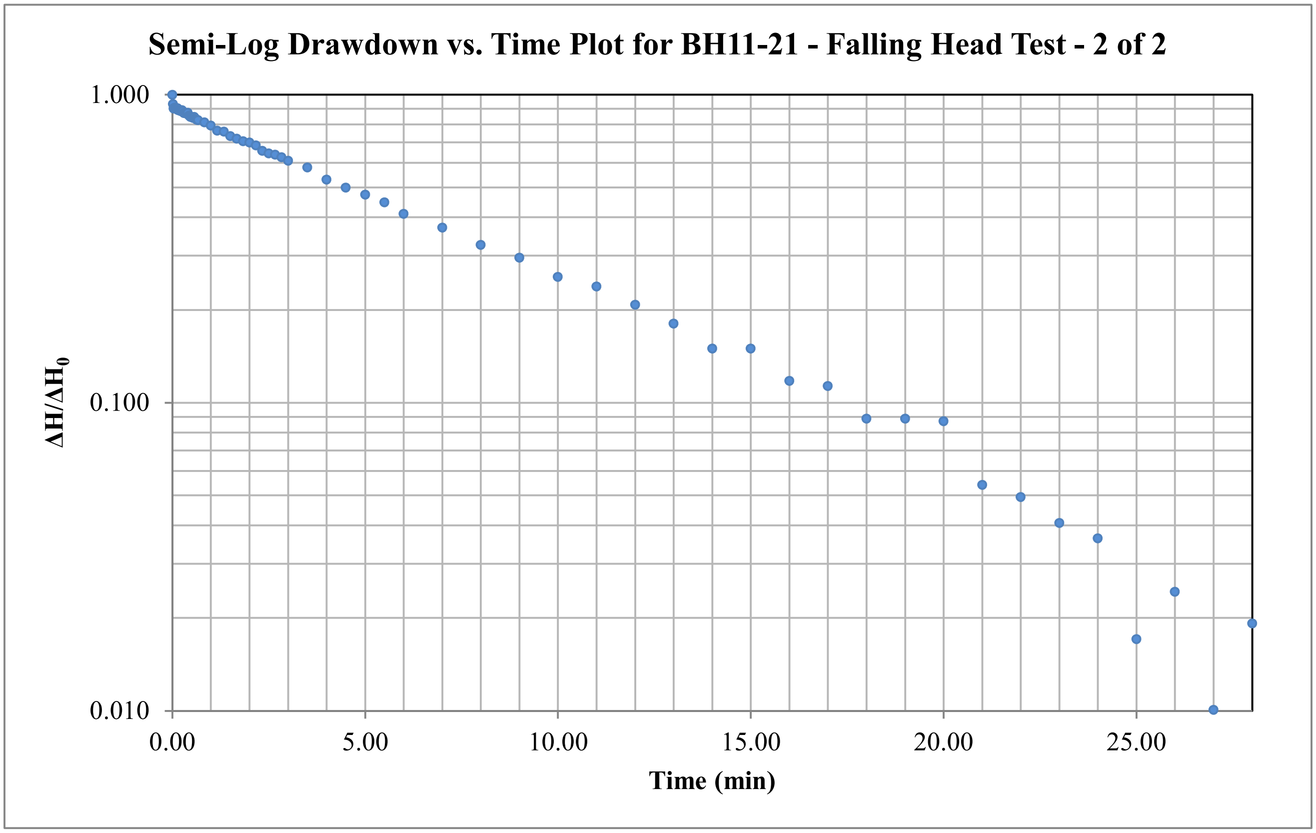
Data Points (from plot):

t*: 7.863 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 1.05E-06 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH11-21
Test: Falling Head - 2 of 2
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t*} \ln\left(\frac{\Delta H *}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3 m	Saturated length of screen or open hole
D	0.05 m	Diameter of well
r_c	0.025 m	Radius of well

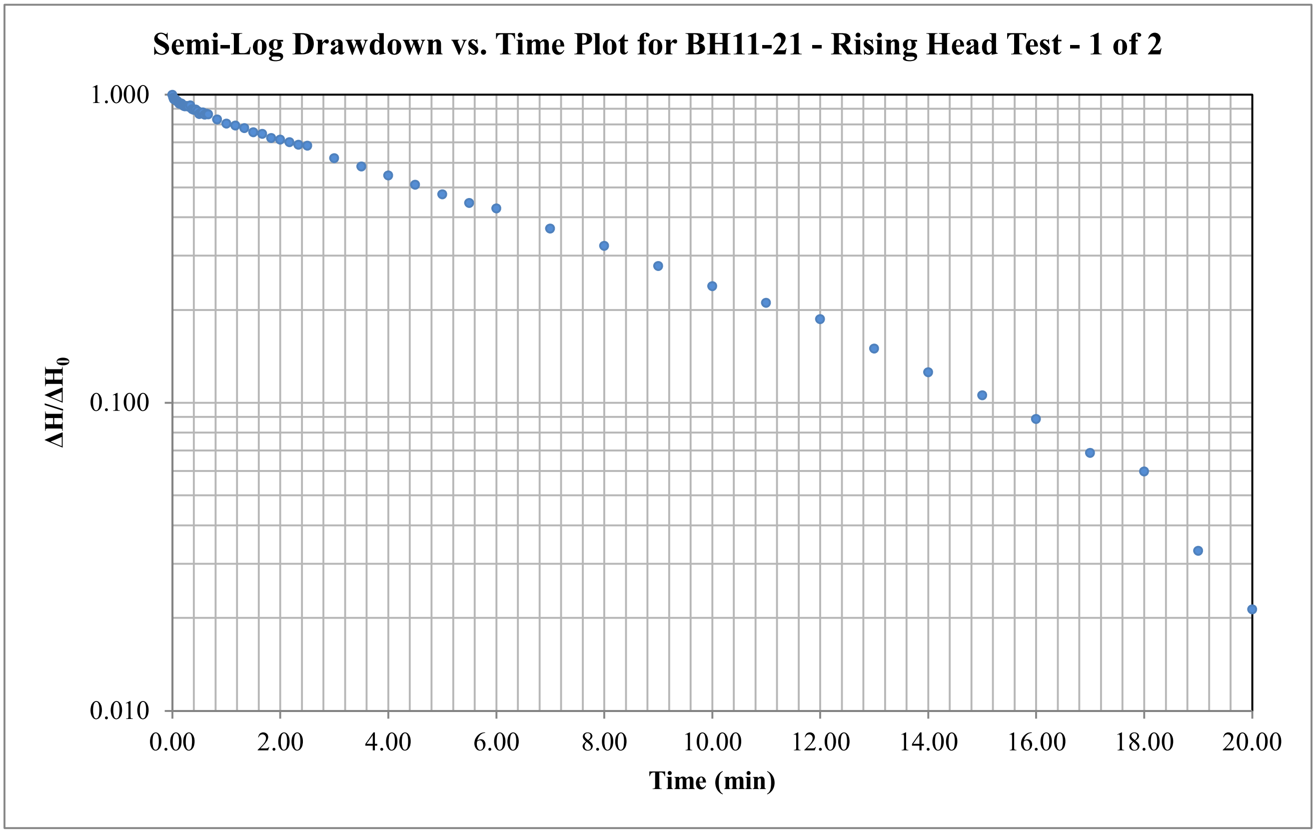
Data Points (from plot):

t*: 7.152 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 1.16E-06 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH11-21
Test: Rising Head - 1 of 2
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F}\frac{1}{t^*}\ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3 m	Saturated length of screen or open hole
D	0.05 m	Diameter of well
r_c	0.025 m	Radius of well

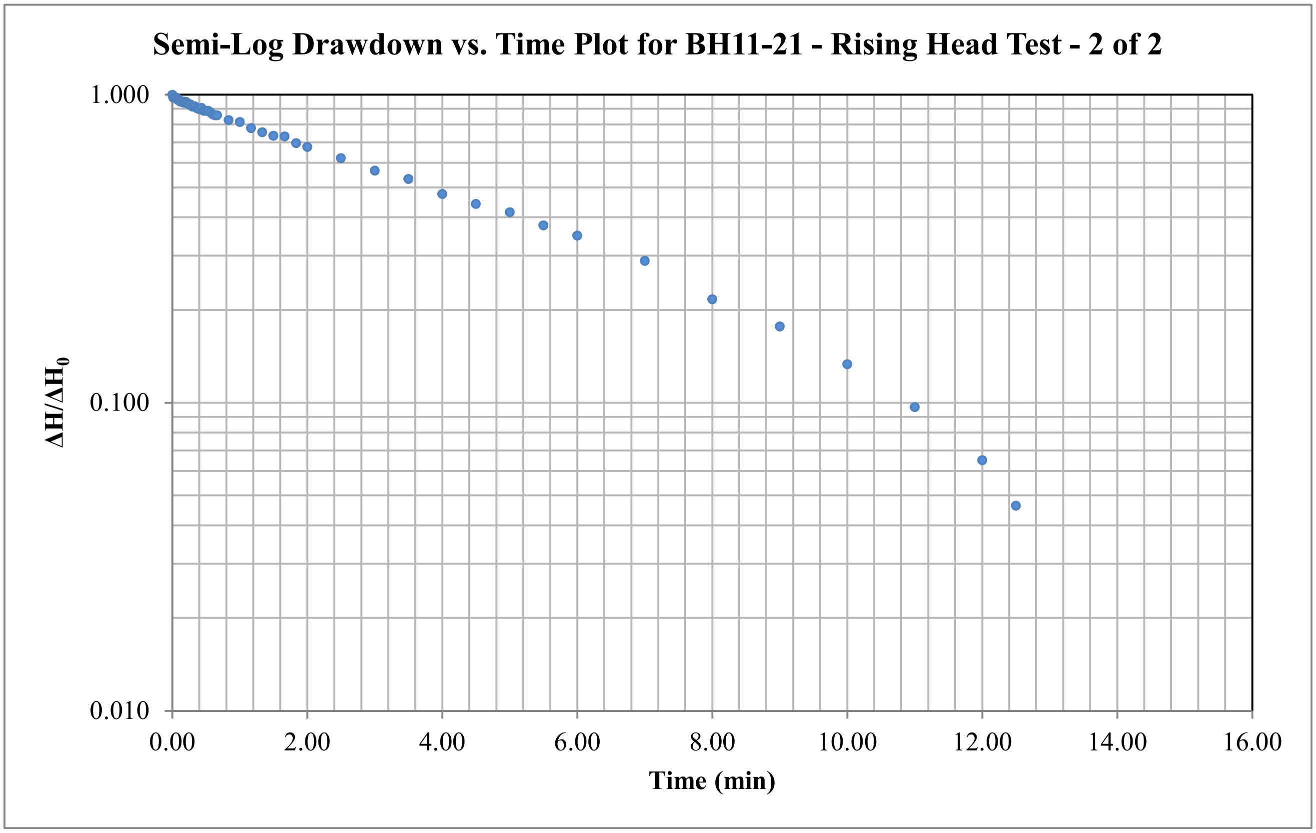
Data Points (from plot):

t*: 6.868 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 1.20E-06 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: 2 Robinson LP - 2 Robinson Avenue
Test Location: BH11-21
Test: Rising Head - 2 of 2
Date: August 24, 2021



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 3.93725

Well Parameters:

L	3 m	Saturated length of screen or open hole
D	0.05 m	Diameter of well
r_c	0.025 m	Radius of well

Data Points (from plot):

t*: 5.621 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 1.47E-06 m/sec

Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 33972

Report Date: 03-Mar-2022

Order Date: 25-Feb-2022

Project Description: PG4811

	Client ID:	BH3-22 SS5	-	-	-
	Sample Date:	17-Feb-22 09:00	-	-	-
	Sample ID:	2209482-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	86.1	-	-	-
General Inorganics					
pH	0.05 pH Units	7.79	-	-	-
Resistivity	0.10 Ohm.m	29.2	-	-	-
Anions					
Chloride	5 ug/g dry	74	-	-	-
Sulphate	5 ug/g dry	107	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURE 2 - SECTION A - STATIC CONDITIONS

FIGURE 3 - SECTION A - SEISMIC CONDITIONS

DRAWING PG4811-1 - TEST HOLE LOCATION PLAN

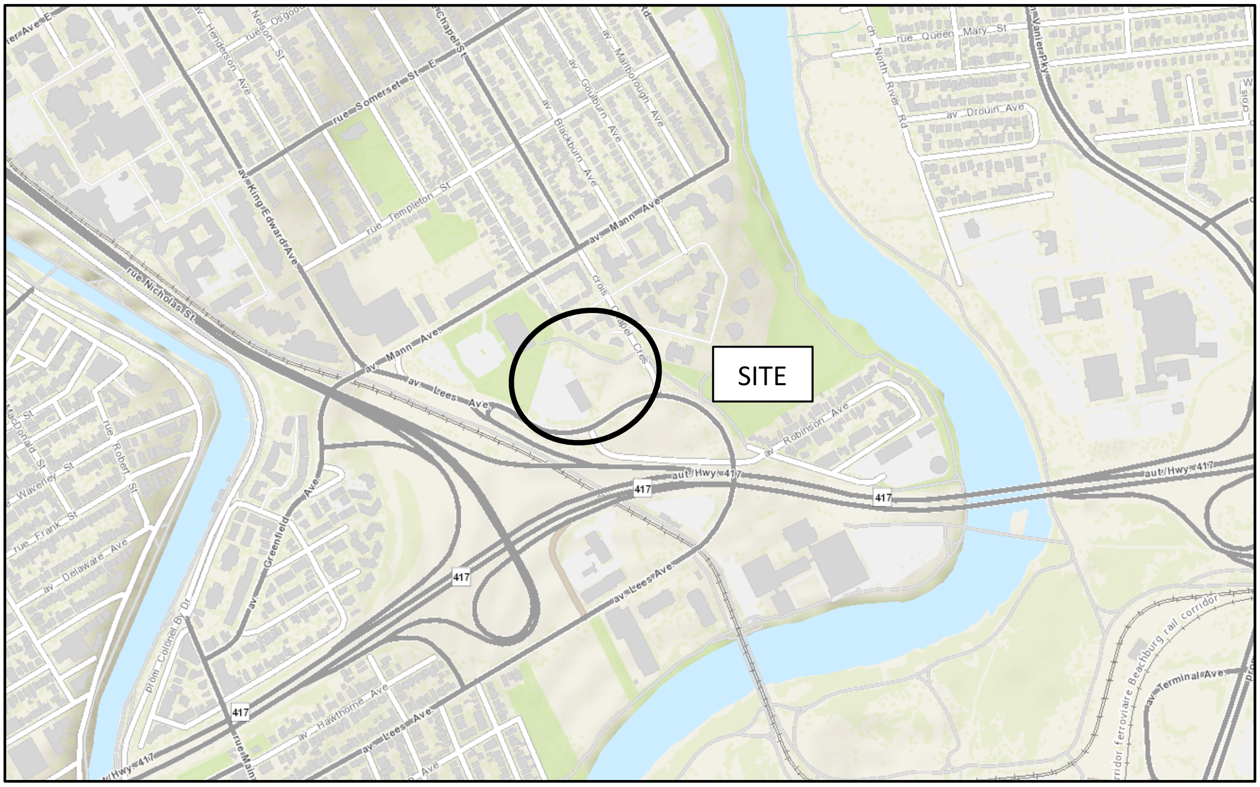


FIGURE 1

KEY PLAN

PATERSON
GROUP

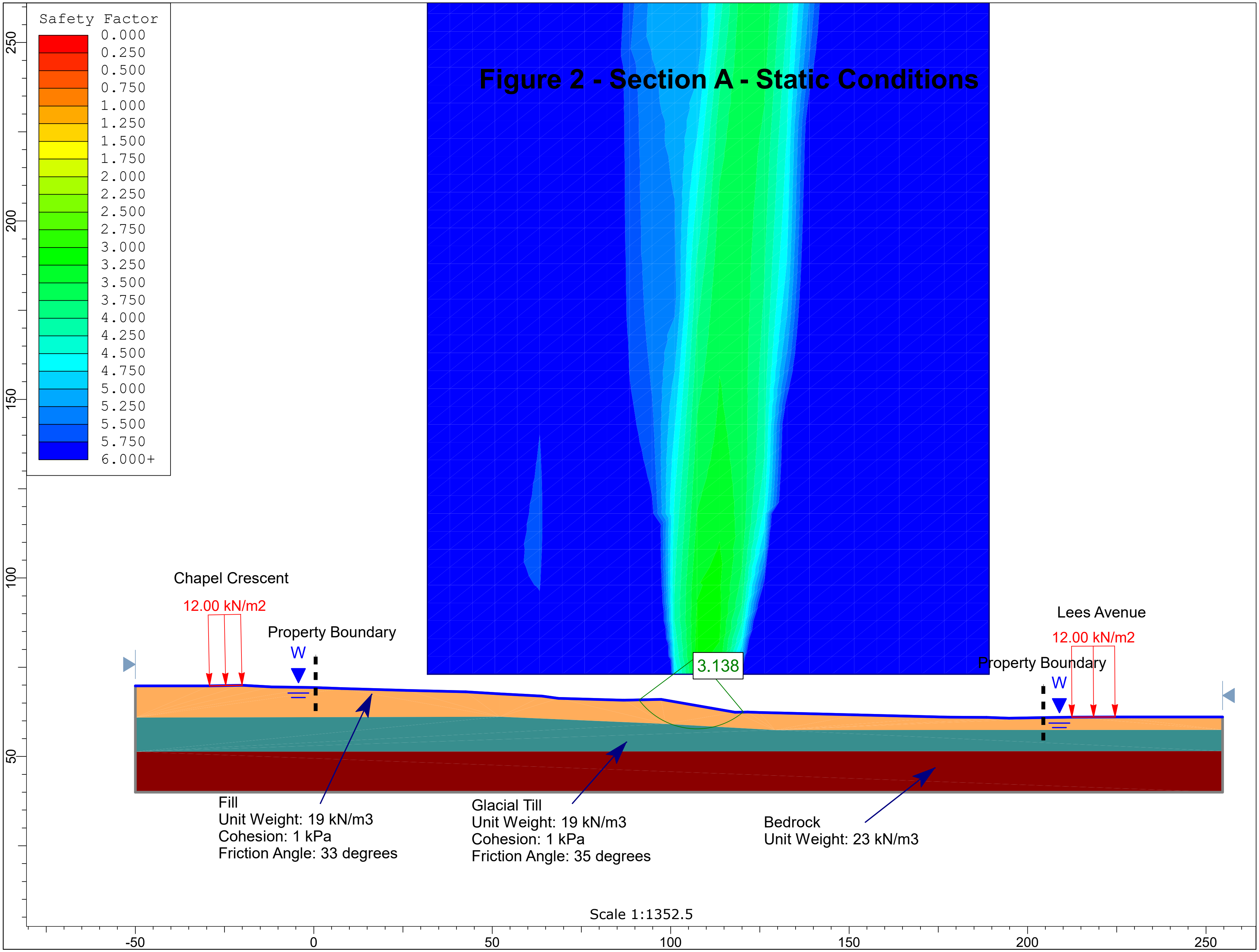


Figure 2 - Section A - Static Conditions

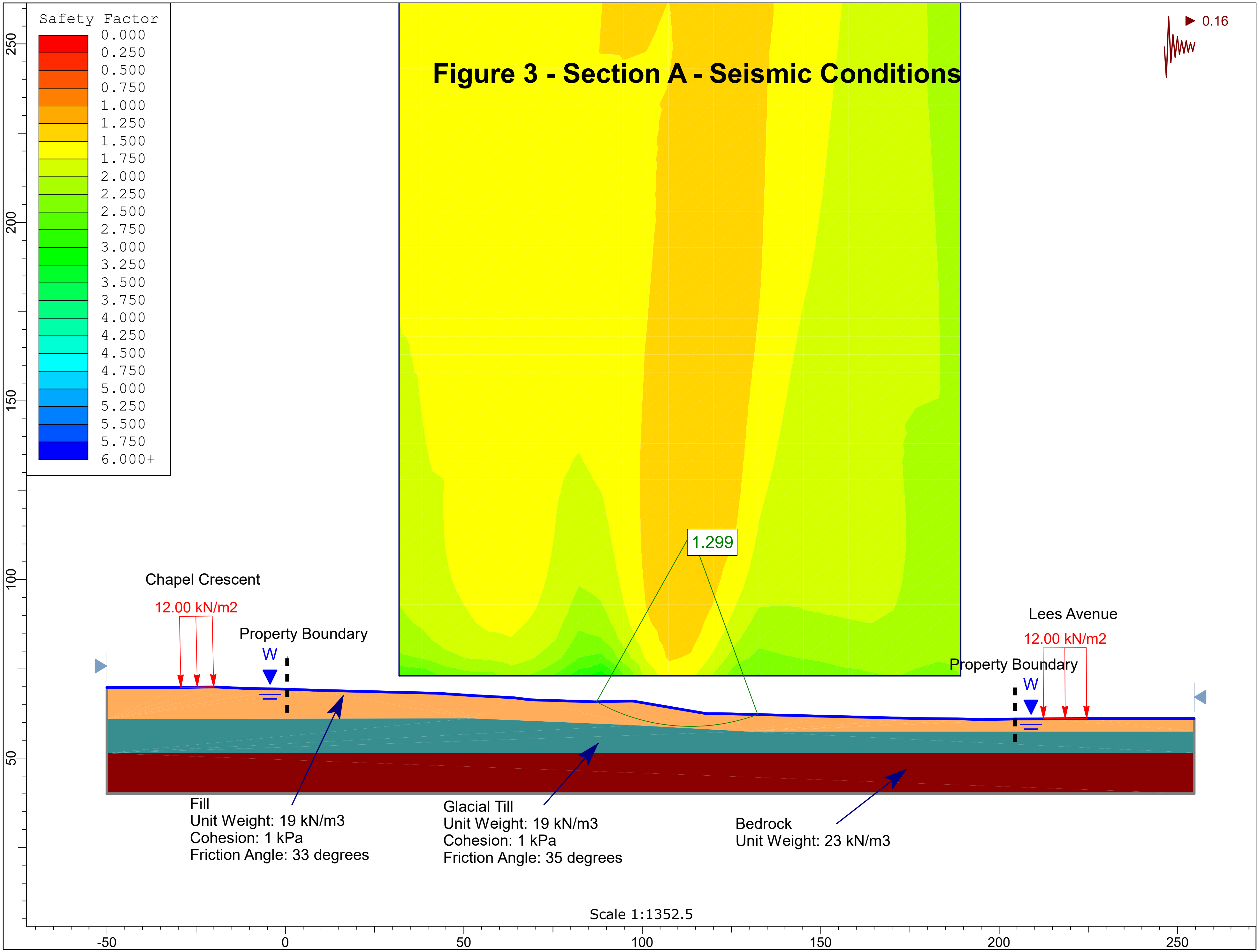
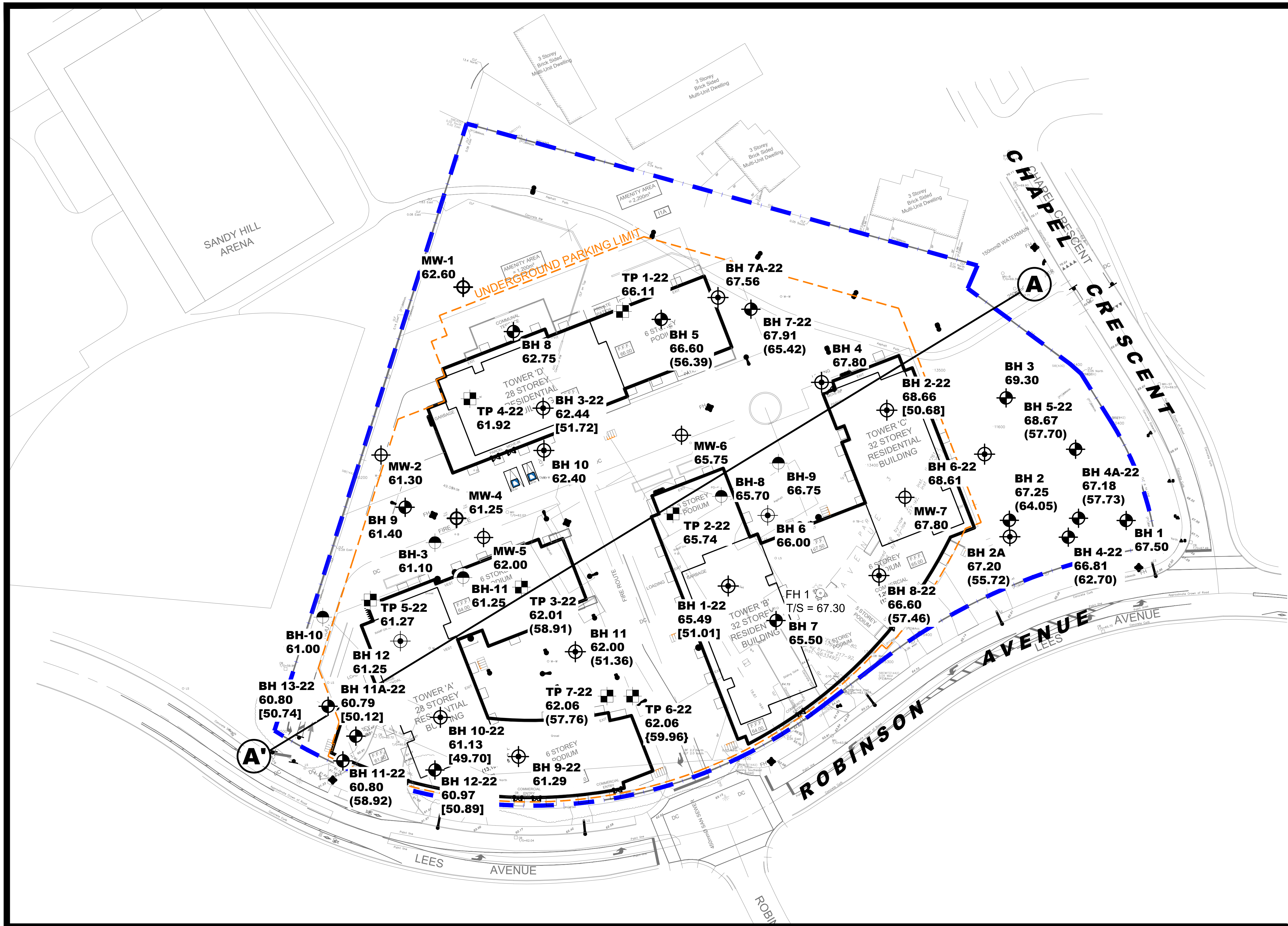


Figure 3 - Section A - Seismic Conditions



LEGEND:

⊕	BOREHOLE LOCATION
⊕	BOREHOLE WITH MONITORING WELL LOCATION
▨	TEST PIT LOCATION
◓	BOREHOLE LOCATION BY OTHERS LOCATION (PINCHIN ENVIRONMENTAL STUDY,10/2018)
⊕	BOREHOLE WITH MONITORING WELL BY OTHERS (PINCHIN ENVIRONMENTAL STUDY,10/2018)
Ⓐ—Ⓐ'	CROSS SECTION LOCATION
66.81	GROUND SURFACE ELEVATION (m) (INTERPOLATED FROM CITY TOPOGRAPHICAL MAPPING)
[50.68]	BEDROCK SURFACE ELEVATION (m)
{59.96}	PRACTICAL REFUSAL TO EXCAVATION ON INFERRED CONCRETE SLAB (m)
(57.36)	PRACTICAL REFUSAL TO AUGERING/DCPT ELEVATION (m)

CONCEPTUAL PLAN PROVIDED BY RODERICK LAHEY ARCHITECT INC.

GROUND SURFACE ELEVATIONS AT BOREHOLE LOCATIONS ARE REFERENCED TO A GEODETIC DATUM.

SCALE: 1:1000

0 10 20 30 40 50m 75m

PATERSON GROUP

9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
5	BH 11-22 - BH 13-22 ADDED TO PLAN	14/12/2022	NP
4	AS PER REVISED TEST PIT DATA	06/09/2022	NP
3	AS PER REVISED CONCEPTUAL PLAN	28/07/2022	NP
2	TP 1-22 - TP 7-22 ADDED TO PLAN BH 1-22 - BH 10-22 ADDED TO PLAN	018/03/2022	NP
1	UPDATED TO INCLUDE CROSS SECTION LOCATION	28/05/2021	JV

2 ROBINSON PROPERTY LIMITED PARTNERSHIP
GEOTECHNICAL INVESTIGATION
PROPOSED MIXED-USE DEVELOPMENT
2 ROBINSON AVENUE AND 320 LEES AVENUE

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1000	Date: 03/2019
Drawn by: JM	Report No.: PG4811-1
Checked by: NP	Dwg. No.: PG4811-1
Approved by: DJG	Revision No.: 5

p:\autocad drawings\geotechnical\pg48xx\pg4811\pg4811-1 test hole location plan rev 4.dwg

11x17