Geotechnical Desktop Review: The LeBreton Flats Plan of Subdivision, Ottawa, Ontario

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National Capital Commission

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1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) has been retained by National Capital Commission (NCC, the Client) to carry out a geotechnical desktop review for the LeBreton Flats Plan of Subdivision in Ottawa, Ontario. It is understood that a preliminary geotechnical report is required as part of the Plan of Subdivision application to the City of Ottawa.

The geotechnical review was completed to summarize the subsurface conditions at the site and to provide geotechnical recommendations and design parameters. This report presents a summary of the previous investigations at the site and geotechnical design recommendations. Limitations associated with this report and its contents are provided in the Statement of General Conditions included in Appendix A.

2.0 SITE AND PROJECT DESCRIPTIONS

The site is approximately 29 hectare, a largely undeveloped transit oriented brownfield site located at the western edge of the downtown core of Ottawa, within the National Capital Region. The NCC developed a Master Concept Plan (MCP) for LeBreton Flats (approved in April 2021). The MCP area is shown in figure 2.1, the Library Parcel area (665 Albert St., Parcels A9-10) is not included in the MCP. The study area generally bounded by:

- Albert Street and Slater Street to the south;
- Trillium Pathway to the west;
- Sir John A. Macdonald Parkway and Wellington Street to the north; and
- Booth Street, Lett Street, future Empress Avenue extension and the escarpment to the east.

The Confederation Light Rail Transit (LRT) corridor bisects the study area and two O-Train stations, Bayview and Pimisi O-Train, are located within LeBreton Flats. LeBreton Flats is a brownfield site from its industrial legacy, with a portion having been remediated in the mid-2000s.

Two aqueducts cross the site, a partially buried aqueduct (a heritage feature), and a second fully buried aqueduct located on the north side of the LRT corridor between Booth Street and Nepean Bay Inlet. The approximate location of the aqueducts is shown on Drawing No.1 in Appendix B.

The East Flats is an adjacent development east of Booth Street consisting of four to 14 storey residential buildings with a new high rise building currently under construction. To the south of Albert Street is an existing residential neighborhood.

Based on the framework in the MCP, the development will include residential space, office/hotel/loft space and retail space as well as a Park District and open space network comprising approximately 12.5 hectares (43 per cent) of the 29-hectare site. It will include low- to high-rise buildings of up to 40-storeys with underground parking areas, surface pathways and access streets and lanes. The aqueducts will be maintained as a landscaping feature.

The study area is situated in close proximity to major infrastructure. In addition to above-mentioned LRT lines and stations as well as northern covered aqueduct and southern open heritage aqueduct, the following are elements of note:

- Fleet Street Water Pumping Station
- High-Pressure Transmission Watermain
- Low-Pressure Transmission Watermain (within the Open Aqueduct)
- LeBreton Flats Sanitary Pumping Station
- West-Nepean Collector Sewer, Cave Creek Collector Sewer, and Interceptor Outfall Sewer
- Combined Sewage Storage Tunnel
- Miscellaneous Sanitary and Combined Sewer Regulators and Diversion Chambers (Booth-Lloyd and Preston-Lloyd Regulator)



Figure 2.1: LeBreton Flats MCP area

3.0 BACKGROUND INFORMATION

The site was formerly occupied by residences and heavy industries, including a lumber and train yard until the early 1970's. The west portion of the site was formerly part of the Nepean Bay (part of the Ottawa River), which was used as a municipal landfill facility in the late 1950's to the early 1970's. The landfill raised the grade of this land to a level above the Ottawa River and enabled the construction of the Sir John A. Macdonald Parkway. the approximate footprint of the landfill is shown on Drawing No.1 in Appendix B. Most structure were removed from the site in the early 1970's.

A remediation program was conducted in the mid 2010's to remove the contaminated soil located in the central north portion of the site, west of Booth Street. The bedrock surface has been exposed and remains exposed at the time of writing.

The parcels situated south of the LRT alignment are slightly sloped down toward the northwest from Albert Street. The area is generally covered with grass with signs of construction activity and disturbance observed through the area. The west portion of the site, situated south of the Sir John A. Macdonald Parkway and north of the LRT alignment, are generally grass covered with some mature trees dispersed throughout the site.

3.1 SITE GEOLOGY

Based on available information including geological mapping from the Ontario Geological Survey (OGS), available geotechnical reports, historical boreholes, and Stantec's site specific experience, the stratigraphy at the site is generally expected to consist of highly variable fill and overburden native soils, underlain by bedrock.

The bedrock depth varies in different areas of the site and typically ranges from 0 m (existing ground surface) to about 18 m below ground surface. Based on available information obtained from the Geological Survey of Canada (GSC) Surficial Materials and Terrain Features, in the areas to the east of the Nepean Bay to the Pimisi LRT station and to the east of Booth Street Paleozoic bedrock is expected at the ground surface. At the rest of the site, glacial deposits of till (a heterogenous mixture of material ranging from sandy silt to silty sand) on Paleozoic bedrock can be expected.

According to the OGS 1:250 000 scale map of the Bedrock Geology of Ontario, the bedrock at the site is anticipated to be limestone, dolostone, shale, arkose, or sandstone of the Ottawa Group, Simcoe Group, or Shadow Lake Formation. The bedrock geology map produced in Canadian Geology Society, paper 77-11, by Bélanger and Harrison suggests that the site is underlain by limestone and shows a fault (a splays of the regional Gloucester Fault) extending in the east-west direction in the north of the site. The regional Gloucester Fault has a NW-SE strike, extending from Gloucester northwest to Hull. The Gloucester Fault splays at the site area are shown in the following figure. Some of the variations in bedrock surface may be due to presence of these bedrock faulting.

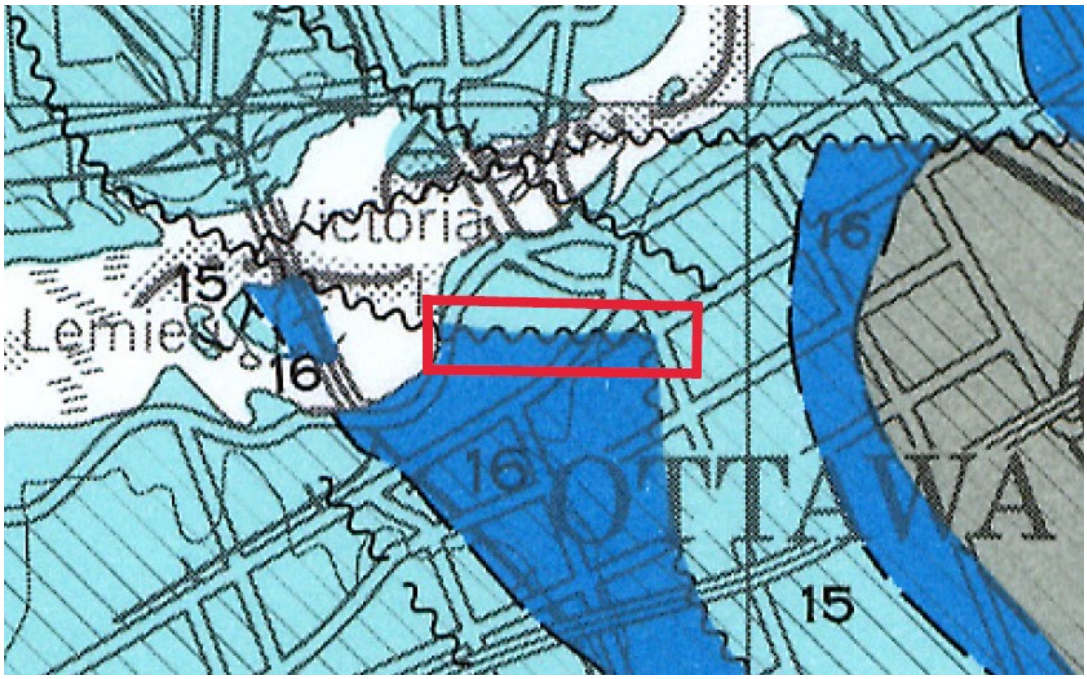

Figure 3.1: The splays of the regional Gloucester Fault at the site area (Bélanger and Harrison, 1976)

A significant number of historical boreholes have been advanced throughout the site. The following studies and reports were reviewed as part of this despot study:

- Data Gap and Remedial Options Analyses Report, Nepean Bay Sector, LeBreton Flats, Ottawa, ON (Geofirma, 2019)
- Geotechnical Desktop Review Report (Paterson Group, 2020)

3.2 SITE TOPOGRAPHY

Based on the recorded ground surface elevation at the previous borehole locations, ground surface elevation contours provided in Geofirma 2019 report for a western portion of the site (based on City of Ottawa 2006 LiDAR, Light Detection and Ranging, digital elevation survey flown in 2006), and publicly available ground surface (Google Earth) date, the ground surface elevation at the site varied between approximately elevations 52 m to 68 m.

Ground surface elevation contours of a portion of the site to the west of the Nepean Bay and between the Kichi Zībī Mīkan (Sir John A. MacDonald Parkway) and the transitway as well as a portion of the site between the transitway and Albert Street and to the west of the access road for the parking lot in the area are provided in Geofirma 2019 report. Topographical relief of this area ranges from a low of about elevation 56 m in the southwest corner to a high of about elevation 67 m in the west part within the footprint of the former landfill. Ground slopes downward from the landfill mound to the southwest and east. Minor elevation highs are also apparent near the western end of this area, along the transitway (elevation 64 m) and in the center of this area, north of the transitway (elevation 63 m). Ground surface elevation of the east of this area ranges from a low of about elevation 53 m in the southeastern part to a high of about elevation 63 m in the center of the area. The central high ground surface is due to landfilling. from the landfill mound ground slopes downward to the north, south and east. South of the transitway, the ground surface slopes

gently from a high of about elevation 64 m at the western end to a low of about elevation 58 m along the parking lot access road.



Figure 3.2: Ground surface elevation contours for a portion of the site to the west of the Nepean Bay (Geofirma 2019 report)

4.0 SUBSURFACE CONDITIONS

4.1 GENERAL

Detailed descriptions of the subsurface soil and bedrock conditions are presented on the Borehole Records and Bedrock Core Log provided in Appendix C.

The stratigraphic boundaries on the borehole records are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact boundaries between geological units. The borehole records depict conditions encountered at the specific locations drilled. The subsurface soil and groundwater

conditions between boreholes and/or at locations away from the borehole locations will vary from those indicated on the borehole records.

It is noted that information provided in the following sections is intended to summarize the conditions encountered; however, the borehole records provided in Appendix C should be used as the primary source of the subsurface information for the site.

A summary of the subsurface conditions encountered in the boreholes is provided in the following sections. The site has been divided into 4 portions with generally similar subsurface conditions. The site divisions identified as the North Portion, East Portion, South Portion and West Portion are shown on the Borehole Location Plan provided in Appendix B.

4.2 OVERBURDEN

North Portion of Site

Generally, a slightly weathered limestone bedrock was encountered at ground surface at the borehole locations (MW13-1 to MW13-6, MW13-10 to MW13-15, and BH11-21). At other borehole locations, the bedrock was encountered at 2.7 m to 4.8 m depth (or elevations of 50.9 m to 52.4 m). The bedrock contains thin interbeds of dark shale and the rock quality generally increase to good to excellent with depth.

The overburden was removed from the land parcels where a remedial program was competed. A silty sand fill and gravel is overlying the bedrock surface at a small section, where Preston Street formerly extended to the Sir John A. Macdonald Parkway. The buried aqueduct runs from west to east at this portion of the site, the cover material consisted of a silty sand with gravel and cobbles fill material.

South Portion of Site

Boreholes located along Albert Street and south of the transitway alignment generally encountered a loose to compact silty sand fill layer containing gravel, cobbles, boulders, construction debris, such as brick, wood, slag, and ashes. The fill layer was generally underlain by a compact to very dense fluvial deposit of gravel, cobbles and boulders within a silty fine sand soil matrix. However, loose/very loose sand/silty sand was encountered at several boreholes.

A silty clay and clayey silt deposit was encountered underlying the fill material between the old Preston Street extension and former Broad Street. A thin deposit of peat was also encountered at some borehole locations.

Bedrock surface is variable in this portion of the site and bedrock was encountered at 3.5 m to 9.2 m depth (or between elevation 48.1 m and elevation 51.9 m) at borehole locations within this area. The bedrock surface appears to be deeper toward the east within this portion of site.

West Portion of Site

The former Nepean Bay landfill was located at the west portion of the site. A layer of silty sand and gravel fill with various amount of debris, including wood, brick and plastic was encounter at borehole locations in this portion of the site. The fill layer is up to 12 m thick in the central portion of the former landfill and could be as high as 19 m at landfill

mounds (Geofirma 2019). The approximate footprint of the former landfill is shown on Drawing No.1 in Appendix C. To the south of the transitway the fill layer is generally 1.5 m to 4.9 m thick.

The fill material was underlain by a variety of deposits. To the north of the transitway, a (0.1 m to 1.5 m thick) peat deposit was encountered at four boreholes (BHW-09, BHW-11, BHW-15, and MW01-7). A firm to stiff silty clay deposit was encountered underlying the fill material in borehole BH10-04 and BH11-17. A compact native grey fluvial deposit of sand, gravel, cobbles and boulders within a silt sand soil matrix was encountered underlying the fill material at the rest of boreholes. Loose/very loose sand/silty sand was encountered at several boreholes. Cobbles and boulders were encountered in some boreholes located south of the transitway (e.g. below 8.5 m at BH10-01, below 4.2 m at BH10-05, and below 3.2 m at BH11-09).

Bedrock, described as a highly weathered black shale, was encountered in some borehole locations in this portion of the site. The bedrock was encountered at 3.7 m to 15.4 m depth (or between elevation 45.0 m to elevation 50.8 m) at borehole locations to the north of the transitway within this portion of the site. To the south of the transitway, the bedrock was encountered at 5.6 m to 11.0 m depth (or between elevation 46.5 m and elevation 50.0 m). No bedrock coring was carried out in boreholes to the west of the City Center Avenue.

East Portion of Site

Generally, a silty sand fill layer overlying a compact native glacial till or bedrock was encountered at boreholes at the east portion of the site, to the east of Booth Street and North of Fleet Street. The bedrock was encountered at 2.2 m to 3.8 m depth (or between elevation 51.5 m to elevation 53.2 m) at the borehole locations within this portion.

At the block situated east of Booth Street and to the south of the open aqueduct, fill material overlain bedrock. Bedrock was cored at one borehole (MW13-8) at 4.9 m (or elevation of 51.0 m). Fill material (3.0 to 4.6 m thick) overlying till were encountered at boreholes located at the parcels situated between Slater Street and Albert Street.

4.3 BEDROCK

Bedrock was proven by rock coring at several boreholes at the site. Bedrock surface depth/elevation encountered along with the measured RQD values are presented in Appendix D. A summary of bedrock surface depth/elevation is presented in the following table. Based on the data provided in the table:

- the bedrock depth ranges from 0 m (existing ground surface) to about 16.6 m below ground surface.
- the bedrock surface was encountered between approximate elevations of 45.0 m and 59.4 m.

Depths/elevations of auger refusal (or split-spoon refusal) encountered at boreholes are also included in the table. Split-spoon driving refusal or auger refusal may be due to the presence of cobbles and boulders or due to the presence of bedrock.

The bedrock encountered in boreholes consisted slightly weathered to fresh, very poor to excellent quality (with Rock Quality Designation, RQD, of zero to 100%), of either limestone with interbedded shale or shale. The RQD reflects the degree of fracturing which is an expression of the cumulated length of the rock pieces longer than 100 mm. The bedrock is generally slightly weathered at and near surface and rock quality increases with depth. Results of two Unconfirmed Compressive Strength (UCS) tests on rock specimens are reported on the available record of

boreholes: 75.9 MPa (7.4 m depth, BH13-7) and 127.9 MPa (9.6 m depth, MW13-8). Based on these results, the limestone bedrock at the site could be classified as strong to very strong.

Table 4.1: Summary of the Encountered Bedrock Surface and Auger (or Split-Spoon) Refusal Depth/Elevation and Measured RQD Values

Location	-	Bedrock Surface Depth (m)	Bedrock Surface Elevation (m)
North Portion the Site	Minimum	0.0	50.2
	Maximum	5.5	55.1
	Average	1.3	53.0
South Portion of the Site	Minimum	3.1	48.1
	Maximum	10.1	53.9
	Average	5.3	51.4
East Portion of the Site	Minimum	2.2	51.0
	Maximum	10.0	59.4
	Average	4.8	55.6
West Portion of the Site	Minimum	1.6	45.0
	Maximum	16.6	59.4
	Average	7.7	49.6

4.4 GROUNDWATER CONDITIONS

Several monitoring wells were installed in boreholes previously advanced at the site. The groundwater levels measured in these monitoring and observed during drilling (inferred groundwater level) are provided in Appendix D and are summarized in the following table.

Table 4.2: Summary of Groundwater Levels

Location	-	Groundwater Depth (m)	Groundwater Elevation (m)
North Portion the Site	Minimum	1.1	49.2
	Maximum	6.7	52.3
	Average	3.7	51.4
East Portion of the Site	Minimum	2.1	51.4
	Maximum	5.0	59.6
	Average	3.5	52.9
West Portion of the Site	Minimum	1.7	52.1
	Maximum	9.8	54.1
	Average	5.6	53.1

Based on the data presented in the preceding table, the groundwater elevation range between 49.2 m to 59.6 m at the site. The groundwater was measured at depths between 1.1 m to 9.8 m.

It should be noted that fluctuations in the groundwater levels should be anticipated during and following periods of sustained precipitation and snowmelt as well as throughout the various seasons. As well, lower water levels would be expected during severe drought conditions.



Considering the vicinity of the site to the Ottawa River, the groundwater level at the site should be expected to be affected by the stage elevation of the river. Based on the data provided by Ottawa River Regulation Planning Board[1], the river water level at upstream and downstream of the site are as follows:

Table 4.3: Stage Elevation of the Ottawa River

Stage Elevation of the Ottawa River.	On 2024-01-03	Historic Low	Historic High
Lake Deschenes at Britannia (upstream of the site)	58.3 m	57.4 m - 58.1 m	60.7 m – 58.5 m
Gatineau/Hull (downstream of the site)	41.7 m	41.6 m - 40.9 m	41.6 m – 45.2 m

5.0 DISCUSSION AND RECOMMENDATIONS

This section provides preliminary engineering input related to the geotechnical design aspects of the proposed development based on our interpretation of the available subsurface information described herein and our understanding of the project requirements.

The discussion and recommendations presented in the following sections of this report are intended to provide the designers with preliminary information for planning and design purposes only. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the data as it affects their proposed construction techniques, schedule, safety, and equipment capabilities.

The following geotechnical input is based on the information that was available at the time of writing this report. As not all details (e.g., final building configurations and site grades, structural loads etc.) related to the proposed development were available at the time of preparation of this report, all geotechnical comments and input provided herein should be reviewed and revised, as required, as the design progresses and once the final plans become available.

5.1 USING SITE DATA

This geotechnical desktop study is based on the existing/available record of 128 boreholes advanced at the site between 1992 and 2018. This study is preliminary, and the recommendations provided in this report are general in nature and are provided for planning purposes. Considering that this review report is intended for a Plan of Subdivision application, the existing information is deemed sufficient. The provided recommendations and comments should be confirmed prior to use for final design purposes by conducting a supplementary geotechnical investigation. The requirements for a supplementary geotechnical investigation are discussed in Section 7 of this report.

The available borehole data provide information on the depth/elevation and consistency/relative density of native deposits and existing fill layers. These data are sufficient to provide preliminary geotechnical resistance recommendations for shallow footings.

[1] https://ottawariver.ca/conditions/

The existing borehole data included bedrock coring data which provide information on bedrock surface depth/elevation, bedrock type, quality, and conditions that are applicable to current site conditions. These data are used in the design of shallow and deep foundation options.

The groundwater levels/depths measured in the monitoring well installed at the site or inferred groundwater levels at the time of the drilling are also provided on the existing record of boreholes. These data were compiled and the groundwater elevation ranges were determined for each portion of the site and are used in the development of the geotechnical model and foundation design. It should be noted that considering the vicinity of the site to the Ottawa River, the groundwater level at the site should be expected to be affected by the stage elevation of the river.

In summary, the existing borehole data at the site are sufficient to provide general geotechnical comments and recommendations. A geotechnical field investigation should be carried out for each of the properties after the development details such as building locations are determined. The investigation should include, boreholes, groundwater monitoring program and a laboratory testing program.

5.2 KEY GEOTECHNICAL ISSUES

Key geotechnical issues that require consideration for this project include the following:

- The bedrock was encountered at depths varying from 0 (at ground surface) to 16.6 m at borehole locations at the site.
- The subsurface at the site is consisted of either bedrock or fill and/or native soils overlying bedrock. The proposed buildings could be founded on conventional shallow footings placed on an approved competent native soil subgrade or sound bedrock bearing surface. Where higher geotechnical capacity is required, consideration could be given to deep foundation (caisson, steel pipe or h-pile on bedrock, or micropiles socketed into bedrock): The preferred foundation options for each portion of the site is provided in Table 5.2.
- The overburden at site includes topsoil, fill, occasionally peat deposit and native soils. Topsoil, peat deposit, and all fills mixed with topsoil and organic soils should be removed from the proposed building footprint and paved areas.
- The former Nepean Bay landfill was located at the west portion of the site. Based on the LeBreton Flats Master Concept plan, this portion of site will be redeveloped to a park Districts. As such, building construction is not expected within the former landfill area. Significant debris and waste (including concrete, ash, mortar, wood, wood chips/fragments, glass, brick, slag, asphalt, plastic, rubber, metal, coal, and construction debris of former roadways, buildings, and sidewalks) were found within the fill material across the site.
- As part of the site preparation works, fill material and loose/very loose native soils which is not suitable for founding foundation and construction of slab-on-grade, need to be removed from the building footprint. Alternatively, in-situ densification of soils at the site via shallow surface compaction or dynamic compaction could be considered. Dynamic compaction ground improvement techniques (such as Deep Dynamic Compaction or Rapid Impact Compaction) are effective for compacting fills as well as loose native sandy or relatively free-draining soils.
- Considering the presence of bedrock at ground surface and shallow depths, bedrock removal may be required to construct the proposed underground levels and utilities. Depending on the quantities of bedrock to be removed, hoe ramming (where only small need to be removed) or line drilling and controlled blasting (where large quantities of bedrock need to be removed) is recommended.
- The blasting operations should be planned and completed under the guidance of a professional engineer with experience in blasting operations. Critical infrastructure sensitive to vibrations is present within and near the site, such as the aqueducts, Fleet Street Water Pumping Station, City of Ottawa High-Pressure Transmission Watermain, City of Ottawa Low-Pressure Transmission Watermain and several large diameter sewers. Vibration monitoring will be required during construction.

- It should be anticipated that an underslab drainage system will be required to control groundwater, particularly during wet seasons, where basement/underground floors are proposed.
- It is recommended that a groundwater monitoring program be implemented to help assess variability in the groundwater levels at the site.
- The silty overburden soils at the site are typically expected to be highly frost susceptible. All foundations founded on frost-susceptible materials should be provided with a minimum of 1.8 m of earth cover or equivalent insulation for frost protection purposes. The bedrock at site could be considered non-frost susceptible provided that the weathered or loose bedrock are removed.
- The liquefaction assessment indicates that a 1.3 m to 1.6 m thick portion of native deposits at the site is considered susceptible to liquefaction at five borehole locations (BH10-1, BH10-2, BH11-18, BH11-19, and BH11-29. Earthquake-induced settlements in the order of 90 mm to 200 mm should be anticipated. For building structures supported on deep foundations, these settlements would apply only to non-pile supported elements, such as the basement floor slab. Shallow foundations are not recommended where soils are considered susceptible to liquefaction. To improve soil resistance against liquefaction consideration could be given to in-situ densification of soils at the site.
- Generally, where liquifiable soils are present, a Site Class F is applicable to the site. If in-situ densification of site soil is conducted, the seismic site class designation could be reviewed based on the results of the final verification testing of the in-situ densification.
- Where soils are not susceptible to liquefaction, the applicable seismic site class to each portion of site is as follows:
  - For the East and North Portions of Site: Where the footing will be placed on bedrock or if the underside of the footings are located within 3 m of the bedrock surface, Site Class ‘B’ is recommended. If there is more than 3 metres of softer materials present above the bedrock, the use of a Site Class ‘C’ designation is recommended.
  - For the South Portion of Site: Where the footing will be placed on bedrock or if the underside of the footings are located within 3 m of the bedrock surface, Site Class ‘B’ is recommended. If there is more than 3 metres of softer materials present above the bedrock, the use of a Site Class ‘D’ designation is recommended.
  - For the West Portion of Site, the use of a Site Class ‘D’ designation is recommended.
  - Geophysical testing could be carried out to measure the in-situ shear wave velocity of the subsurface soils and bedrock at the site to potentially improve the recommended Seismic Site Class.

The following sections incorporate the above-mentioned key geotechnical issues.

Based on a recent Methane Monitoring Report for the site (2023 Semi-Annual Nepean Bay Methane Monitoring Report, Former Nepean Bay Landfill, Ottawa, Ontario, NCC Property Asset Numbers 96030 and 96129, prepared by Geofirma, dated January 19, 2024), elevated methane concentrations (above the lower explosive limit, LEL) have been recorded on some monitoring well locations at the site since methane monitoring programs have begun in 1998. The detailed design will need to evaluate the risk of landfill gases presence at the site.

5.3 GEOTECHNICAL MODEL

Based on a compilation of all geotechnical data and testing carried out at the site as presented on the Borehole Records and geotechnical laboratory testing (grain size analyses, Atterberg limits, and moisture contents) carried out at the site. The soil parameters provided in the following table were estimated and were used for geotechnical design in the following section of the report.

Table 5.1: Soil and Bedrock Parameters

Soil/Rock Type	Design Parameters		
	Total Unit Weight, γ (kN/m^3)	Friction Angle, ϕ' (°)	Undrained Shear Strength, S_u (kPa)
Fill	19	30	-
Clay	19	-	50
Till (generally compact to very dense silty sand)	20	30	-
Limestone with interbedded shale or Shale Bedrock(1)	26	UCS = 70 MPa	

Notes:

[1] The bedrock depth ranges from 0 m (existing ground surface) to about 16.6 m below ground surface. The bedrock surface was encountered between approximate elevations of 45.0 m and 59.4 m.

[2] The groundwater level within the site was approximately 1.1 m to 9.8 m below the ground surface (or at approximate elevations of 49.2 m to 59.6 m).

5.4 SEISMIC DESIGN CONSIDERATIONS

5.4.1 Liquefaction Potential

Loose/very loose sand/silty sand was encountered at several boreholes in southern and west portion of the site (generally south of the transitway between Booth Street and City Center Avenue). Generally, this material if saturated is prone to liquefaction.

The potential liquefaction of the site native soils under seismic loading conditions was assessed using the analysis methodology suggested by Idriss and Boulanger (2008)[4]. The evaluation was completed based on the SPT resistance values (SPT-N values with depth) from the boreholes and based on the following:

- A Site Adjusted PGA of 0.281g.
- An earthquake magnitude of 6.3.

The formulation by Idriss and Boulanger (2008)[2] compare the earthquake induced cyclic stress ratios (CSR) with the cyclic resistance ratios (CRR) of the soil based on the soil SPT-values. These formulations are discussed in detail in Idriss and Boulanger (2008) with an example illustrated on Page 118 (subsection 3.14).

The factor of Safety values were calculated based on the recorded SPT-N values within the native soils from the different boreholes. The assessment indicates that the native soils are considered susceptible to liquefaction (factor of safety against liquefaction of less than one) at the following depths and locations:

- From 4.3 m to 7.5 m at BH10-1
- From 4.0 m to 7.6 m at BH10-2
- From 4.3 m to 4.9 m, 5.5 m to 6.8 m, and 7.3 m to 8.5 m at BH11-18
- From 4.9 to 7.2 m at BH11-19
- From 1.7 m to 2.4 m and 3.0 m to 3.6 m at BH11-29

[2] Idriss, I.M. and Boulanger, R.W. (2008). "Soil Liquefaction During Earthquakes", Earthquake Engineering Research Institute, Monograph MNO-12, 2008

As a result of liquefaction, earthquake-induced settlements in the order of 90 mm to 200 mm should be anticipated. For building structures supported on deep foundations, these settlements would apply only to non-pile supported elements, such as the basement floor slab. Shallow foundations are not recommended where soils are considered susceptible to liquefaction (factor of safety against liquefaction of less than one) at the following depths and locations.

Moreover, thin layers of loose sand/silty sand was encountered at several boreholes (such as BH92-C1, BH10-17, BH10-20, MW3-23, BH10-05, BH11-06, BH11-14, BH11-15, BH11-17, BH11-18, BH11-20A, BH11-22, and BH11-28 which should be considered susceptible to liquefaction; however, since the thickness of liquifiable layer is 0.6 m to 0.8 m, the manifestation of liquefaction at surface is less likely and post-liquefaction settlement is expected to be limited.

It should be noted the above assessment was carried out only on native soils, existing loose to very loose sand or silty sand fill, if saturated, will be susceptible to liquefaction at the site.

5.4.1.1 Considerations For In-situ Densification

To improve soil resistance against liquefaction consideration could be given to in-situ densification of soils at the site. Dynamic compaction is a ground improvement technique that is effective for compacting fills as well as loose native soils. The main advantages offered by the process are its low cost, rapidity of execution, and applicability to a large variety of constructed fills and loose natural sandy or relatively free-draining soils. Caution should be applied with other soils.

Dynamic compaction requires a controlled application of dynamic stresses to the ground surface. Dynamic compaction can produce significant vibration outside the treatment area. The effect of this induced vibration on structures must be considered during design.

Deep dynamic compaction (DDC)

One method of dynamic compaction is Deep Dynamic Compaction (DDC) with drop weights, which involves using a crane to drop weights of between 5 to 30 tons, from heights of up to 30 m. DDC compacts to depths of as much as 8–10 m. This technique is best suited to large, open sites where few obstructions are present.

The vibrations caused by dynamic compaction can potentially be detrimental to existing structures. Therefore, it's crucial to conduct a thorough analysis and take necessary precautions when performing dynamic compaction near existing structures to mitigate potential damage. This might include monitoring vibration levels, adjusting the compaction process as needed, and implementing mitigation measures if necessary.

During its execution, the process should be continuously monitored to evaluate the degree of soil improvement being achieved and for other environmental considerations such as potential damage to nearby structures and annoyance to surrounding population from vibrations and noise. Earthworks carried out to level the site after each phase and to replace non-compactable materials with suitable soils are also part of the operation. Final verification testing to ensure that the specification requirements have been fulfilled must be performed upon completion of the treatment.

Rapid impact compaction (RIC)

Rapid impact compaction (RIC) follows the same principles as DDC but utilizes smaller equipment and a faster construction technique that results in compaction depths of up to 6 m. RIC involves the use of a hydraulic



hammer/weight, typically 7.5–12 tonnes, which is dropped from 0.3 to 2 m onto a 1.5–2.0 m diameter plate at a rate of about 40–60 blows per minute.

Like DDC, RIC can produce noise and vibration; however, generally at a higher frequency (lower damage criteria), resulting in a shorter distance propagation than that produced by DDC. An assessment of influence and a vibration study are prudent measures when employing dynamic methods such as DDC and RIC.

Vibration studies involve the identification of the typical zone of influence of a given technique and then, applying a factor of safety, identifying the various receptors, structures, or stakeholder property in the factored zone of influence and determining if further steps are needed, such as site- and structure-specific vibration monitoring during compaction work.

5.4.2 Seismic Site Class

The seismic Site Class value, as defined in Section 4.1.8.4 of the 2012 Ontario Building Code (OBC), contains a seismic analysis and design methodology which uses a seismic site response and site classification system defined by the shear stiffness of the upper 30 m of the ground below the foundation level. There are six site classes (from A to F), decreasing in stiffness from A (hard rock) to E (soft soil); Site Class F denotes problematic soils for which a site-specific evaluation is required.

Generally, where liquifiable soils are present, such as discussed in the previous section, a Site Class F is applicable to the site. Liquifiable soils (more than 0.8 m in thickness) were observed in five boreholes (BH10-1, BH10-2, BH11-18, BH11-19, and BH11-29), and the liquifiable thickness was up to 2.6 m. Considering that the thickness and extend of the liquifiable soil is limited, a site-specific response analysis is not necessary and a Site Class E could be considered in design. If in-situ densification of site soil is conducted, the seismic site class designation could be reviewed based on the results of the final verification testing of the in-situ densification.

The bedrock was encountered at depths varying from 0 (at ground surface) to 16.6 m at borehole locations at the site. Where the footing will be placed on bedrock or if the underside of the footings are located within 3 m of the bedrock surface (i.e. there is 3 metres or less of soil between the bedrock surface and the bottom of the footings), Site Class ‘B’ is recommended.

Geophysical testing (using the multi-channel analysis of surface waves (MASW) method) could be carried out to measure the in-situ shear wave velocity of the subsurface soils and bedrock at the site to potentially improve the recommended Seismic Site Class.

The seismic site class applicable to the North Portion, East Portion, South Portion and West Portion of the site is discussed in the following paragraphs.

North Portion of Site

Bedrock was generally encountered at ground surface or at 2.7 m to 4.8 m depth at borehole locations. Where the footing will be placed on bedrock or if the underside of the footings are located within 3 m of the bedrock surface (i.e. there is 3 metres or less of soil between the bedrock surface and the bottom of the footings), Site Class ‘B’ is recommended. If there is more than 3 metres of softer materials (not susceptible to liquefaction) present above the bedrock, the use of a Site Class ‘C’ designation is recommended.

South Portion of Site

Bedrock surface is variable in this portion of the site and appears to be deeper toward the east within this portion of site. Bedrock was encountered at 3.5 m to 9.2 m depth at borehole locations within this area. Native soil overlain the bedrock generally consisted of a compact to very dense fluvial deposit of gravel, cobbles and boulders within a silty fine sand soil matrix. However, loose/very loose sand/silty sand was encountered at several boreholes

Where the footing will be placed on bedrock or if the underside of the footings are located within 3 m of the bedrock surface (i.e. there is 3 metres or less of soil between the bedrock surface and the bottom of the footings), Site Class 'B' is recommended. If there is more than 3 metres of softer materials (not susceptible to liquefaction) present above the bedrock, the use of a Site Class 'D' designation is recommended.

West Portion of Site

the bedrock was encountered at 3.7 m to 15.4 m depth. Considering that loose to compact silty sand and sand deposit was encountered at several borehole within this area of the site, the use of a Site Class 'D' designation is recommended.

A seismic site class cannot be specified for the area to the west of the City Center Avenue as bedrock surface depth was not confirmed by coring in boreholes advanced within this area.

East Portion of Site

The bedrock was encountered at 2.2 m to 3.8 m depth at the borehole locations to the east of Booth Street and North of Fleet Street. At the block situated east of Booth Street and to the south of the open aqueduct, bedrock was cored at one borehole (MW13-8) at 4.9 m.

Where the footing will be placed on bedrock or if the underside of the footings are located within 3 m of the bedrock surface (i.e. there is 3 metres or less of soil between the bedrock surface and the bottom of the footings), Site Class 'B' is recommended. If there is more than 3 metres of softer materials (not susceptible to liquefaction) present above the bedrock, the use of a Site Class 'C' designation is recommended.

No borehole was located at the parcels situated between Slater Street and Albert Street. Consequently, a seismic site class cannot be specified for those parcels.

5.5 FROST PENETRATION

The frost penetration depth for foundation design at this site is 1.8 m. All foundations founded on frost-susceptible materials should be provided with a minimum of 1.8 meters of earth cover or equivalent insulation for frost protection purposes.

It is noted that the above frost penetration depth is applicable only to foundation design. Short period deeper frost penetrations, which would have little impacts on foundations, may occur. The typical soil cover for watermain construction is 2.4 m below ground surface in the City of Ottawa.

Exterior slabs-on-grade or slabs-on-grade within unheated areas will also be subject to the risk of heave and deformation/cracking due to frost. Consideration could be given to use rigid insulation to protect structures against frost action; however appropriate frost tapers would need to be incorporated at the ends of the insulation.

The bedrock at site could be considered non-frost susceptible provided that the weathered or loose bedrock are removed.

5.6 SITE PREPARATION

Buildings Footprint

Beneath all building and foundations, all existing surficial topsoil, vegetation, peat/organic material, fill material and/or other deleterious materials (e.g., any loose, wet, and/or otherwise disturbed native materials) should be removed.

Since a relative thick layer of fill materials was encountered at borehole locations in the west and south portions of the site, consideration could be given to conducting soil improvement (such as in-situ densification) to improve the site soils instead of mass fill removal and replacement. Verification tests should be carried to approve improved soil areas as subgrade.

The prepared subgrade soils will require inspection by geotechnical personnel prior to structural fill placement to verify all unsuitable material has been removed.

Beneath all buildings and foundations, site grades should then be raised, if needed, using Structural Fill consisting of Ontario Provincial Standard Specification (OPSS) Granular B Type I or II materials that are placed in lifts no thicker than 300 mm and compacted to at least 100% of the material's Standard Proctor Maximum Dry Density (SPMDD). The final layer of fill should consist of OPSS Granular A materials with a minimum thickness of 300 mm beneath the floor slabs and 200 mm in other areas, excluding basement areas where a drainage system will be required.

Pavement Areas

Beneath pavement areas, all existing surficial topsoil, vegetation, peat/organic material, and other deleterious materials should be removed. Fill material, free of deleterious material, can be left in place and surface compacted to act as a subgrade for the proposed paved areas. However, where layers of fill material are thick (such as the south and west portions of the site) and surface compaction is not effective, consideration could be given to conducting soil improvement (such as in-situ densification) to improve the site soils instead of mass fill removal and replacement. Verification tests should be carried to approve improved soil areas as subgrade.

Beneath pavement and sidewalks, site grades should be raised using OPSS Select Subgrade Material (SSM) compacted in lifts not exceeding 300 mm to 95% of the material's Standard Proctor Maximum Dry Density (SPMDD)

Engineered Fill Placement

The placement of all engineered fill materials should be monitored on a full-time basis by qualified and experienced geotechnical personnel under the supervision of a geotechnical engineer, with the authority to stop the placement of fill at any time when conditions are unacceptable.

All fill materials imported to the site must meet all applicable municipal, provincial, and federal guidelines and requirements associated with environmental characterization of the materials.

Imported fill materials should be tested and approved by a geotechnical engineering firm prior to delivery/use. Monitoring of fill placement and in situ compaction testing should be carried out to confirm that all fill is placed and compacted to the required degree.

5.6.1 Site Drainage and Subgrade Protection

The contractor should be responsible for protecting the subgrade soils from disturbance due to construction traffic. This may require that construction access routes are temporarily overbuilt (i.e., provided with increased granular fill) and/or geotextiles are provided between the granular fill and the subgrade surface.

The clayey/silty soils are susceptible to disturbance due to wet weather and/or construction traffic. Therefore, it is critical to control surface water run-off to prevent pounding of water and/or softening of the underlying soils. The prepared subgrade surface for the site should be shaped to prevent pounding of water. Preparation of subgrade should be scheduled such that the protective cover of overlying granular materials or concrete is placed as quickly as possible after subgrade approval by the geotechnical engineer.

The finished grades should provide surface drainage away from all structures. Within 2 m of structures, the exterior should be graded to slope away from the structure at a sufficient gradient. A gradient of 2% should be used wherever possible.

It should be noted that the surface drainage within the site should be collected and directed towards a storm water management system.

5.6.2 Grade Raise Restriction

A silty clay/clayey silt deposit was encountered at several boreholes, especially at the southern portion. The silty clay/clayey silt deposit was described to have a generally firm to stiff consistency and is 0.3 m 1.5 m. Considering the consistency and thickness of this deposit, the potential settlement of the silty clay/clayey silt deposit at this site due to the placement of the any site grade fill materials is not expected to be significant.

However, in-situ measurement of undrained shear strength of silty clay/clayey silt deposit using field vane test and laboratory testing (plasticity limits and consolidation testing) of silty clay/clayey silt samples are required to assess the compressibility of this deposit and calculation of the potential settlement of due to the placement of any site grade fill.

Large settlements may occur if site grade fills are placed where peat was encountered in boreholes (e.g. BHW-009 BHW-11, BHW-015, MW01-7, etc.)



5.7 FOUNDATION DESIGN

Considering the subsurface conditions encountered at the borehole locations, the foundation options are as follows:

- Shallow footings placed on an approved competent native soil subgrade or sound bedrock bearing surface.
- Deep foundations; The following deep foundation options could be considered.

Driven piles:	applicability depend on the bedrock depth (for axially loaded piles, the minimum driven length is typically considered to be 5 m)
Micro-piles:	applicable throughout
Caissons:	applicable throughout

Considering the presence of relatively thick fill layers at some location at the site and high load expected for the multi-story building, shallow foundation may not be an option throughout the site. Deep foundation systems are considered technically feasible for the proposed development at this site. The buildings could be supported on deep foundations transferring the foundation loads through the fill layers, down to the bedrock surface.

Table 5.2: Preferred Foundation Options

Location	Preferred Foundation Options	
	Shallow Foundations	Deep Foundations
North Portion of Site	On Bedrock	Micro-piles or Caissons
South Portion of Site	On Competent Native Soils	Caissons or Micro-piles
West Portion of Site (north of the transitway)	-	Micro-piles or Caissons (where the bedrock surface is below 5 m depth)
West Portion of Site (south of the transitway)	On Competent Native Soils	Driven Piles or Caisson (where cobbles/boulders may be present in overburden)
East Portion of Site	On Bedrock or Competent Native Soils	Micro-piles or Caissons

5.7.1 Shallow Foundations

5.7.1.1 Geotechnical Bearing Resistances

Based on the subsurface conditions encountered at the boreholes previously advanced at the site, shallow foundations founded on competent native soil (compact to very dense silt sand/sand/till deposit or stiff silty clay/clayey silt), sound bedrock surface, or on structural fill constructed on these natural materials could be considered for buildings at the site; all existing fill materials, disturbed/unsuitable native soils, weathered bedrock will need to be removed as discussed in Section 5.6.

The geotechnical resistance calculations for shallow footings were carried out according to the Canadian Manual of Foundation Engineering, considering a non-inclined and non-eccentric load, for foundations buried at the frost penetration depth or deeper.

The values of the geotechnical bearing resistance (bearing capacity) at the Ultimate Limit States (ULS) and the Serviceability Limit States (SLS), presented in the following table, are recommended for the design of the **foundations founded on the compact to very dense till deposit, stiff silty clay/clayey silt, or on the sound**

bedrock surface. Alternatively, the building foundations could be founded on structural fill placed on the native soil or bedrock.

Table 5.3: Geotechnical Resistance for Shallow Footings on Competent Native Granular Soils

Footing Type and Width (m)	Minimum Footing Embedment Below Floor Slab Surface (m)	Factored Geotechnical Resistance at SLS (kPa)	Geotechnical Resistance at ULS (kPa)
Square Footings			
0.9 to 2.5	0.9	220	220
	1.8	250	430
Strip Footings			
0.6 to 1.5	0.9	160	160
	1.8	220	290

Table 5.4: Geotechnical Resistance for Shallow Footings on Competent Native Cohesive Soils

Footing Type and Width (m)	Minimum Footing Embedment Below Floor Slab Surface (m)	Factored Geotechnical Resistance at SLS (kPa)	Geotechnical Resistance at ULS (kPa)
Square Footings			
0.9 to 2.5	0.9	180	180
	1.8	180	200
Strip Footings			
0.6 to 1.5	0.9	160	160
	1.8	160	180

Foundations founded on the sound bedrock surface could be designed based on factored geotechnical resistance of 1,000 kPa at ULS conditions for square and strip footings ($0.6 \leq$ footing width ≤ 5.0). Rock settlement is considered negligible (less than 10 mm) and the total settlement should correspond to the elastic deformation of the rock mass and for this reason the SLS resistance is not applicable.

Both ULS and SLS factored bearing resistance are based on the unfactored strength properties of the soils. The ULS bearing resistance does not account for inclined or eccentric loading conditions. The ULS values include a resistance factor of 0.5. The geotechnical reaction at SLS typically corresponds to a maximum total settlement of 25 mm and a maximum differential settlement of 20 mm.

The geotechnical resistances in the above tables are provided for the range of footing widths and the minimum footing embedment depths (below the floor slab surface) listed in the above table. Additional input should be provided by the geotechnical engineer if the foundation sizes or embedment depths are outside of the ranges outlined above.

The native soils could be highly susceptible to disturbance by construction activity especially during wet or freezing weather. Care should be taken to preserve the integrity of the materials as bearing strata. It is essential that the founding level for the footings be inspected by the geotechnical engineer prior to placing concrete. If the concrete for the footings on the native soil cannot be placed immediately after excavation and inspection, it is recommended that a working mat of lean concrete be placed in the excavation to protect the integrity of the bearing stratum.



The unfactored horizontal resistance to sliding of the spread foundations may be calculated using the following unfactored coefficients of friction:

0.55 between Structural fill materials and cast-in-place concrete
0.40 between native (silty till or cohesive) soil and cast-in-place concrete

In accordance with Table 8.1 of the Canadian Foundation Engineering Manual 4th Edition (CFEM), a resistance factor (ϕ) against sliding of 0.8 should be applied to obtain the factored sliding resistance at ULS.

5.7.1.2 Soil-Bedrock Transition

It should be noted that where footings of a building may cross between subgrade types (i.e. between soil and bedrock), some differential settlement may occur. Such settlements should be accounted for through structural design. Therefore, it may be preferable to have all foundations extend to a bedrock subgrade or on the overburden, in order to avoid potential differential settlements.

Each foundation should be founded on one subgrade material only to limit the differential settlement. Given the variability of rock level, if this is not practical and part of the foundations would be on rock, soil-rock transitions will be required to limit the risk of excessive differential settlement. The transition consists of profiling the bedrock with a slope of 1V:5H and profiling the soils with a slope of 1V:3H, to reach a depth of 600 mm at their contact with the projected level of the foundations. The excavation must be filled with a structural granular material to promote the gradual development of settlements. This backfill should be composed of OPSS Granular A or B Type II materials placed in layers of 300 mm compacted to at least 100% of material's SPMDD. The width of the subexcavation should be at least the proposed footing width plus 0.5 m.

5.7.1.3 Foundation Wall Backfill

To avoid problems with frost adhesion and heaving, foundation walls in these areas should be backfilled with non-frost susceptible granular fill meeting the gradation requirements of OPSS Granular B Type I materials. The fill should be placed in maximum 300-millimetre thick lifts and should be compacted to at least 98 percent of the material's SPMDD using suitable vibratory compaction equipment.

In areas where hard surfacing (e.g., concrete slabs, sidewalks) surround the building, differential frost heaving will occur between the granular fill backfill zone and other areas. To reduce this differential heaving, a frost taper of the granular backfill is recommended. The frost taper should extend up from 1.2 meters below finished exterior grade (at the foundation wall) at a slope of 3 horizontal to 1 vertical, or flatter, to the surface level.

Exterior grades should be sloped away from the building to prevent ponding of water around the buildings.

5.7.2 Piled Foundations

Depth to bedrock is variable at the site. For axially loaded piles, the minimum driven length is typically considered to be 5 m. As such, driven piled foundations are considered suitable only for portion of the building area where bedrock surface is deeper than 5 m. Where the bedrock is shallower than 5 m or presence of cobble and/or boulder could create heavy driving resistances, impede pile driving, or damage the piles, drilled piles (socketed to bedrock) could be considered.



Suitable pile types for driving would be concrete filled steel pipe piles (driven closed-ended) or H-piles, with the piles end-bearing on bedrock. The piles should be driven to practical refusal within the very dense till or on the bedrock surface. The piles should attain refusal reaching the surface of the bedrock; however, some limited penetration of the piles into the weathered bedrock may occur. Considering the presence of cobbles and boulders in the native till deposit in the South and West portions of the site, some of piles may attain refusal on cobbles or boulders within the till deposit.

Where the quality of the bedrock near surface is poor and/or till (which potentially contains cobbles and/or boulders) is present, it is recommended that rock-points, such as the Titus rock injector points be included to protect the pile tips.

For piles attaining refusal at or slightly below the bedrock surface, settlement at the toe will be negligible and the total pile head settlement will correspond to the elastic deformation of the piles. The ultimate limit states (ULS) axial geotechnical resistance in compression of piles driven to refusal on bedrock (or slightly within) at this site should be considered to be the structural capacity of the pile. For piles driven to refusal within the till deposit, generally, the ULS axial geotechnical resistance in compression is considered to be 80% of the structural capacity of pile.

Due to stresses imposed by the pile driving methods and to avoid damaging the steel during driving, it is recommended that the ULS geotechnical resistance be limited to 140 N/mm^2 of the steel cross-sectional area of the piles. In the case where pipe piles are to be filled with concrete and the pile driving contractor proposes higher capacities to incorporate the structural benefits of the concrete, the contractor would be required to demonstrate that the piles have achieved the proposed higher capacities by field-testing.

Based on a limiting stress value of 140 N/mm^2 against steel cross-sectional area for piles driven to refusal on bedrock (or slightly within), the following ULS geotechnical resistances may be considered. For piles driven to refusal within the till deposit, generally, a lower limiting stress value of 112 N/mm^2 against steel cross-section is used to calculate the ULS geotechnical resistance.

Table 5.5: Geotechnical Resistance for Driven Pile at ULS

Pile Type	ULS geotechnical resistances (kN)	
	piles driven to refusal on bedrock (or slightly within)	piles driven to refusal within till
HP 310x110	1975	1580
Pipe 324 mm diameter, 11 mm thick wall	1530	1220

Note: The sacrificial thickness, if any, does not apply to the geotechnical resistance which will be provided by the bedrock.

The actual piles selected will depend on the pile load requirements and the pile cap configurations. The piles recommended to be spaced at least three diameters apart. Considering that the piles will be on bedrock surface, no group effects is required to be considered in assessment of geotechnical vertical resistance of piles.

For piles driven to bedrock, the geotechnical resistance at serviceability limit state (SLS) exceeds the ULS value and therefore is considered not to be applicable to the design.

The pile driving contractor should be required to submit the following information prior to mobilizing to the site.

- Outline of proposed pile driving equipment
- Pile driving refusal criteria to provide the ULS design value selected for the project

Pile caps/grade beams for unheated areas such as exterior structures should be provided with 1.8 m of soil cover.

10% of the driven piles should be subjected to dynamic pile testing to confirm that they are well seated on bedrock and that the pile driving strategy did damage the piles upon reaching bedrock. Dynamic testing should be carried out using a Pile Driving Analyser (PDA).

Downdrag due to potential soil liquefaction

The granular native soils underlie the site is sporadically considered potentially susceptible to liquefaction during a design seismic event. Based on the conducted liquefaction analyses, settlements associated with liquefaction could reach 90 mm to 200 mm. Therefore, drag loads should be incorporated in the design where liquefaction is expected.

The structural capacity of the pile would need to account for drag load imposed during a seismic event. The geotechnical capacity is not affected by the drag loads. Drags loads should be considered in detailed design of piles.

As discussed elsewhere in this report, clayey soil consolidation due to potential site grade raise at the site is not expected. Therefore, it has been assumed that drag loads due to soil consolidation settlements may not be considered in the design.

5.7.3 Micropile Foundation System

The elevation of the bedrock surface encountered at the site is highly variable. Therefore, the consideration could be given to using a micropile foundation system as an alternative to the piled foundation design.

The following conditions have been assumed in assessing the micropile capacities:

- Assumed Rock Unconfined Compressive Strength 70 MPa
- f'c = 30 MPa for concrete
- Pile capacity calculated strictly based on the rock socket shaft resistance

For Ultimate Limit States (ULS) design, the unfactored bond strength at the grout/rock interface may be taken as 1,500 kPa. Using a resistance factor of 0.4, the factored ULS bond strength is 600 kPa. If higher factored resistance values are required, on-site testing of the micropiles should be carried out. Based on these values, the factored bearing resistances in the following table may be used for micropile design. As the uppermost 1 m of the bedrock mass is often more heavily fractured and less competent, the first metre of rock should not be included as part of the socket length.

Table 5.6: Micropile Axial Capacities

Pile Diameter (m)	Socket length in Competent Bedrock[1] (m)	Factored Bearing Resistance at ULS[2] (kN) Socket Friction
0.150	1.00	285
	2.00	565
	3.00	850
0.175	1.00	330
	2.00	660
	3.00	990
0.200	1.00	375
	2.00	750
	3.00	1125
0.225	1.00	425
	2.00	850
	3.00	1275

Notes:

[1] Micropiles should be socketed into competent bedrock. The socket length in the table above represents the depth socketed into competent bedrock; for design purposes, it should be assumed that uppermost metre of the bedrock is not included in the socket length.
[2] The above geotechnical resistances at ULS include a resistance factor of 0.4 in compression.
[3] Negligible axial deformation would occur and therefore, reactions at SLS are not expected to govern.

The following provides additional considerations that should be accounted for in the design and construction of the micropile foundation system:

- The micropiles should be designed and constructed in accordance with standard practices such as those identified in the US Department of Transportation – Federal Highway Administration Publication No. FHWA NHI-05-039 (Micropile Design and Construction Reference Manual).
- Micropiles intended as permanent structural elements should be provided with double corrosion protection.
- In order to limit the potential for differential foundation settlement, all foundations should for a building should consist of either shallow foundations bearing on bedrock or micropile foundations socketed into bedrock (i.e. shallow foundations bearing on overburden materials should not be used). In this regard, micropile supported grade beams could be considered around the perimeter of the building.
- The resistance values provided above represent the geotechnical capacity of the micropiles; an assessment should be completed to confirm if the geotechnical or structural capacity of the micropiles will govern. Similarly, the structural design of micropiles should take into account other potential failure mechanisms (e.g. buckling).
- Full-time inspection should be carried out by qualified geotechnical personnel during micropile installation. Additionally, sufficient materials testing (e.g. grout compressive strength testing) should be completed to monitor conformance to the pertinent project specifications.
- Stantec's geotechnical group should review the final drawings and specifications for this project prior to tendering/construction to ensure that the guidelines in this report have been adequately interpreted.

5.7.4 Rock Socketed Caissons

Rock socketed caissons may be considered for foundation design. Depending on the prevailing groundwater level at each building location at the time of construction, the use of a steel liner and the tremie technique would be required due to the presence of the highly permeable silty sand/till deposit.

Given the fracture nature of the bedrock at the site, the following should be considered.

- That the top 1.0 m of the rock socket is not to be included in the calculated capacity.



- That the rock socket length, within the calculated zone, be at least three (3) times the caisson diameter.
- A minimum caisson diameter of 0.9 m be considered.
- A factored geotechnical resistance at the concrete-rock shaft interface at ULS of 700 kPa, which includes a resistance factor of 0.4.
- Negligible axial deformation would occur at the concrete-rock shaft interface and therefore, reactions at SLS are not expected to govern.

Construction Inspection

It is anticipated that contractor would use flight augers to construct the caissons. The following should be anticipated.

- That caissons would need be to clean and dewatered to allow for inspection to ensure that all loose materials are removed and that the sidewalks are free of debris.
- That concrete should not be placed within a dewatered caisson since waterflow from the fractured bedrock would wash out the cement paste from the concrete.
- Where the caisson bottom will be below groundwater level, the caissons would need to be filled with water prior to concreting to allow for use of the tremie method where concrete is pumped underwater, from the bottom of the caisson, while displacing the overlying water.
- That full time inspection by a geotechnical engineer's representative would be required while constructing caissons, including placement of concrete by the tremie method.

5.8 EXCAVATIONS AND RETAINING WALLS

5.8.1 Temporary Excavations

5.8.1.1 Temporary Excavation in Overburden

All temporary excavations should be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. Shallow open cut excavations (extended to depths of 3 m or less below existing ground surface) could be conducted following the recommendation provided in this section. The potential for instability of excavations extending to greater depths should be reviewed by a geotechnical engineer.

Based on the boreholes advanced within the site, the overburden soils within upper 3 m of existing site grades could be generally classified as Type 3 soils, as defined by the Occupational Health and Safety Act and Regulations for Construction Projects. Provided that appropriate groundwater control is provided to maintain the water level below the base of the excavation, OHSA indicates that temporary excavations made within Type 3 soils should be developed with side slopes no steeper than 1H:1V.

Very loose or soft/very soft portions of the overburden soils should be classified as Type 4 soils. If infiltration of groundwater is encountered, soils should be considered Type 4. For Type 4 soils, OHSA requires that open cut excavations must be sloped no steeper than 3-horizontal to 1-vertical (3H:1V) from the bottom of the excavation.

Based on OHSA requirements, the soil must be classified as the type with highest classification of the types of soils present if an excavation contains more than one soil type (e.g. if both Type 3 and Type 4 soils are present within the excavation, the excavation must be sloped or supported in accordance with the requirements for Type 4 soils).



Steeper side slopes would require shoring to meet the requirements of the OHSA. The stability of the wall of the excavation can also be affected by:

- Surcharge loads
- Stockpiles
- External loads (e.g. from adjacent buildings foundations)
- Groundwater seepage conditions

Regular inspections by qualified geotechnical engineering personnel must be conducted to confirm that conditions in the excavations are safe and consistent with the requirements of the OH&S Act. Care should be taken to direct surface water away from the open excavations.

Stockpiling of any materials adjacent to excavations should be avoided. Similarly, traffic should not be permitted in proximity to open excavations. For this purpose, it is recommended that all storage of materials and traffic be restricted from a 2 m wide strip around the excavations, measured from the crest of the excavation designed and constructed in accordance with the OH&S Act.

The base of excavations should not be exposed for extended periods of time.

If space is restricted such that the side slope cannot be safely cut back in accordance with the OH&S Act & Regulations, or if sloughing and cave-in are encountered in the excavations, or if the excavations are to remain open for a longer period, a trench box system can be used for shallow localized excavations (such as for service trenches), or a shoring system can be used for larger or deeper excavations to maintain safe working conditions. All shoring systems should be designed and approved by a qualified Professional Engineer.

The contractor is fully responsible for the selection of, and the detailed design and performance of the temporary shoring systems. In general, there are three shoring methods that are commonly used in local construction practice:

- soldier piles and timber lagging;
- driven sheet piles; and
- continuous concrete (e.g. secant pile) walls.

Soldier pile and lagging systems are suitable where the objective is to maintain an essentially vertical excavation wall and the movements above and behind the wall need only be sufficiently limited that relatively flexible features (such as roadways) will not be adversely affected. Where foundations or other deformation-sensitive facilities (such as site services) are present within the zone of influence of the shoring, the shoring system will need to be designed to limit deflections/deformations to tolerable levels. Interlocking steel sheet piling systems with pre-stressed tie backs are often used for these conditions. However, for excavations adjacent to aqueducts, the use of tie-back anchors should be limited due to potential conflicts with the aqueduct structures.

Cobbles, boulders, and/or construction debris were encountered in boreholes advanced at the south and west portions of the site. The presence of cobble, boulders, and /or construction debris cold impede installation of sheet piles. Secant pile walls would be appropriate where difficulties may be encountered installing sheet piles, where heavily loaded foundations exist adjacent to the shoring, or where groundwater inflow needs to be controlled.



Underpinning of the existing foundations could also be required if the settlements due to shoring movements would be unacceptable and/or if the loads on the adjacent foundations are large.

Allowance should be made for excavation of cobbles, boulders, construction debris expected to be present both in fill and glacial till at the site, especially at the south and western portion of the site.

5.8.1.2 Temporary Excavation in Bedrock

Bedrock removal may be required for construction of underground structure or utility installation where bedrock is shallow. The bedrock surface was found to be variable and bedrock could also be encountered at shallow depths.

Where the bedrock is highly fractured, it may be possible to carry out the bedrock removal using mechanical methods (such as hydraulic excavators and hoe ramming with pneumatic rock breakers) particularly for shallow bedrock excavation. For deeper excavation or where the bedrock strength and measured RQD values are higher, it is expected that excavation of the majority of the bedrock will require drill and blast techniques or hoe ramming in conjunction with closely spaced line drilling.

Perimeter line drilling should be used to define the excavation limits. Loose rocks should be removed from the sidewalls during excavation.

For shallow localized excavations (such as for service trenches), relatively steep to near-vertical walls in the bedrock should stand unsupported for a short period. The rock walls should be inspected at the time of excavation so that the rock wall stability can be confirmed. Alternatively, work carried out in the excavation can be done within a fully braced, steel trench box for worker safety.

For deeper or larger excavation (such as for the below grade level excavations), the excavation side walls may need to be stabilized with a pattern of grouted rock bolts and dowels. Tieback anchors may also be required to stabilize unstable rock blocks.

Blasting

If blasting is considered, significant caution should be exercised in carrying out the blasting because of the near proximity of underground services and existing buildings. All blasting should therefore be controlled to limit the peak particle velocities at all adjacent structures and services such that blast induced damage will be avoided. This will require blast designs by a specialist in this field.

A pre-construction/blast survey should be carried out of all of the surrounding structures and utilities. Consideration should be given to monitoring selected existing interior and exterior cracks in the structures identified during the pre-blast survey for lateral or shear movements by means of pins, glass plate telltales and/or movement telltales.

The contractor should be required to submit a complete and detailed blasting design and monitoring proposal prepared by a blasting/vibrations specialist prior to commencing blasting. This would have to be reviewed and accepted in relation to the requirements of the blasting specifications. The contractor should be limited to only small controlled shots. The following frequency dependent peak vibration limits at the nearest structures and services are suggested for all bedrock removal.



Table 5.7: Peak Vibration Limits

Frequency Range (Hz)	Vibration Limits (mm/sec)
< 10	5
10 to 40	5 to 50 (sliding scale)
> 40	50

Note: For sensitive infrastructure, the vibration limit may need to be reduced to 2.5 mm/sec for all frequencies.

It is recommended that the monitoring of ground vibration intensities (peak ground vibrations and accelerations) from the blasting operations be carried out both in the ground adjacent to the closest structures or within the structures themselves on a continuous basis throughout the blasting process.

If practical, blasting should commence at the furthest points from the closest structure or service to assess the ground vibration attenuation characteristics and to confirm the anticipated ground vibration levels based on the contractor's blasting proposal.

Blasting should be carried out in accordance with the City of Ottawa's Special Provision F-1201 which provides the requirements for blast design and submissions, including pre-blast surveys. Vibration monitoring should be carried out by qualified personnel throughout all blasting operations.

5.8.2 Dewatering

Based on the existing water levels measurement at the site, the groundwater elevation at the site range between 49.2 m to 59.6 m corresponding to depths between 1.1 m to 9.8 m.

Considering the nature of overburden soils at the site (fill and native silty sand/till), groundwater inflows into small and shallow excavations of less than 3.0 m deep developed within the fill material and clay deposit could be handled by pumping from filtered sumps within the excavation areas.

More significant groundwater inflows should be expected for deeper or larger excavations, especially extending below the prevailing groundwater level at site at the time of excavation or penetrating layers containing cobbles and/or boulders. Therefore, more extensive dewatering systems could be required for such conditions requiring Ministry of the Environment and Climate Change (MOECC) permitting.

A hydrogeological study is being prepared by Stantec and will be provided in a separate report, which assesses the dewatering requirement and provides guidance for the PTTW application or EASR registration, if necessary. Comments on calculation of groundwater flow rate, recommended depth to lower the water table, and anticipated pumping rates are provided in the hydrogeological report. All the information regarding ground settlements from dewatering is provided in the hydrogeological report. This information should be considered by the contractor while selecting an appropriate groundwater control system.

5.8.3 Earth Pressures on Retaining Walls

Earth pressures will need to be considered in the design of the foundation and basement walls. Any retaining walls should be backfilled with non-frost susceptible granular fill meeting the gradation requirements of OPSS Granular B Type I materials.



The total active (P_A), passive (P_P), and at-rest (P_O) thrusts acting on the walls can be calculated using the following equations:

$$P_A = ½ K_a \gamma H^2$$
$$P_P = ½ K_p \gamma H^2$$
$$P_O = ½ K_o \gamma H^2$$

where;

H = height of the wall

γ = unit weight of the backfill soil

Values for K_a, K_p, K_o and γ for granular backfill material are provided in the table below. These values are based on the assumption that a horizontal back slope is present behind and adjacent to the wall system(s). The earth pressure coefficients need to be adjusted (i.e., increased) where sloping backfill will be present behind the walls.

At-rest earth pressures should be used in the design of walls that are restrained from movement. The thrust acts at a point one third up the height of the wall.

Table 5.8: Non-Seismic Lateral Earth Pressure Parameters (Horizontal Backfill)

Parameter	**OPSS Granular B – Type I**
Bulk Unit Weight, γ (kN/m^3)	22
Effective Friction Angle	32º
Coefficient of Earth Pressure at Rest (K_o)	0.47
Coefficient of Active Earth Pressure (K_a)	0.31
Coefficient of Passive Earth Pressure (K_p)	3.25

The total active and passive thrusts under earthquake conditions can be calculated using the following equations:

$$P_{AE} = ½ K_{AE} \gamma H^2$$
$$P_{PE} = ½ K_{PE} \gamma H^2$$

where;

K_{AE} = active earth pressure coefficient (combined static and seismic)
K_{PE} = passive earth pressure coefficient (combined static and seismic)
H = height of wall
γ = total unit weight

The recommended seismic earth pressure parameters (based on a seismic Site Class C) are provided in table below. The angle of friction between the soil and the wall has been assumed to be 0° to provide a conservative estimate.



Table 5.9: Seismic Earth Pressure Parameters (Horizontal Backfill)

Parameter	OPSS Granular B – Type I
Bulk Unit Weight, γ (kN/m^3)	22
Effective Friction Angle	32º
Site PGA (g)	0.281
K_{AE} (Non-Yielding Wall)	0.51
Height of Application of P_{AE} from base as a ratio of wall height, (H) – Non-Yielding Wall	0.440
Active Earth Pressure (K_{AE}) – Yielding Wall	0.40
Height of Application of P_{AE} from base as a ratio of wall height, (H) – Yielding Wall	0.393
Passive Earth Pressure, (K_{PE})	2.99
Height of Application of P_{PE} from base as a ratio of wall height, (H)	0.310

In order to use the coefficients of active and at-rest pressures for the granular materials presented in the tables above, the granular backfill must be provided within a wedge extending out from the base of the wall at 45 degrees (or smaller) to the horizontal. The coefficient of passive earth pressure applicable to wall design should be confirmed during detailed design when additional information on wall configuration and depths/founding elevations are determined.

5.9 PIPE BEDDING AND BACKFILL

OPSS Granular A materials should be placed below sewer and water pipes as bedding material. The bedding should have a minimum thickness of 150 mm or more to meet City of Ottawa standards. Where unavoidable disturbance to the subgrade surface does occur, it may be necessary to thicken the bedding layer or provide a sub-bedding layer of compacted Granular B Type II materials. Pipe backfill and cover materials should also consist of OPSS Granular A material. A minimum of 300 mm vertical and side cover should be provided. These materials should be compacted to at least 95% of the material's SPMDD in lifts no greater than 300 mm. Clear crushed stone backfill should not be permitted as pipe bedding materials.

Where the pipe trenches will be covered with hard-surfaced areas, the type of native material placed in the frost zone (i.e. between subgrade level and 1.8 meters depth or the top of the pipe cover materials) should match the soil exposed on the trench walls for frost heave compatibility.

Trench backfill should be placed in maximum 300 mm thick lifts and should be compacted to at least 98 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

If there is insufficient reusable material at the site, any bulk fill required to raise the site grades should consist of imported granular fill meeting the requirements of OPSS Select Subgrade Material (SSM).

All imported fill materials should be tested and approved by a geotechnical engineering firm prior to delivery to the site.



5.10 PAVEMENT DESIGN RECOMMENDATIONS

Provided that subgrade preparation below pavements will comply with the requirements outlined in Section 5.6 of this report, in the absence of traffic data, the pavement structure provided in the following table may be used for the design of the proposed new streets and parking areas. Where required, site grades below pavement structures are to be raised using imported soils meeting the requirements of OPSS Select Subgrade Material (SSM).

Table 5.10: Recommended Pavement Structure

Location	Asphalt Thickness	Base Thickness OPSS Granular A (mm)	Subbase Thickness Granular B Type II (mm)
Standard Duty Parking Areas	60 mm SP12.5 mm	150	300
Heavy Duty Parking Areas	40 mm SP12.5 mm 50 mm SP SP19.0 mm	150	400
Local Roads (no bus traffic)	50 mm SP 12.5 FC1 or FC2 50 mm SP 19	150	500
Local Roads (with bus traffic)	60 mm SP 12.5 FC1 or FC2 70 mm SP 19	150	600

Notes:

- The above pavement structure assumes that the subgrade will consist of either the surface compacted existing fill materials or compacted OPSS SSM material.
- The pavement subgrade must be proof rolled under the supervision of geotechnical personnel prior to subbase or engineered fill placement. Any soft areas identified during proof rolling may require subexcavation and replacement with additional Granular 'B'. Where required, site grades below pavement structures are to be raised using OPSS SSM fill.
- The finished subgrade surface and the pavement surface should be crowned and graded to direct runoff water away from the development and associated infrastructure.
- Perimeter drains and pavement subdrains connected to catch basins are recommended to promote drainage of the pavement structure. The subdrains should comprise 100 mm or 150 mm diameter perforated corrugated pipes with filter socks bedded in sand. The top of pipe should be below the lower limit of the granular subbase.
- Asphalt performance grade and PG 64-34 should be used for roadways with bus traffic. PG 58-34 should be specified where bus traffic is not anticipated.
- Based on the Ontario Provincial Standard Specification "Material Specification for Superpave and Stone Mastic Asphalt Mixtures" OPSS.MUNI 1151 (April 2018), the following Superpave Traffic Categories are suitable:
  - Traffic Category A for parking areas
  - Traffic Category B for local roads without bus traffic
  - Traffic Category D for local roads with bus traffic
- A tack coat is recommended between asphalt layers and along the edges of any cuts in asphalt.
- In the event that the asphalt layer is not placed at the same time as the granular sub-base/base and the base is left exposed for a period of time, the top layer of granular material should be re-shaped, surface compacted and replaced with a fresh layer of Granular A prior to the placement of the asphalt surface.
- Control of surface water is a critical factor in achieving good performance over the pavement structure life. In this regard, the elevations of the surface of the parking areas should be designed to promote adequate surface drainage.



Compaction Requirements:

- The finished sub-grade surface must be compacted to achieve a minimum of 95% of the materials SPMDD immediately prior to placement of the granular materials.
- All granular materials should be in accordance with the requirements of OPSS Specification. These materials should be compacted to at least 100% of the material's Standard Proctor maximum dry density (SPMDD) in lifts no greater than 300 mm.
- The compaction of the asphalt layers should be to at least 92.5% Maximum Theoretical Relative Density (MTRD) in accordance with OPSS 310.

5.11 SLOPE STABILITY REQUIREMENTS

If a site has potential Hazard Lands, the City of Ottawa requires slope stability assessment reports. These reports are reviewed according to the Slope Stability Guidelines for Development Applications within Ottawa. For new development projects, these guidelines may apply to both permanent natural slopes as well as temporary slopes associated with construction. Where unstable slopes exist, the report should define the Limit of Hazard Lands associated with that slope. Based on these guidelines, in the Ottawa area, any land which is sloped or inclined more steeply than about 11 degrees from horizontal (5 horizontal to 1 vertical) and has a grade difference of more than 2 metres across it has the potential for instability. A review of the available topography data indicates that existing lands at the site do not meet these criteria and, therefore, do not require a slope stability assessment. Future grading plans should be evaluated by a geotechnical engineer to determine whether a slope stability assessment is necessary.

6.0 CONSTRUCTION CONSIDERATIONS AND CONSTRAINTS

6.1 UNDERFLOOR DRAINAGE

For buildings that include basement/underground level(s), both a perimeter drainage and an under-slab drainage system is recommended to be included in the design. The following is recommended for the underslab drainage system.

- Concrete floor
- Vapour barrier
- 50 mm of compacted OPSS Granular A, as a working surface
- 250 mm of 19 mm clearstone
- 100 mm perforated drains placed up to 6 m apart
- Filtering, non-woven geotextile between the clearstone and the native soil

The underfloor drainage system should be designed to accommodate the highwater levels associated with spring conditions. Unless seasonal water levels are taken, it should be assumed that the water level could be as high as 1 m below ground surface for brief periods of time.

6.2 REUSE OF ON-SITE MATERIALS

The surficial topsoil materials are geotechnically unsuitable for reuse in any application except for general landscaping purposes, however environmental impacts to the soil my restrict the reuse of the material.



The fill material is not considered to be suitable for reuse as engineered/structural fill below or adjacent to new foundations. These materials that are free of organic matter and other deleterious materials, may be considered suitable for reuse as trench backfill (outside of foundation areas) or as general site grade fill (i.e. materials used to raise the site grade to the design elevations outside building footprints).

The ability to compact these materials to required levels is dependent on the moisture content of the materials; thus, the amount of re-useable material will be dependent on the natural moisture content, weather conditions and the construction techniques at the time of excavation and placement. Any boulders or cobbles with dimensions greater than 150 mm should be removed from these materials prior to placement.

6.3 COLD WEATHER CONSTRUCTION

Placement of fill materials in cold weather requires a considerable increase in effort from that required in “better” weather conditions. Additional costs are typically incurred as a result, and general productivity can be expected to suffer. In addition to the prevailing weather conditions, the quantity of fill to be placed, the required lateral extent and thickness, the equipment used for placement and compaction, and the protection methods employed by the contractor, will all have an influence on the success of placing fill in adverse weather conditions.

Notwithstanding the comments provided in the previous sections of this report pertaining to backfilling and engineered fill, when construction is undertaken during periods of inclement weather or when freezing conditions exist, the placement of fill materials for any purpose should consider the comments provided below.

- Foundations/pile caps/slabs shall be constructed on non-frozen ground only; where non-frozen ground includes the material at surface and all underlying soils. The non-frozen nature of the ground must be confirmed by a geotechnical inspection within 1 hour of concrete placement.
- Following construction of foundations/pile caps/slabs, protection measures must be provided to prevent freezing of the foundation subgrade/bearing soils and for protection of the concrete during curing. The protective measures must also keep the subgrade soils beneath the foundations from freezing after the concrete has cured.
- Foundations/pile caps shall be backfilled with free-draining granular material and drainage shall be provided to prevent lifting of the foundations due to adfreeze during the construction period.
- Structural fill shall not be placed on frozen ground and the structural fill materials shall be free of snow and frozen material.
- Overnight frost penetration into the existing sub-grade or the structural fill must be prevented. Alternatively, the frozen fill must be completely removed prior to placing subsequent lifts. Breaking the frost in-situ is not considered acceptable.
- Moisture adjustment of the fill materials (i.e., adding water or allowing fill to dry) is not practical in freezing conditions. Therefore, obtaining the required compaction levels of 100 percent of the materials Standard Proctor maximum dry density for Structural Fill will not be practical if the fill materials are not supplied to the site near their optimum water content for compaction.
- Regular checks of the temperature of the fill should be made. The soil temperature should be greater than +2C to allow for compaction to the specified degree.
- Imported fill should not be stockpiled on site in such a condition where freezing of the material in the stockpile can develop. Direct import, placement, and compaction is recommended.
- Full-time inspection and testing services is required during earthworks in winter conditions.



7.0 SUPPLEMENTARY GEOTECHNICAL INVESTIGATION

The recommendations provided in this report are general in nature and are provided for planning purposes. The provided recommendation and comments should be confirmed to use for final design purposes.

The following should be considered in a supplementary geotechnical investigation:

- The existing borehole data at the site was collected between 1992 and 2018. A new field investigation will provide current geotechnical conditions at the site.
- A supplementary site and project specific geotechnical investigation should be planned for each proposed development at the site once the details (e.g., final building configurations and site grades, structural loads etc.) related to the proposed development are available.
- It is recommended that a groundwater monitoring program be implemented to help assess variability in the groundwater levels at the site. A hydrological investigation is also recommended to assess the dewatering requirements.
- Geophysical testing could be carried out to measure the in-situ shear wave velocity of the subsurface soils and bedrock at the site to potentially improve the recommended Seismic Site Class.
- In-situ measurement of undrained shear strength of silty clay/clayey silt deposit using field vane test and laboratory testing (plasticity limits and consolidation testing) of silty clay/clayey silt samples are required to assess the compressibility of this deposit and calculation of the potential settlement of due to the placement of any site grade fill.
- The bedrock surface was found to be variable, and the bedrock depth ranges from 0 m (existing ground surface) to about 16.6 m below ground surface. Additional boreholes, including bedrock coring and bedrock testing, at each building location to establish the bedrock level at each development and refine the deep foundation recommendations.
- Additional borehole data will be required for infrastructure such as the pumping station and wet well.

8.0 CLOSURE

This report documents work that was performed in accordance with generally accepted professional standards at the time and location in which the services were provided. No other representations, warranties or guarantees are made concerning the accuracy or completeness of the data or conclusions contained within this report, including no assurance that this work has uncovered all potential liabilities associated with the identified property.

This report provides an evaluation of selected geotechnical conditions associated with the identified portion of the property that was assessed at the time the work was conducted and is based on information obtained by and/or provided to Stantec at that time. There are no assurances regarding the accuracy and completeness of this information. All information received from the client or third parties in the preparation of this report has been assumed by Stantec to be correct. Stantec assumes no responsibility for any deficiency or inaccuracy in information received from others.

Conclusions made within this report consist of Stantec's professional opinion as of the time of the writing of this report and are based solely on the scope of work described in the report, the limited data available and the results of the work. They are not a certification of the property's environmental condition. This report should not be construed as legal advice.

This report has been prepared for the exclusive use of the client identified herein and any use by any third party is prohibited. Stantec assumes no responsibility for losses, damages, liabilities, or claims, howsoever arising, from third party use of this report.

Should additional information become available which differs significantly from our understanding of conditions presented in this report, Stantec requests that this information be brought to our attention so that we may reassess the conclusions provided herein.

Respectfully submitted,

STANTEC CONSULTING LTD.



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APPENDIX A

A.1 STATEMENT OF GENERAL CONDITIONS

Stantec

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This professional work product ("hereinafter referred to as the Report") has been prepared for the sole benefit of the Client in accordance with Stantec's contract with the Client. While the Report may be provided by the Client to applicable authorities having jurisdiction and to other third parties in connection with the project, Stantec disclaims any legal duty based upon warranty, reliance, or any other theory to any third party, and will not be liable to such third party for any damages or losses of any kind that may result.

BASIS OF THIS REPORT: This Report relates solely to the site-specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The information, opinions, conclusions and/or recommendations made in this Report are in accordance with Stantec's present understanding of the site-specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time the scope of work was conducted and do not take into account any subsequent changes. If the proposed site-specific project differs or is modified from what is described in this Report or if the site conditions are altered, this Report is no longer valid unless Stantec is requested by the Client to review and revise the Report to reflect the differing or modified project specifics and/or the altered site conditions. This Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose or site, and any unauthorized use or reliance is at the recipient's own risk.

STANDARD OF CARE: Preparation of this Report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

PROVIDED INFORMATION: Stantec has assumed all information received from the Client and third parties in the preparation of this Report to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein.

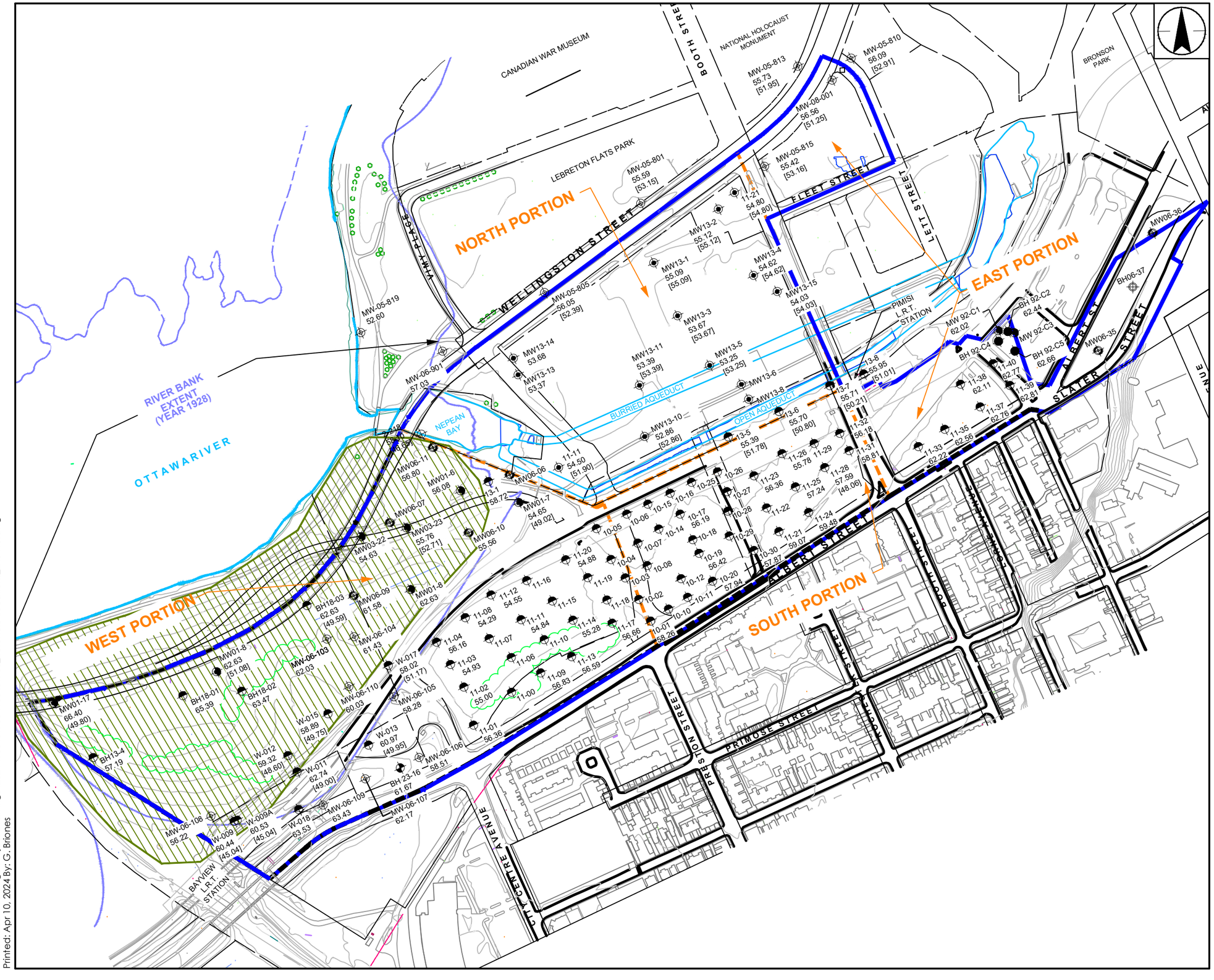
INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this Report are based on site conditions encountered by Stantec at the time of the scope of work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behaviour. Extrapolation of in-situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this Report or encountered at the test and/or sample locations, Stantec must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the Report conclusions or recommendations are required. Stantec will not be responsible to any party for damages incurred as a result of failing to notify Stantec that differing site or subsurface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec geotechnical engineers, sufficiently ahead of initiating the next project stage (e.g., property acquisition, tender, construction, etc.), to confirm that this Report completely addresses the elaborated project specifics and that the contents of this Report have been properly interpreted. Specialty quality assurance services (e.g., field observations and testing) during construction are a necessary part of the evaluation of subsurface conditions and site work. Site work relating to the recommendations included in this Report should only be carried out in the presence of a qualified geotechnical engineer; Stantec cannot be responsible for site work carried out without being present.

APPENDIX B

B.1 DRAWING NO. 1 – BOREHOLE LOCATION PLAN



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LEGEND

- BOREHOLE LOCATION (PATERSON GROUP, 2016)
- BOREHOLE LOCATION (GOLDER, 2010-2013)
- BOREHOLE WITH MONITORING WELL LOCATION (GOLDER, 2010-2013)
- BOREHOLE LOCATION (JACQUES, WHITFORD LIMITED, 2001)
- BOREHOLE WITH MONITORING WELL LOCATION (JACQUES, WHITFORD LIMITED, 2001)
- BOREHOLE LOCATION (TROW, 2002)
- BOREHOLE WITH MONITORING WELL LOCATION (AQUA TERRA, 2005-2008)
- BOREHOLE LOCATION (INTERA, 2006)
- BOREHOLE WITH MONITORING WELL LOCATION (INTERA, 2006)
- FORMER LANDFILL (Ur-06)
- 55.76 GROUND SURFACE ELEVATION (m)
- [52.71] BEDROCK SURFACE ELEVATION (m)

NOTES

1. BASEPLAN TAKEN FROM A PDF COPY OF A DRAWING PREPARED BY PATERSON GROUP ENTITLED HISTORICAL TEST HOLE LOCATION PLAN, DATED 29/04/2020.

40m 0 40 80m
1 : 4000

APRIL 2024
Project No. 106401780

Client/Project
NATIONAL CAPITAL COMMISSION
GEOTECHNICAL DESKTOP REVIEW
LEBRETON FLATS PLAN OF SUBDIVISION, OTTAWA, ON

Drawing No.
1

Title
BOREHOLE LOCATION PLAN

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Printed: Apr 10, 2024 By: G. Briones

APPENDIX C

C.1 BOREHOLE RECORDS

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Rootmat	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization 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 successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25 - 0.5	12.5 - 25	2-4
Firm	0.5 - 1.0	25 - 50	4-8
Stiff	1.0 - 2.0	50 – 100	8-15
Very Stiff	2.0 - 4.0	100 - 200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor Quality*
25-50	*Poor Quality*
50-75	*Fair Quality*
75-90	*Good Quality*
90-100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT



measured in standpipe, piezometer, or well



inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

JACQUES WHITFORD
ENVIRONMENT LIMITED

MONITOR WELL RECORD

92-C1

CLIENT National Capital Commission
LOCATION Site C - Lebreton Flats, Ottawa, Ontario
DATES: BORING 92-02-01 WATER LEVEL 92-02-18

PROJECT No. 30203
DATUM Geodetic
TPC ELEV. 61.99

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	VAPOUR CONCENTRATIONS ● %LEL ▲ ppm	SAMPLES TYPE	SAMPLES N-VALUE OR RQD	WELL CONSTRUCTION
	62.02					● 20 40 60 80 ▲ 100 200 300 400			
0		Dark brown, sand and gravel : FILL							Bentonite Seal
	61.3								
1		Loose, dark brown, SILTY SAND, trace gravel					SS	6	Sand Backfill
	60.6								
2		Compact, olive brown, sand and silt, trace gravel : TILL					SS	28	Slotted Pipe with Sand Backfill
	59.8								
		Dense, olive brown, sand and silt, trace gravel : TILL		▼			SS	42	
	59.4								
3		End of Borehole Auger refusal on possible bedrock							
4									
5									
6									



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BOREHOLE RECORD

92-C2

CLIENT National Capital Commission — PROJECT No. 30203

LOCATION Site C - Lebreton Flats, Ottawa, Ontario — DATUM Geodetic

DATES: BORING 92-02-01 — WATER LEVEL N.A. — TPC ELEV. N.A.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	VAPOUR CONCENTRATIONS ● %LEL ▲ ppm	SAMPLES TYPE	SAMPLES N-VALUE OR RQD	WELL CONSTRUCTION
0	62.44					● 20 40 60 80 ▲ 100 200 300 400			
		Dark brown, sand and gravel : FILL							No Monitoring Well Installed
	61.7				2				
1		Compact, brownish orange, sand and gravel, trace silt : FILL				▲	SS	20	
	61.0				4				
	60.8	Compact, dark brown, sand and gravel : FILL							
		Compact, grey, sand and silt, some gravel : TILL			6	▲	SS	28	
2	60.2								
		Very dense, grey, sand and silt, trace gravel : TILL			8	▲	SS	62	
3					10	▲	SS	65	
					12				
4						▲	SS	83	
					14				
							SS	*	
5					16	▲			
	57.2								
		End of Borehole			18				
		* Split spoon refusal on possible bedrock							
6									

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MONITOR WELL RECORD

92-C3

CLIENT National Capital Commission
LOCATION Site C - Lebreton Flats, Ottawa, Ontario
DATES: BORING 92-02-01 WATER LEVEL 92-02-18 - Dry

PROJECT No. 30203
DATUM Geodetic
TPC ELEV. 62.12

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES N-VALUE OR RQD
0	62.25			
		Very dense, brown to dark brown, sand and gravel with trace organics : FILL		
1	60.8		SS	51
		Compact, grey, sand and silt, trace gravel : TILL	SS	27
2			SS	65
3	58.8		SS	*
		End of Borehole * Split spoon refusal on possible bedrock		
4				
5				
6				

VAPOUR CONCENTRATIONS
● %LEL ▲ ppm
● 20 40 60 80
▲ 100 200 300 400

DEPTH (ft): 2, 4, 6, 8, 10, 12, 14, 16, 18

WELL CONSTRUCTION
Bentonite Seal
Sand Backfill
Slotted Pipe with Sand Backfill

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ENVIRONMENT LIMITED

BOREHOLE RECORD

92-C4

CLIENT National Capital Commission
LOCATION Site C - Lebreton Flats, Ottawa, Ontario
DATES: BORING 92-02-01 WATER LEVEL N.A.

PROJECT No. 30203
DATUM Geodetic
TPC ELEV. N.A

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	VAPOUR CONCENTRATIONS ● %LEL ▲ ppm	SAMPLES TYPE	SAMPLES N-VALUE OR RQD	WELL CONSTRUCTION
	62.00					● 20 40 60 80 ▲ 100 200 300 400			
0		Brown, sand and gravel, trace silt : FILL							No Monitoring Well Installed
	61.3								
1		Compact, brown, sand and silt with some brick, wood and slag : FILL			2		SS	29	
	60.6				4				
		Loose, light brown, sand and some cobbles with some black staining at 2 m below grade : FILL							
2	59.8				6		SS	9	
		Dense, grey, sand and silt, trace to some gravel : TILL			8		SS	52	
							SS	49	
3					10				
	58.4						SS	45	
		End of Borehole Auger refusal on possible bedrock			12				
4					14				
					16				
5					18				
6									

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BOREHOLE RECORD

92-C5

CLIENT National Capital Commission — PROJECT No. 30203

LOCATION Site C - Lebreton Flats, Ottawa, Ontario — DATUM Geodetic

DATES: BORING 92-02-01 — WATER LEVEL N.A. — TPC ELEV. N.A.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	VAPOUR CONCENTRATIONS ● %LEL ▲ ppm	SAMPLES TYPE	SAMPLES N-VALUE OR RQD	WELL CONSTRUCTION
						● 20 40 60 80 ▲ 100 200 300 400			
0	62.66	Compact, brown to dark brown, sand and gravel, some brick : FILL			2	▲	SS	24	No Monitoring Well Installed
1	61.2	Compact to dense, light brown to grey, sand and silt, trace gravel : TILL			4				
2					6	▲	SS	26	
					8	▲	SS	50	
3					10	▲	SS	31	
4	58.2				12				
		End of Borehole Auger refusal on possible bedrock			14	▲	SS	51	
5					16				
					18				
6									

JACQUES, WHITFORD AND ASSOCIATES LIMITED

MONITORING WELL RECORD

CLIENT Robinson Consultants Inc.

LOCATION LeBretons Flats, ABC Lines, Ottawa, Ontario

DATES: BORING 01 04 06 WATER LEVEL 01 04 18

BOREHOLE No. MW01-6

PROJECT No. ONO11359

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	56.08							
	56.0	TOPSOIL						
		Compact, brown silt and sand, trace gravel, trace organics, trace clay: FILL			AS	1	---	---
1					SS	2	200	10
	54.6			▽				
		Stiff, grey brown silty clay, trace gravel, trace organics: FILL			SS	3	250	11
2	54.0							
		Dense, grey brown silty sand and gravel: FILL			SS	4	200	27
		Frequent cobbles and boulders						
3				▼	SS	5	150	36
					SS	6	150	50/
4	52.0							280 mm
		Grey black limestone and shale boulders			NQ	7	100%	63%
					SS	8	0	50/
5					NQ	9	100%	200 mm 100%
	50.8							
		Void						
	50.1							
6	49.8	Compact, black silty sand and gravel, trace organics (wood chips): FILL			SS	10	300	19
		Loose, grey SAND, trace to some silt and gravel			SS	11	510	7
7	48.9							
		Installed Well						
		End of Borehole						
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m *

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

A-

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD AND ASSOCIATES LIMITED

MONITORING WELL RECORD

CLIENT Robinson Consultants Inc.

LOCATION LeBretons Flats, ABC Lines, Ottawa, Ontario

DATES: BORING 01 04 06 WATER LEVEL 01 04 18

BOREHOLE No. MW01-7

PROJECT No. ONO11359

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	54.65							
	54.6	TOPSOIL						
		Loose, brown black silty sand, trace gravel, trace to some clay:			AS	1	---	---
	53.9	FILL						
1		Loose, grey black silty sand, trace clay, debris (plastic): FILL		▽	SS	2	330	4
				▼	SS	3	400	2
2	52.5	Soft, black peat, some silt, some sand: ORGANICS			SS	4	260	13
3					SS	5	270	9
	51.0	Compact, grey SILTY SAND, some clay, trace gravel			SS	6	530	10
4								
5					SS	7	410	16
	49.2	Severely fractured, grey limestone: BEDROCK			NQ	8	100%	0%
6								
7					NQ	9	79%	36%
	47.2	Installed Well						
8		End of Borehole						
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

A-

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD AND ASSOCIATES LIMITED

MONITORING WELL RECORD

CLIENT Robinson Consultants Inc. BOREHOLE No. MW01-8

LOCATION LeBretons Flats, ABC Lines, Ottawa, Ontario PROJECT No. ONO11359

DATES: BORING 01 04 06 WATER LEVEL 01 04 18 DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	62.63							
	62.6	TOPSOIL			AS	1	---	---
	61.9	Firm, brown silty clay, trace gravel, trace organics, trace debris (wood fragments): FILL			SS	2	400	10
1		Firm to stiff, brown grey sandy clay, some silt, trace gravel, trace debris (rubber, brick, wood): FILL			SS	3	520	4
2					SS	4	270	4
3					SS	5	530	35
4					SS	6	140	3
5	57.3				SS	7	90	8
		Stiff, grey silty clay, some sand, trace gravel, rock fragments, trace debris (wood, plastic) : FILL			SS	8	170	3
6					SS	9	310	8
7					SS	10	440	13
8		Sand seam			SS	11	470	8
					SS	12	470	17
9	53.6	Compact, grey silty sand, rock fragments, trace debris (glass, brick, wood): FILL		▼	SS	13	460	19
	52.7							
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

A-

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD AND ASSOCIATES LIMITED

MONITORING WELL RECORD

CLIENT: Robinson Consultants Inc.
LOCATION: LeBretons Flats, ABC Lines, Ottawa, Ontario
DATES: BORING 01 04 06 WATER LEVEL 01 04 18

BOREHOLE No. MW01-8
PROJECT No. ONO11359
DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
10		Decomposed paper, trace wood fragments: FILL		▽	SS	14	540	50/ 330 mm
		Few cobbles			SS	15	170	27
11	51.5	Auger Refusal at 10.52 m, hammered spoon, then continued augering			SS	16	280	50/ 430 mm
	51.1	Dense, grey SILTY SAND, some to trace gravel, trace clay						
12		Auger Refusal Inferred Bedrock at 11.55 m Installed Well End of Borehole						
13								
14								
15								
16								
17								
18								
19								
20								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m: *

STANDARD PENETRATION TEST, BLOWS/0.3m: ●

10 20 30 40 50 60 70 80 90

A-

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

J[redacted]11359[redacted]EL.G[redacted]5/01

JACQUES WHITFORD
ENVIRONMENT LIMITED

MONITORING WELL RECORD

MW01-10

CLIENT Robinson Consultants Inc. PROJECT No ONO11359 ORIGINATED BY BC

LOCATION LeBreton Flats, ABC Lines, Ottawa, Ontario DATUM Geodetic COMPILED BY SS

DATES: BORING 2001-04-09 WATER LEVEL 2001-04-18 TPC ELEV 60.283 CHECKED BY FG

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	VAPOUR CONCENTRATIONS ● %LEL ▲ ppmv	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES N-VALUE	WELL CONSTRUCTION
						● 20 40 60 80 ▲ 100 200 300 400				
0	59.45									
	59.4	TOPSOIL								Protective Casing and Concrete Seal
		Loose, dark brown silty sand, trace clay: FILL			2	▲	AS	1	---	Bentonite Seal
1	58.2				4	▲	SS	2	8	
		Firm, grey brown silty clay, trace gravel, trace debris (brick): FILL								51 mm, #10. Slotted PVC Screen with Sandpack
2					6	▲	SS	3	4	
	57.2									
		Loose, grey black silty sand, trace gravel, trace debris (steel, wood waste): FILL			8	▲	SS	4	3	
3					10	▲	SS	5	8	
	56.1									
		Firm, grey black silty clay, trace debris (brick, glass): FILL			12					
4					14	▲	SS	6	5	
	54.9									
		Compact, grey black silty sand, trace debris (brick, wood waste): FILL			16	▲	SS	7	3	
5					18	▲	SS	8	15	
6					20	▲	SS	9	8	
7					22					
					24	▲	SS	10	5	
8					26	▲	SS	11	4	
					28	▲	SS	12	50/ 560 mm	
	50.6									
9	50.3	Compact, grey SAND, some gravel, trace silt			30					
		Auger Refusal								
		Inferred Bedrock at 9.14 m			32					
10										

LABORATORY ANALYSES: Sample MW01-10 SS10 submitted for laboratory analysis of TPH(gas/diesel), VOCs, PAHs, PCBs, Chloride, Sulphate and Inorganic Soil Decommissioning parameters

▽ Groundwater Level

JACQUES WHITFORD
ENVIRONMENT LIMITED

MONITORING WELL RECORD

MW01-17

CLIENT Robinson Consultants Inc.
LOCATION LeBreton Flats, ABC Lines, Ottawa, Ontario
DATES BORING 2001-08-15 WATER LEVEL 2001-08-23

PROJECT No ONO11359 ORIGINATED BY BC
DATUM Geodetic COMPILED BY SS
TPC ELEV 67.315 CHECKED BY EG

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	SAMPLES TYPE	NUMBER	N-VALUE	WELL CONSTRUCTION
				VAPOUR CONCENTRATIONS ● %LEL ▲ ppmv			
				● 20 40 60 80 ▲ 100 200 300 400			
0	**66.40**						
	66.2	200 mm of TOPSOIL/ROOTMAT Compact to dense, brown sand with silt, trace gravel: FILL	2	GS	1	---	Protective Casing and Bentonite Seal
1			4	SS	2	20	Bentonite Seal
			6	SS	3	50/300	Backfill of Auger Cuttings
2			8	SS	4	50/250	
3			10	SS	5	17	
	62.6		12				
4		Loose, brown sand, trace silt, trace gravel, debris (bricks): FILL	14	SS	6	5	
			16	SS	7	5	
5							
	61.1		18	SS	8	4	
		Firm, grey clay, some gravel: FILL					
6	60.3		20	SS	9	23	
		Compact, grey brown sand, some silt, trace gravel: FILL	22				
7			24	SS	10	22	
			26	SS	11	12	Bentonite Seal
8			28	SS	12	3	51 mm, #10, PVC Casing, with Sandpack
9			30	SS	13	26	51 mm, #10, Slotted PVC Screen with Sandpack
			32				
10							

LABORATORY ANALYSES

Sample MW 01-17 SS-10 submitted for laboratory analysis of VOCs sample MW 01-17 SS-17 submitted for analysis of PAHs and sample MW 01-17 SS-6 submitted for analysis of TPH (gas/diesel)

· Groundwater Level

JACQUES WHITFORD
ENVIRONMENT LIMITED

MONITORING WELL RECORD

MW01-17

CLIENT Robinson Consultants Inc. PROJECT No ONO11359 ORIGINATED BY BC

LOCATION LeBreton Flats, ABC Lines, Ottawa, Ontario DATUM Geodetic COMPILED BY SS

DATES BORING 2001-08-15 WATER LEVEL 2001-08-23 TPC ELEV 67.315 CHECKED BY FG

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES N-VALUE
10	66.40		34	SS	14	33
11			36	SS	15	25
			38	SS	16	31
12	54.2	Stiff, grey brown silty clay, organics, debris (wood): FILL	40	SS	17	50
13	53.5	Compact, grey sand, some silt, trace clay, trace gravel, occasional rock fragments and debris : FILL	42			
			44	SS	18	22
14			46	SS	19	6
			48	SS	20	50/430
15			50	SS	21	35
	50.6		52			
16		Dense, grey SILTY SAND, some gravel	54	SS	22	61
	49.8	End of Borehole				
17		Auger Refusal on Inferred Bedrock	56			
			58			
18		Installed Well	60			
19			62			
			64			
20						

VAPOUR CONCENTRATIONS ● %LEL ▲ ppmv

● 20 40 60 80
▲ 100 200 300 400

WELL CONSTRUCTION

LABORATORY ANALYSES

Groundwater Level

Sample MW 01-17 SS-10 submitted for laboratory analysis of VOCs, sample MW 01-17 SS-17 submitted for analysis of PAHs, and sample MW 01-17 SS-6 submitted for analysis of TPH (gas/diesel)

Log of Borehole 2-218

Trow

Auger Sample ⊠
SPT (N) Value ○○ ▨ Natural Moisture ✖
Dynamic Cone Test —— Plastic & Liquid Limit ⊢—
Shelby Tube ●● ■ Undrained Triaxial at 0
Rock Core ▩ Overburden Pressure 15 ⊕ 5
Field Vane Test + S % Strain at Failure 10
Penetrometer ▲
Water Level: Est.: ▽ Measured: ▼ Perched: ▼

Project Geotechnical Investigation Dwg. No. 19

Lebreton Flats Infrastructure and Rehabilation Project

Ottawa, Ontario Project No. MA15510A

Borehole Location Refer to Drawing No. 1

GWL	SYMBOL	Soil Description	Geodetic Elev. m	Depth	N Value / Shear Strength (20 40 60 80)	Natural Moisture Content and Atterberg Limits % Dry Weight (10 20 30)	Natural Unit Weight KN/m³
		TOPSOIL ~75mm **FILL** Silty sand with some gravel, trace concrete and brick pieces, occasional cobbles and boulders, grey, wet (compact)	58.1	0	○		
		FILL Silty sand and gravel, occasional cobbles and boulders, some clay , moist, grey to dark grey (loose to compact)	55.1	3	○		
▽		-Sand blow-up into augers from 8.2 to 7.2m depth	52.7	4	○Bouncing		
				6	○		
				8	○		
				9	○		

JACQUES WHITFORD
ENVIRONMENT LIMITED

MONITORING WELL RECORD

MW03-22

CLIENT Robinson Consultants Inc. PROJECT No. ONO11359-4 ORIGINATED BY CM/EK

LOCATION Lemieux Island Low Pressure Transmission Main, Ottawa, ON DATUM Geodetic COMPILED BY JF

DATES: BORING 05-30-03 WATER LEVEL 06-26-03 TPC ELEV. 54.55 CHECKED BY CM

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	VAPOUR CONCENTRATIONS ● %LEL ▲ ppmv	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES N-VALUE	WELL CONSTRUCTION
						● 20 40 60 80 ▲ 100 200 300 400				
0	**54.63**									
	54.5	100 mm ASPHALT					GS	1	---	Protective Casing and Bentonite Seal
	54.4	Granulars								
1		Compact to loose, grey to brown sand and gravel, some brick, some wood: FILL			2	▲	SS	2	21	Bentonite Seal
					4	▲	SS	3	9	51 mm, Schedule 40, PVC Casing, with Sandpack
2				▽	6		SS	4	6	Protective Casing and Concrete Seal
					8	▲	SS	5	7	
3					10		SS	6	7	
	51.0									
		Very loose, sandy gravel, trace organics, wood: FILL			12		SS	7	3	
4	50.4									
		Very loose to compact, grey clay, trace gravel, wood: FILL			14	▲	SS	8	2	
5					16	▲	SS	9	15	
	49.1									
		Compact to dense, grey silty sand, some clay: GLACIAL TILL			18		SS	10	21	
6					20		SS	11	25	Backfill of Auger Cuttings
					22		SS	12	50/80mm	
7	47.4									
		End of Borehole			24					
		Auger Refusal on Inferred Bedrock								
8					26					
		Monitoring Well Installed			28					
9					30					
					32					
10										

LABORATORY ANALYSES: MW03-22 SS8 submitted for analysis of BTEX, TPH (g, d, ho), and VOCs. MW03-22 SS6 submitted for PAHs. MW03-22 SS2 submitted for analysis of general inorganics. Groundwater sample submitted for analysis of BTEX, TPH (g, d, ho), VOCs, PAHs and general inorganics.

▽ Groundwater Level

A-

JWE .GDT .GP

JACQUES WHITFORD
ENVIRONMENT LIMITED

MONITORING WELL RECORD

MW03-23

CLIENT Robinson Consultants Inc. PROJECT No. ONO11359-4 ORIGINATED BY CM/EK
LOCATION Lemieux Island Low Pressure Transmission Main, Ottawa, ON DATUM Geodetic COMPILED BY JF
DATES: BORING 05-30-03 WATER LEVEL 06-26-03 TPC ELEV. 55.669 CHECKED BY CM

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	VAPOUR CONCENTRATIONS ● %LEL ▲ ppmv	SAMPLES TYPE	NUMBER	N-VALUE	WELL CONSTRUCTION
0	55.76					● 20 40 60 80 ▲ 100 200 300 400				
	55.7	100 mm ASPHALT					GS	1	---	Protective Casing and Bentonite Seal
	55.6	Grey sand and gravel: FILL								
		Compact, brown sand: FILL			2		SS	2	12	Bentonite Seal
1	54.5	Compact, grey sand, brick, wood: FILL			4		SS	3	29	51 mm, Schedule 40, PVC Casing, with Auger Cuttings
2	53.9	Dense to loose, brown to grey sand and gravel: FILL			6		SS	4	45	
				▽	8		SS	5	5	
3					10		SS	6	11	
4	52.1	Loose to very loose, grey gravel, some sand, some rock fragments: FILL			12		SS	7	8	
					14		SS	8	3	
5					16		SS	9	3	
					18	▲	SS	10	7	
6	49.7	Loose to compact, grey silty sand: GLACIAL TILL			20	▲	SS	11	6	
7					22	▲	SS	12	14	
	48.1	Compact to dense, grey to brown silty sand, trace gravel: GLACIAL TILL			24	▲	SS	13	32	
8					26	▲	SS	14	70	
					28	▲	SS	15	50/ 100mm	
9					30					
	46.0				32					Bentonite Seal
10										

LABORATORY ANALYSES: MW03-23 SS12 submitted for analysis of BTEX, TPH (g, d, ho), and VOCs. MW03-23 SS3 submitted for analysis of Regulation 347, PAHs and general inorganics.
Groundwater sample submitted for analysis of BTEX, TPH (g, d, ho), VOCs, PAHs and general inorganics.

▽ Groundwater Level

A-

JWE. ...3-4.GP. ...GDT

JACQUES WHITFORD
ENVIRONMENT LIMITED

MONITORING WELL RECORD

MW03-23

CLIENT Robinson Consultants Inc. PROJECT No. ONO11359-4 ORIGINATED BY CM/EK
LOCATION Lemieux Island Low Pressure Transmission Main, Ottawa, ON DATUM Geodetic COMPILED BY JF
DATES: BORING 05-30-03 WATER LEVEL 06-26-03 TPC ELEV. 55.669 CHECKED BY CM

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	VAPOUR CONCENTRATIONS ● %LEL ▲ ppmv	SAMPLES TYPE	NUMBER	N-VALUE	WELL CONSTRUCTION
	55.76					● 20 40 60 80 ▲ 100 200 300 400				
10		Poor to good, light grey limestone with occasional shale interbeds: BEDROCK			34		HQ	16	49 %	51 mm, Schedule 40, PVC Casing, with Sandpack
11					36		HQ	17	80 %	51 mm, Schedule 40, slot #10, PVC Screen with Sandpack
	44.0				38					
12		End of Borehole Monitoring Well Installed			40					
13					42					
					44					
14					46					
					48					
15					50					
16					52					
					54					
17					56					
					58					
18					60					
19					62					
					64					
20										

LABORATORY ANALYSES: MW03-23 SS12 submitted for analysis of BTEX, TPH (g, d, ho), and VOCs. MW03-23 SS3 submitted for analysis of Regulation 347, PAHs and general inorganics.
Groundwater sample submitted for analysis of BTEX, TPH (g, d, ho), VOCs, PAHs and general inorganics.

▽ Groundwater Level

A-

JWEL ...3-4.GPJ ...GDT

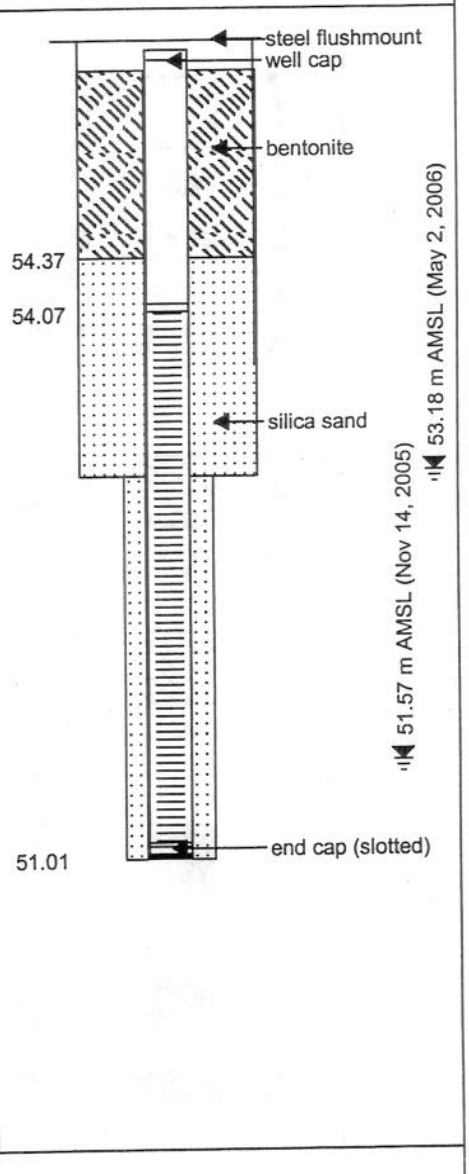
Borehole/Monitoring Well ID: MW-05-801

Project No.: 97-142H
Client: National Capital Commission
Location: LeBreton Flats, Ottawa
Date Completed: November 2, 2005
Site Datum: IB84 with geodetic elevation of 55.035 m AMSL

ATSI Supervisor: S.Dingee
Drilling Method: HSA/DTH
Borehole Diameter: 203 mm/102 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling Ltd.
Drilling Equipment: CME 55 Truck
Well Casing: PVC Schedule 40
Well Screen: PVC Schedule 40, Slot 10
OVM: Samples not screened

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
						Ground Surface	55.59
0 / 0		BH-05-801-1				TOPSOIL moist, black	
3 / 1	2 8 11 12	BH-05-801-2		33%		SAND AND GRAVEL FILL moist, brown, coarse-grained sand and gravel	55.00
6 / 2	1 4 3 3	BH-05-801-3		17%		wet, grey/brown, medium-grained	54.00
9 / 3	6 5 50 for 51 mm	BH-05-801-4		7%		BEDROCK	53.00
12 / 4							52.00
15 / 5						End of borehole at 4.58 m	51.00
18 / 6							50.00
20							



(1) Blow count per 0.15 m using conventional hammer and split spoons

HSA = Hollow Stem Auger
DTH = Down the hole Hammer

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

AQUA TERRE

Borehole/Monitoring Well ID: MW-05-805

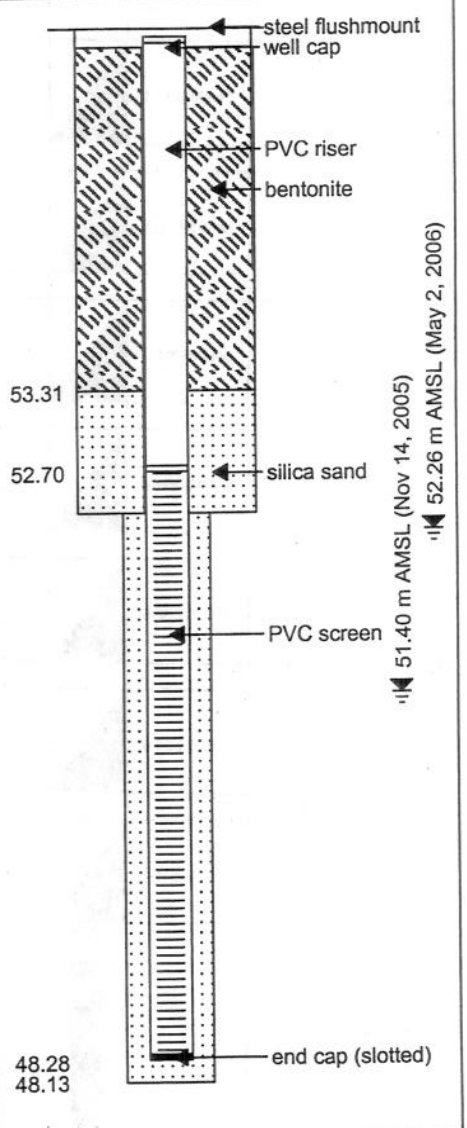
Project No.: 97-142H
Client: National Capital Commission
Location: LeBreton Flats, Ottawa
Date Completed: November 2, 2005
Site Datum: IB84 with geodetic elevation of 55.035 m AMSL

ATSI Supervisor: S.Dingee
Drilling Method: HSA/DTH
Borehole Diameter: 204 mm/102mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling Ltd.
Drilling Equipment: CME 55 Truck
Well Casing: PVC Schedule 40
Well Screen: PVC Schedule 40, Slot 10
OVM: Samples not screened

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
						Ground Surface	56.05
0 / 0				N/A		ASPHALT	
1						SAND AND GRAVEL FILL dry, grey,fine sand, coarse gravel	
2							
3 / 1	20 24 18 20	BH-05-805-1		50%			55.00
4						clayey, silty, grey	
5	19 18 16 20	BH-05-805-2		46%			
6 / 2							54.00
7							
8	7 4 4 7	BH-05-805-3		50%		SILTY CLAY moist, grey/brown, with fine sand, trace gravel	
9							
10 / 3							53.00
11	11 1 6 50 for 127 mm	BH-05-805-4		17%			
12						BEDROCK	
13 / 4							52.00
14							
15							
16 / 5							51.00
17							
18							
19							
20 / 6							50.00
21							
22							
23 / 7							49.00
24							
25						End of borehole at 7.92m	
26 / 8							48.00
27							

Top of pipe Elev. = 55.96m ASL



(1) Blow count per 0.15 m using conventional hammer and split spoons

HSA = Hollow Stem Auger
DTH = Down the hole Hammer

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

AQUA TERRE

Borehole/Monitoring Well ID: MW-05-810

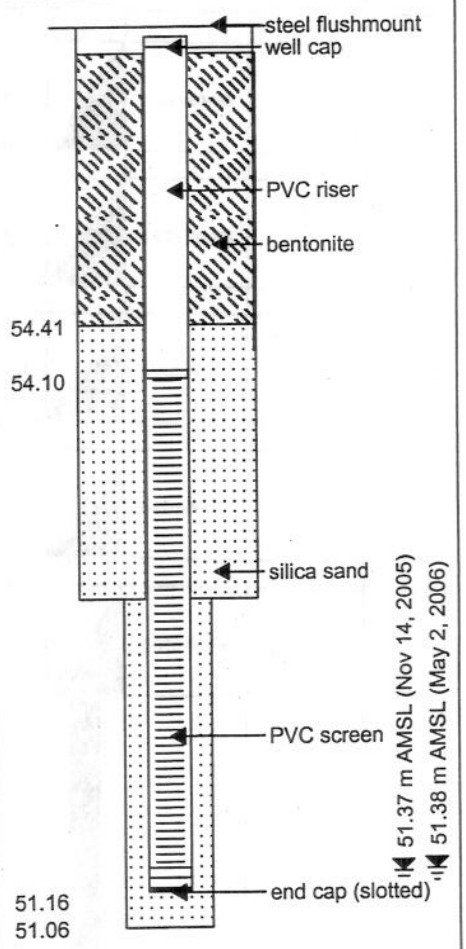
Project No.: 97-142H
Client: National Capital Commission
Location: LeBreton Flats, Ottawa
Date Completed: November 7, 2005
Site Datum: IB84 with geodetic elevation of 55.035 m AMSL

ATSI Supervisor: S.Dingee
Drilling Method: HSA/DTH
Borehole Diameter: 204 mm/102
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling Ltd.
Drilling Equipment: CME 45 Track
Well Casing: PVC Schedule 40
Well Screen: PVC Schedule 40, Slot 10
OVM: Samples not screened

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
						Ground Surface	56.09
0 / 0	2, 4, 7, 9	BH-05-810-1		54%		SAND AND GRAVEL FILL moist, grey, med to fine sand and fine gravel	
3 / 1	11, 7, 4, 5	BH-05-810-2		33%			55.00
6 / 2	5, 19, 18, 11	BH-05-810-3		50%			54.00
9 / 3	3, 3, 2, 4	BH-05-810-4		50%		wet	53.00
11 / 3	2 50 for 127 mm	BH-05-810-5		25%		BEDROCK	
16 / 5						End of borehole at 5.03m	51.00
20 / 6							50.00

Top of Pipe Elev. = 56.00m ASL



(1) Blow count per 0.15 m using conventional hammer and split spoons

HSA = Hollow Stem Auger
DTH = Down the hole Hammer

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

AQUA TERRE

Borehole/Monitoring Well ID: MW-05-813

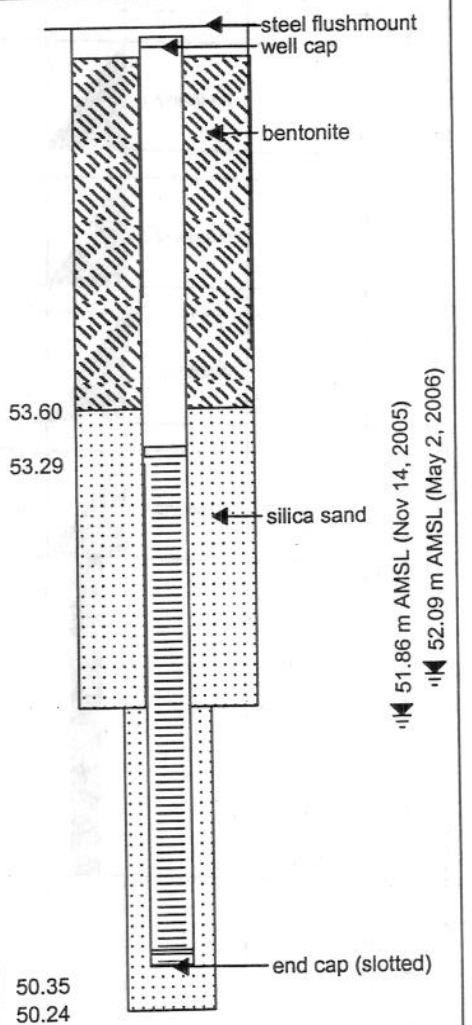
Project No.: 97-142H
Client: National Capital Commission
Location: LeBreton Flats, Ottawa
Date Completed: November 7, 2005
Site Datum: IB84 with geodetic elevation of 55.035 m AMSL

ATSI Supervisor: S.Dingee
Drilling Method: HSA/DTH
Borehole Diameter: 203 mm/102 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling Ltd.
Drilling Equipment: CME 45 Track
Well Casing: PVC Schedule 40
Well Screen: PVC Schedule 40, Slot 10
OVM: Samples not screened

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
						Ground Surface	55.73
0–1 / 0	4, 7, 18, 30	BH-05-813-1		58%		SILTY CLAY FILL moist, grey/brown silty clay with some sand	
						SAND AND GRAVEL FILL dry, grey, med. sand and fine gravel	
1–3 / 0–1	4, 10, 9, 11	BH-05-813-2		33%		moist, brown, fine to coarse gravel @ 0.76 m	55.00
5–7 / 1–2	2, 15, 17, 19	BH-05-813-3		83%		SAND FILL moist, brown, fine sand, some medium gravel	54.00
8–9 / 2–3	8, 11, 9, 11	BH-05-813-4		100%		no gravel	53.00
10–11 / 3	5, 6, 8, 8	BH-05-813-5		67%		SILTY SAND FILL moist, clayey, some gravel	52.00
12–13 / 4						BEDROCK	51.00
17 / 5						End of borehole at 5.49m	50.00

Top of Pipe Elev. = 55.60m ASL



(1) Blow count per 0.15 m using conventional hammer and split spoons

HSA = Hollow Stem Auger
DTH = Down the hole Hammer

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

AQUA TERRE

Borehole/Monitoring Well ID: MW-05-815

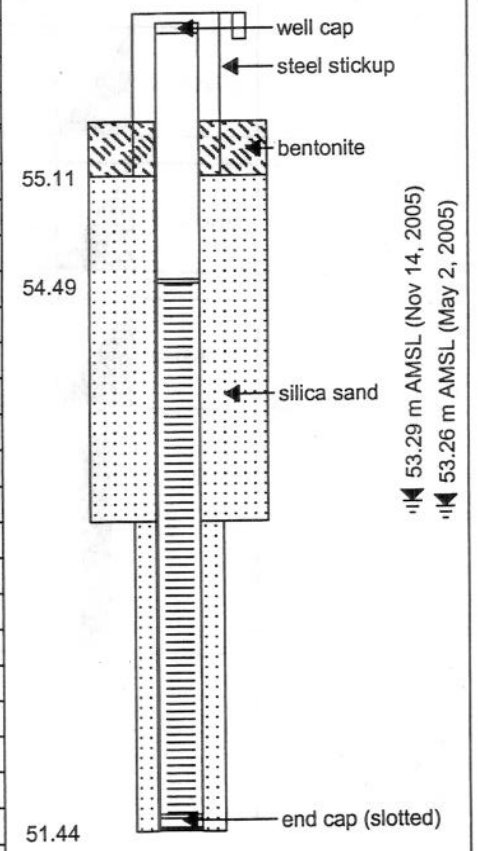
Project No.: 97-142H
Client: National Capital Commission
Location: LeBreton Flats, Ottawa
Date Completed: November 9, 2005
Site Datum: IB84 with geodetic elevation of 55.035 m AMSL

ATSI Supervisor: S.Dingee
Drilling Method: HSA/DTH
Borehole Diameter: 203 mm/102 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling Ltd.
Drilling Equipment: CME 45 Track
Well Casing: PVC Schedule 40
Well Screen: PVC Schedule 40, Slot 10
OVM: Samples not screened

DEPTH	BLOW COUNT (1)	SAMPLE ID	LOCATION	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
0						Ground Surface	55.42
1	2, 4, 6, 6	BH-05-815-1		67%		SILTY SAND FILL moist, grey, clayey with fine gravel	55.11
2	6, 2, 4, 5	BH-05-815-2		63%			54.49
3	6, 7, 6, 6	BH-05-815-3		75%			54.00
4						BEDROCK	53.00
5						End of borehole at 3.96 m	51.44

Top of Pipe Elev. = 56.12m ASL



(1) Blow count per 0.15 m using conventional hammer and split spoons

HSA = Hollow Stem Auger
DTH = Down the hole Hammer

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

AQUA TERRE

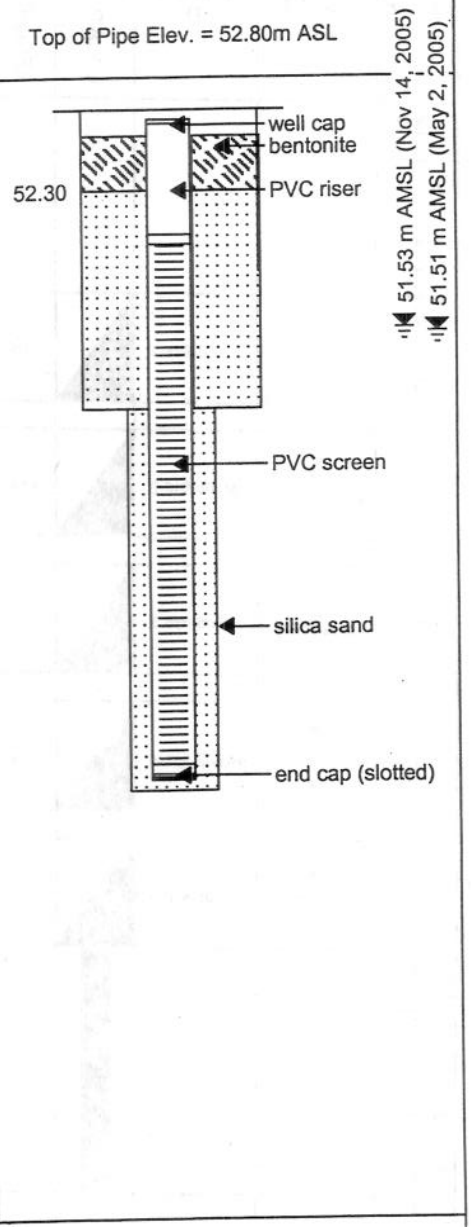
Borehole/Monitoring Well ID: MW-05-819

Project No.: 97-142H
Client: National Capital Commission
Location: LeBreton Flats, Ottawa
Date Completed: November 8, 2005
Site Datum: IB84 with geodetic elevation of 55.035 m AMSL

ATSI Supervisor: S.Dingee
Drilling Method: HSA/DTH
Borehole Diameter: 204 mm/102mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling Ltd.
Drilling Equipment: CME 45 Track
Well Casing: PVC Schedule 40
Well Screen: PVC Schedule 40, Slot 10
OVM: Samples not screened

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
						Ground Surface	52.60
0	7 4 7 12	BH-05-819-1		71%		TOPSOIL moist, dark brown	
1						SILTY CLAY FILL moist, grey/brown, with sand	
2						SAND FILL moist, brown, med. to fine	52.00
3	7 12 7 6	BH-05-819-2		25%		SHALE AND GRAVEL moist, grey/black shale and grey, coarse gravel	
1							
4							
5						BOULDER FILL wet, grey/brown, clay infill	51.00
6							
2							
7							
8							50.00
9							
10							
3							
11						End of borehole at 3.66m	49.00
12							
13							
4							
14							
15							48.00
16							
5							
17							
18							47.00
19							



(1) Blow count per 0.15 m using conventional hammer and split spoons

HSA = Hollow Stem Auger
DTH = Down the hole Hammer

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

AQUA TERRE

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH06-6/MW06-6

MOE Well ID: A029553

Project Number: 05-215-20

Date Completed: June 20, 2006

Client: National Capital Commission

Supervisor: ADG/TLJ

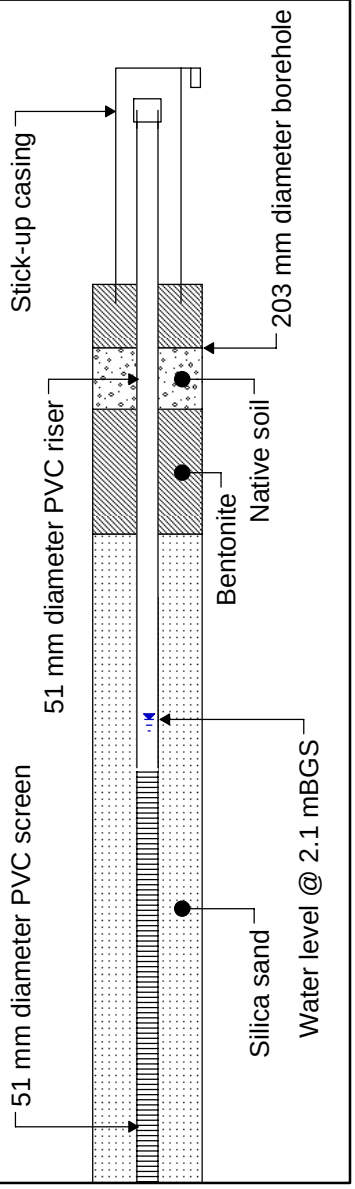
Site Location: Municipal Lands

Ground Surface Elevation: 54.96 mASL

Coordinates: MTM NAD83 - 366010 E, 5030649 N

Drilling Method: Hollow stem auger with split spoon

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
0 / 0							GROUND SURFACE	
0 / 0			4 12 15 20	0			FILL Topsoil near surface, underlain by dark brown silty sand fill with trace gravel. Dry, no odour.	
3 / 1			5 9 10 8	5			Brown silt and sand fill with brick fragments and minor iron staining. Slightly moist, no odour.	
5 / 2			2 4 6 18	5			Brown silt and sand fill. Dry, no odour. 9 cm of black slag fill with rock fragments at 2.1 mBGS. Moist, no odour.	
8 / 3			7 11 1 5	0			Dark brown silt and sand fill with trace gravel and roots. Wet, no odour.	
10 / 3			5 12 6 4	0				



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH06-6/MW06-6

MOE Well ID: A029553

Project Number: 05-215-20

Date Completed: June 20, 2006

Client: National Capital Commission

Supervisor: ADG/TLJ

Site Location: Municipal Lands

Ground Surface Elevation: 54.96 mASL

Coordinates: MTM NAD83 - 366010 E, 5030649 N

Drilling Method: Hollow stem auger with split spoon

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
15							Borehole terminated at 4.6 mBGS.	
							BOREHOLE TERMINATED	Depth of MW06-6 = 4.6 mBGS
16								
17	5							
18								
19								
20	6							
21								
22								
23	7							
24								
25								
26	8							
27								
28								
29	9							
30								
31								
32								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH06-7/MW06-7

MOE Well ID: A029553

Project Number: 05-215-20

Date Completed: June 20, 2006

Client: National Capital Commission

Supervisor: ADG/TLJ

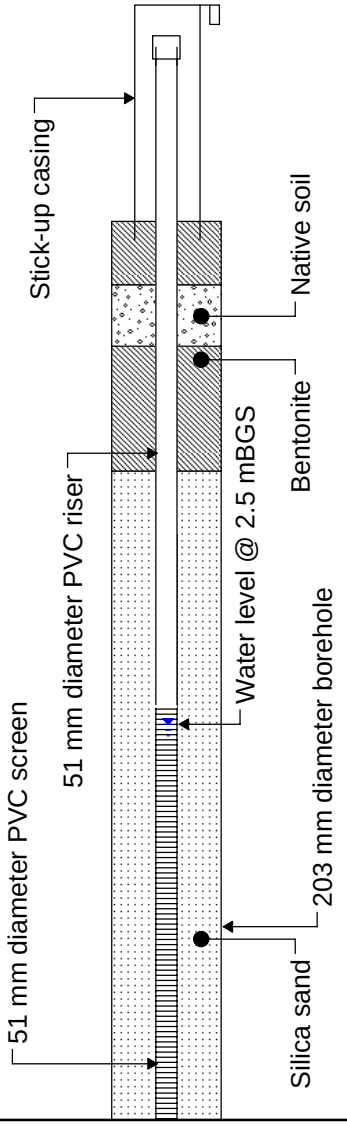
Site Location: Municipal Lands

Ground Surface Elevation: 55.24 mASL

Coordinates: MTM NAD83 - 365882 E, 5030604 N

Drilling Method: Hollow stem auger with split spoon

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
							GROUND SURFACE
0 / 0			3 5 10 12	0			FILL Brown topsoil. Grey/brown silt and sand fill with trace gravel. Slightly moist, no odour.
3 / 1			4 10 9 7	0			
5 / 2			3 7 13 9	10			Brown silt and sand fill with black slag, brick and gravel. Slightly moist, no odour.
8			50	0			Dark brown silt and sand fill. Dry, no odour.
10 / 3			11 18 18 50	0			Dark brown silt and sand fill with black slag fragments. Wet, no odour.
12							Grey and black sand with rock fragments.
13 / 4			7 16 23 13	0			



INSTALLATION

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH06-7/MW06-7

MOE Well ID: A029553

Project Number: 05-215-20

Date Completed: June 20, 2006

Client: National Capital Commission

Supervisor: ADG/TLJ

Site Location: Municipal Lands

Ground Surface Elevation: 55.24 mASL

Coordinates: MTM NAD83 - 365882 E, 5030604 N

Drilling Method: Hollow stem auger with split spoon

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
15							Borehole terminated at 4.6 mBGS.	
							BOREHOLE TERMINATED	Depth of MW06-7 = 4.6 mBGS
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH06-9/MW06-9

MOE Well ID: A029553

Project Number: 05-215-20

Date Completed: June 21, 2006

Client: National Capital Commission

Supervisor: ADG/SNG

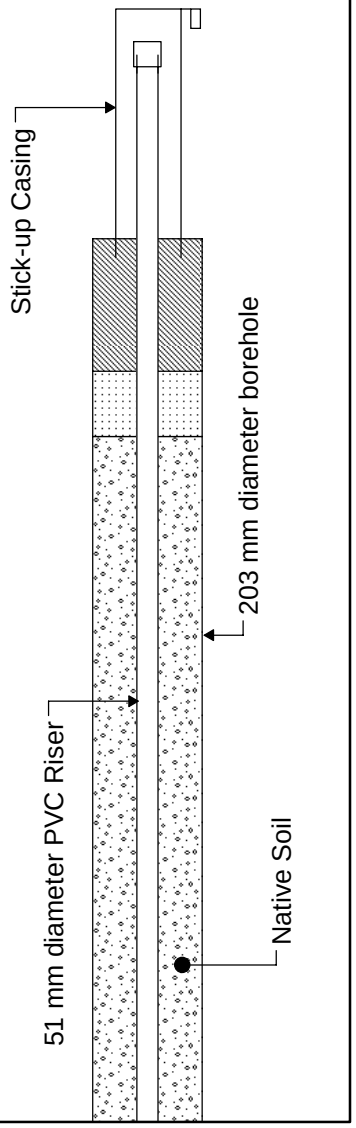
Site Location: Municipal Lands

Ground Surface Elevation: 61.58 mASL

Coordinates: MTM NAD83 - 365843 E, 5030527N

Drilling Method: Hollow stem auger with split spoon

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
							GROUND SURFACE
0 / 0			9 50	0			FILL Brown topsoil. Brown silty sand fill with organic material near surface. Dry, no odour.
3 / 1			7 21 15 11	0			Brown silty sand fill with some clay and trace gravel. Moist, no odour.
5 / 2			7 14 10 6	2			Dark brown sand and gravel fill. Dry, no odour.
8 / 3			5 7 10 10	0			Brown silty sand fill with trace gravel. Dry, no odour.
11 / 3			8 24 9 5	3			Grey silt fill with some clay. Moist, no odour.
13							Black sand fill with some silt and gravel. Wet, landfill odour.



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH06-9/MW06-9

MOE Well ID: A029553

Project Number: 05-215-20

Date Completed: June 21, 2006

Client: National Capital Commission

Supervisor: ADG/SNG

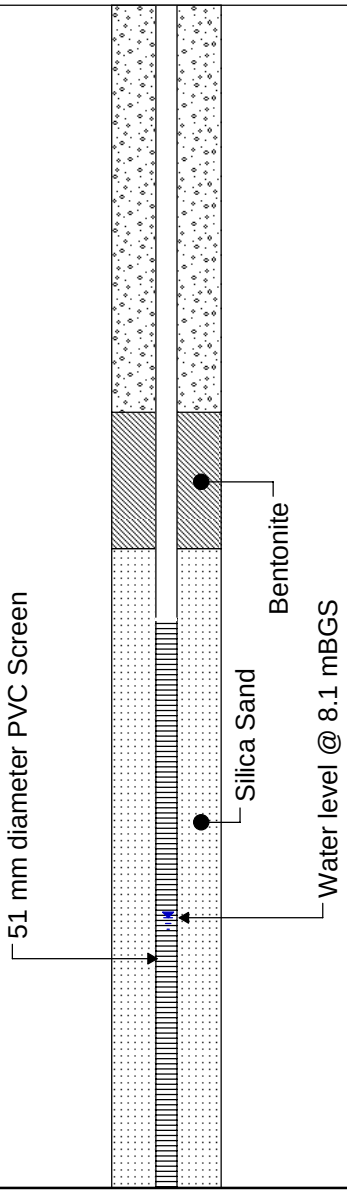
Site Location: Municipal Lands

Ground Surface Elevation: 61.58 mASL

Coordinates: MTM NAD83 - 365843 E, 5030527N

Drilling Method: Hollow stem auger with split spoon

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
4			3 4 3	2				
14								
15			4 4 50	2			Silty sand fill with some clay and wood fragments. Wet, no odour.	
16								
5								
17								
18			50				Boulder (no recovery)	
19								
6								
20			46 20 12 50	4			Grey sand fill with some gravel. Slightly moist, landfill odour.	
21								
22								
23			25 32 43 14	3				
7								
24								
25								
26		X	8 6 4 8	35			Minor brick fragments.	
8								
27								
28			15 7 5 9	25			Hydrocarbon odour.	
29								
9								
30								



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH06-9/MW06-9

MOE Well ID: A029553

Project Number: 05-215-20

Date Completed: June 21, 2006

Client: National Capital Commission

Supervisor: ADG/SNG

Site Location: Municipal Lands

Ground Surface Elevation: 61.58 mASL

Coordinates: MTM NAD83 - 365843 E, 5030527N

Drilling Method: Hollow stem auger with split spoon

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
31			2 1 1 1	50			Sandy fill with glass and paper debris. Wet, landfill odour. Borehole terminated at 9.8 mBGS.	
32							BOREHOLE TERMINATED	Depth of MW06-9 = 9.8 mBGS
33 – 10								
34								
35								
36 – 11								
37								
38								
39 – 12								
40								
41								
42 – 13								
43								
44								
45								
46 – 14								
47								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH06-10/MW06-10

MOE Well ID: A029553

Project Number: 05-215-20

Date Completed: June 21, 2006

Client: National Capital Commission

Supervisor: ADG

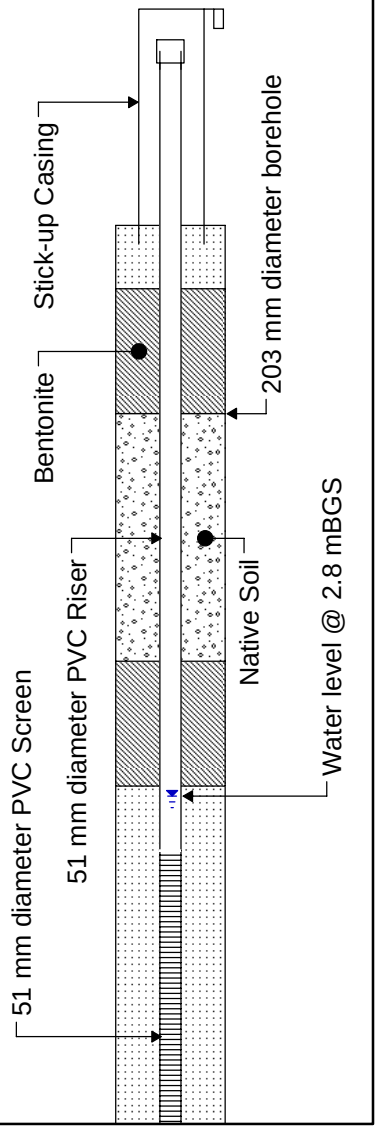
Site Location: LeBreton Flats

Ground Surface Elevation: 55.56 mASL

Coordinates: MTM NAD83 - 365965 E, 5030592 N

Drilling Method: Hollow stem auger with split spoon

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
0 / 0							GROUND SURFACE	
0 / 0			6 22 30 38	0			FILL Brown sandy topsoil underlain by brown silt and sand fill with trace gravel and brick fragments. Dry, no odour.	
3 / 1			19 48 41 36	0			Grey/brown silty sand fill with gravel and cobbles. Dry, no odour.	
5 / 2			5 5 12 7	0			Grey and black silty sand fill with gravel and wood debris. Dry, no odour.	
8 / 3			3 2 3 6	0			Grey/brown silty sand fill with trace wood debris. Dry, no odour.	
10 / 3			6 3 3 7	20			Sand fill with garbage, paper, and plastic. Dry, landfill odour.	
13 / 4			8 5 8 22	0			Brown/black silty sand fill with wood debris. Moist, landfill odour.	



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH06-10/MW06-10

MOE Well ID: A029553

Project Number: 05-215-20

Date Completed: June 21, 2006

Client: National Capital Commission

Supervisor: ADG

Site Location: LeBreton Flats

Ground Surface Elevation: 55.56 mASL

Coordinates: MTM NAD83 - 365965 E, 5030592 N

Drilling Method: Hollow stem auger with split spoon

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
15								
16			23				Grey clay fill with trace silt and gravel. Wet.	
5			11	0				
17			3					
18			1				SAND Grey sand fill with silt seams. Wet, no odour.	
19			3	0				
6			9				Borehole terminated at 6.1mBGS.	
20			14				BOREHOLE TERMINATED	Silica Sand
21			15					Depth of MW06-10 = 6.1 mBGS
22								
23								
7								
24								
25								
26								
8								
27								
28								
29								
9								
30								
31								
32								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH06-11/MW06-11

MOE Well ID: A029553

Project Number: 05-215-20

Date Completed: June 21, 2006

Client: National Capital Commission

Supervisor: ADG

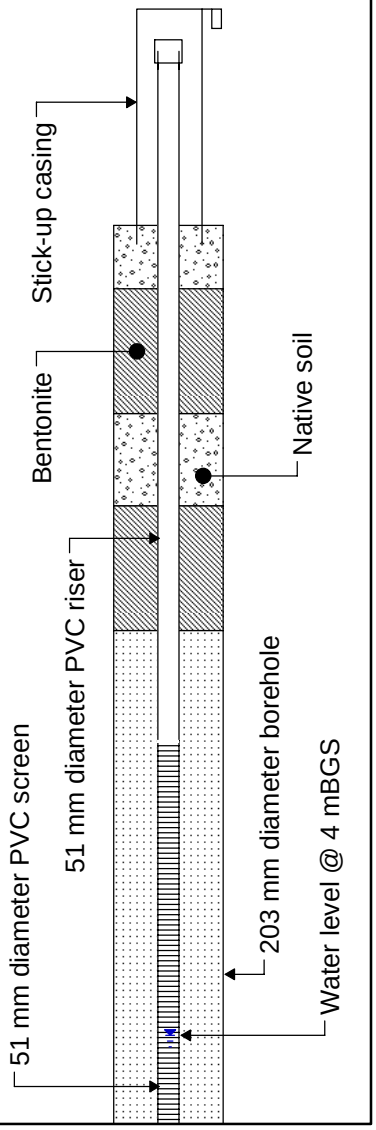
Site Location: Municipal Lands

Ground Surface Elevation: 56.80 mASL

Coordinates: MTM NAD83 - 365928 E, 5030683 N

Drilling Method: Hollow stem auger with split spoon

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
0 / 0							GROUND SURFACE
0 / 0			7 11 50	0			FILL Brown sand fill with gravel and brick. Dry, no odour.
3 / 1			16 14 22 27	0			
5 / 2			1 5 5 10	0			
8 / 3			6 9 6 10	0			
10 / 3			4 4 21 19	0			Brown sand fill with gravel and minor silt. 12 cm of rock fragments. Dry, no odour.
13 / 4			20 50	0			Brown sand and gravel fill. Dry, no odour.



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH06-11/MW06-11

MOE Well ID: A029553

Project Number: 05-215-20

Date Completed: June 21, 2006

Client: National Capital Commission

Supervisor: ADG

Site Location: Municipal Lands

Ground Surface Elevation: 56.80 mASL

Coordinates: MTM NAD83 - 365928 E, 5030683 N

Drilling Method: Hollow stem auger with split spoon

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
15								
16			1 9 5 50	0			Gravel fill with minor sand. Wet, no odour.	
17							Borehole terminated at 5.6 mBGS.	
18							BOREHOLE TERMINATED	Silica sand
19								Depth of MW06-11 =5.6 mBGS
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								

5 6 7 8 9

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW06-35

MOE Well ID: A029553

Project Number: 05-215-23

Date Completed: August 2, 2006

Client: National Capital Commission

Supervisor: TLJ

Site Location: Southern LeBreton Flats

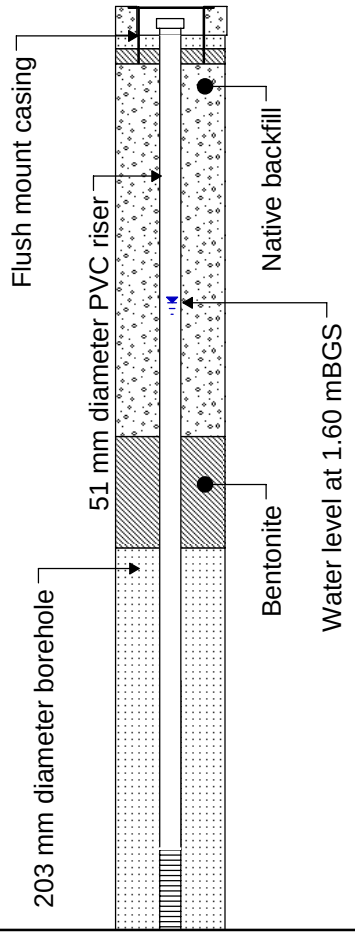
Ground Surface Elevation: 62.608 mASL

Coordinates: MTM NAD83 - 366650 E, 5030786 N

Drilling Method: Hollow stem auger with split spoons

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
							GROUND SURFACE
0 / 0			2 4 6 6	0			**FILL** Brown topsoil underlain with brown silty sand fill. Dry, no odour.
2 / 1			5 8 5 5	40			Brown silty sand fill with gravel and bricks. Dry, no odour.
5 / 2			1 2 4 3	30			Brown to grey silty sand fill with clay and gravel. Slightly wet, no odour.
8 / 3			5 10 9 12	20			Brown and grey silty sand fill with gravel. Dry, no odour.
10 / 3			4 10 9 8	30			**TILL** Grey clayey silt till with gravel. Moist, no odour.
13 / 4		X	2 3 10 15	25			Grey clayey silt till with gravel. Dry, no odour. Fractured rock at 4.1 mBGS.
15 / 4			4 8	20			Grey clayey silt till with gravel. Moist, no odour.

INSTALLATION



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW06-35

MOE Well ID: A029553

Project Number: 05-215-23

Date Completed: August 2, 2006

Client: National Capital Commission

Supervisor: TLJ

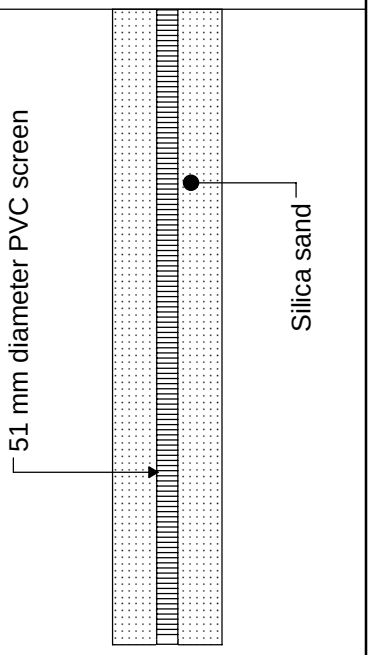
Site Location: Southern LeBreton Flats

Ground Surface Elevation: 62.608 mASL

Coordinates: MTM NAD83 - 366650 E, 5030786 N

Drilling Method: Hollow stem auger with split spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
5 (17)			50					
18			50	20				
19								
6 (20)			15	5			Grey till with gravel. Dry, no odour.	
21			30					
			50					
22								
7 (23)			22	25			Grey sandy till with gravel. Dry, no odour.	
			50					
24								
25			50	--				
8 (26)								
27							Borehole terminated at 8.22 mBGS.	
							BOREHOLE TERMINATED	
28								
29								
9 (30)								
31								
32								
10 (33)								
34								
35								
36								



Depth of MW06-35 = 8.22 mBGS

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW06-36

MOE Well ID: A029553

Project Number: 05-215-23

Date Completed: August 3, 2006

Client: National Capital Commission

Supervisor: TLJ

Site Location: Southern LeBreton Flats

Ground Surface Elevation: 65.47 mASL

Coordinates: MTM NAD83 - 366710 E, 5030912 N

Drilling Method: Hollow stem auger with split spoons and air hammer

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
-4 to 16 ft / 0 to 4 m							GROUND SURFACE	
0 ft / 0 m			12 14 21 10	60			**FILL** Brown topsoil underlain by rock fragments and brown silty sand fill and gravel. Moist, no odour.	Flush mount casing; 51 mm diameter PVC riser; Native backfill; 203 mm diameter borehole; Bentonite; Water level at 1.85 mBGS
3 ft			2 5 9 7	70			Brown and grey silty sand fill with gravel. Minor iron staining. Moist, no odour.	
5 ft		X	2 19 18 5	75			Brown to grey silty sand fill with gravel. Moist, no odour.	
8 ft			8 12 15 17	55			Brown and grey silty sand fill with gravel. Moist, no odour.	
10 ft			10 16 50	55			Grey silty sand fill with clay and gravel. Moist, no odour.	
13 ft			50	0			Rock fragments at 3.78 mBGS.	
15 ft			27 50	70			**TILL** Grey sandy clay till. Moist, no odour.	

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW06-36

MOE Well ID: A029553

Project Number: 05-215-23

Date Completed: August 3, 2006

Client: National Capital Commission

Supervisor: TLJ

Site Location: Southern LeBreton Flats

Ground Surface Elevation: 65.47 mASL

Coordinates: MTM NAD83 - 366710 E, 5030912 N

Drilling Method: Hollow stem auger with split spoons and air hammer

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
5 (17)								
6 (18–19)			11 50	60				
6 (20)			50	10				
7 (21–23)			50	25				
8 (24–26)							Borehole teminated at 7.62 mBGS. BOREHOLE TERMINATED	51 mm diameter PVC screen Silica sand Depth of MW06-36 = 7.62 mBGS
9 (27–29)								
10 (30–33)								
(34–36)								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH06-37

MOE Well ID: Not applicable

Project Number: 05-215-23

Date Completed: August 3, 2006

Client: National Capital Commission

Supervisor: TLJ

Site Location: Southern LeBreton Flats

Ground Surface Elevation: 63.47 mBGS

Coordinates: MTM NAD83 - 366688 E, 5030854 N

Drilling Method: Hollow stem auger with split spoons

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
							GROUND SURFACE	No monitoring well installed
0		X	2 3 3 2	100			FILL Brown topsoil underlain by silty sand fill with black slag and ash. Minor iron staining. Moist, no odour.	
1			2 1 3	70			Charcoal and ash with brown silty sand fill. Moist, no odour.	
2			2 4 4 5	75			Dark brown silty sand fill with gravel. Trace clay and minor iron staining. Dry, no odour.	
3			6 8 6 8	75			Brown silty sand fill with gravel. Minor iron staining and ash, white and black sand. Moist, no odour.	
4			1 2 2 3	60			Brown and grey silty sand fill with gravel. Wet, no odour.	
5			1 3 2 1	50			Grey silty sand fill with gravel and trace clay. Wet, no odour.	
16			1 3	50			TILL Grey sandy silt till with gravel.	

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH06-37

MOE Well ID: Not applicable

Project Number: 05-215-23

Date Completed: August 3, 2006

Client: National Capital Commission

Supervisor: TLJ

Site Location: Southern LeBreton Flats

Ground Surface Elevation: 63.47 mBGS

Coordinates: MTM NAD83 - 366688 E, 5030854 N

Drilling Method: Hollow stem auger with split spoons

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
5 (17)			25 36					
(18)			20 50	55				
(19)								
6 (20)			50	50				
(21)								
(22)								
7 (23)			36 50	50			Rock fragments at 6.8 mBGS. Borehole terminated at 7.2 mBGS on refusal. BOREHOLE TERMINATED	
(24)								
(25)								
8 (26)								
(27)								
(28)								
(29)								
9 (30)								
(31)								
(32)								
10 (33)								
(34)								
(35)								
(36)								

Borehole/Monitoring Well ID: BH/MW-06-103

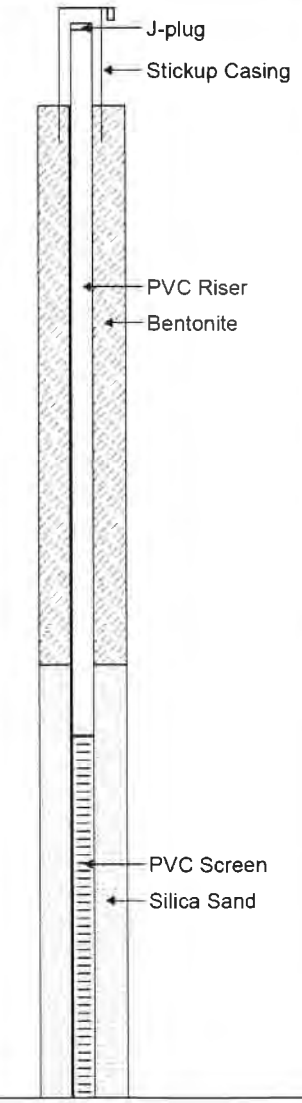
Project No.: 06-830
Client: National Capital Commission
Location: Nepean Bay, Ottawa, ON
Date Completed: July 19 & 20, 2006
Site Datum: Nail in tree on south side of Ottawa River Pkwy, Elevation = 62.621 masl

ATSI Supervisor: M. Nash
Drilling Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling
Drilling Equipment: CME 55 Truck Mount
Well Casing: Stickup
Well Screen: PVC Schedule 40 Slot 10
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	62.03
0	6, 9, 12, 15	BH-06-103-1		<25	58%		TOPSOIL FILL Dry, brown, sand and gravel, with coal, brick fragments, shale and wood	62.00
1	4, 8, 30, 34	BH-06-103-2		45	71%			61.00
2	7, 18, 14, 14	BH-06-103-3	◆	30	33%		Petroleum odour from 1.5 to 2.9 mbgs	
3	6, 4, 9, 9	BH-06-103-4	◆	100	62%			60.00
4	1, 3, 7, 17	BH-06-103-5		<25	8%			59.00
5	12, 10, 11, 13	BH-06-103-6		80	58%		Dry, grey, silty clay, with gravel, coal, brick fragments and wood	58.00
6	4, 5, 6, 6	BH-06-103-7		90	71%			57.00
7	3, 5, 9, 4	BH-06-103-8		55	75%		Dry, grey, silty sand and gravel, with brick fragments and wood	56.00
8	20, 20, 7, 4	BH-06-103-9		40	50%		Dry, brown to grey, clay and clayey sand with gravel, coal and brick fragments	
	7, 4, 5, 6	BH-06-103-10		40	50%		Moist to wet, grey, silty sandy clay and gravel	55.00
	3, 4, 50 for 51 mm	BH-06-103-11		<25	33%			54.00

Elevation of top of PVC riser = 62.72 masl



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ = Sample submitted for laboratory analysis

BH-06-103-3 = VOCs, F1-F4 PHCs, PHC Subfractions, PCBs
BH-06-103-4 = Metals, PAHs

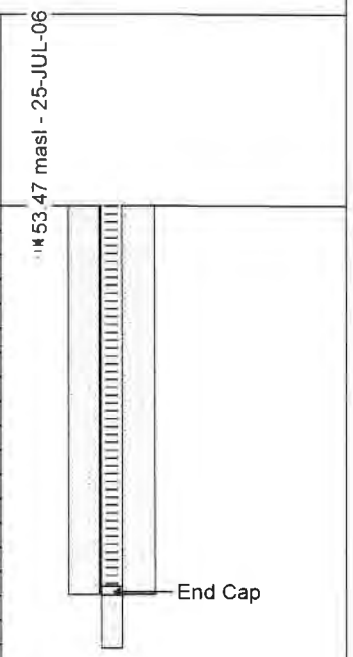
Borehole/Monitoring Well ID: BH/MW-06-103

Project No.: 06-830
Client: National Capital Commission
Location: Nepean Bay, Ottawa, ON
Date Completed: July 19 & 20, 2006
Site Datum: Nail in tree on south side of Ottawa River Pkwy, Elevation = 62.621 masl

ATSI Supervisor: M. Nash
Drilling Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling
Drilling Equipment: CME 55 Truck Mount
Well Casing: Stickup
Well Screen: PVC Schedule 40 Slot 10
OVM: Gastech 1238 ME

DEPTH	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
28–29	29 8 10 20	BH-06-103-12		<25	8%			
30–32	38 13 18 15	BH-06-103-13		200	71%		Mixed debris including wood, cloth, plastic, glass and newspaper	53.00
33–34	13 11 8 6	BH-06-103-14		80	46%		Wet, wood, with some gravel and clay	52.00
35–36	9 2 3 4	BH-06-103-15		<25	<4%			51.00
38–39	12 31 50 for 127 mm	BH-06-103-16		<25	92%		SAND Wet, grey to black, medium to coarse grained, with boulder fragments End of borehole at 11.86 mbgs	50.00
41–57								49.00 48.00 47.00 46.00 45.00



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ = Sample submitted for laboratory analysis

Borehole/Monitoring Well ID: BH/MW-06-104

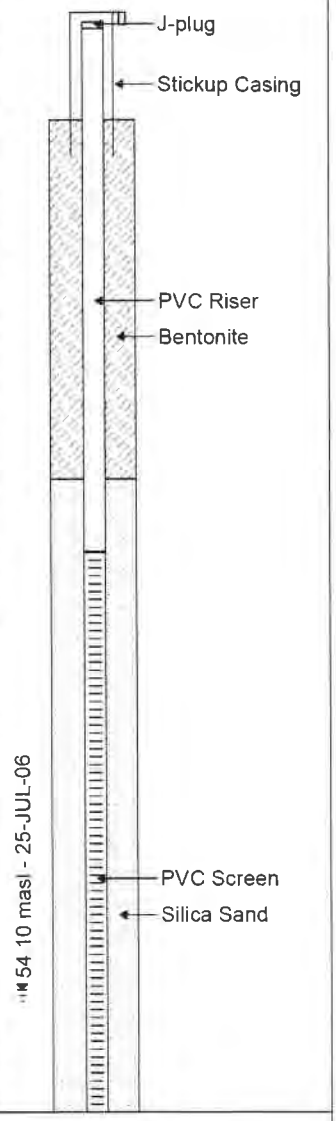
Project No.: 06-830
Client: National Capital Commission
Location: Nepean Bay, Ottawa, ON
Date Completed: July 19, 2006
Site Datum: Nail in tree on south side of Ottawa River Pkwy, Elevation = 62.621 masl

ATSI Supervisor: M. Nash
Drilling Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling
Drilling Equipment: CME 55 Truck Mount
Well Casing: Stickup
Well Screen: PVC Schedule 40 Slot 10
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	61.43
0	4, 10, 24, 20	BH-06-104-1	◆	25	62%		TOPSOIL FILL Dry, dark brown, sand, with gravel and asphalt pieces	61.00
1	16, 19, 24, 32	BH-06-104-2	◆	75	62%		Dry, light to dark brown, sand	
2	9, 13, 16, 19	BH-06-104-3	◆	80	96%		Dry, dark brown, sand, with gravel and shale	60.00
3	10, 15, 9, 8	BH-06-104-4	◆	260	42%		Dry, dark brown, silty sand, with shale, gravel and pebbles, trace coal	59.00
4	7, 7, 5, 2	BH-06-104-5		50	8%			58.00
5	31, 10, 13, 12	BH-06-104-6		150	46%		Dry, dark brown, sand, with dark grey clay and gravel	57.00
6	44, 50 for 51 mm	BH-06-104-7			<4%		Refusal on boulder	
7	1, 2, 2, 1	BH-06-104-8		100	8%		FILL Moist, black to brown, clayey sand, with gravel, glass, slag and wood	56.00
8	1, 2, 1, 3	BH-06-104-9		130	<4%		Gravel, concrete, brick fragments	55.00
	1, 4, 1, 1	BH-06-104-10	◆	100	58%		Wet, grey, clay, with gravel and mixed debris (cloth, glass, wood, paper, coal, plastic, concrete, newspaper)	
	1, 11, 6, 7	BH-06-104-11		125	58%			54.00

Elevation of top of PVC riser = 62.26 masl



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ = Sample submitted for laboratory analysis

BH-06-104-2 = Fraction Organic Carbon
BH-06-104-3 = Metals, PAHs
BH-06-104-4 = VOCs, F1-F4 PHCs
BH-06-104-10 = Grain Size, pH
BH-06-104-15 = Grain Size, pH

Borehole/Monitoring Well ID: BH/MW-06-104

Project No.: 06-830
Client: National Capital Commission
Location: Nepean Bay, Ottawa, ON
Date Completed: July 19, 2006
Site Datum: Nail in tree on south side of Ottawa River Pkwy, Elevation = 62.621 masl

ATSI Supervisor: M. Nash
Drilling Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling
Drilling Equipment: CME 55 Truck Mount
Well Casing: Stickup
Well Screen: PVC Schedule 40 Slot 10
OVM: Gastech 1238 ME

DEPTH	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
28–29	11, 5, 7, 5	BH-06-104-12		<25	<4%			53.00
30–31	10, 4, 4, 3	BH-06-104-13		110	29%			52.00
33–34	6, 5, 12, 18	BH-06-104-14		30	4%		Wet, gravel, brick fragments, newspaper	51.00
36–37	9, 12, 6, 3	BH-06-104-15	◆	85	83%		SAND Wet, grey, medium to fine grained End of borehole at 11.28 mbgs	50.00
								49.00
								48.00
								47.00
								46.00
								45.00

End Cap

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ = Sample submitted for laboratory analysis

BH-06-104-2 = Fraction Organic Carbon
BH-06-104-3 = Metals, PAHs
BH-06-104-4 = VOCs, F1-F4 PHCs
BH-06-104-10 = Grain Size, pH
BH-06-104-15 = Grain Size, pH

Borehole/Monitoring Well ID: BH/MW-06-105

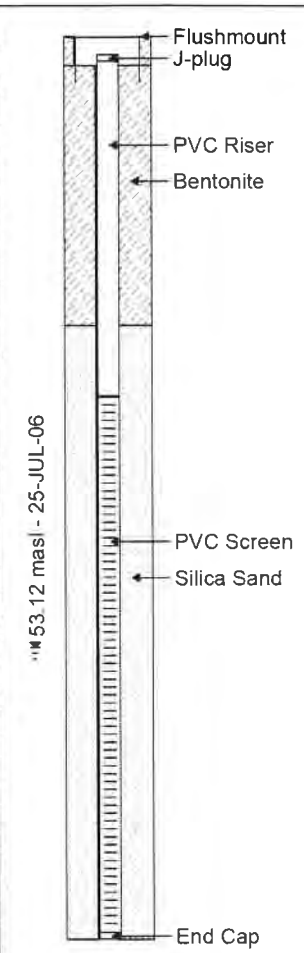
Project No.: 06-830
Client: National Capital Commission
Location: Nepean Bay, Ottawa, ON
Date Completed: July 18, 2006
Site Datum: Nail in tree on south side of Ottawa River Pkwy, Elevation = 62.621 masl

ATSI Supervisor: M. Nash
Drilling Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling
Drilling Equipment: CME 55 Truck Mount
Well Casing: Flushmount
Well Screen: PVC Schedule 40 Slot 10
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	58.28
0	5 10 8 4	BH-06-105-1		<25	75%		TOPSOIL FILL Moist, brown, clayey silty sand, with gravel and trace coals	
1	33 34 39 15	BH-06-105-2		<25	25%		Dry, gravel	57.00
2	50 for 152 mm	BH-06-105-3		<25	<4%			
	12 9 3 2	BH-06-105-4		<25	12%		Brick fragments from 2.3 to 2.9 mbgs	56.00
3	5 7 11 50 for 102 mm	BH-06-105-5		40	12%		Moist, black, sand, with gravel and brick fragments	55.00
4	3 4 4 3	BH-06-105-6	◆	90	54%		Moist, black, sand, with coal, ash, slag and iron ore	54.00
	2 1	BH-06-105-7A	◆	50	50%			
5	2 2	BH-06-105-7B		<25	50%		Granular black and orange material with slag and coal	53.00
	2 1 1 11	BH-06-105-8		25	42%		Wet, black to brown, sand, some silt and coal	
6	11 13 20 14	BH-06-105-9		30	54%		SAND Wet, grey, medium to coarse grained	52.00
7	28 27 22 14	BH-06-105-10		30	-			51.00
8							End of borehole at 7.62 mbgs	50.00
9								

Elevation of top of PVC riser = 58.28 masl



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ = Sample submitted for laboratory analysis

BH-06-105-6 = VOCs, F1-F4 PHCs, PAHs
BH-06-105-7A = Metals

Borehole/Monitoring Well ID: BH/MW-06-106

Project No.: 06-830
Client: National Capital Commission
Location: Nepean Bay, Ottawa, ON
Date Completed: July 18, 2006
Site Datum: Nail in tree on south side of Ottawa River Pkwy, Elevation = 62.621 masl

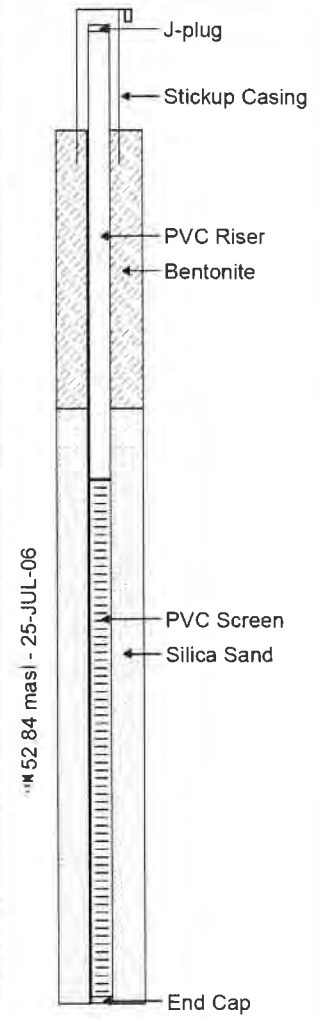
ATSI Supervisor: M. Nash
Drilling Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling
Drilling Equipment: CME 55 Truck Mount
Well Casing: Stickup
Well Screen: PVC Schedule 40 Slot 10
OVM: Gastech 1238 ME

DEPTH	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	58.51
0	8 10 14 14	BH-06-106-1		<25	50%		TOPSOIL FILL Dry, brown, sand, with some coal and brick fragments	
1	15 11 5 3	BH-06-106-2		<25	54%		Dry, dark brown to black, clayey silty sand, with gravel, shale, coal, slag, ash, cinders and glass	
2	3 4 4 3	BH-06-106-3		60	38%			
	1 2 1 3	BH-06-106-4		40	42%			
3	1 3 9 9	BH-06-106-5	◆	30	58%		Wet, black, coal, slag, wood and brick fragments	
4	5 14 15 12	BH-06-106-6		50	46%		Moist, grey to dark brown/black, silty sand and gravel, with coal, ash, cinders and wood	
5	10 15 20 16	BH-06-106-7		-	0%		No recovery	
	6	BH-06-106-8A		110	75%		FILL	
	10 14 16	BH-06-106-8B		80	75%		Moist, dark brown/black, silty sand and gravel, with wood	
6	11 50 for 127 mm	BH-06-106-9		100	8%		Wet, brown, sand, some gravel Wet, grey/brown, clayey sand and gravel, with wood	
7	23 46 50 for 152 mm	BH-06-106-10		-	0%		No recovery	
	50 for 25 mm	BH-06-106-11		130	4%		SAND Wet, brown, medium to coarse grained	
8							End of borehole at 7.64 mbgs	

59.00
58.00
57.00
56.00
55.00
54.00
53.00
52.00
51.00

Elevation of top of PVC riser = 59.43 masl



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk

All elevations and locations are approximate

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling

◆ = Sample submitted for laboratory analysis

BH-06-106-5 = VOCs, F1-F4 PHCs, Metals, PAHs

Borehole/Monitoring Well ID: BH/MW-06-107

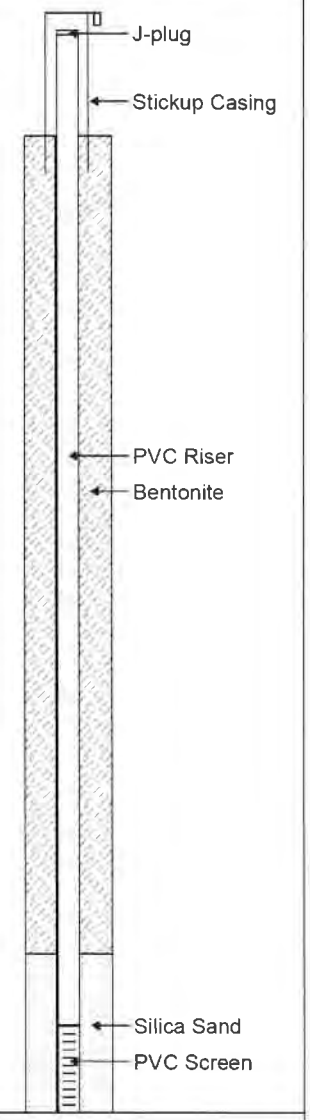
Project No.: 06-830
Client: National Capital Commission
Location: Nepean Bay, Ottawa, ON
Date Completed: July 18 & 19, 2006
Site Datum: Nail in tree on south side of Ottawa River Pkwy, Elevation = 62.621 masl

ATSI Supervisor: M. Nash
Drilling Method: HSA / HQ Coring
Borehole Diameter: 203 mm / 96 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling
Drilling Equipment: CME 55 Truck Mount
Well Casing: Stickup
Well Screen: PVC Schedule 40 Slot 10
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	62.17
0	11 16 12 11	BH-06-107-1		<25	71%		TOPSOIL	
1							FILL Dry to moist, dark brown, sand, with gravel, coal, ash, slag, shale and glass	62.00
1	2 3 3 3	BH-06-107-2		30	25%			61.00
2	1 1 1 1	BH-06-107-3	◆	125	17%			
2								60.00
3	3 6 8 6	BH-06-107-4		80	4%		Asphalt pieces, asphalt paper and plastic	
3	3 3 2 4	BH-06-107-5		110	17%		Moist, black, silty clayey sand, with gravel, coal, cinders, brick fragments, wood, glass, rubber, metal and plastic	59.00
4	2 1 1 3	BH-06-107-6		80	62%			
4								58.00
5	2 2 2 5	BH-06-107-7		90	25%			
5								57.00
6	2 4 4 5	BH-06-107-8	◆	130	46%			
6		BH-06-107-9		75	4%		Refusal on boulder	56.00
7	23 20 11 50 for 25 mm	BH-06-107-10		35	29%		FILL Moist, black, clayey sand, with gravel, wood and cinders. Refusal on boulders	55.00
8	10 23 40 50 for 102 mm	BH-06-107-11		25	4%			54.00

Elevation of top of PVC riser = 63.08 masl



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel Third parties using this log do so at their own risk.

All elevations and locations are approximate

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling

◆ = Sample submitted for laboratory analysis

BH-06-107-3 = Grain Size, pH
BH-06-107-8 = VOCs, F1-F4 PHCs, Metals, PAHs

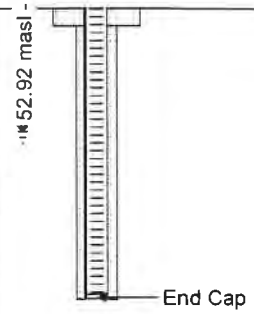
Borehole/Monitoring Well ID: BH/MW-06-107

Project No.: 06-830
Client: National Capital Commission
Location: Nepean Bay, Ottawa, ON
Date Completed: July 18 & 19, 2006
Site Datum: Nail in tree on south side of Ottawa River Pkwy, Elevation = 62.621 masl

ATSI Supervisor: M. Nash
Drilling Method: HSA / HQ Coring
Borehole Diameter: 203 mm / 96 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling
Drilling Equipment: CME 55 Truck Mount
Well Casing: Stickup
Well Screen: PVC Schedule 40 Slot 10
OVM: Gastech 1238 ME

DEPTH	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
28–35	9, 10						BOULDERS With seams of sand and gravel	53.00, 52.00
35–57	11, 12, 13, 14, 15, 16, 17						End of borehole at 10.67 mbgs	51.00, 50.00, 49.00, 48.00, 47.00, 46.00, 45.00



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

= Sample submitted for laboratory analysis

BH-06-107-3 = Grain Size, pH
BH-06-107-8 = VOCs, F1-F4 PHCs, Metals, PAHs

Borehole/Monitoring Well ID: BH/MW-06-108

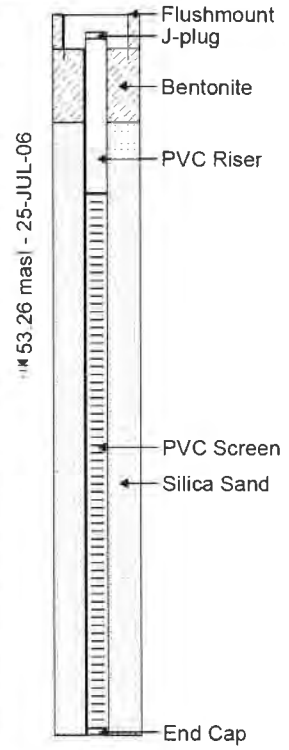
Project No.: 06-830
Client: National Capital Commission
Location: Nepean Bay, Ottawa, ON
Date Completed: July 19, 2006
Site Datum: Nail in tree on south side of Ottawa River Pkwy, Elevation = 62.621 masl

ATSI Supervisor: M. Nash
Drilling Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling
Drilling Equipment: CME 55 Truck Mount
Well Casing: Flushmount
Well Screen: PVC Schedule 40 Slot 10
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	56.22
0 / 0	4 6 6 9	BH-06-108-1		<25	67%		TOPSOIL FILL Dry, brown to black, sand, with gravel and coal fragments	
3 / 1	1 1 50 for 127 mm	BH-06-108-2		<25	8%		Moist, grey to black, clayey sand and gravel, with slag, glass, plastic, brick fragments and wood	55.00
6 / 2	6 9 12 11	BH-06-108-3	◆	80	54%			
8 / 3	6 4 4 3	BH-06-108-4		180	8%			54.00
10 / 3	7 4 3 3	BH-06-108-5	◆	275	54%		Moist, dark grey clay with glass Moist to wet, mixed refuse (newspaper, plastic, aluminum sheeting, glass, wood)	53.00
13 / 4	6 6 6 50 for 25 mm	BH-06-108-6		<25	4%		Wet, grey, clay, refusal on boulder	52.00
15 / 5	18 6 3 4	BH-06-108-7		<25	75%		Wet, grey, sand, medium to coarse grained	
18 / 6	4 2 3 2	BH-06-108-8		<25	46%			51.00
20 / 6							PEAT With wood and sea shells	50.00
							End of borehole at 6.10 mbgs	
23 / 7								49.00
26 / 8								48.00
29 / 9								

Elevation of top of PVC riser = 56.20 masl



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling

◆ = Sample submitted for laboratory analysis

BH-06-108-3 = Metals, PAHs
BH-06-108-5 = VOCs, F1-F4 PHCs

MOE Well Tag A033435

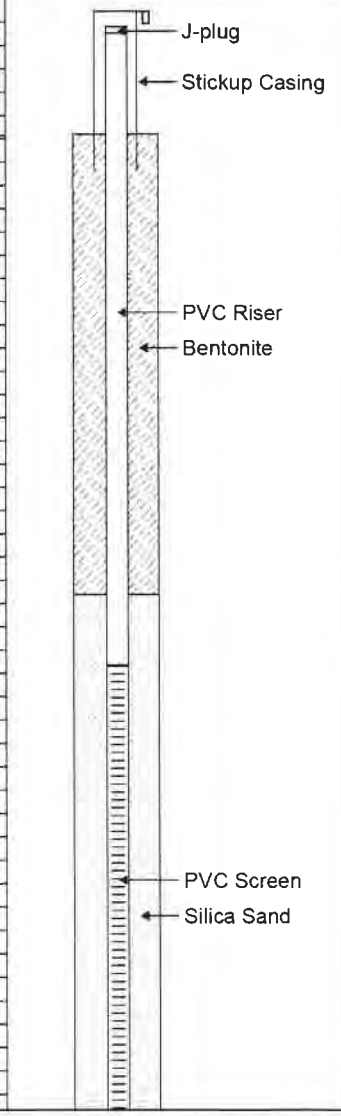
Borehole/Monitoring Well ID: BH/MW-06-109

Project No.: 06-830
Client: National Capital Commission
Location: Nepean Bay, Ottawa, ON
Date Completed: July 20 & 21, 2006
Site Datum: Nail in tree on south side of Ottawa River Pkwy, Elevation = 62.621 masl

ATSI Supervisor: M. Nash
Drilling Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling
Drilling Equipment: CME 55 Truck Mount
Well Casing: Stickup
Well Screen: PVC Schedule 40 Slot 10
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	63.43
0	5, 6, 11, 9	BH-06-109-1		<25	62%		TOPSOIL	
1							FILL Dry, brown, sand, with gravel, coal, glass, brick fragments and wood	63.00
1	1, 2, 3, 1	BH-06-109-2		50	29%			
2	1, 1, 1, 2	BH-06-109-3	◆	25	29%		Moist, dark grey, clayey sand, with coal, glass, brick fragments and creosote coated wood	62.00
3	3, 3, 5, 4	BH-06-109-4		25	29%		Moist, brown to black, silty sand, with gravel, coal, glass and brick fragments	61.00
3	2, 5, 4, 3	BH-06-109-5	◆	180	21%			60.00
4	1, 2, 2, 3	BH-06-109-6		140	46%			
5	-	BH-06-109-7	◆	-	-		Undisturbed sample collected in shelby tube	59.00
6	4, 50 for 127 mm	BH-06-109-8		<25	21%		FILL Dry, black, silty clayey sand, with wood and glass	58.00
6	39, 50 for 76 mm	BH-06-109-9		<25	17%		5 cm wood, 5 cm boulder fragments	57.00
7	14, 19, 9, 6	BH-06-109-10		<25	8%		2.5 cm brown/grey clayey sand and gravel with brick fragments, 2.5 cm of wood and boulder fragments	56.00
8	9, 8, 11, 14	BH-06-109-11		<25	92%		Moist to wet, grey sand	



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ = Sample submitted for laboratory analysis

BH-06-109-3 = PAHs
BH-06-109-5 = VOCs, F1-F4 PHCs
BH-06-109-7 = Bulk Soil Physical Properties
BH-06-109-12 = Metals, PAHs

Borehole/Monitoring Well ID: BH/MW-06-109

Project No.: 06-830
Client: National Capital Commission
Location: Nepean Bay, Ottawa, ON
Date Completed: July 20 & 21, 2006
Site Datum: Nail in tree on south side of Ottawa River Pkwy, Elevation = 62.621 masl

ATSI Supervisor: M. Nash
Drilling Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling
Drilling Equipment: CME 55 Truck Mount
Well Casing: Stickup
Well Screen: PVC Schedule 40 Slot 10
OVM: Gastech 1238 ME

DEPTH	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
9	5 18 40 50 for 102 mm	BH-06-109-12	◆	75	100%		Moist, dark brown to black, silty sand, with coal and brick fragments	55.00
10	50 for 51 mm	BH-06-109-13		<25	8%		Moist, brown, sand 2.5 cm wood, 2.5 cm boulder fragments End of borehole at 9.20 mbgs	54.00 53.00 52.00 51.00 50.00 49.00 48.00 47.00 46.00

DRY - 25/JUL/2006

End Cap

(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ = Sample submitted for laboratory analysis

BH-06-109-3 = PAHs
BH-06-109-5 = VOCs, F1-F4 PHCs
BH-06-109-7 = Bulk Soil Physical Properties
BH-06-109-12 = Metals, PAHs

Borehole/Monitoring Well ID: BH/MW-06-110

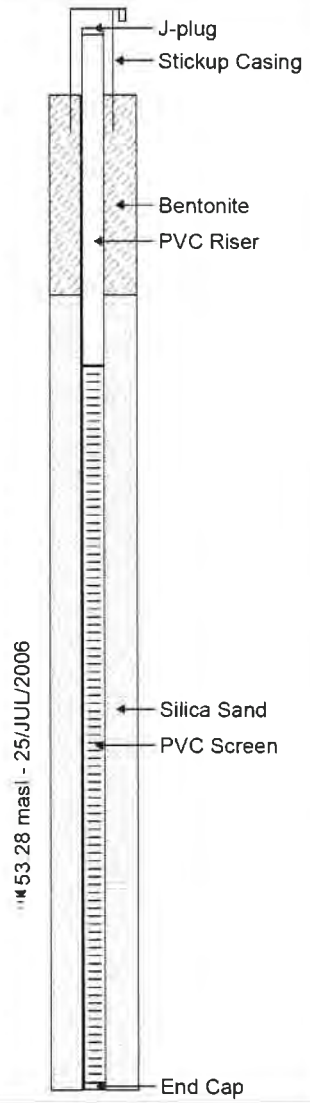
Project No.: 06-830
Client: National Capital Commission
Location: Nepean Bay, Ottawa, ON
Date Completed: July 21, 2006
Site Datum: Nail in tree on south side of Ottawa River Pkwy, Elevation = 62.621 masl

ATSI Supervisor: M. Nash
Drilling Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling
Drilling Equipment: CME 55 Truck Mount
Well Casing: Stickup
Well Screen: PVC Schedule 40 Slot 10
OVM: Gastech 1238 ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	60.03
0	6 7 6 3	BH-06-110-1		<25	46%		TOPSOIL FILL Dry, brown silty sand, with coal, brick fragments and wood	60.00
3 / 1	-	BH-06-110-2	◆	-	-		Undisturbed sample collected in shelby tube	59.00
6 / 2	3 4 11 12	BH-06-110-3		50	50%		FILL Dry to moist, brown sand, with coal and boulder fragments	58.00
9	3 5 50 for 102 mm	BH-06-110-4		45	29%		Wet, grey clayey silty sand, with gravel, coal, wood and slag	
10 / 3	13 11 8 7	BH-06-110-5		180	54%			57.00
13 / 4	2 1 6 3	BH-06-110-6		175	42%			56.00
16 / 5	5 4 4 3	BH-06-110-7		50	4%			55.00
19 / 6	3 10 16 20	BH-06-110-8	◆	150	67%			
20	13 11 7 6	BH-06-110-9	◆	400	42%			54.00
23 / 7	6 8 14 10	BH-06-110-10		50	33%		Wet, black sand, with mixed refuse (wood, paper, glass and plastic)	53.00
26 / 8	3 50 for 51 mm	BH-06-110-11		75	4%		Wet, grey sand, with wood End of borehole at 8.41 mbgs	52.00

Elevation of top of PVC riser = 60.61 masl



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ = Sample submitted for laboratory analysis

BH-06-110-2 = Bulk Soil Physical Properties
BH-06-110-8 = Metals, PAHs
BH-06-110-9 = VOCs, F1-F4 PHCs

Borehole/Monitoring Well ID: MW-06-901

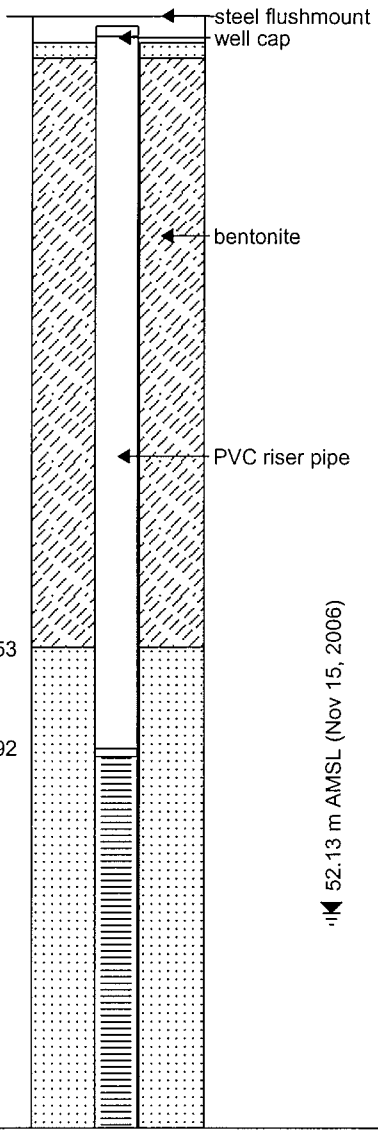
Project No.: 97-142H
Client: National Capital Commission
Location: LeBreton Flats, Ottawa
Date Completed: November 8, 2006
Site Datum: IB84 with geodetic elevation of 55.035 m AMSL

ATSI Supervisor: Andrey Belokurov
Drilling Method: HSA/Air Hammer
Borehole Diameter: 203 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing Drilling Ltd.
Drilling Equipment: CME 55 Truck
Well Casing: PVC Schedule 40
Well Screen: PVC Schedule 40, Slot 10
OVM: Gastech 1238ME

DEPTH (ft / m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	57.03
0 / 0	2, 5, 8, 8	BH-06-901-1		75	79%		TOPSOIL moist, black	
1							SAND AND GRAVEL (FILL) Dry, grey, compact to dense coarse-grained sand, gravel and some cobbles.	
2 / 1	5, 7, 11, 10	BH-06-901-2		25	62%			56.00
3								
4 / 1	2, 9, 12, 7	BH-06-901-3		25	88%			
5								
6 / 2	12, 22, 27, 25	BH-06-901-4		50	92%			55.00
7								
8	5, 19, 30, 34	BH-06-901-5		75	88%		From 2.4 to 3.8 m bgs - moist, grey, dense gravel with some sand and silt	
9 / 3								
10	7, 11, 13, 15	BH-06-901-6		75	83%			54.00
11								
12 / 4	4, 4, 7, 11	BH-06-901-7		75	67%		SILT (FILL) Moist, grey, grey/light green, stiff silt, some coarse grey sand.	53.53
13								52.92
14	3, 5, 9, 10	BH-06-901-8		50	100%		SAND AND GRAVEL (FILL) Moist to very wet, grey/brown, compact, coarse gravel with sand and cobbles.	53.00
15 / 5								
16	9, 12, 10, 13	BH-06-901-9		5%	67%		From 5.5 to 8.5 m bgs - Water	52.00
17								
18 / 6	4, 5, 7, 7	BH-06-901-10		50	29%			51.00
19								
20								

Top of Pipe Elev. = 56.97 m ASL



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well recorded under MOE Well Tag A045175

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

ATSI BH / MW IO

Borehole/Monitoring Well ID: MW-08-001

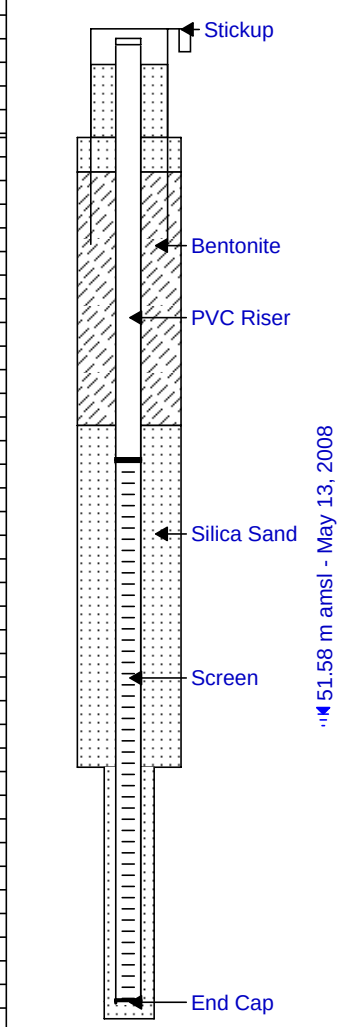
Project No.: 97-142H
Client: National Capital Commission
Location: LeBreton Flats, Ottawa
Date Completed: May 7, 2008
Site Datum: IB84 with geodetic elevation of 55.035m amsl

ATSI Supervisor: A. Scheepers
Drilling Method: HSA/Air Hammer
Borehole Diameter: 203 mm/96 mm
Monitoring Well Diameter: 51 mm

Drilling Company: Downing
Drilling Equipment: CME 75 Truck
Well Casing: PVC Stickup
Well Screen: PVC Schedule 40, Slot 10
OVM: Gastech 1238 ME

DEPTH (m)	BLOW COUNT (1)	SAMPLE ID	LOCATION	OVM (2)	RECOVERY (%)	GRAPHIC LOG	DESCRIPTION	ELEVATION (m)
							Ground Surface	56.56
0	6, 8, 9, 10	BH-08-001-1		25	58		SAND AND GRAVEL FILL Moist, brown, compact, medium	
1	10, 5, 2, 2	BH-08-001-2		25	46		dark brown	
2	7, 8, 6, 12	BH-08-001-3		50	67			
	16, 24, 50 for 51 mm	BH-08-001-4		25	86			
3	11, 13, 16, 31	BH-08-001-5		25	38		wet	
4	14, 13, 14, 50 for 25mm	BH-08-001-6		25	37			
5	50 for 0 mm	BH-08-001-7		25	NR			
6							BEDROCK at 5.3 mbgs	
7							End of Borehole at 7.5 m bgs	

Top of PVC Elev = 57.57 m amsl



(1) Blow count per 0.15 m using conventional hammer and split spoons
(2) Organic Vapour Meter (OVM) reading (ppmv unless noted)

The data represented in this borehole log requires interpretation by Aqua Terre personnel. Third parties using this log do so at their own risk.

All elevations and locations are approximate.

Monitoring well equipped with dedicated inertial foot valve and polyethylene tubing for sampling.

◆ = Sample submitted for laboratory analysis

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-01

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: March 17, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm / Headspace Comb. Vapour Conc. [%LEL] ppm	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT Wp W Wl	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		58.26							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		58.11							
		Compact brown to dark brown silty sand, some gravel, trace clay with brick and concrete (FILL)		0.15	1	50 DO	16				
1					2	50 DO	21				
					3	50 DO	21				
2					4	50 DO	19				
				55.82							
		Very loose black sand, some gravel (FILL)		2.44							
				55.52	5	50 DO	2				
		Loose grey brown silty clay, trace brick (FILL)		2.74							
3					6	50 DO	15				
				54.91							
		Loose to compact grey SILTY SAND, some gravel, trace clay		3.35	7	50 DO	12				
4					8	50 DO	5				
					9	50 DO	5				
5					10	50 DO	1				
				52.16							
		Compact brown fine SAND		6.10	11	50 DO	16				
6											
				51.55							
		Compact grey fine SAND		6.71	12	50 DO	13				
7											
				50.64							
		Very dense grey SILTY SAND, some gravel, trace clay		7.62	13	50 DO	64				
8											
				49.75	14	50 DO	50				
	Rotary Drill NW Casing	COBBLES and BOULDERS		8.51	15	NQ RC	DD				
9					16	NQ RC	DD				
10					17		DD				
		CONTINUED NEXT PAGE									

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-01

SHEET 2 OF 2

LOCATION: See Site Plan

BORING DATE: March 17, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm / Headspace Comb. Vapour Conc. [%LEL] ppm	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	Rotary Drill / NW Casing	COBBLES and BOULDERS *(continued)*			17	NQ RC	DD				
					18	NQ RC	DD				
11				47.26							
	Rotary Drill / NQ Core	Fresh grey LIMESTONE BEDROCK with interbedded shale		11.00	19	NQ RC	DD	T.C.R. (%) 100; S.C.R. (%) 86; R.Q.D. (%) 94			
				46.37							
12		End of Borehole		11.89							
13											
14											
15											
16											
17											
18											
19											
20											

Headspace Org. Vapour Conc. [PPM] ppm: 6, 12, 18, 24

Headspace Comb. Vapour Conc. [%LEL] ppm: 20, 40, 60, 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10, 20, 30, 40

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-02

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 16, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (6, 12, 18, 24) / Headspace Comb. Vapour Conc. [%LEL] ppm (20, 40, 60, 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) / WATER CONTENT PERCENT Wp, W, Wl (10, 20, 30, 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		57.54							
0	Power Auger 200 mm Diam. (Hollow Stem)	Black sandy silt with organic matter (TOPSOIL)		57.39							
		Compact brown silty sand, some gravel, trace clay with cobbles and boulders (FILL)		0.15	1	50 DO	16				
					2	50 DO	55				
1					3	50 DO	8				
					4	50 DO	8				
2					5	50 DO	13				
				54.80							
		Compact black sand, some gravel, trace silt (FILL)		2.74	6	50 DO	22				
3				54.49							
		Compact brown silty clay and brown silty sand layers (FILL)		3.05	7	50 DO	20				
					8	50 DO	8				
4				53.27							
		PEAT		4.34							
		Loose grey SILTY fine SAND, trace gravel			9	50 DO	6				
5					10	50 DO	4				
					11	50 DO	1				
6											
				50.83	12	50 DO	3				
		Loose rusty fine SAND, trace gravel		50.68							
		Loose grey SANDY SILT		50.53							
7		Loose to dense brown coarse SAND		7.01	13	50 DO	1				
					14	50 DO	73				
8				49.34							
		Very dense grey SANDY SILT, some gravel, trace clay		8.20	15	50 DO	65				
				48.80							
		End of Borehole Auger Refusal		8.74							
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-03

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 9, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (⊕) 6 12 18 24 / Headspace Comb. Vapour Conc. [%LEL] ppm (□) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		57.06							
0	Power Auger 200 mm Diam. (Hollow Stem)	Loose black silty clay with organic matter (FILL)		0.00	1	50 DO	13 ⊕				
				56.60							
		Brick (FILL)		56.45							
1		Compact brown sand, some gravel, trace clay with some brick and concrete (FILL)		0.61	2	50 DO	21 ⊕				
				55.84							
		Very dense to compact brown to dark grey sandy silt with cobbles and organic matter (FILL)		1.22	3	50 DO	70 ⊕				
2					4	50 DO	14 ⊕				
				54.62							
		Compact black sand, some gravel, trace silt (FILL)		2.44	5	50 DO	15 ⊕				
				54.32							
3		Compact, brown, medium to coarse sand (FILL)		2.74	6	50 DO	13 ⊕				
				53.71							
		Compact black sand, some gravel, trace silt (FILL)		3.35							
				53.40							
		Compact, brown, medium to coarse sand (FILL)		3.66	7	50 DO	14 ⊕				
4				52.79							
		Compact grey sand and gravel (FILL)		4.27	8	50 DO	18 ⊕				
				52.39							
		PEAT		52.28							
		Compact grey SILTY CLAY									
5		Compact grey fine SAND		4.88	9	50 DO	18 ⊕				
				51.73							
		Compact grey SILTY SAND, some gravel, trace clay		5.33	10	50 DO	11 ⊕				
6				50.96							
		Loose to compact, brown, medium to coarse SAND		6.10	11	50 DO	5 ⊕				
					12	50 DO	16 ⊕				
7				49.74							
		End of Borehole		7.32							
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-04

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 8, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
		Ground Surface		56.57			
0	Power Auger 200 mm Diam. (Hollow Stem)	Black sandy silt with organic matter (TOPSOIL)		56.42			
		Dense grey brown silty sand, some gravel (FILL)		0.15	1	50 DO	45
				55.99			
		Compact black sandy silt, some gravel (FILL)		0.58	2	50 DO	21
1				55.35			
		Loose brown silty sand, some gravel (FILL)		1.22	3	50 DO	7
				54.82			
		Loose to dense black sandy silt, some gravel (FILL)		1.75	4	50 DO	47
2				54.44			
		Compact, brown, medium to coarse sand, some gravel (FILL)		2.13	5	50 DO	13
					6	50 DO	16
3				53.06			
		Stiff grey silty clay (FILL)		3.51	7	50 DO	5
					8	50 DO	5
4				51.77			
		PEAT		4.88			
5		Stiff grey SILTY CLAY		51.39	9	50 DO	13
		Compact grey SANDY SILT, some gravel		5.18			
				51.08			
		Compact grey fine SAND		5.49	10	50 DO	17
				50.65			
6		End of Borehole Auger Refusal		5.92			
7							
8							
9							
10							

Headspace Org. Vapour Conc. [PPM] ppm ⊕: 6, 12, 18, 24

Headspace Comb. Vapour Conc. [%LEL] ppm □: 20, 40, 60, 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; 10, 20, 30, 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE

1 : 50

LOGGED: D.G.

CHECKED: K.P.H.

Golder Associates

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-05

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 10, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (6, 12, 18, 24) / Headspace Comb. Vapour Conc. [%LEL] ppm (20, 40, 60, 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10, 20, 30, 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		55.61							
0	Power Auger, 200 mm Diam. (Hollow Stem)	Compact to dense black silty sand, some gravel, trace brick with cobbles and boulders (FILL)		0.00	1	50 DO	25				
					2	50 DO	42				
1				54.39							
		Dense grey brown sand, trace silt with cobbles and boulders (FILL)		1.22	3	50 DO	36				
2					4	50 DO	42				
				53.17							
		Compact dark brown sandy silt, some gravel (FILL)		2.44	5	50 DO	18				
3				52.59							
		Loose black sandy silt, some gravel, trace wood (FILL)		3.02	6	50 DO	8				
				51.95							
		Loose dark grey fine SAND, some gravel		3.66	7	50 DO	6				
4				51.42							
		COBBLES and BOULDERS		4.19	8	NQ RC	DD	T.C.R. (%): 69; S.C.R. (%): 17; R.Q.D. (%): 17			
5					9	NQ RC	DD				
					10	NQ RC	DD				
				50.00							
	Rotary Drill, NQ Core	Grey LIMESTONE BEDROCK with interbedded shale		5.61	11	NQ RC	DD	T.C.R. (%): 100; S.C.R. (%): 32; R.Q.D. (%): 9			
6				48.90							
		End of Borehole		6.71							
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-06

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 8, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
		Ground Surface		55.04			
0	Power Auger 200 mm Diam. (Hollow Stem)	Grey sandy silt, some gravel, trace brick (FILL)		0.00	1	50 DO	52
				54.51			
		Black silty sand (FILL)					
1		Loose to compact, brown, medium to coarse sand (FILL)		0.61	2	50 DO	13
					3	50 DO	5
				53.21			
2		Compact coarse grey crushed stone (FILL)		1.83	4	50 DO	29
				52.30	5	50 DO	76
		Grey silty clay (FILL)		2.74			
3				51.97	6	50 DO	
		End of Borehole Auger Refusal		3.07			
4							
5							
6							
7							
8							
9							
10							

SAMPLES

Headspace Org. Vapour Conc. [PPM] ppm ⊕
6 12 18 24

Headspace Comb. Vapour Conc. [%LEL] ppm □
20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s
10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT
Wp W Wl
10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE
1 : 50

LOGGED: D.G.

CHECKED: K.P.H.

Golder Associates

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-07

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 8, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (⊕) 6 12 18 24 / Headspace Comb. Vapour Conc. [%LEL] ppm (□) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		55.38							
0	Power Auger 200 mm Diam. (Hollow Stem)	Black sandy silt with organic matter (TOPSOIL)		0.05	1	50 DO	23	⊕			
		Compact black sand, some gravel (FILL)		54.77							
		Loose to compact, brown, medium to coarse sand, some gravel (FILL)		0.61	2	50 DO	20	⊕			
1					3	50 DO	12	⊕			
2					4	50 DO	7	⊕			
					5	50 DO	22				
3					6	50 DO	17	⊕			
		PEAT		51.93							
		Compact grey SILTY CLAY		51.82							
		Dense grey GRAVEL		51.55	7	50 DO	50	⊕			
4		End of Borehole Auger Refusal		3.83							
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-08

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 11, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (⊕) 6 12 18 24 / Headspace Comb. Vapour Conc. [%LEL] ppm (□) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		55.98							
0	Power Auger 200 mm Diam. (Hollow Stem)	Loose brown fine sand, some silt, trace gravel, brick (FILL)		0.00	1	50 DO	8 ⊕				
				55.37							
		Compact brown silty fine sand, some gravel with cobbles and boulders (FILL)		0.61	2	50 DO	69 ⊕				
1				54.76							
		Compact black sand, some gravel, trace silt, pieces of wood (FILL)		1.22	3	50 DO	27 ⊕				
					4	50 DO	47 ⊕				
2				53.54							
		Firm grey brown SILTY CLAY, some sandy gravel, organic layer from 3.66 to 3.73 m depth		2.44	5	50 DO	6 ⊕				
					6	50 DO	11 ⊕				
3				52.25							
		Compact grey SANDY SILT, trace gravel		3.73	7	50 DO	9 ⊕				
					8	50 DO	23 ⊕				
4											
					9	50 DO	26 ⊕				
5				50.49							
		Dense grey SANDY SILT, some gravel, trace clay		5.49	10	50 DO	35 ⊕				
				50.16							
6	Rotary Drill NW Casing	Boulders		5.82	11	NQ RC	DD				
				49.63							
	Rotary Drill NQ Core	Grey LIMESTONE BEDROCK with interbedded shale		6.35	12	NQ RC	DD	T.C.R. (%) 100 / S.C.R. (%) 23 / R.Q.D. (%) 0			
7					13	NQ RC	DD	T.C.R. (%) 100 / S.C.R. (%) 20 / R.Q.D. (%) 0			
				48.36							
		End of Borehole		7.62							
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-09

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 9, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm / Headspace Comb. Vapour Conc. [%LEL] ppm	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT Wp W Wl	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		56.97							
0	Power Auger 200 mm Diam. (Hollow Stem)	Compact to dense grey brown sandy silt, some gravel, trace clay (FILL)		0.00	1	50 DO	9				
1					2	50 DO	11				
					3	50 DO	45				
2					4	50 DO	47				
				54.68							
		Compact black sand, some gravel, trace clay (FILL)		2.29							
				54.33	5	50 DO	36				
		Dense brown medium sand with cobbles (FILL)		2.64							
3				53.95							
		Loose grey to black SILTY CLAY, trace gravel with organic matter		3.02	6	50 DO	9				
				53.16							
		Compact brown medium to coarse SAND		53.01	7	50 DO	15				
4		Compact to dense grey SANDY SILT, some gravel, trace clay		3.96	8	50 DO	20				
5					9	50 DO	89				
					10	50 DO	39				
6					11	50 DO	49				
					12	50 DO	39				
7				49.83							
		End of Borehole Auger Refusal		7.14							
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: D.G.

CHECKED: K.P.H.

Golder Associates

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-10

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 18, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (⊕) 6 12 18 24 / Headspace Comb. Vapour Conc. [%LEL] ppm (□) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		57.82							
0	Power Auger 200 mm Diam. (Hollow Stem)	Black sandy silt with organic matter (TOPSOIL)		0.05							
		Compact grey brown silty sand, some gravel with brick (FILL)			1	50 DO	14 ⊕				
					2	50 DO	16 ⊕				
1				56.60							
		Compact black sand, some gravel, with brick and ashes (FILL)		1.22	3	50 DO	23 ⊕				
				55.99							
2		Compact brown to dark brown SAND, some gravel, trace silt		1.83	4	50 DO	16 ⊕				
					5	50 DO	10 ⊕				
3				54.77							
		Compact brown SAND and GRAVEL		3.05	6	50 DO	16 ⊕				
				54.16							
		Dense brown coarse SAND		3.66	7	50 DO	50 ⊕				
				53.88							
4		End of Borhole Auger Refusal		3.94							
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-11

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 18, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (6, 12, 18, 24) / Headspace Comb. Vapour Conc. [%LEL] ppm (20, 40, 60, 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10, 20, 30, 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		57.86							
	Power Auger 200 mm Diam. (Hollow Stem)	Black sandy silt with organic matter (TOPSOIL)		0.08	1	50 DO	15				
		Compact brown silty sand, some gravel (FILL)			2	50 DO	38				
1				56.87							
		Dense to loose brown and black sand, some gravel with brick, trace concrete and wood (FILL)		0.99	3	50 DO	57				
2					4	50 DO	6				
				55.42							
		Compact brown silty sand layers, some clay, trace gravel with cobbles and boulders (FILL)		2.44	5	50 DO	24				
3					6	50 DO	28				
				54.20							
		Very dense grey CLAYEY SILT, trace very fine sand with cobbles and boulders		3.66	7	50 DO	53				
4					8	50 DO	34				
5					9	50 DO	80				
					10	50 DO	74				
6					11	50 DO	50				
					12	50 DO	50				
7					13	50 DO	79				
				49.96							
8	Rotary Drill NQ Core	Fresh grey LIMESTONE BEDROCK with interbedded shale		7.90	14	NQ RC	DD	T.C.R. (%): 100 / S.C.R. (%): 29 / R.Q.D. (%): 0			
					15	NQ RC	DD	T.C.R. (%): 100 / S.C.R. (%): 44 / R.Q.D. (%): 28			
9					16	NQ RC	DD	T.C.R. (%): 100 / S.C.R. (%): 50 / R.Q.D. (%): 36			
				48.36							
		End of Borehole		9.50							
10											

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-14

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 12, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (6, 12, 18, 24) / Headspace Comb. Vapour Conc. [%LEL] ppm (20, 40, 60, 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10, 20, 30, 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		55.85							
	Power Auger 200 mm Diam. (Hollow Stem)	Dark brown sandy silt with organic matter (TOPSOIL)		0.10	1	50 DO	8				
		Compact dark brown sand, some gravel, trace silt and brick (FILL)			2	50 DO	26				
1				54.63							
		Compact, brown, medium to coarse sand, some gravel, trace silt (FILL)		1.22	3	50 DO	16				
2					4	50 DO	17				
					5	50 DO	17				
3				52.50	6	50 DO	12				
		Compact light brown SANDY SILT		3.35							
				52.19							
		Dense coarse SAND, some gravel		3.66	7	50 DO	50				
4	RD / NW			51.86							
		Fresh LIMESTONE BEDROCK with interbedded shale		3.99	8	NQ RC	DD	T.C.R. (%): 96			
	Rotary Drill NQ Core							S.C.R. (%): 28			
5								R.Q.D. (%): 16			
					9	NQ RC	DD	T.C.R. (%): 100			
								S.C.R. (%): 96			
								R.Q.D. (%): 96			
6				49.85							
		End of Borehole		6.00							
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-15

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 12, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm / Headspace Comb. Vapour Conc. [%LEL] ppm	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT Wp W Wl	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		55.34							
0	Power Auger 200 mm Diam. (Hollow Stem)	Dark grey silty sand with organic matter (TOPSOIL)		55.14							
		Compact grey silty sand, some gravel, trace clay with cobbles (FILL)		0.20	1	50 DO	40				
				54.63							
		Compact black sand, some gravel, trace silt (FILL)		0.81	2	50 DO	14				
1		Loose, brown, fine to medium sand, trace gravel (FILL)			3	50 DO	7				
2					4	50 DO	6				
				52.90							
		Compact dark brown to black silt, trace brick and paper (FILL)		2.44	5	50 DO	20				
3				52.29							
		Loose coarse GRAVEL with dark brown to black silt		3.05	6	50 DO	9				
				51.96							
		End of Borehole Auger Refusal		3.38							
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: D.G.

CHECKED: K.P.H.

Golder Associates

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-16

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 12, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (⊕) 6 12 18 24 / Headspace Comb. Vapour Conc. [%LEL] ppm (□) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		55.72							
0	Power Auger 200 mm Diam. (Hollow Stem)	Black sandy silt with organic matter (TOPSOIL)		0.08							
		Compact dark brown to brown sand, some gravel, trace silt with pieces of concrete (FILL)			1	50 DO	22 ⊕				
1					2	50 DO	53 ⊕				
				54.50							
		Loose to compact brown fine sand (FILL)		1.22							
2					3	50 DO	13 ⊕				
					4	50 DO	4 ⊕				
					5	50 DO	3 ⊕				
3				52.70							
		Peat with sand and wood (FILL)		3.02							
					6	50 DO	2 ⊕				
					7	50 DO	1 ⊕				
4	Rotary Drill NQ Core			51.73							
		Fresh grey LIMESTONE BEDROCK with interbedded shale		3.99	8	NQ RC	DD	T.C.R. (%) 100 / S.C.R. (%) 91 / R.Q.D. (%) 83			
5					9	NQ RC	DD	T.C.R. (%) 100 / S.C.R. (%) 100 / R.Q.D. (%) 100			
				50.21							
		End of Borehole		5.51							
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-17

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 15, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (6, 12, 18, 24) / Headspace Comb. Vapour Conc. [%LEL] ppm (20, 40, 60, 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10, 20, 30, 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		56.19							
0	Power Auger 200 mm Diam. (Hollow Stem)	Dark brown silty sand with organic material (TOPSOIL)		56.06							
		Loose to compact dark brown silty sand, some gravel with brick, cobbles and boulders (FILL)		0.13	1	50 DO	13				
1					2	50 DO	9				
		Compact black sand, some gravel, trace silt (FILL)		55.05 1.14							
				54.67	3	50 DO	18				
2		Loose to compact, brown, medium to coarse SAND, trace gravel with cobbles and boulders		1.52	4	50 DO	7				
					5	50 DO	20				
3				53.14							
		Compact coarse GRAVEL with dark brown silty sand		3.05	6	50 DO	18				
					7	50 DO	23				
4				52.08							
		End of Borehole Auger Refusal		4.11							
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-19

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 16, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		56.42							
0	Power Auger 200 mm Diam. (Hollow Stem)	Black sandy silt with organic matter (TOPSOIL)		0.10							
		Compact to very dense grey brown silty sand, some gravel with brick, concrete, and asphalt (FILL)			1	50 DO	14				
1					2	50 DO	50				
					3	50 DO	10				
				54.74							
		Compact black sand, some gravel (FILL)		54.59							
2		Compact brown silty sand, some gravel, trace black sand (FILL)		1.83	4	50 DO	18				
				53.98							
		Dense grey brown silty clay, trace gravel (FILL)		2.44	5	50 DO	36				
				53.45							
3		Dense black SANDY SILT with organic matter		53.17	6	50 DO	50				
		Dense brown fine SAND, some silt		3.25							
		End of Borehole Auger Refusal									
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: D.G.

CHECKED: K.P.H.

Golder Associates

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-20

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 22, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (⊕) 6 12 18 24 / Headspace Comb. Vapour Conc. [%LEL] ppm (□) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		57.94							
0	Power Auger 200 mm Diam. (Hollow Stem)	Black sandy silt with organic matter (TOPSOIL)		0.08	1	50 DO	18	⊕			
		Compact dark brown silty sand and brick (FILL)		57.33							
		Compact sand, some gravel, trace concrete and brick (FILL)		0.61	2	50 DO	39	⊕			
1					3	50 DO	16	⊕			
				56.11							
2		Loose to compact brown SILTY SAND with cobbles and boulders		1.83	4	50 DO	8	⊕			
				55.20	5	50 DO	30	⊕			
		Dense grey SILTY SAND, some gravel, trace clay		2.74							
3					6	50 DO	66	⊕			
				54.28							
		Very dense grey CLAYEY SILT, some very fine sand, trace gravel		3.66	7	50 DO	97	⊕			
4					8	50 DO	86	⊕			
				52.86							
5		End of Borehole Auger Refusal		5.08							
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-25

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 10, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (6, 12, 18, 24) / Headspace Comb. Vapour Conc. [%LEL] ppm (20, 40, 60, 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10, 20, 30, 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		55.79							
0	Power Auger 200 mm Diam. (Hollow Stem)	Dark brown silty sand with organic matter (TOPSOIL)		55.64							
		Dense grey brown to brown sand, some gravel, trace silt with cobbles and boulders, trace brick from 1.22 to 1.52 m depth (FILL)		0.15	1	50 DO	29	⊕			
1					2	50 DO	46				
				54.27	3	50 DO	15	⊕			
		Loose brown fine to medium sand (FILL)		1.52							
2					4	50 DO	3	⊕			
					5	50 DO	4	⊕			
				52.89							
3		Wood (FILL)		2.90							
					6	50 DO	15	⊕			
				52.13							
		Very dense coarse GRAVEL with dark brown silt (FILL)		3.66	7	50 DO	53	⊕			
4				51.65							
		End of Borehole Auger Refusal		4.14							
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-26

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 24, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm / Headspace Comb. Vapour Conc. [%LEL] ppm	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		55.27							
0	Power Auger, 200 mm Diam. (Hollow Stem)	Black sandy silt with organic matter (TOPSOIL)		0.08	1	50 DO	20				
		Compact grey crushed stone, some sand (FILL)		54.81							
		Compact black sand, some gravel (FILL)		54.66							
1		Compact to dense grey crushed stone, some sand (FILL)		0.61	2	50 DO	27				
					3	50 DO	37				
				53.44							
2		Compact, brown, medium to coarse sand, trace crushed stone (FILL)		1.83	4	50 DO	14				
				52.83							
		Loose grey brown silty sand, trace crushed stone (FILL)		2.44	5	50 DO	6				
3				52.22							
		Peat, trace wood (FILL)		3.05	6	50 DO	50				
				51.97							
		Highly weathered LIMESTONE BEDROCK		51.79							
	RD / NW	Grey LIMESTONE BEDROCK with interbedded shale		3.48	7	NQ RC	DD	T.C.R. (%) 100; S.C.R. (%) 59; R.Q.D. (%) 27			
4	Rotary Drill, NQ Core				8	NQ RC	DD	T.C.R. (%) 100; S.C.R. (%) 100; R.Q.D. (%) 100			
5				50.22							
		End of Borehole		5.05							
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-28

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 22, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
		Ground Surface		56.33			
0	Power Auger 200 mm Diam. (Hollow Stem)	Black sandy silt with organic matter (TOPSOIL)		56.20			
		Compact brown coarse sand, some gravel (FILL)		0.13	1	50 DO	17
				55.42	2	50 DO	22
1		Loose to compact black sand, some gravel, some glass, trace wood from 1.83 m depth (FILL)		0.91	3	50 DO	10
2					4	50 DO	4
				53.89			
		Loose brown to grey brown SILTY CLAY		2.44	5	50 DO	9
3					6	50 DO	6
				52.67	7	50 DO	
		Dense brown SILTY SAND, some gravel with cobbles and boulders		3.66	8	50 DO	60
4				52.09			
		End of Borehole Auger Refusal		4.24			
5							
6							
7							
8							
9							
10							

SAMPLES

Headspace Org. Vapour Conc. [PPM] ppm ⊕ — 6, 12, 18, 24

Headspace Comb. Vapour Conc. [%LEL] ppm □ — 20, 40, 60, 80

HYDRAULIC CONDUCTIVITY, k, cm/s — 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}

WATER CONTENT PERCENT — Wp, W, Wl — 10, 20, 30, 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE

1 : 50

LOGGED: D.G.

CHECKED: K.P.H.

Golder Associates

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-29

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 22, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (⊕) 6 12 18 24 / Headspace Comb. Vapour Conc. [%LEL] ppm (□) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		56.80							
	Power Auger 200 mm Diam. (Hollow Stem)	Black sandy silt with organic matter (TOPSOIL)		56.67							
		Compact brown silty clay, some sand, trace gravel (FILL)		0.13	1	50 DO	10 ⊕				
				56.19							
		Compact brown silty sand, some gravel, trace concrete (FILL)		0.61	2	50 DO	28 ⊕				
1				55.58							
		Very dense black sand, some gravel, trace brick (FILL)		1.22	3	50 DO	55 ⊕				
				54.97							
		Compact brown coarse sand (FILL)		1.83	4	50 DO	18 ⊕				
2				54.67							
		Compact grey brown silty clay (FILL)		2.13							
				54.21							
		Loose dark brown silty sand with organic matter (FILL)		2.59	5	50 DO	8 ⊕				
3				53.75							
		Hard grey CLAYEY SILT, some very fine sand		3.05	6	50 DO	28 ⊕				
					7	50 DO	49 ⊕				
4				52.37							
		End of Borehole Auger Refusal		4.43							
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0044

RECORD OF BOREHOLE: 10-30

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 25, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	Headspace Org. Vapour Conc. [PPM] ppm (⊕) 6 12 18 24 / Headspace Comb. Vapour Conc. [%LEL] ppm (□) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		57.87							
0	Power Auger 200 mm Diam. (Hollow Stem)	Black sandy silt with organic matter (TOPSOIL)		57.72							
		Loose brown silty sand, some gravel (FILL)		0.15	1	50 DO	6 ⊕				
1					2	50 DO	4 ⊕				
				56.65							
		Compact to dense light brown silty sand, some gravel, trace clay (FILL)		1.22	3	50 DO	17 ⊕				
2					4	50 DO	35 ⊕				
				55.43							
		Dense to very dense grey SILTY SAND, some gravel, trace clay with cobbles and boulders		2.44	5	50 DO	49 ⊕				
3					6	50 DO	49 ⊕				
					7	50 DO	86 ⊕				
4					8	50 DO	92 ⊕				
5					9	50 DO	99 ⊕				
	RD / NW				10	50 DO	50				
6					11	NQ RC	DD				
				51.19							
	Rotary Drill NQ Core	Fresh grey LIMESTONE BEDROCK with interbedded shale		6.68	12	NQ RC	DD	T.C.R. (%) 100 / S.C.R. (%) 100 / R.Q.D. (%) 100			
7											
					13	NQ RC	DD	T.C.R. (%) 100 / S.C.R. (%) 97 / R.Q.D. (%) 91			
8				49.62							
		End of Borehole		8.25							
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.G.

CHECKED: K.P.H.

BOREHOLE 1011220044.GPJ HYDROGEO.GDT 7/27/10

PROJECT: 10-1122-0169

RECORD OF BOREHOLE: 11-11

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: Mar. 4, 2011

DATUM: Geodetic

SAMPLER HAMMER, 63.5 kg; DROP, 760 mm

PENETRATION TEST HAMMER, 63.5 kg; DROP, 760 mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		54.5									
0	Power Auger 200mm Diam. (Hollow Stem)	Compact black sand and gravel, some silt, trace clay, wood and ash (FILL)		0.0									Cuttings
1					1	50 DO	29						
2					2	50 DO	14					MH	
					3	50 DO	>100						
				51.9									
3	Rotary Drill NQ Coring	Slightly weathered grey LIMESTONE BEDROCK, with interbedded shale		2.7	C1	NQ RC	DD						Bentonite Seal
				51.2									
		Fresh grey medium bedded LIMESTONE BEDROCK, with interbedded shale		3.4	C2	NQ RC	DD					UC	
4													
5					C3	NQ RC	DD						
					C4	NQ RC	DD						
				48.6									
6		End of Borehole		5.9									
7													
8													
9													
10													

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: SR

MIS-BHS 001 1011220169.GPJ GAL-MIS.GDT 15/06/11 DATA INPUT:

PROJECT: 10-1122-0169

RECORD OF DRILLHOLE: 11-21

SHEET 1 OF 1

LOCATION: See Site Plan

DRILLING DATE: Mar. 1, 2011

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Track

DRILLING CONTRACTOR: Marathon Drilling

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		BEDROCK SURFACE		54.8												Protective Monument
0	P.A. (Hollow Stem)	Slightly weathered LIMESTONE BEDROCK, with shale interbedding		0.0												
1					C1		0									Bentonite Seal
				53.3												
	Rotary Drill NQ Coring	Fresh grey medium bedded LIMESTONE BEDROCK, with interbedded shale		1.5												
2					C2		100									Silica Sand
3					C3		100									38mm Diam. PVC #10 Slot Screen
				51.1												
		End of Borehole		3.7												
4																W.L. in Screen at Elev. 52.12 m on March 7, 2011
																W.L. in Screen at Elev. 52.44 m on April 19, 2011
5																
6																
7																
8																
9																
10																

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DG
CHECKED: SR

MIS-RCK 001 1011220169 (ROCK).GPJ GAL-MISS.GDT 15/06/11 DATA INPUT:

PROJECT: 10-1121-0222

RECORD OF BOREHOLE: W-009

SHEET 1 OF 2

LOCATION: N 5030282 97 ;E 365715 99

BORING DATE: June 2-6, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V +, rem V ⊕; Q ●, U ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-3} 10^{-5} 10^{-4} 10^{-2})	WATER CONTENT PERCENT (Wp W Wl) (20 40 60 80)	ADDITIONAL LAB TESTING	MON. WELL
0		GROUND SURFACE		60.44									
		ASPHALTIC CONCRETE		0.00									Flush Mount Protective Casing set in Asphalt
		Grey sand and gravel (Crushed Stone FILL)		59.68									Silica Sand
		Compact brown medium sand, trace gravel and silt (FILL)		0.76									Bentonite Seal
1				59.21	1	50 DO	16						
		Loose to dense grey sand and gravel, some brown sand, with cobbles (Crushed Stone FILL)		1.23									
					2	50 DO	14						Cave/Backfill
					3	50 DO	61						
					4	50 DO	9						
4				56.32	5	50 DO	5						
		Very loose to compact brown sandy silt, some clay, trace gravel, with wood fragments, occasional cobble and boulders with depth (FILL)		4.12									Bentonite Seal
5	Power Auger 200mm Diam (Hollow Stem)				6	50 DO	3						
					7	50 DO	10						Silica Sand
6				54.34									
		Compact to dense black sandy silt, some wood, trace gravel, ash, glass and fabric, creosote odour (WASTE)		6.10	8	50 DO	12						
7					9	50 DO	41						32mm Diam PVC #10 Slot Screen
				52.51	10	50 DO	43						Silica Sand
8		Loose brown to grey fine to coarse sand, trace gravel, trace silt (FILL)		7.93									
					11	50 DO	5						Bentonite Seal
9					12	50 DO	5			O		MH	Cave
10					13		5						
		CONTINUED NEXT PAGE											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: SD/HD

OLRT-SOIL 1011210222-1300.GPJ GAL-MIS.GDT 10/18/11 JEM/JM

PROJECT: 10-1121-0222

RECORD OF BOREHOLE: W-009

SHEET 2 OF 2

LOCATION: N 5030282 97 ;E 365715.99

BORING DATE: June 2-6, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V + Q - ●, rem V ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-2}) / WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB TESTING	MON. WELL
10		*--- CONTINUED FROM PREVIOUS PAGE ---*									
	Power Auger	Loose brown to grey fine to coarse sand, trace gravel, trace silt (FILL)		50.07	13	50 DO	5				Cave
		Loose dark brown silt, with organic matter, occasional grey fine sand seams (PEAT)		10.37 10.52							
		Dense brown SILTY SAND, some gravel		49.54	14	50 DO	>50				
11		Dense to very dense grey SILTY SAND to SANDY SILT, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)		10.90							Bentonite Seal
	Rotary Drill				15	NQ RC	DD				
12											
13	NQ Core				16	NQ RC	DD				Cave
14											
					17	NQ RC	DD				Bentonite Seal
15											
					18	NQ RC	DD				W L in Screen at Elev 53.3m on Aug 2, 2011
		Borehole continued on RECORD OF DRILLHOLE W-009		45.04							
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: SD/HD

OLRT-SOIL 1011210222-1300.GPJ GAL-MIS.GDT 10/18/11 JEM/JM

PROJECT: 10-1121-0222

RECORD OF DRILLHOLE: W-009

SHEET 1 OF 1

LOCATION: N 5030282 97 ;E 365715 99

DRILLING DATE: June 2-6, 2011

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Marathon Drilling

JN. - Joint, FLT - Fault, SH - Shear, VN - Vein, CJ - Conjugate
BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Clean
PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular
PO - Polished, K - Slickensided, SM - Smooth, RO - Rough, MB - Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV / DEPTH (m)	RUN No	FLUSH RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R Q D %	FRACT INDEX PER 0.25m	DISCONTINUITY DATA DIP / CORE AXIS	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH-ERING INDEX	NOTES
		BEDROCK SURFACE		45.04											MON WELL
16	Rotary Drill NQ Core	Fresh, interbedded sequence of shale and limestone, comprised of dark brownish black, moderately calcareous SHALE BEDROCK, with thinly to medium bedded, dark brownish grey, fine grained, medium strong micritic LIMESTONE BEDROCK LINDSAY FORMATION UNIT 3		15.40	1	100						BD PL SM BD CU,Ro			Bentonite Seal Cave
				43.52											
17		End of Drillhole		16.92											W L in Screen at Elev 53 3m on Aug 2, 2011
18															
19															
20															
21															
22															
23															
24															
25															

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: RI
CHECKED: SD/HD

OLRT-ROCK 1011210222-1300.GPJ GAL-MISS.GDT 10/18/11 JEM JM

PROJECT: 10-1121-0222

RECORD OF BOREHOLE: W-009A

SHEET 1 OF 1

LOCATION: N 5030284 17 ;E 365718.48

BORING DATE: June 13, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V +, rem V ⊕; Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB TESTING	GAS WELL
0		GROUND SURFACE		60.53							
	Power Auger 200mm Diam (Hollow Stem)	See RECORD OF BOREHOLE W-009 for subsurface condition details		0.00							Flush Mount Protective Casing set in Bentonite Seal; Bentonite Seal; Backfill; Pea Gravel; Bentonite Seal; Pea Gravel; 20mm Diam PVC #10 Slot Screen; Pea Gravel
7		End of Borehole		53.67 6.86							

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: CHM

CHECKED: SD/HD

OLRT-SOIL 1011210222-1300.GPJ GAL-MIS.GDT 10/18/11 JEM/JM

PROJECT: 10-1121-0222

RECORD OF BOREHOLE: W-011

SHEET 1 OF 2

LOCATION: N 5030336 81 ;E 365783 53

BORING DATE: June 22-24, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V +, rem V ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-2})	WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB TESTING
0	Power Auger 200mm Diam. (Hollow Stem)	GROUND SURFACE		62.74								
		Topsoil (FILL)		0.00								
		Grey to brown sand and gravel (Crushed Stone FILL)		0.05								
1					1	50 DO	10					
				61.44								
		Compact to dense dark brown fine to coarse sand, some silt, trace gravel (FILL)		1.30								
2					2	50 DO	47			○		M
				60.61								
		Compact dark brown silty sand, some gravel, trace organic matter, with brick fragments and pockets of silty clay (FILL)		2.13								
					3	50 DO	28					
				59.84								
3		Compact dark brown to black sandy silt, some gravel, trace to some clay, trace brick, wood, ash and organic matter (FILL)		2.90								
					4	50 DO	26					
				59.18								
		Dense grey sand and gravel, trace silt, occasional cobble (FILL)		3.56								
4					5	50 DO	31					
					6	50 DO	46					
5				57.56								
		Compact dark brown to black sandy silt, trace to some gravel, trace clay, with wood, brick, ash, organic matter, glass, plastic and pockets of silty clay (WASTE)		5.18								
					7	50 DO	29					
6					8	50 DO	18					
7					9	50 DO	11					
8				54.74	10	50 DO	21					
		Compact brown fine to medium sand, trace gravel and silt (WASTE)		8.00								
				54.51								
		Compact dark brown silty sand to sandy silt, some gravel, trace clay, ash, brick, ceramics and organic matter (WASTE)		8.23								
9					11	50 DO	27					
				53.59								
		Loose to compact dark brown to black sandy silt, some sand, trace paper, fabric, wood, metal and organic matter (WASTE)		9.15								
					12	50 DO	28					
10					13		6					
		CONTINUED NEXT PAGE										

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: SD/HD

OLRT-SOIL 1011210222-1300.GPJ GAL-MIS.GDT 10/18/11 JEM/JM

PROJECT: 10-1121-0222

RECORD OF BOREHOLE: W-011

SHEET 2 OF 2

LOCATION: N 5030336 81 ;E 365783 53

BORING DATE: June 22-24, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (20 40 60 80) nat V + Q - ● rem V ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-3} 10^{-5} 10^{-4} 10^{-2})	WATER CONTENT PERCENT Wp W Wl (20 40 60 80)	ADDITIONAL LAB TESTING
10	Powar Auger 200mm Diam (Hollow Stem)	*— CONTINUED FROM PREVIOUS PAGE —*										
		Loose to compact dark brown to black sandy silt, some sand, trace paper, fabric, wood, metal and organic matter (WASTE)			13	50 DO	6					
				51.92								
		Dark brown amorphous PEAT		10.82 51.69	14	50 DO	13					
11		Very stiff grey SILTY CLAY, some organic matter		11.05 51.31								
		Very dense grey brown fine to coarse SAND, some gravel, some silt, trace clay and pieces of shale (GLACIAL TILL)		11.43	15	50 DO	69					
12					16	50 DO	53			O		MH
				49.78								
13		Highly weathered, black, very weak SHALE BEDROCK		12.96	17	50 DO	>86					
				49.00	18	50 DO	>50					
		Sampler Refusal at 13.74m Borehole continued on RECORD OF DRILLHOLE W-011										
14												
15												
16												
17												
18												
19												
20												

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: RI
CHECKED: SD/HD

OLRT-SOIL 1011210222-1300.GPJ GAL-MIS.GDT 10/18/11 JEM/JM

PROJECT: 10-1121-0222

RECORD OF DRILLHOLE: W-011

SHEET 1 OF 1

LOCATION: N 5030336 81 ;E 365783 53

DRILLING DATE: June 22-24, 2011

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Downing

JN - Joint; FLT - Fault; SH - Shear; VN - Vein; CJ - Conjugate; BD - Bedding; FO - Foliation; CO - Contact; OR - Orthogonal; CL - Clean; PL - Planar; CU - Curved; UN - Undulating; ST - Stepped; IR - Irregular; PO - Polished; K - Slickensided; SM - Smooth; RO - Rough; MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV DEPTH (m)	RUN No	FLUSH RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R Q D %	FRACT INDEX PER 0.25m	DISCONTINUITY DATA: TRUE CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec	WEATHERING INDEX	NOTES
		BEDROCK SURFACE at 12.96m		49.00											
14	Rotary Drill NQ Core	Highly weathered, black, very weak SHALE BEDROCK - No recovery from 13.74m to 14.26m		13.74 48.48	1	100									
		Moderately weathered, laminated, black, weak SHALE BEDROCK BILLINGS FORMATION - Broken core from 14.26m to 14.40m - Broken core from 14.55m to 14.62m		14.26 48.12	1	100						BD PL,SM BD,PL SM BD CU SM BD CU SM			
15		Fresh, laminated, black, weak SHALE BEDROCK		14.62	2	100						BD IR,SM Ca 3mm BD,PL SM BD CU,SM			
16				46.69											
		End of Drillhole		16.05											
17															
18															
19															
20															
21															
22															
23															

HYDRAULIC CONDUCTIVITY K, cm/sec: 10^{-8} 10^{-6} 10^{-4} 10^{-2}

WEATHERING INDEX: W1 W2 W3 W4 W5 W6

OLRT-ROCK 10111210222-1300.GPJ GAL-MISS.GDT 10/18/11 JEM/JM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: SD/HD

PROJECT: 10-1121-0222

RECORD OF BOREHOLE: W-012

SHEET 1 OF 2

LOCATION: N 5030354 08 ;E 365772 87

BORING DATE: June 7-8, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2})	ADDITIONAL LAB TESTING	MON. WELL
		GROUND SURFACE		59.32				SHEAR STRENGTH Cu, kPa: nat V + Q - ●; rem V ⊕ U - ○ (20 40 60 80)	WATER CONTENT PERCENT: Wp — W — Wl (20 40 60 80)		
0	Power Auger 200mm Diam (Hollow Stem)	Dark brown sandy silt, trace to some gravel and organic matter (TOPSOIL)		0.00 / 59.12							Flush Mount Protective Casing set in Sand
		Very loose to compact dark brown to black sandy silt to silty sand, trace to some gravel and clay, with silty clay pockets, brick, wood, ash, glass, organic matter, mortar, ceramics, paper and plastic (WASTE)		0.20	1	50 DO	9				Silica Sand
1											Bentonite Seal
					2	50 DO	13				
2											Cave/Backfill
					3	50 DO	16				
3											
					4	50 DO	16				
4											
					5	50 DO	12				Bentonite Seal
					6	50 DO	3				Silica Sand
5											▽
					7	50 DO	18				
6				53.22							
		Dark brown to black wood, plastic and paper, some sand and gravel (WASTE)		6.10	8	50 DO	19				32mm Diam PVC #10 Slot Screen
7					9	50 DO	69				
											Silica Sand
					10	50 DO	6				
8				50.94							
		Very dense grey fine to coarse SAND, trace gravel, trace to some silt		8.38	11	50 DO	98				
											Bentonite Seal
9											
				49.72	12	50 DO	67				
		Very dense black GRAVELLY SAND, with shale fragments		9.60							
10					13		>50				
		CONTINUED NEXT PAGE									

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: SD/HD

PROJECT: 10-1121-0222

RECORD OF BOREHOLE: W-012

SHEET 2 OF 2

LOCATION: N 5030354 08 ;E 365772.87

BORING DATE: June 7-8, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V +, rem V ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2})	WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB TESTING	MON WELL
10		— CONTINUED FROM PREVIOUS PAGE —											
	Power Auger			49.11	13	50 DO	>50						[redacted]
		Highly weathered, black, weak SHALE BEDROCK		10.21									W L in Screen at Elev 54.1m on Aug. 2, 2011
				48.60	14	50 DO	>50						
11		Sampler Refusal at 10.72m Borehole continued on RECORD OF DRILLHOLE W-012											
12													
13													
14													
15													
16													
17													
18													
19													
20													

GLRT-SOIL 1011210222-1300.GPJ GAL-MIS.GDT 10/18/11 JEM/JM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: SD/HD

PROJECT: 10-1121-0222

RECORD OF DRILLHOLE: W-012

SHEET 1 OF 1

LOCATION: N 5030354 08 ;E 365772 87

DRILLING DATE: June 7-8, 2011

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Marathon Drilling

JN - Joint, FLT - Fault, SH - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Clean, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, RO - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV DEPTH (m)	RUN No	FLUSH RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R Q D %	FRACT INDEX PER 0.25m	DISCONTINUITY DATA DIP w r t CORE AXIS	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K cm/sec	WEATHERING INDEX W1 W2 W3 W4 W5 W6	NOTES
		BEDROCK SURFACE at 10.21m		48.60														MON WELL
11	Rotary Drill NQ Core	Fresh, laminated, black, weak SHALE BEDROCK BILLINGS FORMATION		10.72	1	100						BD,PL,SM BD,PL,SM BD,PL,SM BD,PL,SM						Bentonite Seal
12		- Subvertical fracture from 11.91m to 12.27m, infilled with calcite (<1mm) - Broken core from 12.04m to 12.10m		47.05								FR ST Ro FR PL SM Ca <1mm						
		End of Drillhole		12.27														W.L. in Screen at Elev 54.1m on Aug 2, 2011
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: SD/HD

OLRT-ROCK 1011210222-1300.GPJ GAL-MISS.GDT 10/18/11 JEM/JM

PROJECT: 10-1121-0222

RECORD OF BOREHOLE: W-013

SHEET 1 OF 2

LOCATION: N 5030375 10 ;E 365845.61

BORING DATE: June 22-23, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V +, rem V ⊕; Q ●, U ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-3} 10^{-4} 10^{-5} 10^{-6})	WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB TESTING
0	Power Auger 200mm Diam. (Hollow Stem)	GROUND SURFACE		60.97								
		ASPHALTIC CONCRETE		0.00								
		Dense to compact grey sand and gravel (Crushed Stone FILL)		0.12								
1					1	50 DO	39					
					2	50 DO	17					
2		Compact to dense brown sand and gravel, trace silt, with cobbles (Crushed Stone FILL)		58.84 2.13								
					3	50 DO	15					
3					4	50 DO	15					
4					5	50 DO	35					
					6	50 DO	24					
5		Loose to compact dark grey to black sandy silt, some clay and organic matter, trace gravel, with wood, glass and brick (WASTE)		55.79 5.18								
					7	50 DO	13					
6					8	50 DO	6					
7					9	50 DO	15					
		Dark grey to black wood, organic matter plastic, glass, brick and paper, some silty sand (WASTE)		53.50 7.47								
8					10	50 DO	11					
		Very dense grey brown fine to medium SAND, some gravel, with cobbles		52.26 8.69	11	50 DO	37					
9					12	50 DO	>100					
10					13		>100					
		CONTINUED NEXT PAGE										

OLRT-SOIL 1011210222-1300.GPJ GAL-MIS.GDT 10/18/11 JEM/JM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: HEC

CHECKED: SD/HD

PROJECT: 10-1121-0222

RECORD OF BOREHOLE: W-013

SHEET 2 OF 2

LOCATION: N 5030375 10 ;E 365845 61

BORING DATE: June 22-23, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (20 40 60 80) nat V + Q - ● rem V ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-2}) WATER CONTENT PERCENT Wp W Wl (20 40 60 80)	ADDITIONAL LAB TESTING	
10		*— CONTINUED FROM PREVIOUS PAGE —*										
	Power Auger	Very dense grey brown fine to medium SAND, some gravel, with cobbles		50.46	13	50 DO	>100					
		Highly weathered, black, weak SHALE BEDROCK		10.51	14	50 DO	>100					W.L. in open hole at Elev. 52.8m upon completion of drilling
11		Borehole continued on RECORD OF DRILLHOLE W-013		49.95								
12												
13												
14												
15												
16												
17												
18												
19												
20												

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: HEC
CHECKED: SD/HD

OLRT-SOIL 1011210222-1300.GPJ GAL-MIS.GDT 10/18/11 JEM/JM

PROJECT: 10-1121-0222

RECORD OF DRILLHOLE: W-013

SHEET 1 OF 1

LOCATION: N 5030375 10 ;E 365845 61

DRILLING DATE: June 22-23, 2011

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Downing

JN - Joint, FLT - Fault, SH - Shear, VN - Vein, CJ - Conjugate | BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Clean | PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular | PO- Polished, K - Slickensided, SM- Smooth, RO- Rough, MB- Mechanical Break | BR - Broken Rock. NOTE: For additional abbreviations refer to list of abbreviations & symbols

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV DEPTH (m)	RUN No	FLUSH RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R Q D %	FRACT INDEX PER 0.25m	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec	WEATHERING INDEX	NOTES
		BEDROCK SURFACE at 10.51m		49.95											
12	Rotary Drill / NQ Core	Slightly weathered, laminated, dark grey to black, weak SHALE BEDROCK, with thin cross-cutting veins of calcite BILLINGS FORMATION - Broken core from 11.14m to 11.22m - Broken core from 11.59m to 11.68m - Fractured core from 12.15m to 13.52m		11.02	1	100						FR,PL,Ro JN,PL,SM JN,PL,SM		W1 W2 W3 W4 W5 W6	
13					2	100 to 0						JN,UN,Ro BD,UN,Ro			
					3	0									
		End of Drillhole		47.45 13.52											W.L. in open hole at Elev. 52.8m upon completion of drilling
14															
15															
16															
17															
18															
19															
20															
21															

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: HEC

CHECKED: SD/HD

OLRT-ROCK 1011210222-1300.GPJ GAL-MISS.GDT 10/18/11 JEM/JM

PROJECT: 10-1121-0222

RECORD OF BOREHOLE: W-015

SHEET 1 OF 1

LOCATION: N 5030400 13 ;E 365816 06

BORING DATE: June 13-14, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V +, rem V ⊕, Q -, U -) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-3} 10^{-2} 10^{-4} 10^{-2})	WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB TESTING
		GROUND SURFACE		58.89								
0	Power Auger 200mm Diam (Hollow Stem)	Dark brown sandy silt, trace organic matter and gravel (TOPSOIL)		0.00								
		Grey brown sand and gravel, trace silt, with cobbles (Crushed Stone FILL)		0.08								
				58.08								
1		Loose to compact dark brown to black sandy silt, trace to some clay, trace gravel, with ash, wood, brick, organic matter, mortar, glass and plastic (WASTE)		0.81	1	50 DO	11					
2					2	50 DO	13					
3					3	50 DO	12					
					4	50 DO	3					
4					5	50 DO	7					
				54.32								
5		Black wood and organic mattter, with plastic, paper, glass, metal and sand (WASTE)		4.57	6	50 DO	10					
					7	50 DO	9					
6					8	50 DO	15					▽
				52.03								
7		Dark brown organic matter, trace silt (PEAT)		6.91	9	50 DO	16					
		Compact to dense grey brown fine to medium SAND, some gravel and silt										
8					10	50 DO	>50					
				50.63								
		Highly weathered, black, weak SHALE BEDROCK		8.26	11	50 DO	>50					
9				49.75								W L in open hole at Elev. 52.8m upon completion of drilling.
		Borehole continued on RECORD OF DRILLHOLE W-015										
10												

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: CHM

CHECKED: SD/HD

OLRT-SOIL 1011210222-1300.GPJ GAL-MIS.GDT 10/18/11 JEM/JM

PROJECT: 10-1121-0222

RECORD OF DRILLHOLE: W-015

SHEET 1 OF 1

LOCATION: N 5030400 13 ;E 365816.06

DRILLING DATE: June 13-14, 2011

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Marathon Drilling

JN - Joint, FLT - Fault, SH - Shear, VN - Vein, CJ - Conjugate; BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Clean; PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular; PO - Polished, K - Slickensided, SM - Smooth, RO - Rough, MB - Mechanical Break; BR - Broken Rock. NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	RQD %	FRACT INDEX PER 0.25m	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec	WEATHERING INDEX	NOTES
		BEDROCK SURFACE at 8.26m		49.75											
	Rotary Drill / NQ Core	Slightly weathered, laminated, dark grey, weak SHALE BEDROCK, with thin cross-cutting veins of calcite BILLIINGS FORMATION - Broken core from 9.14m to 9.18m		9.14	1	100						FR,UN,Ro JN,PL,SM Cl <1mm JN,PL,Ro			
10		- Broken core from 10.00m to 10.05m - Broken core from 10.18m to 10.34m										FR,PL,Ro FR,PL,Ro FR,PL,Ro FR,PL,Ro FR,CU,Ro			
		- No recovery from 10.71m to 11.00m			2							FR,PL,Ro FR,PL,Ro FR,CU,Ro			
11		- Broken core from 11.00m to 11.03m			2	100						FR,UN,Ro			
		- Broken core from 11.08m to 11.11m - Broken core from 11.36m to 11.58m										FR,PL,Ro			
		- Broken core from 11.68m to 11.70m			3	100						FR,PL,Ro Ca <1mm FR,PL,Ro Ca <1mm JN,UN,Ro Ca <1mm			
12		- Broken core from 11.85m to 11.91m										FR,PL,Ro Ca <1mm FR,PL,Ro Ca <1mm FR,PL,Ro Ca <1mm BD,UN,Ro Ca <1mm			
		- No recovery from 12.15m to 12.25m			3							FR,PL,SM Ca <1mm FR,PL,SM FR,PL,Ro			
		- Broken core from 12.21m to 12.28m										BD,PL,Ro Cl 5mm			
		- Broken core from 12.85m to 12.94m										FR,UN,Ro Cl <1mm			
13		- Broken core from 13.07m to 13.16m			4	100						FR,PL,Ro Ca <1mm			
		- Broken core from 13.58m to 13.95m										BD,CU,Ro Ca <1mm FR,UN,Ro			
14		- Fracture (25°) from 14.25m to 14.90m			5	100						FR,UN,Ro Ca <1mm JN,UN,Ro			
												FR,UN,Ro Ca <1mm FR,UN,Ro Ca <1mm FR,PL,Ro			
15		- No recovery from 14.93m to 15.12m			5										
				43.56	5	100									
		End of Drillhole		15.33											W.L. in open hole at Elev. 52.8m upon completion of drilling
16															
17															
18															
19															

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: CHM

CHECKED: SD/HD

OLRT-ROCK 1011210222-1300.GPJ GAL-MISS.GDT 10/18/11 JEM/JM

PROJECT: 10-1121-0222

RECORD OF BOREHOLE: W-017

SHEET 1 OF 1

LOCATION: N 5030453 15 ;E 365880 77

BORING DATE: June 14, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE BLOWS/0.3m (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-3} 10^{-5} 10^{-4} 10^{-2})	ADDITIONAL LAB TESTING	MON WELL
		GROUND SURFACE		58.02				SHEAR STRENGTH Cu, kPa (20 40 60 80); nat V + Q - ●; rem V ⊕ U - ○	WATER CONTENT PERCENT Wp — W — Wl (20 40 60 80)		
0	Power Auger 200mm Diam (Hollow Stem)	ASPHALTIC CONCRETE		0.00 / 57.79							Flush Mount Protective Casing set in Asphalt
		Very dense grey sand and gravel, some cobbles (Crushed Stone FILL)		0.23	1	50 DO	54				
1					2	50 DO	>50				
2											Bentonite Seal
					3	50 DO	>50				
3				54.97							
		Compact grey sand and gravel (Crushed Stone FILL)		3.05	4	50 DO	16				
4					5	50 DO	17				Silica Sand
					6	50 DO	68				32mm Diam PVC #10 Slot Screen
5				52.69							
		Compact dark grey brown sand, trace wood, organic matter, glass, metal and plastic fragments, with grey clayey silt pockets (WASTE)		5.33	7	50 DO	26				Silica Sand
6					8	50 DO	26				Cave
				51.17							
7		End of Borehole Auger Refusal		6.85							W L in Screen at Elev 52.7m on Aug 2 2011
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: HC

CHECKED: SD/HD

OLRT-SOIL 1011210222-1300.GPJ GAL-MIS.GDT 10/18/11 JEM/JM

PROJECT: 10-1121-0222

RECORD OF BOREHOLE: W-018

SHEET 1 OF 1

LOCATION: N 5030296 52 ;E 365785 63

BORING DATE: October 28, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V +, rem V ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-4} 10^{-2})	WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB TESTING
		GROUND SURFACE		63.53								
0	Power Auger 200mm Diam. (Hollow Stem)	Dark brown silty sand, some gravel and organic matter (TOPSOIL) 0.00m - 0.02m		0.00	1	50 DO	20					
		Compact brown and dark grey silty fine to coarse sand, some gravel (FILL)		62.70								
1		Loose brown to dark brown silty fine to coarse sand, some gravel, trace clay, ash, brick and boulders (FILL)		0.83	2	50 DO	>54					
					3	50 DO	5					
2		Loose to compact dark brown silty fine to coarse sand to sandy silt, some gravel, trace clay, brick, ash, wood, slag and mortar (FILL)		61.40 2.13	4	50 DO	27					
3					5	50 DO	5					
4					6	50 DO	4					
5					7	50 DO	6					
					8	50 DO	21					
6				57.43								
		Very loose to dense brown silty sand to sandy silt, with gravel layers, cobbles and boulders (FILL)		6.10	9	50 DO	>58					
7					10	50 DO	3					
					11	50 DO	31					
8				55.30								
		End of Borehole		8.23								
9												
10												

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: RI
CHECKED: HD

GLRT-SOIL 1011210222-1300.GPJ GAL-MIS.GDT 10/18/11 JEM/JM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-01

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 23, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		56.36							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Dark brown to black silty sand (FILL)		0.13	1	50 DO	22				
				55.95							
		Compact fine to medium brown silty sand, some gravel, trace brick (FILL)		0.41							
1					2	50 DO	51				
					3	50 DO	24				
				54.53							
		Gravel (FILL)		1.83							
2				54.23	4	50 DO	41				
		Dense medium to fine grey to brown sand, trace gravel and silt (FILL)		2.13							
				53.62	5	50 DO	>50				
		GRAVEL and COBBLES (GLACIAL TILL)		2.74							
3				53.44							
		End of Borehole Auger Refusal		2.92							
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-02

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: November 24, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		55.00							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Compact black silty sand, trace ash and clay, occasinal layers of medium brown sand and gravel (FILL)		0.15	1	50 DO	12				
					2	50 DO	35				
1		Compact medium to fine brown sand, some gravel, trace silt (FILL)		53.96 1.04	3	50 DO	17				
					4	50 DO	25				
2		Coarse brown sand, some gravel, trace silt and brick, occasional layers of gravel (FILL)		52.61 2.39	5	50 DO	38				
					6	50 DO	59				
3		Compact to dense coarse grey sand, some gravel, trace silt, with cobbles and boulders (FILL)		51.34 3.66	7	50 DO	24				
		COBBLES, BOULDERS, and GRAVEL (GLACIAL TILL)		50.78 4.22	C1	NQ RC	DD				
4					C2	NQ RC	DD				
		Very dense grey coarse SAND, some silt, some gravel (GLACIAL TILL)		49.82 5.18	8	50 DO	>50				
5		COBBLES, BOULDERS, and GRAVEL		49.23 5.77	C3	NQ RC	DD				
		Very dense grey coarse SAND and GRAVEL, trace cobbles		48.90 6.10	9	50 DO	78				
6				48.29							
		End of Borehole		6.71							
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: BM

CHECKED: JW

Golder Associates

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF DRILLHOLE: 11-02

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: November 24, 2011

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH	% RETURN	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.
		BEDROCK SURFACE		50.78																
5	Power Auger 200 mm Diam. (Hollow Stem)	COBBLES, BOULDERS, and GRAVEL (GLACIAL TILL)		4.22	C1															
					C2															
				49.82																
		Very dense grey coarse SAND, some silt, some gravel (GLACIAL TILL)		5.18																
				49.23																
6		COBBLES, BOULDERS, and GRAVEL		5.77	C3															
				48.90																
		Very dense grey coarse SAND and GRAVEL, trace cobbles		6.10																
				48.29																
		End of Borehole		6.71																
7																				
8																				
9																				
10																				
11																				
12																				
13																				
14																				

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate

BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage

PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular

PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE

1 : 50

LOGGED: BM

CHECKED: JW

Golder Associates

MIS-RCK 004 1111220199.GPJ GAL-MISS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-03

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 28, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		54.93							
0	Power Auger 200 mm Diam. (Hollow Stem)	Compact dark brown silty sand, trace gravel, organics (TOPSOIL)		0.00 / 54.75							
		Compact black silty sand, some gravel, ash, slag (FILL)		0.18 / 54.32	1	50 DO	10				
		Compact brown fine to medium sand, some gravel, some silt, brick (FILL)		0.61							
1		Compact to loose black silty sand, some gravel, ash, slag (FILL)		0.74 / 53.58	2	50 DO	14				
		Loose brown fine to coarse sand, some gravel, trace silt (FILL)		1.35 / 53.10	3	50 DO	9				
2		Compact brown medium to coarse sand, some gravel, some fine sand, trace silt (FILL)		1.83 / 52.49	4	50 DO	11				
		Loose dark brown SILTY SAND, some gravel, trace to some clay, organics		2.51	5	50 DO	38				
3		Dense to very dense grey brown to brown SILTY SAND, some gravel, with cobbles and boulders			6	50 DO	33				
					7	50 DO	>50				
4				50.36	8	50 DO	74				
		Very dense grey SILTY SAND, some gravel, cobbles, boulders (GLACIAL TILL)		4.57	9	50 DO	54				
5					10	50 DO	>50				
		End of Borehole Auger Refusal Possible Bedrock		49.24 / 5.69							
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-04

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 1, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		56.16							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Compact black silty sand, some gravel, trace brick, ash, slag, wood and glass (FILL)		0.15	1	50 DO	8				
					2	50 DO	16				
1					3	50 DO	10				
				54.33							
		Loose dark brown to red coarse sand, some gravel, trace brick, ash, silt and slag (FILL)		1.83	4	50 DO	5				
2											
				53.42	5	50 DO	3				
		Loose medium to fine orange sand, trace slag and silt (FILL)		2.74							
3				53.11							
		Very loose red coarse sand, trace silt (FILL)		3.05	6	50 DO	2				
				52.81							
		Very loose black crushed asphaltic concrete (FILL)		3.35							
				52.20	7	50 DO	2				
4		ORGANICS		3.96							
		Grey CLAY		4.11							
		Grey SILTY SAND, some gravel		4.27	8	50 DO	>50				
				51.59							
		Compact to dense grey to brown coarse SAND and GRAVEL, trace silt		4.57							
5					9	50 DO	49				
					10	50 DO	54				
6				49.96							
		Very dense SAND and GRAVEL, some cobbles, trace boulders (GLACIAL TILL)		6.20							
7											
					11	50 DO	112				
8					12	50 DO	>75				
					13	50 DO	58				
9											
					14	50 DO	27				
				46.46							
		End of Borehole Auger Refusal		9.70							
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-05

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 23, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		56.91							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Dark brown to black silty sand, some gravel, trace brick (FILL)		0.13	1	50 DO	24				
		Compact brown medium to fine sand, some silt, some gravel (FILL)		0.30							
		Dark brown to black silty sand, some gravel (FILL)		56.20 0.71 56.00	2	50 DO	15				
1		Loose to compact light brown fine sand, trace silt (FILL)		0.91	3	50 DO	7				
2				54.81	4	50 DO	24				
		Compact brown medium to fine SAND, trace silt, gravel		2.10	5	50 DO	21				
3					6	50 DO	>50				
		End of Borehole Auger Refusal Possible Boulder		53.46 3.45							
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-06

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 23, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp ⊖W WI) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		54.79							
0		Loose dark brown silty sand, trace gravel, organics (TOPSOIL)		0.00							
		Loose black silty sand, some gravel, ash, brick, clay (FILL)		0.13	1	50 DO	9				
				54.03							
1		Loose brown fine to medium sand, some gravel, trace silt (FILL)		0.76	2	50 DO	9				
				53.57							
		Loose black silty sand, some gravel, ash, organics (FILL)		1.22							
				53.27	3	50 DO	6				
		Loose brown SILTY SAND, some gravel		1.52							
2				52.66	4	50 DO	53				
		Very dense brown fine to coarse SAND, some gravel, some silt		2.13							
				52.33							
		End of Borehole Auger Refusal		2.46							
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-07

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 25 & 28, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		54.92							
0	Power Auger, 200 mm Diam. (Hollow Stem)	Compact dark brown silty sand, trace gravel, organics (TOPSOIL)		0.00 / 54.74							
		Compact black silty sand, some gravel, ash, slag, organics (FILL)		0.18	1	50 DO	12				
				54.01	2	50 DO	19				
1		Compact to loose brown fine to coarse sand, some gravel, trace silt, occasional brown silt pockets (FILL)		0.91	3	50 DO	6				
				53.09							
2		Loose dark brown silty sand, some gravel, trace to some clay, organics, wood, ash, with brown clayey silt layers (FILL)		1.83	4	50 DO	5				
				52.48							
		Loose dark grey silty clay to clayey silt, trace sand (FILL)		2.44							
				52.18	5	50 DO	8				
		Loose to very dense brown silty sand, some gravel (FILL)		2.74 / 2.89							
3		Very dense to dense grey to brown fine to coarse SAND, some gravel, trace to some silt, with brown medium to coarse sand, trace to some fine sand, trace silt layers, with cobbles and boulders			6	50 DO	94				
					7	50 DO	127				
4					8	50 DO	41				
					9	50 DO	50				
5					10	50 DO	51				
					11	50 DO	43				
6					12	50 DO	63				
					13	50 DO	63				
7					14	50 DO	46				
				46.38							
		Compact to dense brown medium to coarse SAND, some gravel, trace fine sand, trace silt		8.54	15	50 DO	>50				
8				45.95							
9		End of Borehole Auger Refusal Possible Bedrock		8.97							
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-08

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 30, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		54.29							
0	Power Auger 200 mm Diam. (Hollow Stem)	Loose dark brown silty sand and sandy silt, trace gravel, organics (TOPSOIL)		0.00							
				0.13	1	50 DO	8				
		Loose dark brown to black silty sand, some gravel, brick (FILL)		53.88							
				0.41							
		Loose brown silty sand to sandy silt, trace to some gravel (FILL)		53.68							
				0.61							
1		Compact brown fine to coarse sand, some gravel, trace to some silt, occasional silty sand seam (FILL)			2	50 DO	17				
					3	50 DO	16				
2					4	50 DO	15				
				51.85							
		Very loose black silty ORGANICS		2.44							
		Firm grey SILTY SAND, trace sand, trace gravel		2.59							
				2.74	5	50 DO	12				
3		Compact to very dense grey SILTY SAND, some gravel, with cobbles and boulders			6	50 DO	<100				
4					7	50 DO	59				
					8	50 DO	<100				
				49.77							
		End of Borehole Auger Refusal		4.52							
5											
6											
7											
8											
9											
10											

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: RI

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-09

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 23, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		56.83							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Dark brown to black silty sand (FILL)		0.13	1	50 DO	33				
		Compact dark brown silty sand (FILL)		0.30 / 56.22							
		Loose black silty sand, trace brick and glass (FILL)		0.61 / 55.84	2	50 DO	12				
1		Loose medium to fine brown sand, trace silt (FILL)		0.99	3	50 DO	9				
				54.95							
2		Compact medium to fine brown to grey sand, some silt and gravel, trace brick (FILL)		1.88	4	50 DO	39				
					5	50 DO	32				
3				53.78							
		Brown to grey SILTY SAND, trace gravel and clay		3.05 / 53.59	6	50 DO	>50				
		COBBLES and BOULDERS		3.24							
					7	50 DO	>60				
4				52.85							
		End of Borehole Auger Refusal		3.98							
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-10

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 23, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		54.76							
0	Power Auger 200 mm Diam. (Hollow Stem)	Loose dark brown sandy silt, trace gravel, organics (TOPSOIL)		0.00 54.58							
		Loose black silty sand, some gravel, ash, slag (FILL)		0.18	1	50 DO	8				
1					2	50 DO	8				
				53.59							
		Very loose brown fine to medium sand, trace to some silt, some gravel, with black silty sand, organic layers (FILL)		1.17	3	50 DO	4				
				52.93							
2		Compact to very dense brown SILTY SAND, some gravel		1.83	4	50 DO	11				
					5	50 DO	41				
3					6	50 DO	>50				
				51.33							
		End of Borehole Auger Refusal		3.43							
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: RI

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-11

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 24 & 25, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		54.84							
0	Power Auger 200 mm Diam. (Hollow Stem)	Compact dark brown silty sand, trace gravel, organics (TOPSOIL)		0.00							
		Compact black silty sand, some gravel, mortar, ash, slag (FILL)		0.08	1	50 DO	13				
				54.21							
		Compact brown fine to medium sand, trace gravel, trace silt, some coarse sand, occasional brown silt pocket, occasional black silty sand layer (FILL)		0.63							
1				53.90	2	50 DO	6				
		Compact brown fine to coarse sand, trace silt, trace to some gravel, occasional brown silt pocket (FILL)		0.94							
					3	50 DO	26				
				53.01							
2		Loose grey silty clay, trace gravel, trace sand, black staining, occasional grey silty sand layer (FILL)		1.83	4	50 DO	8				
				52.25							
		Loose dark brown to black silty ORGANICS		2.59	5	50 DO	6				
				2.74							
3		Loose grey brown SILTY CLAY and CLAYEY SILT, trace sand		2.82							
				51.79							
		Loose grey SILTY SAND, some gravel		3.05							
		Compact to very dense brown to grey fine to coarse SAND, trace to some gravel, trace to some silt			6	50 DO	28				
4					7	50 DO	40				
					8	50 DO	36				
5					9	50 DO	36				
				49.35							
		Compact to very dense brown medium to coarse SAND, some gravel, trace fine sand, trace silt, occasional fine to medium sand layer, with cobbles and boulders		5.49	10	50 DO	21				
6				48.59							
		Very dense fine to coarse grey and brown SAND, some gravel, trace to some silt, with cobbles and boulders (GLACIAL TILL)		6.25	11	50 DO	53				
				47.98							
		Very dense brown silty fine SAND, occasional grey silt seam (GLACIAL TILL)		6.86	12	50 DO	100				
7				7.01							
		Very dense grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)			13	50 DO	>50				
				47.07							
		End of Borehole Auger Refusal		7.77							
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-12

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 1, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		54.55							
0	Power Auger 200 mm Diam. (Hollow Stem)	Loose dark silty sand to sandy silt, trace gravel, organics (TOPSOIL)		0.00							
		Loose black silty sand to sandy silt, some gravel, ash, slag (FILL)		0.12 / 53.94	1	50 DO	8				
		Compact brown silty sand, some gravel (FILL)		0.61 / 53.33	2	50 DO	19				
1		Compact to loose brown fine to medium sand, trace to some silt, trace to some gravel (FILL)		1.22	3	50 DO	13				
					4	50 DO	8				
2				51.96							
		Very loose dark brown to black silty ORGANICS		2.59 / 2.74	5	50 DO	4				
		Very loose grey SILTY CLAY to CLAY SILT, trace sand		2.90							
3		Very loose to compact grey SILTY SAND, some gravel			6	50 DO	24				
					7	50 DO	>50				
4				50.28							
		Very dense grey brown SILTY fine to course SAND, some gravel, occasional fine to coarse sand pockets (GLACIAL TILL)		4.27	8	50 DO	66				
5					9	50 DO	>50				
				49.37							
		End of Borehole Auger Refusal		5.18							
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: RI

CHECKED: JW

Golder Associates

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-13

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 22, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		56.59							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Dark brown to black silty sand, trace gravel and brick (FILL)		0.15	1	50 DO	9				
					2	50 DO	17				
1				55.37							
		Loose to compact medium to fine brown sand, trace gravel and silt (FILL)		1.22	3	50 DO	4				
2					4	50 DO	14				
					5	50 DO	14				
3					6	50 DO	46				
				52.93							
		Dense coarse brown to black SAND and GRAVEL, trace cobbles and silt		3.66	7	50 DO	30				
4					8	50 DO	33				
					9	50 DO	55				
5					10	50 DO	50				
					11	50 DO	19				
6					12	50 DO	>80				
				49.63							
		Cobbles and boulders (GLACIAL TILL)		6.96							
7					13	50 DO	105				
				48.61	14	50 DO	>50				
8		End of Borehole Auger Refusal		7.98							
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-14

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 22 & 23, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		55.28							
0	Power Auger 200 mm Diam. (Hollow Stem)	Compact dark brown silty sand, some gravel, organics (TOPSOIL)		0.00 / 54.95	1	50 DO	26				
		Compact dark brown fine to medium sand, some gravel, asphalt pieces (FILL)		0.33 / 54.54							
1		Compact black to dark brown silty sand, some gravel, ash, coal (FILL)		0.74 / 54.06	2	50 DO	22				
		Compact brown fine to medium sand, some silt (FILL)		1.22 / 53.66	3	50 DO	13				
		Compact black silty sand, some gravel, ash (FILL)		1.62 / 53.45							
2		Compact dark brown sandy silt, some clay, trace to some gravel, organics, occasional brown fine to medium sand, occasional grey brown clayey silt to silty clay layers (FILL)		1.83 / 52.84	4	50 DO	14				
		Very loose to dense grey brown fine to medium SAND, some silt, trace gravel		2.44 / 51.93	5	50 DO	2				
3					6	50 DO	33				
		Dense to compact to very dense brown medium to coarse SAND, some gravel, trace fine sand, trace silt		3.35 / 50.40	7	50 DO	15				
4					8	50 DO	85				
5		Very dense grey fine to coarse sand, some gravel, some silt, with cobbles and boulders (GLACIAL TILL)		4.88 / 49.77	9	50 DO	102				
		End of Borehole Auger Refusal		5.51							
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-15

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 24, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		54.87							
0	Power Auger 200 mm Diam. (Hollow Stem)	Compact dark brown silty sand, trace gravel, organics (TOPSOIL)		0.05							
		Compact black silty sand, some gravel, ash (FILL)		54.54	1	50 DO	10				
		Compact to very loose brown fine to medium sand, some coarse sand, trace to some gravel, trace to some silt, occasional brown silt pockets, occasional cobble (FILL)		0.33	2	50 DO	14				
1				53.55							
		Very loose dark brown and black silty sand, trace gravel, trace clay, occasional grey silty clay to clayey silt layers (ORGANICS)		1.32	3	50 DO	4				
2					4	50 DO	4				
				52.43							
		Loose dark brown to black fine to medium SAND, some silt, some gravel, organics		2.44	5	50 DO	9				
3				51.82							
		Very dense to compact grey to brown SILTY SAND, some gravel, occasional cobble and boulder, with fine to medium sand, some gravel, some silt layers		3.05	6	50 DO	57				
					7	50 DO	14				
4					8	50 DO	>50				
				50.35							
		End of Borehole Auger Refusal		4.52							
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-16

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 28 & 29, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		54.61							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Compact black silty sand, some gravel, trace ash, brick, occasional layers of fine to medium brown sand and gravel (FILL)		0.15	1	50 DO	12				
1					2	50 DO	22				
				53.39							
		Very loose black coarse sand, some ash, gravel, trace silt and brick (FILL)		1.22	3	50 DO	5				
				52.78							
2		Very loose brown to grey coarse sand, trace silt and gravel (FILL)		1.83	4	50 DO	4				
					5	50 DO	5				
3				51.26	6	50 DO	19				
		Compact medium to fine grey SAND, trace silt, trace gravel		3.35							
					7	50 DO	18				
4					8	50 DO	12				
5											
					9	50 DO	12				
6					10	50 DO	>50				
				48.18							
		End of Borehole Auger Refusal		6.43							
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-17

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 21, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		56.66							
0	Power Auger 200 mm Diam. (Hollow Stem)	Compact dark grey crushed stone with organics (FILL)		0.00							
		Compact brown to dark brown silty sand, some gravel, trace clay, brick (FILL)		0.13 / 56.05	1	50 DO	17				
		Compact dark brown and black silty sand to sandy silt, some gravel, ash, brick (FILL)		0.61 / 55.67	2	50 DO	22				
1		Compact brown sand, some silt, some gravel, with grey brown silty clay layers (FILL)		0.99 / 54.98	3	50 DO	14				
		Loose to very loose grey brown SILTY CLAY, trace to some sand, trace gravel, occasional sand pockets		1.68	4	50 DO	7				
2					5	50 DO	4				
3				53.46							
		Very dense to loose brown SAND, trace to some silt, some gravel, occasional cobble and boulder, occasional coarse sand layers, occasional silty sand layers, occasional fine sand layers		3.20	6	50 DO	16				
4					7	50 DO	34				
					8	50 DO	46				
5					9	50 DO	26				
					10	50 DO	4				
6					11	50 DO	62				
					12	50 DO	27				
7					13	50 DO	104				
				48.89							
		Very dense grey SANDY SILT, some gravel, trace clay (GLACIAL TILL)		7.77	14	50 DO	>100				
8											
				48.07	15	50 DO	>70				
		End of Borehole Auger Refusal Possible Bedrock		8.59							
9											
10											

DEPTH SCALE

1 : 50

LOGGED: RI

CHECKED: JW

Golder Associates

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-18

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 22, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		56.83							
0	Power Auger 200 mm Diam. (Hollow Stem)	Compact dark brown silty sand, trace gravel, organics (TOPSOIL)		0.00							
		Compact dark brown to brown fine to medium sand, some gravel, some silt, ash, brick, with occasional brown clayey silt layers, some sand, trace gravel (FILL)		0.13	1	50 DO	18				
					2	50 DO	22				
1				55.69							
		Compact to dense dark brown to black fine to medium sand, some gravel, some silt, brick, ash, organics, occasional grey brown silty clay layers (FILL)		1.14	3	50 DO	11				
2					4	50 DO	>50				
				54.39							
		Compact grey fine to medium sand, some gravel, some silt, brick (FILL)		2.44							
		Compact black silty sand, some gravel, ash (FILL)		2.59	5	50 DO	16				
				53.93							
3		Compact brown fine to coarse sand, some gravel, trace silt (FILL)		2.90							
		Compact dark brown to black silty sand, some gravel, ash, coal (FILL)		3.05							
				53.48	6	50 DO	14				
		Compact grey brown SILTY CLAY to CLAYEY SILT, some sand, trace gravel, occasional fine to coarse sand layer		3.35							
4					7	50 DO	21				
				52.61							
		Loose brown sandy silt, some clay, trace to some gravel (FILL)		4.22							
		Loose black silty ORGANICS		52.41							
		Loose to dense brown fine to medium SAND, trace to some silt, trace gravel		4.42	8	50 DO	7				
				4.57							
5				51.65							
		Dense to loose brown medium to coarse SAND, trace gravel, trace silt, trace fine sand		5.18	9	50 DO	30				
					10	50 DO	6				
6				50.73							
		Very loose brown fine to medium SAND, trace silt		6.10	11	50 DO	4				
					12	50 DO	19				
7				49.51							
		Very loose to compact brown medium to coarse SAND, trace fine sand, trace silt, occasional fine to medium sand layer		7.32	13	50 DO	1				
8					14	50 DO	11				
				48.29							
		End of Borehole Auger Refusal		8.54							
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-19

SHEET 1 OF 3

LOCATION: See Site Plan

BORING DATE: November 25 & December 15, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		GROUND SURFACE		56.03							
	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Compact brown silty sand, some gravel, trace slag (FILL)		0.13 / 55.67	1	50 DO	11				
		Compact fine to medium brown sand, some gravel, trace silt (FILL)		0.36 / 55.47							
		Grey clay (FILL)		0.56							
1		Compact grey gravel, some sand, trace silt, slag, and brick (FILL)		0.69 / 54.71	2	50 DO	29				
		Black silty sand, trace brick (FILL)		1.32 / 54.51	3	50 DO	52				
		Grey to brown fine to medium sand, trace silt (FILL)		1.52 / 54.25							
		Grey to black clay (FILL)		1.78 / 54.05							
2		Compact brown coarse sand, some gravel and clay, trace silt and brick (FILL)		1.98 / 53.29	4	50 DO	20				
					5	50 DO	5				
		Grey to black CLAY		2.74							
3					6	50 DO	4				
					7	50 DO	4				
4				51.92							
		Grey to blue CLAY		4.11							
		Dark brown silty ORGANICS		4.27 / 51.15	8	50 DO	27				
5		Loose grey brown SAND and GRAVEL, trace silt		4.88	9	50 DO	9				
					10	50 DO	7				
6					11	50 DO	10				
				49.33							
		Loose, coarse to medium brown SAND, some silt		6.70	12	50 DO	6				
7				48.71							
		Loose medium to fine grey to brown SAND, trace silt		7.32 / 48.49	13	50 DO	>50				
		Coarse grey to brown SAND, some gravel, with cobbles and boulders		7.54 / 48.03							
8	Rotary Drill, NQ Core	Cobbles and boulders (GLACIAL TILL)		8.00	C1	NQ RC	DD				
9					C2	NQ RC	DD				
				46.50							
		Fresh, grey LIMESTONE BEDROCK		9.53	C3	NQ RC	DD				
10											

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-19

SHEET 2 OF 3

LOCATION: See Site Plan

BORING DATE: November 25 & December 15, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Rotary Drill NQ Core	Fresh, grey LIMESTONE BEDROCK			C3	NQ RC	DD				
11					C4	NQ RC	DD				
				44.17							
12		End of Borehole		11.86							
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF DRILLHOLE: 11-19

SHEET 3 OF 3

LOCATION: See Site Plan

DRILLING DATE: November 25 & December 15, 2011

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.
8	Rotary Drill NQ Core	BEDROCK SURFACE	48.03															
		Cobbles and boulders (GLACIAL TILL)	8.00	C1														
9				C2														
			46.50															
		Fresh, grey LIMESTONE BEDROCK	9.53	C3														
10																		
11				C4														
			44.17															
12		End of Drillhole	11.86															
13																		
14																		
15																		
16																		
17																		
18																		

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate

BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage

PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular

PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE

1 : 50

LOGGED: BM

CHECKED: JW

Golder Associates

MIS-RCK 004 1111220199.GPJ GAL-MISS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-20

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 28, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		54.88							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00 / 54.70							
		Compact dark brown to black silty sand, some gravel, trace ash and brick (FILL)		0.18	1	50 DO	28				
1					2	50 DO	24				
					3	50 DO	>50				
				53.30							
		End of Borehole Auger Refusal		1.58							
2											
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: BM

CHECKED: JW

Golder Associates

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-20A

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 1, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		GROUND SURFACE		54.88							
	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00 / 54.70							
		Compact dark brown to black silty sand, some gravel, trace ash and brick (FILL)		0.18							
1				53.66							
		Compact to dense brown to grey fine to medium sand, trace silt, some gravel, concrete, asphalt (FILL)		1.22	1	50 DO	21				
2				52.75	2	50 DO	35				
		Dense to loose dark brown with black silty sand, trace to some gravel, trace clay, ash, mica, organics, brick (FILL)		2.13	3	50 DO	9				
3				51.83							
		Compact grey brown clayey silt to silty clay, trace to some sand, trace gravel, wood, sheen, odours (FILL)		3.05 / 51.53	4	50 DO	10				
		Compact black fine to medium sand, trace silt, trac egravel, black staining, odours, sheens (ORGANICS)		3.35 / 51.22							
		Compact grey brown fine SAND, with fine to medium sand seams/layers, trace silt		3.66	5	50 DO	12				
4				50.46							
		Compact grey CLAYEY SILT, some silt		4.42	6	50 DO	14				
		Compact grey brown medium to coarse SAND, trace fine sand		4.57 / 50.00							
5		Loose to very dense grey to brown fine to medium SAND, trace to some coarse sand, trace silt		4.88	7	50 DO	7				
					8	50 DO	36				
6				48.55	9	50 DO	35				
		Very dense grey fine to coarse SAND, some gravel, trace silt		6.33 / 48.27							
		End of Borehole Auger Refusal		6.61							
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: RI

CHECKED: JW

Golder Associates

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-21

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 6, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		59.07							
0	Power Auger 200 mm Diam. (Hollow Stem)	Loose dark brown silty sand, organics (TOPSOIL)		0.00 / 58.71	1	50 DO	5				
		Compact dark brown silty sand, some gravel, brick, organics, ash (FILL)		0.36	2	50 DO	>50				
1					3	50 DO	18				
				57.24	4	50 DO	15				
2		Compact to very dense grey brown SILTY SAND, trace to some gravel		1.83	5	50 DO	54				
3					6	50 DO	35				
					7	50 DO	76				
				55.11							
4		Very dense grey brown SILTY SAND, trace to some gravel (GLACIAL TILL)		3.96	8	50 DO	>75				
					9	50 DO	>150				
5				53.89							
		Very dense grey SILTY SAND to SANDY SILT, trace to some gravel (GLACIAL TILL)		5.18	10	50 DO	>102				
					11	50 DO	>100				
6					12	50 DO	>85				
				52.62							
		End of Borehole Auger Refusal		6.45							
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: RI

CHECKED: JW

Golder Associates

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-22

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 7, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE		57.34			
0	Power Auger 200 mm Diam. (Hollow Stem)	Very loose dark brown silty sand, organics (TOPSOIL)		0.00			
		Very loose grey brown silty sand to sandy silt, trace to some gravel, trace clay, bricks, organics (FILL)		0.13	1	50 DO	3
1					2	50 DO	4
					3	50 DO	4
				55.51			
2		Loose grey brown silty clay, some sand, trace gravel (FILL)		1.83	4	50 DO	6
				54.60	5	50 DO	7
		Loose dark brown to black silty ORGANICS		2.74			
3		Loose to dense brown silty fine SAND, trace gravel, black staining (odours)		2.90	6	50 DO	48
				53.83			
		Dense to very dense grey brown SILTY SAND, trace to some gravel, trace clay, black staining (odours), occasional black fine to medium sand layer		3.51	7	50 DO	>80
4				53.27			
		Very dense grey brown silty sand to sandy silt, trace to some gravel, occasional fine to course sand layer (GLACIAL TILL)		4.07	8	50 DO	42
					9	50 DO	170
5					10	50 DO	>130
					11	50 DO	>160
				51.45			
6		End of Borehole Auger Refusal		5.89			
7							
8							
9							
10							

SOIL PROFILE

SAMPLES

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
20 40 60 80

SHEAR STRENGTH Cu, kPa
nat V. + Q - ●
rem V. ⊕ U - ○
20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s
10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT
Wp — W — Wl
20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE
1 : 50

LOGGED: RI

CHECKED: JW

Golder Associates

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-23

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 6, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		56.36							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Compact brown fine to medium sand, trace silt, gravel, clay, brick, ash and mortar (FILL)		0.15	1	50 DO	13				
1					2	50 DO	11				
					3	50 DO	15				
2					4	50 DO	46				
		Compact gravel layer (FILL)		54.23 2.13							
		Compact light brown to grey fine to medium sand, some gravel, trace brick, ash and mortar (FILL)		2.29	5	50 DO	18				
3				53.31							
		Loose layers of brick, brown silty sand, mortar, ash, fine to medium dark brown sand, and concrete, construction debris (FILL)		3.05	6	50 DO	6				
				52.75							
4		Loose black silty sand, trace ash, slag, occasional layers of medium brown sand, gravel, brick, clay (FILL)		3.61	7	50 DO	7				
				52.09							
		Compact dark grey SILTY CLAY, trace gravel, trace brick		4.27	8	50 DO	32				
5				51.46							
		End of Borehole Auger Refusal		4.90							
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-24

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 5 & 6, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		59.48							
0	Power Auger 200 mm Diam. (Hollow Stem)	Very loose dark brown silty sand, trace clay, organics (TOPSOIL)		0.00							
		Very loose to very dense dark brown silty sand, trace clay, trace gravel, brick, concrete, mortar, ash, metal, slag, concrete slab, grey crushed stone (FILL)		0.10	1	50 DO	4				
1					2	50 DO	8				
					3	50 DO	4				
2				57.35	4	50 DO	53				
		Very dense to dense brown grey SILTY SAND, some gravel, ashes on top of layer		2.13	5	50 DO	34				
3				56.43							
		Dense to very dense grey SILTY SAND, trace to some gravel, black staining (strong odours) (GLACIAL TILL)		3.05	6	50 DO	43				
					7	50 DO	>70				
4					8	50 DO	175				
				54.60							
		Very dense grey SILTY SAND to SANDY SILT, trace to some gravel, odours (GLACIAL TILL)		4.88	9	50 DO	>150				
5					10	50 DO	180				
					11	50 DO	>150				
6					12	50 DO	>100				
					13	50 DO	>50				
7				51.86							
		Very dense grey SILTY SAND to SANDY SILT, trace to some gravel, slight odours (GLACIAL TILL)		7.62	14	50 DO	>100				
8					15	50 DO	134				
					16	50 DO	125				
9					17	50 DO	>100				
					18	50 DO	>50				
10				49.37							
		End of Borehole Auger Refusal		10.11							
11											

DEPTH SCALE

1 : 55

LOGGED: RI

CHECKED: JW

Golder Associates

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-25

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 7, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		57.24							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Loose to compact brown fine to medium sand, trace silt, gravel, ash, brick and mortar (FILL)		0.15	1	50 DO	7				
1					2	50 DO	9				
				55.72	3	50 DO	14				
		Compact grey clay (FILL)		1.52							
		Compact dark brown to black silty sand (FILL)		1.68	4	50 DO	40				
2				54.80							
		Compact brown fine to medium sand, trace gravel, trace concrete (FILL)		2.44	5	50 DO	14				
				54.50							
		Compact dark brown to black silty sand, some mica fragments (FILL)		2.74							
3				53.89	6	50 DO	8				
		Compact to dense grey fine to medium SAND, some gravel, trace silt (GLACIAL TILL)		3.35	7	50 DO	>50				
4					8	50 DO	68				
					9	50 DO	>50				
5				52.01							
		End of Borehole Auger Refusal		5.23							
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-26

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 6, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		55.78							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Loose grey clay, some sand (FILL)		0.13 / 55.32	1	50 DO	9				
		Compact dark brown silty sand, some gravel, trace ash, brick and mortar, occasional layers of fine to coarse sand (FILL)		0.46	2	50 DO	38				
1					3	50 DO	25				
2					4	50 DO	14				
				53.04	5	50 DO	8				
		Very loose black silty sand, trace ash, brick, wood and gravel, occasional layers of fine sand (FILL)		2.74							
3					6	50 DO	4				
					7	50 DO	9				
4				51.51							
		Very dense grey brown fine to medium SAND, some silt and gravel (GLACIAL TILL)		4.27	8	50 DO	110				
				50.78	9	50 DO	>75				
5		End of Borehole Auger Refusal		5.00							
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-28

SHEET 1 OF 3

LOCATION: See Site Plan

BORING DATE: December 8, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		57.59							
0	Power Auger 200 mm Diam. (Hollow Stem)	Very loose brown medium to fine sand (FILL)		0.00 / 57.13	1	50 DO	2				
		Compact black silty sand, some gravel, trace ash (FILL)		0.46 / 56.37	2	50 DO	17				
1		Loose to compact brown medium to fine SAND, some gravel, trace silt and brick		1.22 / 54.85	3	50 DO	13				
					4	50 DO	5				
2		Very dense brown to grey fine to medium SAND, trace gravel and silt (GLACIAL TILL)		2.74	5	50 DO	70				
					6	50 DO	>50				
3					7	50 DO	112				
					8	50 DO	119				
4					9	50 DO	>60				
					10	50 DO	108				
5					11	50 DO	>100				
					12	50 DO	>90				
6		Compact grey SILTY CLAY, some sand, trace gravel (GLACIAL TILL)		7.62 / 49.97	13	50 DO	80				
					14	50 DO	42				
7	Rotary Drill NQ Core	Grey CLAYEY SILT, some sand, trace gravel, with cobbles and boulders (GLACIAL TILL)		8.84 / 48.75	C1	NQ RC	DD				
		Fresh, medium bedded, grey LIMESTONE BEDROCK, with thin beds of black shale		9.53 / 48.06	C2	NQ RC	DD				
8											
9											
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-28

SHEET 2 OF 3

LOCATION: See Site Plan

BORING DATE: December 8, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Rotary Drill / NQ Core	Fresh, medium bedded, grey LIMESTONE BEDROCK, with thin beds of black shale			C2	NQ RC	DD				
11					C3	NQ RC	DD				
				45.90							
		End of Borehole Auger Refusal		11.69							
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF DRILLHOLE: 11-28

SHEET 3 OF 3

LOCATION: See Site Plan

DRILLING DATE: December 8, 2011

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.
		BEDROCK SURFACE		48.75															
9	Rotary Drill / NQ Core	Grey CLAYEY SILT, some sand, trace gravel, with cobbles and boulders (GLACIAL TILL)		8.84	C1														
				48.06															
		Fresh, medium bedded, grey LIMESTONE BEDROCK, with thin beds of black shale		9.53	C2														
10																			
11					C3														
				45.90															
		End of Drillhole		11.69															
12																			
13																			
14																			
15																			
16																			
17																			
18																			

DEPTH SCALE

1 : 50

LOGGED: BM

CHECKED: JW

Golder Associates

MIS-RCK 004 1111220199.GPJ GAL-MISS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-29

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 5, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		55.66							
0	Power Auger 200 mm Diam. (Hollow Stem)	ORGANICS/TOPSOIL		0.00							
		Compact brown fine to medium sand, trace silt, gravel and ash (FILL)		0.15 55.05	1	50 DO	11				
1		Loose to compact dark brown to black silty sand, trace ash and gravel (FILL)		0.61	2	50 DO	11				
					3	50 DO	3				
				53.98							
2		Loose to very loose brown fine to medium SAND		1.68 53.37	4	50 DO	5				
		Compact dark brown to black SILTY SAND, trace gravel and clay		2.29	5	50 DO	14				
3				52.61							
		Loose dark brown SAND and GRAVEL		3.05 52.05	6	50 DO	6				
		Compact dark grey to grey SILTY SAND, trace gravel		3.61	7	50 DO	28				
4					8	50 DO	49				
				50.78							
5		Dense dark grey to grey SILTY SAND, trace gravel (GLACIAL TILL)		4.88	9	50 DO	90				
					10	50 DO	42				
6				49.49							
		End of Borehole Auger Refusal		6.17							
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: BM

CHECKED: JW

Golder Associates

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-31

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 2, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		58.81							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00 / 58.61							
		Compact fine to medium light brown sand, trace silt (FILL)		0.20 / 58.20	1	50 DO	12				
1		Loose dark brown silty sand, trace gravel, ash and brick (FILL)		0.61 / 57.64	2	50 DO	7				
		Very loose construction debris made up of layers of brick, ash, slag, mortar, insulation, and wood (FILL)		1.17 / 56.37	3	50 DO	2				
2					4	50 DO	9				
		Compact light brown to grey fine to medium SAND, trace silt and gravel		2.44 / 55.15	5	50 DO	15				
3					6	50 DO	42				
		Dense to very dense grey brown fine to medium SAND, trace silt and gravel (GLACIAL TILL)		3.66 / 53.32	7	50 DO	75				
4					8	50 DO	65				
5					9	50 DO	84				
		Very dense grey fine to coarse SAND, some silt, trace gravel (GLACIAL TILL)		5.49 / 52.18	10	50 DO	97				
6					11	50 DO	69				
		End of Borehole Auger Refusal		6.63							
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-32

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 5, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		56.18							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		Loose brown silty sand, some gravel (FILL)		0.15 / 55.57	1	50 DO	8				
1		Loose to compact brown fine to medium sand, some gravel, trace brick, mortar and slag (FILL)		0.61	2	50 DO	9				
					3	50 DO	20				
2					4	50 DO	4				
		Loose brown to black fine to medium silty sand, occasional wood, brick, mortar, ceramic, trace clay (FILL)		53.74 / 2.44	5	50 DO	4				
3					6	50 DO	8				
		Compact grey SANDY SILT, trace gravel and clay		52.83 / 3.35	7	50 DO	42				
4					8	50 DO	34				
		Dense grey SANDY SILT, trace gravel and clay (GLACIAL TILL)		51.30 / 4.88	9	50 DO	>50				
5					10	50 DO	63				
6		End of Borehole		50.21 / 5.97							
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-33

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 8, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		62.22							
0	Power Auger 200 mm Diam. (Hollow Stem)	Dense dark grey crushed stone (Gravel lot BASE)		0.08	1	50 DO	46				
		Dense brown fine to medium sand, some coarse sand, some gravel, trace silt (Gravel lot SUBBASE)		61.69							
		Loose to very dense dark brown silty sand, trace to some gravel, brick, wood, organics, concrete, occasional grey silty clay layer (FILL)		0.53	2	50 DO	9				
1					3	50 DO	60				
					4	50 DO	12				
2					5	50 DO	56				
				59.32							
		Compact to very dense brown to grey brown SILTY SAND to SANDY SILT, trace to some gravel (GLACIAL TILL)		2.90	6	50 DO	23				
3					7	50 DO	48				
					8	50 DO	74				
4					9	50 DO	49				
					10	50 DO	55				
5					11	50 DO	>89				
					12	50 DO	>100				
6					13	50 DO	>100				
					14	50 DO	>100				
7				54.60							
		Very dense grey brown SILTY SAND, trace to some gravel, occasional grey silt seam, occasional fine to medium sand seam (GLACIAL TILL)		7.62	15	50 DO	>111				
8					16	50 DO	>105				
					17	50 DO	>50				
9					18	50 DO	>100				
					19	50 DO	>50				
				52.26	20	50 DO	>110				
10		End of Borehole Split Spoon Refusal		9.96							
11											

DEPTH SCALE

1 : 55

Golder Associates

LOGGED: RI

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-35

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 12, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		62.56							
0	Power Auger 200 mm Diam. (Hollow Stem)	Dense grey sand and gravel (Gravel lot BASE)		0.00 / 62.25	1	50 DO	52				
		Compact brown medium to fine sand, trace gravel (Gravel lot SUBBASE)		0.31 / 61.65	2	50 DO	17				
1		Compact dark brown to black silty sand, trace gravel, ash, wood, brick, mortar (FILL)		0.91 / 60.88	3	50 DO	19				
		Compact brown fine to medium sand, trace gravel (FILL)		1.68 / 60.43	4	50 DO	24				
2		Dense to very dense light brown to brown SILTY SAND, occasional gravel and medium sand layers, trace gravel (GLACIAL TILL)		2.13 / 58.16	5	50 DO	45				
					6	50 DO	65				
3					7	50 DO	176				
4					8	50 DO	>50				
		End of Borehole Auger Refusal		4.40							
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-37

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 12, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		62.76							
0	Power Auger 200 mm Diam. (Hollow Stem)	Compact sand and gravel (Gravel lot BASE)		0.00 / 62.46	1	50 DO	29				
		Compact brown medium to fine sand, trace gravel (Gravel lot SUBBASE)		0.30 / 61.85	2	50 DO	20				
1		Loose dark brown to black silty sand, trace gravel, occasional layers of ash, gravel, sandy mortar, glass, construction debris (FILL)		0.91	3	50 DO	6				
2				60.63	4	50 DO	34				
		Compact brown medium to fine sand, trace gravel (FILL)		2.13 / 60.32							
		Dense to very dense grey brown SILTY SAND, some gravel, trace cobbles (GLACIAL TILL)		2.44	5	50 DO	73				
3					6	50 DO	>75				
4					7	50 DO	>65				
					8	50 DO	>75				
5					9	50 DO	40				
6				56.23	10	50 DO	>50				
		End of Borehole Auger Refusal		6.53							
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-38

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 19, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		62.11							
0	Power Auger 200 mm Diam. (Hollow Stem)	Compact to dense brown sand and gravel (Gravel lot BASE)		0.00							
		Loose to compact brown medium to fine sand, some gravel (Gravel lot SUBBASE)		0.10	1	50 DO	35				
1					2	50 DO	8				
				60.89							
		Compact to very dense grey brown sand, some gravel, trace silt (FILL)		1.22	3	50 DO	15				
2					4	50 DO	52				
				59.67							
		Very dense grey brown SILTY SAND, some gravel, medium brown sand seams (GLACIAL TILL)		2.44	5	50 DO	61				
3					6	50 DO	112				
					7	50 DO	148				
4				57.94							
		End of Borehole Auger Refusal		4.17							
5											
6											
7											
8											
9											
10											

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: JDR

CHECKED: JW

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-39

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 15, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		62.81							
0	Power Auger 200 mm Diam. (Hollow Stem)	Compact sand and gravel (Gravel lot BASE)		0.00							
		Compact brown to red sandy silt, trace gravel (FILL)		0.15	1	50 DO	15				
				61.90	2	50 DO	20				
1		Compact to dense light brown fine to medium sand, trace gravel, silt, and mortar (FILL)		0.91	3	50 DO	40				
2				60.68	4	50 DO	120				
		Dense sandy gravel to brown fine to medium sand and gravel (FILL)		2.13	5	50 DO	67				
3					6	50 DO	99				
				59.15							
		Compact to very dense grey SILTY SAND, some gravel (GLACIAL TILL)		3.66	7	50 DO	34				
4					8	50 DO	27				
5					9	50 DO	33				
					10	50 DO	>50				
6					11	50 DO	>100				
				56.46	12	50 DO	>100				
		End of Borehole Auger Refusal		6.35							
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: BM/JD

CHECKED: JW

Golder Associates

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1122-0199

RECORD OF BOREHOLE: 11-40

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 16, 2011

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		62.77							
0	Power Auger 200 mm Diam. (Hollow Stem)	Compact red to fine brown sand, some gravel (Gravel lot BASE)		0.00	1	50 DO	13				
				62.39							
		Compact fine to medium brown sand, some gravel, red brick (FILL)		0.38	2	50 DO	19				
1				61.55							
		Compact light brown fine to medium sand, trace gravel, silt, red brick (FILL)		1.22	3	50 DO	15				
					4	50 DO	25				
2					5	50 DO	51				
				59.78							
		Very dense grey brown SAND, some gravel, trace silt (GLACIAL TILL)		2.99	6	50 DO	59				
3				59.11							
		Very dense grey brown SILTY SAND, some gravel (GLACIAL TILL)		3.66	7	50 DO	100				
					8	50 DO	>50				
4					9	50 DO	>100				
					10	50 DO	187				
5					11	50 DO	>50				
				56.52							
6		End of Borehole Auger Refusal		6.25							
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: JD

CHECKED: JW

Golder Associates

MIS-BHS 001 1111220199.GPJ GAL-MIS.GDT 1/28/13 JEM

PROJECT: 11-1121-0229

RECORD OF BOREHOLE: 13-1

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: March 8, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}) / WATER CONTENT PERCENT (Wp W Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		58.72							MON. WELL
0	Power Auger 200 mm Diam. (Hollow Stem)	(SP/GP) SAND and GRAVEL, crushed, inferred presence of cobbles and/or boulders; grey, (FILL); non-cohesive, moist, compact		0.00							Silica Sand
1					1	SS	28				
				57.35							
		(SM) SILTY SAND, some gravel; grey brown; non-cohesive, moist, compact		1.37							
2					2	SS	12				
					3	SS	30		○	MH	Native Backfill and Bentonite Mix
3				55.67							
		(SM) SILTY SAND, some gravel to gravelly, inferred presence of cobbles and/or boulders; grey brown, (GLACIAL TILL); non-cohesive, moist, dense to very dense		3.05	4	SS	55		○	MH	
4											
					5	SS	>50				Bentonite Seal
5											
6					6	SS	>50				Silica Sand
7	RD NQ				C1	NQ RC	DD				32 mm Diam. PVC #10 Slot Screen
				50.75							
8		Borehole continued on RECORD OF DRILLHOLE 13-1									
9											
10											

DEPTH SCALE

1 : 50

LOGGED: HEC

CHECKED: MJK

Golder Associates

MIS-BHS 001 1111210229-1000.GPJ GAL-MIS.GDT 06/07/13 PLG

PROJECT: 11-1121-0229

RECORD OF BOREHOLE: 13-5

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: March 13, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		55.39							
0	Power Auger 200 mm Diam. (Hollow Stem)	(SM) SILTY SAND, trace gravel; brown, (TOPSOIL); non-cohesive, moist		0.00							
		(SP/GP) SILTY SAND and GRAVEL, crushed; grey, (FILL); non-cohesive, moist, dense to loose		0.15	1	SS	12				
1					2	SS	54		○	M	
2					3	SS	13				
					4	SS	9				
				52.49							
3		(SM) SILTY SAND, fine; grey brown, (FILL); non-cohesive, moist, very loose		2.90							
				52.19							
		(OL) ORGANIC SILT; dark brown; non-cohesvie, moist, very loose		3.20	5	SS	3		○	OC = 24.0%	
				51.86							
		LIMESTONE		3.53							
		Borehole continued on RECORD OF DRILLHOLE 13-5									
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: HEC

CHECKED: MJK

MIS-BHS 001 1111210229-1000.GPJ GAL-MIS.GDT 06/07/13 PLG

PROJECT: 11-1121-0229

RECORD OF BOREHOLE: 13-6

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: March 14, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}) / WATER CONTENT PERCENT (Wp W Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		55.70							MON. WELL
0	Power Auger 200 mm Diam. (Hollow Stem)	ASPHALTIC CONCRETE		0.00							
		(SP/GP) SAND and GRAVEL, crushed; grey, (FILL); non-cohesive, moist, compact to dense		0.08	1	SS	20				
1					2	SS	45				
				54.33							
		(CI) SILTY CLAY; grey brown, (FILL); cohesive, moist, very stiff		1.37							Bentonite Seal
		(SM) SILTY SAND and GRAVEL; grey brown, contains orange brick fragments, (FILL); non-cohesive, moist, loose to compact		1.52	3	SS	9				
2					4	SS	9		○	M	
3					5	SS	14				Silica Sand
				52.04							
		(SM) SILTY SAND, some gravel; grey brown, (FILL); non-cohesive, wet, compact		3.66	6	SS	20				32 mm Diam. PVC #10 Slot Screen
4											
				51.05							
		(OL) ORGANIC SILT, dark brown; non-cohesive, most, loose		4.65	7	SS	>50		○	OC = 16.2%	
		LIMESTONE		4.80							
5		Borehole continued on RECORD OF DRILLHOLE 13-6									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: HEC

CHECKED: MJK

Golder Associates

MIS-BHS 001 1111210229-1000.GPJ GAL-MIS.GDT 06/07/13 PLG

PROJECT: 11-1121-0229

RECORD OF BOREHOLE: 13-7

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: March 11, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		55.71							
0	Power Auger 200 mm Diam. (Hollow Stem)	(SP/GP) SAND and GRAVEL, crushed; grey, (FILL); non-cohesive, moist, compact		0.00	1	GRAB					
1					2	SS	32				
2					3	SS	20		○		
				53.58							
		(SM) SILTY SAND; grey brown, contains fly ash and orange brick fragments, (FILL); non-cohesive, moist, loose to compact		2.13	4	SS	10		○		
3					5	SS	7				
				52.05							
		(SM) SILTY SAND, some gravel, inferred presence of cobbles and/or boulders; brown, (GLACIAL TILL); non-cohesive, moist to wet, compact		3.66							
4					6	SS	20		○		
					7	SS	>50				
5				50.21							
		Borehole continued on RECORD OF DRILLHOLE 13-7									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: HEC

CHECKED: MJK

MIS-BHS 001 1111210229-1000.GPJ GAL-MIS.GDT 06/12/13 PLG

PROJECT: 11-1121-0229

RECORD OF DRILLHOLE: 13-7

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: March 11, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Downing Drilling

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate
BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage
PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular
PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	DISCONTINUITY DATA: Jr	DISCONTINUITY DATA: Ja	DISCONTINUITY DATA: Jn	ROCK STRENGTH INDEX: R4	ROCK STRENGTH INDEX: R3	ROCK STRENGTH INDEX: R2	ROCK STRENGTH INDEX: R1	WEATHERING INDEX: W1	WEATHERING INDEX: W2	WEATHERING INDEX: W3	WEATHERING INDEX: W4	Q AVG.	
		BEDROCK SURFACE		50.21																						
	Rotary Drill / NQ Core	Fresh thinly to medium bedded grey fine to coarse grained non-porous strong nodular LIMESTONE, with black shale partings and interlaminates		5.50	1	100							,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
6													,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
		- Broken core from 6.13 m to 6.18 m											,BD,PL,Ro	1.5	1											
													,BD,IR,Ro	3	1											
		- Broken core from 6.34 m to 6.39 m											,BD,PL,Ro	1.5	1											
					2	100							,BD,PL,Ro	1.5	1											
		- Broken core from 6.78 m to 6.84 m											,BD,PL,SM	1	1											
7													,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
																										UCS = 75.9 MPa
													,BD,PL,Ro	1.5	1											
8					3	100							,BD,PL,Ro	1.5	1											
													,BD,PL,SM	1	1											
													,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
													,BD,CU,Ro	1.5	1											
9													,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
													,BD,CU,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
					4	100							,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
10													,,,													
					5	100							,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
					6	100							,BD,PL,Ro	1.5	1											
11		- Mud seam and vertical fracture from 10.98 m to 11.23 m		44.48									,BD,IR,Ro	3	1											
		End of Drillhole		11.23																						
12																										
13																										
14																										
15																										

DEPTH SCALE

1 : 50

LOGGED: HEC

CHECKED: MJK

Golder Associates

MIS-RCK 004 1111210229-1000.GPJ GAL-MISS.GDT 06/07/13 PLG

PROJECT: 11-1121-0229

RECORD OF BOREHOLE: 13-8

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: March 5, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		55.95							MON. WELL
0	Power Auger 200 mm Diam. (Hollow Stem)	ASPHALTIC CONCRETE		0.00 / 55.75							
		(SP/GP) SAND and GRAVEL, crushed; grey, (BASE); non-cohesive		0.20 / 55.57							
		(SP/GP) SAND and GRAVEL; brown, (FILL); non-cohesive		0.38 / 55.19							
1		(SM) SILTY SAND, some gravel, inferred presence of cobbles and/or boulders; grey, contains asphalt fragments, (FILL); non-cohesive, moist, compact		0.76	1	SS	>50				
					2	SS	18		○		
2											
					3	SS	11				
3				52.75							
		(Cl) SILTY CLAY; grey brown; cohesive, moist, stiff to very stiff		3.20	4	SS	7		⊕—|		
				52.14							Bentonite Seal
4		(SM) SILTY SAND, some gravel to gravelly, inferred presence of cobbles and/or boulders; grey, (GLACIAL TILL); non-cohesive, moist, dense to very dense		3.81	5	SS	32		○	MH	
					6	SS	33				
				51.01							
5		Borehole continued on RECORD OF DRILLHOLE 13-8									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: HEC

CHECKED: MJK

MIS-BHS 001 1111210229-1000.GPJ GAL-MIS.GDT 06/07/13 PLG

PROJECT: 11-1121-0229

RECORD OF DRILLHOLE: 13-8

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: March 5, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Downing Drilling

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate
BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage
PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular
PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	ROCK STRENGTH INDEX: R4	R3	R2	R1	WEATH-ERING INDEX: W1	W2	W3	W4	Q AVG.	
		BEDROCK SURFACE		51.01																						MON. WELL
5	Rotary Drill NQ Core	Fresh thinly to medium bedded grey fine to coarse grained non-porous strong to very strong nodular LIMESTONE, with black shale partings and interlaminates		4.94	1	0							,BD,CU,SM	1	1											
													,BD,CU,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
													,BD,PL,SM	1	1											
					2	0							,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
6													,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
													,BD,CU,SM	1	1											
													,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
7		- Mud seam from 7.11 m to 7.12 m			3	0							,BD,PL,Ro	1.5	2											
													,BD,PL,Ro	1.5	1											
													,BD,PL,SM	1	1											
8													,BD,PL,Ro	1.5	1											
													,BD,ST,Ro	3	1											
					4	0							,BD,PL,Ro	1.5	1											
9													,BD,PL,Ro	1.5	1											
													,BD,PL,SM	1	1											
													,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
													,BD,IR,Ro	3	1											
10													,BD,IR,Ro	3	1											
													,BD,PL,Ro	1.5	1											
					5	0							,BD,PL,Ro	1.5	1											
													,BD,PL,Ro	1.5	1											
11				44.80																						
		End of Drillhole		11.15																						
12																										
13																										
14																										

Bentonite Seal

Silica Sand

32 mm Diam. PVC #10 Slot Screen

UCS = 127.9 MPa

Bentonite Seal

W.L. in Screen at Elev. 49.24 m on March 25, 2013

DEPTH SCALE

1 : 50

LOGGED: HEC

CHECKED: MJK

Golder Associates

MIS-RCK 004 1111210229-1000.GPJ GAL-MISS.GDT 06/07/13 PLG

PROJECT: 12-1122-0198/8000/8100

RECORD OF BOREHOLE: MW 13-01

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 28, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		55.09							
0	Power Auger (Hollow Stem) 200 mm Diam. / Air Rotary Drill 100 mm Diam. (DHH)	Grey LIMESTONE BEDROCK		0.00							
1											
2											Bentonite Seal
3											
4											
5											Silica Sand
6											
7											51 mm Diam. PVC #10 Slot Screen
8				46.91							
		End of Drillhole		8.18							
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: KPH

MIS-BHS 001 1211220198-8000-8100.GPJ GAL-MIS.GDT 06/10/14 JEM

PROJECT: 12-1122-0198/8000/8100

RECORD OF BOREHOLE: MW 13-02

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 28, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		55.12							
0	Power Auger (Hollow Stem) 200 mm Diam.	Grey LIMESTONE BEDROCK		0.00							
1											Bentonite Seal
2											
3											Silica Sand
4	Air Rotary Drill 100 mm Diam. (DHH)										
5											51 mm Diam. PVC #10 Slot Screen
6											
7											Silica Sand Bentonite Seal
				47.37							
		End of Drillhole		7.75							
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: KPH

MIS-BHS 001 1211220198-8000-8100.GPJ GAL-MIS.GDT 06/10/14 JEM

PROJECT: 12-1122-0198/8000/8100

RECORD OF BOREHOLE: MW 13-03

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 28, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		53.67							
0	Power Auger (Hollow Stem) 200 mm Diam.	Grey LIMESTONE BEDROCK		0.00							
1											
2											Bentonite Seal
3											
4	Air Rotary Drill 100 mm Diam. (DHH)										Silica Sand
5											
6											51 mm Diam. PVC #10 Slot Screen
7				46.02							
		End of Drillhole		7.65							
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: KPH

MIS-BHS 001 1211220198-8000-8100.GPJ GAL-MIS.GDT 06/10/14 JEM

PROJECT: 12-1122-0198/8000/8100

RECORD OF BOREHOLE: MW 13-04

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 27, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger (Hollow Stem) 200 mm Diam.	GROUND SURFACE		54.62							
		Grey LIMESTONE BEDROCK		0.00							
1											Bentonite Seal
2											
3											Silica Sand
4	Air Rotary Drill 100 mm Diam. (DHH)										51 mm Diam. PVC #10 Slot Screen
5											
6											
7											Silica Sand
8				46.49							Bentonite Seal
		End of Drillhole		8.13							
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: KPH

MIS-BHS 001 1211220198-8000-8100.GPJ GAL-MIS.GDT 06/10/14 JEM

PROJECT: 12-1122-0198/8000/8100

RECORD OF BOREHOLE: MW 13-05

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 27, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		53.25							
0	Power Auger (Hollow Stem) 200 mm Diam. / Air Rotary Drill 100 mm Diam. (DHH)	Grey LIMESTONE BEDROCK		0.00							Bentonite Seal
1											
											Silica Sand
2											
3											
											51 mm Diam. PVC #10 Slot Screen
4											
5											Silica Sand
6											
											Bentonite Seal
7											
8				45.12							
		End of Drillhole		8.13							
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: KPH

MIS-BHS 001 1211220198-8000-8100.GPJ GAL-MIS.GDT 06/10/14 JEM

PROJECT: 12-1122-0198/8000/8100

RECORD OF BOREHOLE: MW 13-06

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 27, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		52.13							
0	Power Auger (Hollow Stem) 200 mm Diam. / Air Rotary Drill 100 mm Diam. (DHH)	Grey LIMESTONE BEDROCK		0.00							
1											Bentonite Seal
2											Silica Sand
3											
4											51 mm Diam. PVC #10 Slot Screen
5											Silica Sand
6											
7											Bentonite Seal
8				44.08							
		End of Drillhole		8.05							
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: KPH

MIS-BHS 001 1211220198-8000-8100.GPJ GAL-MIS.GDT 06/10/14 JEM

PROJECT: 12-1122-0198/8000/8100

RECORD OF BOREHOLE: MW 13-08

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: March 28, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		51.82							
0	Power Auger 200 mm Diam. (Hollow Stem)	Brown fine to medium sand (Placed FILL)		0.00							
				51.52							
		Grey LIMESTONE BEDROCK		0.30							
1											
2											Bentonite Seal
3											
4	Air Rotary Drill 100 mm Diam. (DHH)										
5											Silica Sand
6											
7											51 mm Diam. PVC #10 Slot Screen
8				43.77							
		End of Drillhole		8.05							
9											
10											

DEPTH SCALE

1 : 50

LOGGED: RI

CHECKED: KPH

Golder Associates

MIS-BHS 001 1211220198-8000-8100.GPJ GAL-MIS.GDT 06/10/14 JEM

PROJECT: 12-1122-0198/8000/8100

RECORD OF BOREHOLE: MW 13-10

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: August 15, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		52.86							
0	Power Auger (Hollow Stem) 200 mm Diam. / Air Rotary Drill 100 mm Diam. (DHH)	Grey LIMESTONE BEDROCK		0.00							Concrete
1											
2											Bentonite Seal
3											
4											
5											Silica Sand
6											
7											51 mm Diam. PVC #10 Slot Screen
8				44.73							
		End of Drillhole		8.13							
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: KPH

MIS-BHS 001 1211220198-8000-8100.GPJ GAL-MIS.GDT 06/10/14 JEM

PROJECT: 12-1122-0198/8000/8100

RECORD OF BOREHOLE: MW 13-11

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: August 14, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		53.39							
0	Power Auger (Hollow Stem) 200 mm Diam.	Grey LIMESTONE BEDROCK		0.00							Concrete
1											
2											Bentonite Seal
3											
4	Air Rotary Drill 100 mm Diam. (DHH)										Silica Sand
5											
6											
7											51 mm Diam. PVC #10 Slot Screen
8				45.36							
		End of Drillhole		8.03							
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: KPH

MIS-BHS 001 1211220198-8000-8100.GPJ GAL-MIS.GDT 06/10/14 JEM

PROJECT: 12-1122-0198/8000/8100

RECORD OF BOREHOLE: MW 13-12

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: August 14, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		53.64							
0	Power Auger (Hollow Stem) 200 mm Diam. / Air Rotary Drill 100 mm Diam. (DHH)	Grey LIMESTONE BEDROCK		0.00							Concrete
1											
2											Bentonite Seal
3											
4											Silica Sand
5											
6											51 mm Diam. PVC #10 Slot Screen
7											
				45.74							
8		End of Drillhole		7.90							
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: KPH

MIS-BHS 001 1211220198-8000-8100.GPJ GAL-MIS.GDT 06/10/14 JEM

PROJECT: 12-1122-0198/8000/8100

RECORD OF BOREHOLE: MW 13-13

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: August 14, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		53.37							
0	Power Auger 200 mm Diam. (Hollow Stem)	Brown fine to medium sand (FILL)		0.00							Concrete; Bentonite Seal; Silica Sand; 51 mm Diam. PVC #10 Slot Screen
1											
2				51.03							
		End of Borehole		2.34							
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: KPH

MIS-BHS 001 1211220198-8000-8100.GPJ GAL-MIS.GDT 06/10/14 JEM

PROJECT: 12-1122-0198/8000/8100

RECORD OF BOREHOLE: MW 13-14

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: August 14, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		53.68							
0	Power Auger 200 mm Diam. (Hollow Stem)	Brown fine to medium sand (FILL)		0.00							Concrete; Bentonite Seal; Silica Sand
1											
2				51.24							51 mm Diam. PVC #10 Slot Screen
		End of Borehole		2.44							
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: KPH

MIS-BHS 001 1211220198-8000-8100.GPJ GAL-MIS.GDT 06/10/14 JEM

PROJECT: 12-1122-0198/8000/8100

RECORD OF BOREHOLE: MW 13-15

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: August 14, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		54.03							
0	Power Auger (Hollow Stem) 200 mm Diam.	Grey LIMESTONE BEDROCK		0.00							
1											
2											Bentonite Seal
3											
4	Air Rotary Drill 100 mm Diam. (DHH)										Silica Sand
5											
6											
7											51 mm Diam. PVC #10 Slot Screen
8				46.02							
		End of Drillhole		8.01							
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: KPH

MIS-BHS 001 1211220198-8000-8100.GPJ GAL-MIS.GDT 06/10/14 JEM

PROJECT: 13-1125-0103

RECORD OF BOREHOLE: 13-4

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE December 12, 2013

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-2} 10^{-3} 10^{-4} 10^{-5}) / WATER CONTENT PERCENT Wp — W — Wl (20 40 60 80)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger 200 mm Diam. (Hollow Stem)	GROUND SURFACE		57.19 0.00							Bentonite Seal
1											
2											Silica Sand 50 mm Diam. PVC #10 Slot Screen
3		End of Borehole Note: Elevation of top of pipe: 58.13 masl		54.14 3.05							
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: JD

CHECKED: DMH

MIS-BHS 001 1311250103.GPJ GAL-MIS.GDT 8/12/14 JM

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Supplemental Geotechnical Investigation
Prop. Commercial Development - 801 Albert Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Limited.

FILE NO. **PG3272**

REMARKS

HOLE NO. **BH23-16**

BORINGS BY CME-55 Low Clearance Drill DATE March 18, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	61.67
FILL: Crushed stone with silty sand 0.60		AU	1				
FILL: Black topsoil with organic matter, sand and gravel 1.37		SS	2	50	6	1	60.67
FILL: Brown silty sand, some clay and gravel		SS	3	54	4	2	59.67
		SS	4	17	4		
		SS	5	25	4	3	58.67
		SS	6	33	5	4	57.67
		SS	7	71	15	5	56.67
		SS	8	42	24	6	55.67
6.86		SS	9	58	32		
FILL: Black rail bed material, some coal		SS	10	58	22	7	54.67
		SS	11	50	10	8	53.67
		SS	12	42	26	9	52.67
9.60		SS	13	75	16		
FILL: Brown silty sand with gravel, some coal and rail bed material		SS	14	86	86	10	51.67
11.23		SS	15	71	24	11	50.67
GLACIAL TILL: Compact to very dense, grey silty sand with gravel, cobbles and boulders		SS	16	75	11	12	49.67
		SS	17	83	61		
		SS	18	77	93	13	48.67
14.33		SS	19	95	72	14	47.67
End of Borehole							

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

PROJECT: 18100285

RECORD OF BOREHOLE: 18-01

SHEET 1 OF 2

LOCATION: N 5030415 3 ;E 365618 8

BORING DATE: July 21-22, 2018

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕ / HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] □ (ND = Not Detected; 20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-3} 10^{-5} 10^{-4} 10^{-2}); WATER CONTENT PERCENT (Wp — W — Wl; 20 40 60 80)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger 200 mm Diam. (Hollow Stem)	GROUND SURFACE		65.39							
		FILL/TOPSOIL - SILTY SAND, trace gravel; brown; non-cohesive, moist,		0.00							
		FILL - (SM) SILTY SAND, some gravel to gravelly; brown, contains brick, asphalt and organic matter (rootlets); non-cohesive, moist, compact (15% debris)		0.15	1	SS	20	ND			
1				63.87							
		FILL - (CI/CL) SILTY CLAY, trace sand, trace gravel; grey to grey brown, contains asphalt; cohesive, w>PL, firm to stiff (5% debris)		1.52	2	SS	6	ND			
2											
3					3	SS	3	ND			
4				60.82							
		FILL - (SP/GP) SAND and GRAVEL, some silt to silty; dark brown, contains asphalt, cobbles and boulders; non-cohesive, moist (20% debris)		4.57	4	SS	>50	ND			
5				60.06							
		FILL - SILTY SAND and GRAVEL; brown to black, contains asphalt, cobbles and boulders; non-cohesive, moist (20% debris)		5.33							
6				59.29							
		FILL - (SC/ML) CLAYEY SILTY SAND to sandy CLAYEY SILT, some gravel; grey, contains cobbles and wood; non-cohesive, w~PL, compact (5% debris)		6.10	5	SS	17	ND			
7				57.77							
		FILL - (CI/CL) SILTY CLAY, trace to some sand; grey, contains wood; cohesive, w>PL, stiff (5% debris)		7.62	6	SS	6				
8				57.31							
		FILL - (SM) SILTY SAND, trace to some gravel; grey to black, contains brick, asphalt, wood and glass; non-cohesive, wet, compact (30-60% debris)		8.08							
9					7	SS	23				
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE
1 : 50

GOLDER

LOGGED: SS
CHECKED: WC

MIS-BHS 001 18100285.GPJ GAL-MIS.GDT 8/24/18 ZS

PROJECT: 18100285

RECORD OF BOREHOLE: 18-01

SHEET 2 OF 2

LOCATION: N 5030415 3 ;E 365618 8

BORING DATE: July 21-22, 2018

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected; 20 40 60 80) / HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] □ (ND = Not Detected; 20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-3} 10^{-5} 10^{-4} 10^{-2}) / WATER CONTENT PERCENT Wp W Wl (20 40 60 80)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		— CONTINUED FROM PREVIOUS PAGE —									
10	Power Auger 200 mm Diam (Hollow Stem)	FILL - (SM) SILTY SAND, trace to some gravel; grey to black, contains brick, asphalt, wood and glass; non-cohesive, wet, compact (30-60% debris)									
		(0-5% debris)		54.49	8	SS	>50	⊕			
11		FILL - (SM) SILTY SAND, medium to coarse, trace gravel; black, contains asphalt and wood; non-cohesive, wet, compact (20% debris)		10.90							
12					9	SS	22	⊕			
13											
14					10	SS	23	⊕ ND			
15				50.15							
		FILL - (CI) SILTY CLAY, trace sand; grey, contains wood; cohesive, w>PL (No debris)		15.24	11	SS	>50	⊕ ND			
16											
				48.63							
17		(SM/GM) gravelly SILTY SAND; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet		16.76	12	SS	>50	⊕ ND			
				48.17							
		End of Borehole		17.22							
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: SS

CHECKED: WC

MIS-BHS 001 18100285.GPJ GAL-MIS.GDT 8/24/18 ZS

PROJECT: 18100285

RECORD OF BOREHOLE: 18-02

SHEET 1 OF 2

LOCATION: N 5030424 4 ;E 365719 8

BORING DATE: June 11, 2018

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ND = Not Detected	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] ND = Not Detected	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		63.47								
0	Rotary Drill HW Casing	FILL/TOPSOIL - (ML) sandy SILT, trace gravel; brown; moist		0.00								
				63.17	1	SS	22	ND				
		FILL - (SM) SILTY SAND, some gravel; brown, contains brick; non-cohesive, moist, compact (No debris)		0.30								
					2	SS	16	ND				
1				62.25								
		FILL - (CL) SILTY CLAY, some sand, some gravel; grey, contains brick; cohesive, w~PL (5% debris)		1.22								
				61.82								
		FILL - (GP) sandy GRAVEL; brown, contains asphalt and brick; non-cohesive, moist, compact (5% debris)		1.65	3	SS	17	ND				
2				61.34								
		FILL - (CL/ML) SILTY CLAY to sandy CLAYEY SILT; brown, contains brick and wood; cohesive, w>PL, stiff to very stiff (10-20% debris)		2.13	4	SS	24	ND				
3					5	SS	24	ND				
4					6	SS	8	ND				
				58.90								
		FILL - (SM) GRAVEL and SILTY SAND; brown, contains brick; non-cohesive (5% debris)		4.57	7	SS	>50	ND				
5				58.14								
		FILL - (CL) SILTY CLAY and GRAVEL, some sand; brown, contains brick; cohesive, moist, compact (5% debris)		5.33	8	SS	13	ND				
6				57.37								
		FILL - (SM) SILTY SAND, some gravel; grey brown, contains brick, wood and asphalt; non-cohesive, moist, compact (15% debris)		6.10	9	SS	19	ND				
				56.61								
7		FILL - (CL) sandy SILTY CLAY; grey brown, contains brick and wood; cohesive, w>PL (5% debris)		6.86	10	SS	32					
				55.85								
		FILL - (SM) SILTY SAND, some gravel; grey, contains brick, asphalt, wood and plastic (garbage); non-cohesive, moist, dense to compact (15-20% debris)		7.62	11	SS	45					
8					12	SS	12					
9				54.33								
		FILL - (SM) SILTY SAND, trace to some gravel; brown, contains brick, asphalt, wood and mortar; non-cohesive, moist to wet, compact (50% debris)		9.14	13	SS	12	ND				
10					14	SS	19					
		CONTINUED NEXT PAGE										

DEPTH SCALE

1 : 50

GOLDER

LOGGED: SS

CHECKED: WC

PROJECT: 18100285

RECORD OF BOREHOLE: 18-02

SHEET 2 OF 2

LOCATION: N 5030424 4 ;E 365719 8

BORING DATE: June 11, 2018

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ND = Not Detected (20 40 60 80) ⊕ / HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] ND = Not Detected (20 40 60 80) □	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}) / WATER CONTENT PERCENT (Wp — W — Wl; 20 40 60 80)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10		*— CONTINUED FROM PREVIOUS PAGE —*									
	Rotary Drill / HW Casing	FILL - (SM) SILTY SAND, trace to some gravel; brown, contains brick, asphalt, wood and mortar; non-cohesive, moist to wet, compact (50% debris)			14	SS	19	⊕ ND			
				52 80							
		FILL - (SM) SILTY SAND, trace to some gravel; grey brown, contains brick, asphalt, wood, glass, ceramic and aluminum; non-cohesive, wet, compact (70% debris)		10 67	15	SS	18	⊕			
11					16	SS	22	⊕ ND			
12					17	SS	11				
				50 52							
13		FILL - (CL) SILTY CLAY, some sand; grey, contains brick and plastic (garbage); cohesive, w>PL, very stiff (20% debris)		12 95	18	SS	>50	⊕ ND			
				50 31							
		FILL - COBBLES and BOULDERS (ROCK FILL) (No debris)		13 16	19	RC	DD				
14											
					20	RC	DD				
15											
				48 10							
		End of Borehole		15 37							
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: SS

CHECKED: WC

MIS-BHS 001 18100285.GPJ GAL-MIS.GDT 8/24/18 ZS

PROJECT: 18100285

RECORD OF BOREHOLE: 18-03

SHEET 1 OF 3

LOCATION: N 5030518 9 ;E 365789 7

BORING DATE: June 6-7 2018

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ND = Not Detected (20 40 60 80) / HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] ND = Not Detected (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-5} 10^{-6} 10^{-4} 10^{-2}) / WATER CONTENT PERCENT Wp W Wl (20 40 60 80)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		62.63							
0	Rotary Drill HW Casing	FILL/TOPSOIL - (SM) SILTY SAND, some gravel; dark brown; moist		0.00 62.43							
		FILL - (SM) SILTY SAND, some gravel; grey brown, contains brick; non-cohesive, moist (0-5% debris)		0.20 61.87	1	SS	25	ND			
1		FILL - (SP) SAND; light brown; non-cohesive, moist, dense (No debris)		0.76 61.11	2	SS	39	ND			
		FILL - (GP) sandy GRAVEL; brown, contains cobbles; non-cohesive, moist, very dense to compact		1.52	3	SS	100	ND			
2					4	SS	51				
3					5	SS	14	ND			
4					6	SS	25	ND			
					7	SS	16	ND			Bentonite Seal
5		FILL - COBBLES and BOULDERS, some sand and gravel; grey (ROCK FILL) (No debris)		57.45 5.18	8	SS	>50				
6					9	RC	DD				
7					10	RC	DD				
8					11	RC	DD	ND			
9					12	RC	DD				
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

GOLDER

LOGGED: SS

CHECKED: WC

MIS-BHS 001 18100285.GPJ GAL-MIS.GDT 8/24/18 ZS

PROJECT: 18100285

RECORD OF BOREHOLE: 18-03

SHEET 2 OF 3

LOCATION: N 5030518 9 ;E 365789 7

BORING DATE: June 6-7, 2018

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0 30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ND = Not Detected (20 40 60 80) / HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] ND = Not Detected (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}) / WATER CONTENT PERCENT (Wp — W — Wl; 20 40 60 80)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		— CONTINUED FROM PREVIOUS PAGE —									
10	Rotary Drill / HW Casing	FILL - COBBLES and BOULDERS, some sand and gravel; grey (ROCK FILL) (No debris)			12	RC	DD	ND			Bentonite Seal
11					13	RC	DD				Silica Sand
12				50.19							32 mm Diam. PVC #10 Slot Screen 'B'
		FILL - (SM) gravelly SILTY SAND, dark brown to black, contains wood; non-cohesive, wet, dense (5% debris)		12.44	14	SS	31	ND			Silica Sand
13				49.59							
		Borehole continued on RECORD OF DRILLHOLE 18-03		13.04							Bentonite Seal
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE
1 : 50

GOLDER

LOGGED: SS
CHECKED: WC

MIS-BHS 001 18100285.GPJ GAL-MIS.GDT 8/24/18 ZS

PROJECT: 18100285

RECORD OF DRILLHOLE: 18-03

SHEET 3 OF 3

LOCATION: N 5030518 9 ;E 365789 7

DRILLING DATE: June 6-7, 2018

DATUM: CGVD28

INCLINATION: -90° AZIMUTH: --

DRILL RIG: CME Track

DRILLING CONTRACTOR: Downing Drilling

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate; BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage; PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular; PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV / DEPTH (m)	RUN No	COLOUR % RETURN / FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R Q D %	FRACT INDEX PER 0.25 m	DISCONTINUITY DATA Dip° w.r.t. CORE AXIS	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC Q' AVG	
		BEDROCK SURFACE		49.59												
	Rotary Drill / HQ3 Core	Fresh, thinly to medium bedded, grey, fine to medium grained, non-porous, medium strong LIMESTONE, with thin to thick laminations of black shale VERULAM FORMATION		13.04	1	70										Bentonite Seal
14					2	70										Silica Sand
15																32 mm Diam PVC #10 Slot Screen 'A'
16					3	70										Silica Sand
17																
					4	0										Bentonite Seal
18																
					5	0										
19				43.42												
		End of Drillhole		19.21												
		Note(s): 1. Falling head packer test results and slug test results are shown on the log above														WL in Screen 'A' at Elev 52.77 m on June 26, 2018 WL in Screen 'B' at Elev 52.97 m on June 29, 2018
20																
21																
22																
23																

DEPTH SCALE

1 : 50

GOLDER

LOGGED: SS

CHECKED: WC

MIS-RCK 004 18100285.GPJ GAL-MISS.GDT 8/24/18 ZS

APPENDIX D

D.1 TABLE D.1: SUMMARY OF THE ENCOUNTERED BEDROCK SURFACE AND AUGER (OR SPLIT-SPOON) REFUSAL DEPTH/ELEVATION AND MEASURED RQD VALUES

D.2 TABLE D.2: SUMMARY OF GROUNDWATER LEVELS

Table D.1: Summary of Encountered Bedrock Surface Depth/Elevation, the Measured RQD Values, and Encountered Depths/Elevations of Auger (or Split-Spoon) Refusal at Boreholes

Borehole No.	Approximate Ground Surface Elevation (m)	Approximate Bedrock Surface Depth (m)	Approximate Bedrock Surface Elevation (m)	Comment
MW-05-805	56.05	**3.65**	**52.4**	**Bedrock was proven by rock coring**
MW-05-801	55.59	**2.39**	**53.2**	**Bedrock was proven by rock coring**
MW-05-810	56.09	**3.19**	**52.9**	**Bedrock was proven by rock coring**
MW-05-813	55.73	**3.83**	**51.9**	**Bedrock was proven by rock coring**
MW-05-815	55.42	**2.22**	**53.2**	**Bedrock was proven by rock coring**
MW-08-001	56.56	**5.1**	**51.46**	**Bedrock was proven by rock coring**
BH10-06	55.04	3.07	51.97	Auger refusal
BH10-07	55.38	3.83	51.55	Auger refusal
BH10-08	55.98	**6.35**	**49.63**	**Limestone bedrock with interbedded shale (RQD of 0)**
BH10-09	56.97	7.14	49.83	Auger refusal
BH10-10	57.82	3.94	53.88	Auger refusal
BH10-11	57.86	**7.9**	**49.96**	**Limestone bedrock with interbedded shale (RQD of 0, 28%, and 36%)**
BH10-14	55.85	**3.99**	**51.86**	**Limestone bedrock with interbedded shale (RQD of 16% and 96%)**
BH10-15	55.34	3.38	51.96	Auger refusal
BH10-16	55.72	**3.99**	**51.73**	**Limestone bedrock with interbedded shale (RQD of 83% and 100%)**
BH10-17	56.19	4.11	52.08	Auger refusal
BH10-19	56.42	3.25	53.17	Auger refusal
BH10-20	57.94	5.08	52.86	Auger refusal
BH10-25	55.79	4.14	51.65	Auger refusal
BH10-26	55.27	**3.48**	**51.79**	**Limestone bedrock with interbedded shale (RQD of 27% and 100%)**
BH10-28	56.33	4.24	52.09	Auger refusal
BH10-29	56.8	4.43	52.37	Auger refusal
BH10-30	57.87	**6.68**	**51.19**	**Limestone bedrock with interbedded shale (RQD of 100% and 91%)**
BH11-11	54.5	**2.7**	**51.9**	**Limestone bedrock with interbedded shale**
BH11-21	54.8	**0**	**54.8**	**Limestone bedrock with interbedded shale (RQD of 30%, 80%, and 90%)**
BHW-009	60.44	**15.4**	**45.04**	**Interbedded sequence of shale and limestone bedrock (RQD of 90%)**

Borehole No.	Approximate Ground Surface Elevation (m)	Approximate Bedrock Surface Depth (m)	Approximate Bedrock Surface Elevation (m)	Comment
BHW-11	62.74	**13.74**	**49**	**Shale bedrock (RQD of 0%, 30%, and 100%)**
BHW-012	59.32	**10.72**	**48.6**	**Shale bedrock (RQD of 90%)**
BHW-013	60.97	**10.51**	**50.46**	**Shale bedrock (RQD of 70%, 30%, and 0)**
BHW-015	58.89	**9.14**	**49.75**	**Shale bedrock (RQD of 20%, 0, 30%, 20%, 0, 80%, 40%, 0, and 100%)**
BHW-017	58.02	6.85	51.17	Auger refusal
BHW-018	63.53	n/a	n/a	n/a
MW92-C3	62.25	3.5	58.75	Split spoon refusal on possible bedrock
MW01-7	54.65	**5.45**	**49.2**	**Severely fractured limestone Bedrock (RQD of 0 and 36%)**
MW01-8	62.63	11.55	51.1	Auger refusal on inferred bedrock
MW01-10	59.45	9.14	50.3	Auger refusal on inferred bedrock
MW01-17	66.4	16.6	49.8	Auger refusal on inferred bedrock
MW03-22	54.63	7.23	47.4	Auger refusal on inferred bedrock
MW03-23	55.76	**9.7**	**46**	**Limestone with occasional shale interbeds bedrock (RQD of 49% and 80%)**
BH06-37	63.47	7.2	56.3	Auger refusal
BH10-01	58.26	11	47.26	**Limestone bedrock with interbedded shale (RQD of 94%)**
BH10-02	57.54	8.74	48.8	Auger refusal
BH10-04	56.57	5.92	50.65	Auger refusal
BH10-05	55.61	**5.61**	**50**	**Limestone bedrock with interbedded shale (RQD of 9%)**
BH11-01	56.36	2.92	53.44	Auger refusal
BH11-03	54.93	5.69	49.24	Auger refusal on possible bedrock
BH11-04	56.16	9.7	46.46	Auger refusal
BH11-05	56.91	3.45	53.46	Auger refusal on possible bedrock
BH11-06	54.79	2.46	52.33	Auger refusal on possible bedrock
BH11-07	54.92	8.97	45.95	Auger refusal on possible bedrock
BH11-08	54.29	4.52	49.77	Auger refusal
BH11-09	56.83	3.98	52.85	Auger refusal
BH11-10	54.76	3.43	51.33	Auger refusal
BH11-11	54.84	7.77	47.07	Auger refusal
BH11-12	54.55	5.18	49.37	Auger refusal

Borehole No.	Approximate Ground Surface Elevation (m)	Approximate Bedrock Surface Depth (m)	Approximate Bedrock Surface Elevation (m)	Comment
BH11-13	56.59	7.98	48.61	Auger refusal
BH11-14	55.28	5.51	49.77	Auger refusal
BH11-15	54.87	4.52	50.35	Auger refusal
BH11-16	54.61	6.43	48.18	Auger refusal
BH11-17	56.66	8.59	48.07	Auger refusal on possible bedrock
BH11-18	56.83	8.54	48.29	Auger refusal
BH11-19	56.03	**9.53**	**46.5**	**Limestone bedrock (RQD of 70% and 80%)**
BH11-20	54.88	1.58	53.3	Auger refusal
BH11-20A	54.88	6.61	48.27	Auger refusal
BH11-21	59.07	6.45	52.62	Auger refusal
BH11-22	57.34	5.89	51.45	Auger refusal
BH11-23	56.36	4.9	51.46	Auger refusal
BH11-24	59.48	10.11	49.37	Auger refusal
BH11-25	57.24	5.23	52.01	Auger refusal
BH11-26	55.78	5	50.78	Auger refusal
BH11-28	57.59	**9.53**	**48.06**	**Limestone bedrock**
BH11-29	55.66	6.17	49.49	Auger refusal
BH11-31	58.81	6.63	52.18	Auger refusal
BH13-1	58.72	**3.65**	**50.75**	**Coring**
BH13-5	55.39	**3.53**	**51.86**	**Limestone bedrock**
MW13-1	55.09	**0**	**55.09**	**Limestone bedrock**
MW13-2	55.12	**0**	**55.12**	**Limestone bedrock**
MW13-3	53.67	**0**	**53.67**	**Limestone bedrock**
MW13-4	54.62	**0**	**54.62**	**Limestone bedrock**
MW13-5	53.25	**0**	**53.25**	**Limestone bedrock**
MW13-6	52.13	**0**	**52.13**	**Limestone bedrock**
MW13-6	55.7	**4.8**	**50.9**	**Limestone bedrock**
BH13-7	55.71	**5.5**	**50.21**	**Limestone bedrock (RQD of 90%, 80%, 90%, 95%, 0, and 60%)**
MW13-8	51.82	0.3	51.52	Limestone bedrock
MW13-10	52.86	0	52.86	Limestone bedrock
MW13-11	53.39	0	53.39	Limestone bedrock
MW13-12	53.64	0	53.64	Limestone bedrock
MW13-15	54.03	0	54.03	Limestone bedrock
MW18-3	62.63	**13.04**	**49.59**	**Limestone bedrock (RQD of 70%, 65%, 90%, 95%, and 85%)**

Borehole No.	Approximate Ground Surface Elevation (m)	Approximate Bedrock Surface Depth (m)	Approximate Bedrock Surface Elevation (m)	Comment
BH92-C1	62.02	2.6	59.42	Auger refusal on possible bedrock
BH92-C2	62.44	4.9	57.54	Split spoon refusal on possible bedrock
BH92-C4	62	3.6	58.4	Auger refusal on possible bedrock
BH92-C5	62.66	4.46	58.2	Auger refusal on possible bedrock
BH11-33	62.22	9.96	52.26	Split Spoon Refusal
BH11-35	62.56	4.4	58.16	Auger refusal
BH11-37	62.76	6.53	56.23	Auger refusal
BH11-38	62.11	4.17	57.94	Auger refusal
BH11-39	62.81	6.35	56.46	Auger refusal
BH11-40	62.77	6.25	56.52	Auger refusal
MW13-8	55.95	**4.94**	**51.01**	**Limestone bedrock (RQD of 90% and 95%)**

Note: bedrock surface depth/elevation confirmed by coring are shown with bold font.

Table D.2: Summary of Groundwater Levels

Borehole No.	Approximate Ground Surface Elevation (m)	Groundwater Depth (m)	Approximate Groundwater Elevation (m)	Date of Measurement
MW-05-805	56.1	4.7	51.4	Measured on Nov 14, 2005
		3.8	52.3	Measured on May 2, 2006
MW92-C1	62.0	2.4	59.6	Measured on Feb 18, 1992
MW-05-801	55.6	4.0	51.6	Measured on Nov 14, 2005
		2.4	53.2	Measured on May 2, 2006
MW-05-810	56.1	4.7	51.4	Measured on Nov 14, 2005
		4.7	51.4	Measured on May 2, 2006
MW-05-813	55.7	3.9	51.9	Measured on Nov 14, 2005
		3.6	52.1	Measured on May 2, 2006
MW-05-815	55.4	2.1	53.3	Measured on Nov 14, 2005
		2.2	53.3	Measured on May 2, 2006
MW-05-819	52.6	1.1	51.5	Measured on Nov 14, 2005
		1.1	51.5	Measured on May 2, 2006
MW06-6	55.0	2.1	52.9	N. A / installed on June 20, 2006
MW06-7	55.2	2.5	52.7	N. A / installed on June 20, 2006
MW06-9	61.6	8.1	53.5	N. A / installed on June 21, 2006
MW06-10	55.6	2.8	52.8	N. A / installed on June 21, 2006
MW06-11	56.8	4.0	52.8	N. A / installed on June 21, 2006
BH/MW06-	62.6	1.6	61.0	N. A / installed on August 2, 2006

Borehole No.	Approximate Ground Surface Elevation (m)	Groundwater Depth (m)	Approximate Groundwater Elevation (m)	Date of Measurement
BH/MW06-	65.5	1.9	63.6	N. A / installed on August 3, 2006
MW-06-103	62.0	8.6	53.5	Measured on July 25, 2006
MW-06-104	61.4	7.3	54.1	Measured on July 25, 2006
MW-06-105	58.3	5.2	53.1	Measured on July 25, 2006
MW-06-106	59.4	6.6	52.8	Measured on July 25, 2006
MW-06-107	62.2	9.3	52.9	Measured on July 25, 2006
MW-06-108	56.2	3.0	53.3	Measured on July 25, 2006
MW-06-109	63.4	dry	dry	Dry on July 25, 2006
MW-06-110	60.0	6.8	53.3	Measured on July 25, 2006
MW-06-901	57.0	4.9	52.1	Measured on July 25, 2006
MW-08-001	56.6	5.0	51.6	Measured on May 13, 2008
BHW-009	60.4	7.1	53.3	Measured on August 2, 2011
BHW-012	59.3	7.1	54.1	Measured on August 2, 2011
MW92-C3	62.3	< 3.5	<58.8	Dry on Feb 18, 1992
MW01-6	56.1	3.2	52.9	Measured on April 18, 2001
MW01-7	54.7	1.7	53.0	Measured on April 18, 2001
MW01-8	62.6	9.4	53.2	Measured on April 18, 2001
MW03-22	54.6	1.7	52.9	Inferred at the time of drilling (May 30, 2003)
MW03-23	55.8	2.7	53.1	Inferred at the time of drilling (May 30, 2003)
BHW-013	61.0	8.2	52.8	Inferred at the time of drilling (June 23, 2011)
BHW-015	58.9	6.1	52.8	Inferred at the time of drilling (June 14, 2011)
BHW-017	58.0	5.3	52.7	Inferred at the time of drilling (June 14, 2011)
MW13-1	58.7	6.6	52.1	Inferred at the time of drilling (March 8, 2013)
MW13-6	55.7	3.9	51.8	Inferred at the time of drilling (March 14, 2013)
MW13-8	56.0	6.7	49.2	Measured on March 25, 2013
MW18-3	62.6	9.8	52.9	Measured on June 29, 2018