Geotechnical Investigation Report – Parkdale Tower Development at 340 Parkdale, Ottawa, Ontario

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GEOTECHNICAL INVESTIGATION REPORT – PARKDALE TOWER DEVELOPMENT AT 340 PARKDALE, OTTAWA, ONTARIO

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Table of Contents

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

On behalf of Ontario Corporation 1000147699, Taggart Realty Management (the "Client") is proposing the redevelopment of a block of properties bound by Parkdale Avenue, Armstrong Street, Hamilton Avenue, and Spencer Street in Ottawa, Ontario (the "Site").

Stantec Consulting Ltd. (Stantec) was retained by the Client to complete a geotechnical investigation to support the design and construction of the redevelopment. The interpreted subsurface conditions and available project information were used to provide input related to geotechnical design considerations and identify potential geotechnical issues or concerns associated with the proposed design.

The geotechnical investigation program was completed in accordance with the proposal entitled "Geotechnical Investigation at Parkdale Development, 340 Parkdale, Ottawa, ON" dated April 2, 2025.

The results of the environmental and hydrogeological investigations are reported separately, and the findings and recommendations are not presented within this report.

Limitations associated with this report and its contents are provided in the statement of general conditions included in **Appendix A**.

2.0 BACKGROUND INFORMATION

2.1 SITE DESCRIPTION

The Site is located at 340 Parkdale Avenue, Ottawa, Ontario, and is bound by Spencer Street to the north, Hamilton Avenue to the west, Parkdale Avenue to the east and Armstrong Street to the south. The location of the site is shown in Drawing No.1 – Key Plan and Drawing No. 2 – Borehole Location Plan provided in **Appendix B**.

The Site of this investigation comprises of currently developed land with multiple low-rise commercial buildings with civic addresses identified as 3 Hamilton Avenue; 223, 229, and 233 Armstrong Street; and 338, 340 Parkdale, Ottawa, ON.

2.2 PROPOSED DEVELOPMENT

The redevelopment of the Site involves the demolition of the existing properties, and the proposed design will consist of a podium with high-rise and mid-rise towers serving primarily for residential units, with retail on the ground floor. The high-rise tower will have approximately 38 storeys, and the mid-rise tower will have approximately 8 storeys. The development will also include below grade levels of up to 12 m below the existing grade.

The design finished floor elevations for each proposed structure have yet to be established, however for this report, finished floor elevations were estimated assuming no additional grade raises and considering the number of parking levels for each building.

The site plan of the proposed development has been included in Appendix B.

2.3 AVAILABLE GEOLOGICAL AND SUBSURFACE INFORMATION

The Ontario Geological Survey (OGS) mapping data of the physiography of Southern Ontario indicates that the Site is within the Drumlinized Till Plains consisting of *sandy silt to silty sand-textured till*. The Bedrock Geology from the OGS mapping data indicates that the bedrock in the area of the Site is expected to be limestone, dolostone, shale, arkose or sandstone of the Ottawa Group and Shadow Lake Formation.

Site-specific subsurface information is available from previous environmental and geotechnical investigations carried out at this Site and are provided in following reports/documents:

- Golder Associates Limited Report No. 18102200/6100/3, titled “April 2018 Targeted Site Wide Groundwater Monitoring” and dated May 2019.
- Paterson Group Report No. PE2183-3, titled “Phase II - Environmental Site Assessment, Proposed Multi-Storey Building, 233 Armstrong Street and 3 Hamilton Avenue North, Ottawa, ON” and dated December 1, 2011.
- Paterson Group Report No. PG2281-1, titled “Geotechnical Investigation, Proposed Multi-Storey Building, 233 Armstrong Street, Ottawa, Ontario” and dated June 2021

Based on previous reports and completed projects in the vicinity of the Site, the subsurface profile generally consists of variable amounts of fill materials followed by limestone bedrock interbedded with siltstone, dolostone, and sandstone. The boreholes previously completed within the site encountered bedrock at depths ranging from approximately 0 m to 2.3 m below grade. The RQD values reported in these historical investigations indicated the upper 1 m to 2 m of bedrock is weathered at the surface and was observed to have generally an RQD of 0-70%. Below the upper 2m, the bedrock generally had an RQD of 70-100%. Deeper zones with more fractures were also observed within several boreholes at which RQD values were reported at around 0-50% at various depths within the bedrock. Groundwater levels are generally observed between 2.0 m and 6.5 m below the ground surface. Selected borehole records from previous investigations are provided in Appendix C. The borehole locations are shown on Drawing No. 2 in Appendix B.

3.0 METHOD OF INVESTIGATION

3.1 FIELD INVESTIGATION

Prior to commencing the field investigation, Stantec contacted Ontario One Call to confirm the location of public services and utilities and retained the services of a private utility locate company, Multiview Locates Inc., to provide additional utility locate clearances at the intended borehole locations.

One (1) borehole, identified as MW25-1, was advanced at the location shown in Drawing No. 2 – Borehole Location Plan. The borehole was advanced on May 5th to 6th, 2025 and using a CME 55 LC track-mounted drill rig, equipped with hollow stem augers and HW casing, supplied and operated by George Downing Estate Drilling Ltd. Borehole MW25-1 was first hydro-excavated to depth of approximately 1.1 m below ground surface for utility clearance purposes before advancing with the drill rig. A hydro-excavation truck was supplied and operated by Badger Daylighting Inc. Hydrovac refusal on inferred cobbles and boulders was encountered in borehole MW25-1 at approximately 1.1 m below ground surface. The layer of cobbles and boulders extended to a depth of 1.4 m below ground surface, after switching to regular drilling operations, at which bedrock was encountered. The borehole was extended into the bedrock to depth of 18.5 m (with total drill length in the bedrock of 17.1 m) using rotary diamond drilling techniques while retrieving HQ sized core.

After hydrovac operations were complete, manual grab samples of the soil were recovered in each of the observed stratigraphy layers. Approximate layer thicknesses were recorded and all soil grab samples recovered from the boreholes were placed in moisture-proof bags and were transported to the Stantec Ottawa laboratory for detailed geotechnical classification and testing. Soil and rock core samples remaining after testing were placed in storage and will be retained for a period of three months after the date of issue of the final report for this project. After the storage period, the samples will be discarded.

Packer testing was completed within the borehole at three depth intervals on May 6th and 7th, 2025. Packer testing using a double packer setup was conducted to evaluate the hydraulic conductivity in specific zones of the bedrock. The packer tests were completed at depths of 14.3 m, 6.9 m and 3.5 m below ground surface, measured from the top of the packer interval. The packer spacing used for the test was approximately 1.5 m.

One (1) groundwater monitoring well was installed in the borehole, after completing the packer testing, to allow for groundwater level measurements. The monitoring well consisted of 50 mm inside diameter, Schedule 40 PVC piping, with a No. 10 slot screen (0.01-inch slot) and a screen length of 3.1 m. The annular space between the monitoring well pipe and surrounding geological formation was backfilled with sand to 0.4 m above the top of screen, with the remainder of the annular space being filled with a granular bentonite to minimize the potential for a hydraulic connection from occurring between the soil layers along the length of the screen. The monitoring well was covered with a flush-mount cap at surface. The screen depths relative to the ground surface are noted on the borehole records included in **Appendix C**.

The borehole location for the present investigation was surveyed, the ground surface elevation is 62.74 m.

An MASW investigation was carried out in order to determine the seismic site classification. The MASW survey was carried out within the sidewalk on the south side of Spencer Street between Hamilton Avenue and Parkdale Avenue on May 27, 2025. A copy of the Geophysical Investigation Report is included in **Appendix E**.

The environmental investigation by Stantec included four boreholes identified as MW25-02 to MW25-05, these locations are shown in Drawing No. 2 – Borehole Location Plan in **Appendix B** and their borehole records are included in **Appendix C.**

3.2 LABORATORY TESTING

Soil samples from the boreholes were subjected to visual and tactile examination upon return to Stantec's geotechnical and materials testing laboratory. Detailed rock core logging was completed on all the recovered rock core. Unconfined compressive strength testing was carried out on rock core samples. All laboratory testing was completed at Stantec's geotechnical and materials testing laboratory to determine engineering properties in accordance with American Society for Testing and Materials (ASTM).

The results of the laboratory tests are discussed in the text of this report and are provided on the Borehole Records in **Appendix C**, and on the laboratory, testing figures in **Appendix D**.

Samples remaining after testing were placed in storage and will be retained for a period of three months after the date of issue of the final report for this project. After the storage period, the samples will be discarded.

4.0 SUBSURFACE CONDITIONS

4.1 OVERVIEW

In general, the stratigraphy encountered in the boreholes consisted of pavement asphalt over fill materials that are underlain by limestone bedrock interbedded with shale. Hydrovac refusal (inferred to be a result of encountering either bedrock or cobbles and boulders) was encountered at a depth of 1.1 m in MW25-1.

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records provided in **Appendix C** and in the following subsections. An explanation of the symbols and terms used to describe the Borehole Records is also provided in **Appendix C**.

The soils encountered in the boreholes and reported herein have been classified in accordance with the Unified Soil Classification System as defined in ASTM D2487 and D2488.

The stratigraphic boundaries on the borehole records are inferred from in field measurements and grab samples and therefore represent transitions between soil types rather than the exact boundaries between geological units. The subsoil conditions will vary between and beyond the borehole locations.

4.1.1 Ground Surface Cover

The ground surface cover at the borehole location consisted of asphalt pavement. The thickness of the asphalt was approximately 54 mm.

4.1.2 Fill Materials

A layer of fill material described as grey to brown sand and gravel was encountered beneath the asphalt. The fill layer was observed to contain cobbles and boulders. The fill layer extended to a depth of 1.4 m below the existing grade. Based on visual and textural examination, the fill material was assessed as moist.

The N-values were not obtained in the fill layer due to the hydrovac operations for utility clearances.

No representative samples of the fill were selected for grain size distribution testing

4.1.3 Boulders

Hydrovac refusal on inferred bedrock or cobbles and boulders was encountered at borehole MW25-1 at a depth of 1.1 m (elevations 61.6 m). Upon encountering refusal, borehole MW25-1 was extended through a layer of cobbles and boulders approximately 0.3 m thick, using traditional HQ sized core drilling methods.

4.1.4 Bedrock

Bedrock was cored within borehole MW25-1 from a depth of 1.4 m to 18.5 m (total length cored of 17.1 m) using rotary diamond drilling techniques while retrieving HQ sized core. The depth and elevations of the confirmed bedrock surface was 1.4 m below ground surface, corresponding to an elevation of 61.3 m.

The bedrock retrieved from the borehole can be described as slightly weathered to fresh, fine to medium grained grey to dark grey thickly bedded limestone with medium shale interbeds. Photos of the rock core collected from borehole MW25-1 are included in Appendix C.

The bedrock encountered was slightly weathered near the surface, becoming fresh below the first core run. The rock cores display grey to dark grey limestone with prominent horizontal bedding planes.

The surfaces of the discontinuities are generally undulating or planar. The discontinuities observed in the recovered rock core were a combination of slightly altered with iron staining, clear or partially or completed coated with silt or clay infilling of up to 5 mm. The orientation of the discontinuities observed were generally flat.

The Rock Quality Designation (RQD) measures the degree of fracturing of the rock mass and is determined by measuring the percentage of intact core sections with a length of 10 cm or more in the borehole. Based on the quantity of intact rock over a defined length, the rock is described as follows.

Table 4.1: Rock Quality Designation (RQD)

RQD	100 – 90 %	90 – 75%	75 – 50%	50 – 25%	25 – 0%
Rock Description	Excellent	Good	Fair	Poor	Very Poor

RQD values measured on the retrieved bedrock core ranged between 21% and 100%, indicating a poor to excellent rock mass quality. It should be noted the poor RQD value of 21% was limited to the upper 0.5 m of bedrock, the RQD values increased with depth and remained 100% from a depth of 3.4 m to the termination depth of 18.5 m. The Total Core Recovery (TCR) of the bedrock ranged from 88% to 100%.

Five (5) bedrock core samples were submitted for unconfined compressive strength (UCS) testing, with the results presented in Table 4.2. The UCS test results ranged from 94.9 MPa to 201.5 MPa, indicating a strong to very strong rock.

Table 4.2: Unconfined Compressive Strength Tests

Borehole	Run No.	Sample Depth (m)	Rock Type	Unconfined Compressive Strength (MPa)
MW25-1	HQ5	3.4 – 3.7 m	Limestone with shale interbeds	201.5
MW25-1	HQ8	8.8 – 9.1 m	Limestone with shale interbeds	173.9
MW25-1	HQ9	10.0 – 10.3 m	Limestone with shale interbeds	176.6
MW25-1	HQ11	13.2 – 13.5 m	Limestone with shale interbeds	185.3
MW25-1	HQ14	17.3 – 17.5 m	Limestone with shale interbeds	94.9

4.1.4.1 Hydraulic Conductivity of Bedrock

Packer tests were carried out in MW25-1 after the full length of bedrock was cored to determine the hydraulic conductivity of the rock mass. The double packer setup was used at three test intervals, 3.5-5.7 m, 6.9-9.1 m, and 14.3-16.5 m below ground. Within each interval, the injections were performed at five different pressures. The results are summarized in the table below

Table 4.3: Packet Test Results Summary

Borehole	Test No.	Test Interval Depth (m)	Average hydraulic conductivity, k (m/s)
MW25-1	1	3.5 – 5.7 m	- *
	2	6.9 – 9.1 m	2.56×10^{-3} **
	3	14.3 – 16.5 m	4.96×10^{-6} *

*Note: Within test number 1, all five injections resulted in 'no flow' tests and within test number 3, four out of five injections resulted in 'no flow' tests, meaning the volume of water injected was too low to be measured with the equipment on hand. These results suggest very low permeability rock at these test depths.

** Note: Within test number 2, water was observed to be leaking out of the top of the well casing of an adjacent monitoring well, suggesting the presence of a fracture connecting the tested borehole to the adjacent well, which has impacted the hydraulic conductivity value.

A typical range of permeability for limestone is 10^{-6} to 10^{-12} as provided in Table 4.20 in the Canadian Foundation Engineering Manual 5th Edition (CFEM 5th Edition).

4.2 GROUNDWATER

The groundwater level was measured within MW25-1 to be 5.42 m below ground surface on June 17, 2025.

Additional groundwater level measurements are presented in the Table below from previously installed monitoring wells at the site. The groundwater level measurements ranged from 1.94 m to 21.56 m below ground surface.

Table 4.4: Groundwater Level Readings

Borehole ID	Installation Details	Groundwater Reading Date	Groundwater Level (mbgs)
MW25-01	Stantec Geotechnical - 2025	June 17, 2025	5.42
MW25-02	Stantec Environmental - 2025	June 18, 2025	1.94
MW25-03	Stantec Environmental - 2025	June 17, 2025	2.34
MW25-04	Stantec Environmental - 2025	June 16, 2025	2.19
MW25-05	Stantec Environmental - 2025	June 16, 2025	2.05
MW16-1	Golder - 2016	June 16, 2025	3.71
E3	Golder - 2014	June 16, 2025	6.37
MW14-1A	Golder – 2014	June 16, 2025	5.21
MW14-1B	Golder - 2014	June 16, 2025	4.01
MW14-2	Golder - 2014	June 17, 2025	6.49
MW08-32A	Golder - 2008	June 18, 2025	4.11
MW08-34	Golder - 2008	June 18, 2025	5.30
BH1	Patterson - 2010	June 18, 2025	21.56

Groundwater levels at this site will be subject to fluctuations due to seasonal changes, precipitation events and variations in the water level in the nearby Ottawa River. The water levels should be expected to be higher during the spring season or during and following periods of heavy precipitation or snow melt.

4.3 CHEMICAL ANALYSIS

One (1) representative soil sample and one (1) representative groundwater sample were submitted to Paracel Laboratories in Ottawa, Ontario, for analysis of pH, water soluble sulphate, chloride concentrations, and resistivity. The testing was completed to determine the potential for degradation of the concrete in the presence of soluble sulphates and the potential for corrosion of exposed steel used in foundations and buried infrastructure.

The analysis results are summarized in the following table and are provided in Appendix D.

Table 4.5: Chemical Test Results

Borehole No.	Sample No.	Depth (m)	pH	Chloride (µg/g)	Suphate (µg/g)	Resistivity (Ohm-m)
MW25-01	GS2 (soil)	0.25 – 1.2	7.74	90	419	16.4
MW25-01	2532113-01 (water)	N/A	7.3	1820	119	1.78

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 KEY GEOTECHNICAL ISSUES

The following general development considerations and constraints are provided with respect to observations made during the investigation, the subsurface conditions encountered, and the intended scope of development:

- It is anticipated that the existing commercial buildings and associated infrastructure will be demolished and/or decommissioned as a component of the re-development of the site. Excavations created through the demolition and decommissioning process should be backfilled with approved, compacted engineered fill materials, or concrete.
- Given the site is already developed, a significant cut and fill program to adjust site grade is not anticipated to be required for the proposed redevelopment.
- The site includes a 1.1 m thick layer of fill which is not suitable for supporting foundation and construction of slab-on-grade. Therefore, as part of the site preparation works, the fill will need to be removed from the building footprint. All topsoil and/or organic soils should be removed from the proposed paved areas.
- The site is underlain by shallow bedrock and therefore, excavation within the bedrock will be required in order to facilitate the underground levels. Spread foot foundations on bedrock are suitable for the design of the building.
- The proposed basement floor level is not known at this time; however, considering number of underground parking levels for each building (as discussed in Section 2), it is anticipated that the elevation of the below grade levels for the residential towers will be below the groundwater level. As such, an under-slab drainage system will be required to control groundwater. The measured groundwater depth in MW25-1 was 5.42 m below ground surface on June 17, 2025. Groundwater levels within previously installed monitoring wells were measured in June 2025 and ranged from 1.94 m to 21.56 m below grade.

- **The chemical analysis of the soils and groundwater indicated high concentrations of chloride. Therefore, there is potential for corrosion of steel used for shotcrete framing, reinforced concrete, rock anchors and utility structures. Mitigation measures will be required such the use of corrosion protection systems for steel and concrete/grout designed to be impervious.**

Preliminary geotechnical comments, discussion, and recommendations are provided in the following sections with respect to the design and construction of the planned scope.

5.2 SITE GRADING AND PREPARATION

The subsurface conditions encountered at the site typically consist of pavement and fill materials overlying the limestone bedrock. In preparation for construction of the buildings, all organic soil (including topsoil), vegetation and tree roots, fill material, and any loose, wet, and/or otherwise disturbed native material should be removed from within the footprint of the proposed structures and foundations. Any existing infrastructure (e.g. existing buried services/utilities) should also be removed/relocated from within the influence zone of new foundations. Footings should be founded on sound bedrock. Exposed bedrock surfaces should be free of loose bedrock, soil, water, bedrock irregularities, bedrock pinnacles and sloping surfaces. Hand cleaning and pressure washing of the bearing areas to remove any loose material swill be required to achieve the recommended bearing pressure.

Temporary frost protection should be provided for all footings if construction is carried out under winter conditions.

Beneath pavement areas, non-clay fill material, free of deleterious material, can be left in place and surface compacted to act as a subgrade for any proposed paved areas.

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 A or Granular B Type 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 foundation slabs and 200 mm in other areas, excluding basement areas where a drainage system will be required.

Foundation wall backfill should be placed and compacted in lifts and should consist of OPSS Granular A or OPSS Granular B Type II. It should be compacted in lifts no thicker than 300 mm to at least 95% SPMDD.

Beneath pavement and sidewalks and landscaped areas, 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 should be tested and approved by a Geotechnical Engineer prior to delivery to the site. 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.

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.

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.

5.2.1 Grade Raise Restrictions

Based on the proposed development plans, the new facilities will be constructed at or near existing grades and, as such, it is understood that significant grade raises are not planned as part of the new developments at the site. Grade raise restrictions, if applicable to any areas outside of the foundation footprints, are not required at this site due to the presence of shallow bedrock.

5.2.2 Demolition and Decommissioning

It is anticipated that the demolition and decommissioning of the existing commercial buildings, including removal of the superstructure, floor slabs and foundations, will be required. It is also anticipated that decommissioning and removal/relocation of buried services will be required. All demolition and stripped materials should be removed to an approved off-site location.

Excavations created through the demolition and decommissioning process should be backfilled with Structural Fill as described in Section 5.2.

Where the demolished structures are within proposed paved or landscaped areas, 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) as described in Section 5.2.

5.3 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.

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% of the material's standard Proctor maximum dry density using suitable compaction equipment.

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

5.4 REUSE OF ON-SITE MATERIALS

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.

The Stantec Environmental report should be reviewed regarding material reuse. The recommendations in this report consider only the geotechnical aspects of material reuse.

5.5 FROST CONSIDERATION

The design frost penetration depth at the site is 1.8 m.

The design depth for new perimeter foundations should extend to a minimum of 1.8 m or to sound bedrock, if shallower, to protect against frost heaving.

Where adequate earth cover for frost protection cannot be provided, the use of rigid insulation can be considered. As a general guideline, 25 mm of rigid insulation may be assumed to provide approximately 300 mm of equivalent soil cover.

For foundation elements that are directly placed on sound limestone bedrock, it is not required to implement the foundation at the depths previously mentioned in order to obtain protection against the frost. However, to avoid all detrimental behaviour from the frost, it is recommended that all fragments of loose rock, cobbles, and boulders not connected to the bedrock be removed from the foundation footprint.

The base of all footing excavations should be inspected by a geotechnical engineer prior to placing concrete. Where construction is undertaken during winter conditions, all footing subgrades should be protected from freezing. Foundation walls and columns should be protected against heave due to soil adfreeze.

5.6 SEISMIC DESIGN CONSIDERATIONS

5.6.1 Site Classification

The seismic Site Class value, as defined in Section 4.1.8.4 of the 2024 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 meters of the ground below the ground surface 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.

An MASW investigation was carried out in order to determine the site classification based on the OBC requirements for Site Class A or B designation. The MASW survey was carried out within the sidewalk on the south side of Spencer Street between Hamilton Avenue and Parkdale Avenue. V_{S30} measurements were taken within the study site and reviewed to determine the site classification. The measurements obtained indicated a V_{S30} of 1672 m/s, which puts the site into Site Designation X_{1672} which corresponds to a seismic Site Class A (“hard rock”) according to the Ontario Building Code of Canada 2024.

It should be noted that the Site Designation X_{1672}, corresponding to Site Class A, is not to be used in cases where more there are more than 3 m of soft material between rock and the underside of mat foundations.

A copy of the Geophysical Investigation Report is included in **Appendix E**.

5.6.2 Peak Ground Acceleration (PGA)

Seismic hazard values for this site were obtained from the Natural Resources Canada (2020 National Building Code). The 2020 NBC Seismic Hazard Calculation Data sheet for this site is provided in **Appendix E**. The Table below summarizes the parameters based on a 2475-year return period.

Table 5.1: Results from 2020 NBS Seismic Hazard Tool

PGA	*$S_a(0.2)$*	*Site Class*
0.308	0.379	A

5.6.3 Liquefaction Potential

Considering the underground levels of the proposed development, the liquefaction potential of the existing fill materials is not pertinent to the design as these materials will be removed from beneath the building footprint.

Moreover, considering the shallow depth of the bedrock, liquefaction is not an applicable concern to the design of the foundation as the proposed structure is expected to be founded directly within the bedrock.

5.7 FOUNDATION DESIGN CONSIDERATIONS

The project consists of a mix of mid-rise and high-rise residential tower structures. The foundation types should be selected based on the structural loads, soil conditions, and groundwater considerations.

Based on the proposed underground level of parking for each structure and assumed finished floor elevations (FFE) and footing depths, the foundations for the proposed building may be supported on spread footings provided that the foundation preparation work described in Section 5.2 above is carried out. Spread footings should be placed on clean, undisturbed, sound bedrock.

According to the Canadian Foundation Engineering Manual 5th Edition (CFEM 5th Edition), a rock mass is considered sound when the spacing of discontinuities is in excess of 0.3 m.

5.7.1 Shallow Foundation on Rock

The factored geotechnical resistance at Ultimate Limit State (ULS) is presented in Table 5.2 can be used for the design of foundations on sound unweathered bedrock.

The ultimate limit state (ULS) geotechnical resistance for foundations on rock was evaluated using the fractured rock method developed by Hoek and Brown (Carter & Kulhawy, 1992). The Hoek and Brown method considers the simple compressive strength of the rock (q_u), the rock type and quality (GSI, m and s parameters) and the foundation geometry (Cf). Applying the limit state approach to the Hoek and Brown method, the unfactored ultimate limit state (q_{ult}) geotechnical resistance is given by the following relationship:

$$q_{ult} = \left[s^a + (m \cdot s^a + s)^a\right] \cdot q_u$$

where :

$$m = m_i * \exp\left(\frac{GSI - 100}{28 - 14D}\right)$$

$$s = \exp\left(\frac{GSI - 100}{9 - 3D}\right)$$

$$a = \frac{1}{2} + \frac{1}{6}\left(e^{-GSI/15} - e^{-20/3}\right)$$

The following parameters were used in the calculation of the ultimate strength on rock:

- q_u = 100 MPa (cautious design value)
- GSI = 55 (cautious design value)
- m_i = 8 (for limestone)
- D = 0.3 (rock mass disturbance factor)

The above calculation would suggest unfactored geotechnical resistance of 36,000 kPa for square footings constructed on bedrock. Using a resistance factor of 0.5, this would result in a factored ULS_f resistance of 18,000 kPa.

The table below provides the Geotechnical Bearing Resistances for shallow foundations applicable to the buildings.

Table 5.2: Geotechnical Bearing Resistance

Foundation Type	Footing Width (m)	Geotechnical Resistance (kPa)
		Bedrock (founded on competent rock)
$ULS_{factored}$	Up to 4 m assumed	10,000
SLS	Up to 4 m assumed	-

Notes:

The factored geotechnical bearing resistance at ultimate limit states ($ULS_{factored}$) is already factored and incorporates a resistance factor of 0.5.

The settlement of foundations founded on bedrock is expected to be negligible. The factored resistance at ULS for footings on bedrock will govern, since failure within bedrock mass is likely to occur before the serviceability limit state (SLS) deformation of 25 mm total settlement is realized.

Footings should not be founded on a weathered and highly fractured bedrock surface. If weathered and fractured rock is encountered at the footing elevation, subexcavation of the rock mass may locally be required based on inspections carried out by the geotechnical engineer. Should this be the case, the excavated bedrock should be replaced with mass concrete.

The bearing capacities provided above reflect axial loading conditions, and do not account for eccentric loads which may occur as a result of crane towers and scaffolding. The above values should be reduced to account for the effects of eccentric loading, as per Section 10.3.6, Eccentric Forces and Moments, of the Canadian Foundation Engineering Manual.

The base of all footing excavations should be inspected by a geotechnical engineer prior to placing concrete to confirm the design pressures and to ensure that there is no disturbance of the founding soils.

Should stepped footings steeper than 7V:10H be proposed, the geotechnical resistances may need to be reduced. Localized rock anchoring of bedrock step downs may also be required.

Where construction is undertaken during winter conditions, all footing subgrades should be protected from freezing. Foundation walls and columns should be protected against heave due to soil adfreeze.

High concentrations of chloride were observed in the soil and groundwater. Mitigation measures against physical and chemical attacks on the foundation steel components is required, such as the use of corrosion protection systems for steel and increasing the concrete density to reduce permeability.

5.7.2 Coefficient of Sliding Friction

The table below summarizes the coefficient of friction between concrete and sound bedrock, estimated in accordance with the Canadian Foundation Engineering Manual.

Sliding resistance can be calculated using the following unfactored friction coefficients.

Foundation Type	Unfactored Friction Coefficient
Between Concrete and clean, sound Bedrock	0.6
Between Concrete and Structural Fill	0.55

A geotechnical resistance factor of 0.8 should be applied to assess the stability with respect to sliding.

5.7.3 Rock Anchors

It is anticipated that rock anchors will be required to ensure stability of temporary shoring systems and resist uplift forces. For the design of rock anchors extending into bedrock, the following design parameters may be considered for the rock mass.

- A rock to grout working bond stress of 1000 kPa may be used for holes grouted with non-shrink grout having a minimum compressive strength of 30 MPa.
- The minimum fixed anchor length (i.e. the length over which the rock to grout bond stress is developed) should be no less than 3 m.
- The unbounded length of anchor should be equal to the height of the rock cone and less half the bonded length.

To ensure against the possibility of a rock mass failure, the following design parameters should be used:

- Submerged Unit weight of rock = 16 kN/m3
- A 90° (apex angle) failure cone with the apex located at the midpoint of the bonded length as shown on the sheet titled “Rock Anchor: Resistance to Rock Mass Failure” in **Appendix F**.

The bond stress used by the contractor for design should be confirmed by full scale testing of anchors.

High concentrations of chloride were observed in the results of the chemical analysis of soils and groundwater. Mitigation measures against corrosion of the steel anchors will be required.

5.8 PAVEMENT DESIGN RECOMMENDATIONS

Provided that subgrade preparation below pavements will comply with the requirements outlined in Section 5.2 of this report, the pavement structure provided in the table below may be used for design if parking areas are applicable to the development. Where required, site grades below pavement structures are to be raised using imported soils meeting the requirements of OPSS Select Subgrade Material (SSM).

Table 5.3: Recommended Pavement Structure

Material	Heavy Duty Parking Access Roads	Standard Duty Parking Area
SP 12.5 Asphaltic Concrete	40 mm	50 mm
SP 19 Asphaltic Concrete	50 mm	-
Granular Base Course, OPSS Granular A	150 mm	150 mm
Granular Subbase Course, OPSS Granular B Type II	400 mm	300 mm

Notes:

- The above pavement structure assumes that the subgrade will consist of either the existing granular fill materials or OPSS SSM material, and that all areas unsuitable fill subgrade is present, it will be sub excavated to either the bedrock or at least 1.5 m below the proposed pavement level and replaced with 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 sub excavation and replacement with additional Granular 'B'. Where required, site grades below pavement structures are to be raised using subgrade 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.
- Given the low permeability of the native subgrade soils, 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 PG 58-34 should be specified.
- Based on the Ontario Provincial Standard Specification "Material Specification for Superpave and Stone Mastic Asphalt Mixtures" OPSS.MUNI 1151 (April 2018) a Superpave Traffic Category of A is suitable.
- 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.

5.9 TEMPORARY EXCAVATIONS

All temporary excavations should be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. Care should be taken to direct surface water away from open excavations.

It is anticipated that deep open cut excavations are to extend to depths up to 13 m below grade may be required for residential towers with three levels of underground parking. The excavation will border the surrounding roads, including Parkdale Ave, Hamilton Ave, Armstrong St, and Spencer St. Shoring systems will be required to support the overburden and to protect the existing road infrastructure. Note the overburden thickness varies across the site.

Based on the boreholes advanced within the site, excavations within the upper 1.5 m of existing site grades are expected to be within the fill layers. This material would be 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. 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).

The stability of the wall of the excavation may be affected by surcharge loads, stockpiles as well as groundwater seepage conditions. Therefore, soils excavated from the trenches and/or construction materials should not be stockpiled adjacent to excavations.

It is understood that the excavation for the site may extend to the property line to the north, south, east and west sides of the excavation, which would require temporary support of the excavation.

The use of shotcrete on the excavation side walls could act as a mitigation method to reduce the risk of rockfall and groundwater seepage within the excavation. As per OPSS 203, shotcreting should not be carried out when the air temperature or existing rock face temperature is less than 10ºC or greater than 30ºC throughout the duration of the shotcreting operation unless cold weather protection is provided. All surfaces against which shotcrete is to be placed, should be cleaned of dust and loose material, solid, and free from loose or partially detached rock. Any foreign substances or other debris must be removed from the rock face. The minimum thickness of shotcrete applied will be 100 mm and its full thickness must be placed within the same day and cured for a minimum of 4 days. The shotcrete should be placed with a mesh of reinforced concrete and anchored to the rock face with dowels/pins to resist hydrostatic forces.

All shoring systems should be designed and approved by a qualified Professional Engineer. Shoring systems are understood to be required for at least portions of the excavations for the high-rise buildings. Soldier pile and lagging support systems are not considered feasible for use based on the groundwater conditions present at this site. Sheet pile wall or secant pile wall support systems are recommended as per Table 5.4. For each of these systems, some form of lateral support is generally required for excavations that extend to depths of about 2 m or more below ground surface. For the relatively

narrow excavations, the lateral restraint could include waler beams with bracing at corner points and/or interior struts connected to the opposite sides of the excavation. Lateral restraint for wider excavations is typically provided by ground (soil or rock) anchors, dead-man anchors or raker footings.

Table 5.4: Potential Soil Retention System

System	Advantage	Disadvantage	Relative Cost	Risks	Risk Attenuation Measures
• Soldier Piles and Timber Lagging • With inclined rock anchors	• Common practice • Pipe piles can be advanced trough the rock to below the excavation base for lateral pinning	• Does not retain water • Would require external dewatering	Lowest	• Groundwater problems	Dewatering and water treatment disposal
• Sheet Pile Wall • With inclined rock anchors	• Common practice • Provides better groundwater control	• Uneven rock surface would require grouting or concreting at the base of the sheets	Moderate	• Difficulties due to driving as a result of cobbles and boulders • Difficulties seating and sealing the sheet piles on an uneven rock surface	Switching to secant piles
• Secant Pile Wall • With inclined rock anchors	• Best groundwater control • Adapts well to uneven rock surfaces	• Specialist Contractor	High	• Anchor conflicts with existing infrastructure	None

For temporary works, it is the contractor's responsibility to develop and design a shoring to retain the soils and provide a dry and safe work excavation within the bedrock. Based on the above table, it is anticipated that the contractor would select either *sheet piling or* a *secant wall* construction approach in order to extend the excavations below the water table. A secant wall approach would impose the least risk, however is more costly.

In the case of *sheet piles* driven to bedrock, rock pins and lower-level rock anchors can be incorporated to provide lateral stability, as well as concreting the base of the sheet piles where a good contact has not been achieved in order to reduce the groundwater flow and ensuing ground loss.

If an excavation is made within sound and solid bedrock, the walls of the excavation may be left vertical, without shoring, provided that the rock is free from loose or potentially unstable fragments and the excavation is inspected by geotechnical personnel.

The transition in an unsupported slope from soil to rock can typically be irregular and transitional. Groundwater often accumulates at the transition and could create seepage issues that need to be controlled. If blasting is required for the rock excavation, it could lead to undermining of the overlying soils.

The contractor is fully responsible to select, design and implement a temporary support/shoring system meeting the requirements of OPSS.PROV 539, including establishing suitable geotechnical design parameters for the soil and groundwater conditions at the site. The earth pressure distributions to be used in the design of the shoring system will depend on the lateral support methods used (e.g. cantilever, dead man anchors, rakers, and bracing etc.); appropriate pressure distribution(s) may be selected from Chapter 26 of the Canadian Foundation Engineering Manual.

5.9.1 Excavations in Bedrock

Excavations in bedrock are anticipated for the proposed development. At some borehole locations, the upper portion (1 m) of the bedrock is lower quality (poor) and can likely be excavated using hoe-ramming. Deeper bedrock will require other methods, described below. Excavations in competent rock may be conducted with vertical walls up to a depth of 3 m, except in cases where the excavation is immediately adjacent to an existing structure. For excavations deeper than 3 m in rock, rock mass stabilization will be required, as described in Section 5.9.2.

Drilling, blasting, and hoe ramming techniques will be required to excavate bedrock. If the bedrock is overly fractured such that loose rock cannot be entirely removed, a temporary rock catchment system such as a wire mesh system should be used. The catchment system should be designed to contain and/or prevent loose rock particles from falling on workers within the excavation.

During winter conditions, ice building-up on the surface of the rock face could occur. Additional precautions should be taken to mitigate the risk of ice falls.

5.9.2 Rock Mass Stabilization

Excavation-related vibration (including from mechanical excavation methods) may have the potential to cause movement; so too could incorrect excavation sequencing. Movement is more likely to occur along faults, bedding planes and joints, as opposed to stress-related movements.

Based on the results of this analysis, the excavations may require pre-support of the rock consisting of untensioned dowels to integrate the rock mass, as well as tensioned rock bolts to provide positive restraint to areas identified as potential wedge or block failures. Rock mass stabilization may be needed in the upper weathered/highly fractured portion of the bedrock.

The walls of the rock excavation should be inspected regularly, as the excavation progresses, by the contractor's geotechnical engineer to determine if rock anchors are required to address any unfavorable conditions due to the exposed joint sets and random joints. Any use of rock anchors would need to consider the presence of nearby structures.

5.9.3 Earth Pressures on Shoring Systems and Walls

Earth pressure will need to be considered in the design of shoring systems for temporary excavations during construction and walls. The table below gives the coefficients of lateral earth pressure for shoring systems and walls. These values are based on the assumption that a horizontal back slope will be utilized behind the shoring system and walls.

Table 5.5: Lateral Earth Pressure Parameters

Parameter	Existing Fill	OPSS Granular A	OPSS Granular B Type I
Unit Weight (kN/m^3)	19	22.0	21.2
Angle of Internal Friction, Φ	32°	40°	35°
Coefficient of Passive Earth Pressure, K_p	3.25	4.60	3.69
Coefficient of at Rest Earth Pressure, K_o	0.47	0.36	0.43
Coefficient of Active Earth Pressure, K_a	0.31	0.22	0.27

5.10 GROUNDWATER CONTROL

Separate hydrogeological and environmental studies have been carried out for the site and are reported under a separate cover. The Contractor is solely responsible for the design and implementation of any required unwatering and/or dewatering, including requirements for withdrawal, handling, treatment, and discharge. This hydrogeological and environmental reports should be reviewed for recommendations relating to groundwater control.

6.0 CONSTRUCTION CONSIDERATIONS AND CONSTRAINTS

6.1 WATERPROOFING

The proposed development is to include multiple underground levels; it is anticipated that the preferred solution will be to waterproof the basements of the proposed buildings. Waterproofing and vapour barriers are understood to be part of the design due to the existing contamination at the site. Waterproof and vapour barriers of the basement will include both vertical barriers of the foundations walls and horizontal barriers of the lower floor and foundation. Waterproofing a lower floor usually involves several steps, with the exact sequence and method depending on the chosen waterproofing products.

- Preparation of the rock surface, shotcrete may be used in preparation of the walls as described in Section 5.9.
- Installation or rock anchors that will tie down the structural slab to resist and hydrostatic pressure and relief valves to reduce the hydrostatic uplift forces.
- Placement of the structural footings on the rock.
- Placement of a waterproof membrane.
- Placement of a granular drainage layers, clearstone, with drains every 6 to 8 m to capture leakage from the waterproofing.
- Placement of 50 mm of OPSS Granular A to provide a stable construction layer over the clearstone.

- Placement of a vapour barrier.
- Placement of the lower-level concrete slab.

As the design progresses, a geotechnical engineer should review the details of the proposed system. It should be noted that the above procedure may need to be redesigned after selection of the waterproofing and vapour barrier systems. These membrane systems have manufacturer specific design requirements that may require specific preparations for construction. The required capacity of the groundwater handling system will need to be assessed by a hydrogeologist once the final basement elevations are confirmed. Different volumes would be anticipated for different quality bedrock. The proposed basement floor level is not known at this time; the required capacity of the groundwater handling system should be estimated based on the hydrogeological assessment.

With the design of the waterproofing system, the water collection system and structure will need to be designed to consider the build up of hydrostatic pressure based on the depth of the below grade levels with respect to the groundwater levels at the site. The design should be able to withstand water pressure from the sides and below corresponding to 13 m of water head, a factor of safety should be included in the design.

6.2 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/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/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 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.

6.3 VIBRATIONS MONITORING AND PRE-CONSTRUCTION SURVEYS

The required construction activities for the proposed building will generate some vibrations that will be perceptible to nearby residents. The vibrations are expected to be greatest during bedrock excavation by blasting/mechanical methods. It is recommended that pre-construction surveys of all buildings, utilities, structures, water wells and facilities likely to be affected by the blast be carried out in accordance with OPSS Muni 120 “General Specifications for the Use of Explosives”.

It is recommended that construction vibrations generally be limited to a maximum peak particle velocity as outlined in OPSS Muni 120. Should there be structures in the area sensitive to vibrations, more stringent specifications should be developed by a vibration specialist. For instance, the particle velocity should be limited to 10 mm/sec if there is any historic building in the area. Vibration monitoring should be carried out prior to and throughout the construction period.

No blasting should be carried out within a distance of 200 m from any water storage reservoir, pumping station, water works transformer station or water storage tank without prior approval by the owner of the facility. Additionally, the City of Ottawa has restrictions for blasting within a radius of 300 m of any school building or hospital.

Means and methods for rock excavation and rock removal are the responsibility of the Contractor.

7.0 REFERENCES

Armstrong, Derek K., and J. E. P. Dodge. "Paleozoic geology of southern Ontario." Ontario Geological Survey, Miscellaneous Release—*Data* 219 (2007): 2007.

ASTM 4.08. Standard D2487-06: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

Canadian Geotechnical Society. Canadian Foundation Engineering Manual, 5th Edition. Richmond: BiTech Publisher Ltd, 2023.

Chapman, L.J. and Putnam, D.F. 1984. The Physiography of Southern Ontario; Ontario Geological Survey, Special Volume 2, 270p. Accompanied by Map P.2715 (coloured), scale 1:600 000.

Ministry of Labour. Occupational Health & Safety Act & Regulations Consolidated Edition. Carswell, 2017.

Natural Resources Canada (2020 National Building Code). https://www.seismiccanada.mcan.gc.ca.

Ontario Geological Survey 2000. Quaternary geology, seamless coverage of the Province of Ontario; Ontario Geological Survey, Data Set 14---Revised.

Ontario Ministry of Northern Development and Mines. (2012, October 5). Geotechnical boreholes. Ontario Data Catalogue

Ontario Geological Survey 2010. Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128-REV.

Ontario Geological Survey (OGS) Paleozoic Geology of Southern Ontario mapping data (MRD219, 2007).

Ontario Ministry of the Environment, Conservation and Park (MECP) Water Well Record database.

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.

We trust that the information contained in this report is adequate for your present purposes. If you have any questions about the contents of the report or if we can be of any other assistance, please contact us at your convenience.

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 KEY PLAN

B.2 BOREHOLE LOCATION PLAN

B.3 SITE PLAN OF PROPOSED DEVELOPMENT

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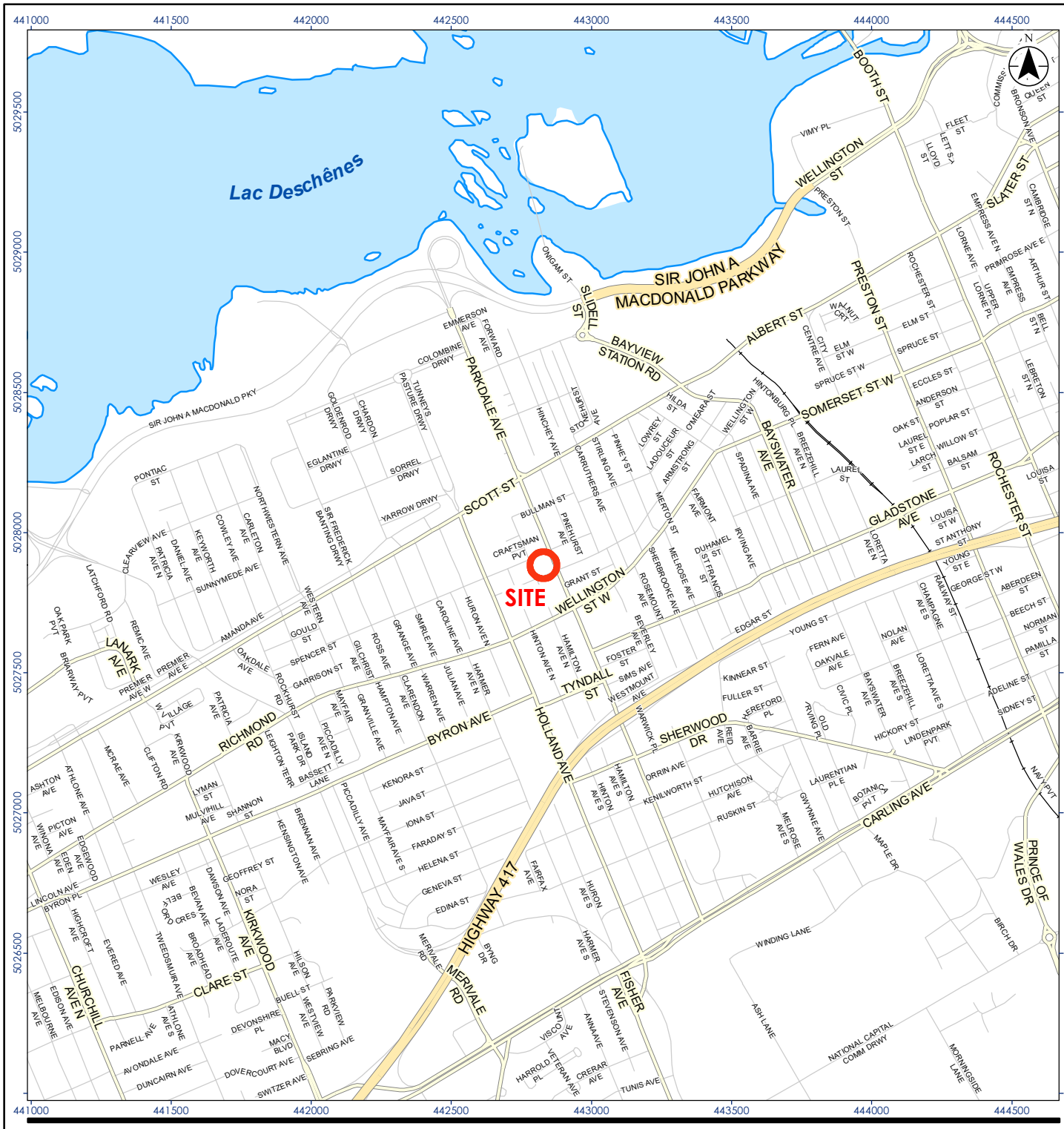


Notes
1. Coordinate System: NAD 1983 UTM Zone 18N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2023.
3. Imagery provided by Esri ©2025

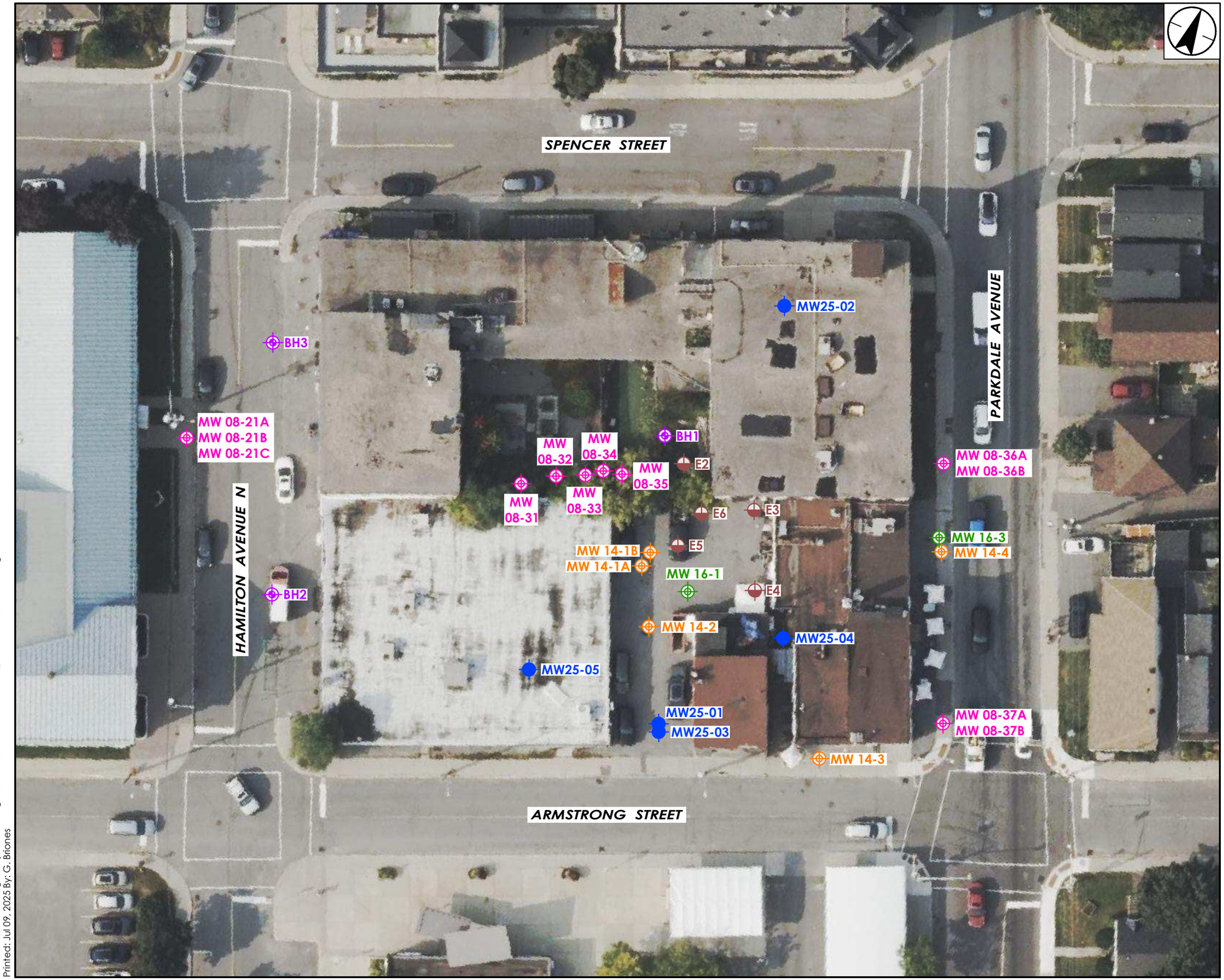
Stantec

Project Location	Project No. 122170424
340 Pardale Avenue Ottawa, Ontario	Prepared by G. Briones on 2025-07-09

Client/Project
CORPORATION 1000147699 C/O TAGGART REALTY MANAGEMENT, GEOTECHNICAL INVESTIGATION - PARKDALE DEVELOPMENT

Drawing No.
1

Title
KEY PLAN



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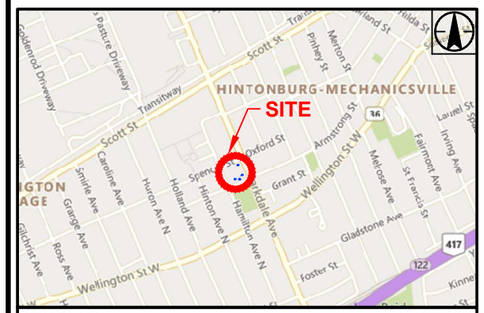
LEGEND

- MONITORING WELL (STANTEC, 2025)
- MONITORING WELL (GOLDER, 2016)
- MONITORING WELL (GOLDER, 2014)
- INJECTION WELL (GOLDER, 2014)
- MONITORING WELL (GOLDER, 2008)
- MONITORING WELL (PATTERSON, 2010)



KEY PLAN 1 : 20 000

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 18N.
2. IMAGERY:IMAGERY: © 2025 MICROSOFT CORPORATION © 2025 MAXAR © CNES (2025) DISTRIBUTION AIRBUS DS.

4m 0 4 8m
1 : 400

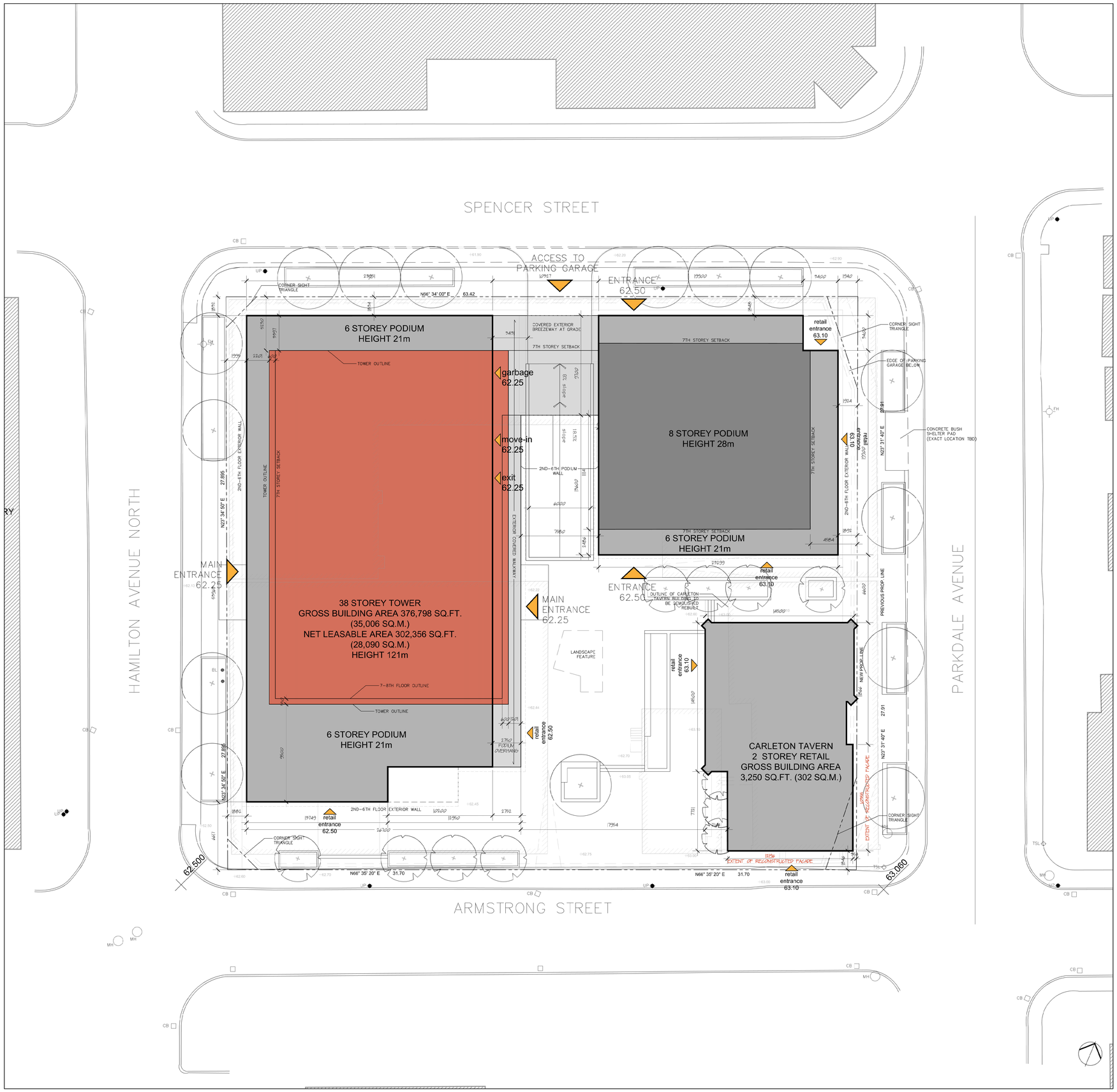
JULY 2025
Project No. 122170424

Client/Project
CORPORATION 1000147699 C/O TAGGART REALTY MANAGEMENT
GEOTECHNICAL INVESTIGATION - PARKDALE DEVELOPMENT, 340 PARKDALE AVENUE, OTTAWA, ON

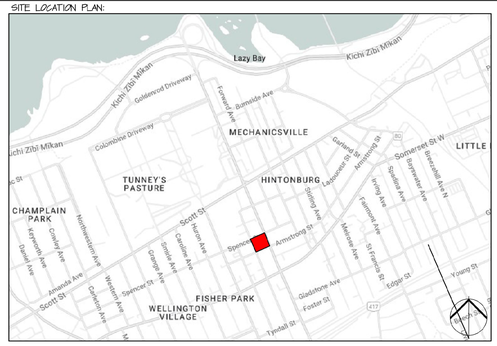
Drawing No.
2

Title
BOREHOLE LOCATION PLAN

T:\Autocad\Drawings\Project Drawings\2025\122170424\122170424_Borehole Locations.dwg
Printed: Jul 09, 2025 By: G. Briones



SITE LOCATION PLAN:



ZONING NOTES

CURRENT ZONING: MC16 [2093] H(60) S333-h & LB [104] H(12.0) H(135)

LOT AREA 3898 m²

DEVELOPMENT STATS

	PROPOSED
LOT WIDTH	63.4m
LOT DEPTH	55.1m
UNITS	
TOTAL UNITS	283
PARKDALE SETBACK	3.0 m
ARMSTRONG SETBACK	VARIES MINIMUM 1m
HAMILTON SETBACK	2.0 m
SPENCER SETBACK	VARIES MINIMUM 2m
BUILDING HEIGHTS	
6 storey podium	21 m
38 STOREY TOWER	+/-121 m
BUILDING AREA	
TOTAL GROSS	+/-44521 sq.ft. (4,792 sqm)
TOTAL NET (RESIDENTIAL + COMMERCIAL/RETAIL)	+/-366,425 sq.ft (34,04 sqm)
GROSS FLOOR AREA (city def.)	TBD

NOTE: ALL EXISTING SITE INFORMATION AS PER SITE SURVEY PLAN DATED JANUARY 16, 2024 AND PREPARED BY STANTEC GEOMATICS LTD

UNIT RATIOS

	PROPOSED	
TOTAL UNIT COUNT	527	
STUDIOS	74	14%
1 BEDROOM	241	46%
1 BEDROOM + DEN	40	8%
2 BEDROOM	114	40%
2 BEDROOM + DEN (3 BED)	16	3%

AMENITY SPACE REQUIREMENTS: 6 m² REQUIRED PER UNIT
(527 X 6 SQM. = 3162 SQM. REQUIRED TO BE AMENITY SPACE)
(1581 SQM. REQUIRED TO BE COMMON AMENITY SPACE)

PROVIDED AMENITY SPACE
TOTAL AMENITY AREA: TBD
TOTAL COMMUNAL AMENITY AREA: TBD EXTERIOR, TBD INTERIOR
TOTAL PRIVATE AMENITY AREA: TBD

VEHICLE PARKING

RESIDENTIAL
REQUIRED: 0 PROVIDED: 302 (.057/unit)
VISITOR
REQUIRED: 30 PROVIDED: 55 (.01/unit)
COMMERCIAL
REQUIRED: TBD PROVIDED: TBD

BICYCLE PARKING

REQUIRED: 0.5*527 = 264
PROVIDED: 264 (194 VERTICAL, 192 HORIZONTAL)
LOCATION: UNDERGROUND PARKING GARAGE AND GROUND FLOOR (INTERIOR)

LEGEND:

DRAFT

TAGGART REALTY MANAGEMENT

PROJECT TEAM

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STANTECT GEOMATICS
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no.	date	revision
1	24-12-03	ISSUED FOR PRECONSULTATION

It is the responsibility of the appropriate contractor to check and verify all dimensions on site and report all errors and/or omissions to the architect.

All contractors must comply with all pertinent codes and by-laws.

Do not scale drawings.

This drawing may not be used for construction until signed.

Hobin Architecture Incorporated
63 Pamilla Street
Ottawa, Ontario
Canada K1S 3K7
T: 613-238-7200
F: 613-235-2005
E: mail@hobinarc.com
hobinarc.com

HOBIN ARCHITECTURE

PROJECT/LOCATION:
340 PARKDALE
OTTAWA ON.

DRAWING TITLE:
SITE PLAN

DRAWN BY:	DATE:	SCALE:
PB	24-12-03	1:150

PROJECT: 2409

DRAWING NO.: A100

REVISION NO.:

None
2409

APPENDIX C

C.1 SYMBOLS AND TERMS USED ON BOREHOLE RECORDS

C.2 BOREHOLE LOGS

C.3 BEDROCK CORE PHOTOGRAPHS

C.4 BOREHOLE LOGS – PREVIOUS INVESTIGATIONS BY OTHERS

MONITORING WELL RECORD

MW25-1

CLIENT: **Taggart Realty Management** PROJECT NO. : **122170424**

PROJECT: **Pardakle Tower Development** MW ELEVATION: **62.74m**

LOCATION: **340 Armstrong Street, Ottawa, ON** DATUM: **Geodetic**

DATE BORED: **05/05/2025 to 05/06/2025** WATER LEVEL: **5.4 m on 07/17/2025**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (USCS)	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or TCR %	SAMPLES N-VALUE or RQD %	OTHER TESTS / REMARKS
0	62.7							
	62.7	ASPHALT - 50 mm		GS	1			
	62.7	FILL: Grey SAND and GRAVEL, moist						
	62.5	FILL: Brown SAND and GRAVEL, contains cobbles and boulders, moist		GS	2			
1	61.6							
	61.4	Boulders						
		Slightly to freshly weathered (W2-W1), strong to very strong (R4-R5) fine to medium grained, grey to dark grey, thinly to thickly bedded LIMESTONE with shale interbeds (Refer to Bedrock Core Log)		HQ	3	100	21	
2				HQ	4	88	86	
3				HQ	5	100	100	UCS = 201.5 MPa
4				HQ	6	100	100	
5				HQ	7	100	100	
6				HQ	8	100	100	UCS = 173.9 MPa
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH, Cu (kPa)

LABORATORY TEST ▲ FIELD VANE TEST ◆

POCKET PEN. ★ POCKET SHEAR VANE ◘

50 kPa 100 kPa 150 kPa 200 kPa

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

SPT (N-value) BLOWS/0.3m ●

Water Content (%) and Blow Count

10 20 30 40 50 60 70 80

BACKFILL/ MONITOR WELL/ PIEZOMETER

ELEVATION (m)

62 61 60 59 58 57 56 55 54 53

▼ Water Level Measured On Date Indicated

BACKFILL SYMBOL: ASPHALT, GROUT, CONCRETE, BENTONITE, DRILL CUTTINGS, SAND, SLOUGH

Drilling Contractor: Downing Drilling | Logged By: MG

Drilling Method: HW/HQ | Reviewed By: KF

Completion Depth: 18.5 m | Page 1 of 2

Stantec

MONITORING WELL RECORD

MW25-1

CLIENT: **Taggart Realty Management** PROJECT NO. : **122170424**

PROJECT: **Pardakle Tower Development** MW ELEVATION: **62.74m**

LOCATION: **340 Armstrong Street, Ottawa, ON** DATUM: **Geodetic**

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UNDRAINED SHEAR STRENGTH, Cu (kPa)
LABORATORY TEST ▲ FIELD VANE TEST ◆
POCKET PEN. ★ POCKET SHEAR VANE ◘
50 kPa 100 kPa 150 kPa 200 kPa
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N-value) BLOWS/0.3m ●
Water Content (%) and Blow Count
10 20 30 40 50 60 70 80

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (USCS)	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or TCR %	SAMPLES N-VALUE or RQD %	OTHER TESTS / REMARKS	BACKFILL/ MONITOR WELL/ PIEZOMETER	ELEVATION (m)
10				HQ	9	100	100	UCS = 176.6 MPa		52
11				HQ	10	100	100			51
12				HQ	11	100	100			50
13				HQ	12	100	100	UCS = 185.3 MPa		49
14				HQ	13	100	100			48
15				HQ	14	100	100			47
16										46
17								UCS = 94.9 MPa		45
18	44.2									44
19		End of Borehole UCS = Unconfined Compressive Strength								43
20										

▼ Water Level Measured On Date Indicated

BACKFILL SYMBOL: ASPHALT, GROUT, CONCRETE, BENTONITE, DRILL CUTTINGS, SAND, SLOUGH

Drilling Contractor: Downing Drilling | Logged By: MG

Drilling Method: HW/HQ | Reviewed By: KF

Completion Depth: 18.5 m | Page 2 of 2

Printed Jul 8 2025 16:21:47 STANTEC GEO 2016 122170424_PARKDALE-TOWER.GPJ GINT_1233_SOIL_2018_DATA_TEMP_REV2.GDT 7/8/25

Stantec

Field Bedrock Core Log

Client: Taggart Realty Management
Project: Parkdale Tower Development
Contractor: George Downing Estate Drilling Ltd.

Project No.: 122170424
Date: 05/05/2025 to 05/06/2025
Borehole No.: MW25-1
Logger: MG

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
1.37	HQ3	100	21	1.85	Slightly weathered (W2), medium strong (R3) fine to medium grained, grey to dark grey, thickly bedded LIMESTONE with medium shale interbeds	R3	W2	6	B	F		RU		SA		
									B	F		RU		SA		
									JN	F		RU		T		
									B	V		RU		T		
									B	F		RP		Si		
									B	F		SP		NC		
1.85	HQ4	88	86	3.4	Fresh (W1), strong (R4) fine to medium grained, grey to dark grey, thickly bedded LIMESTONE with medium shale interbeds	R4	W1	5	B	F		SP		T		
									B	F		SP		NC		
									B	F		RU		SA		
									B	F		RP		T		
									B	F		RU		SA		
3.4	HQ5	100	99	4.93	Fresh (W1), strong (R4) fine to medium grained, grey to dark grey vuggy, laminated to very thinly bedded LIMESTONE and SHALE.	R4	W1	2	B	F		RP		T		
									B	F		RP		T		
4.93	HQ6	100	94	6.45	Fresh (W1), strong (R4) fine to medium grained, grey to dark grey vuggy, laminated to very thinly bedded LIMESTONE and SHALE.	R4	W1	2	B	F		RP		T		
									B	F		RP		T		

STRENGTH (MPa)

Grade/Classification	Est. Strength (MPa)
R0 Extremely Week	0.25 - 1.0
R1 Very Weak	1.0 - 5.0
R2 Weak	5.0 - 25.0
R3 Medium Strong	25.0 - 50.0
R4 Strong	50.0 - 100.0
R5 Very Strong	100.0 - 250.0
R6 Extremely Strong	>250.0

JOINT TYPE

BD = Bedding
JN = Joint
FOL = Foliation
CON = Contact
FLT = Fault
VN = Vein

ORIENTATION

F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

FILLING

T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

WEATHERING

Grade/Classification	Description
W1 Fresh	No Visible Signs of Weathering
W2 Slightly	Discoloration, Weathering on Discontinuities
W3 Moderately	<50% of Rock Material is Decomposed, Fresh Core Stones
W4 Highly	>50% Decomposed to soil: Fresh Core Stones
W5 Completely	100% Decomposed to Soil: Original Structure Intact
W6 Residual Soil	All Rock Converted to Soil, Structure and Fabric Destroyed

DISCONTINUITY SPACING

Spacing (mm)	
EW = >6000	Extremely Wide
VW = 2000 - 6000	Very Wide
W = 600 - 2000	Wide
M = 200 - 600	Moderate
C = 60 - 200	Close
VC = 20 - 60	Very Close
EC = <20	Extremely Close

JOINT ROUGHNESS

Jr	Description
4	DJ = Discontinuous Joints
3	RU = Rough, Irregular, Undulating
1.5	SU = Smooth, Undulating
1.5	LU = Slickensided, Undulating
1.0	RP = Rough or Irregular, Planar
0.5	SP = Smooth, Planar
2	LP = Slickensided, Planar

Stantec

Field Bedrock Core Log

Client: Taggart Realty Management
Project: Parkdale Tower Development
Contractor: George Downing Estate Drilling Ltd.

Project No.: 122170424
Date: 05/05/2025 to 05/06/2025
Borehole No.: MW25-1
Logger: MG

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
6.45	HQ7	100	100	7.98	Fresh (W1), strong (R4) fine to medium grained, grey to dark grey, medium bedded LIMESTONE with thinly laminated to laminated shale	R3	W1	1	B	F		RP		T		
7.98	HQ8	100	99	9.5	Fresh (W1), strong (R4) fine to medium grained, grey to dark grey, medium bedded LIMESTONE with thinly laminated to laminated shale	R4	W1	2	B B	F F		RP RP		T T		
9.5	HQ9	100	100	10.92	Fresh (W1), strong (R4) fine to medium grained, grey to dark grey, medium bedded LIMESTONE with thinly laminated to laminated shale	R4	W1	1	B	F		RU		NC		
10.92	HQ10	100	100	12.45	Fresh (W1), strong (R4) fine to medium grained, grey to dark grey, medium bedded LIMESTONE with thinly laminated to laminated shale	R4	W1	1	B	F		RU		NC		

STRENGTH (MPa)

Grade/Classification	Est. Strength (MPa)
R0 Extremely Week	0.25 - 1.0
R1 Very Weak	1.0 - 5.0
R2 Weak	5.0 - 25.0
R3 Medium Strong	25.0 - 50.0
R4 Strong	50.0 - 100.0
R5 Very Strong	100.0 - 250.0
R6 Extremely Strong	>250.0

JOINT TYPE

BD = Bedding
JN = Joint
FOL = Foliation
CON = Contact
FLT = Fault
VN = Vein

ORIENTATION

F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

FILLING

T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

WEATHERING

Grade/Classification	Description
W1 Fresh	No Visible Signs of Weathering
W2 Slightly	Discoloration, Weathering on Discontinuities
W3 Moderately	<50% of Rock Material is Decomposed, Fresh Core Stones
W4 Highly	>50% Decomposed to soil: Fresh Core Stones
W5 Completely	100% Decomposed to Soil: Original Structure Intact
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DISCONTINUITY SPACING

Spacing (mm)	
EW = >6000	Extremely Wide
VW = 2000 - 6000	Very Wide
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VC = 20 - 60	Very Close
EC = <20	Extremely Close

JOINT ROUGHNESS

Jr	Description
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3	RU = Rough, Irregular, Undulating
1.5	SU = Smooth, Undulating
1.5	LU = Slickensided, Undulating
1.0	RP = Rough or Irregular, Planar
0.5	SP = Smooth, Planar
2	LP = Slickensided, Planar

Stantec

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Client: Taggart Realty Management
Project: Parkdale Tower Development
Contractor: George Downing Estate Drilling Ltd.

Project No.: 122170424
Date: 05/05/2025 to 05/06/2025
Borehole No.: MW25-1
Logger: MG

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
12.45	HQ11	100	97	13.97	Fresh (W1), strong (R4) fine to medium grained, grey to dark grey, medium bedded LIMESTONE with thinly laminated to laminated shale	R3	W1	1	B	F		RP		T		
13.97	HQ12	100	100	15.37	Fresh (W1), strong (R4) fine to medium grained, grey to dark grey, medium bedded LIMESTONE with thinly bedded shale	R4	W1	1	B	F		RP		T		
15.37	HQ13	100	97	16.97	Fresh (W1), strong (R4) fine to medium grained, grey to dark grey, medium bedded LIMESTONE with thinly bedded shale	R4	W1	1	B	F		RU		NC		
16.97	HQ14	100	100	18.49	Fresh (W1), strong (R4) fine to medium grained, grey to dark grey, medium bedded LIMESTONE with thinly bedded shale	R4	W1	1	B	F		RU		NC		

STRENGTH (MPa)

Grade/Classification	Est. Strength (MPa)
R0 Extremely Week	0.25 - 1.0
R1 Very Weak	1.0 - 5.0
R2 Weak	5.0 - 25.0
R3 Medium Strong	25.0 - 50.0
R4 Strong	50.0 - 100.0
R5 Very Strong	100.0 - 250.0
R6 Extremely Strong	>250.0

JOINT TYPE

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JN = Joint
FOL = Foliation
CON = Contact
FLT = Fault
VN = Vein

ORIENTATION

F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

FILLING

T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
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1.5	LU = Slickensided, Undulating
1.0	RP = Rough or Irregular, Planar
0.5	SP = Smooth, Planar
2	LP = Slickensided, Planar

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 1	Borehole: BH25-01 (dry)	Depth: 1.4– 3.1 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 2	Borehole: BH25-01 (wet)	Depth: 1.4– 3.1 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 3	Borehole: BH25-01 (dry)	Depth: 3.1 – 4.8 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 4	Borehole: BH25-01 (wet)	Depth: 3.1 – 4.8 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 5	Borehole: BH25-01 (dry)	Depth: 4.8 – 6.3 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 6	Borehole: BH25-01 (wet)	Depth: 4.8 – 6.3 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 7	Borehole: BH25-01 (dry)	Depth: 6.3 – 8.0 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 8	Borehole: BH25-01 (wet)	Depth: 6.3 – 8.0 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 9	Borehole: BH25-01 (dry)	Depth: 8.0 – 9.5 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 10	Borehole: BH25-01 (wet)	Depth: 8.0 – 9.5 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 11	Borehole: BH25-01 (dry)	Depth: 9.5 – 10.9 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 12	Borehole: BH25-01 (wet)	Depth: 9.5 – 10.9 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 13	Borehole: BH25-01 (dry)	Depth: 10.9 – 12.5 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 14	Borehole: BH25-01 (wet)	Depth: 10.9 – 12.5 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 15	Borehole: BH25-01 (dry)	Depth: 12.5 – 14.0 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 16	Borehole: BH25-01 (wet)	Depth: 12.5 – 14.0 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 17	Borehole: BH25-01 (dry)	Depth: 14.0 – 15.4 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 18	Borehole: BH25-01 (wet)	Depth: 14.0 – 15.4 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 19	Borehole: BH25-01 (dry)	Depth: 15.4 – 17.0 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 20	Borehole: BH25-01 (wet)	Depth: 15.4 – 17.0 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 21	Borehole: BH25-01 (dry)	Depth: 17.4 – 18.5 m

Stantec	Project No.: 122170424 Project Name: Parkdale Tower Development	Rock Core Photograph

Rock Core Photo No.: 22	Borehole: BH25-01 (wet)	Depth: 17.4 – 18.5 m

PROJECT: 1649112

RECORD OF BOREHOLE: 16-01

SHEET 1 OF 4

LOCATION: N ;E

BORING DATE: October 4, 5, 6, 2016

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
0		GROUND SURFACE									
0	Geoprobe Direct Push	ASPHALTIC CONCRETE FILL - (SP/GP) SAND and GRAVEL; brown grey; non-cohesive, dry, medium to compact		0.05	1	SS	-				Flush Mount Casing Bentonite Gravel Grout
1					2	SS	-				
		Borehole continued on RECORD OF DRILLHOLE 16-01		1.58							
2											
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: JW

MIS-BHS 001 1649112.GPJ GAL-MIS.GDT 11/25/20

PROJECT: 1649112

RECORD OF DRILLHOLE: 16-01

SHEET 2 OF 4

LOCATION: N ;E

DRILLING DATE: October 4, 5, 6, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55

DRILLING CONTRACTOR: Strata 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	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		BEDROCK SURFACE																	
2	Rotary Drill NQ Core	**UNIT G2** Fresh to moderately weathered, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		1.58	C1														
					C2														
				2.21															
3		**UNIT G3** Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.			C3														
					C4														
4																			
5					C5														
6		**UNIT G4** Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		5.56															
					C6														Grout
7		**UNIT G5** Fresh, medium to dark grey, very fine to fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.68															
					C7														
8																			
9		**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.		8.46	C8														
					C9														
11				10.87															
					C10														
		CONTINUED NEXT PAGE																	

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: JW

MIS-RCK 004 1649112.GPJ GAL-MISS.GDT 11/25/20

PROJECT: 1649112

RECORD OF DRILLHOLE: 16-01

SHEET 3 OF 4

LOCATION: N ;E

DRILLING DATE: October 4, 5, 6, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55

DRILLING CONTRACTOR: Strata 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	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		--- CONTINUED FROM PREVIOUS PAGE ---																	
12	Rotary Drill NQ Core	**UNIT G7** Fresh, medium to dark grey, fine grained, thinly to medium bedded, laminar, mottled to nodular textured, argillaceous **Limestone** with interbedded medium grey fine to medium grained partly crystalline, stylolitic limestone and minor calcareous siltstone.			C11														
13					C12														
14					C13														Grout
15																			
16					C14														
17		**UNIT G8** Fresh, light greenish to grey, fine grained, fainly porous, thin to thickly bedded, mottled to brecciated textured, bioturbated, dolomitic, siliceous **Siltstone** and fine grained **Sandstone** with interbeds of laminar to nodular textured **Limestone** and **Dolomitic Limestone**.		16.56	C15														Bentonite Pellets
18																			
19		**UNIT G7** Fresh, medium to dark grey, fine grained, thinly to medium bedded, laminar, mottled to nodular textured, argillaceous **Limestone** with interbedded medium grey fine to medium grained partly crystalline, stylolitic limestone and minor calcareous siltstone.		18.59	C16														Silica Sand
20																			38 mm Diam. PVC #10 Slot Screen
21					C17														
					C18														
		CONTINUED NEXT PAGE																	

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: JW

MIS-RCK 004 1649112.GPJ GAL-MISS.GDT 11/25/20

PROJECT: 1649112

RECORD OF DRILLHOLE: 16-01

SHEET 4 OF 4

LOCATION: N ;E

DRILLING DATE: October 4, 5, 6, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55

DRILLING CONTRACTOR: Strata 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	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		--- CONTINUED FROM PREVIOUS PAGE ---																	
22	Rotary Drill / NQ Core				C18														38 mm Diam. PVC #10 Slot Screen
		End of Drillhole		22.05															
23																			
24																			
25																			
26																			
27																			
28																			
29																			
30																			
31																			

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JD
CHECKED: JW

MIS-RCK 004 1649112.GPJ GAL-MISS.GDT 11/25/20

PROJECT: 1649112

RECORD OF BOREHOLE: 16-03

SHEET 1 OF 4

LOCATION: N ;E

BORING DATE: October 7, 11, 12, 2016

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 - ○	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) WATER CONTENT PERCENT Wp W Wl	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	Geoprobe Direct Push	CONCRETE		0.00							Flush Mount Casing
		FILL - (SP/GP) SAND and GRAVEL; brown grey; non-cohesive, dry, compact		0.10	1	SS	-				Grout
1		Borehole continued on RECORD OF DRILLHOLE 16-03		1.22							
2											
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: JW

MIS-BHS 001 1649112.GPJ GAL-MIS.GDT 11/25/20

PROJECT: 1649112

RECORD OF DRILLHOLE: 16-03

SHEET 2 OF 4

LOCATION: N ;E

DRILLING DATE: October 7, 11, 12, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55

DRILLING CONTRACTOR: Strata 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	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		BEDROCK SURFACE																	
2	Rotary Drill NQ Core	**UNIT G2** Fresh to moderately weathered, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		1.22	C1														
					C2														
3					C3														
4		**UNIT G3** Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		3.68	C4														
5		**UNIT G4** Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		4.57	C5														Grout
6																			
7		**UNIT G5** Fresh, medium to dark grey, very fine to fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		7.01	C6														
8																			
9		**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.		9.04	C7														
10					C8														
11																			
		CONTINUED NEXT PAGE																	

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: JW

MIS-RCK 004 1649112.GPJ GAL-MISS.GDT 11/25/20

PROJECT: 1649112

RECORD OF DRILLHOLE: 16-03

SHEET 3 OF 4

LOCATION: N ;E

DRILLING DATE: October 7, 11, 12, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55

DRILLING CONTRACTOR: Strata 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.	FLUSH	COLOUR % RETURN	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	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		--- CONTINUED FROM PREVIOUS PAGE ---																		
12	Rotary Drill NQ Core	**UNIT G7** Fresh, medium to dark grey, fine grained, thinly to medium bedded, laminar, mottled to nodular textured, argillaceous **Limestone** with interbedded medium grey fine to medium grained partly crystalline, stylolitic limestone and		11.30	C8															
					C9															
					C10															
13					C11															
14																				Grout
					C12															
15																				
16					C13															
		UNIT G8 Fresh, light greenish to grey, fine grained, fainly porous, thin to thickly bedded, mottled to brecciated textured, bioturbated, dolomitic, siliceous **Siltstone** and fine grained **Sandstone** with interbeds of laminar to nodular textured **Limestone** and **Dolomitic Limestone**.		16.79																
17					C14															
18																				Bentonite Pellets
					C15															Silica Sand
19																				
20					C16															38 mm Diam. PVC #10 Slot Screen
21																				
		CONTINUED NEXT PAGE																		

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: JW

MIS-RCK 004 1649112.GPJ GAL-MISS.GDT 11/25/20

PROJECT: 1649112

RECORD OF DRILLHOLE: 16-03

SHEET 4 OF 4

LOCATION: N ;E

DRILLING DATE: October 7, 11, 12, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55

DRILLING CONTRACTOR: Strata 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	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		--- CONTINUED FROM PREVIOUS PAGE ---																	
22	Rotary Drill / NQ Core				C16														38 mm Diam. PVC #10 Slot Screen
					C17														Native Backfill
		End of Drillhole		22.15															
23																			
24																			
25																			
26																			
27																			
28																			
29																			
30																			
31																			

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JD
CHECKED: JW

MIS-RCK 004 1649112.GPJ GAL-MISS.GDT 11/25/20

Monitoring Well: MW25-02

Project:	Proposed Hintonburg Development	**Method:**	Hilti DD250 (Core)
Client:	Taggart	**Date started/completed:**	22-May-2025
Location:	Ottawa, ON	**Ground surface elevation:**	n/a
Number:	122170424	**Top of casing elevation:**	n/a
Field investigator:	J. Zachariah	**Easting:**	n/a
Contractor:	OGS	**Northing:**	n/a

SUBSURFACE PROFILE				SAMPLE DETAILS						INSTALLATION DETAILS	
Depth (ft)	Depth (m)	Graphic Log	Stratigraphic Description	Depth (m BGS)	Sample Number	Sample Type	Recovery	SCR	RQD	Fractures per 1.52m	Diagram / Description
			Ground Surface								
			CONCRETE	0.00							Flushmount protective cover with concrete seal
			GRANULAR (FILL) coarse	0.13							
2			LIMESTONE (BEDROCK) grey, highly weathered, interbedded shale	0.46	1	CORE	5" 63%	2" 25%	0" 0%	n/a	
			- grey-black		2	CORE	10" 91%	1" 9%	0" 0%	11	32 mm ID PVC pipe backfilled with bentonite
4	1				3	CORE	35" 85%	24" 58%	14" 34%	13	
6	2		- black		4	CORE	33" 100%	33" 100%	32" 97%	3	
8											
10	3				5	CORE	24" 92%	23" 88%	23" 88%	2	32 mm ID slotted PVC pipe backfilled with silica sand
12	4				6	CORE	26" 96%	23" 85%	19" 70%	5	
14					7	CORE	21" 105%	21" 105%	17" 85%	3	
16	5		End of Borehole	4.68							

Screen Interval: 1.63 - 4.68 m BGS
Sand Pack Interval: 1.32 - 4.68 m BGS
Well Seal Interval: 0.23 - 1.32 m BGS

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
n/a - not available

BTEX - benzene, toluene, ethylbenzene, xylenes
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
PAHs - polycyclic aromatic hydrocarbons
M&I - Metals and inorganics
VOCs- volatile organic compounds
FOC - fraction organic carbon
SPLP - synthetic precipitation leaching procedure
gs - grain size
EC - electrical conductivity
SAR - sodium adsorption ratio

Stantec

Drawn By/Checked By: M. Ford

Monitoring Well: MW25-03

Project:	Proposed Hintonburg Development	**Method:**	Hilti DD250 (Core)
Client:	Taggart	**Date started/completed:**	26-May-2025
Location:	Ottawa, ON	**Ground surface elevation:**	n/a
Number:	122170424	**Top of casing elevation:**	n/a
Field investigator:	J. Zachariah	**Easting:**	n/a
Contractor:	OGS	**Northing:**	n/a

Depth (ft)	Depth (m)	Graphic Log	Stratigraphic Description	Depth (m BGS)	Sample Number	Sample Type	Recovery	SCR	RQD	Fractures per 1.52m	%LEL / ppm / OTOV / Comb	Diagram	Description
			Ground Surface										
			ASPHALT	0.00									Flushmount protective cover with concrete seal
			GRANULAR (FILL)	0.08									
			asphalt fragments	0.15									
			GRANULAR (FILL) some sand and cobbles, trace clay		1	SS	12" 50%	n/a	n/a	n/a	25 (Comb) / <0.02 (OTOV)		
2			SAND brown, with clay, some silt and cobbles, moist	0.76	2	SS	15" 63%	n/a	n/a	n/a	15 (Comb) / <0.02 (OTOV)		32 mm ID PVC pipe backfilled with bentonite
4	1		LIMESTONE (BEDROCK) black-grey, highly weathered, interbedded shale	1.37	1	CORE	5" 63%	0" 0%	0" 0%	n/a			
6	2				2	CORE	12" 67%	3" 17%	0" 0%	n/a			
					3	CORE	10" 99%	8" 79%	5" 50%	n/a			
8					4	CORE	38" 90%	31" 74%	24" 57%	10			
10	3				5	CORE	36" 100%	31" 86%	28" 78%	6			32 mm ID slotted PVC pipe backfilled with silica sand
12	4												
14					6	CORE	27" 93%	14" 48%	13" 45%	4			
16	5		End of Borehole	5.00									

Screen Interval: 1.96 - 5.00 m BGS
Sand Pack Interval: 1.65 - 5.00 m BGS
Well Seal Interval: 0.23 - 1.65 m BGS

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
SS - split-spoon sample
ppm - parts per million by volume
%LEL - percent lower explosive limit
n/a - not available

BTEX - benzene, toluene, ethylbenzene, xylenes
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
PAHs - polycyclic aromatic hydrocarbons
M&I - Metals and inorganics
VOCs- volatile organic compounds
FOC - fraction organic carbon
SPLP - synthetic precipitation leaching procedure
gs - grain size
EC - electrical conductivity
SAR - sodium adsorption ratio

Drawn By/Checked By: M. Ford

Monitoring Well: MW25-04

Project:	Proposed Hintonburg Development	**Method:**	Hilti DD250 (Core)
Client:	Taggart	**Date started/completed:**	27-May-2025
Location:	Ottawa, ON	**Ground surface elevation:**	n/a
Number:	122170424	**Top of casing elevation:**	n/a
Field investigator:	J. Zachariah	**Easting:**	n/a
Contractor:	OGS	**Northing:**	n/a

Depth (ft)	Depth (m)	Graphic Log	Stratigraphic Description	Depth (m BGS)	Sample Number	Sample Type	Recovery	SCR	RQD	Fractures per 1.52m	%LEL / ppm (OTOV / Comb)	Diagram	Description
			Ground Surface										
			ASPHALT	0.00									Flushmount protective cover with concrete seal
			GRANULAR (FILL) with asphalt fragments and cobbles	0.10									
2	1		SAND brown, with clay, some cobbles, moist	0.46	1	SS	12" 52%	n/a	n/a	n/a	15 / <0.02		32 mm ID PVC pipe backfilled with bentonite
4			COBBLES	1.04	2	SS	0" 0%	n/a	n/a	n/a			
			LIMESTONE (BEDROCK) grey, highly weathered - black-grey, interbedded shale	1.27	1	CORE	4" 81%	0" 0%	0" 0%	n/a			
6	2				2	CORE	12" 85%	2" 14%	0" 0%	n/a			
8					3	CORE	27" 77%	27" 77%	21" 60%	12			32 mm ID slotted PVC pipe backfilled with silica sand
			- cutting head lost off of core, unable to retreive		4	CORE	n/a	n/a	n/a	n/a			
10	3		End of Borehole	2.72									
12	4												
14													
16	5												

Screen Interval: 1.65 - 2.72 m BGS
Sand Pack Interval: 1.35 - 2.72 m BGS
Well Seal Interval: 0.23 - 1.35 m BGS

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
SS - split-spoon sample
ppm - parts per million by volume
%LEL - percent lower explosive limit
n/a - not available

BTEX - benzene, toluene, ethylbenzene, xylenes
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
PAHs - polycyclic aromatic hydrocarbons
M&I - Metals and inorganics
VOCs- volatile organic compounds
FOC - fraction organic carbon
SPLP - synthetic precipitation leaching procedure
gs - grain size
EC - electrical conductivity
SAR - sodium adsorption ratio

Drawn By/Checked By: M. Ford

Monitoring Well: MW25-05

Project:	Proposed Hintonburg Development	**Method:**	Hilti DD250 (Core)
Client:	Taggart	**Date started/completed:**	20-May-2025
Location:	Ottawa, ON	**Ground surface elevation:**	n/a
Number:	122170424	**Top of casing elevation:**	n/a
Field investigator:	J. Zachariah	**Easting:**	n/a
Contractor:	OGS	**Northing:**	n/a

SUBSURFACE PROFILE				SAMPLE DETAILS						INSTALLATION DETAILS	
Depth (ft)	Depth (m)	Graphic Log	Stratigraphic Description	Depth (m BGS)	Sample Number	Sample Type	Recovery	SCR	RQD	Fractures per 1.52m	Diagram / Description
			Ground Surface								
			CONCRETE	0.00							Flushmount protective cover with concrete seal
			GRANULAR (FILL)	0.18							
			CONCRETE	0.20							
			GRANULAR (FILL)	0.30							
2			LIMESTONE (BEDROCK) grey, weathered, interbedded shale	0.61							
	1				1	CORE	27" 64%	16" 38%	8" 19%	n/a	32 mm ID PVC pipe backfilled with bentonite
4											
			- black-grey		2	CORE	30" 91%	30" 91%	21" 64%	n/a	
6											
	2										
8			- black, petroleum hydrocarbon odour from 2.51 m BGS to 2.99 m BGS		3	CORE	19" 100%	19" 100%	14" 73%	4	
10											
	3				4	CORE	37" 88%	34" 81%	34" 81%	4	32 mm ID slotted PVC pipe backfilled with silica sand
12											
	4										
14					5	CORE	36" 100%	36" 100%	34" 94%	4	
16											
	5		End of Borehole	4.98							

Screen Interval: 1.93 - 4.98 m BGS
Sand Pack Interval: 1.63 - 4.98 m BGS
Well Seal Interval: 0.23 - 1.63 m BGS

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
n/a - not available

BTEX - benzene, toluene, ethylbenzene, xylenes
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
PAHs - polycyclic aromatic hydrocarbons
M&I - Metals and inorganics
VOCs- volatile organic compounds
FOC - fraction organic carbon
SPLP - synthetic precipitation leaching procedure
gs - grain size
EC - electrical conductivity
SAR - sodium adsorption ratio

Stantec

Drawn By/Checked By: M. Ford

PROJECT: 13-1122-0009

RECORD OF DRILLHOLE: 14-1A

SHEET 1 OF 2

LOCATION: See Site Plan

DRILLING DATE: September 29, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-55

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR % RETURN	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
		GROUND SURFACE															
0	Rotary Drill NQ Core	Overburden		0.00													Flush Mount Protective Casing
1																	
2		**UNIT G2** Fresh to moderately weathered, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		1.63													
		UNIT G3 Fresh to slightly weathered, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		2.01	C1												
3																	
4					C2												Bentonite Seal
5																	
					C3												
		UNIT G4 Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		5.57													
6																	
		UNIT G5 Fresh, medium to dark grey, very fine to fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.72	C4												
7																	
8					C5												Silica Sand
		UNIT G6 Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.		8.78													
9					C6												38 mm Diam. PVC #10 Slot Screen
10		*CONTINUED NEXT PAGE*															

DEPTH SCALE

1 : 50

LOGGED: RI

CHECKED: JW

Golder Associates

MIS-RCK 001 1311220009.GPJ GAL-MISS.GDT 09/04/15 JEM

PROJECT: 13-1122-0009

RECORD OF DRILLHOLE: 14-1A

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: September 29, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-55

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR % RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*															
10	Rotary Drill NQ Core	**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.			C6												
11					C7												38 mm Diam. PVC #10 Slot Screen
12		**UNIT G7** Fresh, medium to dark grey, fine grained, thinly to medium bedded, laminar, mottled to nodular textured, argillaceous **Limestone** with interbedded medium grey fine to medium grained partly crystalline, stylolitic limestone and minor calcareous siltstone.		11.98													Silica Sand
13		End of Drillhole		12.21													
14																	
15																	
16																	
17																	
18																	
19																	
20																	

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: JW

MIS-RCK 001 1311220009.GPJ GAL-MISS.GDT 09/04/15 JEM

PROJECT: 13-1122-0009

RECORD OF DRILLHOLE: 14-1B

SHEET 1 OF 1

LOCATION: See Site Plan

DRILLING DATE: October 1, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-55

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR % RETURN	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
		GROUND SURFACE															
0	Rotary Drill NQ Core	Overburden		0.00													Flush Mount Protective Casing
1																	
		UNIT G2 Fresh to moderately weathered, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		1.70													Bentonite Seal
2				2.04													
		UNIT G3 Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.			C1												
3					C2												
																	Silica Sand
4					C3												
5																	
		UNIT G4 Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		5.57	C4												38 mm Diam. PVC #10 Slot Screen
6																	
		UNIT G5 Fresh, medium to dark grey, very fine to fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.74	C5												
7				7.20													Silica Sand
		End of Drillhole															
8																	
9																	
10																	

DEPTH SCALE

1 : 50

LOGGED: RI

CHECKED: JW

Golder Associates

MIS-RCK 001 1311220009.GPJ GAL-MISS.GDT 09/04/15 JEM

PROJECT: 13-1122-0009

RECORD OF DRILLHOLE: 14-2

SHEET 1 OF 2

LOCATION: See Site Plan

DRILLING DATE: September 29, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55

DRILLING CONTRACTOR: Downing 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
		GROUND SURFACE														
0	Rotary Drill NQ Core	Overburden		0.00												Flush Mount Protective Casing
1																
2		**UNIT G2** Fresh to slightly weathered, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		1.70												
		UNIT G3 Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		2.38	C1											
3																
4					C2											Bentonite Seal
5					C3											
6		**UNIT G4** Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		5.70	C4											
7		**UNIT G5** Fresh, medium to dark grey, very fine to fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.90												
8					C5											
9		**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.		8.89												Silica Sand
					C6											38 mm Diam. PVC #10 Slot Screen
10		*CONTINUED NEXT PAGE*														

DEPTH SCALE

1 : 50

LOGGED: RI

CHECKED: JW

Golder Associates

MIS-RCK 001 1311220009.GPJ GAL-MISS.GDT 09/04/15 JEM

PROJECT: 13-1122-0009

RECORD OF DRILLHOLE: 14-2

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: September 29, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR % RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*															
10	Rotary Drill NQ Core	**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.			C6												
11					C7												38 mm Diam. PVC #10 Slot Screen
12		End of Drillhole		12.09													Silica Sand
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: RI
CHECKED: JW

MIS-RCK 001 1311220009.GPJ GAL-MISS.GDT 09/04/15 JEM

PROJECT: 13-1122-0009

RECORD OF DRILLHOLE: 14-3

SHEET 1 OF 2

LOCATION: See Site Plan

DRILLING DATE: October 2, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-55

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR % RETURN	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
		GROUND SURFACE															
0	Rotary Drill NQ Core	Overburden		0.00													Flush Mount Protective Casing
1																	
2		**UNIT G2** Fresh to moderately weathered, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		1.42	C1												
					C2												
3																	
4		**UNIT G3** Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		3.23	C3												Bentonite Seal
					C4												
6		**UNIT G4** Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		6.14	C5												
7																	
		UNIT G5 Fresh, medium to dark grey, very fine to fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		7.54	C6												
8					C7												
9																	Silica Sand
		UNIT G6 Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.		9.36	C8												38 mm Diam. PVC #10 Slot Screen
10		*CONTINUED NEXT PAGE*															

DEPTH SCALE

1 : 50

LOGGED: RI

CHECKED: JW

Golder Associates

MIS-RCK 001 1311220009.GPJ GAL-MISS.GDT 09/04/15 JEM

PROJECT: 13-1122-0009

RECORD OF DRILLHOLE: 14-3

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: October 2, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-55

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR % RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*															
10	Rotary Drill NQ Core	**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.			C8												
11					C9												38 mm Diam. PVC #10 Slot Screen
12		End of Drillhole		12.20													
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

DEPTH SCALE
1 : 50

LOGGED: RI
CHECKED: JW

MIS-RCK 001 1311220009.GPJ GAL-MISS.GDT 09/04/15 JEM

PROJECT: 13-1122-0009

RECORD OF DRILLHOLE: 14-4

SHEET 1 OF 2

LOCATION: See Site Plan

DRILLING DATE: October 6, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-75

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR / % RETURN	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
		GROUND SURFACE															
0	Hollow Stem Auger / NW Casing	CONCRETE sidewalk		0.04													Flush Mount Protective Casing
		SILTY SAND, some gravel (FILL)															
1		**UNIT G2** Fresh to slightly weathered, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		1.14	C1												
2		**UNIT G3** Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		2.03													
3					C2												
4																	
5	Rotary Drill / NQ Core				C3												Bentonite Seal
6		**UNIT G4** Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		5.70	C4												
7		**UNIT G5** Fresh, medium to dark grey, very fine to fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.98													
8					C5												Silica Sand
9		**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.		9.01	C6												38 mm Diam. PVC #10 Slot Screen
10		*CONTINUED NEXT PAGE*															

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: RI

CHECKED: JW

MIS-RCK 001 1311220009.GPJ GAL-MISS.GDT 09/04/15 JEM

PROJECT: 13-1122-0009

RECORD OF DRILLHOLE: 14-4

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: October 6, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-75

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR % RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*															
10	Rotary Drill NQ Core	**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.			C7												38 mm Diam. PVC #10 Slot Screen
11					C8												
12		End of Drillhole		12.02													
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

DEPTH SCALE
1 : 50

LOGGED: RI
CHECKED: JW

MIS-RCK 001 1311220009.GPJ GAL-MISS.GDT 09/04/15 JEM

PROJECT: 10-1122-0257-4100

RECORD OF DRILLHOLE: E2

SHEET 1 OF 2

LOCATION: See Site Plan

DRILLING DATE: April 18, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-75 Truck Mount

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR % RETURN	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
		GROUND SURFACE		62.22													
0	Rotary Drill HQ Core	Overburden		0.00													Flush Mount Protective Casing
				61.38													
1		**UNIT G1** Moderately weathered, medium to dark grey, very fine to fine grained, thinly bedded, nodular, textured, argillaceous **Limestone** with brownish grey, crystalline very thin to laminar beds of calcarenite limestone.		0.84 / 61.12													
				1.10													
		UNIT G2 Fresh to moderately weathered, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.			C1												NW Casing
2				60.18													
		UNIT G3 Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		2.04	C2												
3					C3												
4																	
5				57.16	C4												
		UNIT G4 Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		5.06													
6	Rotary Drill NQ Core			56.00													Open Hole
		UNIT G5 Fresh, medium to dark grey, very fine to fine grained thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.22	C5												
7																	
8				54.10													
		UNIT G6 Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.		8.12	C6												
9					C7												
10		*CONTINUED NEXT PAGE*															

DEPTH SCALE

1 : 50

LOGGED: AB

CHECKED: PH

Golder Associates

MIS-RCK 001 1011220257.GPJ GAL-MISS.GDT 1/4/13 JEM

PROJECT: 10-1122-0257-4100

RECORD OF DRILLHOLE: E2

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: April 18, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-75 Truck Mount

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR % RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*															
	Rotary Drill / NQ Core	**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.			C7												
					C8												Open Hole
11				51.17													
		End of Drillhole		11.05													
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

DEPTH SCALE
1 : 50

LOGGED: AB
CHECKED: PH

PROJECT: 10-1122-0257-4100

RECORD OF DRILLHOLE: E3

SHEET 1 OF 2

LOCATION: See Site Plan

DRILLING DATE: April 12, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-75 Truck Mount

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR & % RETURN	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
		GROUND SURFACE		62.81													
0	Rotary Drill / HQ Core	Overburden		0.00													Flush Mount Protective Casing
1				61.44													NW Casing
2		**UNIT G2** Fresh to moderately weathered, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		1.37	C1												
				60.61													
3		**UNIT G3** Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		2.20	C2												
4																	
5				57.75	C3												
		UNIT G4 Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		5.06													
6	Rotary Drill / NQ Core			56.51													Open Hole
		UNIT G5 Fresh, medium to dark grey, very fine to fine grained thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.30	C4									___*			
7														___*			
8					C5												
9					C6												
10		*CONTINUED NEXT PAGE*															

DEPTH SCALE

1 : 50

LOGGED: AB

CHECKED: PH

Golder Associates

MIS-RCK 001 1011220257.GPJ GAL-MISS.GDT 1/4/13 JEM

PROJECT: 10-1122-0257-4100

RECORD OF DRILLHOLE: E3

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: April 12, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-75 Truck Mount

DRILLING CONTRACTOR: Downing 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)	FLUSH / % RETURN	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
10		*--- CONTINUED FROM PREVIOUS PAGE ---*														
	Rotary Drill / NQ Core	**UNIT G5** Fresh, medium to dark grey, very fine to fine grained thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.			C6											
					C7											Open Hole
11				51.79												
		End of Drillhole		11.02												
12																
13																
14																
15																
16																
17																
18																
19																
20																

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: AB
CHECKED: PH

MIS-RCK 001 1011220257.GPJ GAL-MISS.GDT 1/4/13 JEM

PROJECT: 10-1122-0257-4100

RECORD OF DRILLHOLE: E4

SHEET 1 OF 2

LOCATION: See Site Plan

DRILLING DATE: April 12, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-75 Truck Mount

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR % RETURN	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
		GROUND SURFACE		62.80													
0	Rotary Drill HQ Core	Overburden		0.00													Flush Mount Protective Casing
1				61.53													
2		**UNIT G2** Fresh to moderately weathered, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		1.27	C1												NW Casing
				60.52													
3		**UNIT G3** Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		2.28	C2												
4																	
5					C3												
				57.65													
	Rotary Drill NQ Core	**UNIT G4** Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		5.15										1-2 mm vertical fracture observed in G4, partially open in G4, infilled in G5, and closed in G6			
6					C4												Open Hole
				56.47													
		UNIT G5 Fresh, medium to dark grey, very fine to fine grained thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.33													
7														___✳			
8					C5												
				54.23													
		UNIT G6 Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.		8.57													
9					C6												
														___✳			
10		*CONTINUED NEXT PAGE*															

DEPTH SCALE

1 : 50

LOGGED: AB

CHECKED: PH

Golder Associates

MIS-RCK 001 1011220257.GPJ GAL-MISS.GDT 1/4/13 JEM

PROJECT: 10-1122-0257-4100

RECORD OF DRILLHOLE: E4

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: April 12, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-75 Truck Mount

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR % RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*															
	Rotary Drill / NQ Core	**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.			C6												
					C7												Open Hole
11				51.78													
		End of Drillhole		11.02													
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: AB
CHECKED: PH

MIS-RCK 001 1011220257.GPJ GAL-MISS.GDT 1/4/13 JEM

PROJECT: 13-1122-0009

RECORD OF DRILLHOLE: E5

SHEET 1 OF 2

LOCATION: See Site Plan

DRILLING DATE: October 6, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-55

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR % RETURN	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
		GROUND SURFACE															
0	Rotary Drill PQ Core	Overburden		0.00													Flush Mount Protective Casing; Silica Sand
1		**UNIT G2** Fresh, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		1.52	C1												
2		**UNIT G3** Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		1.97	C2												
3					C3												
4					C4												Bentonite Seal
5																	
6		**UNIT G4** Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		5.53	C5												
7		**UNIT G5** Fresh, medium to dark grey, very fine to fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.72	C6												Silica Sand
8					C7												51 mm Diam. PVC #10 Slot Screen
9		**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.		8.72	C8												
10		*CONTINUED NEXT PAGE*															

DEPTH SCALE

1 : 50

LOGGED: RI

CHECKED: JW

Golder Associates

MIS-RCK 001 1311220009.GPJ GAL-MISS.GDT 09/04/15 JEM

PROJECT: 13-1122-0009

RECORD OF DRILLHOLE: E5

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: October 6, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-55

DRILLING CONTRACTOR: Downing 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)	FLUSH / COLOUR / % RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---														
10	Rotary Drill / PQ Core	**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.			C8											
					C9											51 mm Diam. PVC #10 Slot Screen
11		End of Drillhole		11.06												
12																
13																
14																
15																
16																
17																
18																
19																
20																

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: RI
CHECKED: JW

MIS-RCK 001 1311220009.GPJ GAL-MISS.GDT 09/04/15 JEM

PROJECT: 13-1122-0009

RECORD OF DRILLHOLE: E6

SHEET 1 OF 2

LOCATION: See Site Plan

DRILLING DATE: October 3, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-55

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR / % RETURN	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
		GROUND SURFACE															
0	Rotary Drill / PQ Core	Overburden		0.00													Flush Mount Protective Casing; Silica Sand
1		Cobbles or weathered rock		1.37													
		UNIT G2 Fresh, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		1.46	C1												
2		**UNIT G3** Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		1.99	C2												
3																	
4					C3												Bentonite Seal
5					C4												
		UNIT G4 Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		5.35													
6					C5												
		UNIT G5 Fresh, medium to dark grey, very fine to fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.61													
7					C6												Silica Sand
8					C7												51 mm Diam. PVC #10 Slot Screen
		UNIT G6 Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.		8.70													
9					C8												
10		*CONTINUED NEXT PAGE*															

DEPTH SCALE

1 : 50

LOGGED: RI

CHECKED: JW

Golder Associates

MIS-RCK 001 1311220009.GPJ GAL-MISS.GDT 09/04/15 JEM

PROJECT: 13-1122-0009

RECORD OF DRILLHOLE: E6

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: October 3, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-55

DRILLING CONTRACTOR: Downing 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)	FLUSH	COLOUR % RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
10	Rotary Drill PQ Core	*--- CONTINUED FROM PREVIOUS PAGE ---*															
		UNIT G6 Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.			C8												
11																	51 mm Diam. PVC #10 Slot Screen
					C9												
12																	
		UNIT G7 Fresh, grey, fine grained, thinly to medium bedded **Limestone** with dark grey to black shale partings		12.39													
		End of Drillhole		12.60													
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

DEPTH SCALE

1 : 50

LOGGED: RI

CHECKED: JW

Golder Associates

MIS-RCK 001 1311220009.GPJ GAL-MISS.GDT 09/04/15 JEM

PROJECT: 08-1122-0143

RECORD OF DRILLHOLE: 08-21

SHEET 1 OF 2

LOCATION: N ;E

DRILLING DATE: September 5, 2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-60

DRILLING CONTRACTOR: Marathon Drilling Ltd.

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)	FLUSH	COLOUR % RETURN	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_s cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		ASPHALT SURFACE		61.77													
0	Rotary Drill HW Casing	Dark brown silty sand (FILL)		0.00													Flush Mount Protective Casing
																	Bentonite Seal
1				60.75													
		Boulders to weathered bedrock		1.02													
				60.37													
		Fractured/seam, weathered bedrock		1.40	1												
				59.92													
2		**UNIT G3** Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		1.85	2												Coated Bentonite
3					3												Silica Sand
4																	
5				56.79													
		UNIT G4 Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		4.98	4												19 mm Diam. PVC #10 Slot Screen 'C'
				56.08													
		UNIT G5 Fresh, medium to dark grey, very fine to fine grained thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		5.69													
6	Rotary Drill HQ Core																Silica Sand
7					5												Coated Bentonite
8																	Silica Sand
				53.00	6												
9		**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.		8.77													19 mm Diam. PVC #10 Slot Screen 'C'
					7												
10		*CONTINUED NEXT PAGE*															

DEPTH SCALE

1 : 50

LOGGED: R.I.

CHECKED: P.H.

Golder Associates

MIS-RCK 001 0811220143.GPJ GAL-MISS.GDT 4/2/09 JFC/JEM

PROJECT: 08-1122-0143

RECORD OF DRILLHOLE: 08-21

SHEET 2 OF 2

LOCATION: N ;E

DRILLING DATE: September 5, 2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-60

DRILLING CONTRACTOR: Marathon Drilling Ltd.

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)	FLUSH	COLOUR % RETURN	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
		--- CONTINUED FROM PREVIOUS PAGE ---															
10	Rotary Drill / HQ Core	**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.			7												19 mm Diam. PVC #10 Slot Screen 'C'
11				50.54													
		UNIT G7 Fresh, medium to dark grey, fine grained, thinly to medium bedded, laminar, mottled to nodular textured, argillaceous **Limestone** with interbedded medium grey fine to medium grained partly crystalline, stylolitic limestone and minor calcareous siltstone.		11.23	8												Silica Sand
12																	Bentonite Seal
13					9												Silica Sand
14				47.59													
		UNIT G8 Fresh, light greenish to grey, fine grained, fainly porous, thin to thickly bedded, mottled to brecciated textured, bioturbated, dolomitic, siliceous **Siltstone** and fine grained **Sandstone** with interbeds of laminar to nodular textured **Limestone** and **Dolomitic Limestone**.		14.18	10												19 mm Diam. PVC #10 Slot Screen 'C'
15																	
				45.99	11												
16		**UNIT G9** Fresh, light grey to medium reddish brown, fine grained, faintly porous, medium to thickly bedded, calcareous, siliceous **Sandstone** extensively bioturbated with interbedded off calcareous **Siltstone** and medium to dark grey to black, thin beds of slake susceptible **Shale**.		15.85													
		End of Drillhole															
17																	
18																	
19																	
20																	

DIAMETRAL POINT LOAD INDEX (MPa): 2, 4, 6

HYDRAULIC CONDUCTIVITY K, cm/sec: 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}

MIS-RCK 001 0811220143.GPJ GAL-MISS.GDT 4/2/09 JFC/JEM

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: R.I.

CHECKED: P.H.

PROJECT: 08-1122-0143

RECORD OF DRILLHOLE: 08-31

SHEET 1 OF 1

LOCATION: N ;E

DRILLING DATE: November 28, 2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-60

DRILLING CONTRACTOR: Marathon Drilling Ltd.

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
		GROUND SURFACE		61.98												
0		Very loose grey limestone gravel (FILL)		0.00												Flush Mount Protective Casing
				61.13												
1		**UNIT G2** Fresh to moderately weathered, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		0.85	1											
				60.69												Bentonite Seal
				1.29	2											
2		**UNIT G3** Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.														Silica Sand
					3											19 mm Diam. PVC #10 Slot Screen 'C'
3																Silica Sand
																Bentonite Seal
																Silica Sand
4	Rotary Drill NQ Core				4											
					5											19 mm Diam. PVC #10 Slot Screen 'B'
				57.03												
5		**UNIT G4** Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		4.95												
					6											
6				55.92												Silica Sand
		UNIT G5 Fresh, medium to dark grey, very fine to fine grained thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.06												Bentonite Seal
																Silica Sand
7					7											19 mm Diam. PVC #10 Slot Screen 'A'
				53.93												
8		End of Drillhole		8.05												
9																
10																

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: D.L.
CHECKED: P.H.

MIS-RCK 001 0811220143.GPJ GAL-MISS.GDT 4/2/09 JFC/JEM

PROJECT: 08-1122-0143

RECORD OF DRILLHOLE: 08-32

SHEET 1 OF 1

LOCATION: N ;E

DRILLING DATE: November 27, 28, 2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-60

DRILLING CONTRACTOR: Marathon Drilling Ltd.

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/m:n)	COLOUR % RETURN	FLUSH	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		62.03													
0		Very loose grey limestone gravel (FILL)		0.00													Flush Mount Protective Casing
1				60.81													
2	Rotary Drill NQ Core	**UNIT G3** Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		1.22	1												Bentonite Seal Silica Sand
3					2												19 mm Diam. PVC #10 Slot Screen 'C'
				58.22													Silica Sand
4		**UNIT G4** Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		3.81	3												Bentonite Seal Silica Sand
5																	19 mm Diam. PVC #10 Slot Screen 'B'
				56.42													
6		**UNIT G5** Fresh, medium to dark grey, very fine to fine grained thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		5.61	4												Silica Sand Bentonite Seal
7					5												Silica Sand 19 mm Diam. PVC #10 Slot Screen 'A'
8				53.86													
		End of Drillhole		8.17													
9																	
10																	

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: D.L.
CHECKED: P.H.

MIS-RCK 001 0811220143.GPJ GAL-MISS.GDT 4/2/09 JFC/JEM

PROJECT: 08-1122-0143

RECORD OF DRILLHOLE: 08-33

SHEET 1 OF 1

LOCATION: N ;E

DRILLING DATE: November 26, 27, 2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-60

DRILLING CONTRACTOR: Marathon Drilling Ltd.

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/m:n)	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	D'AMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		62.29												
0		Very loose grey limestone gravel, trace electronics debris (FILL)		0.00												Flush Mount Protective Casing
1				61.13												Bentonite Seal
		Weathered, thinly to medium bedded silicious grey LIMESTONE BEDROCK		1.16	1											
				60.77												Silica Sand
2		**UNIT G2** Fresh to moderately weathered, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		1.52	2											
				59.98												
3	Rotary Drill / NQ Core	**UNIT G3** Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		2.31	3											19 mm Diam. PVC #10 Slot Screen 'C'
																Silica Sand
																Bentonite Seal
4					4											Silica Sand
5				57.19												19 mm Diam. PVC #10 Slot Screen 'B'
		UNIT G4 Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		5.10	5											
6																Silica Sand
				55.92												
		UNIT G5 Fresh, medium to dark grey, very fine to fine grained thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.37												Bentonite Seal
7																Silica Sand
					6											19 mm Diam. PVC #10 Slot Screen 'A'
8				53.94												
		End of Drillhole		8.35												
9																
10																

MIS-RCK 001 0811220143.GPJ GAL-MISS.GDT 4/2/09 JFC/JEM

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: D.L.
CHECKED: P.H.

PROJECT: 08-1122-0143

RECORD OF DRILLHOLE: 08-34

SHEET 1 OF 1

LOCATION: N ;E

DRILLING DATE: December 2, 2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-60

DRILLING CONTRACTOR: Marathon Drilling Ltd.

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
		GROUND SURFACE		62.26												
0	Rotary Drill / HW Casing	Open void space (inside previously drilled casing)		0.00												
				61.32												
1		Grey CONCRETE (no aggregate)		0.94												
				60.98												
		Grey CONCRETE with course sand aggregate		1.28	1											
2																
				59.97												
		UNIT G3 Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		2.29	2											
3																
				58.41												
4	Rotary Drill / NQ Core	**UNIT G4** Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		3.85	3											101.6 mm Diam. ID Steel Casing
5																
					4											
6																
7					5											
8																
				53.72	6											
		UNIT G5 Fresh, medium to dark grey, very fine to fine grained thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		8.54												
				53.42												
9		End of Drillhole		8.84												
10																

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.L.

CHECKED: P.H.

MIS-RCK 001 0811220143.GPJ GAL-MISS.GDT 4/2/09 JFC/JEM

PROJECT: 08-1122-0143

RECORD OF DRILLHOLE: 08-35

SHEET 1 OF 1

LOCATION: N ;E

DRILLING DATE: December 3, 2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: LC-60

DRILLING CONTRACTOR: Marathon Drilling Ltd.

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)	FLUSH	COLOUR % RETURN	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
		GROUND SURFACE		62.40													
0	Rotary Drill NQ Core	Very loose grey limestone gravel (FILL)		0.00													Flush Mount Protective Casing
1				61.21													
		UNIT G2 Fresh to moderately weathered, medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, lithoclastic and stylolitic **Limestone** with trace fossil debris.		1.19	1												Bentonite Seal
2				60.21													Silica Sand
		UNIT G3 Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		2.19	2												19 mm Diam. PVC #10 Slot Screen 'C'
3																	
4					3												Silica Sand Bentonite Seal Silica Sand
5																	19 mm Diam. PVC #10 Slot Screen 'B'
				56.94													
		UNIT G4 Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		5.46	4												
6																	Silica Sand
				56.00													Bentonite Seal
		UNIT G5 Fresh, medium to dark grey, very fine to fine grained thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.40													Silica Sand
7					5												19 mm Diam. PVC #10 Slot Screen 'A'
8				54.17													
		End of Drillhole		8.23													
9																	
10																	

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: D.L.
CHECKED: P.H.

MIS-RCK 001 0811220143.GPJ GAL-MISS.GDT 4/2/09 JFC/JEM

PROJECT: 08-1122-0143

RECORD OF DRILLHOLE: 08-36

SHEET 1 OF 2

LOCATION: N ;E

DRILLING DATE: February 6, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME Truck Mount

DRILLING CONTRACTOR: Marathon Drilling Ltd.

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)	FLUSH	COLOUR / % RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE															
0	Rotary Drill / HQ Casing	**UNIT G3** Fresh, medium to dark grey, very fine grained, thinly bedded, laminar textured, argillaceous **Limestone** with dark grey shaly partings.		0.00													
1																	
2					1												Bentonite Seal
3					2												
4																	
5					3												Silica Sand
6	Rotary Drill / HQ Core	**UNIT G4** Fresh, light to medium grey to medium brownish grey, fine to medium grained, partly crystalline, thinly to medium bedded, stylolitic **Limestone** with tabular gypsum casts and disseminated gypsum crystals.		5.58	4												19 mm Diam. PVC #10 Slot Screen 'B'
7		**UNIT G5** Fresh, medium to dark grey, very fine to fine grained thinly bedded, laminar textured, argillaceous **Limestone** with occasional shaly partings.		6.83													Silica Sand
8					5												Bentonite Seal
9																	Silica Sand
10		*CONTINUED NEXT PAGE*		9.54	6												19 mm Diam. PVC #10 Slot Screen 'A'

DEPTH SCALE

1 : 50

LOGGED: J.D.

CHECKED: P.H.

Golder Associates

MIS-RCK 001 0811220143.GPJ GAL-MISS.GDT 5/8/09 JFC/JEM

PROJECT: 08-1122-0143

RECORD OF DRILLHOLE: 08-36

SHEET 2 OF 2

LOCATION: N ;E

DRILLING DATE: February 6, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME Truck Mount

DRILLING CONTRACTOR: Marathon Drilling Ltd.

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 % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*														
	Rotary Drill / HQ Core	**UNIT G6** Fresh, medium grey, fine to medium grained, faintly porous, medium to thickly bedded, massive textured, siliceous **Dolostone** with grey shaly bedding partings.			6											
11					7											19 mm Diam. PVC #10 Slot Screen 'A'
		End of Drillhole		11.81												Bentonite Seal
12																
13																
14																
15																
16																
17																
18																
19																
20																

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: J.D.
CHECKED: P.H.

MIS-RCK 001 0811220143.GPJ GAL-MISS.GDT 5/8/09 JFC/JEM

PROJECT: 08-1122-0143

RECORD OF DRILLHOLE: 08-37

SHEET 1 OF 2

LOCATION: N ;E

DRILLING DATE: February 7,9, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME Truck Mount

DRILLING CONTRACTOR: Marathon Drilling Ltd.

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 % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE														
0	Rotary Drill / HQ Casing	Overburden		0.00												
1																
2	Rotary Drill / HQ Core	Grey LIMESTONE BEDROCK with shale layers		1.42	1											Bentonite Seal
3					2											
4					3											Silica Sand
5					4											19 mm Diam. PVC #10 Slot Screen 'B'
6					5											Silica Sand
7					6											Bentonite Seal
8																Silica Sand
9																19 mm Diam. PVC #10 Slot Screen 'A'
10		*CONTINUED NEXT PAGE*														

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: J.D.

CHECKED: P.H.

MIS-RCK 001 0811220143.GPJ GAL-MISS.GDT 5/8/09 JFC/JEM

PROJECT: 08-1122-0143

RECORD OF DRILLHOLE: 08-37

SHEET 2 OF 2

LOCATION: N ;E

DRILLING DATE: February 7,9, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME Truck Mount

DRILLING CONTRACTOR: Marathon Drilling Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	FLUSH / COLOUR % RETURN	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
		--- CONTINUED FROM PREVIOUS PAGE ---														
10	Rotary Drill HQ Core	Grey LIMESTONE BEDROCK with shale layers			6											
11					7											19 mm Diam. PVC #10 Slot Screen 'A'
12					8											Silica Sand
		End of Drillhole		12.60												
13																
14																
15																
16																
17																
18																
19																
20																

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
1 : 50

LOGGED: J.D.
CHECKED: P.H.

Golder Associates

MIS-RCK 001 0811220143.GPJ GAL-MISS.GDT 5/8/09 JFC/JEM

patersongroup

Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
233 Armstong Street
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant, northeast corner of Armstrong Street and Hamilton Avenue. Assumed elevation = 100.00m.

FILE NO. PG2281

REMARKS

HOLE NO. BH 1

BORINGS BY CME 55 Power Auger **DATE** 6 December 2010

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	98.79
FILL: Crushed stone with silty sand		AU	1				
1.07		SS	2	29	50+	1	97.79
		RC	1	93	41	2	96.79
		RC	2	100	100	3	95.79
		RC	3	100	95	4	94.79
		RC	4	100	98	5	93.79
BEDROCK: Grey limestone		RC	5	100	98	6	92.79
		RC	6	100	100	7	91.79
		RC	7	97	97	8	90.79
		RC	8	100	95	9	89.79
		RC	9	98	98	10	88.79
		RC	10	100	95	11	87.79
		RC	11	97	97	12	86.79
18.04		RC	12	100	100	13	85.79
End of Borehole						14	84.79
(GWL @ 9.67m-Jan. 28/11)						15	83.79
						16	82.79
						17	81.79
						18	80.79

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

Monitoring Well Construction

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

patersongroup

Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
233 Armstong Street
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant, northeast corner of Armstrong Street and Hamilton Avenue. Assumed elevation = 100.00m.

FILE NO. PG2281

REMARKS

HOLE NO. BH 2

BORINGS BY CME 55 Power Auger **DATE** 7 December 2010

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	98.73
Asphaltic concrete 0.08		AU	1				
FILL: Brown silty sand with crushed stone 0.86 / 1.17		SS	2	38	13	1	97.73
FILL: Topsoil with gravel, sand and clay 1.75		SS	3		50+		
GLACIAL TILL: Grey-brown silty clay with gravel		RC	1	86	28	2	96.73
		RC	2	93	90	3	95.73
						4	94.73
		RC	3	100	100	5	93.73
						6	92.73
		RC	4	100	98	7	91.73
		RC	5	100	97	8	90.73
						9	89.73
BEDROCK: Grey limestone		RC	6	100	100	10	88.73
		RC	7	98	90	11	87.73
						12	86.73
		RC	8	100	97	13	85.73
		RC	9	100	100	14	84.73
						15	83.73
		RC	10	100	100	16	82.73
		RC	11	100	100	17	81.73
18.44		RC	12	100	100	18	80.73
End of Borehole							
(GWL @ 2.67m-Jan. 28/11)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

Monitoring Well Construction

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

patersongroup

Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
233 Armstong Street
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant, northeast corner of Armstrong Street and Hamilton Avenue. Assumed elevation = 100.00m.

FILE NO. PG2281

REMARKS

HOLE NO. BH 3

BORINGS BY CME 55 Power Auger **DATE** 8 December 2010

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	98.24
Asphaltic concrete 0.11		AU	1				
FILL: Crushed stone with silty sand 0.91 / 1.12		SS	2	7	50+	1	97.24
FILL: Brown silty sand, some clay and gravel		SS	3	100	50+		
		RC	1	99	59	2	96.24
		RC	2	100	95	3	95.24
						4	94.24
		RC	3	100	96	5	93.24
		RC	4	97	97	6	92.24
						7	91.24
		RC	5	100	98	8	90.24
BEDROCK: Grey limestone		RC	6	100	97	9	89.24
		RC	7	100	95	10	88.24
		RC	8	100	100	11	87.24
		RC	9	100	100	12	86.24
		RC	10	100	100	13	85.24
		RC	11	100	100	14	84.24
		RC	12	100	100	15	83.24
18.06 End of Borehole						16	82.24
(GWL @ 4.43m-Jan. 28/11)						17	81.24
						18	80.24

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

APPENDIX D

D.1 LABORATORY TEST RESULTS

Stantec

Compressive Strength of Intact Rock Core
Method C
ASTM D7012 & D4543

Client:	Taggart Realty Management	Project No.:	122170424
Project:	Parkdale Tower		
Material Type:	Rock Core; Diameter ≥ 47.0 mm	Date Received:	June 3, 2025
Sampled By:	T. Smith	Tested By:	Sagar Khatri
Date Sampled:	May 6, 2025	Date Tested:	June 6, 2025

Sample Information				
Borehole Location	**BH25-01 (Run 3)**	**BH25-01 (Run 6)**	**BH25-01 (Run 9)**	**BH25-01 (Run 12)**
Sample Number	S1-Limestone/Shale	S2-Limestone/Shale	S3-Limestone/Shale	S4-Limestone/Shale
Sample Depth	3.4m - 3.67m (UCS)	8.81m - 9.08m (UCS)	13.21m - 13.45m (UCS	7.32m - 17.54m (UCS
Compressive Strength Test Data				
Physical Description	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report
Average Sample Diameter (mm) (≥47.0)	63	63	63	63
Average Sample Length (mm)	154	153	150	151
Density (kg/m^3)	2700	2720	2704	2561
Unit Weight (kN/m^3)	**26.5**	**26.7**	**26.5**	**25.1**
L/D Ratio (2.0-2.5)	2.42	2.41	2.36	2.38
Failure Load (lbs)	143230	123550	131400	67110
Compressive Strength (MPa)	**201.5**	**173.9**	**185.3**	**94.9**
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02	<0.02	<0.02
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001	<0.001	<0.001
Parallelism by Procedure FP2 (≤0.25°)	0.023	0.024	0.077	-0.009
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043	<0.0043	<0.0043
Moisture Condition	As-Received	As-Received	As-Received	As-Received
Description of Break D7012/11.1.13	Small cone formed on one end, vertical cracks running through caps	Diagonal fracture with no cracking through one end.	Vertical cracking through both ends, no well formed cones.	Reasonably well formed cones on both ends.
Note				

Remarks:

Reviewed by: Brian Prevost Date: June 9, 2025

Stantec

Compressive Strength of Intact Rock Core
Method C
ASTM D7012 & D4543

Client:	Taggart Realty Management	Project No.:	122170424
Project:	Parkdale Tower		
Material Type:	Rock Core; Diameter ≥ 47.0 mm	Date Received:	June 3, 2025
Sampled By:	T. Smith	Tested By:	Sagar Khatri
Date Sampled:	May 6, 2025	Date Tested:	June 6, 2025

Sample Information				
Borehole Location	**BH25-01 (Run 3)**	**BH25-01 (Run 6)**	**BH25-01 (Run 9)**	**BH25-01 (Run 12)**
Sample Number	S1-Limestone/Shale	S2-Limestone/Shale	S3-Limestone/Shale	S4-Limestone/Shale
Sample Depth	3.4m - 3.67m (UCS)	8.81m - 9.08m (UCS)	13.21m - 13.45m (UCS	7.32m - 17.54m (UCS
Compressive Strength Test Data				
Physical Description	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report
Average Sample Diameter (mm) (≥47.0)	63	63	63	63
Average Sample Length (mm)	154	153	150	151
Density (kg/m^3)	2700	2720	2704	2561
Unit Weight (kN/m^3)	**26.5**	**26.7**	**26.5**	**25.1**
L/D Ratio (2.0-2.5)	2.42	2.41	2.36	2.38
Failure Load (lbs)	143230	123550	131400	67110
Compressive Strength (MPa)	**201.5**	**173.9**	**185.3**	**94.9**
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02	<0.02	<0.02
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001	<0.001	<0.001
Parallelism by Procedure FP2 (≤0.25°)	0.023	0.024	0.077	-0.009
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043	<0.0043	<0.0043
Moisture Condition	As-Received	As-Received	As-Received	As-Received
Description of Break D7012/11.1.13	Small cone formed on one end, vertical cracks running through caps	Diagonal fracture with no cracking through one end.	Vertical cracking through both ends, no well formed cones.	Reasonably well formed cones on both ends.
Note				

Remarks:

Reviewed by: Brian Prevost Date: June 9, 2025

Stantec

Compressive Strength of Intact Rock Core
Method C
ASTM D7012 & D4543

Client:	Taggart Realty Management	Project No.:	122170424
Project:	Parkdale Tower		
Material Type:	Rock Core; Diameter ≥ 47.0 mm	Date Received:	June 3, 2025
Sampled By:	T. Smith	Tested By:	Sagar Khatri
Date Sampled:	May 6, 2025	Date Tested:	June 6, 2025

Sample Information				
Borehole Location	**BH25-01 (Run 7)**			
Sample Number	S5-Limestone/Shale			
Sample Depth	10.03m-10.34m			
Compressive Strength Test Data				
Physical Description	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report
Average Sample Diameter (mm) (≥47.0)	63			
Average Sample Length (mm)	153			
Density (kg/m^3)	2714			
Unit Weight (kN/m^3)	**26.6**			
L/D Ratio (2.0-2.5)	2.42			
Failure Load (lbs)	124810			
Compressive Strength (MPa)	**176.6**			
Straightness by Procedure S1 (≤0.02inch)	<0.02			
Flatness by Procedure FP2 (≤0.001inch)	<0.001			
Parallelism by Procedure FP2 (≤0.25°)	-0.028			
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043			
Moisture Condition	As-Received			
Description of Break D7012/11.1.13	Small cone formed on one end, vertical cracking running through caps			
Note				

Remarks:

Reviewed by: Brian Prevost Date: June 9, 2025

Stantec

Compressive Strength of Intact Rock Core
Method C
ASTM D7012 & D4543

Client:	Taggart Realty Management	Project No.:	122170424
Project:	Parkdale Tower		
Material Type:	Rock Core; Diameter ≥ 47.0 mm	Date Received:	June 3, 2025
Sampled By:	T. Smith	Tested By:	Sagar Khatri
Date Sampled:	May 6, 2025	Date Tested:	June 6, 2025

Sample Information				
Borehole Location	**BH25-01 (Run 7)**			
Sample Number	S5-Limestone/Shale			
Sample Depth	10.03m-10.34m			
Compressive Strength Test Data				
Physical Description	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report
Average Sample Diameter (mm) (≥47.0)	63			
Average Sample Length (mm)	153			
Density (kg/m^3)	2714			
Unit Weight (kN/m^3)	**26.6**			
L/D Ratio (2.0-2.5)	2.42			
Failure Load (lbs)	124810			
Compressive Strength (MPa)	**176.6**			
Straightness by Procedure S1 (≤0.02inch)	<0.02			
Flatness by Procedure FP2 (≤0.001inch)	<0.001			
Parallelism by Procedure FP2 (≤0.25°)	-0.028			
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043			
Moisture Condition	As-Received			
Description of Break D7012/11.1.13	Small cone formed on one end, vertical cracking running through caps			
Note				

Remarks:

Reviewed by: Brian Prevost Date: June 9, 2025

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Certificate of Analysis

Stantec Consulting Ltd. (Ottawa)
1331 Clyde Avenue Suite 300
Ottawa, ON K2C 3G4
Attn: Brian Prevost

Client PO: Parkdale Tower
Project: 122170424
Custody:

Report Date: 7-Aug-2025
Order Date: 31-Jul-2025

Order #: 2531387

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2531387-01	BH25-01, GS2, 0.25-1.2m

Approved By:

Mark Foto, M.Sc.
Laboratory Director

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	6-Aug-25	6-Aug-25
pH, soil	MOE E3137 - probe @25 °C, CaCl2 ext	1-Aug-25	1-Aug-25
Resistivity	EPA 120.1 - probe, water extraction	5-Aug-25	5-Aug-25
Solids, %	CWS Tier 1 - Gravimetric	1-Aug-25	5-Aug-25

	Client ID:	BH25-01, GS2, 0.25-1.2m	-	-	-		
	Sample Date:	05-May-25 09:00	-	-	-	-	-
	Sample ID:	2531387-01	-	-	-		
	Matrix:	Soil	-	-	-		
	MDL/Units						
Physical Characteristics							
% Solids	0.1 % by Wt.	91.0	-	-	-	-	-
General Inorganics							
pH	0.05 pH Units	7.74 [1]	-	-	-	-	-
Resistivity	0.1 Ohm.m	16.4 [1]	-	-	-	-	-
Anions							
Chloride	10 ug/g	90 [1]	-	-	-	-	-
Sulphate	10 ug/g	419 [1]	-	-	-	-	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions								
Chloride	ND	10	ug/g					
Sulphate	ND	10	ug/g					
General Inorganics								
Resistivity	ND	0.1	Ohm.m					

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	10	ug/g	ND			NC	35	
Sulphate	28.6	10	ug/g	27.0			5.4	35	
General Inorganics									
pH	7.48	0.05	pH Units	7.45			0.4	2.3	
Resistivity	111	0.1	Ohm.m	114			3.2	20	
Physical Characteristics									
% Solids	78.3	0.1	% by Wt.	77.4			1.1	25	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	107	10	ug/g	ND	107	82-118			
Sulphate	130	10	ug/g	27.0	103	80-120			

Qualifier Notes:

Login Qualifiers :

Sample - One or more parameter received or added past hold time. Directed by client to proceed with analysis - Chloride, pH, resistivity, and sulphate.

Applies to Samples: BH25-01, GS2, 0.25-1.2m

Sample Qualifiers :

1: Holding time had been exceeded upon receipt of the sample at the laboratory or prior to the analysis being requested.

Sample Data Revisions:

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

Soil results are reported on a dry weight basis unlesss otherwise noted.

Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

Paracel ID: 2531387

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Chain of Custody
(Lab Use Only)

Page ___ of ___

Client Name:	**Stantec Consulting Ltd.**	Project Reference:	**Parkdale Tower**
Contact Name:	**Brian Prevost/Max Guerout**	Task #:	
Address:	**100A&B-2781 Lancaster Rd. Ottawa ON. K1B-1A7**	PO #	**122170424**
Telephone:	**613-612-5860**	Email Address:	brian.prevost@stantec.com max.guerout@stantec.com

TAT: **[x] Regular** [ ] 3 Day [ ] 2 Day [] 1 Day

Date Required: _____

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality:_____ [ ] Other:_____

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Paracel Order Number: 2531387

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken		Required Analyses										
					Date	Time	Resistivity	PH	Sulphate & Chloride	Corrosivity							
1	BH25-01, GS2, 0.25-1.2m	S		1	5-May-25		X	X	X	X							
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Comments:

Method of Delivery: Swift

Relinquished By (Print & Sign): Brian Prevost	Received by Driver/Depot:	Received at Lab:
Date/Time: 31-Jul-25	Date/Time:	Date/Time: July 31/25
	Temperature: ____ °C	Temperature: 22.4 °C
		Verified By:
		Date/Time: July 31/25 16:06
		pH Verified [ ] By:

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Certificate of Analysis

Stantec Consulting Ltd. (Ottawa)
2781 Lancaster Road, Suite 101
Ottawa, ON K1B 1A7
Attn: Omar Elghazal

Client PO:
Project: 122170424.401
Custody: 77867

Report Date: 7-Aug-2025
Order Date: 5-Aug-2025

Order #: 2532113

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2532113-01	MW25-1

Approved By:

Mark Foto

Mark Foto, M.Sc.
Laboratory Director

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC	6-Aug-25	6-Aug-25
pH	SM 4500-H+	7-Aug-25	7-Aug-25
Resistivity	EPA 120.1 - probe	7-Aug-25	7-Aug-25
Sulphide	SM 4500SE - Colourimetric	6-Aug-25	6-Aug-25

	Client ID:	MW25-1	-	-	-		
	Sample Date:	05-Aug-25 03:25	-	-	-	-	-
	Sample ID:	2532113-01	-	-	-		
	Matrix:	Ground Water	-	-	-		
	MDL/Units						
General Inorganics							
pH	0.1 pH Units	7.3	-	-	-	-	-
Resistivity	0.01 Ohm.m	1.78	-	-	-	-	-
Sulphide	0.02 mg/L	0.03	-	-	-	-	-
Anions							
Chloride	1 mg/L	1820	-	-	-	-	-
Sulphate	1 mg/L	119	-	-	-	-	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions								
Chloride	ND	1	mg/L					
Sulphate	ND	1	mg/L					
General Inorganics								
Resistivity	ND	0.01	Ohm.m					
Sulphide	ND	0.02	mg/L					

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	1830	5	mg/L	1820			0.1	20	
Sulphate	119	1	mg/L	119			0.0	10	
General Inorganics									
pH	8.2	0.1	pH Units	8.2			0.6	3.3	
Resistivity	1.85	0.01	Ohm.m	1.78			3.9	20	
Sulphide	ND	0.02	mg/L	ND			NC	10	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	10.2	1	mg/L	ND	102	78-114			
Sulphate	128	1	mg/L	119	99.2	74-126			
General Inorganics									
Sulphide	0.48	0.02	mg/L	ND	96.4	82-118			

Certificate of Analysis

Report Date: 07-Aug-2025

Client: **Stantec Consulting Ltd. (Ottawa)**

Order Date: 5-Aug-2025

Client PO:

Project Description: 122170424.401

Qualifier Notes:

Sample Data Revisions:

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

PARACE LABORATORIES

Paracel ID: 2532113

Blvd.
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Paracel Order Number (Lab Use Only)	Chain Of Custody (Lab Use Only)
2532113	№ 77867

Client Name: Stantec Consulting Ltd.	Project Ref: 122170424.401	Page 1 of 1
Contact Name: Omar El-Ghazal	Quote #:	Turnaround Time
Address: 1331 Clyde Avenue, #300, Ottawa, ON, K2C 3G4	PO #:	☐ 1 day ☐ 3 day ☑ 2 day ☐ Regular
Telephone: 613-618-0846	E-mail: omar.elghazal@stantec.com	Date Required:

☑ REG 153/04 ☐ REG 406/19	Other Regulation
☐ Table 1 ☐ Agri/Other ☐ Med/Fine	☐ REG 558 ☐ PWQO
☐ Table 2 ☐ Res/Park ☐ Coarse	☐ CCME ☐ MISA
☑ Table 3 ☐ Ind/Comm	☐ SU - Sani ☐ SU - Storm
☐ Table ___	Mun:
For RSC: ☐ Yes ☐ No	☐ Other:

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Field Filtered	Sample Taken: Date	Sample Taken: Time	Required Analysis: pH	Corrosivity	Resistivity	Sulphides	Chlorides
1	MW25-1	GW	N/A	2	N/A	August 5, 2025	3:25→3:35	X	X	X	X	X
2												
3												
4												
5												
6												
7												
8												
9												
10												

Comments:

Method of Delivery: Walk-in

Relinquished By (Sign):	Received at Depot: KD 1627 Aug 5th	Received at Lab: LTJ	Verified By: SD
Relinquished By (Print): Omar El-Ghazal	Date/Time:	Date/Time: 06/08/25; 10:35	Date/Time: Aug 6, 2025 11:12am
Date/Time: August 5, 2025 / 4:27 PM	Temperature: 20.6 °C	Temperature: 6.2 °C	pH Verified: ☑ By: JM

APPENDIX E

E.1 GEOPHYSICAL INVESTIGATION REPORT

E.2 SEISMIC HAZARD CALCULATION DATA SHEET

Stantec

Memo

To:	Mr. Kyle Kazda Development Manager 1000147699 Ontario Inc. c/o Taggart Realty Management 225 Metcalfe Street, Suite 708 Ottawa, Ontario K2P 1P9	From:	Abderrezak Bouchedda, P.Eng., Ph. D. Nassim Douali, tech. Stantec Consulting Ltd. 110-100 Alexis-Nihon Boulevard Saint-Laurent (QC) H4M 2N6
Project/File:	122170424	Date:	June 9, 2025

Reference: Geophysical investigation for Seismic Site Class at 340 Parkdale Ave, Ottawa, Ontario

1 Introduction

Stantec Consulting Ltd. (Stantec) performed a Multi-Channel Analysis of Surface Waves (MASW) sounding to determine the shear-wave velocity structure and the seismic site classification at 340 Parkdale Ave, Ottawa,Ontario.

This technical memo describes the equipment and procedure used to perform the MASW measurements and provides a summary of the MASW interpretation.

The MASW survey was carried out on May 27, 2025.

2 Survey Location

The site is located on the south side of Spencer St. Between Hamilton Ave. and Parkdale Ave.

In order to determine the shear wave velocity structure and seismic site classification, a MASW survey was conducted using passive and active measurements, as shown on the location map in Appendix A. Table 1 shows the locations of the active and passive MASW profile. Active MASW measurement were carried out using 0.5 m and 2.5 m receiver spacing, while passive MASW measurement were achieved using 2.5 m spacing.

Table 1: MASW survey position

Active and Passive MASW1 Profiles (NAD83-UTM zone 18T)			
Position	**Start**	**Center**	**End**
EAST (m)	442841	442814	442788
NORTH (m)	5027922	5027912	5027901

3 MASW Method

The multichannel analysis of surface waves (MASW) method deals with surface waves in lower frequencies (e.g., 1-30 Hz) and uses a shallower depth range of investigation (e.g., a few to a few tens of meters). The active MASW method generates surface waves through an impact source like a sledgehammer, whereas the passive method uses surface waves generated passively by cultural (e.g., traffic) or natural (e.g., thunder and tidal motion) activities.

In some cases, the energy generated by a sledgehammer impact source could be insufficient to reach a depth of investigation of more than 30m. Consequently, it is recommended to perform passive measurements, in addition to active measurements, to improve the depth of investigation of active MASW data (> 20m). In our case, passive measurements are always performed. During the data processing step, passive data are used only when the resolution of the low frequency part of dispersion image is improved.

In the case of active MASW measurements, the length of the receiver spread is directly related to the longest wavelength that can be analyzed, which determines the maximum depth of investigation, while receiver spacing is related to the shortest wavelength and therefore determines the shallowest resolvable depth of investigation.

The entire procedure for MASW usually consists of three steps as illustrated in Figure 1 (Park et al., 2007): (1) acquiring multichannel field records (or shot gathers); (2) extracting dispersion curves (one from each record); and (3) inverting the dispersion curve to obtain 1D (depth) Vs sounding.

To process active and passive data, we used ParkSeis software which uses an effective way of combining active and passive dispersion images as described in Park et al. (2005). Additionally, passive data are processed using dynamic azimuth detection algorithm of Park (2010).

Because all surface-wave methods, in theory, are based on a layered earth model, the data analysis steps inevitably apply lateral averaging of subsurface conditions along the surface distance occupied by the receiver array. As a result, the interpreted MASW sounding best represents the subsurface velocity (Vs) model below the center of the profile.

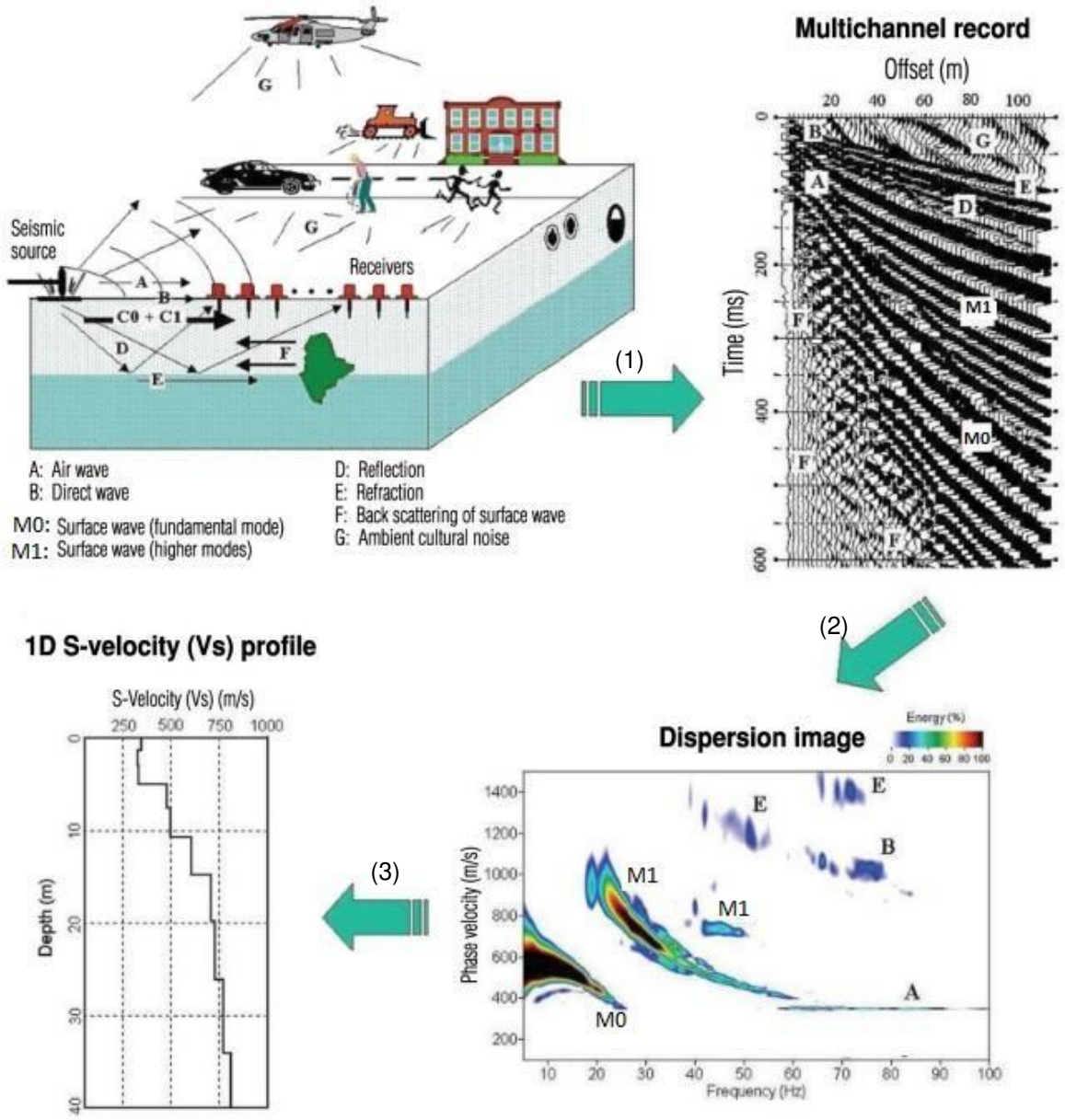

Figure 1: Illustration of active and passive MASW methods (Park et al., 2007). (1) data acquisition, (2) dispersion image generated using seismic data and (3) Vs profile obtained using 1-D inversion of dispersion curve of fundamental mode M0.

4 Data Acquisition

MASW data acquisition was carried out using the geometrics MASW kit system (USA), which consists of a 24-channel seismograph (Geode), a laptop, a seismic cable with 24 hookups (takeouts), 24 low-frequency 4.5-Hz geophones, a 10 lb sledgehammer and an aluminum strike plate. Figure 2 illustrates a typical configuration of MASW data acquisition.

Reference: Geophysical investigation for Seismic Site Class at 340 Parkdale Ave, Ottawa, Ontario

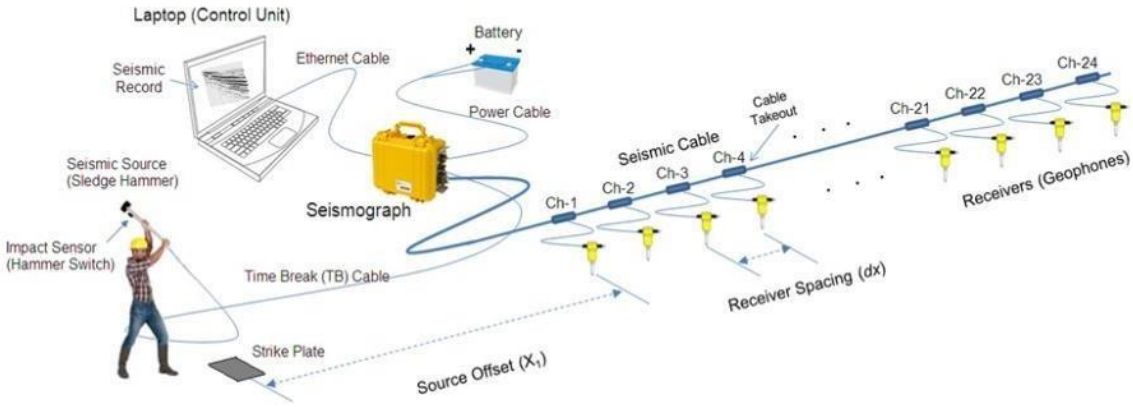

Figure 2: MASW data acquisition setup using 24-Channel seismic acquisition system (From: www.masw.com). The seismic cable is connected to the geode which is controlled by a laptop. An impact sensor is fixed on the hammer and connected to the geode using a trigger cable.

The following acquisition parameters were used for:

- Active MASW measurements:
  - Array length = 23 m and 57.5 m.
  - Source: 10 lb sledge hammer.
  - Receiver spacing = 0.5 m and 2.5 m.
  - Number of receivers = 24.
  - Stacking: 5.
  - Sample Interval = 0.25 milliseconds.
  - Record length = 2 seconds.
  - Source positions:
- For 0.5 m receiver spacing (shots on both sides) at 1, 6 and 12 m.
- For 2.5 m receiver spacing (shots on both sides) at 2.5 and 5 m.
- Passive MASW measurements: ○ Array length = 57.5 m.
  - Receiver spacing = m.
  - Number of receivers = 24.
  - Sample Interval= 8 milliseconds.
  - Record length= 262 seconds.

In the case of active MASW measurements, a receiver spacing of 0.5 meter is used for high-resolution determination of the shear-wave velocity of surficial materials, while a 2.5 meters receiver spacing profile is employed for deeper material characterization.

The data quality was rated as “EXCELLENT” for almost all records. This high data quality is evidenced by very high signal-to-noise (S/N) ratios, approximately 0.9, for the fundamental-mode dispersion energy, as shown in Appendix B.

5 Results

All records’ dispersion images are stacked (0.5 m and 2.5 m receiver spacings, and passive data), and one fundamental-mode (M0) dispersion curve is extracted from the stacked image (Figures 3). A 1-D shear-velocity (Vs) profile of a 10-layer model is obtained by inversion of the extracted dispersion curve, as shown in Figures 3. Table 2 summarizes the obtained Vs-30 and the corresponding site class of MASW survey, respectively.

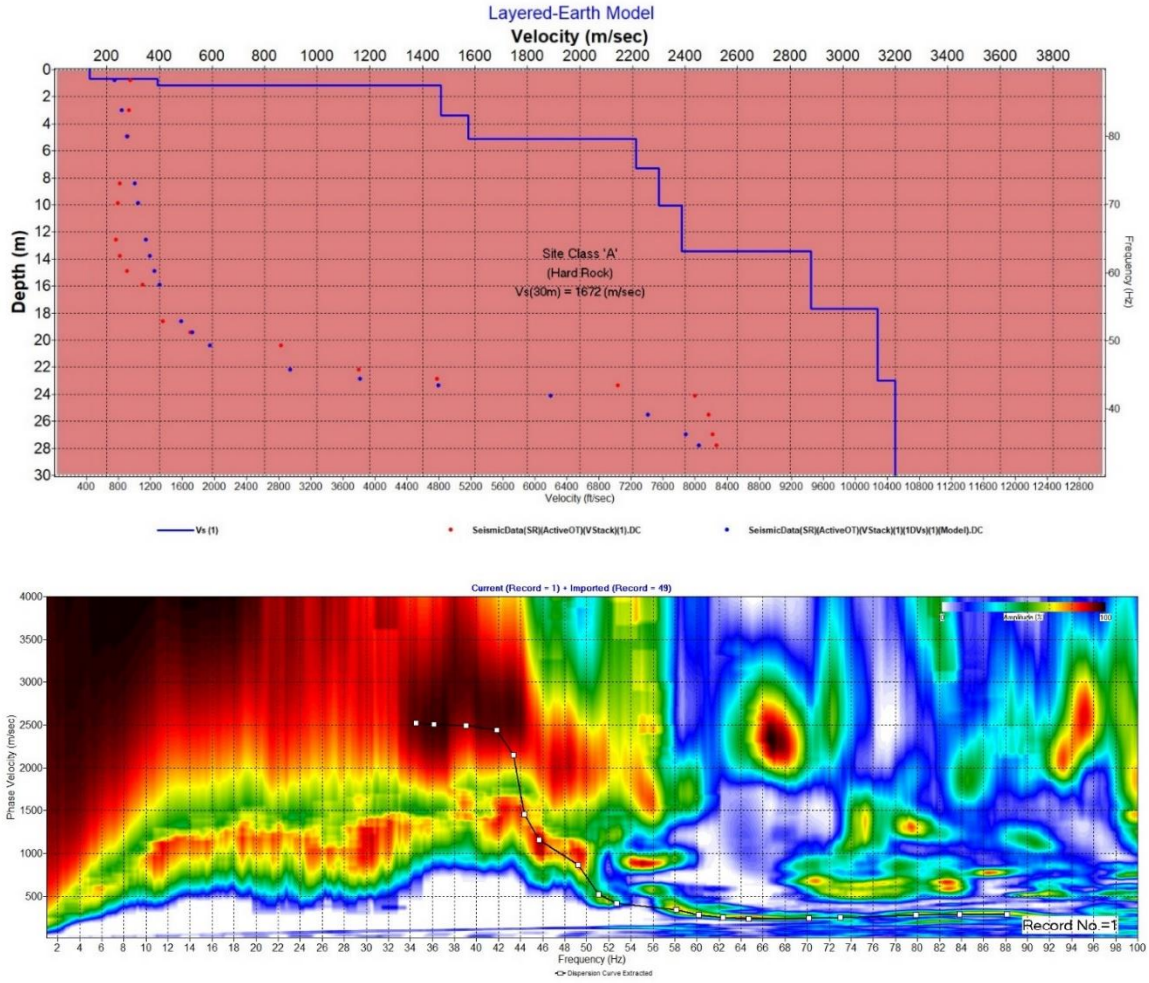

Figure 3: Shear-velocity model (top) obtained by inverting the dispersion curve of MASW1 sounding (bottom).

According to the analyzed 1-D Vs profile for MASW profile, the resulting shear wave velocity model indicated the presence of approximately 1 meter of a variable subsurface consisting of soft to very dense fill (Vs from 135 to 393 m/s), which is followed by stiffer materials with higher velocities (Vs) greater than 1471 m/s, indicating bedrock. The shear wave velocity model of bedrock from 1 m to 7m deep indicates variations in Vs ranging from 1471 to 2500 m/s. This change in bedrock Vs is interpreted to indicate a change from fractured limestone to good quality limestone bedrock.

From MASW 1-D Vs profile, the average Vs for top 30 m depths (i.e., Vs30-m) is calculated.

The value as Vs30-m is 1672 m/s which puts the site into Site Designation $\mathbf{X_{1672}}$, corresponding to seismic **Site Class A** ("hard rock"). according to the seismic site classification codes adopted by The National Building Code of Canada 2020.

6 Conclusions

According to the NBCC 2020 guidelines, the Vs-30 values classify the site into Site Designation $\mathbf{X_{1672}}$ corresponding to seismic **Site Class A** ("hard rock").

It is important to note that the Site Designations $\mathbf{X_{1672}}$, corresponding to Site Class A, is not to be used in cases where the ground profile contains more than 3 m of soft materials between rock and the underside or mat foundations. The appropriate site designation for such cases is $\mathbf{X_{760}}$.

Table 2: 1-D Vs model for MASW1 derived from the inversion of the extracted fundamental mode dispersion curve.

MASW			
Layer #	*** Depth (m)**	**Thickness (m)**	**Vs (m/s)**
1	0,697	0,697	135,23
2	1,176	0,479	392,81
3	3,398	2,222	1470,93
4	5,139	1,741	1575,22
5	7,316	2,177	2214,14
6	10,036	2,72	2301,1
7	13,436	3,4	2387,11
8	17,687	4,251	2879,44
9	23	5,313	3133,67
10	Half-Space	N/A	3200,57
* Depth of the base of the layer **The Vs-30 was calculated in the depth interval (0 m - 30 m)		****Vs-30 (m/s)**	1672,4

7 Limitations

- Estimating the shear wave velocity profile from surface wave analyses requires solving an inverse problem. The results are affected by solution non-uniqueness, as several different models may provide a similar goodness of fit with the experimental data
- The resolution markedly decreases with increasing depth. Therefore, relatively thin deep layers cannot be identified at depth, and the accuracy of the location of layer interfaces is poor at large depths.
- Only 1D models of the subsurface are considered; hence, the outlined procedures assume no significant lateral variations in the seismic properties with a flat or mildly inclined ground surface.

8 References

NBCC, 2020. National Building Code of Canada, National Research Council of Canada, Ottawa, Ontario.

NBCC user's guide, the Structural Commentaries of the NBCC, 2020, National Research Council of Canada, Ottawa, Ontario.

Park, C, B, R, D, Miller, J, H, Xia, and J, Ivanov, 2007, Multichannel analysis of surface waves (MASW)-active and passive methods: The Leading Edge, 26, 60-64.

Park, C, B, R, D, Miller, and J, H, Xia, 1999, Multichannel analysis of surface waves: Geophysics, 64, 800-808.

Xia, J, H, R, D, Miller, and C, B, Park, 1999, Estimation of near-surface shear-wave velocity by inversion of Rayleigh waves: Geophysics, 64, 691-700.

Zhang S X,Chan LSandXiaJ2004Theselection of field acquisition parameters for dispersion images from multichannel surface wave data Pure Appl. Geophys. 161 185–201.

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APPENDICES

Appendix A: MASW Sounding Location.
Appendix B: MASW Data Quality.
Appendix C: Parkseis Color Code Used for Seismic Site Classification (Vs30-M Or Vs100-Ft).
Appendix D: Site Classification for Seismic Site Response (The National Building Code of Canada, 2020).
Appendix E: Geometrics MASW Measurement Kit.

Appendix A
MASW Survey Location

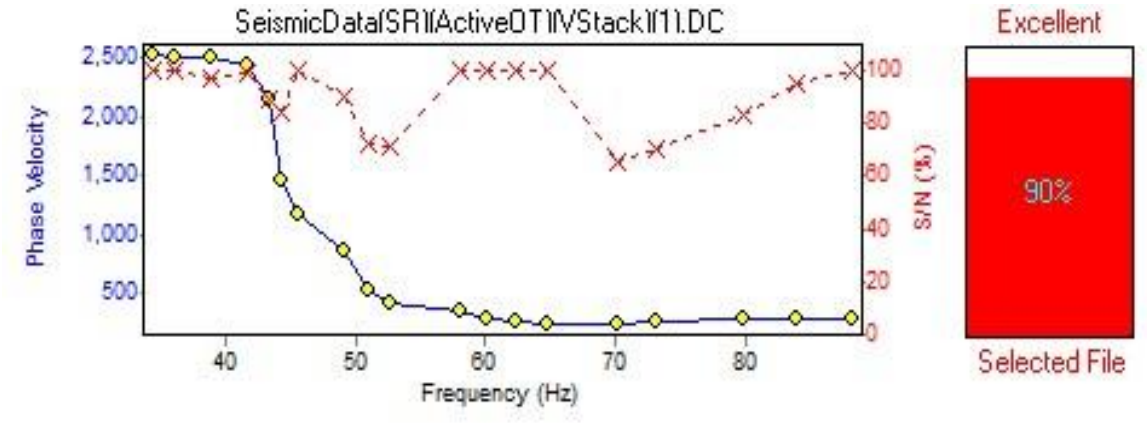
Reference: Geophysical investigation for Seismic Site Class at 340 Parkdale Ave, Ottawa, Ontario

Figure 1A: Location of Active and passive MASW profile on Google Earth map.

Appendix B
MASW Data Quality

Reference: Geophysical investigation for Seismic Site Class at 340 Parkdale Ave, Ottawa, Ontario

Figure 2A: Dispersion curve (yellow diamond) and signal-to-noise ratio (S/N) curve in % (red cross). The mean value of S/N is shown on the right.



Appendix C

Parkseis Color Code Used for Seismic Site Classification (VS30-M or VS100-FT)

Reference: **Geophysical investigation for Seismic Site Class at 340 Parkdale Ave, Ottawa, Ontario**

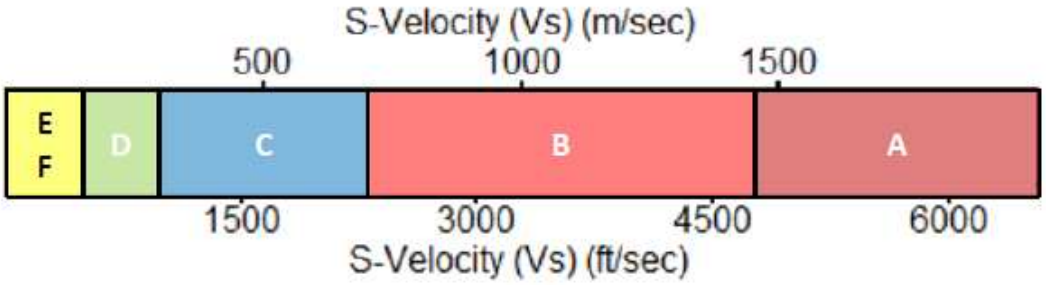


Table 1A: NBCC pour la classe sismique des sites basée sur la vitesse de cisaillement (Vs)

Site Class	S-Velocity (Vs) (ft/sec)	S-Velocity (Vs) (m/sec)
A (Hard Rock)	> 5,000	> 1500
B (Rock)	[2500, 5000]	[760, 1500]
C (Very Dense Soil and Soft Rock)	[1200, 2500]	[360, 760]
D (Stiff Soil)	[600, 1200]	[180, 360]
E (Soft Clay Soil)	< 600	< 180
F (Soils Requiring Add'l Response)	Vs < 600 and meeting some additional conditions,	Vs < 180 and meeting some additional conditions,

* National Building Code of Canada 2015

Appendix D

Site Classification for Seismic Site Response (The National Building Code of Canada, 2020)

Reference: Geophysical investigation for Seismic Site Class at 340 Parkdale Ave, Ottawa, Ontario

Table 4.1.8.4.-B
Site Classes, S, for Site Designation X_S
Forming Part of Sentence 4.1.8.4.(3)

Site Class, S	Ground Profile	Ground Profile Characteristics		
		Average Shear Wave Velocity in Top 30 m, V_{s30}, in m/s(1)	Average Standard Penetration Resistance in Top 30 m, $\bar{N}_{60}$, in Blows per 0.3 m	Average Undrained Shear Strength in Top 30 m, $\bar{s}_u$, in kPa
A	Hard *rock*(2)	$V_{s30} > 1\ 500$	n/a	n/a
B	*Rock*(2)	$760 < V_{s30} \leq 1\ 500$	n/a	n/a
C	Very dense *soil* and soft *rock*	$360 < V_{s30} \leq 760$	$\bar{N}_{60} > 50$	$\bar{s}_u > 100$
D	Stiff *soil*	$180 < V_{s30} \leq 360$	$15 < \bar{N}_{60} \leq 50$	$50 < \bar{s}_u \leq 100$
E	Soft *soil*	$140 < V_{s30} \leq 180$	$10 < \bar{N}_{60} \leq 15$	$40 < \bar{s}_u \leq 50$
		Any ground profile other than Site Class F that contains more than 3 m of *soil* with all the following characteristics: • plasticity index, PI > 20, • moisture content, w ≥ 40%, and • undrained shear strength, $s_u < 25$ kPa		
F	Other *soils*(3)	$V_{s30} \leq 140$	$\bar{N}_{60} \leq 10$	$\bar{s}_u \leq 40$
		Any ground profile that contains • liquefiable *soil*, quick and highly sensitive clay, collapsible weakly cemented *soil*, or other *soil* susceptible to failure or collapse under seismic loading, • more than 3 m of peat and/or highly organic clay, • more than 8 m of highly plastic *soil* (with PI > 75), or • more than 30 m of soft to medium-stiff clay		

Notes to Table 4.1.8.4.-B:

(1) See Note A-4.1.8.4.(2) and (3).

(2) Site designations X_A and X_B, corresponding to Site Classes A and B, are not to be used in cases where the ground profile contains more than 3 m of softer materials between *rock* and the underside of footing or mat *foundations*. The appropriate site designation for such cases is X_{760}.

(3) Site-specific geotechnical evaluation is required.

Appendix E
Geometrics MASW Measurements Kit

Reference: Geophysical investigation for Seismic Site Class at 340 Parkdale Ave, Ottawa, Ontario

MASW Kit

	1 CT: SPREAD CABLE, 24 TAKEOUTS AT 5-M INTERVAL
	26 CT: VERTICAL GEOPHONE, 4.5 HZ
	26 CT: GEOPHONE TRIPODS
	1 CT: HAMMER SWITCH

Reference: Geophysical investigation for Seismic Site Class at 340 Parkdale Ave, Ottawa, Ontario

	2 CT: 300 FT (92 M) TRIGGER EXTENSION CABLE
	1 CT: 12"X12"X2" POLYETHYLENE STRIKER PLATE
	1 CT: 16 LB SLEDGEHAMMER

Government of Canada / Gouvernement du Canada

Canada.ca › Natural Resources Canada › Earthquakes Canada

2020 National Building Code of Canada Seismic Hazard Tool

This application provides seismic values for the design of buildings in Canada under Part 4 of the National Building Code of Canada (NBC) 2020 as prescribed in Article 1.1.3.1. of Division B of the NBC 2020.

Seismic Hazard Values

User requested values

Code edition	NBC 2020
Site designation X_V	X_{1672}
Latitude (°)	45.402
Longitude (°)	-75.73

Please select one of the tabs below.

NBC 2020 | Additional Values | Plots | API | Background Information

The 5%-damped spectral acceleration ($S_a(T,X)$, where T is the period, in s, and X is the site designation) and peak ground acceleration (PGA(X)) values are given in units of acceleration due to gravity (g, 9.81 m/s^2). Peak

ground velocity (PGV(X)) values are given in m/s. Probability is expressed in terms of percent exceedance in 50 years. Further information on the calculation of seismic hazard is provided under the *Background Information* tab.

The 2%-in-50-year seismic hazard values are provided in accordance with Article 4.1.8.4. of the NBC 2020. The 5%- and 10%-in-50-year values are provided for additional performance checks in accordance with Article 4.1.8.23. of the NBC 2020.

See the *Additional Values* tab for additional seismic hazard values, including values for other site designations, periods, and probabilities not defined in the NBC 2020.

NBC 2020 - 2%/50 years (0.000404 per annum) probability

$S_a(0.2, X_{1672})$	$S_a(0.5, X_{1672})$	$S_a(1.0, X_{1672})$	$S_a(2.0, X_{1672})$	$S_a(5.0, X_{1672})$	$S_a(10.0, X_{1672})$	$PGA(X_{1672})$	$PGV(X_{1672})$
0.379	0.194	0.0999	0.0468	0.0129	0.00486	0.308	0.145

The log-log interpolated 2%/50 year $S_a(4.0, X_{1672})$ value is : **0.0177**

▶ Tables for 5% and 10% in 50 year values

Download CSV

← Go back to the seismic hazard calculator form

Date modified: 2021-04-06

APPENDIX F

F.1 ROCK ANCHOR: RESISTANCE TO ROCK MASS FAILURE

Rock Anchor

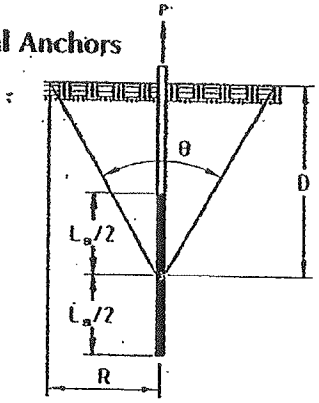
Resistance to Rock Mass Failure

Required Safety Factor for Resistance to Rock Mass Failure: $W_R / P \geq 2.0$

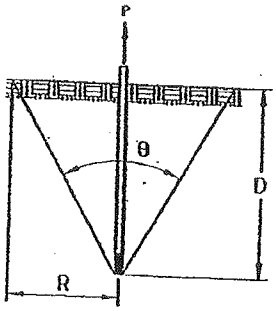
Design Considerations:

1. Use 60° or 90° apex angle as per recommendations in the geotechnical report

Vertical Anchors

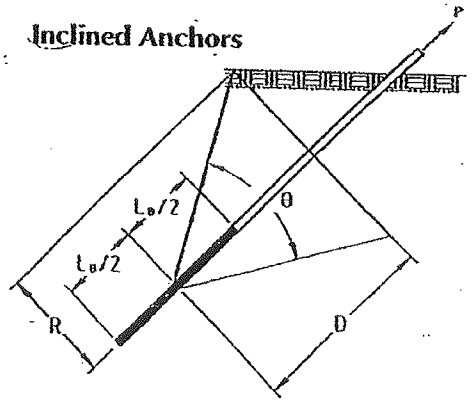


Grouted Rock Anchors

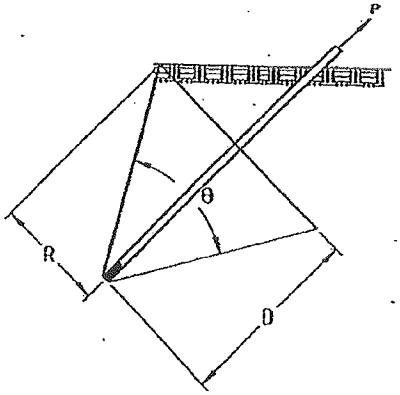


Mechanical Rock Anchors

Inclined Anchors



Grouted Rock Anchors



Mechanical Rock Anchors

P	=	Resultant of maximum axial anchor forces
D	=	Height of rock cone
R	=	Radius of rock cone
θ	=	Appex angle
L_B	=	Bond length
γ_R	=	Submerged unit weight of bedrock
W_R	=	Weight of rock cone ($W_R = \frac{1}{3}\pi R^2 D \gamma_R$)