Geotechnical Investigation

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Executive Summary

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation completed for the proposed development at 112 Montreal Road, Ottawa, Ontario just west of the Vanier Parkway, as shown on Figure No. 1. The terms and conditions of this assignment were outlined in EXP Services Inc. (EXP) proposal number: OTT-00214936-C0 dated June 17, 2022. Authorization to proceed with this geotechnical investigation was provided by email on August 3, 2022.

Drawing SP-2 titled "Site Plan Overall" by Roderick Lahey Architects Ltd. (rla), Revision 6, dated March 15, 2023, was provided. The drawing indicates that the proposed development will be phased with Phase I including the construction of an eight (8) storey mixed use building (Building A) and a thirty-seven (37) storey residential apartment building (Tower B1). It is understood that the finished floor elevations of Building A will be 56.78 m and the finished floor elevation of Building B1 will be 57.47 m. Phase II of the development includes the construction of a twenty-eight (28) storey (Tower B2) and a sixteen (16) storey (Tower B3) residential building towers. Towers B2 and B3 will have six (6) and four (4) storey podiums, respectively. Finished floor elevations of the Phase II buildings have not been provided. It is understood that underside of footing elevation for the buildings will be at Elevation 44.0 m. It is also understood that surficial access roads and parking spaces will be constructed and will consist of a mixture of paved road and paving stones.

A soil characterization report, dated November 2022 and a Phase One Environmental Site Assessment (ESA), dated April 2023, have been carried out by EXP and the results are documented in separate reports. At the time of this report a Phase Two Environmental Site Assessments and a Hydrogeological Assessment by EXP are in progress.

The test hole (boreholes and augerholes) fieldwork was undertaken between September 14 and 22, 2022 and consists of six (6) boreholes (Borehole Nos. 1 to 6) advanced to termination/auger refusal depths ranging from 8.7 m to 15.3 below existing grade and ten (10) augerholes (Augerhole Nos. 1 to 10) advanced to termination/auger refusal depths ranging from 2.4 m to 3.2 below existing grade. Shallow testpits were also excavated in the existing berms as part of the soil characterization report, however, their results were not considered relevant as part of the geotechnical investigation due to the limited data collected.

An additional five (5) boreholes (Borehole Nos. 23-1 to 23-5) were caried out between February 9 and 10, 2023, advanced to termination depths ranging from 4.6 m to 7.3 below existing grade. The environmental boreholes collected limited data and only the bedrock depths and water levels encountered in the 2023 investigation have been incorporated into this report. Where the 2023 boreholes are referred to in this report the prefix "23-" has been added. The fieldwork was supervised on a full-time basis by a representative from EXP.

The test hole information indicates the bedrock is present at the ground surface or that a surficial layer of asphaltic concrete or fill was present. Bedrock at the site ranged from limestone with shaley partings along bedding planes to shale with limestone partings along the bedding planes. Groundwater was encountered at 0.5 m to 5.5 m.

The results of the seismic shear wave survey conducted at the site are provided in the report attached in Appendix B. The survey indicates that the seismic shear wave velocity from the 1.0 m depth to 30.0 m depth 1,501 m/s. Table 4.1.8.4.A of the 2012 Ontario Building Code (as amended May 2, 20219) indicates that a seismic shear wave velocity value greater than 1,500 m/s falls within the range of velocities for site class A (V_{s30} <1,500 m/s) in the case there would be 2.5 metres or less of unconsolidated material between the rock and the bottom of the foundation. Therefore, the site classification for seismic response is **Class A.**

From a geotechnical perspective there are no restrictions to raising the grades at the site since it is anticipated that all subsurface soils will be or have been excavated down to the bedrock, removed from the site and replaced with either imported granular fill (compacted to the specified degree of compaction indicated in this report). EXP however should be consulted to review the final grading plan.

Based on a review of the available design information and test hole data, it is considered that the appropriate foundation to support the proposed buildings, with four levels of underground parking, is spread and strip footings founded on the sound limestone or shale bedrock contacted below any fractured or weathered zones. The design underside of footing elevation is 44.0 m.

Spread and strip footings founded on the sound bedrock, competent and free of soil filled seams, may be designed for a factored geotechnical resistance at Ultimate Limit State (ULS) of 3000 kPa. The factored ULS value includes a resistance factor of 0.5. The

Serviceability Limit State (SLS) bearing pressure of the bedrock, required to produce 25 mm settlement of the structure will be much larger than the recommended value for factored geotechnical resistance at ULS. Therefore, the factored geotechnical resistance at ULS will govern the design. Settlements of footing designed for the above recommended factored geotechnical resistance at ULS and properly constructed are expected to be less than 10 mm.

The factored sliding resistance at ULS between the underside of concrete and the top of the unweathered sound bedrock is 0.56 and includes a resistance factor of 0.8.

The lowest floor level of the parking garage for the proposed buildings is to be slightly above Elevation 44.0 m. Based on the borehole information, the lowest floor slab of the buildings will be founded on the limestone or shale bedrock and may be constructed as a concrete slab-on-grade or as a paved surface. The lowest floor level for the parking garage is anticipated to be located below the groundwater level. Therefore, underfloor and perimeter drainage systems will be required for the proposed below grade parking garage.

Excavations may be undertaken by conventional heavy equipment capable of removing debris, cobbles and boulders present within the fill and glacial till. Reference is made to the soil quality report completed by exp for the management of any excess soils generated form the site. All excavations must be undertaken in accordance with the Occupational Health and Safety Act (OHSA), Ontario Reg. 213/91. Based on the definitions provided in OHSA, the subsurface soils on site are considered to be Type 3 and as such must be cut back at 1H:1V from the bottom of the excavation above the groundwater level. Within zones of persistent seepage and below the groundwater level in the soils, the excavation side slopes are expected to slough and eventually stabilize at a slope of 2H:1V to 3H:1V. Excavations within the weathered bedrock may be undertaken with near vertical sides subject to review by a geotechnical engineer. The weathered and fractured rock face may require support in the form of rock bolts to maintain the integrity of the rock face in conjunction with a wire mesh system and shotcrete.

A conventional shoring system consisting of soldier pile and timber lagging may be used at the site. In areas where there is concern for lateral yielding of the soils and the potential of settlement of nearby structures and infrastructure, the use of a steel interlocking sheeting system or secant pile system can be considered. The shoring system will require lateral restraint provided by tiebacks consisting of rock anchors. Due to the presence of cobbles and boulders in the subsurface soils, pre-drilling may be required for the installation of the soldier piles. The presence of cobbles and boulders in the subsurface soils should also be taken into consideration for other contemplated shoring systems

The excavations are anticipated to extend into the bedrock surface and should be excavated using line drilling and blasting techniques by a specialized blasting contractor. Pre-condition survey of any surrounding structures and services will be required to be completed prior to any blasting. Vibration monitoring must be completed during rock removal to ensure conformance to the City of Ottawa requirement.

It is anticipated that the majority of the material required for backfilling purposes in the interior and exterior of the proposed building and for trench backfill would have to be imported and should preferably conform to Ontario Provincial Standard Specification (OPSS) for Granular B Type II.

The above and other related considerations are discussed in greater detail in the main body of the attached geotechnical report.

1. Introduction

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation completed for the proposed development at 112 Montreal Road, Ottawa, Ontario just west of the Vanier Parkway, as shown on Figure No. 1. The terms and conditions of this assignment were outlined in EXP Services Inc. (EXP) proposal number: OTT-00214936-C0 dated June 17, 2022. Authorization to proceed with this geotechnical investigation was provided by email on August 3, 2022.

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A soil characterization report, dated November 2022 and a Phase One Environmental Site Assessment (ESA), dated April 2023, have been carried out by EXP and the results are documented in separate reports. At the time of this report a Phase Two Environmental Site Assessments and a Hydrogeological Assessment by EXP are in progress.

The geotechnical investigation was undertaken to:

a) Establish the subsurface soil and groundwater conditions at 16 test holes located on the site (six (6) boreholes and ten (10) auger holes),

b) Classify the site for seismic site response in accordance with the requirements of the 2012 Ontario Building Code (as amended May 2, 2019) and assess the potential for liquefaction of the subsurface soils during a seismic event,

c) Comment on grade-raise restrictions and provide site grading requirements,

d) Make recommendations regarding the most suitable type of foundations, founding depth and bearing pressure at serviceability limit state (SLS) and factored geotechnical resistance at ultimate limit state (ULS) of the founding strata and comment on the anticipated total and differential settlements of the recommended foundation type,

e) Provide comment regarding slab-on-grade construction and the requirement for perimeter and underfloor drainage systems,

f) Comment on excavation conditions and de-watering requirements during construction,

g) Discuss backfilling requirements and suitability of on-site soils for backfilling purposes; and

h) Comment on the corrosion potential of subsurface soils buried concrete and steel structures/members; and

The comments and recommendations given in this report are based on the assumption that the above-described design concepts will proceed into construction. If changes are made either in the design phase or during construction, this office must be retained to review these modifications. The result of this review may be a modification of our recommendations or it may require additional field or laboratory work to check whether the changes are acceptable from a geotechnical viewpoint.

2. Site Description

The site is bounded to the north by Montreal Road and an Esso Gas station, to the west and the south by residential housing and to the east by Vanier Parkway. The site has an approximate area of 0.96 hectares and is irregular in shape

The previous structures on the site, consisting of one- and two-storey structures present in the 2013 EXP investigation have been demolished. The eastern part of the site has been partially excavated to the bedrock surface and ponding water is present in the southwest part of this area. The western part of the site is being used for parking and is partially paved. A soil berm has been constructed along the boundary between the parking and the east part of the site.

The elevations of the boreholes within the previously excavated area range from Elevation 55.38 m to Elevation 54.07 m. The remaining boreholes range from Elevation 56.96 m to Elevation 55.74 m.

3. Background Information

In 2013/2014, EXP completed a preliminary geotechnical investigation at the site. At that time the site was occupied by several low-rise buildings which have been subsequently demolished. The preliminary geotechnical investigation comprised of the drilling of ten (10) boreholes, Borehole Nos. 1A, 1B and 2 to 9, drilled from 3.6 m to 8.1 m depth. The investigation revealed that the surficial soil at the site is fill underlain by silty sand glacial till. Limestone bedrock was encountered at 0.9 m to 5.1 m (Elevation 54.3 m to 53.3 m). The groundwater table at the site was established to range from 2.4 m to 4.2 m depth.

In the 2013 investigation a local datum was used. This survey has been tied into the geodetic elevation during the 2022 survey. Where the 2013 boreholes are referred to in this report the prefix “13-“ has been added to the borehole number and geodetic elevations have been used.

Project details were not available at the time of preparation of the 2013 report and preliminary recommendations were that it was considered feasible to found the proposed high rise structures on spread and strip footings set on limestone bedrock with a factored geotechnical resistance at ULS ranging from 1.0 MPa to 3.0 MPa, depending on the number of basements incorporated in the proposed structures. The bedrock was found to becomes more competent with depth.

Preliminary pavement and dewatering recommendations were also provided.

The borehole logs from this investigation are included in Appendix A.

4. Procedure

4.1 Test Hole Fieldwork and Laboratory Testing Program

The test hole (boreholes and augerholes) fieldwork was undertaken between September 14 and 22, 2022 and consists of six (6) boreholes (Borehole Nos. 1 to 6) advanced to termination/auger refusal depths ranging from 8.7 m to 15.3 below existing grade and ten (10) augerholes (Augerhole Nos. 1 to 10) advanced to termination/auger refusal depths ranging from 2.4 m to 3.2 below existing grade. Shallow testpits were also excavated in the existing berms as part of the soil characterization report, however, their results were not considered relevant as part of the geotechnical investigation due to the limited data collected.

An additional five (5) environmental boreholes (Borehole Nos. 23-1 to 23-5) were caried out between February 9 and 10, 2023, advanced to termination depths ranging from 4.6 m to 7.3 below existing grade. The environmental boreholes collected limited data and only the bedrock depths and water levels encountered in the 2023 investigation have been incorporated into this report. Where the 2023 boreholes are referred to in this report the prefix “23-“ has been added.

The fieldwork was supervised on a full-time basis by a representative from EXP.

The locations and geodetic elevations of the test holes were established on site by EXP and are shown on the Test Hole Location Plan, Figure 2.

The boreholes and augerholes locations were cleared of private and public underground services, prior to the start of drilling and excavating operations.

The 2022 test holes were drilled using a CME-75 track-mounted drill rig equipped with continuous flight hollow stem augers, washboring, rock coring and soil sampling capabilities. Standard penetration tests (SPTs) were performed in all the test holes within the overburden at depth intervals of 0.75 m with soil samples retrieved by the split-barrel sampler. The boreholes were advanced beyond the depth of refusal in the six (6) boreholes by conventional coring techniques using the N-size core barrel. A field record of wash water return, colour of wash water and any sudden drops of the drill rods were kept during rock coring operations. The subsurface soil conditions in each test hole were logged with each soil sample placed in a labelled plastic bags. Similarly, the rock cores were visually examined, placed in a core box, identified and logged.

The 2023 Environmental boreholes were drilled using a Geomachine Model GM 100 track-mounted drill rig. The boreholes were advanced beyond bedrock surface in all five (5) boreholes by the use of an air hammer with bedrock no samples recovered.

Thirty-two (32) mm or fifty (50) mm diameter monitoring wells with slotted section were installed in selected boreholes for long-term monitoring of the groundwater levels as well as for groundwater sampling for the EXP Soil Characterization Report. The wells were installed in accordance with EXP standard practice, and the installation configuration is documented on the respective borehole log. The boreholes were backfilled upon completion of drilling.

On completion of the test hole fieldwork, the soil and rock samples were transported to the EXP laboratory in Ottawa. The soil and rock samples were visually examined in the laboratory by a geotechnical engineer. All the samples were classified in accordance with the Unified Soil Classification System (USCS) and the modified Burmeister System (2006 Fourth Edition of the Canadian Foundation Engineering Manual (CFEM)).

The geotechnical engineer also assigned the laboratory testing program which is summarized in Table I.

Table I: Summary of Laboratory Testing Program	
Type of Test	Number of Tests Completed
Soil Samples	
Moisture Content Determination	49
Unit Weight Determination	3
Rock Samples	
Unit Weight Determination	32
Unconfined Compressive Strength	32

4.2 Seismic Shear Wave Survey

A seismic shear wave survey of the site was undertaken by Geophysics GPR International Inc. (GPR) on September 2, 2022. The purpose of the survey is to determine the seismic shear wave velocity of the site from the existing ground surface to 30.0 m depth and based on the results of the survey, provide the classification of the site for seismic response. The location of the seismic survey line is shown in Figure No. 2. The seismic shear wave survey report is attached in Appendix B.

5. Subsurface Conditions and Groundwater Levels

A detailed description of the subsurface conditions and groundwater levels from the borehole are given on the attached Test hole (Borehole and Augerhole) logs, Figure Nos. 4 to 24. The test hole logs and related information depict subsurface conditions only at the specific locations and times indicated. Subsurface conditions and water levels at other locations may differ from conditions at the locations where sampling was conducted. The passage of time also may result in changes in the conditions interpreted to exist at the locations where sampling was conducted.

The test holes were drilled to provide representation of subsurface conditions as part of a geotechnical exploration program and are not intended to provide evidence of potential environmental conditions.

It should be noted that the soil boundaries indicated on the test hole logs are inferred from non-continuous sampling and observations during drilling operations. These boundaries are intended to reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. The “Notes on Sample Descriptions” preceding the test hole logs form an integral part of this report and should be read in conjunction with this report.

A review of the test hole logs indicates the following subsurface conditions with depth and groundwater level measurements.

5.1 Asphaltic Concrete

A 125 mm thick surficial topsoil layer was encountered in Borehole No. AH-8.

5.2 Fill

Fill was contacted surficially or underlying the asphaltic concrete in Augerholes Nos. 1 to 10 and Boreholes Nos. 3, 4 and 6. The fill extends to depths of 0.3 m to 2.2 m (Elevation 55.8 m to Elevation 53.9 m). The fill generally consists of sand with gravel. In Boreholes Nos. 3, 4 and 6 the fill contained concrete and metal fragments. The fill is in a loose to dense state based on standard penetration test (SPT) N-values ranging from 5 to 37. Higher N values with low sampler penetration, i.e. 50 for 75 mm sampler penetration, into the fill is likely a result of the split spoon sampler making contact with a cobble, boulder or debris within the fill. The moisture content of the fill ranged from 3 percent to 13 percent.

5.3 Glacial Till

In Augerholes Nos. 1 to 10 and Boreholes Nos. 3 and 4 glacial till was contacted beneath the fill depths of 0.3 m to 2.2 m (Elevation 55.8 m to Elevation 53.9 m). The glacial till contains varying amounts of gravel, sand, silt and clay within the soil matrix as well as cobbles and boulders. The SPT N-values of the glacial till range from 2 to 72 indicating the glacial till is in a very loose to very dense state. Higher N values with low sampler penetration, i.e. 50 for 75 mm sampler penetration, into the glacial till are likely a result of the split spoon sampler making contact with a cobble or boulder within the glacial till. The natural moisture content and the unit weight of the glacial till range from 2 percent to 28 percent and 19.2 kN/m^3 to 24.2 kN/m^3, respectively.

5.4 Bedrock

Auger refusal was met in Augerholes Nos. 3 and 6 and Boreholes Nos. 1 to 6 at depths ranging from surficially to 4.4 m depth (Elevation 55.4 m to Elevation 52.1 m). Washboring and rock coring were used to advance Borehole Nos. BH-1 to BH-6 and confirmed that refusal was met on bedrock.

Boreholes Nos. 23-1 to 23-5 were advanced to depths ranging from surficially to 3.6 m depth (Elevation 55.3 m to Elevation 52.8 m) where bedrock was encountered. The boreholes were advanced into the bedrock using an air hammer to depths of 4.5 m to 7.3 m (Elevation 51.8 m to Elevation 49.1 m).

Auger refusal was encountered in the 2013 investigation in Boreholes Nos. 13-1A, 13-1B, 13-2 and 13-4 to 13-9 at 2.1 m to 3.3 m depth depths (Elevation 54.3 m to Elevation 53.3 m) and these boreholes were advanced by rock coring techniques to confirmed that refusal was met on bedrock.

The bedrock encountered at the site ranged from limestone with shaley partings along bedding planes to shale with limestone partings along the bedding planes.

A summary of the auger refusal depths and the depth to bedrock confirmed by coring are shown in Table II. Cross sections of the bedrock profile across the site is presented in Figure Nos. 3a and 3b.

Table II: Summary of Soil Sampler Refusal and Bedrock Depths (Elevations) in Boreholes

Borehole (BH) No.	Ground Surface Elevation (m)	Depth (Elevation) of Bedrock Surface (m)	Core Depth – Elevation
BH-01	55.38	0.0 (55.4)	Bedrock Cored from Elev. 55.4 to 46.7 m (8.7 m of bedrock)
BH-02	54.08	0.0 (54.1)	Bedrock Cored from Elev. 54.1 to 43.9 m (10.2 m of bedrock)
BH-03	56.50	4.4 (52.1)	Bedrock Cored from Elev. 52.1 to 47.3 (4.8 m of bedrock)
BH-04	56.10	2.6 (53.5)	Bedrock Cored from Elev. 53.5 to 40.8 (12.7 m of bedrock)
BH-05	55.28	0.0 (55.3)	Bedrock Cored from Elev. 55.3 to 46.4 (8.9 m of bedrock)
BH-06	55.84	0.7 (55.1)	Bedrock Cored from Elev. 55.1 to 43.6 (11.5 m of bedrock)
MW23-1	56.37	3.6 (52.8)	Bedrock removed by air hammer from Elev. 52.8 to 49.1 (3.7 m of bedrock)
MW23-2	54.26	0.0 (54.3)	Bedrock removed by air hammer from Elev. 54.3 to 49.5 (4.8 m of bedrock)
MW23-3	54.27	0.0 (54.3)	Bedrock removed by air hammer from Elev. 54.3 to 49.8 (4.5 m of bedrock)
MW23-4	56.30	1.0 (55.3)	Bedrock removed by air hammer from Elev. 55.3 to 51.8 (3.5 m of bedrock)
MW23-5	56.96	2.7 (54.3)	Bedrock removed by air hammer from Elev. 54.3 to 50.1 (4.2 m of bedrock)
BH13-1A	56.50	2.7 (53.8)	Bedrock Cored from Elev. 53.8 to 52.9 (0.9 m of bedrock)
BH13-1B	56.48	3.0 (53.5)	Bedrock Cored from Elev. 53.5 to 48.4 (5.1 m of bedrock)
BH13-2	56.13	2.8 (53.3)	Bedrock Cored from Elev. 53.3 to 50.5 (2.8 m of bedrock)
BH13-4	56.23	2.7 (53.5)	Bedrock Cored from Elev. 53.5 to 50.5 (3.0 m of bedrock)
BH13-5	55.89	2.4 (53.5)	Bedrock Cored from Elev. 53.5 to 48.7 (4.8 m of bedrock)
BH13-6	56.26	2.6 (53.7)	Bedrock Cored from Elev. 53.7 to 49.4 (4.3 m of bedrock)
BH13-7	56.24	2.6 (53.6)	Bedrock Cored from Elev. 53.6 to 48.9 (4.7 m of bedrock)
BH13-8	56.40	2.1 (54.3)	Bedrock Cored from Elev. 54.3 to 49.4 (4.9 m of bedrock)
BH13-9	57.01	3.3 (53.7)	Bedrock Cored from Elev. 53.7 to 49.1 (4.6 m of bedrock)

Based on the bedrock coring results, the total core recovery (TCR) generally ranges from 84 percent to 100 percent. The rock quality designation (RQD) ranged from 57 percent to 100 percent indicating the bedrock quality ranging from fair to excellent.

In the 2013 exp investigation, coring results, Total Core Recovery (TCR) of 59 to 100 percent and Rock Quality Designation (RQD) of 25 to 100 percent were obtained indicating a bedrock quality may be described as very poor to excellent. Generally, the bedrock quality improves with depth.

Unit weight determination and unconfined compressive strength tests were conducted on thirty-two (32) rock core sections and the results are summarized in Table III. Photographs of the rock cores are shown in Appendix C.

Table III: Summary of Unconfined Compressive Strength Test Results – Bedrock Cores				
Borehole (BH) No. – Run No.	Depth (m)	Unit Weight (kN/m^3)	Unconfined Compressive Strength (MPa)	Classification of Rock with respect to Strength
BH1 Run1	0.4 - 0.5	26.2	115.0	R5
BH1 Run2	1.3 - 1.5	26.4	92.6	R4
BH1 Run3	2.8 - 3.0	26.5	115.5	R5
BH1 Run4	4.4 - 4.6	26.5	189.0	R5
BH1 Run5	6.8 - 6.9	26.6	163.7	R5
BH1 Run6	8.6 - 8.7	26.5	72.9	R4
BH3 Run1	4.5 - 4.7	26.3	209.1	R5
BH3 Run2	6.2 - 6.4	26.3	30.7	R3
BH3 Run3	7.2 - 7.3	26.3	107.7	R5
BH3 Run4	9.0 - 9.2	26.3	95.6	R4
BH4 Run1	3.9 - 4.0	25.5	52.4	R4
BH4 Run2	3.9 - 4.0	25.5	52.4	R4
BH4 Run3	3.9 - 4.0	25.5	52.4	R5
BH4 Run4	3.9 - 4.0	25.5	52.4	R5
BH4 Run5	9.3 - 9.4	25.8	58.6	R4
BH4 Run5	9.3 - 9.4	25.8	58.6	R5
BH4 Run5	9.3 - 9.4	25.8	58.6	R4
BH5 Run2	1.5 - 1.8	25.8	103.1	R3
BH5 Run4	4.6 - 4.8	26.1	130.9	R4
BH5 Run5	6.3 - 6.4	25.3	77.0	R4
BH6 Run1	0.9 - 1.1	26.1	173.1	R4
BH6 Run2	2.8 - 2.9	27.6	69.7	R4
BH6 Run3	3.5 - 3.6	25.5	40.9	R4
BH6 Run4	5.9 - 6.0	25.5	80.5	R4
BH6 Run5	6.3 - 6.5	25.2	74.8	R4
BH6 Run6	8.1 - 8.2	26.3	79.9	R4
BH6 Run7	9.8 - 10.0	26.4	77.8	R4
BH6 Run8	11.2 - 11.3	26.3	65.1	R4
BH13-1B Run 2	3.7 – 3.8	25.4	75.6	R4
BH13-1B Run 4	7.3 – 7.4	26.4	89.9	R4
BH13-6 Run 2	4.4 – 4.5	25.7	63.9	R4
BH13-9 Run 3	7.1 – 7.3	25.8	90.0	R4

A review of the test results in Table III indicates the strength of the rock may be classified as medium strong (R3) to very strong (R5) in accordance with the Canadian Foundation Engineering Manual (CFEM), Fourth Edition, 2006. The average unconfined compressive strength was found to be 90 MPa.

5.5 Groundwater Level Measurements

A total of six (6) monitoring wells were installed in the 2022 investigation and five (5) in the 2023 investigation. The monitoring well in Borehole No. 13-2 (MW13-2) was intact and the water level with the well measured. A summary of the groundwater level measurements taken in the monitoring wells are shown in Table IV.

Table IV: Summary of Groundwater Level Measurements

Borehole (BH) / Monitoring Well (MW) No.	Ground Surface Elevation (m)	October 24, 2022		March 2, 2023	
		Elapsed Time in Days from Date of Installation	Groundwater Depth Below Ground Surface (Elevation), m	Elapsed Time in Days from Date of Installation	Groundwater Depth Below Ground Surface (Elevation), m
BH-01	55.38	39 days	0.5 (54.9)	168 days	0.5 (54.9)
BH-02	54.08	39 days	0.8 (53.3)	168 days	0.8 (53.3)
BH-03	56.50	39 days	3.8 (52.7)	168 days	3.8 (52.7)
BH-04	56.10	40 days	5.5 (50.6)	169 days	5.5 (50.6)
BH-06	55.84	32 days	0.6 (55.3)	161 days	0.6 (54.7)
MW23-1	56.37	--	--	20 days	0.5 (54.9)
MW23-2	54.26	--	--	21 days	0.8 (53.3)
MW23-3	54.27	--	--	21 days	3.8 (52.7)
MW23-4	56.30	--	--	20 days	5.5 (50.6)
MW23-5	56.96	--	--	21 days	0.6 (54.7)
MW13-2	56.13	> 9 years	2.9 (53.3)	> 9 years	2.6 (53.6)

The groundwater level ranges from 0.5 m to 5.5 m (Elevation 55.3 m to Elevation 50.6 m).

Water levels were determined in the boreholes and monitoring wells at the times and under the conditions noted above. Note that fluctuations in the level of groundwater may occur due to a seasonal variation such as precipitation, snowmelt, rainfall activities, and other factors not evident at the time of measurement and therefore may be at a higher level during wet weather periods.

6. Site Classification for Seismic Site Response and Liquefaction Potential of Soils

6.1 Site Classification for Seismic Site Response

The results of the seismic shear wave survey conducted at the site are provided in the report attached in Appendix B. The survey indicates that the seismic shear wave velocity from the 1.0 m depth to 30.0 m depth 1,501 m/s. Table 4.1.8.4.A of the 2012 Ontario Building Code (as amended May 2, 20219) indicates that a seismic shear wave velocity value greater than 1,500 m/s falls within the range of velocities for site class A (V_{s30} <1,500 m/s) in the case there would be 2.5 metres or less of unconsolidated material between the rock and the bottom of the foundation. Therefore, the site classification for seismic response is **Class A.**

6.2 Liquefaction Potential of Soils

All overburden soils will be removed as part of the proposed development and therefore there is no liquefaction potential of the soils at the site during a seismic event.

7. Grade Raise Restrictions

From a geotechnical perspective there are no restrictions to raising the grades at the site since it is anticipated that all subsurface soils will be excavated down to the bedrock, removed from the site and replaced with either imported granular fill (compacted to the specified degree of compaction indicated in this report).

8. Foundation Considerations

It is our understanding that the design elevation of the underside of the footings will be Elevation 44.0 m. Based on a review of the boreholes located within the footprint of the proposed buildings, the footings, at the design underside of footing elevation of Elevation 44.0 m, would be founded on sound limestone or shale bedrock contacted below any fractured or weathered zones contacted.

Spread and strip footings founded on the sound bedrock, competent and free of soil filled seams may be designed for a factored geotechnical resistance at Ultimate Limit State (ULS) of 3000 kPa. The factored ULS value includes a resistance factor of 0.5. The Serviceability Limit State (SLS) bearing pressure of the bedrock, required to produce 25 mm settlement of the structure will be much larger than the recommended value for factored geotechnical resistance at ULS. Therefore, the factored geotechnical resistance at ULS will govern the design. Settlements of footing designed for the above recommended factored geotechnical resistance at ULS and properly constructed are expected to be less than 10 mm.

The factored sliding resistance at ULS between the underside of concrete and the top of the un-weathered sound bedrock is 0.56 and includes a resistance factor of 0.8.

All the footing beds should be thoroughly examined by a geotechnical engineer to ensure that the bedrock area is capable of supporting the design ULS value. Where fractured rock is encountered, sub-excavation may be undertaken to the underlying more competent bedrock. Alternatively, the footings may be redesigned to a reduced factored geotechnical resistance at ULS.

A minimum of 1.5 m of earth cover should be provided to exterior footings of heated structures to protect them from damage due to frost penetration. The frost cover should be increased to 2.1 m for unheated structures if snow will not be removed from the vicinity of the footing and 2.4 m of earth cover if snow will be removed from the vicinity of the footing. In areas where earth cover will be less than the required, rigid insulation may be used to protect the footings. Alternatively, a combination of earth cover and rigid insulation may also be used to protect the footings. For this project it is anticipated that the required earth cover for the footings of the proposed buildings will be satisfied, since the footings are anticipated to be at depths greater than 1.5 m below the final grade.

The recommended factored geotechnical resistance at ULS has been calculated by EXP from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. The interpretation between boreholes and the recommendations of this report must therefore be checked through field monitoring provided by an experienced geotechnical engineer to validate the information for use during the construction stage.

9. Floor Slab and Drainage Requirements

It is understood that the underside of footing elevation for the proposed parking structure will be at Elevation 44.0 m. It has been assumed that the lowest floor level of the parking garage will be slightly above this. Based on the borehole information, the lowest floor slab of the buildings will be founded limestone or shale bedrock and may be constructed as a concrete slab-on-grade or as a paved surface. The concrete and asphalt pavement structures indicated below are for light duty traffic only (cars). EXP can provide concrete and asphalt pavement structures for heavy duty traffic (cars and trucks), if required.

The groundwater level ranges from 0.5 m to 5.5 m (Elevation 55.3 m to Elevation 50.6 m). Therefore, underfloor and perimeter drainage systems will be required for the proposed below grade parking garage.

The underfloor drainage system may consist of 100 mm diameter perforated pipe or equivalent placed in parallel rows at 5 m to 6 m centres and at least 300 mm below the underside of the floor slab. The drains should be set on 100 mm thick bed of 19 mm sized clear stone covered on top and sides with 150 mm thick clear stone that is fully wrapped with an approved porous geotextile membrane, such as Terrafix 270R or equivalent. The perimeter drains may also consist of 100 mm diameter perforated pipe set on the footings and surrounded with 150 mm thick clear stone fully wrapped with a geotextile membrane. The perimeter and underfloor drains should be connected to separate sumps equipped with backup pumps and generators in case of mechanical failure and/or power outage, so that at least one system would be operational should the other fail.

The finished exterior grade around the buildings should be sloped away from the buildings to prevent ponding of surface water close to the exterior walls of the buildings.

9.1 Lowest Floor Level as a Concrete Surface

The subgrade is anticipated to consist of limestone and shale bedrock. The bedrock should be examined by EXP and any loose/soft zones of the bedrock should be excavated and removed.

Following approval of the bedrock subgrade, the concrete slab for light duty traffic (cars only) may be constructed as follows:

- 150 mm thick concrete with 32 MPa compressive strength and air content of 5 percent to 8 percent; over
- 150 mm thick layer of Ontario Provincial Standard Specification (OPSS) 1010 Granular A compacted to 100 percent standard Proctor maximum dry density (SPMDD); over
- 300 mm minimum thick layer of OPSS 1010 Granular B Type II compacted to 100 percent SMPDD.

The concrete slab should be reinforced and adequate saw cuts should be provided in the floor slab to control cracking. Additional recommendations can be provided once the final design of the lowest floor level has been determined.

9.2 Lowest Floor Level as a Paved Surface

The subgrade is anticipated to consist of limestone and shale bedrock. The bedrock should be examined by EXP and any loose/soft zones of the bedrock should be excavated and removed.

Following approval of the bedrock subgrade, the asphalt pavement structure for light duty traffic (cars only) may be constructed on the bedrock subgrade as follow:

- 65 mm thick layer of asphaltic concrete consisting of HL3/SP12.5 – The asphaltic concrete should be placed and compacted as per OPSS 310 and 313 and should be designed in accordance with OPSS 1150/1151; over
- 150 mm thick layer of OPSS Granular A compacted to 100 percent SPMDD; over
- 450 mm thick layer of OPSS Granular B Type II compacted to 100 percent SPMDD.

10. Lateral Earth Pressures Against Subsurface Walls

The subsurface basement walls of the proposed buildings will be subjected to lateral static earth pressure as well as lateral dynamic earth pressure during a seismic event. The lateral static earth pressure that the subsurface walls would be subjected to may be computed from equations (i) and (ii) and the lateral dynamic earth force from equation (iii) given below.

The equations given below assume that the backfill against the subsurface walls will be free-draining granular material and that subsurface drains will be provided to prevent build-up of hydrostatic pressure behind the wall. Equation (i) will be applicable to the portion of the subsurface wall in the overburden soil. Equation (ii) will be applicable to the portion of the subsurface wall in the bedrock where the earth pressure will be considerably reduced due to the narrow backfill between the subsurface wall and the rock face resulting in an arching effect (Spangler & Handy, 1984). The weight of the overburden soil and any surcharge load stress (such as traffic load at ground surface and foundations of existing adjacent buildings) should be considered as surcharge when computing lateral pressure using equation (ii).

The lateral static earth pressure against the subsurface walls may be computed from the following equation:

$$P = K_0 (\gamma h + q) \quad \text{..... (i)}$$

where P = lateral earth pressure acting on the subsurface wall; kN/m^2

K_0 = lateral earth pressure coefficient for 'at rest' condition for Granular B Type II backfill material = 0.50

γ = unit weight of free draining granular backfill; OPSS Granular B Type II = 22 kN/m^3

h = depth of point of interest below top of backfill, m

q = surcharge load stress, kPa

Lateral static earth pressure (σ_n) due to narrow earth backfill between subsurface wall and rock face at depth z:

$$\sigma_n = \frac{\gamma B}{2 \tan \delta} \left(1 - e^{-2k\frac{z}{B} \tan \delta}\right) + kq \quad \text{---------- (ii)}$$

Where

γ = unit weight of backfill = 22 kN/m^3

B = backfill width (m)

z = depth from top of wall (m)

δ = friction angle between the backfill and wall and rock (assumed to be equal) = 17 degrees

k = lateral earth pressure coefficient for 'at rest' condition = 0.50

q = surcharge pressure including pressures from overburden soil, traffic at ground surface and foundations from existing adjacent buildings (kPa)

The lateral dynamic (seismic) thrust may be computed from the equation given below:

$$\Delta_{Pe} = \gamma H^2 \frac{a_h}{g} F_b \quad \text{..... (iii)}$$

where Δ_{Pe} = dynamic thrust in kN/m of wall

H = height of wall, m

γ = unit weight of free draining granular backfill; OPSS Granular B Type II = 22 kN/m^3

$\frac{a_h}{g}$ = seismic coefficient = 0.32 (Ottawa Area)

F_b = thrust factor = 1.0

The dynamic thrust does not take into account the surcharge load. The resultant force acts approximately at 0.63H above the base of the wall.

All subsurface walls should be properly waterproofed.

Where the basement walls will be poured against the bedrock or temporary shoring, vertical drainage board must be installed on the face of the excavation wall or temporary shoring to provide necessary drainage. Vertical drainage board such as Alidrain, Geodrain, Miridrain or equivalent may be used for this purpose. Full coverage using drainage boards can be considered to minimize the risk of water penetration through the subsurface basement walls.

Where the upper portion of the subsurface basement wall is backfilled with granular material, the vertical drainage board should extend into the backfill to provide drainage of the backfill. The top of the drainage board should be covered with a fabric filter to prevent the loss of overlying soil into the drainage board.

The vertical drainage board should be connected to a solid discharge pipe that passes through the foundation wall and outlets to a solid pipe inside the building that leads to a sump. The solid pipe inside the building should be connected to a separate sump from the sumps used for the perimeter and underfloor drains, so that this system would be operational should one of the other drainage systems fail.

11. Excavation and De-Watering Requirements

11.1 Excess Soil Management

Ontario Regulation 406/19 specifies protocols that are required for the management and disposal of excess soils. As set forth in the regulation, specific analytical testing protocols need to be implemented and followed based on the volume of soil to be managed and the requirements of the receiving site. The testing protocols are specific as to whether the soils are stockpiled or in situ. In either scenario, the testing protocols are far more onerous than have been historically carried out as part of standard industry practices. These decisions should be factored in and accounted for prior to the initiation of the project-defined scope of work. EXP would be pleased to assist with the implementation of a soil management and testing program that would satisfy the requirements of Ontario Regulation 406/19.

Further discussion of the environmental aspects of this Site are discussed in the exp soil characterization report prepared under separate.

Overburden Soil Excavation

Excavation of the soils may be undertaken using heavy equipment capable of removing debris as well as cobbles, boulders and within fill or the glacial till.

All excavations must be undertaken in accordance with the Occupational Health and Safety Act (OHSA), Ontario Reg. 213/91. Based on the definitions provided in OHSA, the subsurface soils on site are considered to be Type 3 and as such must be cut back at 1H:1V from the bottom of the excavation above the groundwater level. Within zones of persistent seepage and below the groundwater level in the soils, the excavation side slopes are expected to slough and eventually stabilize at a slope of 2H:1V to 3H:1V.

It is anticipated that due to the significant depth of the excavation for the proposed buildings and the proximity of the excavation to existing buildings and infrastructure, the excavations will likely have to be undertaken within the confines of a shoring system. The shoring system may consist of steel H soldier pile and timber lagging system, interlocking sheeting system and/or secant pile shoring system.

The type of shoring system required would depend on a number of factors including:

- Proximity of the excavation to existing structures and infrastructure;
- Type of foundations of the existing adjacent buildings and the difference in founding levels between the foundations of new buildings and existing adjacent buildings; and
- The subsurface soil, bedrock and groundwater conditions.

A conventional shoring system consisting of soldier pile and timber lagging is more flexible compared to the interlocking steel sheeting system and the secant pile shoring system. In areas where there is concern for lateral yielding of the soils and the potential of settlement of nearby structures and infrastructure, the use of a steel interlocking sheeting system or secant pile system can be considered. The shoring system will require lateral restraint provided by tiebacks consisting of rock anchors. Due to the presence of cobbles and boulders in the subsurface soils, pre-drilling may be required for the installation of the soldier piles. The presence of cobbles and boulders in the subsurface soils should also be taken into consideration for other contemplated shoring systems.

The need for a shoring system, the most appropriate shoring system and the design and installation of the shoring system should be determined by the contractors bidding on this project. The design and installation of the shoring system should be undertaken by a professional engineer experienced in shoring design and by a contractor experienced in the installation of shoring systems. The shoring system should be designed and installed in accordance with OHSA and the 2006 CFEM (Canadian Foundation Engineering Manual (Fourth Edition)).

Soldier Pile and Timber Lagging System

A conventional steel H soldier pile and timber lagging shoring system must be designed to support the lateral earth pressure given by the expression below:

$$P = k\,(\gamma h + q)$$

Where:

P	=	the pressure, at any depth, h, below the ground surface
k	=	applicable earth pressure coefficient; active lateral earth pressure coefficient = 0.33 'at rest' lateral earth pressure coefficient = 0.50
γ	=	unit weight of soil to be retained, estimated at 22 kN/m^3
h	=	the depth, in metres, at which pressure, P, is being computed
q	=	the equivalent surcharge acting on the ground surface adjacent to the shoring system

The pressure distribution assumes that drainage is permitted between the lagging boards and that no build-up of hydrostatic pressure may occur.

The shoring system as well as adjacent settlement sensitive structures and infrastructure should be monitored for movement (deflection) on a periodic basis during construction operations.

Many geologic materials deteriorate rapidly upon exposure to meteorological elements. Unless otherwise specifically indicated in this report, walls and floors of excavations must be protected from moisture, desiccation, and frost action throughout the course of construction.

Secant Pile Shoring System

The secant pile shoring system should be designed to resist 'at rest' lateral earth thrust in addition to the hydrostatic thrust as given by the expression below:

$$P_0 = K_O\, q\, (h_1 + h_2) + \frac{1}{2} K_0\, \gamma\, h_1^2 + K_0\, \gamma\, h_1 h_2 + \frac{1}{2} K_0\, \gamma'\, h_2^2 + \frac{1}{2} \gamma_w\, {h_2}^2$$

where:

P_0	=	at rest' earth and water thrusts acting against secant pile wall (kN/m)
K_0	=	'at rest' lateral earth pressure coefficient = 0.50
q	=	surcharge acting adjacent to the excavation (kPa)
h_1	=	height of shoring from the ground surface to groundwater table (m)
h_2	=	height of shoring from groundwater table to the bottom of excavation (m)
γ	=	unit weight of the soil = 22 kN/m^3
γ'	=	submerged unit weight of soil = 11.2 kN/m^3
γ_w	=	unit weight of water = 9.8 kN/m^3

Secant pile walls consist of overlapping concrete piles that form a strong watertight barrier. They can be constructed with conventional drilling methods. Secant pile walls typically include both reinforced primary and un-reinforced secondary piles. The primary piles overlap the secondary piles, with secondary piles essentially acting as concrete lagging. The reinforcement in the

primary piles generally consists of steel reinforcing bar cages or steel beams. The result is a continuous intersecting line of concrete piles that are placed before any excavation is performed.

The shoring system as well as adjacent settlement sensitive structures and infrastructure should be monitored for movement (deflection) on a periodic basis during construction operations.

11.1.1 Rock Excavation

The excavations will extend into the limestone/shale bedrock. The excavation side slopes in the upper depths of the weathered/highly fractured zones of the bedrock may be cut back at a 1H:1V gradient. The excavation side slopes in the sound bedrock may be undertaken with near vertical sides subject to examination by a geotechnical engineer.

The upper depths of the weathered/highly fractured zones of the limestone bedrock may be excavated using a hoe ram for removal of small quantities of the bedrock; however, this process is expected to be very slow.

The excavation of the sound lbedrock to extensive depths below the bedrock surface may be undertaken by line drilling and blasting method. Should blasting not be permitted, the excavation of the limestone bedrock would have to be undertaken by line drilling. Specialized contractors bidding on this project should decide on their own the most preferred rock removal method; hoe ramming or line drilling and blasting.

Rock Support

The weathered and fractured rock face may require support in the form of rock bolts to maintain the integrity of the rock face in conjunction with a wire mesh system and the shotcrete mentioned above. Excavations that will extend a significant depth into the bedrock will have to be undertaken in a staged approach with the rock excavated in a pre-determined depth interval (for example every 3 m). The exposed rock face in each stage will have to be examined by a geotechnical engineer to determine the number of rock bolts required. The rock bolt system should be installed in this manner to the bottom of the excavation.

Vibration Control

The vibration limits for blasting should be in accordance with City of Ottawa Special Provisions (SP No. 1201).

It is recommended that a pre-construction survey of adjacent building(s) and infrastructure be undertaken prior to any earth (soil) and rock excavation work as well as vibration monitoring during excavation, blasting and construction operations. Prior to the commencement of blasting, a detailed blast methodology should be submitted by the Contractor.

11.2 De-Watering Requirements and Impact of Groundwater Lowering on Adjacent Structures

A hydrogeological study by EXP is in progress. Please refer to this report for full details regarding dewatering at the site.

It is understood that a PTTW application has been submitted.

11.3 Slope Stability

Based on the borehole elevations at the site, there is an approximate grade difference of 2.0 m from the western portion of the site to the previously excavated area.

For short term slope stability, the existing overburden soil is considered to be a Type 3 soil by the definitions within the Occupational Health and Safety Act (OHSA), Ontario Reg. 213/91 and should be no steeper than 1H:1V from the bottom of the excavation above the groundwater level. The slopes for all excavations should be as per Section 11 of this report.

12. Backfilling Requirements and Suitability of On-Site Soils for Backfilling Purposes

The soils to be excavated from the site will comprise of fill, glacial till and limestone/shale bedrock. From a geotechnical perspective, these soils and the bedrock are not considered suitable for reuse as backfill material in the interior or exterior of the buildings and should be discarded. It may be possible to use portions of the fill and glacial till above the groundwater level in landscaped areas, subject to further examination and testing at time of construction. However, these soils are subject to moisture absorption due to precipitation and must be protected at all times from the elements.

Therefore, it is anticipated that all the material required for backfilling purposes in the interior and exterior of the proposed buildings and in the underground service trenches will need to be imported and should preferably conform to the following specifications:

- Engineered fill under the floor slab of the proposed building - OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent SPMDD,
- Backfill material for footing trenches and against foundation walls located outside the proposed buildings – OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 95 percent SPMDD,
- Trench backfill and subgrade fill should consist of OPSS 1010 Granular B Type II for the play structure and OPSS 1010 Select Subgrade Material (SSM) for parking lot and access roads, placed in 300 mm thick lifts and each lift compacted to 95 percent SPMDD; and
- Fill for landscaped areas should be clean fill free of debris, topsoil (organic soil), cobbles and boulders placed in 300 mm thick lifts and each lift compacted to 92 percent SPMDD.

13. Access Roads and Parking Lots

The subgrade for the surface pavement structures is anticipated to consist of the OPSS Granular B Type II material, OPSS Select Subgrade material (SSM) and approved on-site material. Pavement structure thicknesses required for the access roads and parking lots set on the anticipated approved subgrade materials were computed and are shown in Table V. The pavement structures assume a functional design life of 15 to 20 years. The proposed functional design life represents the number of years to the first rehabilitation, assuming regular maintenance is carried out.

Table V: Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Requirements	Computed Pavement Structures	
		Light Duty Traffic (Cars Only)	Heavy Duty Traffic (Buses and Trucks)
Asphaltic Concrete	92 percent to 97 percent MRD	65 mm HL3/SP12.5 mm/ Cat. B (PG 58-34)	50 mm HL3/SP12.5 Cat. B (PG 58-34) 60 mm HL8/SP 19 Cat. B (PG 58-34)
OPSS 1010 Granular A Base (crushed limestone)	100% percent SPMDD	150 mm	150 mm
OPSS 1010 Granular B Type II Sub-base	100% percent SPMDD	300 mm	450 mm

Notes:

1. SPMDD denotes standard Proctor maximum dry density, ASTM, D-698-12e2.
2. MRD denotes Maximum Relative Density, ASTM D2041.
3. The upper 300 mm of the subgrade fill must be compacted to 98% SPMDD.
4. The approved subgrade should be covered with a woven geotextile prior to placement of granular sub-base of the pavement structure.

The foregoing design assumes that construction is carried out during dry periods and that the subgrade is stable under the load of construction equipment. If construction is carried out during wet weather and, heaving or rolling of the subgrade is experienced, additional thickness of granular material may be required in addition to the woven geotextile indicated in Table V.

Additional comments on the construction of the parking lots and access roads are as follows:

1. As part of the subgrade preparation, the areas of the proposed parking area and access roads should be stripped of all organic layers and organic stained soils down to approved subgrade. The subgrade should be properly shaped, crowned, then proofrolled in the full-time presence of a representative of this office. Any soft or spongy subgrade areas detected should be sub excavated and properly replaced with suitable approved backfill compacted to 95 percent SPMDD (ASTM D698-12e2).
2. The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure that uniform subgrade moisture and density conditions are achieved. The need for adequate drainage cannot be over-emphasized. Subdrains should be installed on both sides of the access road(s). Subdrains must be installed in the proposed parking area at low points and should be continuous between catchbasins to intercept excess surface and subsurface moisture and to prevent subgrade softening. This will ensure no water collects in the granular course, which could result in pavement failure during the spring thaw. The location and extent of subdrains required within the paved areas should be reviewed by this office in conjunction with the proposed site grading.
3. To minimize the problems of differential movement between the pavement and catchbasins/manhole due to frost action, the backfill around the structures should consist of free-draining granular preferably conforming to OPSS Granular B Type II material. Weep holes should be provided in the catchbasins/manholes to facilitate drainage of any water that may accumulate in the granular fill.

4. The most severe loading conditions on light-duty pavement areas and the subgrade may occur during construction. Consequently, special provisions such as restricted lanes, half-loads during paving, temporary construction roadways, etc., may be required, especially if construction is carried out during unfavorable weather.
5. The finished pavement surface should be free of depressions and should be sloped (preferably at a minimum cross fall of 2 percent) to provide effective surface drainage towards catch basins. Surface water should not be allowed to pond adjacent to the outside edges of paved areas.
6. Relatively weaker subgrade may develop over service trenches at subgrade level. These areas may require the use of thicker/coarser sub-base material and the use of a geotextile at the subgrade level. If this is the case, it is recommended that additional 150 mm thick granular sub-base, OPSS Granular B Type II, should be provided in these areas, in addition to the use of a geotextile at the subgrade level.
7. The granular materials used for pavement construction should conform to Ontario Provincial Standard Specifications (OPSS 1010) for Granular A and Granular B Type II and should be compacted to 100 percent of the SPMDD.

The asphaltic concrete used, and its placement should meet OPSS 1150 or 1151 requirements. It should be compacted from 92 percent to 97 percent of the MRD (ASTM D2041). Asphalt placement should be in accordance with OPSS 310 and OPSS 313.

It is recommended that EXP be retained to review the final pavement structure design and drainage plans prior to construction to ensure they are consistent with the recommendations of this report.

14. Corrosion Potential

Chemical tests limited to pH, sulphate, chloride and resistivity were undertaken on two (2) rock samples. A summary of the results is shown in Table VI. The laboratory certificate of analysis is shown in Appendix A.

Table VI: Corrosion Test Results on Rock Samples

Borehole – Sample No.	Depth (m)	Soli Type	pH	Sulphate (%)	Chloride (%)	Resistivity (ohm-cm)
BH2 Run 1	0 – 1.2	Rock	8.27	0.010	0.002	2920
BH2 Run 6	8.1 – 8.6	Rock	9.34	0.003	0.006	2650

The results indicate the soils have a negligible sulphate attack on subsurface concrete. The concrete should be designed in accordance with CSA A.23.1-14.

The results of the resistivity tests indicate that bedrock is mildly corrosive as per the National Association of Corrosion Engineers (NACE). Appropriate measures should be taken to protect the buried bare steel from corrosion.

15. Tree Planting Restrictions

It is anticipated that all subsurface soils on site including the fill and native soils will be excavated down to the bedrock and removed from site for the construction of the proposed new buildings. Since all subsurface soils will be excavated and removed from the site, there are no tree planting restrictions from a geotechnical perspective.

16. Additional Comments and Studies

All earthwork activities from subgrade preparation to placement and compaction of engineered fill, fill in service trenches, placement and compaction of granular materials and asphaltic concrete, should be inspected by qualified geotechnicians to ensure that construction proceeds according to the project specifications.

All the footing beds should be examined by a geotechnical engineer to ensure that the founding surfaces are capable of supporting the design bearing pressure and that the footing beds have been properly prepared.

17. General Comments

The comments given in this report are intended only for the guidance of design engineers. The number of test holes required to determine the localized underground conditions between test holes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for the design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual test hole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

The information contained in this report is not intended to reflect on environmental aspects of the soils. Should specific information be required, including for example, the presence of pollutants, contaminants or other hazards in the soil, additional testing may be required.

We trust that the information contained in this report will be satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Sincerely

Daniel Wall, M.Eng., P.Eng.
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Figures

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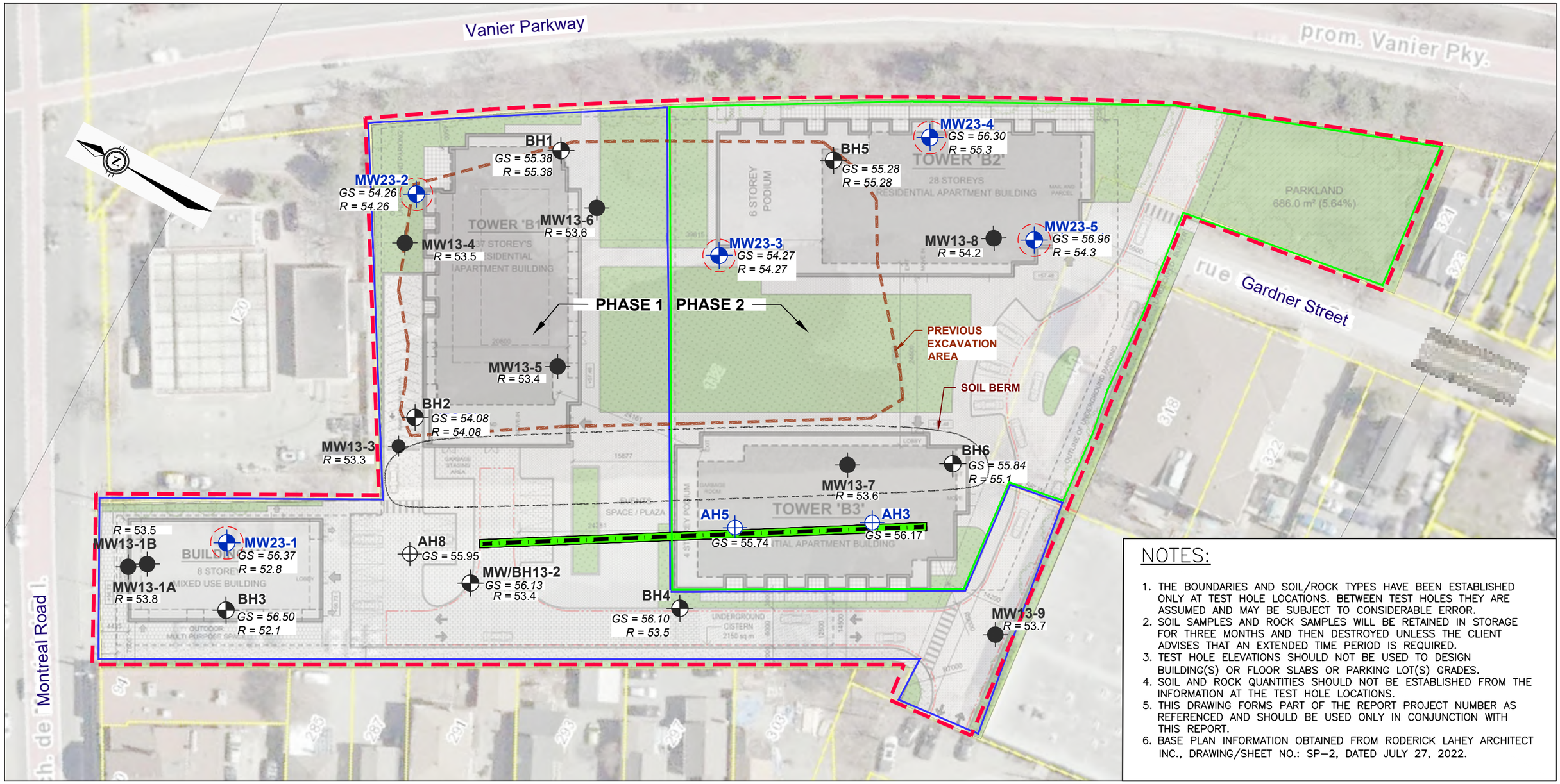
DATE: APRIL 2023	CLIENT: 2705460 ONTARIO INCORPORATED	project no. OTT-00214936-C0
DESIGN: DW / MM; CHECKED: IT	GEOTECHNICAL INVESTIGATION	scale 1:20,000
DRAWN BY: AS	TITLE: SITE LOCATION PLAN 112 MONTREAL ROAD, OTTAWA, ONTARIO	FIG 1



NOTES:

1. THE BOUNDARIES AND SOIL/ROCK TYPES HAVE BEEN ESTABLISHED ONLY AT TEST HOLE LOCATIONS. BETWEEN TEST HOLES THEY ARE ASSUMED AND MAY BE SUBJECT TO CONSIDERABLE ERROR.
2. SOIL SAMPLES AND ROCK SAMPLES WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.
3. TEST HOLE ELEVATIONS SHOULD NOT BE USED TO DESIGN BUILDING(S) OR FLOOR SLABS OR PARKING LOT(S) GRADES.
4. SOIL AND ROCK QUANTITIES SHOULD NOT BE ESTABLISHED FROM THE INFORMATION AT THE TEST HOLE LOCATIONS.
5. THIS DRAWING FORMS PART OF THE REPORT PROJECT NUMBER AS REFERENCED AND SHOULD BE USED ONLY IN CONJUNCTION WITH THIS REPORT.
6. BASE PLAN INFORMATION OBTAINED FROM RODERICK LAHEY ARCHITECT INC., DRAWING/SHEET NO.: SP–2, DATED JULY 27, 2022.

LEGEND

- PROPERTY BOUNDARY
- BH1 — BOREHOLE / MONITORING WELL NO. & LOCATION (*EXP*, 2022)
- MW23-1 — BOREHOLE / MONITORING WELL NO. & LOCATION (*EXP*, 2023)
- MW13-1A — MONITORING WELL NO. & LOCATION (*EXP*, 2013)
- AH3 — AUGER HOLE NO. & LOCATION (*EXP*, 2022)
- APPROXIMATE MASW STUDY AREA
- *GS = 56.92* — GROUND SURFACE LEVEL ELEVATION (m)
- *R = 54.1* — ROCK LEVEL ELEVATION (m)
- PHASE 1 DEVELOPMENT BOUNDRY
- PHASE 2 DEVELOPMENT BOUNDRY

ORIGINAL SHEET SIZE = 17" x 11"

0 6m 12m 24m

HORIZONTAL 1:600

exp Services Inc. **www.exp.com**
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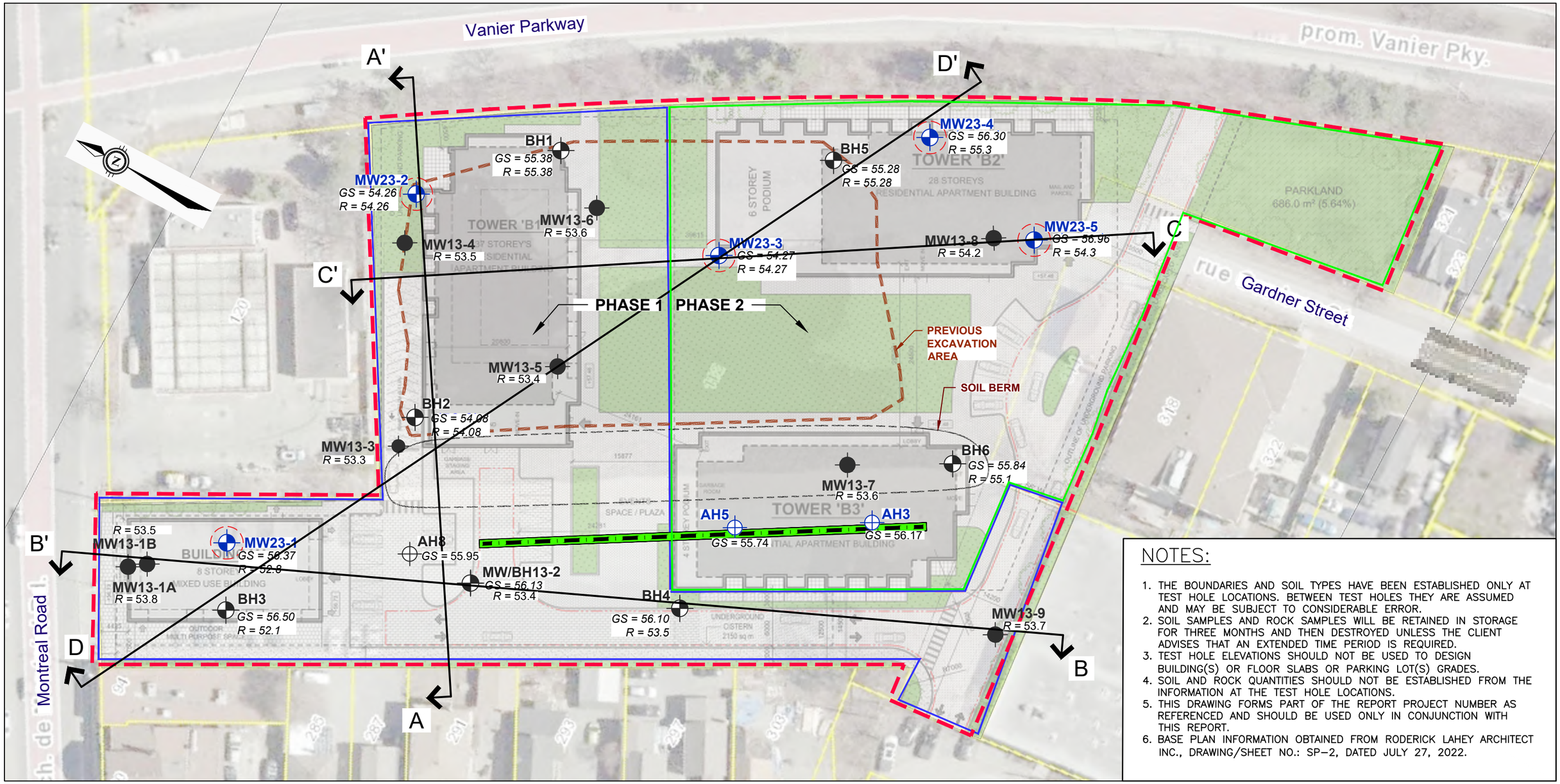
2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6, Canada

DATE: APRIL 2023	CLIENT: 2705460 ONTARIO INCORPORATED	project no. OTT-00214936-C0
DESIGN: DW / MM — CHECKED: IT	GEOTECHNICAL INVESTIGATION	scale 1:600
DRAWN BY: AS	TITLE: TEST HOLE LOCATION PLAN 112 MONTREAL ROAD, OTTAWA, ONTARIO	FIG 2



NOTES:

1. THE BOUNDARIES AND SOIL TYPES HAVE BEEN ESTABLISHED ONLY AT TEST HOLE LOCATIONS. BETWEEN TEST HOLES THEY ARE ASSUMED AND MAY BE SUBJECT TO CONSIDERABLE ERROR.
2. SOIL SAMPLES AND ROCK SAMPLES WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.
3. TEST HOLE ELEVATIONS SHOULD NOT BE USED TO DESIGN BUILDING(S) OR FLOOR SLABS OR PARKING LOT(S) GRADES.
4. SOIL AND ROCK QUANTITIES SHOULD NOT BE ESTABLISHED FROM THE INFORMATION AT THE TEST HOLE LOCATIONS.
5. THIS DRAWING FORMS PART OF THE REPORT PROJECT NUMBER AS REFERENCED AND SHOULD BE USED ONLY IN CONJUNCTION WITH THIS REPORT.
6. BASE PLAN INFORMATION OBTAINED FROM RODERICK LAHEY ARCHITECT INC., DRAWING/SHEET NO.: SP–2, DATED JULY 27, 2022.

LEGEND

- PROPERTY BOUNDARY
- BH1 — BOREHOLE / MONITORING WELL NO. & LOCATION (*EXP*, 2022)
- MW23-1 — BOREHOLE / MONITORING WELL NO. & LOCATION (*EXP*, 2023)
- MW13-1A — MONITORING WELL NO. & LOCATION (*EXP*, 2013)
- AH3 — AUGER HOLE NO. & LOCATION (*EXP*, 2022)
- APPROXIMATE MASW STUDY AREA
- *GS = 56.92* — GROUND SURFACE LEVEL ELEVATION (m)
- *R = 54.1* — ROCK LEVEL ELEVATION (m)
- PHASE 1 DEVELOPMENT BOUNDRY
- PHASE 2 DEVELOPMENT BOUNDRY
- A ↑ ↑ A' — SECTION MARKS

ORIGINAL SHEET SIZE = 17" x 11"

0 6m 12m 24m

HORIZONTAL 1:600

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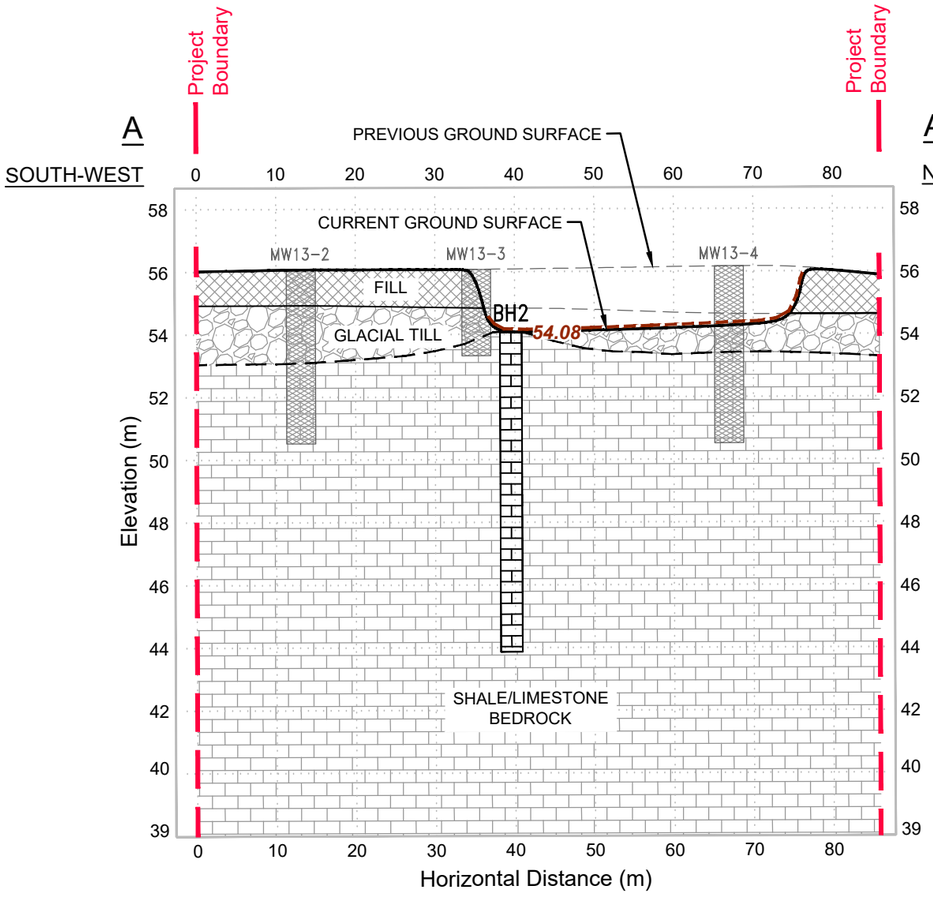
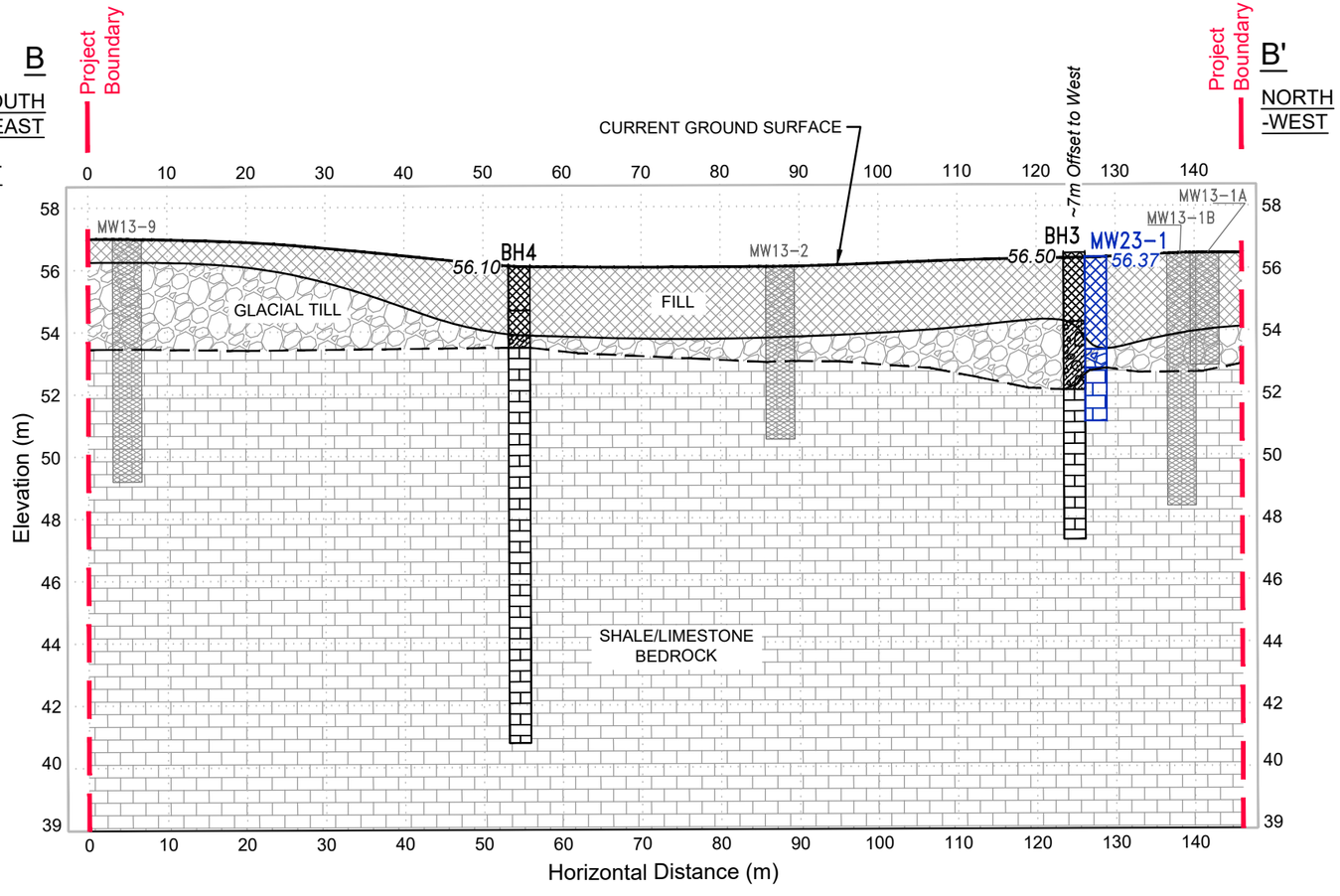
DATE: APRIL 2023	CLIENT: 2705460 ONTARIO INCORPORATED		project no. OTT-00214936-C0
DESIGN: DW / MM	CHECKED: IT	GEOTECHNICAL INVESTIGATION	scale 1:600
DRAWN BY: AS	TITLE: CROSS-SECTION PLAN 112 MONTREAL ROAD, OTTAWA, ONTARIO		FIG 2A



CROSS-SECTION A-A'



CROSS-SECTION B-B'

LEGEND

- FILL
- GLACIAL TILL
- LIMESTONE BEDROCK
- PROPERTY BOUNDARY

0 5m 10m 30m

HORIZONTAL 1:750

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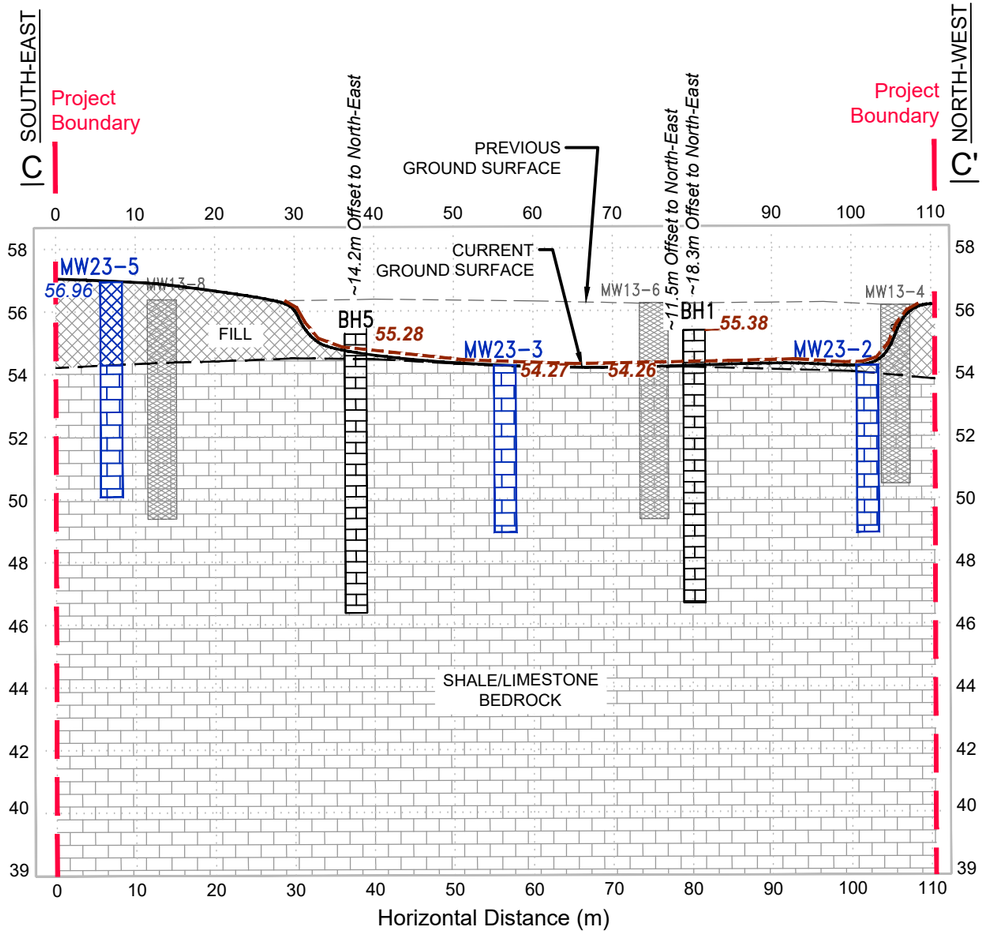
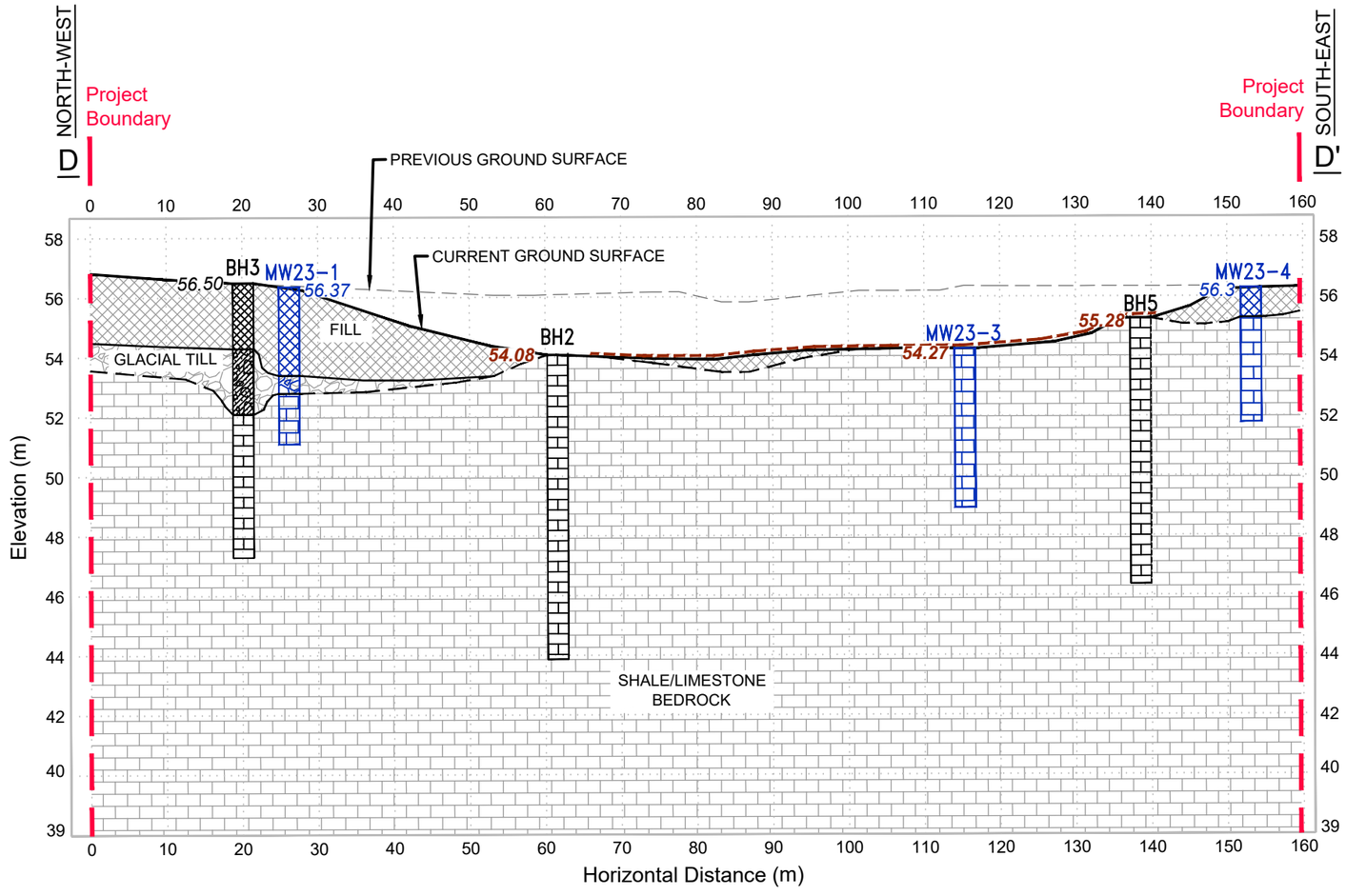
Ottawa, ON K2B 8H6, Canada

DATE: APRIL 2023	CLIENT: 2705460 ONTARIO INCORPORATED		project no. OTT-00214936-C0
DESIGN: DW / MM	CHECKED: IT	GEOTECHNICAL INVESTIGATION	scale 1:750
DRAWN BY: AS	TITLE: CROSS-SECTIONS A-A', B-B' 112 MONTREAL ROAD, OTTAWA, ONTARIO		FIG 3A



CROSS-SECTION C-C'



CROSS-SECTION D-D'

LEGEND

- FILL
- GLACIAL TILL
- LIMESTONE BEDROCK
- PROPERTY BOUNDARY

0 5m 10m 30m
HORIZONTAL 1:750

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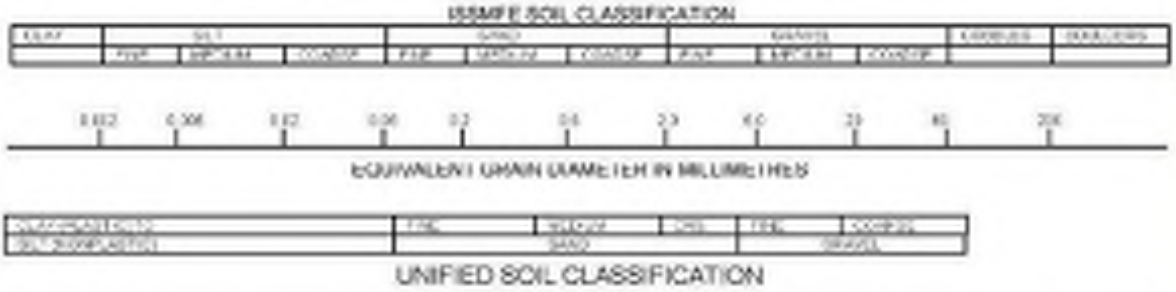
Ottawa, ON K2B 8H6, Canada

DATE: APRIL 2023	CLIENT: 2705460 ONTARIO INCORPORATED	project no. OTT-00214936-C0
DESIGN: DW / MM; CHECKED: IT	GEOTECHNICAL INVESTIGATION	scale 1:750
DRAWN BY: AS	TITLE: CROSS-SECTIONS C-C', D-D' 112 MONTREAL ROAD, OTTAWA, ONTARIO	FIG 3B

Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by **exp** Services Inc. also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.



2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites, unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Log of Borehole BH-01

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 15, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 4

Page. 1 of 1

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test (S)
Combustible Vapour Reading
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test

SOIL DESCRIPTION	Geodetic Elevation m	Depth	Natural Unit Wt. kN/m³
LIMESTONE AND SHALE BEDROCK Ranging from limstone with shaley partings along bedding planes to shale with limestone partings along the bedding planes, unweathered to slightly weathered, grey, (strong to very strong)	55.38 54.91	0 1 2 3 4 5 6 7 8	26.2 RUN1 26.4 RUN2 26.5 RUN3 26.5 RUN4 RUN5 26.6 RUN6
Borehole Terminated at 8.7 m Depth	46.7		26.5

Standard Penetration Test N Value: 20 40 60 80
Shear Strength: 50 100 150 200 kPa
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60
SAMPLES

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. A 32 mm diameter well installed as shown.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
'October 24, 2022	0.5	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	0 - 1.2	100	63
2	1.2 - 2.7	100	88
3	2.7 - 4.2	100	92
4	4.2 - 5.7	100	92
5	5.7 - 7.2	100	100
6	7.2 - 8.7	100	81

LOG OF BOREHOLE GINT NOV 30 2022 OTT-00214936-C0 112 MONTREAL ROAD.GPJ TROW OTTAWA.GDT 4/12/23

Log of Borehole BH-02

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 15, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 5

Page. 1 of 2

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test (S)

Combustible Vapour Reading
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		LIMESTONE AND SHALE BEDROCK Ranging from limstone with shaley partings along bedding planes to shale with limestone partings along the bedding planes, unweathered to slightly weathered, grey	54.08	0	20 40 60 80 / 50 100 150 200 kPa	250 500 750 / 20 40 60	RUN1	
			53.3	1			RUN2	
				2				
				3			RUN3	
				4				
				5			RUN4	
				6				
				7			RUN5	
				8			RUN6	
				9				
				10			RUN7	

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 32 mm diameter well installed as shown.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
'October 24, 2022	0.8	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	0 - 1.2	92	64
2	1.2 - 2.7	104	99
3	2.7 - 4.2	100	97
4	4.2 - 5.7	99	97
5	5.7 - 7.3	98	91
6	7.3 - 8.7	104	89
7	8.7 - 10.2	100	96

Log of Borehole BH-02

Project No: OTT-00214936-C0

Project: Proposed Development

Figure No. 5

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
			44.08	0	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
			43.9	10				
		Borehole Terminated at 10.2 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 32 mm diameter well installed as shown.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
'October 24, 2022	0.8	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	0 - 1.2	92	64
2	1.2 - 2.7	104	99
3	2.7 - 4.2	100	97
4	4.2 - 5.7	99	97
5	5.7 - 7.3	98	91
6	7.3 - 8.7	104	89
7	8.7 - 10.2	100	96

LOG OF BOREHOLE GINT NOV 30 2022 OTT-00214936-C0 112 MONTREAL ROAD.GPJ TROW OTTAWA.GDT 4/12/23

Log of Borehole BH-03

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 15, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 6

Page. 1 of 1

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test

Combustible Vapour Reading
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Sand and gravel with construction debris (concrete), brown, moist, (loose to dense)	56.5	0	19		SS1	
				1	5		SS2	
				2	37		SS3	
			54.3					
		GLACIAL TILL Sand, with gravel, brown, moist, (very loose to compact)		3	10		SS4	
					1 then 50/0 mm		SS5	
			52.67	4				
			52.1					26.3
		LIMESTONE AND SHALE BEDROCK Ranging from limstone with shaley partings along bedding planes to shale with limestone partings along the bedding planes, unweathered to slightly weathered, grey, (medium strong to very strong)		5			RUN1	
				6				26.3
							RUN2	
				7				26.3
				8			RUN3	
				9			RUN4	26.3
			47.3					
		Borehole Terminated at 9.2 m Depth						

LOG OF BOREHOLE GINT NOV 30 2022 OTT-00214936-C0 112 MONTREAL ROAD.GPJ TROW OTTAWA.GDT 4/12/23

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 32 mm diameter well installed as shown.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
'October 24, 2022	3.8	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	4.4 - 5.7	100	59
2	5.7 - 7.2	98	73
3	7.2 - 8.7	99	90
4	8.7 - 9.2	100	98

Log of Borehole BH-04

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 14, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 7

Page. 1 of 2

Split Spoon Sample ⊠ | Auger Sample ▮▯ | SPT (N) Value ○ | Dynamic Cone Test ——— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits |—○—| | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Sand and gravel with construction debris (concrete), brown, moist, (compact)	56.1	0	16	×	SS1	
				1	11 then 50/125 mm	×	SS2	
		FILL Silty sand and gravel, concrete and metal fragments, grey, moist	54.7	2	50/75 mm	×	SS3	
			53.9					
		GLACIAL TILL Sand, with gravel, brown, moist, (loose)	53.5		5 then 50/50 mm	×	SS4	
		LIMESTONE AND SHALE BEDROCK Ranging from limstone with shaley partings along bedding planes to shale with limestone partings along the bedding planes, unweathered to slightly weathered, grey, (strong)		3			RUN1	25.5
				4				
				5			RUN2	
▽			50.56	6				
				7			RUN3	
				8			RUN4	
				9				25.8
				10			RUN5	

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 32 mm diameter well installed as shown.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
'October 24, 2022	5.5	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	2.6 - 4.2	95	67
2	4.2 - 5.7	97	97
3	5.7 - 7.2	100	88
4	7.2 - 8.7	100	78
5	8.7 - 10.2	100	88
6	10.2 - 11.7	100	91
7	11.7 - 13.3	100	90
8	13.3 - 14.8	100	95
9	14.8 - 15.3	100	91

Log of Borehole BH-04

Project No: OTT-00214936-C0

Project: Proposed Development

Figure No. 7

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		LIMESTONE AND SHALE BEDROCK Ranging from limstone with shaley partings along bedding planes to shale with limestone partings along the bedding planes, unweathered to slightly weathered, grey, (strong) *(continued)*	46.1	10	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60	RUN6	
				11				
				12			RUN7	
				13				
				14			RUN8	
				15			RUN9	
			40.8					
		Borehole Terminated at 15.3 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 32 mm diameter well installed as shown.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
'October 24, 2022	5.5	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	2.6 - 4.2	95	67
2	4.2 - 5.7	97	97
3	5.7 - 7.2	100	88
4	7.2 - 8.7	100	78
5	8.7 - 10.2	100	88
6	10.2 - 11.7	100	91
7	11.7 - 13.3	100	90
8	13.3 - 14.8	100	95
9	14.8 - 15.3	100	91

Log of Borehole BH-05

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 15, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 8

Page. 1 of 1

Split Spoon Sample ⊠
Auger Sample ▮▯
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		LIMESTONE AND SHALE BEDROCK Ranging from limstone with shaley partings along bedding planes to shale with limestone partings along the bedding planes, unweathered to slightly weathered, grey, (strong to very strong)	55.28	0	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60	RUN1	25.8
				1			RUN2	
				2				
				3			RUN3	26.1
				4			RUN4	
				5				25.3
				6			RUN5	
				7				
				8			RUN6	
			46.4					
		Borehole Terminated at 8.9 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	0 - 1.4	91	57
2	1.4 - 2.9	100	88
3	2.9 - 4.4	97	71
4	4.4 - 5.9	98	66
5	5.9 - 7.4	87	87
6	7.4 - 8.9	97	90

LOG OF BOREHOLE GINT NOV 30 2022 OTT-00214936-C0 112 MONTREAL ROAD.GPJ TROW OTTAWA.GDT 4/12/23

Log of Borehole BH-06

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 22, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 9

Split Spoon Sample ⊠
Auger Sample ▮▯
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○⊣
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Sand and gravel with construction debris, grey, moist	55.84	0	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60	SS1	
			55.29					26.1
		LIMESTONE BEDROCK Shaley partings along bedding planes, unweathered to slightly weathered, grey, (medium strong to strong)	55.1	1			RUN1	
				2			RUN2	27.6
				3				25.5
				4			RUN3	
				5			RUN4	25.5
				6				25.2
				7			RUN5	
				8				26.3
				9			RUN6	
				10				26.4

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 32 mm diameter well installed as shown.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
'October 24, 2022	0.6	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	0.8 - 1.7	84	69
2	1.7 - 3.2	100	65
3	3.2 - 4.7	91	72
4	4.7 - 6.2	100	98
5	6.2 - 7.7	99	99
6	7.7 - 9.2	100	100
7	9.2 - 10.7	99	99
8	10.7 - 12.2	100	100

Log of Borehole BH-06

Project No: OTT-00214936-C0

Project: Proposed Development

Figure No. 9

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa (20 40 60 80 / 50 100 150 200)	Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60	SAMPLES	Natural Unit Wt. kN/m³
		LIMESTONE BEDROCK Shaley partings along bedding planes, unweathered to slightly weathered, grey, (medium strong to strong) *(continued)*	45.84	10			RUN7	
				11				26.3
							RUN8	
			43.6	12				
		Borehole Terminated at 12.2 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 32 mm diameter well installed as shown.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
'October 24, 2022	0.6	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	0.8 - 1.7	84	69
2	1.7 - 3.2	100	65
3	3.2 - 4.7	91	72
4	4.7 - 6.2	100	98
5	6.2 - 7.7	99	99
6	7.7 - 9.2	100	100
7	9.2 - 10.7	99	99
8	10.7 - 12.2	100	100

Log of Borehole AH-01

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 16, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 10

Page. 1 of 1

Split Spoon Sample ⊠
Auger Sample ▮▯
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Sand, with gravel, brown, moist, (compact)	56.92	0	11	×	SS1	
				1	13	×	SS2	
			55.5					
		GLACIAL TILL Sand with gravel and shale fragments, brown, moist to wet, (compact)		2	26	×	SS3	
					50/25 mm	×	SS4	
			54.4					
		Borehole Terminated at 2.5 m Depth						

Standard Penetration Test N Value: 20 40 60 80
Shear Strength: 50 100 150 200 kPa
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % / Atterberg Limits (% Dry Weight): 20 40 60

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE GINT NOV 30 2022 OTT-00214936-C0 112 MONTREAL ROAD.GPJ TROW OTTAWA.GDT 4/12/23

Log of Borehole AH-02

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 16, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 11

Page. 1 of 1

Split Spoon Sample ⊠
Auger Sample ▮▯
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Sand, with gravel, brown, moist, (compact)	56.19	0	20		SS1	
			55.5					
		GLACIAL TILL Silty sand with gravel and shale fragments, brown, moist to wet, (very dense)		1	14 then 50/150 mm		SS2	
					72		SS3	
				2	22 then 50/125 mm		SS4	
			53.6					
		Borehole Terminated at 2.6 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE GINT NOV 30 2022 OTT-00214936-C0 112 MONTREAL ROAD.GPJ TROW OTTAWA.GDT 4/12/23

Log of Borehole AH-03

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 16, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 12

Page. 1 of 1

Split Spoon Sample ⊠
Auger Sample ▮▯
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Sand, with gravel, brown, moist, (compact)	56.17	0	11	×	SS1	
			55.5					
		GLACIAL TILL Silty sand with gravel and shale fragments, brown, moist to wet, (dense to very dense)		1	64	×	SS2	
					48	×	SS3	
				2	50/125 mm	×	SS4	
			53.8					
		Auger Refusal at 2.4 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE GINT NOV 30 2022 OTT-00214936-C0 112 MONTREAL ROAD.GPJ TROW OTTAWA.GDT 4/12/23

Log of Borehole AH-04

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 16, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 13

Page. 1 of 1

Split Spoon Sample ⊠
Auger Sample ▮▯
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Sand, with gravel, brown, moist, (compact)	56.16	0	14	×	SS1	
			55.5					
		GLACIAL TILL Silty sand with gravel, cobbles and boulders, (compact to very dense)		1	17	×	SS2	
				2	8 then 50/50 mm	×	SS3	
					100	×	SS4	
			53.2	3				
		Borehole Terminated at 3.0 m Depth						

Standard Penetration Test N Value: 20 40 60 80
Shear Strength kPa: 50 100 150 200
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % / Atterberg Limits (% Dry Weight): 20 40 60

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. Borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole AH-05

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 16, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 14

Page. 1 of 1

Split Spoon Sample ⊠ | Auger Sample ▮▯ | SPT (N) Value ○ | Dynamic Cone Test —— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊢○⊣ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Sand, with gravel, brown, moist, (compact)	55.74	0	10	×	SS1	
			55.0					
		GLACIAL TILL Silty sand with gravel and shale fragments, brown, moist to wet, (compact to dense)		1	17	×	SS2	
					40	×	SS3	
				2	39	×	SS4	
			53.0					
		Borehole Terminated at 2.7 m Depth						

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % / Atterberg Limits (% Dry Weight): 20 40 60

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE GINT NOV 30 2022 OTT-00214936-C0 112 MONTREAL ROAD.GPJ TROW OTTAWA.GDT 4/12/23

Log of Borehole AH-06

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 14, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 15

Page. 1 of 1

Split Spoon Sample ⊠
Auger Sample ▮▯
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Sand and with gravel, brown, moist, (compact)	55.91	0	20	×	SS1	
			55.2					
		GLACIAL TILL Silty and with gravel and shale fragments, grey, wet, (loose to very dense)		1	4 then 50/75mm	×	SS2	22.6
				2	5	×	SS3	
					9 then 50/75 mm	×	SS4	
			52.7	3				
		Auger Refusal at 3.2 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE GINT NOV 30 2022 OTT-00214936-C0 112 MONTREAL ROAD.GPJ TROW OTTAWA.GDT 4/12/23

Log of Borehole AH-07

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 14, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 16

Page. 1 of 1

Split Spoon Sample ⊠
Auger Sample ▮▯
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Sand and with gravel, brown, moist,	56.13	0	12	×	SS1	
		GLACIAL TILL Silty sand with gravel and shale fragments, grey, wet, (loose to compact)	55.8	1	8	×	SS2	
				2	26	×	SS3	
					13	×	SS4	
		Borehole Terminated at 2.9 m Depth	53.2					

Standard Penetration Test N Value: 20 40 60 80
Shear Strength kPa: 50 100 150 200
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % / Atterberg Limits (% Dry Weight): 20 40 60

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. Borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE GINT NOV 30 2022 OTT-00214936-C0 112 MONTREAL ROAD.GPJ TROW OTTAWA.GDT 4/12/23

Log of Borehole AH-08

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 14, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 17

Page. 1 of 1

Split Spoon Sample ⊠
Auger Sample ▮▯
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Silty sand and with gravel, brown, moist, (compact)	55.95 / 55.8	0	12	×	SS1	
		FILL Sand and with gravel, brown, moist, (loose to compact)	54.8	1	6	×	SS2	
		GLACIAL TILL Silty sand with with gravel, cobbles, boulders and shale fragments, brown to grey, wet, (compact)		2	14	×	SS3	
					29	×	SS4	24.2
		Borehole Terminated at 2.9 m Depth	53.1					

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE GINT NOV 30 2022 OTT-00214936-C0 112 MONTREAL ROAD.GPJ TROW OTTAWA.GDT 4/12/23

Log of Borehole AH-09

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 14, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 18

Page. 1 of 1

Split Spoon Sample ⊠
Auger Sample ▮▯
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Silty sand with gravel, brown, moist, (compact)	56.29	0	15	×	SS1	
			55.6					
		GLACIAL TILL Silty sand with with gravel, cobbles, boulders and shale fragments, brown to grey, wet, (loose)		1	7	×	SS2	
				2	4	×	SS3	
			53.4		2	×	SS4	
		Borehole Terminated at 2.9 m Depth						

Standard Penetration Test N Value: 20 40 60 80
Shear Strength kPa: 50 100 150 200
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % / Atterberg Limits (% Dry Weight): 20 40 60

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. Borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE GINT NOV 30 2022 OTT-00214936-C0 112 MONTREAL ROAD.GPJ TROW OTTAWA.GDT 4/12/23

Log of Borehole AH-10

Project No: OTT-00214936-C0

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Date Drilled: 'September 14, 2022

Drill Type: CME-75 Track-Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: J.E. Checked by: D.W.

Figure No. 19

Page. 1 of 1

Split Spoon Sample ⊠
Auger Sample ▮▯
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Silty sand and gravel, brown, moist, (compact)	56.32	0	14	×	SS1	
			55.6					
		GLACIAL TILL Clayey silty sand with gravel, cobbles and boulders, brown, moist, (very loose to compact)		1	2	×	SS2	19.2
				2	15	×	SS3	
					17	×	SS4	
			53.4					
		Borehole Terminated at 2.9 m Depth						

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. Borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936-C0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE GINT NOV 30 2022 OTT-00214936-C0 112 MONTREAL ROAD.GPJ TROW OTTAWA.GDT 4/12/23

Log of Borehole MW23-1

Project No: OTT-00214936

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Figure No. 20

Page. 1 of 1

Date Drilled: February 10th, 2023

Drill Type: GEO GM 100

Datum: Geodetic Elevation

Logged by: MR Checked by: MM

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○—|
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		ASPHALT	56.37	0
		FILL	56.3	
		Sand and gravel, brown, moist		1
				2
			53.4	3
		GLACIAL TILL Sand with gravel, brown.	52.8	
		BEDROCK	52.67	4
				5
				6
			49.1	7
		Borehole Terminated at 7.3 m Depth		

Standard Penetration Test N Value: 20 40 60 80
Shear Strength: 50 100 150 200 kPa

Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm monitoring well was installed upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
April 2, 2023	2.2	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BH LOGS 112 MONTREAL RD-MR-FEB 10 2023.GPJ TROW OTTAWA.GDT 4/6/23

Log of Borehole MW23-2

Project No: OTT-00214936

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Figure No. 21

Page. 1 of 1

Date Drilled: February 9th, 2023

Drill Type: GEO GM 100

Datum: Geodetic Elevation

Logged by: MR Checked by: MM

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		BEDROCK	54.26	0	20 40 60 80 / 50 100 150 200 kPa	250 500 750 / 20 40 60		
				1				
				2				
				3				
				4				
			49.5					
		Borehole Terminated at 4.8 m Depth						

LOG OF BOREHOLE BH LOGS 112 MONTREAL RD-MR-FEB 10 2023.GPJ TROW OTTAWA.GDT 4/6/23

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm monitoring well was installed upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
April 2, 2023		

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole MW23-3

Project No: OTT-00214936

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Figure No. 22

Page. 1 of 1

Date Drilled: February 9th, 2023

Drill Type: GEO GM 100

Datum: Geodetic Elevation

Logged by: MR Checked by: MM

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		BEDROCK	54.27	0	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
				1				
				2				
				3				
			49.5	4				
		Borehole Terminated at 4.8 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm monitoring well was installed upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
April 2, 2023		

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BH LOGS 112 MONTREAL RD-MR-FEB 10 2023.GPJ TROW OTTAWA.GDT 4/6/23

Log of Borehole MW23-4

Project No: OTT-00214936

Project: Proposed Development

Location: 112 Montreal Road, Ottawa, ON

Figure No. 23

Page. 1 of 1

Date Drilled: February 10th, 2023

Drill Type: GEO GM 100

Datum: Geodetic Elevation

Logged by: MR Checked by: MM

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		TOPSOIL	56.3	0
		FILL	56.2	
		Sand and gravel, brown, wet		
			55.3	1
		BEDROCK		
				2
			54.1	
				3
				4
			51.7	
		Borehole Terminated at 4.6 m Depth		

Standard Penetration Test N Value: 20 40 60 80
Shear Strength: 50 100 150 200 kPa

Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

LOG OF BOREHOLE BH LOGS 112 MONTREAL RD-MR-FEB 10 2023.GPJ TROW OTTAWA.GDT 4/6/23

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm monitoring well was installed upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
April 2, 2023	2.2	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole MW23-5

Project No: OTT-00214936
Project: Proposed Development
Location: 112 Montreal Road, Ottawa, ON
Date Drilled: February 9th, 2023
Drill Type: GEO GM 100
Datum: Geodetic Elevation
Logged by: MR Checked by: MM

Figure No. 24
Page. 1 of 1

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test
Combustible Vapour Reading
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		TOPSOIL	56.96	0
		FILL	56.9	
		Sand and gravel, brown, wet		1
				2
			54.3	
		BEDROCK	54.06	3
				4
				5
				6
			50.1	
		Borehole Terminated at 6.9 m Depth		

Standard Penetration Test N Value: 20 40 60 80
Shear Strength: 50 100 150 200 kPa
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60
SAMPLES
Natural Unit Wt. kN/m³

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm monitoring well was installed upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00214936

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
April 2, 2023	2.9	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BH LOGS 112 MONTREAL RD-MR-FEB 10 2023.GPJ TROW OTTAWA.GDT 4/6/23

Appendix A – EXP 2013 Borehole Logs

Log of Borehole 1-A

Project No: OTT-00214936-A0

Project: Preliminary Geotechnical Investigation

Location: 112 Montreal Road, Ottawa Ontario

Figure No. 3

Page. 1 of 1

Date Drilled: 'October 23, 2013 / November 7, 2013

Drill Type: CME-75 (Truck Mount)

Datum: Assumed

Logged by: MAD Checked by: MGM/SA

Split Spoon Sample ⊠ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test —— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊢○ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Assumed m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
			100.12		20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
		ASPHALT ~ 50 mm	100.0	0	43	×		
		FILL Crushed limestone, sand and gravel, grey, moist, (dense)	99.3		9	×		
		FILL Sand, silt and gravel with some brick debris, some boulders and cobbles, dark grey with black and lighter patches, moist (loose to very loose)		1	5	×		
				2	4	×		
			97.82					
			97.4		13	×		19.2
		SAND AND GRAVEL TILL Some silt with cobbles, trace clay, brown, wet (compact to very dense)		3	69	×		21.6
			96.5					
		Borehole Terminated at 3.6 m Depth						

LOG OF BOREHOLE LOGS OF BOREHOLES_GEO.GPJ TROW OTTAWA.GDT 12/20/13

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Monitoring Well with a 51mm diameter casing was installed in the borehole upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00214936-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	
7 Days	2.4	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole 1-B

Project No: OTT-00214936-A0

Project: Preliminary Geotechnical Investigation

Location: 112 Montreal Road, Ottawa Ontario

Figure No. 4

Page. 1 of 1

Date Drilled: 'October 23, 2013 / November 7, 2013

Drill Type: CME-75 (Truck Mount)

Datum: Assumed

Logged by: MAD Checked by: MGM/SA

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Assumed m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
					20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
			100.1	0				
		ASPHALT ~ 50 mm	100.0					
		FILL Crushed limestone, sand and gravel, grey, moist, (dense)	99.3					
		FILL Sand, silt and gravel with some brick debris, some boulders and cobbles, dark grey with black and lighter patches, moist (loose to very loose)		1				
				2				
			97.5					
		SAND AND GRAVEL TILL Some silt, cobbles, trace clay, brown, wet (compact to very dense)	97.1	3			Run 1	
		LIMESTONE BEDROCK Shaley partings along bedding planes, stratification flat to gently dipping, principal joints near vertical and moderately to widely spread, (poor to excellent quality)	96.2	4			Run 2	
				5			Run 3	
				6				
				7			Run 4	
			92.0	8			Run 5	
		Borehole Terminated at 8.1 m						

LOG OF BOREHOLE LOGS OF BOREHOLES_GEO.GPJ TROW OTTAWA.GDT 12/20/13

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Monitoring Well with a 51mm diameter casing was installed in the borehole upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00214936-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
12 Days	3.9	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	3 - 3.41	100	38
2	3.41 - 4.45	88	85
3	4.45 - 5.98	100	77
4	5.98 - 7.5	92	87
5	7.5 - 8.06	100	100

Log of Borehole 2

Project No: OTT-00214936-A0

Project: Preliminary Geotechnical Investigation

Location: 112 Montreal Road, Ottawa Ontario

Figure No. 5

Page. 1 of 1

Date Drilled: 'October 24, 2013

Drill Type: CME-75 (Truck Mount)

Datum: Assumed

Logged by: MAD Checked by: MGM/SA

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test (S)

Combustible Vapour Reading
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test

GWL	SYMBOL	SOIL DESCRIPTION	Assumed m	Depth
		ASPHALT ~ 50 mm	99.75	0
		FILL	99.7	
		Sand and gravel, grey, moist, (compact)		
		SANDY GRAVELLY TILL	98.9	1
		Some silt, shale fragments present, brown/grey to dark grey, moist (compact)		
		- Boulders and cobbles at 2.3 m depth		2
			97.0	
		LIMESTONE BEDROCK	96.85	3
		Grey aphanitic to medium grained shaley partings along bedding planes, stratification flat to gently dipping, mainly medium bedding, principal joints near vertical and moderately to widely spread, (excellent quality)		4
				5
			94.2	
		Borehole Terminated at 5.6 m Depth		

Standard Penetration Test N Value: 20 40 60 80
Shear Strength: 50 100 150 200 kPa
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60
SAMPLES
Natural Unit Wt. kN/m³

SPT values: 26, 12, 18, 22, 50/51mm

Run 1
Run 2

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Monitoring Well with a 51mm diameter casing was installed in the borehole upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00214936-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
26 days	2.9	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	3.05 - 4.32	100	100
2	4.32 - 5.64	100	100

LOG OF BOREHOLE LOGS OF BOREHOLES_GEO.GPJ TROW OTTAWA.GDT 12/20/13

Log of Borehole 3

Project No: OTT-00214936-A0

Project: Preliminary Geotechnical Investigation

Location: 112 Montreal Road, Ottawa Ontario

Figure No. 6

Page. 1 of 1

Date Drilled: 'October 23, 2013

Drill Type: CME-75 (Truck Mount)

Datum: Assumed

Logged by: MAD Checked by: MGM/SA

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○⊣
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Assumed m	Depth
			99.75	
		ASPHALT ~ 100 mm	99.7	0
		FILL Sand, silt and gravel with some brick debris, brown grey and orange, moist (compact)	99.2	
		SANDY GRAVELLY TILL Some silt, shale fragments, brown/grey to dark grey, moist to wet, (loose to very dense)		1
		- Boulders and cobbles at 1.8 m depth	97.35	2
			97.0	
		Auger Refusal at 2.8 m Depth, Borehole Terminated		

Standard Penetration Test N Value: 20 40 60 80
Shear Strength: 50 100 150 200 kPa
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60
SAMPLES
Natural Unit Wt. kN/m³

10
6
9
60
50/25mm

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Monitoring Well with a 51mm diameter casing was installed in the borehole upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00214936-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	
1 Day	Dry	
27	2.4	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE LOGS OF BOREHOLES_GEO.GPJ TROW OTTAWA.GDT 12/20/13

Log of Borehole 4

Project No: OTT-00214936-A0

Project: Preliminary Geotechnical Investigation

Location: 112 Montreal Road, Ottawa Ontario

Figure No. 7

Page. 1 of 1

Date Drilled: 'October 24, 2013

Drill Type: CME-75 (Truck Mount)

Datum: Assumed

Logged by: MAD Checked by: MGM/SA

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Assumed m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		ASPHALT ~ 19 mm	99.85	0				
		FILL Sand, silt and gravel with trace organics, clay and wood debris, dark brownish grey and white, moist, (compact to loose)	99.8		31	×		
				1	5	×		
			98.4		12	×		
		SANDY GRAVELLY TILL Some silt, shale fragments, brown/grey to dark grey, moist (compact) - Boulders and cobbles at 2.2 m depth		2	50/50mm	×		
			97.2					
▽		**LIMESTONE BEDROCK** Shaley partings along bedding planes, stratification flat to gently dipping, principal joints near vertical and moderately to widely spread, (excellent quality)	96.75	3				Run 1
				4				
				5				Run 2
			94.2					
		Auger Refusal at 2.7 m Depth, Borehole Terminated at 5.7 m						

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Monitoring Well with a 51mm diameter casing was installed in the borehole upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00214936-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
26 Days	3.1	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	2.69 - 4.35	95	95
2	4.35 - 5.74	98	96

LOG OF BOREHOLE LOGS OF BOREHOLES_GEO.GPJ TROW OTTAWA.GDT 12/20/13

Log of Borehole 5

Project No: OTT-00214936-A0

Project: Preliminary Geotechnical Investigation

Location: 112 Montreal Road, Ottawa Ontario

Figure No. 8

Page. 1 of 1

Date Drilled: 'November 7, 2013

Drill Type: CME-75 (Truck Mount)

Datum: Assumed

Logged by: MAD Checked by: MGM/SA

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test (S)

Combustible Vapour Reading
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test

GWL	SYMBOL	SOIL DESCRIPTION	Assumed m	Depth	Standard Penetration Test N Value / Shear Strength kPa (20 40 60 80 / 50 100 150 200)	Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60	SAMPLES	Natural Unit Wt. kN/m³
		ASPHALT ~ 50 mm	99.5					
		FILL Sand and gravel, dark brown, moist, (loose)	99.4	0	5			16.9
			98.7					
		SANDY GRAVELLY TILL Some silt, shale fragments, brown/grey to dark grey, moist (compact)		1	34			
		- Boulders and cobbles at 2.3 m depth		2	41			
			97.1					
		LIMESTONE BEDROCK Shaley partings along bedding planes, stratification flat to gently dipping, principal joints near vertical and moderately to widely spread, (fair to excellent quality)		3			Run 1	
			96	4			Run 2	
				5			Run 3	
				6			Run 4	
			92.3	7				
		Auger Refusal at 2.4 m Depth, Borehole Terminated at 7.2 m						

LOG OF BOREHOLE LOGS OF BOREHOLES_GEO.GPJ TROW OTTAWA.GDT 12/20/13

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Piezometer with a 13mm diameter casing was installed in the borehole upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00214936-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
7 Days	3.5	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	2.42 - 2.78	85	64
2	2.78 - 4.3	100	100
3	4.3 - 5.74	93	93
4	5.74 - 7.24	100	98

Log of Borehole 6

Project No: OTT-00214936-A0

Project: Preliminary Geotechnical Investigation

Location: 112 Montreal Road, Ottawa Ontario

Figure No. 9

Page. 1 of 1

Date Drilled: 'October 24, 2013

Drill Type: CME-75 (Truck Mount)

Datum: Assumed

Logged by: MAD Checked by: MGM/SA

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test (S)

Combustible Vapour Reading
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test

GWL	SYMBOL	SOIL DESCRIPTION	Assumed m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		ASPHALT ~ 50 mm	99.9	0				
		FILL Crushed limestone, sand and gravel, grey, moist, (loose)	99.8		6			
		SANDY GRAVELLY TILL Some silt, cobbles, dark brown grey, moist, (compact to dense)	99.7	1	15			
					12			
				2	50/130mm			
			97.3					
		LIMESTONE BEDROCK Shaley partings along bedding planes, stratification flat to gently dipping, principal joints near vertical and moderately to widely spread, (excellent quality)		3				Run 1
			95.8	4				
				5				Run 2
				6				Run 3
			93.0					
		Auger Refusal at 2.6 m Depth, Borehole Terminated at 6.9 m						

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Monitoring Well with a 51mm diameter casing was installed in the borehole upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00214936-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
26 days	4.1	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	2.64 - 3.86	100	100
2	3.86 - 5.49	100	97
3	5.49 - 6.91	100	98

LOG OF BOREHOLE LOGS OF BOREHOLES_GEO.GPJ TROW OTTAWA.GDT 12/20/13

Log of Borehole 7

Project No: OTT-00214936-A0

Project: Preliminary Geotechnical Investigation

Location: 112 Montreal Road, Ottawa Ontario

Figure No. 10

Page. 1 of 1

Date Drilled: 'November 7, 2013

Drill Type: CME-75 (Truck Mount)

Datum: Assumed

Logged by: MAD Checked by: MGM/SA

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test (S)
Combustible Vapour Reading
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test

GWL	SYMBOL	SOIL DESCRIPTION	Assumed m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		ASPHALT ~ 50 mm	99.9	0				
		FILL Crushed limestone, sand and gravel, grey, moist, (loose)	99.8					
		SANDY GRAVELLY TILL Some silt, brown and black, moist, (loose to very dense)	99.7		5, 7			21.1
		- Boulders and cobbles at 1.5 m depth		1	50/130mm			19.3
				2	50/25mm			
			97.3					
		LIMESTONE BEDROCK Shaley partings along bedding planes, stratification flat to gently dipping, principal joints near vertical and moderately to widely spread, (excellent quality)	97.2	3				Run 1
				4				
				5				Run 2
				6				
								Run 3
			92.6	7				
		Auger Refusal at 2.6 m Depth, Borehole Terminated at 7.3 m						

LOG OF BOREHOLE LOGS OF BOREHOLES_GEO.GPJ TROW OTTAWA.GDT 12/20/13

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Piezometer with a 13mm diameter casing was installed in the borehole upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00214936-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
12 Days	2.7	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	2.64 - 4.22	98	98
2	4.22 - 5.74	93	93
3	5.74 - 7.27	100	100

Log of Borehole 8

Project No: OTT-00214936-A0

Project: Preliminary Geotechnical Investigation

Location: 112 Montreal Road, Ottawa Ontario

Figure No. 11

Page. 1 of 1

Date Drilled: 'November 7, 2013

Drill Type: CME-75 (Truck Mount)

Datum: Assumed

Logged by: MAD Checked by: MGM/SA

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—⊖
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Assumed m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		ASPHALT ~ 50 mm	100 99.9	0	9	×		
		FILL crushed limestone, sand and gravel, grey, moist, (loose)	99.8					
		FILL Sand and gravel with silt, dark brown, moist (loose to very dense)		1	65	×		
			98.6					
		SANDY GRAVELLY TILL Some silt gravel with boulders and cobbles, trace clay, dark brown/grey, moist, (dense)		2	34	×		23.2
			97.9					
		LIMESTONE BEDROCK Shaley partings along bedding planes, stratification flat to gently dipping, principal joints near vertical and moderately to widely spread, (excellent quality)		3				Run 1
				4				Run 2
			95.8					
				5				Run 3
				6				
								Run 4
			93.0	7				
		Auger Refusal at 2.1 m Depth, Borehole Terminated at 7.0 m						

LOG OF BOREHOLE LOGS OF BOREHOLES_GEO.GPJ TROW OTTAWA.GDT 12/20/13

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Piezometer with a 13mm diameter casing was installed in the borehole upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00214936-A0

WATER LEVEL RECORDS		
Elapsed Time	Water Level (m)	Hole Open To (m)
12 Days	4.2	

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %
1	2.24 - 2.75	89	89
2	2.75 - 4.25	100	100
3	4.25 - 5.77	100	100
4	5.77 - 7.02	100	100

Log of Borehole 9

Project No: OTT-00214936-A0

Project: Preliminary Geotechnical Investigation

Location: 112 Montreal Road, Ottawa Ontario

Figure No. 12

Page. 1 of 1

Date Drilled: 'October 23, 2013

Drill Type: CME-75 (Truck Mount)

Datum: Assumed

Logged by: MAD Checked by: MGM/SA

Split Spoon Sample ⊠ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test —— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊢○ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

Assumed m	Depth	SOIL DESCRIPTION	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
100.6	0	**ASPHALT** ~ 50 mm				
100.5		**FILL** Crushed limestone, sand and gravel, grey, moist, (compact)				
100.4						
99.7	1	**FILL** Sand and gravel with silt, brick debris, dark grey with black and white, moist (loose compact)	15, 6, 12	×		
	2	**SANDY GRAVELLY TILL** Some silt, shale fragments throughout, dark brown/grey, moist, (compact to dense)	29	×		
97.3	3		40, 50/100mm	×		
97.2	4	**LIMESTONE BEDROCK** Shaley partings along bedding planes, stratification flat to gently dipping, principal joints near vertical and moderately to widely spread, (fair to excellent quality)				Run 1
	5					
	6					Run 2
	7					Run 3
92.8		**Auger Refusal at 3.3 m Depth, Borehole Terminated at 7.8 m**				

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Monitoring Well with a 51mm diameter casing was installed in the borehole upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00214936-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	3.2	
1 Day	3.4	
27 Days	3.4	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	3.28 - 4.71	73	61
2	4.71 - 6.23	59	53
3	6.23 - 7.78	100	100

LOG OF BOREHOLE LOGS OF BOREHOLES_GEO.GPJ TROW OTTAWA.GDT 12/20/13

Appendix B – Seismic Shear Wave Survey Report – Geophysics GPR International Inc.

GEOPHYSICS GPR INTERNATIONAL INC.

100 – 2545 Delorimier Street
Longueuil (Québec)
Canada J4K 3P7

Tel. : (450) 679-2400
Fax : (514) 521-4128
info@geophysicsgpr.com
www.geophysicsgpr.com

October 12th, 2022

Transmitted by email: Ismail.Taki@exp.com
Our Ref.: GPR-22-04045

Mr. Ismail Taki, M.Eng., P.Eng.
Senior Manager, Earth & Environment, Eastern Region
exp Services inc.
100 – 2650 Queensview Drive
Ottawa ON K2B 8H6

Subject: **Shear Wave Velocity Sounding for the Site Class Determination**
112 Montréal Road, Vanier, Ottawa (ON)

Dear Sir,

Geophysics GPR International inc. has been mandated by **exp** Services inc. to carry out seismic shear wave surveys at 112 Montréal Road, Vanier, in Ottawa (ON). The geophysical investigation used the Multi-channel Analysis of Surface Waves (MASW), the Spatial AutoCorrelation (SPAC), and the seismic refraction methods. From the subsequent results, the seismic shear wave velocity values were calculated for the soil and the rock, to determine the Site Class.

The surveys were carried out on September 2nd, 2022, by Mr. Louis-Emmanuel Warnock, B.Sc. and Ewen Pasdeloup, trainee. Figure 1 shows the regional location of the site and Figure 2 illustrates the location of the seismic spreads. Both figures are presented in the Appendix.

The following paragraphs briefly describe the survey design, the principles of the testing methods, and the results presented in table and graph.

MASW PRINCIPLE

The *Multi-channel Analysis of Surface Waves* (MASW) and the *SPatial AutoCorrelation* (SPAC or MAM for *Microtremors Array Method*) are seismic methods used to evaluate the shear wave velocities of subsurface materials through the analysis of the dispersion properties of the Rayleigh surface wave. The MASW is considered an "active" method, as the seismic signal is induced at known location and time in the geophones' spread axis. Conversely, the SPAC is considered a "passive" method, using the low frequency "signals" produced far away. The method can also be used with "active" seismic source records. The SPAC method generally allows deeper Vs soundings. Its dispersion curve can then be merged with the one of higher frequency from the MASW to calculate a more complete inversion. The dispersion properties are expressed as a change of velocities with respect to frequencies. Surface wave energy will decay exponentially with depth. Lower frequency surface waves will travel deeper and thus be more influenced by deeper velocity layering than the shallow higher frequency waves. The inversion of the Rayleigh wave dispersion curve yields a shear wave (V_S) velocity depth profile (sounding).

Figure 3 schematically outlines the basic operating procedure for the MASW method. Figure 4 illustrates an example of one of the MASW/SPAC records, the corresponding spectrogram analysis and resulting 1D V_S model.

INTERPRETATION

The main processing sequence involved data inspection and edition when required; spectral analysis ("phase shift" for MASW, and "cross-correlation" for SPAC); picking the fundamental mode; and 1D inversion of the MASW and SPAC shot records using the SeisImagerSW™ software. The data inversions used a nonlinear least squares algorithm.

In theory, all the shot records for a given seismic spread should produce a similar shear-wave velocity profile. In practice, however, differences can arise due to energy dissipation, local surface seismic velocities variations, and/or dipping of overburden layers or rock. In general, the precision of the calculated seismic shear wave velocities (V_S) is around 15% or better.

More detailed descriptions of these methods are presented in *Shear Wave Velocity Measurement Guidelines for Canadian Seismic Site Characterization in Soil and Rock*, Hunter, J.A., Crow, H.L., et al., Geological Surveys of Canada, General Information Product 110, 2015.

SURVEY DESIGN

The seismic acquisition spreads were located at the west extremity of the site (Figure 2). The geophone spacing was of 3.0 metres for the main spread, using 24 geophones. Two shorter seismic spreads, with geophone spacing of 0.5 and 1.0 metre, were dedicated to the near surface materials. The seismic records were produced with a seismograph Terraloc Pro 2 (from ABEM Instrument), and the geophones were 4.5 Hz. The seismic records counted 4096 data, sampled at 1000 µs for the MASW surveys, and 40 µs for the seismic refraction. The records included a pre-trigged portion of 10 ms. An 8 kg sledgehammer was used as the energy source, with impacts being recorded off both ends of the seismic spreads. A stacking procedure was also used to improve the Signal / Noise ratio for the seismic records.

The shear wave depth sounding can be considered as the average of the bulk area within the geophone spread, especially for its central half-length.

RESULTS

From seismic refraction, the rock was calculated at 3.2 metres deep (± 1 metre). The MASW calculated V_S results are illustrated at Figure 5.

The $\overline{V}_{S30}$ value results from the harmonic mean of the shear wave velocities, from the surface to 30 metres deep. It is calculated by dividing the total depth of interest (30 metres) by the sum of the time spent in each velocity layer from the surface down to 30 metres, as:

$$\overline{V}_{S30} = \frac{\sum_{i=1}^{N} H_i}{\sum_{i=1}^{N} {H_i}/{V_i}} \quad | \quad \sum_{i=1}^{N} H_i = 30 \text{ m}$$

(N: number of layers; H_i : thickness of layer "i" ; V_i : V_S of layer "i")

Thus, the $\overline{V}_{S30}$ value represents the seismic shear wave velocity of an equivalent homogeneous single layer response, between the surface and 30 metres deep.

The calculated $\overline{V}_{S30}$ value of the actual site is 1362.4 m/s (Table 1), corresponding to the Site Class "B". However, the Site Classes A and B are not to be used if there are 3 metres or more of unconsolidated material between the rock and the bottom of the spread footing or mat foundation.

In the case the bottom of the foundation would be 2.5 metres or less from the rock, the $\overline{V}_{S30}$* value would be greater than 1500 m/s, corresponding to the Site Class "A" (Table 2).

CONCLUSION

Geophysical surveys were carried out to identify the Site Class at 112 Montréal Road, Vanier, in Ottawa (ON). The seismic surveys used the MASW and the SPAC analysis, and the seismic refraction to calculate the $\overline{V}_{S30}$ value. Its calculation is presented at Table 1.

The $\overline{V}_{S30}$ value of the actual site is 1362 m/s, corresponding to the Site Class "B" (760 < $\overline{V}_{S30}$ ≤ 1500 m/s), as determined through the MASW and SPAC methods, Table 4.1.8.4.-A of the NBC, and the Building Code, O. Reg. 332/12. It must be noted that the Site Classes A and B are not to be used if there are 3 metres or more of unconsolidated material between the rock and the bottom of the spread footing or mat foundation.

In the case there would be 2.5 metres or less of unconsolidated material between the rock and the bottom of the foundation, the $\overline{V}_{S30}$* value would be greater than 1500 m/s, corresponding to the Site Class "A".

It must also be noted that other geotechnical information gleaned on site; including the presence of liquefiable soils, very soft clays, high moisture content etc. (cf. Table 4.1.8.4.-A of the NBC) can supersede the Site classification provided in this report based on the $\overline{V}_{S30}$ value.

The V_S values calculated are representative of the in situ materials and are not corrected for the total and effective stresses.

Hoping the whole to your satisfaction, we remain yours truly,

Jean-Luc Arsenault, M.A.Sc., P.Eng.
Senior Project Manager

LICENSED PROFESSIONAL ENGINEER
J.-L. ARSENAULT
100148122
PROVINCE OF ONTARIO
2022-10-12

Figure 1: Regional location of the Site
(source: *OpenStreetMap*©)

Figure 2: Location of the seismic spreads
(source: *geoOttawa*)

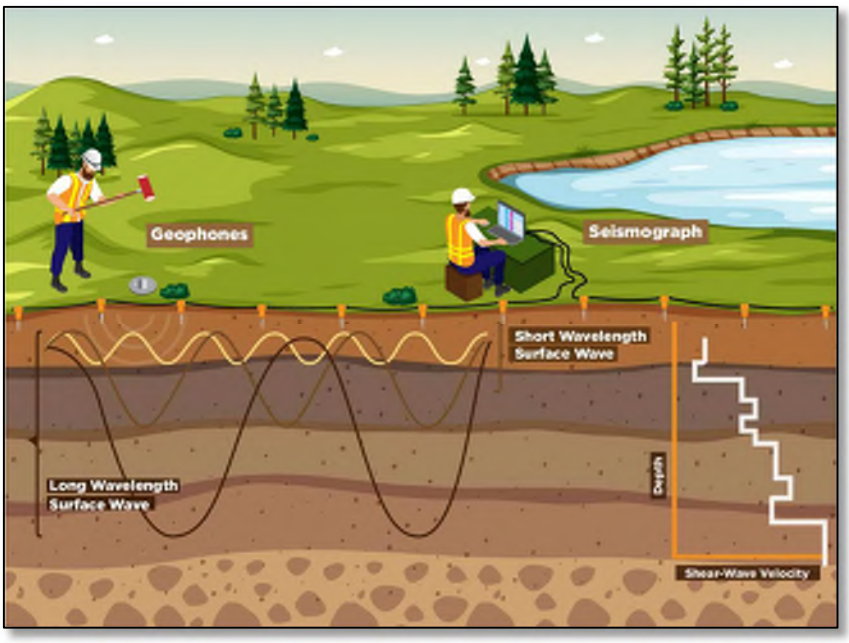


Figure 3: MASW Operating Principle

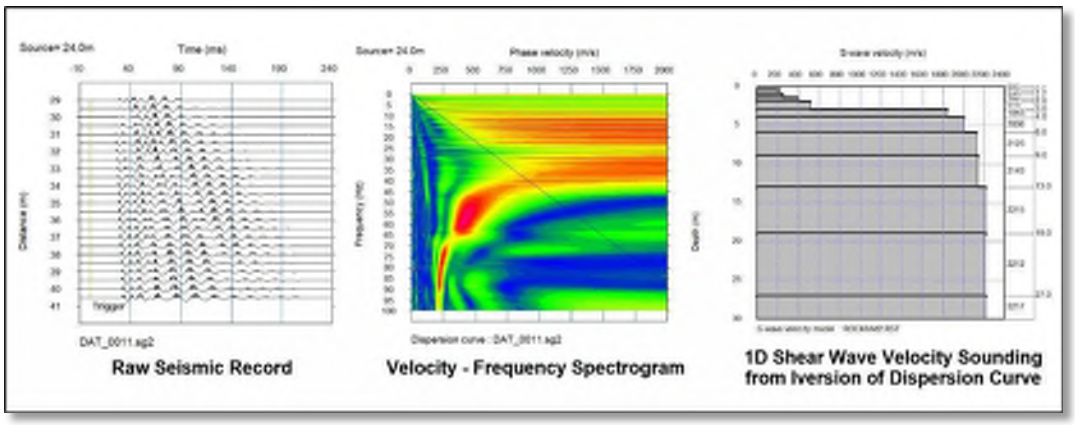


Figure 4: Example of a MASW/SPAC record, Phase Velocity - Frequency curve of the Rayleigh wave and resulting 1D Shear Wave Velocity Model

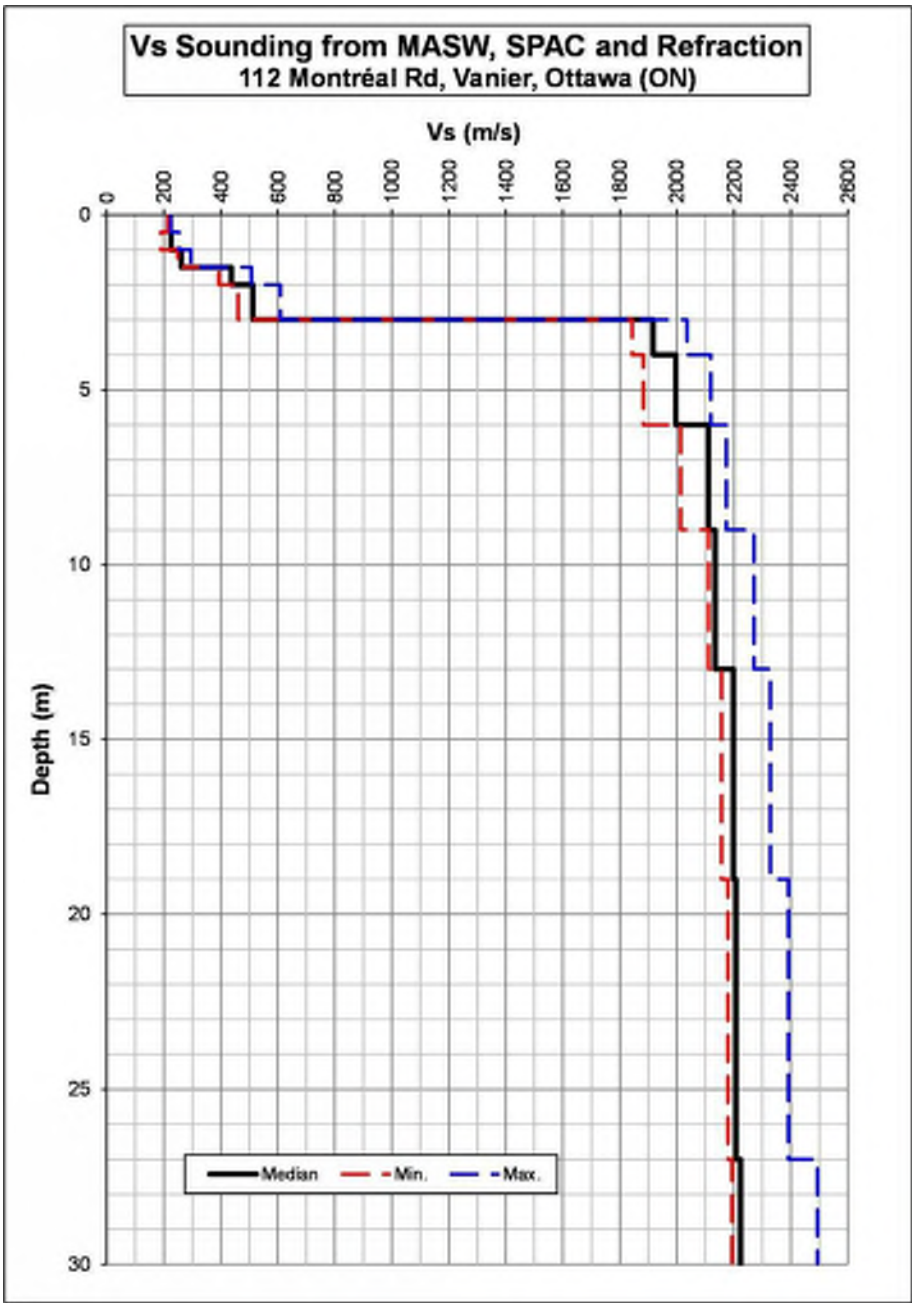


Figure 5: MASW Shear-Wave Velocity Sounding

TABLE 1
V_{S30} Calculation for the Site Class (actual site)

Depth	Vs			Thickness	Cumulative Thickness	Delay for med. Vs	Cumulative Delay	Vs at given Depth
	Min.	Median	Max.					
(m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(s)	(s)	(m/s)
0	215.0	220.5	226.1	**Grade Level (September 2, 0222)**				
0.5	190.1	224.7	253.7	0.50	0.50	0.002267	0.002267	220.5
1.0	248.6	261.3	295.1	0.50	1.00	0.002225	0.004492	222.6
1.5	393.6	437.7	508.3	0.50	1.50	0.001914	0.006406	234.2
2.0	461.3	512.8	609.8	0.50	2.00	0.001142	0.007548	265.0
3.0	1842.9	1917.1	2035.4	1.00	3.00	0.001950	0.009498	315.9
4.0	1882.3	1996.6	2119.2	1.00	4.00	0.000522	0.010020	399.2
6.0	2013.2	2110.8	2174.2	2.00	6.00	0.001002	0.011021	544.4
9.0	2111.6	2133.8	2270.8	3.00	9.00	0.001421	0.012443	723.3
13.0	2156.3	2198.4	2328.0	4.00	13.00	0.001875	0.014317	908.0
19.0	2179.8	2207.1	2391.1	6.00	19.00	0.002729	0.017046	1114.6
27.0	2193.5	2223.1	2492.8	8.00	27.00	0.003625	0.020671	1306.2
30				3.00	30.00	0.001349	0.022020	1362.4

V_{S30} (m/s)	**1362.4**
Class	**B (1)**

(1) The Site Classes A and B are not to be used if there are 3 metres or more of unconsolidated materials between the rock surface and the bottom of the spread footing or mat foundation.

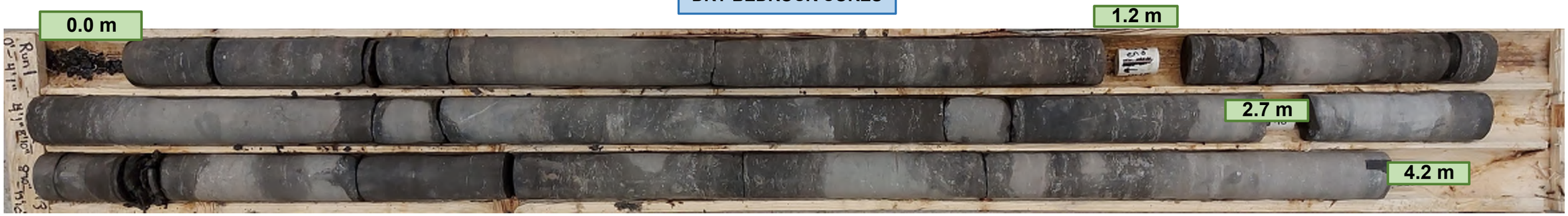
TABLE 2
Limit for the Site Class A

Depth	Vs			Thickness	Cumulative Thickness	Delay for med. Vs	Cumulative Delay	Vs at given Depth
	Min.	Median	Max.					
(m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(s)	(s)	(m/s)
0	215.0	220.5	226.1	**Limit for Site Class A (2.5 metres of soil)**				
0.5	190.1	224.7	253.7					
1.0	248.6	261.3	295.1	0.50	0.50	0.002225	0.002225	224.7
1.5	393.6	437.7	508.3	0.50	1.00	0.001914	0.004139	241.6
2.0	461.3	512.8	609.8	0.50	1.50	0.001142	0.005281	284.0
3.0	1842.9	1917.1	2035.4	1.00	2.50	0.001950	0.007231	345.7
4.0	1882.3	1996.6	2119.2	1.00	3.50	0.000522	0.007752	451.5
6.0	2013.2	2110.8	2174.2	2.00	5.50	0.001002	0.008754	628.3
9.0	2111.6	2133.8	2270.8	3.00	8.50	0.001421	0.010175	835.3
13.0	2156.3	2198.4	2328.0	4.00	12.50	0.001875	0.012050	1037.3
19.0	2179.8	2207.1	2391.1	6.00	18.50	0.002729	0.014779	1251.8
27.0	2193.5	2223.1	2492.8	8.00	26.50	0.003625	0.018404	1439.9
30.5				3.50	30.00	0.001574	0.019978	1501.6

V_{S30}* (m/s)	**1501.6**
Class	**A**

Appendix C – Rock Core Photos

DRY BEDROCK CORES

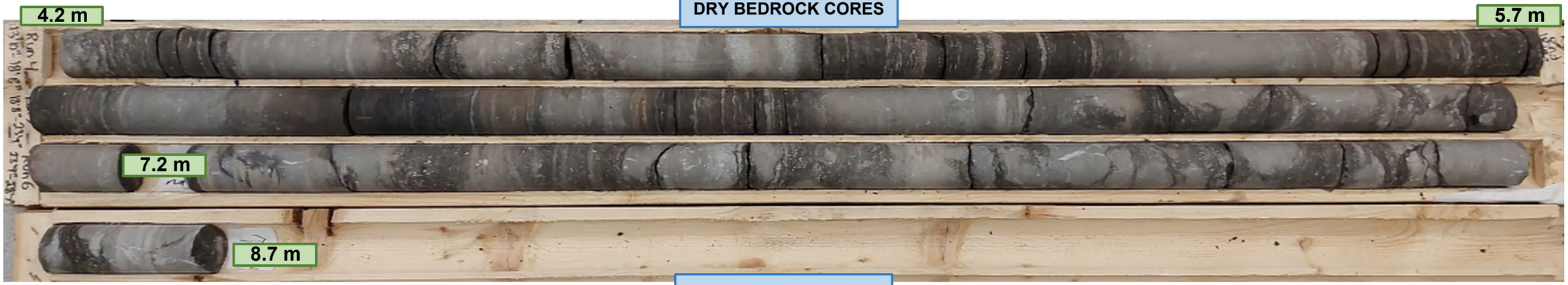


WET BEDROCK CORES

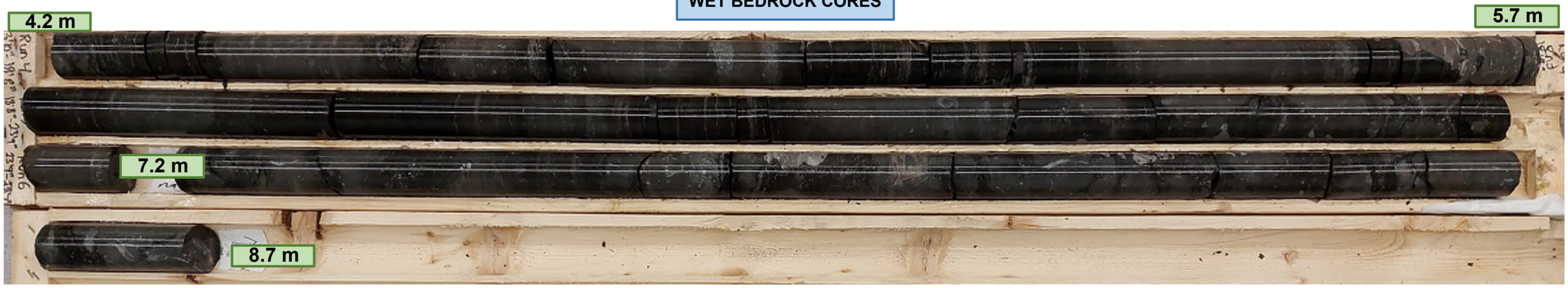
EXP Services Inc. www.exp.com
t: +1.613.688.1899 | f: +1.613.225.7337
2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6, Canada

Borehole No:	Core Runs	project	Project N0:
BH1	Run 1 0.0 m - 1.2 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored	Run 2 1.2 m - 2.7 m	Rock Core Photographs	FIG C-1
Sept 15, 2022	Run 3 2.7 m - 4.2 m		

DRY BEDROCK CORES



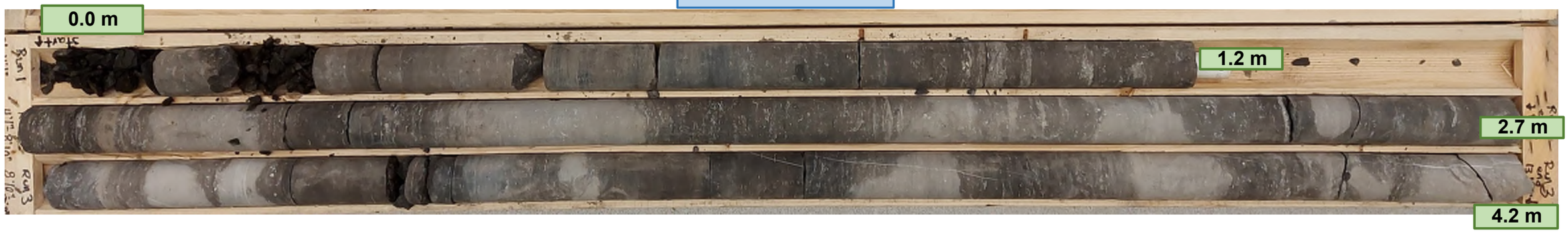
WET BEDROCK CORES



EXP Services Inc. www.exp.com
t: +1.613.688.1899 | f: +1.613.225.7337
2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6, Canada

Borehole No:	Core Runs	project	Project N0:
BH1	Run 4 4.2 m - 5.7 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 15, 2022	Run 5 5.7 m - 7.2 m Run 6 7.2 m - 8.7 m	Rock Core Photographs	FIG C-2

DRY BEDROCK CORES



WET BEDROCK CORES

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t: +1.613.688.1899 | f: +1.613.225.7337
2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6, Canada

Borehole No:	Core Runs	project	Project N0:
BH2	Run 1 0.0 m - 1.2 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored	Run 2 1.2 m - 2.7 m	Rock Core Photographs	FIG C-3
Sept 15, 2022	Run 3 2.7 m - 4.2 m		

DRY BEDROCK CORES

WET BEDROCK CORES

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Ottawa, ON K2B 8H6, Canada

Borehole No:	Core Runs	project	Project N0:
BH2	Run 4 4.2 m - 5.7 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 15, 2022	Run 5 5.7 m - 7.3 m Run 6 7.3 m - 8.7 m	Rock Core Photographs	FIG C-4

DRY BEDROCK CORES

8.7 m

10.2 m

WET BEDROCK CORES

8.7 m

10.2 m

EXP Services Inc. **www.exp.com**
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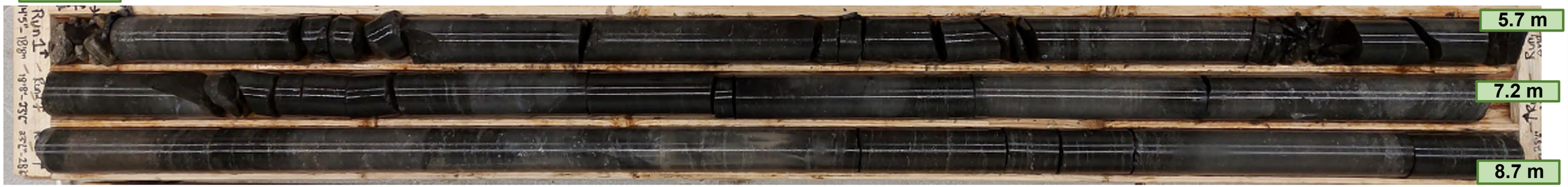
2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6, Canada

Borehole No:	Core Runs	project	Project N0:
BH2	Run 7 8.7 m - 10.2 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 15, 2022		Rock Core Photographs	FIG C-5

DRY BEDROCK CORES

WET BEDROCK CORES



EXP Services Inc. www.exp.com
t: +1.613.688.1899 | f: +1.613.225.7337
2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6, Canada

Borehole No:	Core Runs	project	Project N0:
BH3	Run 1 4.4 m - 5.7 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 15, 2022	Run 2 5.7 m - 7.2 m Run 3 7.2 m - 8.7 m	Rock Core Photographs	FIG C-6

DRY BEDROCK CORES

8.7 m

9.2 m

WET BEDROCK CORES

8.7 m

9.2 m

EXP Services Inc. **www.exp.com**
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2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6, Canada

Borehole No:	Core Runs	project	Project N0:
BH3	Run 4 8.7 m - 9.2 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 15, 2022		Rock Core Photographs	FIG C-7

DRY BEDROCK CORES

WET BEDROCK CORES

EXP Services Inc. **www.exp.com**
t: +1.613.688.1899 | f: +1.613.225.7337
2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6, Canada

Borehole No:	Core Runs	project	Project N0:
BH4	Run 1 2.6 m - 4.2 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sep 14, 2022		Rock Core Photographs	FIG C-8

DRY BEDROCK CORES

WET BEDROCK CORES

EXP Services Inc. www.exp.com
t: +1.613.688.1899 | f: +1.613.225.7337
2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6, Canada

Borehole No:	Core Runs	project	Project N0:
BH4	Run 2 4.2 m - 5.7 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sep 14, 2022		Rock Core Photographs	FIG C-9

DRY BEDROCK CORES

5.7 m

7.2 m

WET BEDROCK CORES

5.7 m

7.2 m

EXP Services Inc. **www.exp.com**
t: +1.613.688.1899 | f: +1.613.225.7337
2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6, Canada

Borehole No:	Core Runs	project	Project N0:
BH4	Run 3 5.7 m - 7.2 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sep 14, 2022		Rock Core Photographs	FIG C-10

DRY BEDROCK CORES

7.2 m

8.7 m

WET BEDROCK CORES

7.2 m

8.7 m

EXP Services Inc. **www.exp.com**
t: +1.613.688.1899 | f: +1.613.225.7337
2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6, Canada

Borehole No:	Core Runs	project	Project N0:
BH4	Run 4 7.2 m - 8.7 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sep 14, 2022		Rock Core Photographs	FIG C-11

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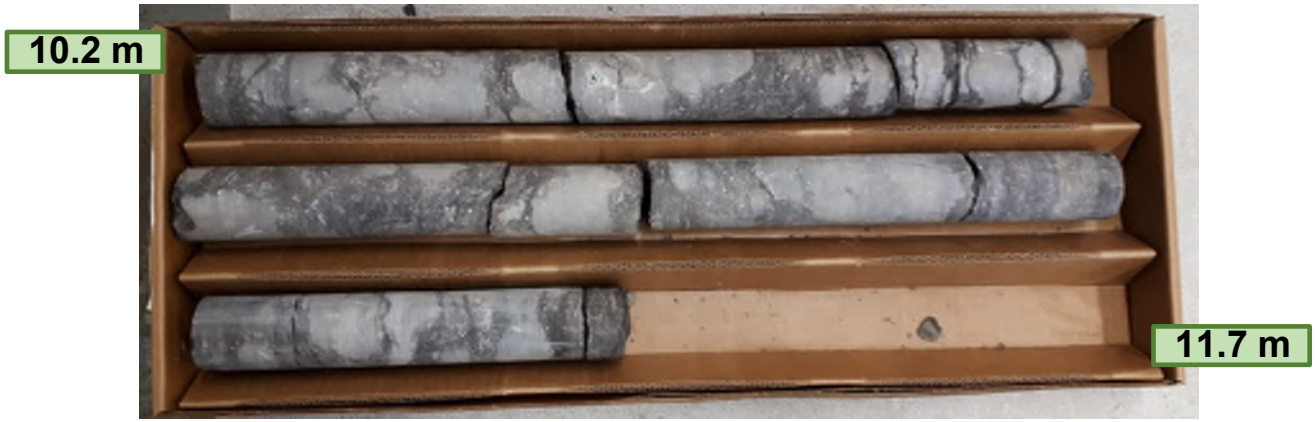
Borehole No:	Core Runs	project	Project N0:
BH4	Run 5 8.7 m - 10.2 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sep 14, 2022		Rock Core Photographs	FIG C-12

DRY BEDROCK CORES



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Borehole No:	Core Runs	project	Project N0:
BH4	Run 6 10.2 m - 11.7 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sep 14, 2022		Rock Core Photographs	FIG C-13

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Borehole No:	Core Runs	project	Project N0:
BH4	Run 7 11.7 m - 13.3 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sep 14, 2022		Rock Core Photographs	FIG C-14

DRY BEDROCK CORES

13.3 m

14.8 m

WET BEDROCK CORES

13.3 m

14.8 m

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Borehole No:	Core Runs	project	Project N0:
BH4	Run 8 13.3 m - 14.8 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sep 14, 2022		Rock Core Photographs	FIG C-15

DRY BEDROCK CORES

14.8 m

15.3 m

WET BEDROCK CORES

14.8 m

15.3 m

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Borehole No:	Core Runs	project	Project N0:
BH4	Run 9 14.8 m - 15.3 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sep 14, 2022		Rock Core Photographs	FIG C-16

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Borehole No:	Core Runs	project	Project N0:
BH5	Run 1 0.0 m - 1.4 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 15, 2022		Rock Core Photographs	FIG C-17

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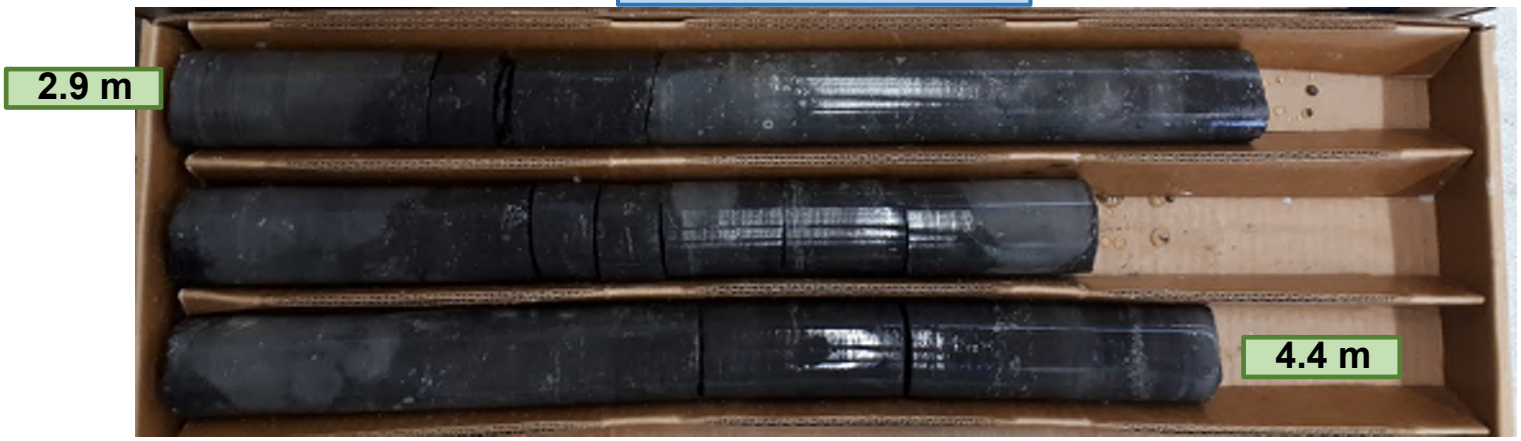
Borehole No:	Core Runs	project	Project N0:
BH5	Run 2 1.4 m - 2.9 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 15, 2022		Rock Core Photographs	FIG C-18

DRY BEDROCK CORES

WET BEDROCK CORES



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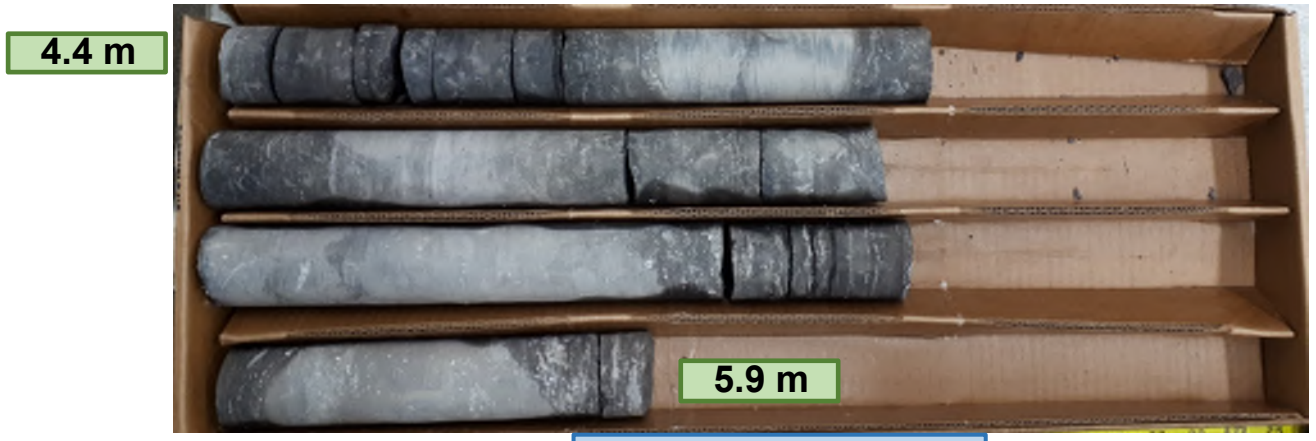
Borehole No:	Core Runs	project	Project N0:
BH5	Run 3 2.9 m - 4.4 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 15, 2022		Rock Core Photographs	FIG C-19

DRY BEDROCK CORES



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Borehole No:	Core Runs	project	Project N0:
BH5	Run 4 4.4 m - 5.9 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 15, 2022		Rock Core Photographs	FIG C-20

DRY BEDROCK CORES

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Borehole No:	Core Runs	project	Project N0:
BH5	Run 5 5.9 m - 7.4 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 15, 2022		Rock Core Photographs	FIG C-21

DRY BEDROCK CORES

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Borehole No:	Core Runs	project	Project N0:
BH5	Run 6 7.4 m - 8.9 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 15, 2022		Rock Core Photographs	FIG C-22

DRY BEDROCK CORES

0.8 m

1.7 m

WET BEDROCK CORES

0.8 m

1.7 m

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Borehole No:	Core Runs	project	Project N0:
BH6	Run 1 0.8 m - 1.7 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 22, 2022		Rock Core Photographs	FIG C-23

DRY BEDROCK CORES

WET BEDROCK CORES

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Borehole No:	Core Runs	project	Project N0:
BH6	Run 2 1.7 m - 3.2 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 22, 2022		Rock Core Photographs	FIG C-24

DRY BEDROCK CORES

3.2 m

4.7 m

WET BEDROCK CORES

3.2 m

4.7 m

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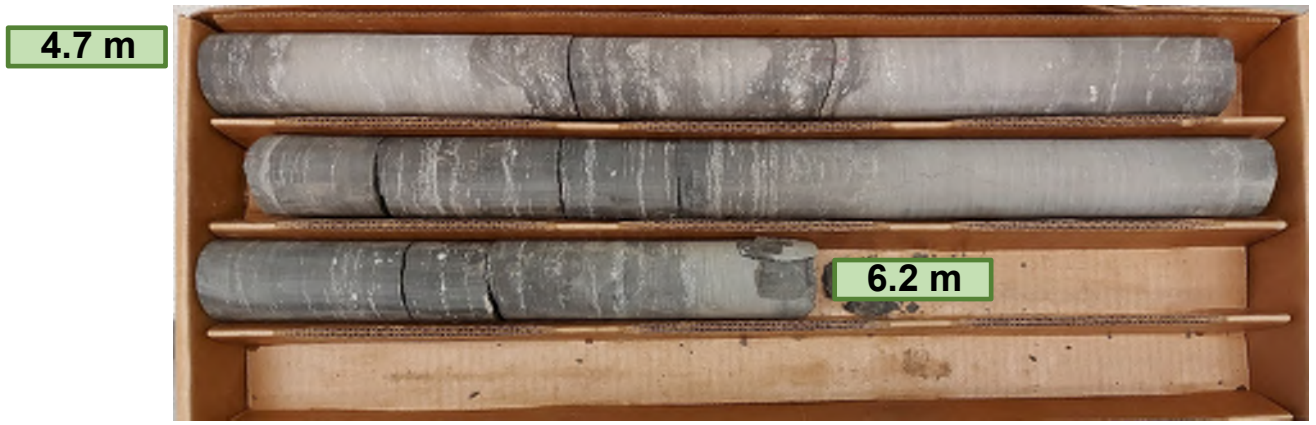
Borehole No:	Core Runs	project	Project N0:
BH6	Run 3 3.2 m - 4.7 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 22, 2022		Rock Core Photographs	FIG C-25

DRY BEDROCK CORES



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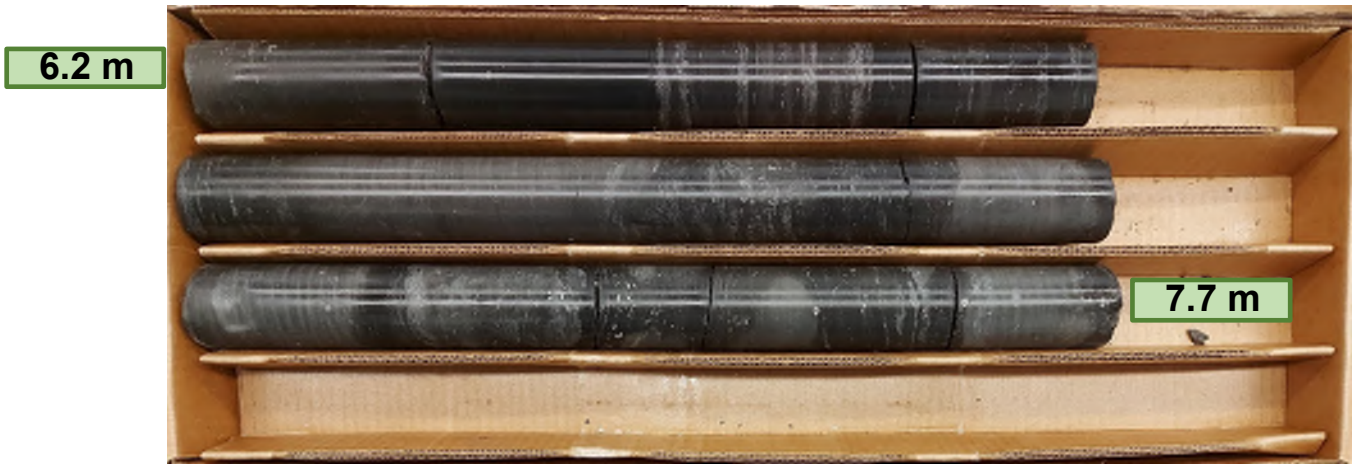
Borehole No:	Core Runs	project	Project N0:
BH6	Run 4 4.7 m - 6.2 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 22, 2022		Rock Core Photographs	FIG C-26

DRY BEDROCK CORES

WET BEDROCK CORES



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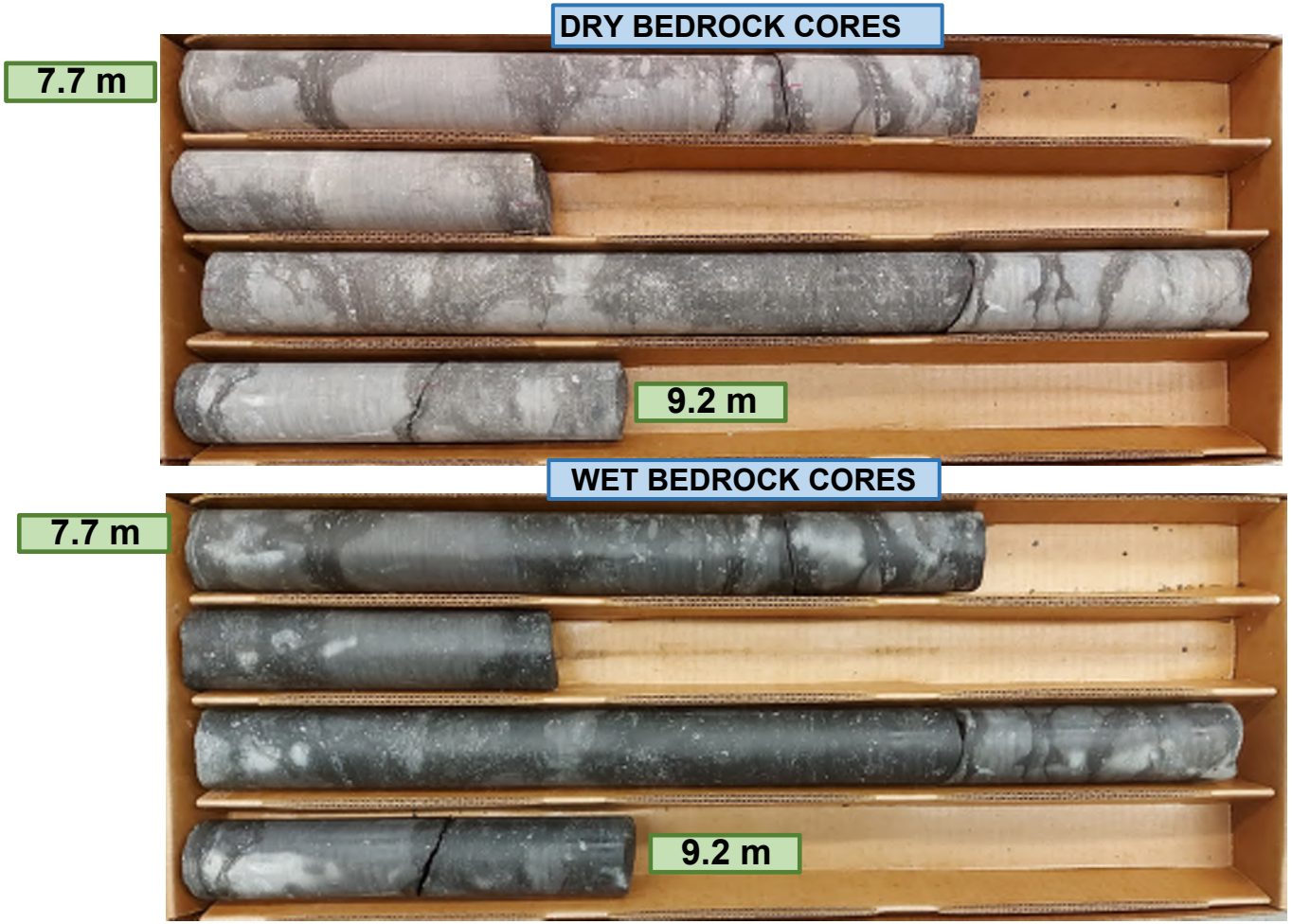
Borehole No:	Core Runs	project	Project N0:
BH6	Run 5 6.2 m - 7.7 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 22, 2022		Rock Core Photographs	FIG C-27



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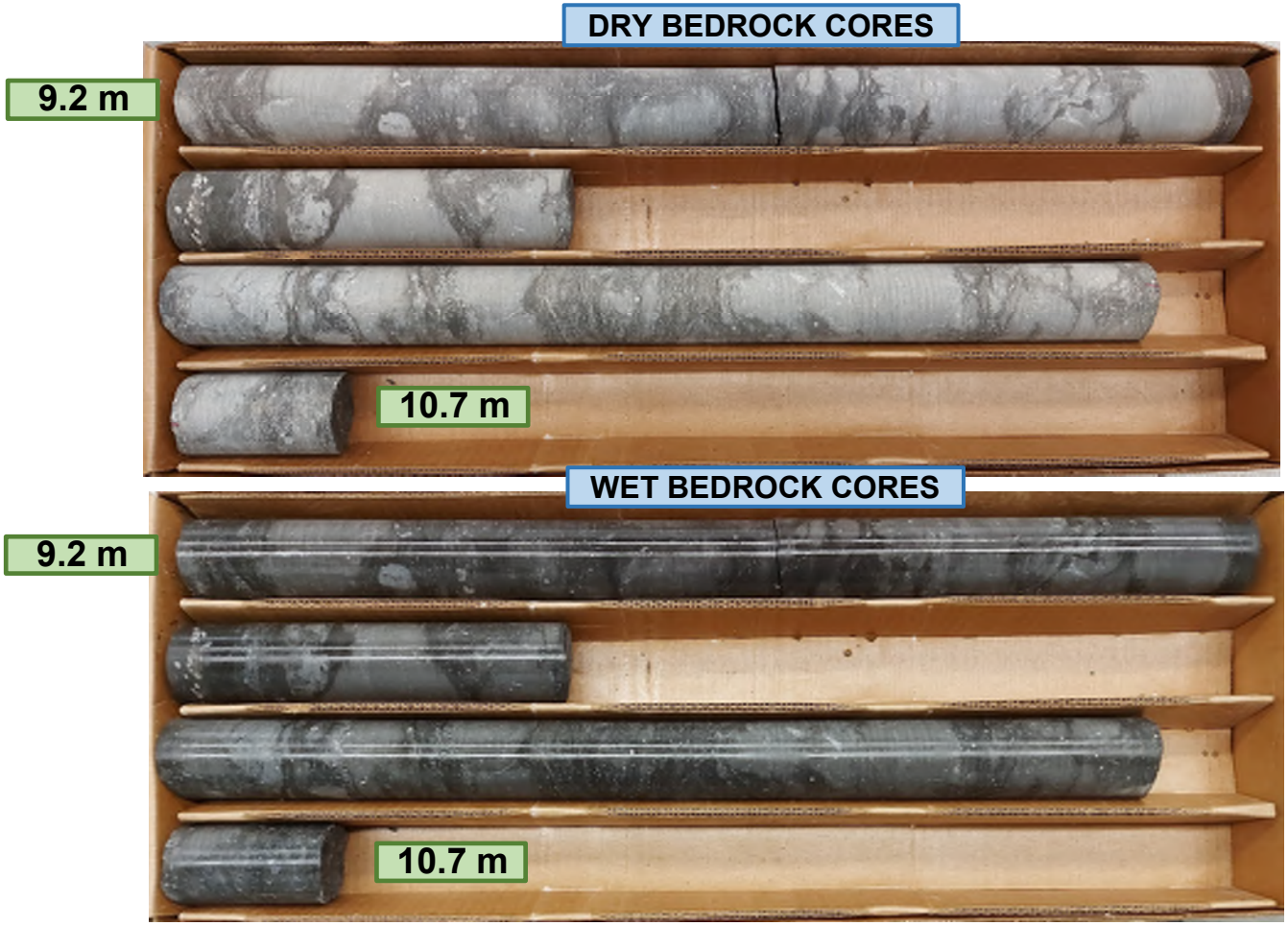
Borehole No:	Core Runs	project	Project N0:
BH6	Run 6 7.7 m - 9.2 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 22, 2022		Rock Core Photographs	FIG C-28



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Borehole No:	Core Runs	project	Project N0:
BH6	Run 7 9.2 m - 10.7 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 22, 2022		Rock Core Photographs	FIG C-29

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Borehole No:	Core Runs	project	Project N0:
BH6	Run 8 10.7 m - 12.2 m	Geotechnical Investigation 112 Montreal Road, Ottawa, ON	OTT-00214936-C0
Date Cored Sept 22, 2022		Rock Core Photographs	FIG C-30

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