



Geotechnical Investigation Proposed 6-Story Commercial and Residential Building 224 Preston Street, City of Ottawa, Ontario

Client:

Attn.: Fernando Matos
Ottawa Carleton Construction Ltd.
101-337 Sunnyside Ave.
Ottawa, Ontario K1S 0Y6

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Prepared By:

Matthew Zammit, P.Eng.
Geotechnical Engineer
Earth and Environment

Reviewed / Approved By:

Susan M. Potyondy, P.Eng.
Senior Geotechnical Engineer
Earth and Environment

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Executive Summary

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation completed at the site registered by the street address of 224 Preston Street, Ottawa, Ontario (Figure 1). Terms and conditions of this assignment were outlined in EXP proposal number OTT-21019479-A0 dated September 30, 2021. This work was authorized by Fernando Matos on behalf of Ottawa Carleton Construction Ltd. via EXP's signed authorization form dated September 30, 2021.

Available preliminary architectural drawings indicate the proposed development at the site will comprise the construction of a new approximate 12.5 m by 23.0 m six-story mixed use commercial and residential building that will house 24-units (20 residential and 4 commercial units). The proposed building will have a one level underground parking garage. The floor slab for the underground parking garage will be constructed at a 3.05 m depth below finished grade. The proposed building will also have an elevator. The depth of the elevator pit below the lowest floor slab (parking garage slab) of the proposed building was not known at the time of this geotechnical investigation. It is anticipated that the final grades will match the existing grades of the site.

The fieldwork for the geotechnical investigation was undertaken on December 3, 2021 and December 11, 2021 and consists of three (3) boreholes (Borehole Nos. 1, 2, and 3) advanced to auger refusal and termination depths of 4.7 m to 6.5 m below the existing ground surface. Monitoring wells were installed in two (2) boreholes for the long-term monitoring of groundwater levels.

Review of the borehole logs indicates the subsurface condition consists of fill underlain by loose to very dense glacial till and gravel overlying limestone bedrock at a 5.8 m depth (Elevation 52.1 m). The groundwater level is at 4.0 m and 4.1 m depths (Elevation 54.0 m and Elevation 53.8 m).

Based on the borehole information and Table 4.1.8.4.A in the 2012 Ontario Building Code (as amended May 2, 2019), the site classification for seismic site response is **Class C**. The subsurface soils are not considered to be liquefiable during a seismic event.

Grading plans were not available at the time of preparation of this report. However, based on a review of the existing grades at the site, the surrounding topography of the adjacent properties and streets and that the site is located within a well-established developed area of Ottawa, a grade raise is likely not required for this project. However, for design purposes, a grade raise of 0.5 m is considered acceptable at the site from a geotechnical point of view.

It is our understanding that the lowest floor slab of the proposed building for the underground parking garage will be placed at 3.05 m below the existing grade. In this case, it is assumed the footings will be placed 600 mm below the lowest floor at a 3.7 m depth. At this depth, the footings will be founded on the compact to very dense zone of the glacial till and on the compact zone of the gravel and slightly above the groundwater level. The native glacial till and gravel are considered suitable to support footings of the proposed building. The existing fill is not considered suitable for supporting the footings of the proposed building.

The depth of the base of the elevator pit was not known at the time of this geotechnical investigation. It is assumed however that the base of the elevator pit will be at a deeper depth than the footings and will likely be below the groundwater level.

It is anticipated that the base of the excavation for the footings and for the elevator pit may undergo basal instability or base type failure in the form of piping or heave due to the groundwater level located only 0.3 m and 0.4 m below

the footings and the presence of the permeable gravel which extends below the groundwater level. To prevent base type failure, it is recommended that the groundwater level should be lowered by at least 1.0 m below the depth of the excavation for the proposed building prior to start of excavation and construction activities. This may be achieved by installing deep sumps and pumping with high-capacity pumps or by the use of well points. A specialist dewatering contractor must be consulted for this purpose.

Alternatively, the excavation may be undertaken within the confines of a shoring system that is also designed to cut-off groundwater flows towards the excavation and minimize groundwater flows into the shored excavation. In this regard, seepage of groundwater into the shored excavation should still be anticipated but may be removed by collecting the water at low points within the excavation and pumping from sumps. In areas of higher seepage, high-capacity pumps may be required to keep the excavation dry.

For an excavation where the groundwater level has been successfully lowered to at least 1.0 m below the base of the excavation for the proposed building, strip and spread footings may be founded at a 3.7 m depth below existing grade on the compact to very dense zone of the glacial till and on the compact zone of the gravel. Strip footings having a maximum width of 1.5 m may be designed for a bearing pressure at SLS of 150 kPa and factored geotechnical resistance at ULS of 225 kPa. Square pad footings having a maximum width and length of 3.0 m may be designed for a bearing pressure at SLS of 150 kPa and factored geotechnical resistance at ULS of 225 kPa. The factored geotechnical resistance includes a resistance factor of 0.5.

Settlement of footings designed for the above SLS bearing pressures are expected to be within tolerable limits of 25 mm total and 19 differential movement.

Consideration should be given to raising the lowest floor of the proposed building (the floor of the underground parking garage) to reduce the level of effort required for lowering the groundwater level as discussed above. Should the founding depth of the footings be different than the 3.7 m below existing grade, EXP should be contacted to review and provide updated SLS and factored ULS values for the revised footing depths.

If the SLS and factored ULS values provided in the report are not sufficient to support the proposed building, consideration may be given to placing the footings at a deeper depth on the bedrock. EXP can provide additional comments in this regard, if required.

A minimum of 1.5 m of earth cover should be provided to the exterior foundations 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 their vicinity and to 2.4 m if snow will be removed from the vicinity of the structure. When earth cover is less than the minimum required, an equivalent thermal combination of earth cover and rigid insulation or rigid insulation alone should be provided.

The subsurface basement walls of the proposed new building should be backfilled with free draining material, such as Ontario Provincial Standard Specification (OPSS) Granular B Type II and equipped with a perimeter drainage system to prevent the buildup of hydrostatic pressure behind the walls. The walls will be subjected to lateral static and dynamic (seismic) earth forces. These forces may be estimated by the equations provided in the report. The elevator pit should be designed as a water-tight structure. All subsurface walls should be properly waterproofed.

The floor of the parking garage of the new building may be designed as a slab-on-grade concrete floor or as a paved surface. Both options are presented in the report. Perimeter and underfloor drainage systems are required.

Excavations at the site may be undertaken using heavy equipment capable of removing cobbles and boulders within the glacial till and must be completed in accordance with the Occupational Health and Safety Act (OHSA), Ontario, Reg. 213/91. Based on the definitions provided in OHSA, the subsurface soils at the site are considered to be Type 3 soil and therefore must be sloped back at 1H:1V from the bottom of the excavation. If side slopes cannot be achieved due to space restrictions on site or due to proximity to adjacent structures, the excavations sides would require to be shored, designed and installed in accordance with latest edition of Ontario Regulation 213/91 under the OHSA and the 2006 Fourth Edition of the Canadian Foundation Engineering Manual (CFEM). Reference is made to the previous paragraph regarding lowering the groundwater level.

Seepage of the surface and subsurface water into the shored excavations is anticipated. However, it should be possible to collect water entering the excavations at low points and to remove it by conventional pumping techniques. In areas where more permeable soils may exist, a higher seepage rate should be anticipated and may require high-capacity pumps.

The materials to be excavated from the site will consist of asphalt, topsoil, sand and gravel fill, clayey silt with sand and gravel fill, and glacial till. The excavated soils are not considered suitable for use under structural elements and for backfilling purposes and therefore must be also disposed of off-site or used in landscaped areas. It is anticipated that the majority of the material required for underfloor fill and backfilling purposes would have to be imported as per the recommendations in the report.

The above and other related considerations are discussed in greater detail in the attached report.

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1. Introduction

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation completed at the site located at 224 Preston Street, Ottawa, Ontario (Figure 1). Terms and conditions of this assignment were outlined in EXP proposal number OTT-21019479-A0 dated September 30, 2021. This work was authorized by Fernando Matos on behalf of Ottawa Carleton Construction Ltd. via EXP's signed authorization form dated September 30, 2021.

Available preliminary architectural drawings indicate the proposed development at the site will comprise the construction of a new approximate 12.5 m by 23.0 m six-story mixed use commercial and residential building that will house 24-units (20 residential and 4 commercial units). The proposed building will have a one level underground parking garage. The floor slab of the underground parking garage will be constructed at a 3.05 m depth below finished grade. The proposed building will also have an elevator. The depth of the elevator pit below the lowest floor slab of the proposed building (parking garage floor slab) was not known at the time of this geotechnical investigation. It is anticipated that the final grades will match the existing grades of the site.

This geotechnical investigation was undertaken to:

- a) Establish the subsurface soil and groundwater conditions at the three (3) boreholes located at the site,
- b) Provide classification of the site for seismic design in accordance with the requirements of the 2012 Ontario Building Code (OBC) as amended May 2, 2019 and assess the liquefaction potential of the subsurface soils in a seismic event,
- c) Discuss grade raise restrictions,
- d) Discuss foundation alternatives and provide the bearing pressure at Serviceability Limit State (SLS) and factored geotechnical resistance at Ultimate Limit State (ULS) for foundations as well as the anticipated total and differential settlements,
- e) Comment on slab-on-grade construction for a concrete surface and for a paved surface for the floor of the parking garage of the proposed building and permanent drainage system requirements (perimeter and underfloor drainage systems),
- f) Discuss lateral earth pressures against subsurface walls and provide lateral earth pressure parameters for static and seismic conditions,
- g) Discuss excavation conditions and dewatering requirements during the construction of the proposed new building,
- h) Comment on backfilling requirements and suitability of the on-site soils for backfilling purposes; and
- i) Comment on subsurface concrete requirements and the corrosion potential of subsurface soils to buried metal structures/members.

The comments and recommendations given in this report assume that the above-described design concept 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 an approximate 15.5 m by 30.0 m deep rectangular shaped parcel of land bounded by Preston Street on the east side and Larch Street on the north side. It is bounded by a commercial property to the south and a residential property to the west. The neighboring lot to the south is developed with a paved driveway and less than 1 m high wooden deck along the adjacent property line. The neighboring lot to the west has a one-story garage constructed adjacent to the west property line of the site.

The site is currently occupied by a 2.5-story house with a basement located in the southeast corner of the site. This existing building will be demolished to allow the construction of the proposed new six story building. The site is flat with ground surface elevations ranging between Elevation 57.94 m and Elevation 58.08 m at the west end of the site to Elevation 57.79 m at the east end of the site based on the ground surface elevations of the boreholes.

3. Procedure

The fieldwork for the geotechnical investigation was undertaken on December 3, 2021 and December 11, 2021 and consists of three (3) boreholes (Borehole Nos. 1, 2, and 3) advanced to auger refusal and termination depths of 4.7 m to 6.5 m below the existing ground surface. The locations of the boreholes are shown on the Borehole Location Plan, Figure 2. The fieldwork was supervised on a full-time basis by a representative from EXP.

The locations and geodetic elevations of the boreholes were surveyed by EXP. Prior to the fieldwork, the locations of the boreholes were cleared of any public and private underground services.

The boreholes were drilled using a CME-55 truck mounted drill rig equipped with continuous flight hollow stem augers and the capability to sample soil and bedrock. Auger samples were obtained in the three (3) boreholes from the ground surface to a 0.6 m depth below existing grade. Standard penetration tests (SPTs) were performed in the boreholes at 0.75 m and 1.5 m depth intervals with soil samples retrieved by the split-barrel sampler. The bedrock was cored in Borehole No. 2 by conventional rock coring method. A careful record of any sudden drops of the core barrel, colour of the wash water and wash water return were recorded during the rock coring operation.

A 32 mm diameter monitoring well with slotted section was installed in Borehole Nos. 1 and 3 for long-term monitoring of the groundwater level. The monitoring 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 the field work and the installation of the monitoring wells.

All soil samples were visually examined in the field for textural classification, logged, preserved in plastic bags and identified. Similarly, the rock core was visually examined, placed in a core box, identified and logged. On completion of the fieldwork, all the soil samples and the rock core were transported to the EXP laboratory in Ottawa, Ontario, where they were visually examined by a geotechnical engineer and borehole logs were prepared. The 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	20
Grain Size Analysis	4
Atterberg Limit Determination	2
Corrosion Analysis (pH, sulphate, chloride and resistivity)	1
Bedrock Core	
Unit Weight Determination	1
Unconfined Compressive Strength Test	1

4. Subsurface Soil and Groundwater Conditions

A detailed description of the geotechnical conditions encountered in the boreholes is given on the borehole logs, Figures 3 to 5. The borehole logs and related information depict subsurface conditions only at the specific locations and times indicated. Subsurface conditions and water levels between the boreholes may differ from conditions at the locations where sampling was conducted. The passage of time may also result in changes in the conditions interpreted to exist at the locations where sampling was conducted.

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

It should be noted that the soil boundaries indicated on the borehole logs 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 borehole logs forms an integral part of this report and should be read in conjunction with this report.

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

4.1 Pavement Structure

Borehole No. 3 is located in a paved area with a pavement structure consisting of 50 mm thick asphaltic concrete underlain by 350 mm thick granular base. The base material comprises of sand with silt and gravel. The moisture content of the granular fill base is 3 percent.

Grain size analysis was conducted on one (1) sample of the granular fill base material and the grain size distribution curve is shown in Figure 6. A summary of the results of the grain size distribution curve is shown in Table II.

Borehole No. (BH)– Auger Sample No. (AS)	Depth (m)	Grain-Size Analysis (%)			Soil Classification (USCS)
		Gravel	Sand	Fines (Silt and Clay)	
BH 3 – AS1	0.0 – 0.6	43	46	11	Poorly Graded Sand with Silt and Gravel (SP-SM)

Based on a review of the results from the grain size analysis, the granular fill base sample may be classified as a poorly graded sand with silt and gravel (SP-SM) in accordance with the Unified Soil Classification System (USCS).

4.2 Fill

A surficial granular fill layer was contacted in Borehole Nos. 1 and 2 extending to depths of 0.5 m and 0.7 m (Elevation 57.3 m and Elevation 57.2 m). The granular fill consists of silty sand and gravel. The moisture content of the granular fill is 10 percent.

The granular fill in Borehole Nos. 1 and 2 and the pavement structure in Borehole No. 3 are underlain by a mixed fill material to 1.4 m and 1.5 m depths (Elevation 56.7 m to Elevation 56.3 m). The fill consists of a heterogeneous

mixture of silty clay and silty sand with gravel, cobbles and boulders. Based on standard penetration test (SPT) N-values of 12 to 29, the fill is in a compact state. The moisture content of the fill is 9 percent to 16 percent.

4.3 Buried Topsoil Layer

The fill in Borehole No. 1 is underlain by a 150 mm thick topsoil layer.

4.4 Sand and Gravel Layer

A 100 mm thick sand and gravel layer was contacted beneath the buried topsoil layer in Borehole No. 1.

4.5 Glacial Till

The thin sand and gravel layer in Borehole No. 1 and the fill in Borehole Nos. 2 and 3 are underlain by glacial till that extends to depths of 3.4 m to 4.6 m (Elevation 54.5 m to Elevation 53.2 m). The glacial till consists of silty sand with gravel, cobbles and boulders. The SPT N-values of 7 to 92 indicate the glacial till is in a loose to very dense state. The higher N-values may be a result of the sampler contacting a cobble and boulder within the glacial till. The presence of cobbles and boulders within the glacial till is also confirmed by the augers grinding as they drilled through the glacial till. The natural moisture content of the glacial till ranges from 7 percent to 11 percent.

Grain-size analysis was conducted on two (2) selected samples of the glacial till and the results are summarized in Table III. The grain-size distribution curves are shown in Figures 7 and 8.

Borehole No. (BH) – Sample No. (SS)	Depth (m)	Grain-Size Analysis (%)			Atterberg Limits (%)				Soil Classification (USCS)
		Gravel	Sand	Fines (Silt and Clay)	Moisture Content	Liquid Limit	Plastic Limit	Plasticity Index	
BH 1 – SS4	3.0 – 3.6	25	46	29	7	NP	NP	NP	Silty Sand with Gravel (SM)
BH 3 – SS3	1.5 – 2.1	24	55	21	8	NP	NP	NP	Silty Sand with Gravel (SM)

Notes: NP = No Plastic

Based on a review of the results of the grain-size analysis, the glacial till may be classified as a silty sand with gravel (SM) in accordance with the USCS. The glacial till contains cobbles and boulders.

4.6 Gravel

Gravel was contacted beneath the glacial till in Borehole Nos. 2 and 3 and extends to a 5.8 m depth (Elevation 52.1 m) in Borehole No. 2. Based on the SPT N-values of 9 to 30, the gravel is in a loose to dense state. The natural moisture content of the gravel is 6 percent to 13 percent.

Grain-size analysis was conducted on one (1) sample of the gravel and the results are summarized in Table IV. The grain-size distribution curve is shown in Figure 9.

Table IV: Summary of Results from Grain-Size Analysis – Gravel Sample					
Borehole (BH) No. – Sample (SS) No.	Depth (m)	Grain-Size Analysis (%)			Soil Classification (USCS)
		Gravel	Sand	Fines (Silt and Clay)	
BH 2 – SS5	3.8 – 4.4	47	43	10	Poorly Graded Gravel with Silt and Sand (GP-GM)

Based on a review of the results of the grain-size analysis, the sand and gravel may be classified as a poorly graded gravel with silt and sand (GP-GM) in accordance with the USCS.

4.7 Limestone Bedrock

Refusal to auger was met in all three (3) boreholes at 4.7 m and 5.8 m depths (Elevation 53.2 m to Elevation 52.1 m). In Borehole Nos. 1 and 3 auger refusal was met on inferred bedrock or cobbles and boulders. The presence of bedrock was proven by coring an 800 mm length of the bedrock in Borehole No. 2. Photographs of the bedrock core are shown in Figure 10.

Based on a review of the published geology map (Map 1508A – Generalized Bedrock Geology, Ottawa-Hull, Ontario and Quebec, Geological Survey of Canada, printed by the Surveys and Mapping Branch, 1979), the bedrock is limestone of the Eastview formation. A review of the recovered rock core indicates the total core recovery (TCR) is 91 percent. The rock quality designation (RQD) value is 36 percent indicating the bedrock is of poor quality.

One (1) uniaxial compressive strength test was conducted on the rock core. The test results indicate a natural unit weight of 25.3 kN/m³ and a uniaxial compressive strength of 77.9 MPa. Based on the uniaxial compressive strength test result, the bedrock may be classified as being strong in accordance with the 2006 Fourth Edition of the Canadian Foundation Engineering Manual (CFEM).

4.8 Groundwater Levels

A summary of the groundwater level measurements taken in the boreholes equipped with monitoring wells is shown in Table V.

Table V: Summary of Groundwater Level Measurements			
Borehole No. (BH)	Ground Surface Elevation (m)	Date of Measurement (Elapsed Time in Days from Date of Installation)	Groundwater Depth Below Ground Surface (Elevation), m
BH 1	57.79	December 22, 2021 (19 days)	4.0 (53.8)
BH 3	58.08	December 22, 2021 (11 days)	4.1 (54.0)

The groundwater level is at 4.0 m and 4.1 m depths (Elevation 54.0 m and Elevation 53.8 m) in Borehole Nos. 1 and 3.

Groundwater levels were determined in the boreholes at the times and under the conditions stated in the scope of services. 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.

5. Seismic Site Classification and Liquefaction Potential of Soils

5.1 Site Classification for Seismic Site Response

Based on the borehole information and Table 4.1.8.4.A in the 2012 Ontario Building Code (as amended May 2, 2019), the site classification for seismic site response is **Class C**.

5.2 Liquefaction Potential of Soils

The subsurface soils are not considered to be liquefiable during a seismic event.

6. Grade Raise Restrictions

Grading plans were not available at the time of preparation of this report. However, based on a review of the existing grades at the site, the topography of the adjacent properties and streets and that the site is located within a well-established developed area of Ottawa, a grade raise is likely not required for this project. However, for design purposes, a grade raise of 0.5 m is considered acceptable at the site from a geotechnical point of view.

7. Foundation Considerations

It is our understanding that the lowest floor slab of the proposed building for the underground parking garage will be placed at 3.05 m below the existing grade. In this case, it is considered feasible to support the proposed building on footings placed 600 mm below the lowest floor at a 3.7 m depth. At this depth, the footings will be founded on the compact to very dense zone of the glacial till and on the compact zone of the gravel and slightly above the groundwater level. The native glacial till and gravel are considered suitable to support footings of the proposed building. The existing fill is not considered suitable for supporting the footings of the proposed building.

The depth of the base of the elevator pit was not known at the time of this geotechnical investigation. It is assumed however that the base of the elevator pit will be at a deeper depth than the footings and will likely be below the groundwater level.

It is anticipated that the base of the excavation for the footings and for the elevator pit may undergo basal instability or base type failure in the form of piping or heave due to the groundwater level located at 0.3 m and 0.4 m depth below the footing and the presence of the permeable gravel which extends below the groundwater level. To prevent base type failure, it is recommended that the groundwater level should be lowered by at least 1.0 m below the depth of the excavation for the proposed building prior to start of excavation and construction activities. This may be achieved by installing deep sumps and pumping with high-capacity pumps or by the use of well points. A specialist dewatering contractor must be consulted for this purpose.

Alternatively, the excavation may be undertaken within the confines of a shoring system that is also designed to cut-off groundwater flows towards the excavation and minimize groundwater flows into the shored excavation. In this regard, seepage of groundwater into the shored excavation should still be anticipated but may be removed by collecting the water at low points within the excavation and pumping from sumps. In areas of high infiltration, a higher seepage rate should be anticipated and high-capacity pumps may be required to keep the excavation dry.

For an excavation where the groundwater level has been successfully lowered to at least 1.0 m below the base of the excavation for the proposed building, strip and spread footings may be founded at a 3.7 m depth below existing grade on the compact to very dense zone of the glacial till and on the compact zone of the gravel. Strip footings having a maximum width of 1.5 m may be designed for a bearing pressure at SLS of 150 kPa and factored geotechnical resistance at ULS of 225 kPa. Square pad footings having a maximum width and length of 3.0 m may be designed for a bearing pressure at SLS of 150 kPa and factored geotechnical resistance at ULS of 225 kPa. The factored geotechnical resistance includes a resistance factor of 0.5.

Settlement of footings designed for the above SLS bearing pressures are expected to be within tolerable limits of 25 mm total and 19 differential movement.

Consideration should be given to raising the lowest floor of the proposed building (the floor of the underground parking garage) to reduce the level of effort required for lowering the groundwater level as discussed above. Should the founding depth of the footings be different than the 3.7 m below existing grade, EXP should be contacted to review and provide updated SLS and factored ULS values for the revised footing depths.

If the SLS and factored ULS values provided in this report are not sufficient to support the proposed building, consideration may be given to placing the footings at a deeper depth on the bedrock. EXP can provide additional comments in this regard, if required.

Foundation that are to be placed at different elevations should be located such that the higher footing is set below a line drawn up at 10H:7V from the near edge of the lower footing. The lower footing should be constructed before the upper footing to prevent the latter from being undermined during subsequent construction. This concept should also be applied to underground service excavations to ensure that foundations and underground services will not be undermined.

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

It is recommended that a 50 mm thick concrete mud slab be placed on the approved glacial till and gravel subgrade to protect the subgrade from disturbance by construction equipment, workers (foot traffic) and the effects of the weather (such as precipitation).

A minimum of 1.5 m of earth cover should be provided to the exterior foundations 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 their vicinity and to 2.4 m if snow will be removed from the vicinity of the structure. When earth cover is less than the minimum required, an equivalent thermal combination of earth cover and rigid insulation or rigid insulation alone should be provided. EXP can provide additional comments in this regard, if required.

The recommended bearing pressure at SLS and factored geotechnical resistances at ULS have 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.

8. Floor Slab and Drainage Requirements

The lowest floor level of the parking garage for the proposed building will be located at an approximate 3.05 m depth below the existing grade. Based on the borehole information, the lowest floor slab of the building will be founded on the glacial till 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 lowest floor level for the parking garages is anticipated to be located within 1.0 m of the groundwater level. Therefore, underfloor and perimeter drainage systems will be required for the floor of 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 and covered on top and sides with 150 mm thick clear stone that is fully wrapped or covered 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 19 mm sized clear stone that is fully wrapped or covered with an approved porous geotextile membrane, such as Terrafix 270R or equivalent. 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 should be sloped away from the building to prevent ponding of surface water close to the exterior walls of the buildings.

8.1 Lowest Floor Level as a Concrete Surface

The lowest floor slab of the parking garage may be designed as a slab-on-grade. The subgrade is anticipated to be glacial till. The exposed glacial till should be proofrolled and examined by a geotechnical engineer. Any loose/soft zones of the glacial till should be excavated and replaced with Ontario Provincial Standard Specification (OPSS) Granular B Type II compacted to 95 percent SPMD.

The slab-on-grade should be set on the Granular A pad noted below that is placed on an engineered fill pad at least 300 mm thick placed on the approved glacial till subgrade. The required engineered fill pad should comprise of OPSS Granular B Type II placed on top of the approved glacial till in 300 mm thick lifts and each lift compacted to 98 percent standard Proctor maximum dry density (SPMD).

Following the preparation of the engineered fill pad, 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 OPSS Granular A base material compacted to 100 percent standard Proctor maximum dry density (SPMD); over

- 300 mm minimum thick layer of OPSS Granular B Type II sub-base material 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 floor of the parking garage has been determined.

8.2 Lowest Floor Level as a Paved Surface

The subgrade is anticipated to be glacial till. The exposed glacial till should be proofrolled and examined by a geotechnical engineer. Any loose/soft zones of the glacial till should be excavated and replaced with OPSS Granular B Type II compacted to 95 percent SPMDD.

Following approval and preparation of the glacial till subgrade, the asphalt pavement structure for light duty traffic (cars only) may be constructed on the approved glacial till 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 base material compacted to 100 percent SPMDD; over
- 450 mm thick layer of OPSS Granular B Type II sub-base material compacted to 100 percent SPMDD.

8.3 Additional Comment

Since the lowest floor slab of the proposed building will be above the groundwater level, the permanent drainage systems (perimeter and underfloor drainage systems) for the proposed building are not expected to adversely impact adjacent existing structures and infrastructure over the long-term.

9. Lateral Earth Pressure on Subsurface Walls

9.1 Basement Walls

The subsurface basement walls of the proposed new building should be backfilled with free draining material, such as OPSS Granular B Type II compacted to 95 percent SPMDD and equipped with a perimeter drainage system to prevent the buildup of hydrostatic pressure behind the walls. The walls will be subjected to lateral static and dynamic (seismic) earth forces. The expressions below assume free draining backfill material, a perimeter drainage system, level backfill surface behind the wall and vertical face on the back side of the wall.

For design purposes, the lateral static earth thrust against the subsurface walls may be computed from the following equation:

$$P = K_0 h \left(\frac{1}{2} \gamma h + q \right)$$

- where
- P = lateral earth thrust acting on the subsurface wall, kN/m
 - K_0 = lateral earth pressure at rest coefficient, assumed to be 0.5 for Granular B Type II backfill material
 - γ = unit weight of free draining granular backfill; Granular B Type II = 22 kN/m³
 - h = depth of point of interest below top of backfill, m
 - q = surcharge load stress, kPa

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

$$\Delta_{pe} = \gamma H^2 \frac{a_h}{g} F_b$$

- where
- Δ_{pe} = dynamic thrust in kN/m of wall
 - H = height of wall, m
 - γ = unit weight of backfill material = 22 kN/m³
 - $\frac{a_h}{g}$ = earth pressure coefficient = 0.32 for 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.

9.2 Elevator Walls

The subsurface walls of the elevator pit should be designed as a water-tight structure with the groundwater level assumed to be at the top of the elevator pit wall. The elevator pit should be designed to resist buoyancy forces that may be resisted by the weight of the elevator structure or by installing rock anchors. EXP can provide comments and recommendations regarding rock anchors if required.

9.3 Additional Comments

All subsurface walls should be properly waterproofed.

10. Excavation and De-Watering Requirements

10.1 Excess Soil Management

A new Ontario Regulation 406/19 made under the Environmental Protection Act (November 28, 2019) was implemented as of January 1, 2021. The new regulation dictates the testing protocol that will be required for the management and disposal of excess soils. As set forth in the regulation, specific analytical testing protocols will need to be implemented and followed based on the volume of soil to be managed. 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.

10.2 Excavations

Excavations for the construction of the proposed building is expected to extend to a maximum depth of 4.0 m below the existing ground surface. These excavations will extend through the fill and into the glacial till and gravel and are anticipated to be approximately at or slightly above the groundwater level.

It is also noted that the existing structures present within the footprint of the proposed new building will need to be demolished and all construction debris removed off site to allow for the construction of the new building.

Excavations through the fill and into the glacial till may be undertaken by heavy equipment capable of removing cobble and boulder sizes within the glacial till.

Excavations above the groundwater level may be undertaken using conventional equipment and should be completed in accordance with the Occupational Health and Safety Act (OHSA), Ontario, Reg. 213/91. Based on the definitions provided in OHSA, the subsurface soils at the site are considered to be Type 3 soil. As per OHSA, the sidewalls of open cut excavations undertaken within Type 3 soil, must be sloped back at 1H:1V from the bottom of the excavation. Within zones of seepage, the excavation side slopes are expected to slough and eventually stabilize at 2H:1V to 3H:1V from the bottom of the excavation. Open cut excavations below the groundwater level are anticipated to be more problematic and will require the lowering the groundwater level prior to the start of excavation and construction activities as discussed in this section of the report.

If side slopes cannot be achieved due to space restrictions on site such as the proximity of open cut excavations to the property limits, existing infrastructure or to foundations of adjacent existing buildings the new building construction would have to be undertaken within the confines of an engineered support system (shoring system). The need for a shoring system, the most appropriate type of shoring system and the design and installation of the shoring system should be determined by the contractors bidding on this project. The design of the shoring system should be undertaken by a professional engineer experienced in shoring design and the installation of the shoring system should be undertaken by a contractor experienced in the installation of shoring systems. The shoring system should be designed and installed in accordance with latest edition of Ontario Regulation 213/91 under the OHSA and the 2006 Fourth Edition of the Canadian Foundation Engineering Manual (CFEM). For tiebacks that may be required to laterally support the shoring system and will extend onto neighboring properties, permission may need to be obtained from the neighboring property owners.

As previously indicated, it is anticipated that the base of the excavation for the footings and the elevator pit may undergo basal instability or base type failure in the form of piping or heave due to the groundwater level located at 0.3 m and 0.4 m below the footing and the presence of the permeable gravel which extends below the groundwater level. To prevent base type failure, it is recommended that the groundwater level should be lowered by at least 1.0 m below the depth of the excavation for the proposed building prior to start of excavation and construction activities. This may be achieved by installing deep sumps and pumping with high-capacity pumps or by the use of well points. A specialist dewatering contractor must be consulted for this purpose.

Alternatively, the excavation may be undertaken within the confines of a shoring system that is also designed to cut-off groundwater flows towards the excavation and minimize groundwater flows into the shored excavation. In this regard, seepage of groundwater into the shored excavation should still be anticipated but may be removed by collecting the water at low points within the excavation and pumping from sumps. In areas of high infiltration, a higher seepage rate should be anticipated and high-capacity pumps may be required to keep the excavation dry.

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

A pre-construction condition survey of buildings and infrastructure within the influence zone of the construction should be undertaken prior to start of construction activities including shoring installation activity.

It is recommended that vibration monitoring be conducted at the site and at adjacent existing buildings and infrastructure during the installation of the shoring system and during construction of the new building to ensure the existing structures and infrastructure are not damaged as a result of the construction activities and shoring installation.

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.

10.3 De-Watering Requirements

As discussed above, to prevent base type failure, it is recommended that the groundwater level should be lowered by at least 1.0 m below the depth of the excavation for the proposed building prior to start of excavation and construction activities. This may be achieved by installing a deep sumps and pumping with high-capacity pumps or by the use of well points. A specialist dewatering contractor must be consulted for this purpose.

Seepage of the surface and subsurface water into shored excavations is anticipated. However, it should be possible to collect water entering the excavations at low points and to remove it by conventional pumping techniques. In areas of high water infiltration or in areas where more permeable soils may exist, a higher seepage rate should be anticipated and may require high capacity pumps.

The dewatering of excavations on site during short-term construction operations is not expected to adversely impact adjacent existing structures and infrastructure.

It has been assumed that the maximum excavation depth at the site will be approximately 4.0 m below existing grade and would necessitate groundwater removal from the site. It is noteworthy to mention that legislation came into force in Ontario on March 29, 2016 to regulate groundwater takings for construction dewatering purposes. Prior

to March 29, 2016, a Category 2 Permit to Take Water (PTTW) was required from the Ontario Ministry of the Environment and Climate Change (MOECC) for groundwater takings related to construction dewatering, where taking volumes in excess of 50 m³/day, but less than 400 m³/day, and the taking duration was no more than 30 consecutive days. The new legislation replaces the Category 2 PTTW for construction dewatering with a new process under the Environmental Activity and Sector Registry (EASR). The EASR is an on-line registry, which allows persons engaged in prescribed activities, such as water takings, to register with the Ministry of Environment, Conservation and Parks (MECP) instead of applying for a PTTW.

To be eligible for the new EASR process, the construction dewatering taking must be less than 400 m³/day under normal conditions. The water taking can be groundwater, storm water, or a combination of both. It should be noted that the 30-consecutive day limit on the water taking under the old Category 2 PTTW process has been removed in the new EASR process. Also, it should be noted that the EASR process requires two technical studies be prepared by a Qualified Person, prior to any water taking. These studies include a Water Taking Report, which provides assurance that the taking will not cause any unacceptable impacts, and a Discharge Plan, which provides assurance that the discharge will not result in any adverse impacts to the environment. A significant advantage of the new EASR process over the former Category 2 PTTW process, is that the groundwater taking may begin immediately after completing the on-line registration of the taking and paying the applicable fee, assuming the accompanying technical studies have been completed. The former PTTW process typically took more than 90 days, which had the potential to impact construction schedules.

Although this investigation has estimated the groundwater levels at the time of the fieldwork, and commented on dewatering and general construction problems, conditions may be present which are difficult to establish from standard boring and excavating techniques and which may affect the type and nature of dewatering procedures used by the contractor in practice. These conditions include local and seasonal fluctuations in the groundwater table, erratic changes in the soil profile, thin layers of soil with large or small permeabilities compared with the soil mass, etc. Only carefully controlled tests using pumped wells and observation wells will yield the quantitative data on groundwater volumes and pressures that are necessary to adequately engineer construction dewatering systems.

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

The materials to be excavated from the site will consist of asphalt, topsoil, sand and gravel fill, clayey silt with sand and gravel fill, and glacial till. The excavated soils are not considered suitable for use under structural elements and for backfilling purposes and therefore must be also disposed of off-site or may be used in landscaped areas. However, subject to additional geotechnical testing at the start of construction, select portions of the glacial till (free of cobbles and boulders) above the groundwater level may be reused as backfill material outside the building.

It is anticipated that the majority of the material required for underfloor fill and backfilling purposes would have to be imported and should preferably conform to the following specifications:

- Engineered fill under the slab-on-grade area - OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent standard Proctor maximum dry density (SPMDD).
- Backfill against elevator pit walls and foundation walls outside the building – OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent of the SPMDD inside the building (elevator pit walls) and 95 percent SPMDD outside the building.
- Backfill in exterior services trenches – on-site approved excavated material or OPSS 1010 Select Subgrade Material (SSM) placed in 300 mm thick lifts and each lift compacted to 95 percent of the SPMDD.

12. Subsurface Concrete and Steel Requirements

Chemical tests limited to pH, sulphate, chloride and resistivity were undertaken on one (1) selected sample of the glacial till and a summary of the results is shown in Table VI. The laboratory certificate of analysis is attached in Appendix A.

Table VI: Corrosion Test Results on Soil Sample						
Borehole – Sample No.	Soil Type	Depth (m)	pH	Sulphate (%)	Chloride (%)	Resistivity (ohm-cm)
BH 1 – SS5	Glacial Till	3.8 – 4.4	8.39	0.0091	0.0033	4270

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 the glacial till is mildly corrosive to bare steel as per the National Association of Corrosion Engineers (NACE). Appropriate measures should be undertaken to protect the buried bare steel from corrosion.

Ottawa Carlton Construction Group
Geotechnical Investigation, Proposed Residential Building
224 Preston Street, City of Ottawa, ON
OTT-21019479-A0
February 8, 2022

13. General Comments

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes required to determine the localized underground conditions, between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for 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 borehole 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 and groundwater. 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 is satisfactory for your purposes. Should you have any questions, please contact this office.

Sincerely,



Matthew Zammit, P.Eng.
Geotechnical Engineer
Earth and Environment



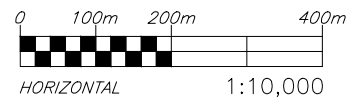
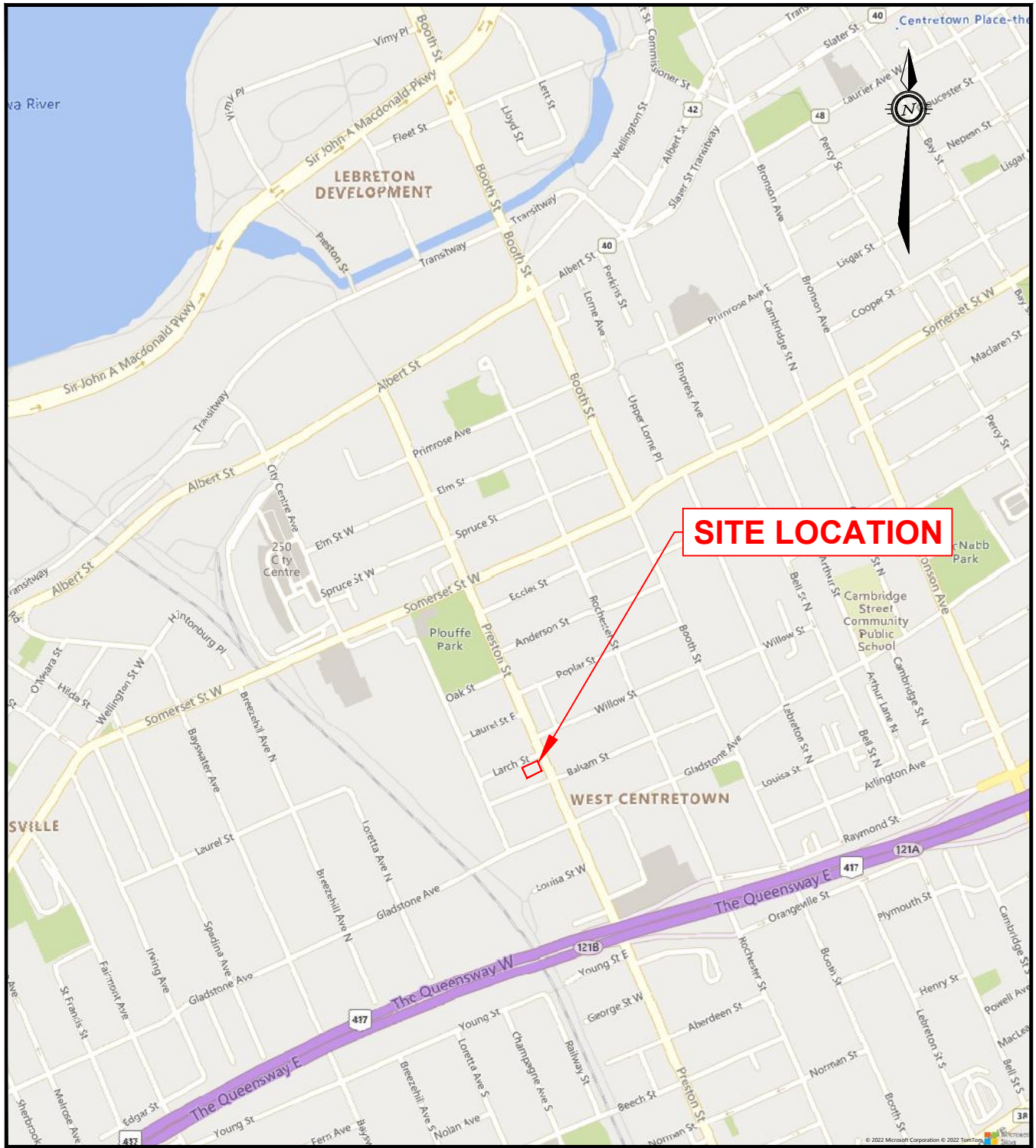
Susan M. Potyondy, P.Eng.
Senior Geotechnical Engineer
Earth and Environment

EXP Services Inc.

*Ottawa Carlton Construction Group
Geotechnical Investigation, Proposed Residential Building
224 Preston Street, City of Ottawa, ON
OTT-21019479-A0
February 8, 2022*

Figures

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exp Services Inc.
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 FILE NO OTT-21019479-A0

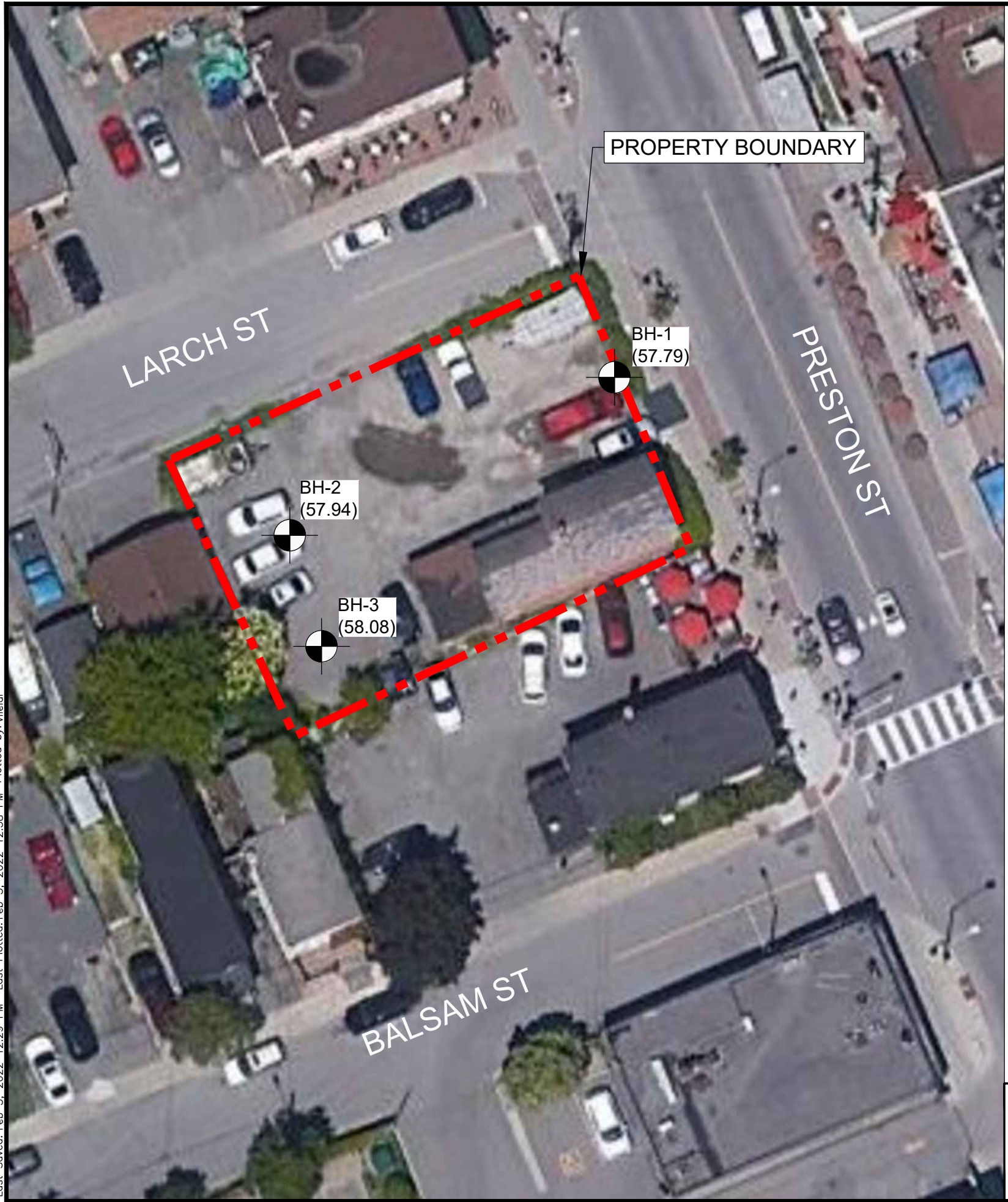
GEOTECHNICAL INVESTIGATION
 PROPOSED SIX STOREY RESIDENTIAL DEVELOPMENT
 224 PRESTON STREET, OTTAWA, ONTARIO

SCALE 1:10,000
 SKETCH NO

SITE LOCATION PLAN

FIG 1

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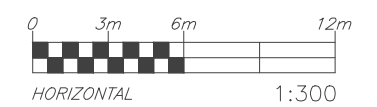


LEGEND

- PROPERTY BOUNDARY
- BOREHOLE LOCATION

NOTES:

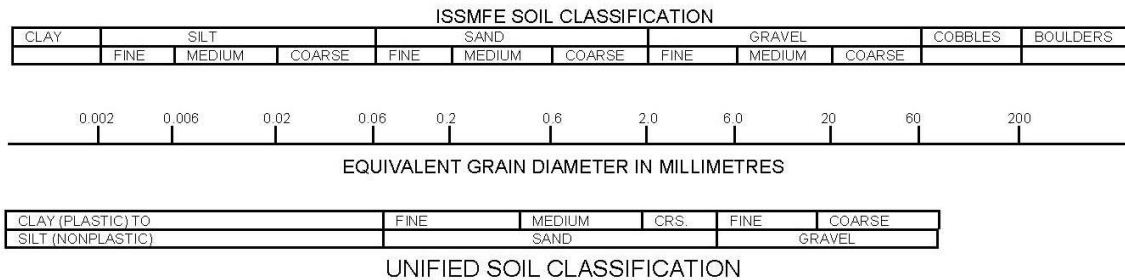
1. THE BOUNDARIES AND SOIL TYPES HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES THEY ARE ASSUMED AND MAY BE SUBJECT TO CONSIDERABLE ERROR.
2. SOIL SAMPLES WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.
3. ASPHALT AND TOPSOIL QUANTITIES SHOULD NOT BE ESTABLISHED FROM THE INFORMATION PROVIDED AT THE BOREHOLE LOCATIONS.
4. BOREHOLE ELEVATIONS SHOULD NOT BE USED TO DESIGN BUILDING(S) OR FLOOR SLABS OR PARKING LOTS GRADES.
5. THIS DRAWING FORMS PART OF THE REPORT PROJECT NUMBER AS REFERENCED AND SHOULD BE USED ONLY IN CONJUNCTION WITH THIS REPORT.



exp Services Inc. 100-2650 Queensview Drive Ottawa, ON K2B 8H6 www.exp.com		DESIGN I.T.	GEOTECHNICAL INVESTIGATION PROPOSED SIX STOREY RESIDENTIAL DEVELOPMENT 224 PRESTON STREET, OTTAWA, ONTARIO	SCALE 1:300
		DRAWN P.V.		SKETCH NO
		DATE JAN. 2022	BOREHOLE LOCATION PLAN	FIG 2
		FILE NO OTT-21019479-A0		

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-21019479-A0

Figure No. 3

Project: Proposed Six-Story Commercial and Residential Building

Page. 1 of 1

Location: 224 Preston Street, Ottawa, ON

Date Drilled: Dec 3, 2021

Split Spoon Sample

Combustible Vapour Reading

Drill Type: CME 55 Truck Mounted Drill Rig

Auger Sample

Natural Moisture Content

SPT (N) Value

Atterberg Limits

Datum: Geodetic Elevation

Dynamic Cone Test

Undrained Triaxial at

Shelby Tube

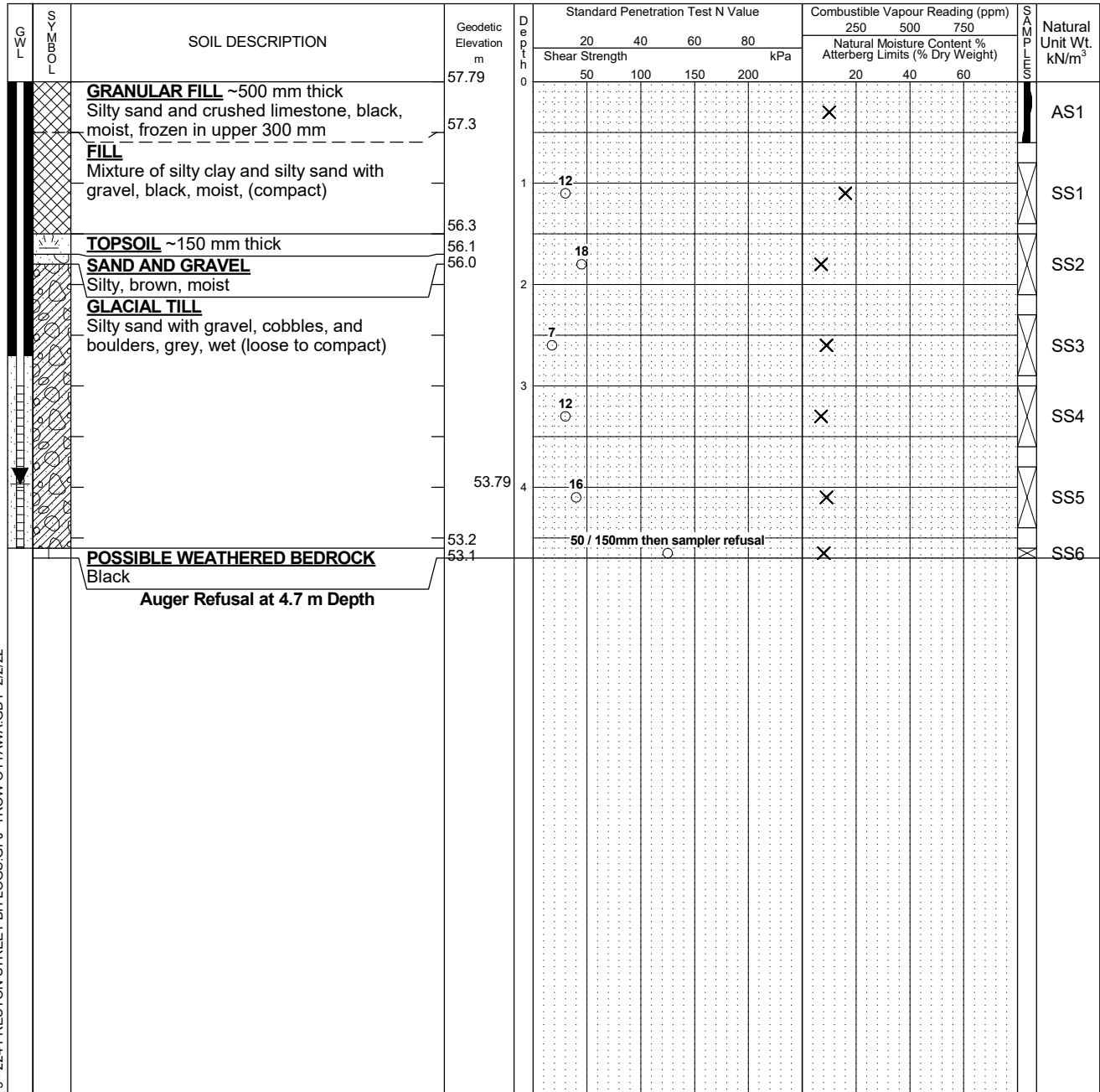
% Strain at Failure

Logged by: M.Z. Checked by: I.T.

Shear Strength by

Penetrometer Test

Vane Test



LOG OF BOREHOLE OTT-21019479 - 224 PRESTON STREET BH LOGS.GPJ TROW OTTAWA.GDT 2/2/22

- NOTES:
- Borehole data requires interpretation by EXP before use by others
 - A 32 mm diameter monitoring well installed as shown.
 - Field work supervised by an EXP representative.
 - See Notes on Sample Descriptions
 - Log to be read with EXP Report OTT-21019479-A0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Upon Completion	3.6	4.4
Dec 22, 2021	4.0	

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-02



Project No: OTT-21019479-A0

Figure No. 4

Project: Proposed Six-Story Commercial and Residential Building

Page. 1 of 1

Location: 224 Preston Street, Ottawa, ON

Date Drilled: Dec 11, 2021

Split Spoon Sample

Combustible Vapour Reading

Drill Type: CME 55 Truck Mounted Drill Rig

Auger Sample

Natural Moisture Content

SPT (N) Value

Atterberg Limits

Datum: Geodetic Elevation

Dynamic Cone Test

Undrained Triaxial at

Shelby Tube

% Strain at Failure

Logged by: M.Z. Checked by: I.T.

Shear Strength by Vane Test

Shear Strength by Penetrometer Test

G W L	SOIL DESCRIPTION	Geodetic Elevation m	Depth m	Standard Penetration Test N Value				Combustible Vapour Reading (ppm)			Natural Unit Wt. kN/m ³				
				Shear Strength kPa				250	500	750					
				20	40	60	80	Natural Moisture Content % Atterberg Limits (% Dry Weight)							
50	100	150	200	20	40	60									
	GRANULAR FILL Silty sand and gravel, brown, moist, (compact)	57.94	0								X				AS1
	FILL Mixture of silty clay and silty sand with gravel, brown, moist, (compact)	57.2	1	15							X				SS2
	GLACIAL TILL Silty sand with gravel, cobbles and boulders, grey, wet, (loose to dense)	56.5	2	7							X				SS3
	augers grinding from 2.3 m to 3.0 m depths		3								X				SS4
		54.5	4								X				SS5
	GRAVEL With silt and sand, brown, wet, (loose to compact)		5	9							X				SS6
		52.1	6												Run 1
	LIMESTONE BEDROCK Black	51.4													
	Borehole Terminated at 6.5 m Depth														

LOG OF BOREHOLE OTT-21019479 - 224 PRESTON STREET BH LOGS.GPJ TROW OTTAWA.GDT 2/2/22

- NOTES:
- Borehole data requires interpretation by EXP before use by others
 - Borehole backfilled upon completion of drilling.
 - Field work supervised by an EXP representative.
 - See Notes on Sample Descriptions
 - Log to be read with EXP Report OTT-21019479-A0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Upon Completion	-	-

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %
1	5.8 - 6.5	91	36

Log of Borehole BH-03



Project No: OTT-21019479-A0

Figure No. 5

Project: Proposed Six-Story Commercial and Residential Building

Page. 1 of 1

Location: 224 Preston Street, Ottawa, ON

Date Drilled: Dec 3/11, 2021

Split Spoon Sample

Combustible Vapour Reading

Drill Type: CME 55 Truck Mounted Drill Rig

Auger Sample

Natural Moisture Content

SPT (N) Value

Atterberg Limits

Datum: Geodetic Elevation

Dynamic Cone Test

Undrained Triaxial at

Shelby Tube

% Strain at Failure

Logged by: M.Z. Checked by: I.T.

Shear Strength by Vane Test

Shear Strength by Penetrometer Test

G W L	L O M E S	SOIL DESCRIPTION	Geodetic Elevation m	D e p t h	Standard Penetration Test N Value				Combustible Vapour Reading (ppm)			Natural Unit Wt. kN/m ³	
					Shear Strength				Natural Moisture Content % Atterberg Limits (% Dry Weight)				
					20	40	60	80	250	500	750		
		ASPHALTIC CONCRETE ~50 mm thick	58.08	0									
		GRANULAR FILL (BASE) ~350 mm thick	58.0										
		Sand with silt and gravel, dark brown, moist, FILL	57.7							X			AS1
		Mixture of silty clay and silty sand with gravel, brown, moist, (compact)		1	29					X			SS2
		GLACIAL TILL	56.6										
		Silty sand with gravel, cobbles and boulders, grey, moist, (compact to very dense)		2	21					X			SS3
					32					X			SS4
		becoming brown and wet below 3.0 m depth		3									
		augers grinding from 3.0 m to 3.8 m depths											
			54.1										
		GRAVEL	53.98	4	30					X			SS6
		Gravel with silt and sand, brown, wet, (compact to dense)											
				5	14					X			SS7
		Auger Refusal at 5.8 m Depth	52.3										

LOG OF BOREHOLE OTT-21019479 - 224 PRESTON STREET BH LOGS.GPJ TROW OTTAWA.GDT 2/2/22

- NOTES:
- Borehole data requires interpretation by EXP before use by others
 - A 32 mm diameter monitoring well installed as shown.
 - Field work supervised by an EXP representative.
 - See Notes on Sample Descriptions
 - Log to be read with EXP Report OTT-21019479-A0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Upon Completion	-	-
Dec 22, 2021	4.1	

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

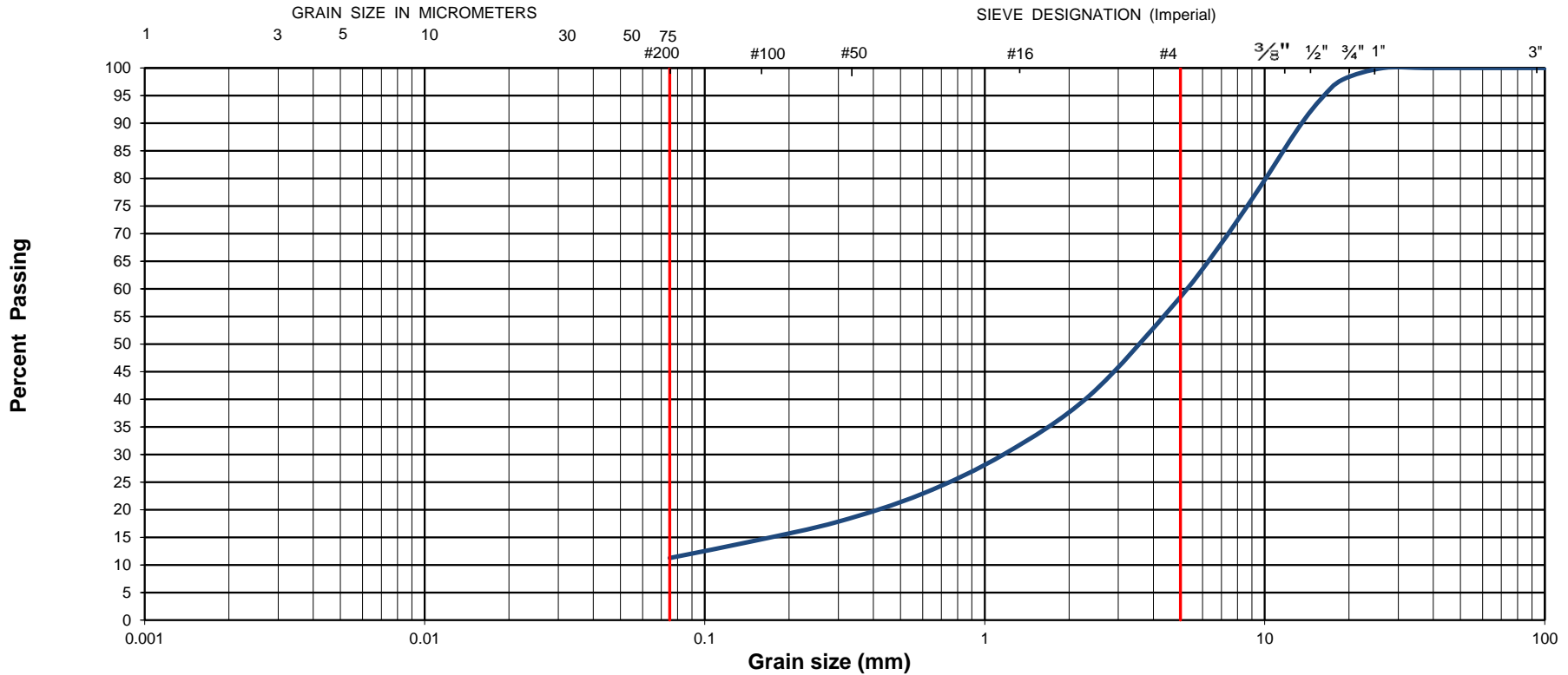


Grain-Size Distribution Curve Method of Test For Sieve Analysis of Aggregate ASTM C-136

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Unified Soil Classification System

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



EXP Project No.:	OTT-21019479-A0	Project Name :	Proposed Six Story Commercial and Residential Building			
Client :	Ottawa Carleton Construction Group	Project Location :	224 Preston Street, Ottawa, Ontario			
Date Sampled :	December 3, 2021	Borehole No:	BH3	Sample:	AS1	
Sample Composition :	Gravel (%)	43	Sand (%)	46	Silt & Clay (%)	11
Sample Description :	GRANULAR FILL (BASE): Poorly Graded Sand with Silt and Gravel (SP-SM)				Figure :	6

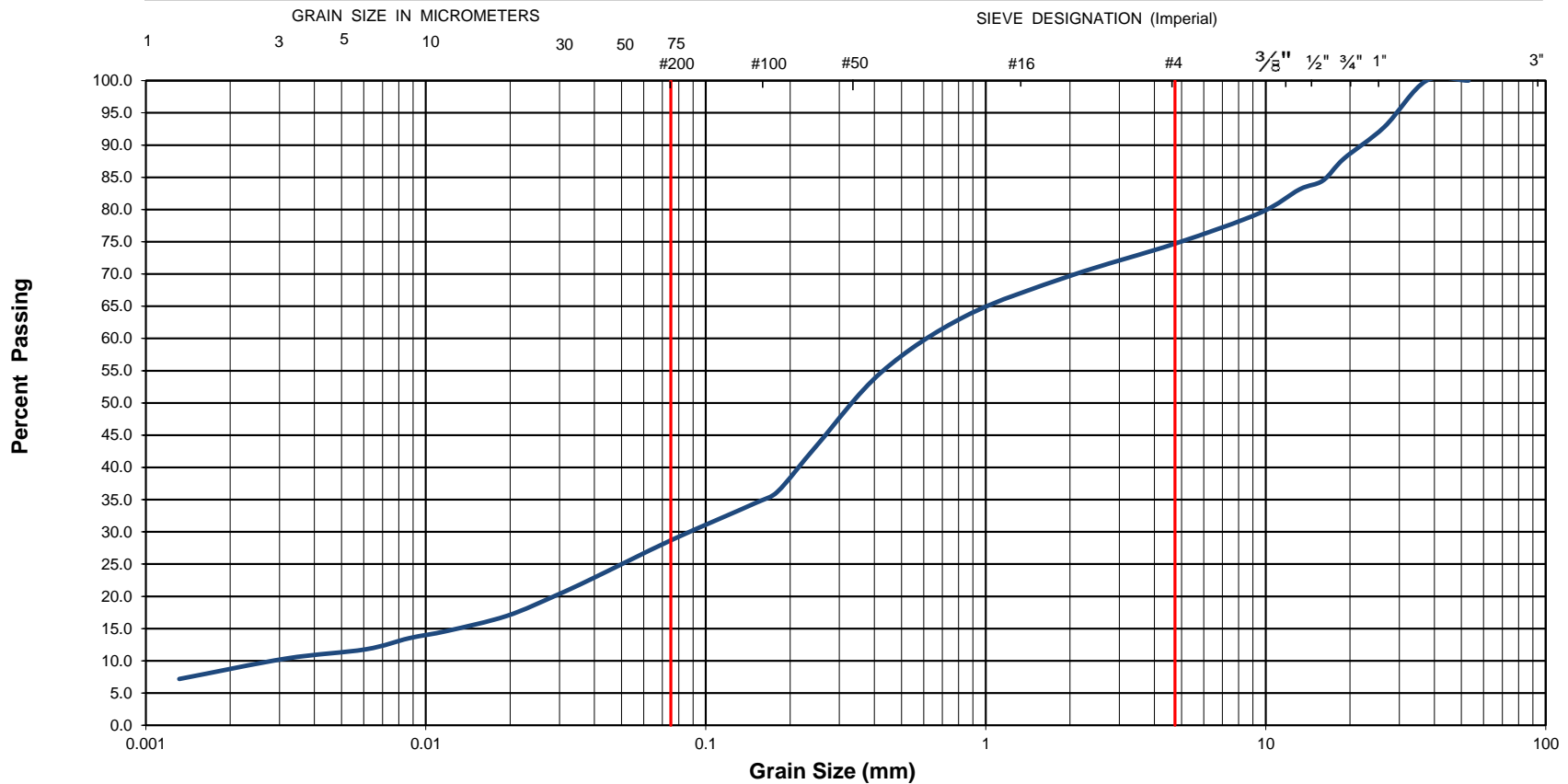


Grain-Size Distribution Curve Method of Test For Particle Size Analysis of Soil ASTM C-136/ASTM D422

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Unified Soil Classification System

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



EXP Project No.:	OTT-21019479-A0	Project Name :	Proposed Six Story Commercial and Residential Building				
Client :	Ottawa Carleton Construction Group	Project Location :	224 Preston Street, Ottawa, Ontario				
Date Sampled :	December 3, 2021	Borehole No:	BH1	Sample No.:	SS4	Depth (m) :	3.0-3.6
Sample Description :	% Silt and Clay	29	% Sand	46	% Gravel	25	Figure : 7
Sample Description :	GLACIAL TILL: Silty Sand with Gravel (SM)						

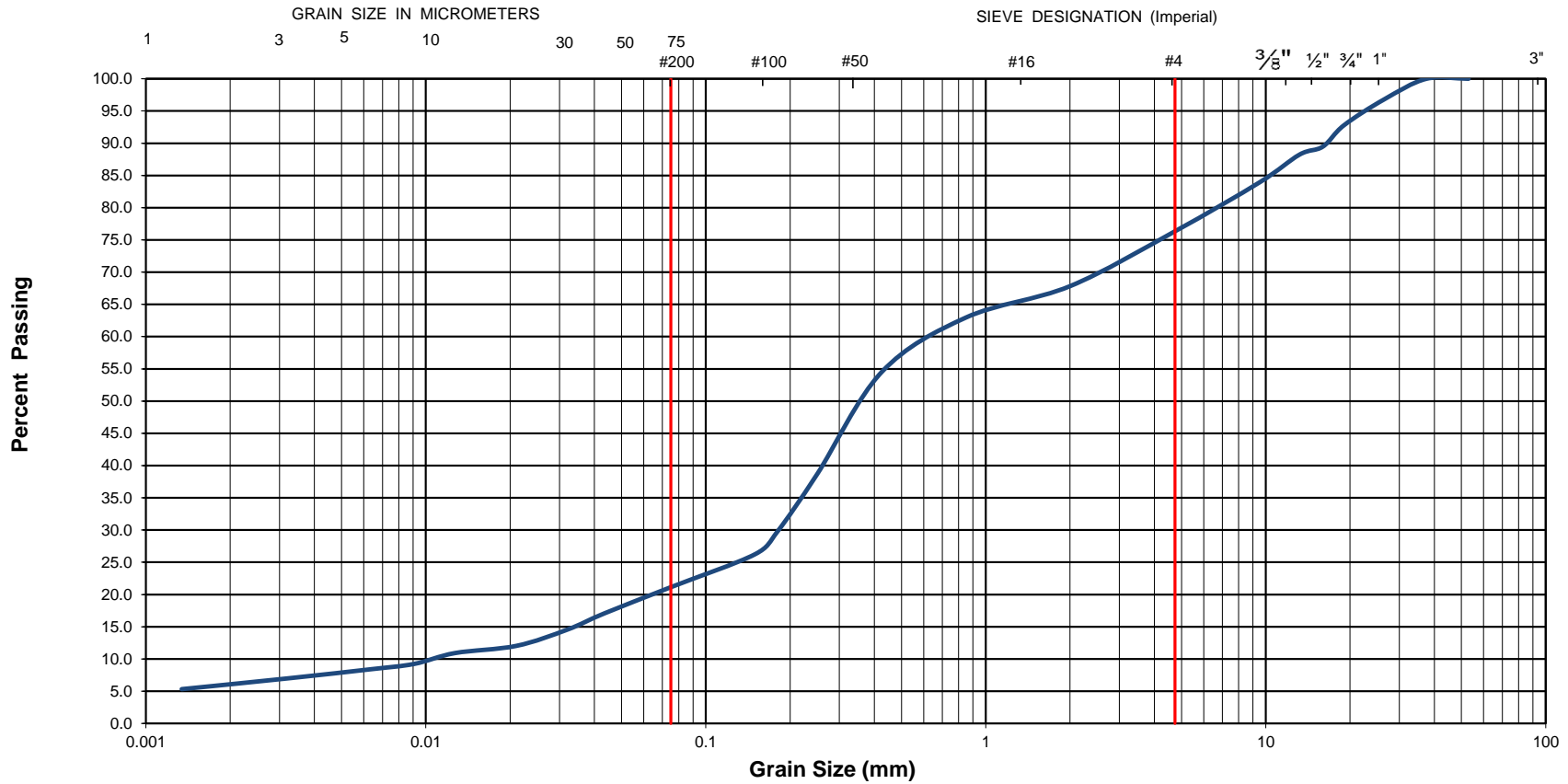


Grain-Size Distribution Curve Method of Test For Particle Size Analysis of Soil ASTM C-136/ASTM D422

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Unified Soil Classification System

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



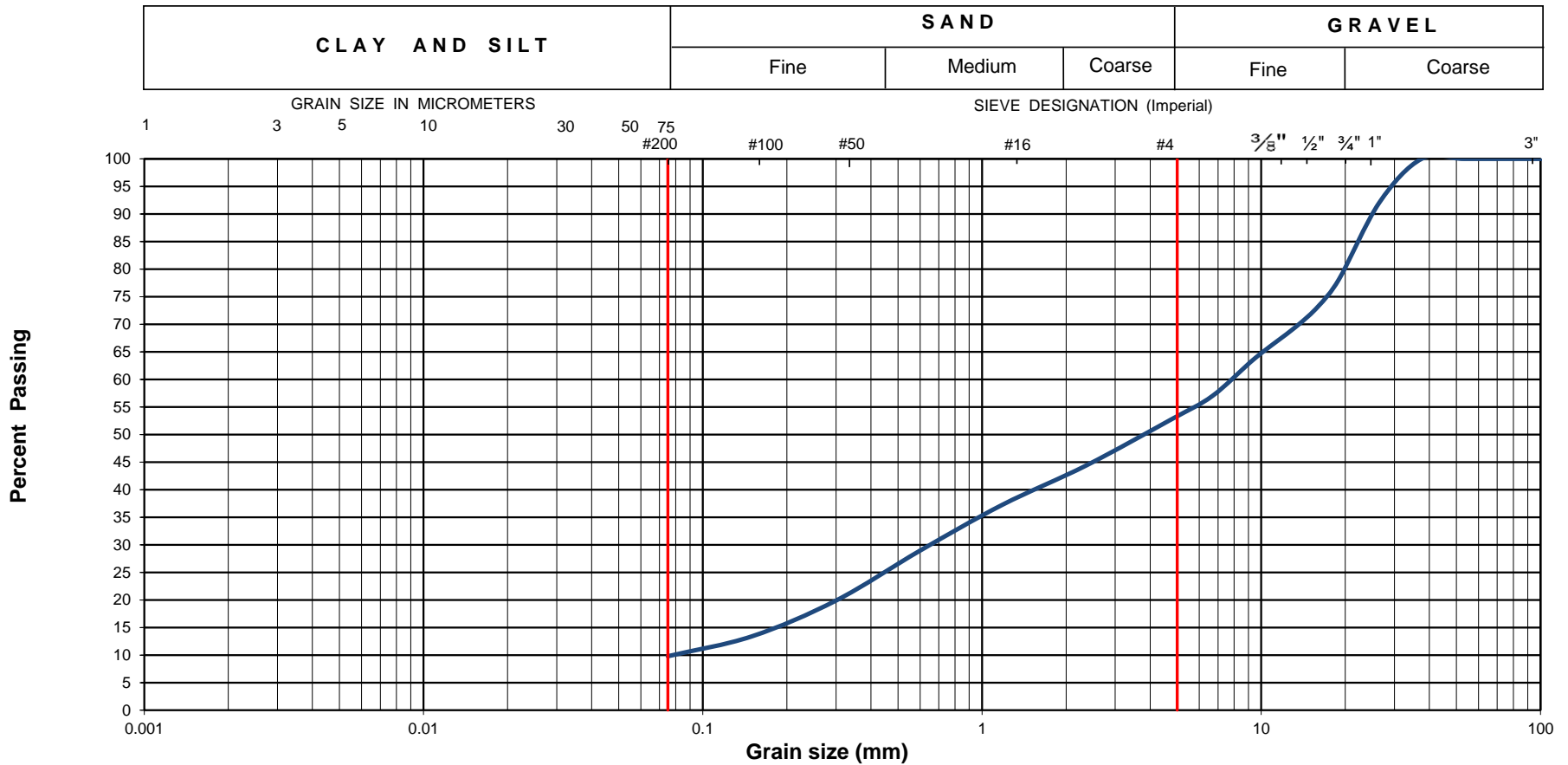
EXP Project No.:	OTT-21019479-A0	Project Name :	Proposed Six Story Commercial and Residential Building		
Client :	Ottawa Carleton Construction Group	Project Location :	224 Preston Street, Ottawa, Ontario		
Date Sampled :	December 3, 2021	Borehole No:	BH3	Sample No.: SS3	
		Depth (m) :	1.5-2.1		
Sample Description :	% Silt and Clay	21	% Sand	55	
			% Gravel	24	
Sample Description :	GLACIAL TILL: Silty Sand with Gravel (SM)			Figure :	8



Grain-Size Distribution Curve Method of Test For Sieve Analysis of Aggregate ASTM C-136

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Unified Soil Classification System



EXP Project No.:	OTT-21019479-A0	Project Name :	Proposed Six Story Commercial and Residential Building		
Client :	Ottawa Carleton Construction Group	Project Location :	224 Preston Street, Ottawa, Ontario		
Date Sampled :	December 11, 2021	Borehole No:	BH2	Sample: SS5	
Sample Composition :	Gravel (%)	47	Sand (%)	43	
Sample Description :	Poorly Graded Gravel with Silt and Sand (GP-GM)			Silt & Clay (%)	10
				Depth (m) :	3.8-4.4
				Figure :	9

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. BH2	core runs Run 1: 5.8 m - 6.5 m	project Location: 224 Preston Street, Ottawa, ON	project no. OTT-21019479-A0
date cored Dec 11, 2021		Rock Core Photographs	FIG 10

EXP Services Inc.

*Ottawa Carlton Construction Group
Geotechnical Investigation, Proposed Residential Building
224 Preston Street, City of Ottawa, ON
OTT-21019479-A0
February 8, 2022*

Appendix A: Laboratory Certificate of Analysis



CLIENT NAME: EXP SERVICES INC
2650 QUEENSVIEW DRIVE, UNIT 100
OTTAWA, ON K2B8H6
(613) 688-1899

ATTENTION TO: Matthew Zammit
PROJECT: OTT-21019479
AGAT WORK ORDER: 21Z845489

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Lab Manager
DATE REPORTED: Dec 24, 2021
PAGES (INCLUDING COVER): 5
VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

***Notes**

Disclaimer:

- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
- All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.
- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
- This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
- The test results reported herewith relate only to the samples as received by the laboratory.
- Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.
- All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.



Certificate of Analysis

AGAT WORK ORDER: 21Z845489

PROJECT: OTT-21019479

5835 COOPERS AVENUE
 MISSISSAUGA, ONTARIO
 CANADA L4Z 1Y2
 TEL (905)712-5100
 FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: EXP SERVICES INC
 SAMPLING SITE: 224 Preston St., Ottawa

ATTENTION TO: Matthew Zammit
 SAMPLED BY: EXP

Inorganic Chemistry (Soil)

DATE RECEIVED: 2021-12-16

DATE REPORTED: 2021-12-24

		SAMPLE DESCRIPTION: BH1 SS5 12.	
		5'-14.5'	
		Soil	
		2021-12-03	
Parameter	Unit	G / S	RDL
Chloride (2:1)	µg/g	2	33
Sulphate (2:1)	µg/g	2	91
pH (2:1)	pH Units	NA	8.39
Electrical Conductivity (2:1)	mS/cm	0.005	0.234
Resistivity (2:1) (Calculated)	ohm.cm	1	4270

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

3358461 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter. Analysis performed at AGAT Toronto (unless marked by *)

Certified By:



Quality Assurance

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 21Z845489

PROJECT: OTT-21019479

ATTENTION TO: Matthew Zammit

SAMPLING SITE: 224 Preston St., Ottawa

SAMPLED BY: EXP

Soil Analysis

RPT Date: Dec 24, 2021			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Inorganic Chemistry (Soil)

Chloride (2:1)	3358453		150	146	2.7%	< 2	99%	70%	130%	109%	80%	120%	106%	70%	130%
Sulphate (2:1)	3358453		6	6	NA	< 2	94%	70%	130%	105%	80%	120%	103%	70%	130%
pH (2:1)	3358453		7.15	7.19	0.6%	NA	100%	80%	120%	NA			NA		
Electrical Conductivity (2:1)	3347188		0.179	0.180	0.6%	< 0.005	104%	80%	120%	NA			NA		

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Duplicate NA: results are under 5X the RDL and will not be calculated.

Certified By:






Method Summary

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 21Z845489

PROJECT: OTT-21019479

ATTENTION TO: Matthew Zammit

SAMPLING SITE: 224 Preston St., Ottawa

SAMPLED BY: EXP

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	modified from EPA 9045D and MCKEAGUE 3.11	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	modified from MSA PART 3, CH 14 and SM 2510 B	EC METER
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B, SSA #5 Part 3	CALCULATION

EXP Services Inc.

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February 8, 2022*

Legal Notification

This report was prepared by EXP Services Inc. (EXP) for the account of Ottawa Carleton Construction Ltd.

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EXP Services Inc.

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Geotechnical Investigation, Proposed Residential Building
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Report Distribution

Fernando Matos, Ottawa Carleton Construction Ltd., fernando@ottawacarletonconstruction.com

Frank Pocari, Ottawa Carleton Construction Ltd., frank.pocari@ottawacarletonconstruction.com

