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Geotechnical Investigation
Proposed Residential Development
1240 Carling Avenue
Ottawa, Ontario

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Submitted to:

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Geotechnical Investigation Proposed Residential Development 1240 Carling Avenue

Ottawa, Ontario

February 10, 2023
Project: 100382.003

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February 10, 2023 File: 100382.003

S.J. Lawrence Architects Incorporated
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Attention: Amanda Lawrence, B.AS, M.Arch, OAA, MRAIC

Re: Geotechnical Investigation
Proposed Residential Development
1420 Carling Avenue
Ottawa, Ontario

Enclosed is our geotechnical investigation for the above noted project, in accordance with our proposal dated May 14, 2021. This report was prepared by Matthew Rainville, C.E.T., and reviewed by Bill Cavers, P.Eng.

Matthew Rainville, C.E.T.

Bill (William) Cavers, P.Eng.

MR/BC

Enclosures
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1.0 INTRODUCTION

This report presents the results of a geotechnical investigation carried out in support of a proposed residential development located at 1240 Carling Avenue in Ottawa, Ontario (hereinafter known as ‘the site’). The purpose of the investigation was to identify the general subsurface and groundwater conditions at the site by means of a limited number of boreholes. Based on the factual information obtained, preliminary engineering guidelines are provided on the geotechnical aspects of the design of the proposed development, including construction considerations that could influence design decisions.

This investigation was carried out in general accordance with our proposal dated May 14, 2021.

2.0 PROJECT AND SITE DESCRIPTION

2.1 Project Description

Plans are being prepared to construct a three-storey residential (apartment) building at the site. The following is known about the site and project:

- The site is located at the southeast corner of the intersection of Carling Avenue and Merivale Road;
- The site is currently occupied with a single family residential dwelling;
- The proposed residential building will be three stories above grade, with one basement level, and will have a footprint of about 250 square metres; and,
- The majority of the exterior areas around the proposed building will be landscaped with soft landscaping features (i.e., no parking areas or laneways) with the exception of one temporary parking/drop-off space.

2.2 Review of Geology Maps

Published geology maps indicate that the subsurface conditions at the site likely consist of deposits of silty clay over glacial till. Bedrock geology maps indicate that the site is underlain by limestone of the Gull River formation with the bedrock surface at depths ranging from about 5 to 10 metres.

3.0 SUBSURFACE INVESTIGATION

The fieldwork for this investigation was carried out on December 22, 2022 and January 4, 2023. During that time, two boreholes (numbered 22-01 and 23-02) were advanced at the approximate locations shown on the Borehole Location Plan (see Figure 1, attached).

Borehole 22-01 was advanced using a limited access hollow stem auger drill rig and borehole 23-02 was advanced using a truck mounted hollow stem auger drill rig; both supplied and operated by CCC Geotechnical and Environmental Drilling Ltd. of Ottawa, Ontario. Boreholes 22-01 and

23-02 were advanced to depths of about 3.9 and 7.4 metres below ground surface, respectively. Practical auger refusal was encountered in both boreholes. Borehole 23-02 was further advanced into the bedrock using rotary diamond drilling techniques while retrieving HQ sized core after encountering auger refusal.

Standard penetration tests were carried out in the boreholes and samples of the soils encountered were recovered using a 50 millimetre diameter drive open sampler. The standard penetration tests were carried out in general conformance with ASTM S2488.

A monitoring well was installed in borehole 23-02, to measure the groundwater levels. The groundwater level was measured on January 24, 2023.

One soil sample recovered from borehole 22-01 was sent to Paracel Laboratories Ltd. for basic chemical testing relating to corrosion of buried concrete and steel.

Following the borehole drilling fieldwork, the soil samples were returned to our laboratory for examination by the geotechnical engineer and for geotechnical laboratory testing. Selected samples of the soil were tested for Atterberg Limit, water content, and grain size distribution testing.

The results of the drilling are provided on the Record of Borehole sheets in Appendix A. The approximate locations of the boreholes are shown on the Borehole Location Plan, Figure 1. The results of the laboratory classification tests on the soil samples are provided on the Record of Borehole sheets and in Appendix B. Photographs of the bedrock core samples are provided in Appendix C. The results of the chemical analysis of a sample of soil relating to corrosion of buried concrete and steel are provided in Appendix D.

The borehole locations were selected by GEMTEC and positioned on the site relative to existing site features. The ground surface elevations at the borehole locations were determined using a Trimble R10 GPS. The elevations are referenced to geodetic datum NAD83 (CSRS) Epoch 2010, vertical network CGVD1928.

4.0 SUBSURFACE CONDITIONS

4.1 General

As previously indicated, the soil and groundwater conditions identified in the boreholes are given on the Record of Borehole Sheets (Appendix A). The logs indicate the subsurface conditions at the specific test locations only. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. The precision with which subsurface conditions are indicated depends on the method of drilling, the frequency and recovery of samples, the method of sampling, and the uniformity of the subsurface conditions. Subsurface conditions at other than the test locations may vary from the conditions encountered in the boreholes. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties.

The groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. These conditions may vary seasonally or because of construction activities in the area.

The soil descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves judgement and GEMTEC does not guarantee descriptions as exact but infers accuracy to the extent that is common in current geotechnical practice.

The following presents an overview of the subsurface conditions encountered in the boreholes advanced during this investigation.

4.2 Existing Pavement Structure

Borehole 22-01 was advanced through the existing at grade laneway at the site. The pavement structure consists of about 50 millimetres of asphaltic concrete over about 150 millimetres of sand and gravel base.

4.3 Topsoil

At borehole 23-02, a 100 millimetre thick layer of topsoil was encountered extending from the ground surface. The material can generally be described as dark brown silt with some sand and organic material, including pieces of wood.

4.4 Fill Material

Below the pavement structure at borehole 22-01 and the topsoil at borehole 23-02, fill material was encountered which extends to depths of about 1.4 to 1.5 metres below ground surface at those locations respectively (about elevations 74.8 and 74.9 metres). The color of the fill varies between grey brown, reddish brown and dark brown and in composition between silty sand and silty clay, with varying amounts of gravel and organic material, including pieces of wood.

4.5 Silty Clay (Weathered Crust)

Native deposits of silt to silty clay were encountered below the fill material at both boreholes. The full thickness of the silty clay encountered in the boreholes has been weathered to a grey brown crust. The silty clay extends to depths of about 2.4 and 2.7 metres below ground surface in boreholes 22-01 and 23-02, respectively (elevations of about 73.8 and 73.7 metres).

Standard penetration tests carried out in the weathered crust gave N values of 7 and 11 blows per 0.3 metres of penetration, which reflect a stiff to very stiff consistency. Silty clay with a blow count of greater than about 2 will generally have a shear strength of greater than 100 kilopascals, which is not measurable using a standard MTO N-vane. Therefore, it is conservative to assume a “stiff to very stiff” consistency in the weathered silty clay crust.

The results of Atterberg limit testing carried out on one sample of the weathered silty clay crust are provided on the Plasticity Chart in Appendix B and are summarized in Table 4.1. The Atterberg limit testing was carried out in general conformance with ASTM D4318.

Table 4.1 – Summary of Atterberg Limit Testing (Weathered Silty Clay)

Borehole	Sample Number	Sample Depth (metres)	Water Content (%)	LL (%)	PL (%)	PI (%)
23-02	4	2.3 – 2.8	24	24	14	11

The measured water contents of four samples of the weathered silty clay crust range from about 24 to 40 percent. The water content testing was carried out in general conformance with ASTM D4959.

4.6 Glacial Till

Native deposits of glacial till were encountered below the silty clay at both boreholes, at depths of about 2.4 and 2.7 metres below ground surface (elevation of about 73.7 metres). Refusal to further auger advancement was encountered in boreholes 22-01 and 23-02 at depths of about 3.9 and 5.4 metres below surface grade, respectively (elevations of about 72.3 and 71.0 metres). Borehole 22-01 was terminated at the noted refusal depth.

Glacial till is generally considered to be a heterogeneous mixture of all grain sizes, generally containing cobbles and boulders, and at this site can be described as grey brown to grey gravelly sand with trace silt, trace clay, likely containing cobbles and boulders.

Standard penetration tests carried out within the glacial till gave N values ranging from 28 to greater than 50 blows per 0.3 metres of penetration, which reflects a dense to very dense relative density. It is noted that the N values obtained in the glacial till from standard penetration testing may have been impacted by cobble and boulder obstructions.

Two grain size distribution tests were undertaken on samples of the glacial till. The results are provided in Appendix B and are summarized in Table 4.2. The grain size distribution testing was carried out in general conformance with ASTM D6913 and ASTM D7928.

Table 4.2 – Summary of Grain Size Distribution Test (Glacial Till)

Location	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
22-01	6	3.1 – 3.7	29	58	8	5
23-02	6	3.8 – 4.4	26	68	3	3

The moisture contents of samples of the glacial till range between about 5 to 22 percent. The water content testing was carried out in general conformance with ASTM D4959.

4.7 Bedrock

Grey limestone bedrock was encountered in borehole 23-02 at a depth of about 5.4 metres below ground surface (elevation of about 71.0 metres) and cored using rotary diamond drilling techniques while retrieving HQ sized bedrock core. The bedrock was cored to a depth of about 7.4 metres below ground surface (elevation of about 69.0 metres).

The recovered bedrock core samples have rock quality designation (RQD) values ranging from about 79 to 100 percent. Based on these values, the bedrock quality is considered to be good to excellent.

A photograph of the bedrock core is presented on Figure C1 in Appendix C.

4.8 Groundwater Levels

A monitoring well was installed in borehole 23-02 to measure stabilized groundwater conditions. Table 4.3 summarizes the groundwater level observed on January 24, 2023.

Table 4.3 – Summary of Groundwater Levels

Borehole	Well Screen	Ground Surface Elevation (metres)	Groundwater Depth (metres)	Groundwater Elevation (metres)
23-02	Glacial Till	76.4	2.2	74.2

It should be noted that the groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation.

4.9 Soil Chemistry Relating to Corrosion

The results of chemical testing on a soil sample recovered from borehole 22-01 are provided in Appendix D and are summarized in Table 4.4 below.

Table 4.4: Summary of Corrosion Testing

Parameter	Borehole 22-01 Sample No. 4
Chloride Content (µg/g)	118
Resistivity (Ohm.m)	25.0
pH	7.7
Sulphate Content (µg/g)	40

5.0 RECOMMENDATIONS

5.1 General

The information in the following sections is provided for the guidance of the design engineers and is intended for the design of this project only. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data as it affects their construction techniques, schedule, safety and equipment capabilities.

The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible surface and/or subsurface contamination resulting from previous uses or activities of this site or adjacent properties, and/or resulting from the introduction onto the site from materials from off site sources are outside the terms of reference for this report.

GEMTEC has conducted a Phase One Environmental Site Assessment for this property and the results of that are provided under separate cover.

5.2 Grade Raise Restrictions

The site is underlain by native deposits of stiff to very stiff weathered silty clay crust over glacial till. Based on the borehole information, there are no grade raise restrictions at this site, from a geotechnical perspective. The settlement due to compression of the native soils due to fill placement should be relatively small and should occur during or shortly after the fill placement.

5.3 Seismic Design of Proposed Structures

Based on the results of the investigation, it is anticipated that the proposed foundations will be supported on the stiff to very stiff weathered silty clay crust and/or glacial till or on a pad of engineered fill constructed on the noted overburden materials.

Based on Table 4.1.8.4.A. of the National Building Code of Canada, the seismic site class can be determined based on the Average Standard Penetration Resistance or the Soil Undrained Shear Strength from the borehole data. Based on the results of this investigation, it is our opinion that Site Class C may be used for the seismic design of the structures. It is pointed out that based on available shear wave velocity mapping, the site could potentially be classified as Site Class A or B, however, site specific testing would be required to confirm the higher site class. Multi Channel Analysis of Surface Waves (MASW), a non-intrusive geophysical test method could be considered for this purpose.

In GEMTEC's opinion, there is no potential for liquefaction of the overburden deposits at this site.

5.4 Foundation Excavation

The excavations for the proposed development will be carried out through the topsoil, fill material, and the weathered silty clay crust deposit, and possibly into the glacial till. The sides of the excavations should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, the weathered silt and clay can be classified as Type 2 and the glacial till above the groundwater level can be classified as Type 3 and, accordingly, allowance should be made for excavation side slopes of 1 horizontal to 1 vertical, or flatter, extending upwards from the bottom of the excavation.

In consideration of the anticipated depth of excavation for the proposed buildings and the assumed distance of the excavations relative to the adjacent properties, providing a 1 to 1 slope without encroaching within the neighboring property may not be feasible and therefore shoring of the excavation walls may be required. The shoring system should be designed to resist lateral earth pressures imposed on the wall from the weight of the retained soil and any other surcharge loads. The selection of the lateral earth pressures should be the responsibility of the contractor, who will also be responsible for the overall shoring design.

For adjacent existing structures founded on overburden, the proposed excavation should not encroach within a line extending downwards and outwards from the nearest edge of the existing foundations, at the founding level, at an inclination of 1 vertical to 1 horizontal. For adjacent existing structures founded on bedrock, the proposed excavation should not encroach within a line extending downwards and outwards from its existing foundations at an inclination of 2 vertical to 1 horizontal

The silty clay and glacial till deposits are very sensitive to disturbance from ponded water and construction traffic. Some disturbance and loosening of the subgrade materials could occur, and allowance should be made for subexcavation, as discussed further in the following sections of this report.

Depending on the depth of the excavation, in order to reduce subgrade disturbance, allowance could be made for a 50 to 75 millimetre thick mud mat of low strength concrete. The mud mat should be placed over the sensitive subgrade surface immediately after exposure and inspection.

5.5 Groundwater Management

The groundwater level on January 24, 2023, was measured to be about 2.2 metres below ground surface in borehole 23-02. The noted level may not represent the seasonal high groundwater level, nor future conditions, as the groundwater level will fluctuate seasonally and during periods of notable precipitation, as well as possibly due to construction activities in the area of the project.

To minimize, not eliminate, issues with temporary and long-term ground water control, the depth of excavation for the basement construction should be limited to about 0.5 metres above the highest measured groundwater level. This will also reduce the potential for disturbance of the more permeable deposits during construction.

Based on the construction details provided to date, the proposed underside of foundations is at about 2.8 metres below ground surface and therefore below the measured groundwater level. However, based on our experience, groundwater inflow from the silty clay and glacial till deposits into the excavations can likely be controlled by pumping from filtered sumps within the excavations. It is not expected that short term pumping during excavation will have any significant affect on nearby structures and services.

Suitable detention and filtration will be required before discharging water. The contractor should be required to submit an excavation and groundwater management plan for review. The discharge of pumped water must be carried-out following City of Ottawa ‘Sewer Use By-Law 2003-514’.

Depending on the depth of the excavations and the groundwater level at the time of construction, groundwater pumping may be required from within the excavations. Where the volume of pumped groundwater will exceed 50,00 litres per day, an Environmental Activity and Sector Registry (EASR) in accordance with Environmental Protection Act Part II will be required. Where the volume will exceed 400,000 litres per day, A ‘Permit to Take Water’ must be obtained from the Ministry of Environment, Conservation and Parks. Further details could be provided as the design progresses. Based on our understanding of the project requirements, we do not expect that the daily groundwater taking during construction will exceed 50,000 and, as such, an EASR or PTTW is likely not required. This recommendation could be reviewed by GEMTEC as the design progresses.

5.6 Foundation Design

Based on the results of the investigation, the proposed building can be founded on shallow foundations bearing on or within the native undisturbed weathered silty clay crust and/or glacial till deposits or a pad of compacted engineered fill overlying these materials.

The topsoil and fill material are considered to be highly compressible and should be removed from below any foundations and slabs on grade. Based on the plans provided, the proposed commercial building will be partially located within the footprint of the existing house on site. Fill material was encountered within the boreholes to a depth of about 1.5 metres below ground surface, however the fill surrounding the existing dwelling may extend to a greater depth. The existing foundation elements and fill material associated with the past construction of the house will need to be removed from the proposed building area.

In areas where the proposed founding level is above the level of the native soil, or where subexcavation of disturbed material or fill is required below proposed founding level, the grade could be raised with compacted granular material (engineered fill). The engineered fill should consist of granular material meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular A or Granular B Type II and should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density. To provide adequate spread of load beneath the footings, the engineered fill should extend horizontally at least 0.3 metres beyond the footings and then down and out from this point at 1 horizontal to 1 vertical, or flatter. The native soils at the site are not suitable for reuse as engineered fill for structures. Where groundwater flow is encountered, the excavation will need to be dewatered during placement of the engineered fill.

For design purposes, foundations of the proposed building should be sized using the bearing values provided in Table 5.1.

Table 5.1 - Foundation Bearing Values

Subgrade Material	Net Geotechnical Reaction at Serviceability Limit State[1] (kilopascals)	Factored Net Geotechnical Resistance at Ultimate Limit State (kilopascals)
Native Silty Clay	100	250
Glacial Till	150	300
Compacted Engineered Fill (overlying native silty clay and/or glacial till)	150	300
Bedrock	-	500

The post construction total and differential settlement of the footings at SLS should be less than 25 and 20 millimetres, respectively, provided that all loose or disturbed soil is removed from the bearing surfaces.

To reduce the potential for cracking in the footings, foundation walls, and concrete slab on grade where the footings transition between different subgrade materials, the foundation walls could be reinforced within the transition areas, as recommended by the structural engineer.

5.7 Frost Protection of Foundations

All exterior footings, adjacent to heated areas of the building, should be provided with at least 1.5 metres of earth cover for frost protection purposes. Isolated (unheated) footings, such as for piers, should be provided with at least 1.8 metres of earth cover for frost protection purposes. If the foundation and/or slab on grade are insulated in a manner that will reduce heat transfer (loss) to the surrounding soil, the frost protection requirements shall conform to that required for foundations for an unheated space. Alternatively, the required frost protection could be provided by means of a combination of earth cover and extruded polystyrene insulation. Where insulation will be placed below the foundations, the provided bearing pressure values for foundations may require adjustment. Further details regarding the insulation of foundations can be provided, upon request.

5.8 Foundation Wall Backfill and Drainage

5.8.1 Basement Foundation Walls

To avoid frost adhesion and possible heaving, the foundations should be backfilled with imported, free-draining, non-frost susceptible granular material such as that meeting the requirements of OPSS Granular A or Granular B Type I or II.

Where the backfill will ultimately support areas of hard surfacing (pavement, sidewalks or other similar surfaces), the backfill should be placed in maximum 200 millimetre thick lifts and should be compacted to at least 95 percent of the standard Proctor maximum dry density value using suitable vibratory compaction equipment. Light walk behind compaction equipment should be used next to the foundation walls to avoid excessive compaction induced stress on the foundation walls. Where future landscaped areas will exist next to the proposed structures and if some settlement of the backfill is acceptable, the backfill could be compacted to at least 90 percent of the standard Proctor maximum dry density value.

Where areas of proposed hard surfacing (concrete, sidewalks, pavement, etc.) will abut the proposed structures, a gradual transition should be provided between those areas of hard surfacing underlain by non-frost susceptible granular wall backfill and those areas underlain by existing frost susceptible fill material to reduce the effects of differential frost heaving. To reduce the magnitude of differential frost induced heaving of the hard surfacing, it is suggested that granular frost tapers be constructed from 1.5 metres below finished grade to the underside of the granular subbase material for the hard surfaced areas. The frost tapers should be sloped at 3 horizontal to 1 vertical, or flatter.

The native deposits at this site are frost susceptible, however could be considered for foundation wall backfill purposes in soft-landscaped areas (where movement and settlement of the backfill will be tolerable) provided that a suitable bond break is applied to the surface of the foundations to prevent frost jacking. A suitable bond break could consist of at least 2 layers of 6 MIL polyethylene sheeting or a proprietary plastic drainage medium. It is also pointed out that the native soils at this site can be impacted by changes in moisture content and this could affect the ability to compact this material to the required density.

A suitable drainage system for the foundation wall backfill and associated foundations should be provided and ultimately outlet by gravity to an adjacent storm sewer.

5.8.2 Isolated Piers

The backfill against isolated (unheated) walls or piers should consist of free draining, non-frost susceptible material, such as sand or sand and gravel meeting OPSS Granular B Type I or II requirements. The backfill material should be placed and compacted as described in the preceding section. Other measures to prevent frost jacking of these foundation elements could be provided, if desired.

5.8.3 Lateral Earth Pressures

Foundation walls that are backfilled with granular material, such as that meeting OPSS Granular B Type I or II requirements, should be designed to resist “at rest” earth pressures calculated using the following formula:

$P_o = 0.5\ K_o\ \gamma\ H^2$

where;

- P_o: Static "At Rest" thrust (kN/m)
- γ: Moist material unit weight (kN/m^3)
- K_o: "At Rest" earth pressure coefficient
- H: Wall height (m)

Seismic shaking can increase the forces on the retaining wall. The total "At Rest" thrust acting on the walls (P_{oe}) during a seismic event is composed of a static component (P_o) and a dynamic component (P_e), that is:

$P_{oe} = P_o + P_e$

The dynamic thrust component (P_e), which acts only during seismic loading conditions, should be calculated using the following formula:

$P_e = 0.5\ (K_{ae} – K_a)\ \gamma\ H^2$

where;

- P_e: Dynamic thrust (kN/m)
- γ: Moist material unit weight (kN/m^3)
- K_a "Active" Earth Pressure Coefficient
- K_{ae}: Dynamic earth pressure coefficient
- H: Wall height (m)

The static thrust component (P_o) acts at a point located H/3 above the base of the wall. During seismic shaking, the dynamic at rest thrust component (P_e) acts at a point located about 0.6H above the base of the wall.

For design purposes, the parameters provided in Table 5.2 can be used to calculate the thrust acting on the walls during static and seismic loading conditions.

Table 5.2 – Summary of Design Parameters (Building Foundation Walls)

Parameter	OPSS Granular B Type I	OPSS Granular B Type II
Material Unit Weight, γ (kN/m^3)	22	22
Estimated Friction Angle (degrees)	34	38

Parameter	OPSS Granular B Type I	OPSS Granular B Type II
“At Rest” Earth Pressure Coefficient, K_o, assuming horizontal backfill behind the structure	0.44	0.38
Active Earth Pressure Coefficient, K_a, assuming horizontal backfill behind the structure	0.28	0.24
Dynamic Earth Pressure Coefficient, K_{ae}, assuming horizontal backfill behind the structure	0.48[1]	0.38[1]

Notes:

1) According to the 2015 National Building Code of Canada, the peak ground acceleration (PGA) for this site is 0.28 for Site Class C. The dynamic earth pressure coefficient was calculated using the method suggested by Mononobe and Okabe, assuming a horizontal seismic coefficient (kh) of 0.28 (based on a non-yielding wall) and a vertical seismic coefficient (kv) is zero.

Heavy construction traffic should not be allowed to operate adjacent to foundation walls for the proposed building (within about 2 metres horizontal) during construction, without the approval of the designers.

5.9 Basement Floor Slab

As discussed, the proposed building will be partially or fully located within the footprint of the existing house and, as such, fill material associated with the construction of the existing house should be anticipated below the proposed slab on grade. To provide predictable settlement performance of basement slab, all topsoil, fill material or debris, and disturbed native soil should be removed from the slab area.

The base of the floor slab should consist of at least 200 millimetres of 19 millimetre clear crushed stone. Any necessary grade raise fill below the under slab clear stone base should consist of either 19 millimetre clear crushed stone or OPSS Granular B Type II. OPSS documents allow recycled asphaltic concrete and concrete to be used in Granular B Type II material. Since the source of recycled material cannot be determined or controlled, it is suggested that any imported Granular B Type II materials be composed of 100 percent crushed rock only.

It is recommended that a non-woven geotextile separator be placed between the subgrade surface and the imported clear stone so as to reduce the potential for the finer native subgrade soils to migrate into the voids of the clear stone which could cause settlement and voids to form beneath the floor slabs.

The clear crushed stone should be nominally compacted in maximum 300 millimetre thick lifts with at least 2 passes of a diesel plate compactor. The Granular B Type II should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density value using suitable vibratory compaction equipment.

A polyethylene vapour retarder is recommended below the floor slabs.

Underfloor drainage should be provided below the basement floor slab. If OPSS Granular B Type II is used below the basement floor slab, we suggest that drainage be provided by means of installing plastic perforated pipes within the granular material, at adequate spacing, and to link any hydraulically isolated areas in the basement. The drains should outlet by gravity to a storm sewer. If clear crushed stone is used below the basement floor slab, drains are not considered essential provided that the clear stone can outlet to a suitable location and ultimately to the storm sewer.

The ACI 302.1R-04 “Guide for Concrete Floor and Slab Construction” should be referenced for design purposes.

5.10 Proposed Services

5.10.1 Excavation

The excavations for the site services will be carried out through topsoil, fill material, silty clay, and glacial till, and possibly into the bedrock. As well, the excavations will likely extend below the level of the groundwater.

5.10.1.1 Overburden Excavation

In the overburden, the excavation for flexible service pipes should be in accordance with Ontario Provincial Standard Drawing (OPSD) 802.010 for Type 3 soil. The excavation for rigid service pipes should be in accordance with OPSD 802.031 for Type 3 soil.

The sides of the excavations within overburden soils should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, the soils at this site above the groundwater level can be classified as Type 2 or Type 3 soils. The glacial till below the groundwater level would be classified as Type 4 soils, unless the water level is lowered in advance of excavation. Therefore, for design purposes and assuming adequate construction dewatering, allowance may be made for 1 horizontal to 1 vertical, or flatter, excavation slopes. As an alternative or where space constraints dictate, the service installations could be carried out within a tightly fitting, braced steel trench box, which is specifically designed for this purpose.

Excavation of the native overburden deposits above the groundwater level should not present significant constraints. Below the groundwater level, sloughing of the glacial till into the excavation should be anticipated along with disturbance to the soils in the bottom of the excavation (e.g. basal instability) unless the excavations are dewatered.

Saturated deposits of silty clay and glacial till will likely be encountered at subgrade level along the proposed service alignments. These deposits are susceptible to weakening under vibration and/or repeated loading which could cause disturbance to the subgrade. We recommend that a contingency allowance be made in the contract for a 300 millimetre thick subbedding layer of OPSS Granular B Type II granular material and a woven geotextile separator meeting OPSS 1860 Class I requirements in the event that the subgrade soils are disturbed during construction.

Given the to the bedrock below ground surface, it is GEMETEC's opinion that the excavations will have an adequate factor of safety (i.e., greater than 2) against basal instability.

5.10.1.2 Bedrock Excavation

Bedrock was encountered and confirmed at borehole 23-02 at a depth of about 5.4 metres below existing grade (elevation 71.0 metres). Refusal to further augering was encountered at borehole 22-01 at a depth of about 3.9 metres below existing grade (elevation 72.3 metres) which could be due to the bedrock surface, although this has not been verified. As well, bedrock could be higher at other locations of the site. As such, it is possible that some bedrock excavation may be required for the installation of the site services.

In consideration that the bedrock at the project site consists of limestone, localized bedrock removal could be carried out using hoe ramming techniques in conjunction with line drilling on close centres, drilling and blasting, or a combination of both. Provided that good bedrock excavation techniques are used, the bedrock could be excavated using near vertical side walls. Any loose bedrock should be scaled from the sides of the excavation.

Any blasting should be carried out under the supervision of a blasting specialist engineer. Monitoring of the hoe-ramming and blasting should be carried out to ensure that the operations meet the allowable threshold values. Pre-construction condition surveys of nearby structures and existing buried services are recommended.

The bedrock may contain numerous irregular discontinuities. As such, overbreak and underbreak should be expected during removal.

5.10.2 Groundwater Management

As indicated, the excavations for the proposed services will potentially be below the measured groundwater level. However, based on our experience, groundwater inflow from the silty clay and glacial till deposits into the excavations can likely be controlled by pumping from filtered sumps within the excavations. It is not expected that short term pumping during excavation will have any significant affect on nearby structures and services.

Suitable detention and filtration will be required before discharging water. The contractor should be required to submit an excavation and groundwater management plan for review. The discharge of pumped water must be carried-out following City of Ottawa 'Sewer Use By-Law 2003-514'.

Depending on the depth of the excavations and the groundwater level at the time of construction, groundwater pumping may be required from within the excavations. Where the volume of pumped groundwater will exceed 50,00 litres per day, an Environmental Activity and Sector Registry (EASR) in accordance with Environmental Protection Act Part II will be required. Where the volume will exceed 400,000 litres per day, A 'Permit to Take Water' must be obtained from the Ministry of Environment, Conservation and Parks. Further details could be provided as the design progresses. Based on our understanding of the project requirements, we do not expect that the daily groundwater taking during construction will exceed 50,000 and, as such, an EASR or PTTW is likely not required. This recommendation could be reviewed by GEMTEC as the design progresses.

5.10.3 Bedding and Cover

The bedding and cover for the proposed utilities should consist of least 150 millimetres and 300 millimetres, respectively, of compacted OPSS Granular A backfill placed in accordance with the applicable Ontario Standard Drawings (OPSD) for the type of underground utility installed. The use of 19 millimetre clear stone is not recommended as bedding or cover.

The native silty clay and glacial till deposits below the groundwater level are sensitive to disturbance. An allowance should be made for sub-bedding composed of at least 300 millimetres of compacted OPSS Granular B Type II where disturbed materials are encountered at subgrade level below the pipe. To provide adequate support for the pipes in the long term in areas where subexcavation of material is required below design subgrade level, the excavations should be sized to allow a 1 horizontal to 1 vertical spread of granular material down and out from the bottom of the pipes.

Subbedding, bedding, and cover materials should be placed in lifts not exceeding 200 millimetres thick and compacted to at least 98 percent of standard Proctor density (ASTM D698).

5.10.4 Trench Backfill

In areas where service trenches will be located below or in close proximity to existing or future areas of hard surfacing (i.e., access roadways and parking), acceptable native materials should be used as backfill between the hard surfaced area subgrade level and the depth of seasonal frost penetration in order to reduce the potential for differential frost heaving between the area over the trench and the adjacent hard surfaced area. The design depth of frost penetration in exposed areas is indicated to be 1.8 metres below finished grade. Where native backfill is used, it should match the native materials exposed on the trench walls. Backfill below the zone of seasonal frost penetration could consist of either acceptable native material or imported granular material conforming to OPSS Granular B Type I.

It is anticipated that most of the inorganic overburden materials encountered during the subsurface investigation will be acceptable for reuse as trench backfill. Topsoil, fill material, or other organic material should be wasted from the trench.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the roadways, curbs, driveways, etc., the trench backfill should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value. The specified density for compaction of the backfill materials may be reduced where the trench backfill is not located below or in close proximity to existing or future areas of hard surfacing and/or structures, provided that some settlement above the trench is acceptable.

Depending on the weather conditions at the time of construction, some wetting of the excavated native materials could occur. Where used in such a condition, some settlement should be expected. Alternatively, consideration could be given to implementing one or a combination of the following measures to reduce post construction settlement above the trenches, depending on the weather conditions encountered during the construction:

- Allow the overburden materials to dry prior to placement and compaction;
- Reuse any wet materials in the lower part of the trenches and make provision to defer installation of hard surfacing for 3 months, or longer, to allow the trench backfill settlement to occur followed by additional compaction and levelling, thereby improving the final performance of the hard surfaced area.

5.11 Seepage Barriers

Given the anticipated, relatively short length of the services to be installed between the proposed structure and the property line, it is the opinion of GEMTEC that the installation of seepage barrier along the installation alignment is not warranted.

5.12 Laneway/Parking Area

5.12.1 Subgrade Preparation

In preparation for construction of the single parking space proposed at the site, all surficial topsoil, fill material, and any soft, wet or deleterious materials should be removed from the proposed parking. Any subexcavated areas could be filled with compacted earth borrow. Similarly, should it be necessary to raise the roadway grades at this site, material which meets OPSS specifications for Select Subgrade Material or Earth Borrow could be used. The Select Subgrade Material or Earth Borrow should be placed in maximum 300 millimetre thick lifts and compacted to at least 95 percent of the standard Proctor maximum dry density value using vibratory compaction equipment. Prior to placing granular material for the roadway, the exposed subgrade should be heavily proof rolled and inspected and approved by geotechnical personnel. Any soft areas evident from the proof rolling should be subexcavated and replaced with suitable earth borrow approved by the geotechnical engineer.

Truck traffic should be avoided on the native soil subgrade or the trench backfill within the parking space area, especially under wet conditions.

5.12.2 Pavement Structure

For the parking area to be used by light vehicles (cars, etc.), the following minimum pavement structure is recommended:

- 80 millimetres of hot mix asphaltic concrete (Two 40 millimetre lifts of Superpave 12.5), over
- 150 millimetres of OPSS Granular A base, over
- 300 millimetres of OPSS Granular B, Type II subbase

For a parking area to be used by heavy truck traffic, the recommended minimum pavement structure is:

- 100 millimetres of hot mix asphaltic concrete (40 millimetres of Superpave 12.5 over 60 millimetres of Superpave 19.0), over
- 150 millimetres of OPSS Granular A base, over
- 450 millimetres of OPSS Granular B, Type II subbase

The above pavement structures assume that the access roadway and parking lot subgrade surfaces are prepared as described in this report. If the subgrade surfaces become disturbed or wetted due to construction operations or precipitation, the granular subbase thicknesses given above may not be adequate and it may be necessary to increase the thickness of the subbase and/or to incorporate a woven geotextile separator between the subgrade surfaces and the granular subbase material. The adequacy of the design pavement thicknesses should be assessed by geotechnical personnel at the time of construction.

5.12.3 Granular Material Placement

The pavement granular materials should be compacted in maximum 300 millimetre thick lifts to at least 99 percent of standard Proctor maximum dry density using suitable vibratory compaction equipment.

5.12.4 Asphalt Cement Type

Performance grade PG 58-34 asphalt cement should be specified for Superpave asphaltic concrete mixes.

5.12.5 Transition Treatments

In areas where the new pavement structure will abut existing pavements, the depths of the granular materials should taper up or down at 5 horizontal to 1 vertical, or flatter, to match the depths of the granular material(s) exposed in the existing pavement.

5.12.6 Pavement Drainage

Adequate drainage of the pavement granular materials and subgrade is important for the long term performance of the pavement at this site. The subgrade surfaces should be crowned and shaped to drain to the ditches and/or catch basins to promote drainage of the pavement granular materials.

5.13 Corrosion of Buried Concrete and Steel

The measured sulphate concentration in the sample of soil recovered from borehole 22-01 was 40 micrograms per gram. According to Canadian Standards Association (CSA) "Concrete Materials and Methods of Concrete Construction", the concentration of sulphate can be classified as low. Therefore any concrete in contact with the native soil could be batched with General Use (GU) cement. The effects of freeze thaw in the presence of de-icing chemical (sodium chloride) use on the roadway should be considered in selecting the air entrainment and the concrete mix proportions for any concrete.

Based on the resistivity and pH of the sample, the soil in this area can be classified as non-aggressive towards unprotected steel. It should be noted that the corrosivity of the soil or groundwater could vary throughout the year due to the application sodium chloride for de-icing.

6.0 ADDITIONAL CONSIDERATIONS

6.1 Sensitive Marine Clay – Effects of Trees

The site is underlain by silty clay, a material which may be susceptible to shrinkage with a change/reduction in moisture content. Research by the Institute for Research in Construction (formerly the Division of Building Research) of the National Research Council of Canada has shown that trees can cause a reduction of moisture content in the silty clays in the Ottawa area, which can result in significant settlement/damage to nearby buildings supported on shallow foundations, or hard surfaced areas.

At this site, based on the design founding elevations, the building footings will be supported on glacial till and restrictions on tree planting are not required, from a geotechnical perspective.

6.2 Effects of Construction Induced Vibration

Some of the construction operations (such as excavation, granular material compaction, etc.) will cause ground vibration on and off the site. The vibrations will attenuate with distance from the source but may be felt at nearby structures. Assuming that any excavating is carried out in accordance with the guidelines in this report, the magnitude of the vibrations will be much less than that required to cause damage to the nearby structures or services in good condition but may be felt at the nearby structures.

6.3 Existing Underground services

The structures and service trenches are proposed to be installed in or near areas where existing underground utilities may be present.

Where a trench box is used, some unavoidable inward horizontal movement and settlement of the ground behind the trench box should be anticipated, which could affect existing services (and structure foundations) located behind the trench box, should the excavation extend below the level of the services.

To reduce the risk of impact to existing underground services, it is recommended that the excavations do not encroach within a line extending downwards and outwards at an inclination of 1 vertical to 2 horizontal from the base of the existing services (or edge of structural foundations). Where this is not possible, a detailed assessment by the geotechnical engineer is recommended.

It is recommended that an assessment be carried out in regards to the position of any existing services that are sensitive to movement within the above limits, and the tolerable limits of movement for the services be established in advance of construction. The contractor should be required to clearly identify the proposed method of maintaining movements below the tolerable limits, and the actions to be carried out should movements approach the limits.

6.4 Winter Construction

The native soils that exist at this site are considered to be frost susceptible and prone to ice lensing. In the event that construction is required during freezing temperatures, the soil within excavations (e.g., for foundations, service trenches, and paved areas) should be protected immediately from freezing using straw, propane heaters and insulated tarpaulins, or other suitable means.

Any service trenches should be opened for as short a time as practicable and the excavations should be carried out only in lengths which allow all the construction operations, including backfilling, to be fully completed in one working day. The materials on the sides of the trenches should not be allowed to freeze. In addition, the backfill should be excavated, stored, and replaced without being disturbed by frost or contaminated by snow or ice.

6.5 Monitoring Well Abandonment

The monitoring well installed as part of this investigation should be decommissioned by a licensed well technician. The well abandonment could be carried out in advance of or during construction.

6.6 Potential for Contaminated Conditions

It is noted that the professional services retained for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible surface and/or subsurface contamination, including naturally occurring sources of contamination, are outside the terms of reference for this report.

6.7 Excess Soil Management Plan

This report does not constitute an excess soil management plan. The disposal requirements for excess soil from the site should be considered by the contractor.

6.8 Design Review and Construction Observation

The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed excavations do not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design. The subgrade surfaces for the buildings, services and roadways should be inspected by experienced geotechnical personnel to ensure that suitable materials have been reached and properly prepared. The placing and compaction of earth fill and imported granular materials should be inspected to ensure that the materials used conform to the grading and compaction specifications.

7.0 CLOSURE

We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report, please do not hesitate to contact our office.

Matthew Rainville, C.E.T.
Senior Technologist

William (Bill) Cavers, P.Eng.
Principal Geotechnical Engineer

LICENSED PROFESSIONAL ENGINEER
W. CAVERS
100077934
Feb 10, 2023
PROVINCE OF ONTARIO

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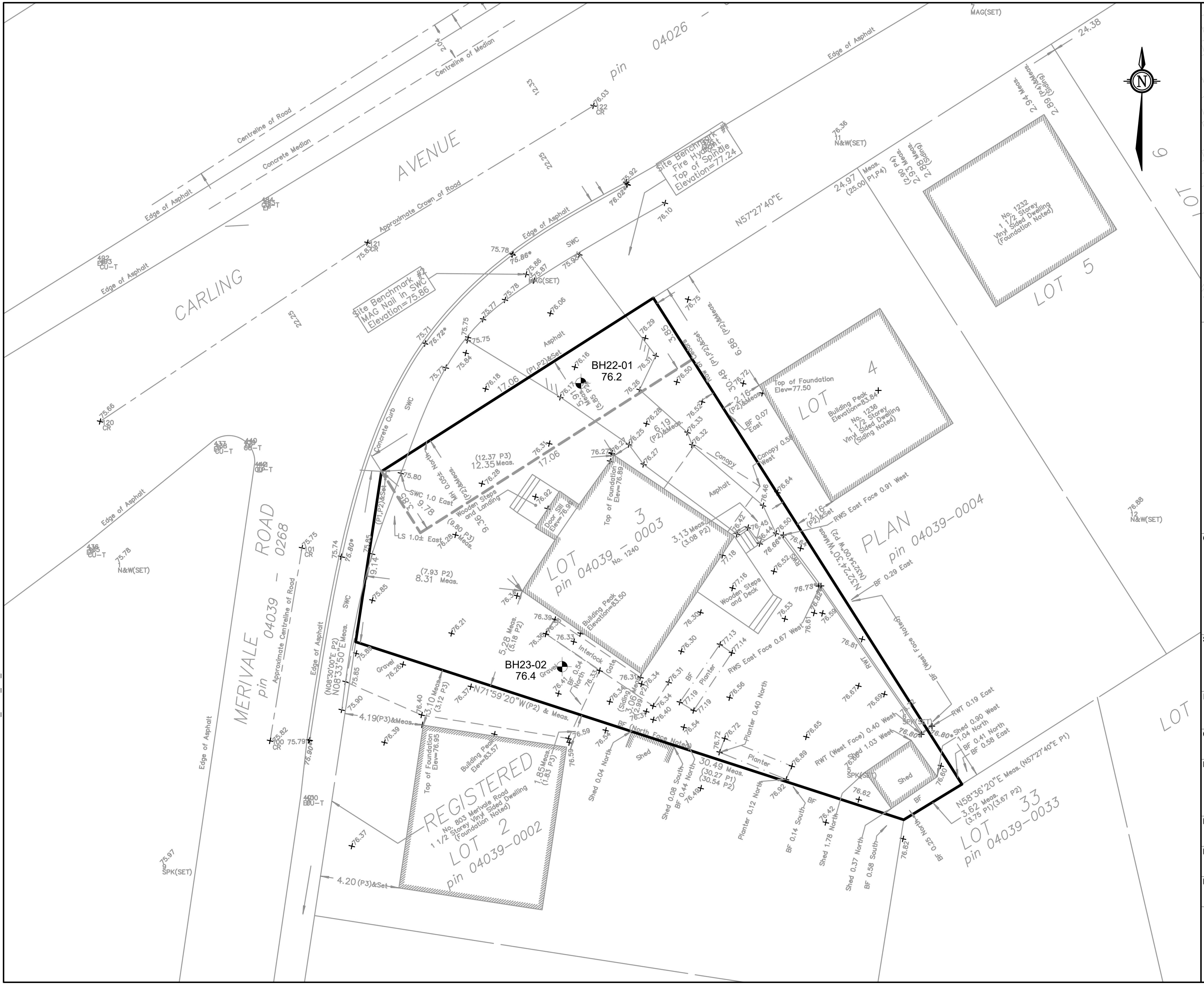

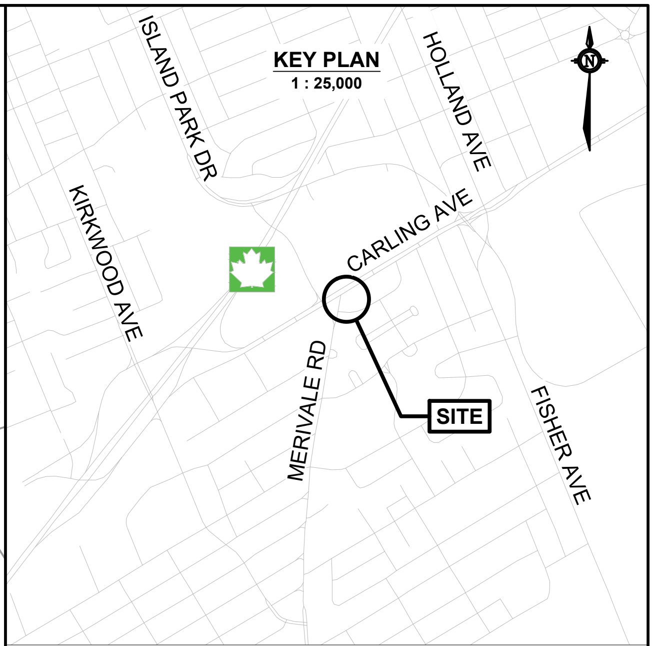

LEGEND

BH # ← BOREHOLE ID

XX.XX ← GROUND SURFACE ELEVATION, IN METRES GEODETIC DATUM

● **BOREHOLE LOCATION**
(current investigation by GEMTEC)

GENERAL NOTE(S)

1. Geographic dataset source: Ontario GeoHub.
2. Contains information licensed under the Open Government Licence – Ontario.
3. Plan prepared using 'Plan of Topographic Survey' prepared by Annis O'Sullivan Vollebekk Ltd., OLS
4. Elevations are geodetic referred to CGVD28.

SCALE
1:200
0 4 8 12m

DRAWING
BOREHOLE LOCATION PLAN

CLIENT
S.J.LAWRENCE ARCHITECTS INC

PROJECT
PROPOSED RESIDENTIAL DEVELOPMENT
1240 CARLING AVENUE
OTTAWA, ON

DRAWN BY	CHECKED BY
M.R.	M.R.
PROJECT NO.	REVISION NO.
100382.003	0
DATE	FIGURE NO.
FEB 3, 2023	**FIGURE 1**

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

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Ottawa, ON, K2K 2A9
Tel: (613) 836-1422
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APPENDIX A

Record of Borehole Sheets
List of Abbreviations and Symbols

Report to: S.J. Lawrence Architects Incorporated
Project: 100382.003 (February 10, 2023)

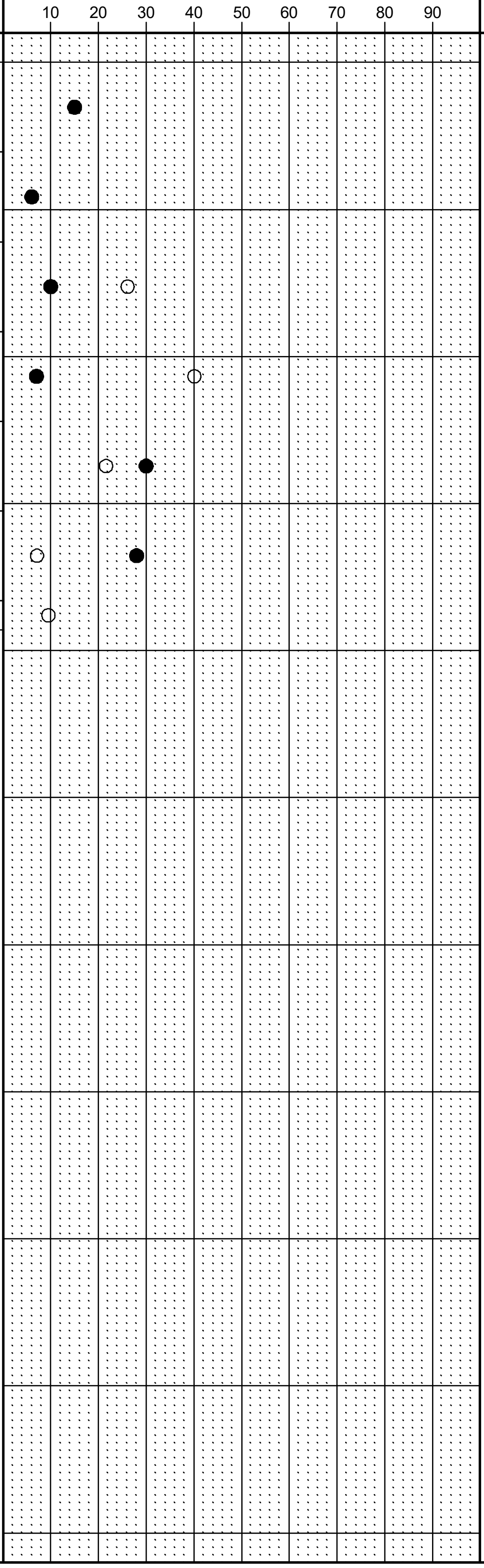
RECORD OF BOREHOLE 22-01

CLIENT: S.J. Lawrence Architects Inc
PROJECT: 1240 Carling Ave., Ottawa, ON
JOB#: 100382.003
LOCATION: See Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Dec 22 2022

BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	Ground Surface	76.20						
Power Auger Solid Stem Auger	ASPHALTIC CONCRETE	0.05						Backfilled with auger clippings
	Grey silty sand, some gravel (BASE)	0.20						
	Loose, grey brown silty sand, some gravel and clay, trace organics (FILL MATERIAL)		1	SS	355	15		
			2	SS	305	6		
	Loose, grey brown to reddish brown SILT some sand, trace to some clay, trace gravel, roots.	74.84 1.36	3	SS	330	10		
	Stiff to very stiff, grey brown SILTY CLAY (Weathered Crust)	74.37 1.83	4	SS	610	7		
	Dense to compact, grey brown gravelly sand, trace silt, trace clay, with cobbles and boulders (GLACIAL TILL)	73.77 2.43	5	SS	610	30		
			6	SS	610	28	MH	
			7	SS	200	>50		
	Refusal to augering. End of borehole	72.34 3.86						

● PENETRATION RESISTANCE (N), BLOWS/0.3m
▲ DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED
WATER CONTENT, % W_P ⊢ W ⊣ W_L



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CHECKED: MR

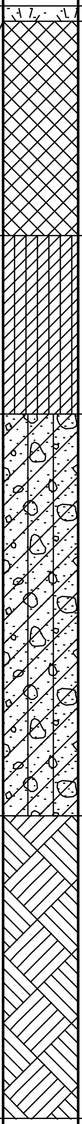
GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

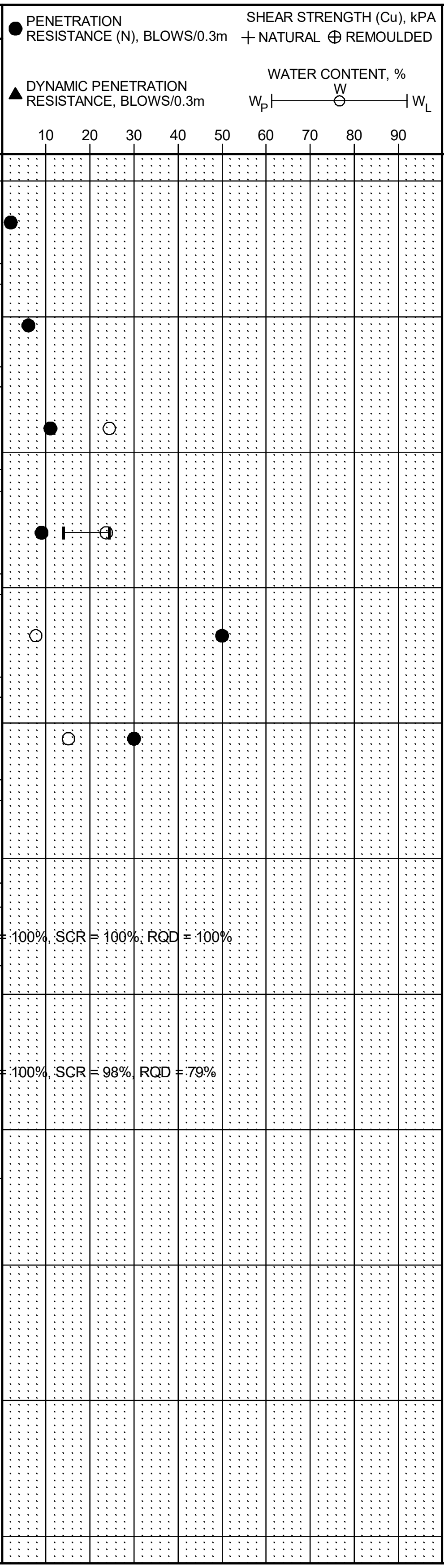
RECORD OF BOREHOLE 23-02

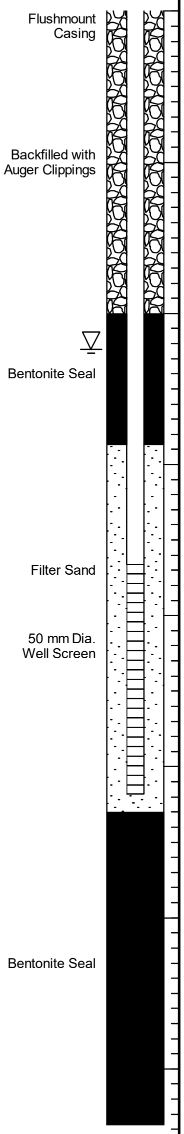
CLIENT: S.J. Lawrence Architects Inc
PROJECT: 1240 Carling Ave., Ottawa, ON
JOB#: 100382.003
LOCATION: See Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jan 4 2023

BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING
Power Auger Hollow Stem Auger (210mm OD)	Ground Surface	76.40					
	Dark brown silt, some sand, some organics and wood pieces (TOPSOIL)	76.30 0.10					
	Very loose to loose, reddish brown to dark brown to grey, silty clay, some sand, trace to some gravel, wood pieces (FILL MATERIAL)		1	SS	305	2	
			2	SS	127	6	
	Stiff to very stiff, grey brown SILT some sand and clay to SILTY CLAY (Weathered Crust)	74.88 1.52	3	SS	508	11	
			4	SS	610	9	
	Very dense to dense, grey brown gravelly sand, trace silt, trace clay, with cobbles and boulders (GLACIAL TILL).	73.70 2.70	5	SS	380	50	
			6	SS	330	30	MH
	Sampler refusal at 4.6 m. Augered to 5.4 m.		7	SS	0	>50	
Diamond Rotary Core HQ (89mm OD)	Fresh, grey LIMESTONE, thinly bedded.	71.04 5.36	8	RC	430	TCR = 100%, SCR = 100%, RQD = 100%	
			9	RC	1570	TCR = 100%, SCR = 98%, RQD = 79%	
		69.04 7.36					







GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
23/01/24	2.2 ∇	74.2

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LOGGED: CC
CHECKED: MR

GEO - BOREHOLE LOG 100382003_GNT01_R0_2023-02-03.GPJ GEMTEC 2018.GDT 2/3/23

ABBREVIATIONS AND TERMINOLOGY USED ON RECORDS OF BOREHOLES AND TEST PITS

SAMPLE TYPES	
AS	Auger sample
CA	Casing sample
CS	Chunk sample
BS	Borros piston sample
GS	Grab sample
MS	Manual sample
RC	Rock core
SS	Split spoon sampler
ST	Slotted tube
TO	Thin-walled open shelby tube
TP	Thin-walled piston shelby tube
WS	Wash sample

SOIL TESTS	
w	Water content
PL, w_p	Plastic limit
LL, w_L	Liquid limit
C	Consolidation (oedometer) test
D_R	Relative density
DS	Direct shear test
G_S	Specific gravity
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	Organic content test
UC	Unconfined compression test
γ	Unit weight

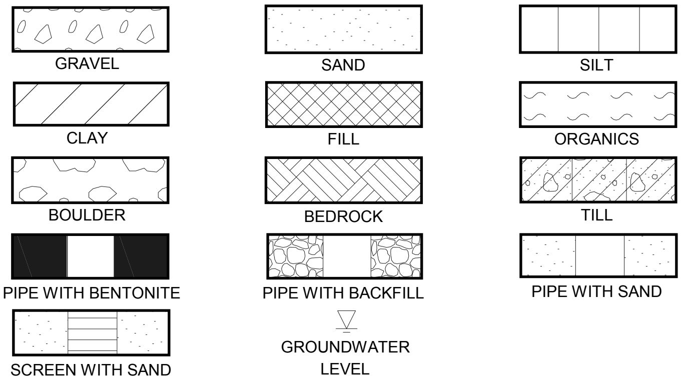
PENETRATION RESISTANCE

Standard Penetration Resistance, N
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 millimetres (30 in.) required to drive a 50 mm split spoon sampler for a distance of 300 mm (12 in.). For split spoon samples where less than 300 mm of penetration was achieved, the number of blows is reported over the sampler penetration in mm.

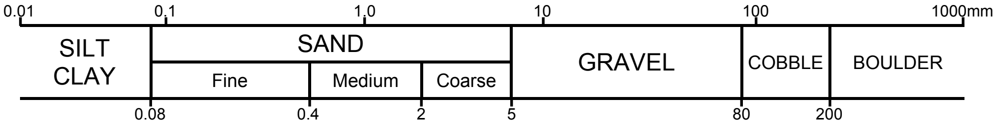
Dynamic Penetration Resistance
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive a 50 mm (2 in.) diameter 60° cone attached to ‘A’ size drill rods for a distance of 300 mm (12 in.).

WH	Sampler advanced by static weight of hammer and drill rods
WR	Sampler advanced by static weight of drill rods
PH	Sampler advanced by hydraulic pressure from drill rig
PM	Sampler advanced by manual pressure

COHESIONLESS SOIL Compactness		COHESIVE SOIL Consistency	
SPT N-Values	**Description**	**Cu, kPa**	**Description**
0-4	Very Loose	0-12	Very Soft
4-10	Loose	12-25	Soft
10-30	Compact	25-50	Firm
30-50	Dense	50-100	Stiff
>50	Very Dense	100-200	Very Stiff
		>200	Hard



GRAIN SIZE



DESCRIPTIVE TERMINOLOGY

(Based on the CANFEM 4th Edition)

0	10	20	35
TRACE	SOME	ADJECTIVE	noun > 35% and main fraction
trace clay, etc	some gravel, etc.	silty, etc.	sand and gravel, etc.

GEMTEC

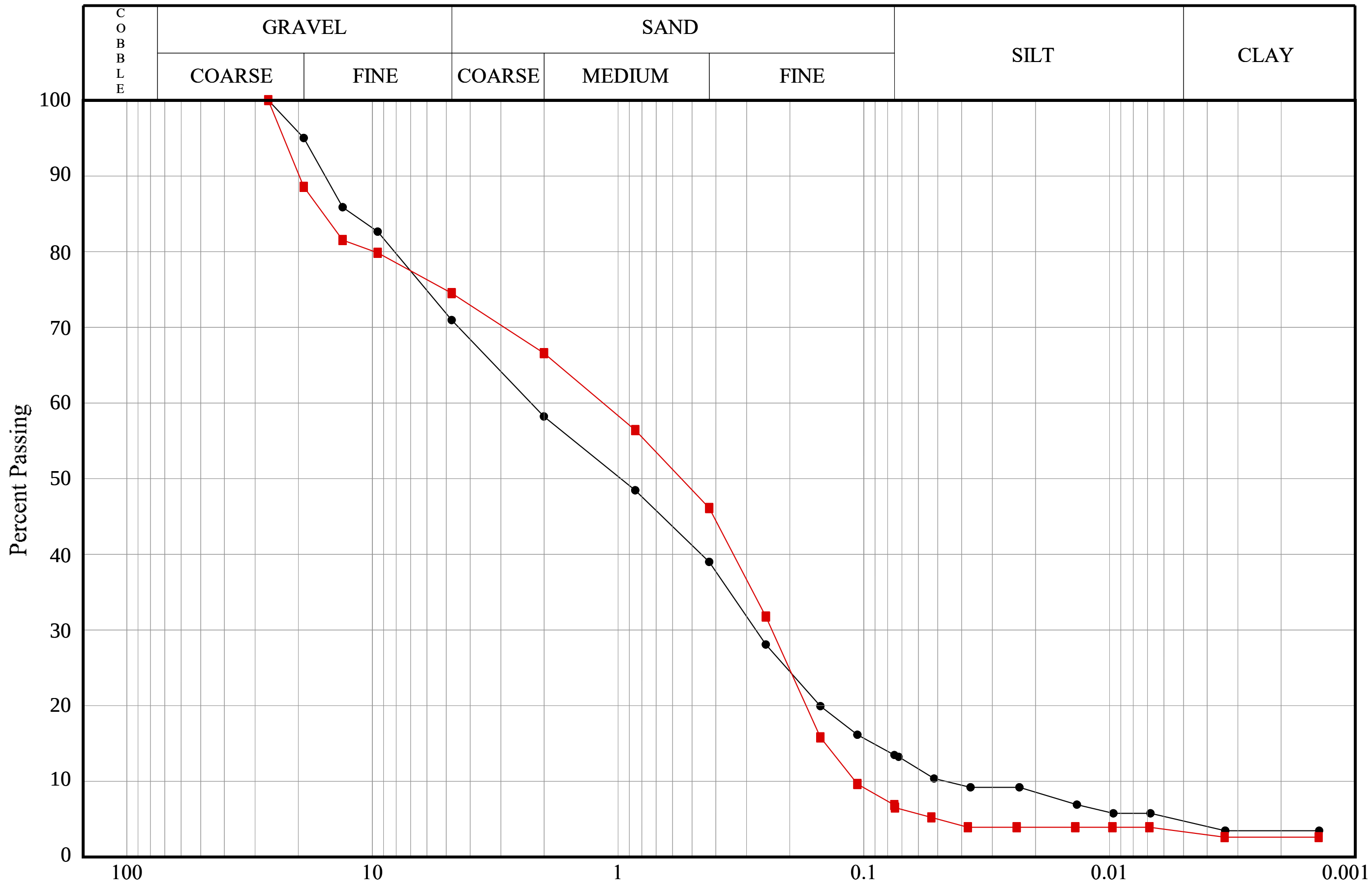
descriptive terms.pub
Modified May 2018

APPENDIX B

Laboratory Test Results

Report to: S.J. Lawrence Architects Incorporated
Project: 100382.003 (February 10, 2023)

GEMTEC Consulting Engineers and Scientists	Client: S.J. Lawrence Architect Incorporated Project: 1240 Carling Ave., Ottawa, ON Project #: 100382.003	Soils Grading Chart (LS-702/ ASTM D-422)



Grain Size, mm

Limits Shown: None

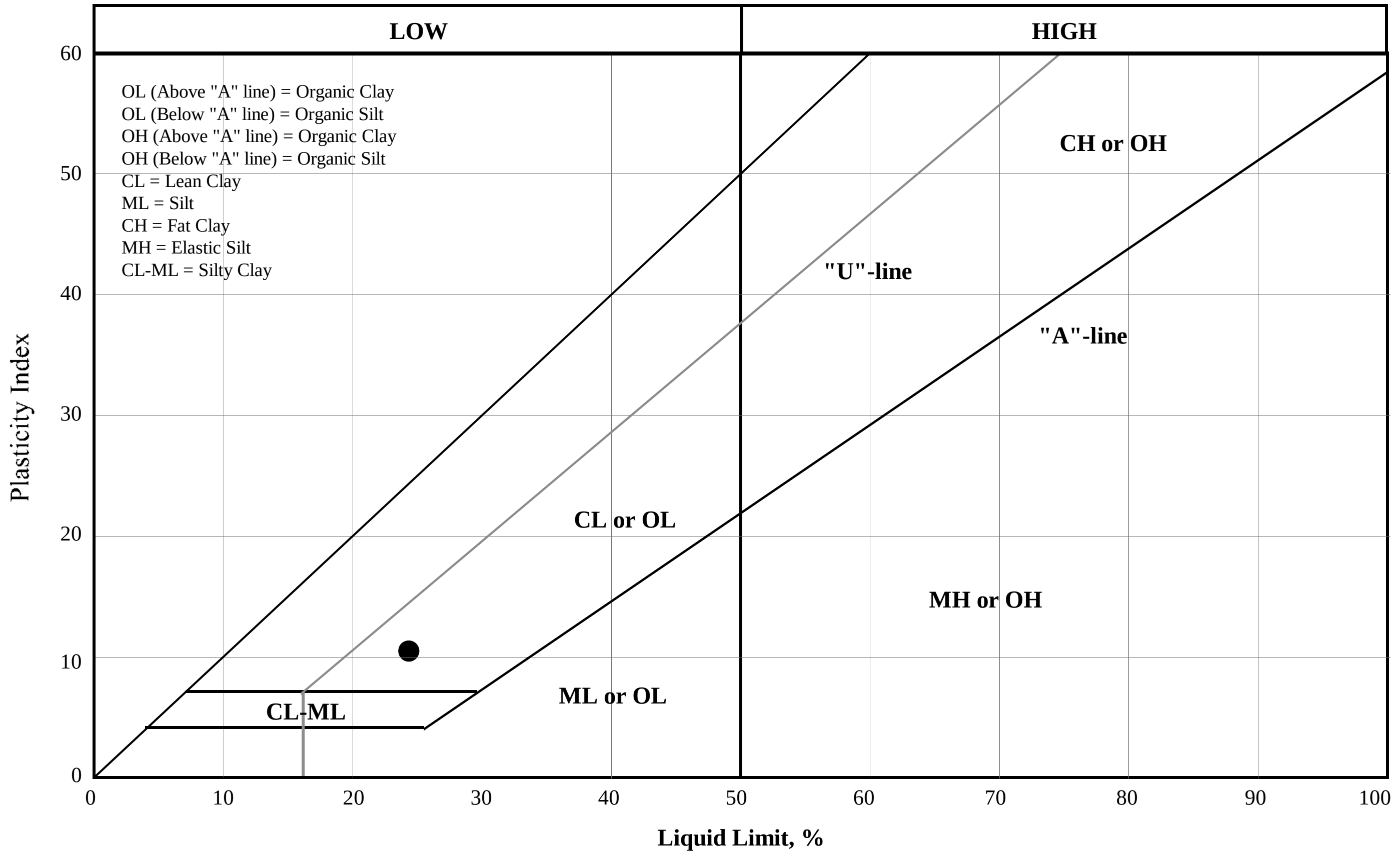
Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
●	Glacial Till	22-01	6	3.1-3.7	29.1	57.5	8.7	4.7
■	Glacial Till	23-02	6	3.8-4.4	25.5	67.7	3.5	3.3

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
●	Gravelly sand , trace silt, trace clay	N/A	0.05	0.09	0.27	0.98	2.26	12.11	8.7
■	Gravelly sand , trace silt, trace clay	N/A	0.11	0.14	0.24	0.55	1.15	15.82	3.5

GEMTEC
Consulting Engineers and Scientists

Client: S.J. Lawrence Architect Incorporated
Project: 1240 Carling Ave., Ottawa, ON
Project #: 100382.003

Plasticity Chart (D4318)



Symbol	Borehole /Test Pit	Sample Number	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Non-Plastic	Moisture Content, %
●	23-02	4A	2.3-2.8	24.3	13.9	10.5	☐	23.66

Note: More information available upon request

APPENDIX C

Rock Core Photograph
Bedrock Description Terminology

Report to: S.J. Lawrence Architects Incorporated
Project: 100382.003 (February 10, 2023)

BOREHOLE: 23-02
DATE: JAN 4, 2023
DEPTH: 5.4 to 7.4 mbgs

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS
32 Steacie Drive, Ottawa, ON K2K 2A9
T: (613) 836-1422 | www.gemtec.ca | ottawa@gemtec.ca

Project

1240 CARLING AVENUE
OTTAWA, ONTARIO

FIGURE C1

File No.

100382.003

ROCKCORE PHOTOGRAPH
BOREHOLE 23-02

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE	
Fresh	No visible sign of rock material weathering
Faintly weathered	Weathering limited to the surface of major discontinuities
Slightly weathered	Penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material
Moderately weathered	Weathering extends throughout the rock mass but the rock material is not friable
Completely weathered	Rock is wholly decomposed and in a friable condition but the rock and structure are preserved

CORE CONDITION
Total Core Recovery (TCR) The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run
Solid Core Recovery (SCR) The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.
Rock Quality Designation (RQD) The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completed broken core to 100% for core in solid segments.

BEDDING THICKNESS	
Description	**Thickness**
Thinly laminated	< 6 mm
Laminated	6 - 20 mm
Very thinly bedded	20 - 60 mm
Thinly bedded	60 - 200 mm
Medium bedded	200 - 600 mm
Thickly bedded	600 - 2000 mm
Very thickly bedded	2000 - 6000 mm

DISCONTINUITY SPACING	
Description	**Spacing**
Very close	20 - 60 mm
Close	60 - 200 mm
Moderate	200 - 600 mm
Wide	600 -2000 mm
Very wide	2000 - 6000 mm

ROCK QUALITY	
RQD	**Overall Quality**
0 - 25	Very poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

ROCK COMPRESSIVE STRENGTH	
Comp. Strength, MPa	**Description**
1 - 5	Very weak
5 - 25	Weak
25 - 50	Moderate
50 - 100	Strong
100 - 250	Very strong

APPENDIX D

Chemical Analysis of Soil Sample Relating to Corrosion

(Paracel Laboratories Ltd. Order No. 2303225)

Report to: S.J. Lawrence Architects Incorporated
Project: 100382.003 (February 10, 2023)

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Ottawa, ON, K1G 4J8
1-800-749-1947
www.paracellabs.com

Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Alex Meacoe

Client PO:
Project: 100382.003
Custody:

Report Date: 24-Jan-2023
Order Date: 17-Jan-2023

Order #: 2303225

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

Paracel ID	**Client ID**
2303225-01	BH22-01 S-4

Approved By:

Dale Robertson, BSc
Laboratory Director

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	19-Jan-23	19-Jan-23
Conductivity	MOE E3138 - probe @25 °C, water ext	19-Jan-23	19-Jan-23
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	17-Jan-23	18-Jan-23
Resistivity	EPA 120.1 - probe, water extraction	19-Jan-23	24-Jan-23
Solids, %	CWS Tier 1 - Gravimetric	18-Jan-23	19-Jan-23

Certificate of Analysis

Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 24-Jan-2023

Order Date: 17-Jan-2023

Project Description: 100382.003

	Client ID:	BH22-01 S-4	-	-	-
	Sample Date:	22-Dec-22 15:10	-	-	-
	Sample ID:	2303225-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	77.6	-	-	-
General Inorganics					
Conductivity	5 uS/cm	400	-	-	-
pH	0.05 pH Units	7.71	-	-	-
Resistivity	0.10 Ohm.m	25.0	-	-	-
Anions					
Chloride	10 ug/g dry	118	-	-	-
Sulphate	10 ug/g dry	40	-	-	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	10	ug/g						
Sulphate	ND	10	ug/g						
General Inorganics									
Conductivity	ND	5	uS/cm						
Resistivity	ND	0.10	Ohm.m						

Certificate of Analysis

Client: **GEMTEC Consulting Engineers and Scientists Limited**

Client PO:

Report Date: 24-Jan-2023

Order Date: 17-Jan-2023

Project Description: 100382.003

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	110	10	ug/g	112			2.1	35	
Sulphate	39.6	10	ug/g	40.8			3.0	35	
General Inorganics									
Conductivity	95.5	5	uS/cm	93.5			2.2	5	
pH	7.58	0.05	pH Units	7.63			0.7	2.3	
Resistivity	105	0.10	Ohm.m	107			2.2	20	
Physical Characteristics									
% Solids	88.2	0.1	% by Wt.	87.0			1.4	25	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	208	10	ug/g	112	96.3	82-118			
Sulphate	140	10	ug/g	40.8	99.5	80-120			

Qualifier Notes:

Login Qualifiers :

Container(s) - Labeled improperly/insufficient information - Sample collection date on the jar is January 16, 2023, chain of custody reads January 17, 2023, client indicated sample collection date was December 22, 2022.

Applies to samples: BH22-01 S-4

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

experience • knowledge • integrity

civil	civil
geotechnical	géotechnique
environmental	environnementale
field services	surveillance de chantier
materials testing	service de laboratoire des matériaux

expérience • connaissance • intégrité