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REPORT ON

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
211 ARMSTRONG STREET
CITY OF OTTAWA, ONTARIO

Project # 211169

Submitted to:

Lion Trade Ltd.
4-91 Prince Albert Street
Ottawa, Ontario
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January 24, 2022 211169

Lion Trade Ltd.
4-91 Prince Albert Street
Ottawa, Ontario
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RE: GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
211 ARMSTRONG STREET
CITY OF OTTAWA, ONTARIO

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation carried out for the above noted proposed residential development at 211 Armstrong Street, City of Ottawa, Ontario (See Key Plan, Figure 1).

The purpose of the investigation was to:

- Identify the subsurface conditions at the site by means of a limited number of boreholes;
- Based on the factual information obtained, provide recommendations and guidelines on the geotechnical engineering aspects of the project design; including bearing capacity and other construction considerations, which could influence design decisions.

2.0 BACKGROUND INFORMATION AND SITE GEOLOGY

2.1 Existing Conditions and Site Geology

The subject site for this assessment consists of about a 0.05 hectare (0.12 acres) rectangular shaped property located at 211 Armstrong Street, City of Ottawa, Ontario (see Key Plan, Figure 1).

For the purposes of this assessment, project north lies in a direction perpendicular to Armstrong Street, which is located immediately south of the site. The site is currently occupied by a single-family dwelling, which is to be demolished prior to construction.

Surrounding land use is residential development. The site is bordered on the west, north and east by residential development and to the south by Armstrong Street followed by residential developments.

The ground surface at the site is currently graded such that surface water drains from the southwest to the northeast, away from Armstrong Street.

Based on a review of the surficial geology map for the site area, it is expected that the site is underlain by shallow bedrock. Bedrock geology maps indicate that the bedrock underlying the site consists of limestone with shaley partings of the Ottawa formation.

Based on a review of available borehole information, the overburden at and near the site likely consists of some 0 to 2 metres of glacial till followed by limestone bedrock.

2.2 Proposed Development

It is understood that preliminary plans are being prepared for the construction of a, 3.5-storey, multi-unit residential building. There is no proposed parking at the site. It is understood that the building will be wood framed with some brick veneer and cast-in-place concrete construction with conventional concrete spread footing foundations and a concrete slab-on-grade ground floor. The proposed building will be serviced by municipal water and sanitary services.

Surface drainage for the proposed building will be by means of swales, nearby catch basins and storm sewers.

3.0 PROCEDURE

The field work for this investigation was carried out on January 19, 2021, at which time three boreholes, numbered BH1 to BH3 were put down at the site using a truck mounted drill rig equipped with a hollow stem auger owned and operated by CCC Geotechnical & Environmental Drilling of Ottawa, Ontario. The boreholes were put down in the driveway of the existing dwelling.

The subsurface soil conditions encountered at the boreholes were classified based on visual and tactile examination of the samples recovered (ASTM D2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), standard penetration tests (ASTM D-1586) as well as laboratory test results on select samples. Groundwater conditions at the boreholes were noted at the time of drilling and at a later date. The boreholes were loosely backfilled with the auger cuttings upon completion of drilling.

Sampling of the overburden materials encountered at the borehole location was carried out at regular 0.75 metre depth intervals using a 50 millimetre diameter drive open conventional split spoon sampler in conjunction with standard penetration testing. All of the boreholes were put down to bedrock at the site. The soils were classified using the Unified Soil Classification System.

One soil sample (BH1 – SS2 – 0.8 – 1.4 m) was delivered to a chemical laboratory for testing for any indication of potential soil sulphate attack on concrete and corrosivity to buried steel.

The field work was supervised throughout by members of our engineering staff who located the boreholes in the field, logged the boreholes and cared for the samples obtained. A description of the subsurface conditions encountered at the boreholes is given in the attached Record of Borehole Sheets. The results of the laboratory testing of the soil samples are presented in the Laboratory Test Results section and Attachment A following the text in this report. The approximate locations of the boreholes are shown on the attached Site Plan, Figure 2.

4.0 SUBSURFACE CONDITIONS

4.1 General

As previously indicated, a description of the subsurface conditions encountered at the boreholes is provided in the attached Record of Borehole Sheets following the text of this report. The borehole logs indicate the subsurface conditions at the specific drill locations only. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted.

Subsurface conditions at locations other than borehole locations may vary from the conditions encountered at the boreholes.

Classification and identification of soil involves judgement and Kollaard Associates Inc. does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The groundwater conditions described in this report refer only to those observed at the location and on the date the observations were noted in the report and on the borehole logs. Groundwater conditions may vary seasonally, or may be affected by construction activities on or in the vicinity of the site.

The following is a brief overview of the subsurface conditions encountered at the boreholes.

4.2 Topsoil

From the surface, a layer of topsoil measuring about 0.6 metres in thickness was encountered in borehole BH1. The material was classified as topsoil based on the colour and the presence of organic materials. The identification of the topsoil layer is for geotechnical purposes only and does not constitute a statement as to the suitability of this layer for cultivation and sustainable plant growth.

4.3 Fill

Fill materials consisting of asphaltic concrete and grey crushed granular stone were encountered in boreholes BH2 and BH3. The fill materials were encountered from the surface to depths of about 0.2 metres. The fill materials were fully penetrated at both borehole locations.

4.4 Glacial Till

Glacial till was encountered beneath the topsoil in BH1 and beneath the fill materials in boreholes BH2 and BH3, at depths between about 0.2 to 0.6 metres below the existing ground surface. The glacial till consisted of grey brown silty sand, with traces of clay, gravel and cobbles. The results of the standard penetration testing carried out in the glacial till material range from 15 to 22 blows per

0.3 metres, indicating a compact state of packing. The glacial till was fully penetrated in all boreholes where encountered.

4.4 Bedrock

Beneath the glacial till material, boreholes BH1, BH2 and BH3 encountered limestone bedrock at depths of about 1.7, 0.5 and 0.9 metres, respectively, below the existing ground surface. Refusal at the bedrock surface was encountered in all boreholes.

4.5 Groundwater

All boreholes were observed to be dry at time of drilling. It should be noted that the groundwater levels may be higher during wet periods of the year such as the early spring.

4.6 Corrosivity on Reinforcement and Sulphate Attack on Portland Cement

The results of the laboratory testing of a soil sample for submitted for chemistry testing related to corrosivity is summarized in the following table.

Item	Threshold of Concern	Test Result	Comment
Chlorides (Cl)	Cl > 0.04 %	0.00771	Negligible concern
pH	5.5 > pH	7.70	Basic Negligible concern
Resistivity	R < 20,000 ohm-cm	8380	Moderately Corrosive
Sulphates (SO_4)	SO_4 > 0.1%	0.0031	Negligible concern

The results of the laboratory testing of a soil sample for sulphate gave a percent sulphate of 0.0031. The National Research Council of Canada (NRC) recognizes four categories of potential sulphate attack of buried concrete based on percent sulphate in soil. From 0 to 0.10 percent the potential is negligible, from 0.10 to 0.20 percent the potential is mild but positive, from 0.20 to 0.50 percent the potential is considerable and 0.50 percent and greater the potential is severe. Based on the above, the soils are considered to have a negligible potential for sulphate attack on buried concrete materials and accordingly, conventional GU or MS Portland cement may be used in the construction of the proposed concrete elements.

The pH value for the soil sample was reported to be at 7.70, indicating a durable condition against corrosion. This value was evaluated using Table 2 of Building Research Establishment (BRE) Digest

362 (July 1991).The pH is greater than 5.5 indicating the concrete will not be exposed to attack from acids.

The chloride content of the sample was also compared with the threshold level and presents negligible concrete corrosion potential.

Corrosivity Rating for soils ranges from extremely corrosive to non-corrosive as follows:

Soil Resistivity (ohm-cm)	Corrosivity Rating
> 20,000	non- corrosive
10,000 to 20,000	mildly corrosive
5,000 to 10,000	moderately corrosive
3,000 to 5,000	corrosive
1,000 to 3,000	highly corrosive
< 1,000	extremely corrosive

The soil resistivity was found to be 8380 ohm-cm for the sample analyzed making the soil moderately corrosive for buried steel within below grade concrete walls. Consideration to increasing the specified strength and/or adding air entrainment into any reinforced concrete in contact with the soil should be given. Consideration should also be given to increasing the minimum concrete cover over reinforcing steel.

5.0 GEOTECHNICAL GUIDELINES AND RECOMMENDATIONS

5.1 General

This section of the report provides engineering guidelines on the geotechnical design aspects of the project based on our interpretation of the information from the test holes and the project requirements. It is stressed that the information in the following sections is provided for the guidance of the designers and is intended for 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 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 at this site or adjacent properties, and/or resulting from the introduction onto the site of materials from offsite sources are outside the terms of reference for this report.

5.2 Foundation for Proposed Residential Building

With the exception of the fill materials and topsoil, the subsurface conditions encountered within the test holes are suitable for the support of the proposed apartment building on conventional spread footing foundations. Excavations for the proposed foundations should be taken through the fill materials, topsoil and glacial till to expose the bedrock subgrade.

5.2.1 Foundation Excavation

Any excavation for the proposed structure will likely be carried out through topsoil, fill materials (asphalt and crushed stone) and glacial till to bear upon the limestone bedrock. The sides of the excavations should be sloped in accordance with the requirements of Ontario Regulation 213/91, s. 226 under the Occupational Health and Safety Act. According to the Act, the native soils at the site can be classified as Type 3 soil above bedrock and Type 1 below the bedrock surface, however this classification should be confirmed by qualified individuals as the site is excavated and if necessary, adjusted.

It is expected that the side slopes of the excavation will be stable in the short term provided the walls are sloped at 1H:1V through the fill materials to 1.2 metres or less from the bottom of the excavation and provided no excavated materials are stockpiled within 3 metres of the top of the excavations.

5.3 Foundation Design and Bearing Capacity

It is suggested that the building be founded either directly on the underlying bedrock or on engineered fill placed on the underlying bedrock. The underside of footings can be stepped as necessary to facilitate placement on the bedrock.

The foundation of the proposed residential building may be placed on conventional pad and strip footings. A maximum allowable bearing pressure of 1500 kilopascals using serviceability limit states design and a factored ultimate bearing resistance of 1500 kilopascals using ultimate limit states design may be used for the design of conventional strip or pad footings, a minimum of 0.6 metres in width, founded on sound bedrock. Sound bedrock consists of a hard relatively level bedrock surface free of loose material, rock shatter and fractured rock.

The foundation of the proposed residential building founded on engineered fill placed on the bedrock may use a maximum allowable bearing pressure of 500 kilopascals using serviceability limit states design and a factored ultimate bearing resistance of 800 kilopascals using ultimate limit states design for the design of convention strip or pad footings, a minimum of 0.6 metres in width.

No maximum allowable landscape grade raise adjacent to the proposed building foundation is required. Total and differential settlement of the footings for the apartment building designed and founded based on the above guidelines should be less than 15 millimetres and 10 millimetres, respectively.

The subgrade surfaces should be inspected and approved by geotechnical personnel prior to placement of any engineered fill or concrete.

5.4 Engineered Fill

It is recommended that the building be founded either on sound bedrock or on engineered fill placed on sound bedrock. It is not recommended that the footings be placed on both bedrock and engineered fill at different locations in the building.

Any fill required to raise the footings for the proposed building to founding level should consist of imported granular material (engineered fill). The engineered fill should consist of granular material meeting Ontario Provincial Standards Specifications (OPSS) requirements for Granular A or Granular B Type II and should be compacted in maximum 300 millimetre thick loose lifts to at least 100 percent of the standard Proctor maximum dry density. It is considered that the engineered fill should be compacted using dynamic compaction with a large diameter vibratory steel drum roller or diesel plate compactor. If a diesel plate compactor is used, the lift thickness may need to be restricted to less than 300 mm to achieve proper compaction. Compaction should be verified by a suitable field compaction test method.

To allow the spread of load beneath the footings, the engineered fill should extend out 0.5 metres horizontally from the edges of the footing then down and out at 1 horizontal to 1 vertical, or flatter. The excavations for the proposed residential building should be sized to accommodate this fill placement.

5.4.2 Effect of Foundation Excavation on Adjacent Structures and City of Ottawa Services

It is expected that bedrock will be encountered during excavating for site services. Small amounts of bedrock removal can most likely be carried out by hoe ramming and heavy excavating equipment. It is considered that where large amounts of bedrock are removed by hoe ramming, the hoe ramming could also introduce significant vibrations through the bedrock. As such it is considered that pre-excavation surveys of nearby structures and existing utilities should also be completed before extensive hoe ramming. It is further recommended that line drilling be used in conjunction with hoe ramming to reduce the effort required to fracture and remove the bedrock.

5.4.3 Ground Water in Excavation and Construction Dewatering

All boreholes were dry at the time of drilling, January 19, 2021. As the building will be founded on shallow bedrock, water intrusion into the excavation is not a concern and dewatering will not be required. As such a permit to take water will not be required prior to excavation.

5.4.4 Effect of Dewatering of Foundation or Site Services Excavations on Adjacent Structures

Since the building is to be founded on shallow bedrock and all adjacent building are also founded on shallow bedrock, dewatering of the foundation will not remove water from any historically saturated soils that are important for the support of any building. As such dewatering of the foundation or site services excavations, if required, will not have a detrimental impact on the adjacent structures.

5.5 Frost Protection Requirements for Spread Footing Foundations

In general, all exterior foundation elements and those in any unheated parts of the proposed building should be provided with at least 1.5 metres of earth cover for frost protection purposes. Isolated, unheated foundation elements adjacent to surfaces, which are cleared of snow cover during winter months should be provided with a minimum 1.8 metres of earth cover for frost protection purposes.

Where less than the required depth of soil cover can be provided, the foundation elements should be protected from frost by using a combination of earth cover and extruded polystyrene rigid insulation. A typical frost protection insulation detail could be provided upon request, if required.

Where the proposed building foundations are placed on sound bedrock or on engineered fill over bedrock, the subgrade materials would be considered to be non susceptible to frost action and no frost protection for the foundations is required.

5.6 Foundation Wall Backfill and Drainage

Provided the proposed finished floor surfaces are above the exterior finished grade at all locations, the granular materials beneath the proposed floor slab are properly compacted and provided the exterior grade is adequately sloped away from the proposed building, no perimeter foundation drainage system is required.

The native soils encountered at this site are considered to be frost susceptible. As such, to prevent possible foundation frost jacking, the backfill against any unheated or insulated walls or isolated walls or piers should consist of free draining, non-frost susceptible material. If imported material is required, it should consist of sand or sand and gravel meeting OPSS Granular B Type I grading requirements.

Alternatively, foundations could be backfilled on the exterior with native material in conjunction with the use of an approved proprietary drainage layer system (such as Platon System Membrane) against the foundation wall. There is potential for possible frost jacking of the upper portion of some types of these drainage layer systems if frost susceptible material is used as backfill. To mitigate this potential, the upper approximately 0.6 metres of the foundation should be backfilled with non-frost susceptible granular material.

Where the granular backfill will ultimately support a pavement structure or walkway, it is suggested that the wall backfill material be compacted in 250 millimetre thick lifts to 95 percent of the standard

Proctor dry density value. In that case any native material proposed for foundation backfill should be inspected and approved by the geotechnical engineer.

A conventional, perforated perimeter drain, with a 150 millimetre surround of 20 millimetre minus crushed stone, should be provided at the founding level for the cast-in-place concrete basement floor slab and should lead by gravity flow to the City Storm Sewer or to a sump. If the perimeter drain tile is discharged by gravity to the Storm Sewer a backup flow valve must be used. If a sump is used, the sump should be equipped with a backup pump and generator. The sump discharge should be equipped with a backup flow protector

The proposed basement should also be provided with under floor drains consisting of perforated pipe with a surround of 20 millimetre minus crushed stone to reduce the potential for buildup of hydrostatic pressure below the basement floor. The under floor drains should be placed beginning at the inside edge of the foundation wall and should be spaced a maximum of 5 metres apart. The under floor drain should also be directed to the storm sewer or to the sump.

The basement foundation walls should be designed to resist the earth pressure, P, acting against the walls at any depth, h, calculated using the following equation.

$$\mathbf{P = k_0 (\gamma h + q)}$$

Where:

	P	=	the pressure, at any depth, h, below the finished ground surface
	k_0	=	earth pressure at-rest coefficient, 0.5
	γ	=	unit weight of soil to be retained, estimated at 22 kN/m^3
	q	=	surcharge load (kPa) above backfill material
	h	=	the depth, in metres, below the finished ground surface at which the pressure, P, is being computed

This expression assumes that the water table would be maintained at the founding level by the above mentioned foundation perimeter drainage and backfill requirements.

5.7 Basement Floor Slab

As stated above, it is expected that the proposed building will be founded on bedrock or on an engineered pad placed on bedrock. For predictable performance of the proposed concrete basement floor slab all existing fill material and any otherwise deleterious material should be removed from below the proposed floor slab areas. The exposed bedrock surface should then be inspected and approved by geotechnical personnel.

The fill materials beneath the proposed concrete basement floor slab on grades should consist of a minimum of 150 millimetre thickness of crushed stone meeting OPSS Granular A immediately beneath the concrete floor slab followed by sand, or sand and gravel meeting the OPSS for Granular B Type I, or crushed stone meeting OPSS grading requirements for Granular B Type II, or other material approved by the Geotechnical Engineer. The fill materials should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density.

The slabs should be structurally independent from walls and columns, which are supported by the foundations. This is to reduce any structural distress that may occur as a result of differential soil movement. If it is intended to place any internal non-load bearing partitions directly on the slab-on-grade, such walls should also be structurally independent from other elements of the building founded on the conventional foundation system so that some relative vertical movement between the floor slab and foundation can occur freely.

The concrete floor slab should be saw-cut at regular intervals to minimize random cracking of the slab due to shrinkage of the concrete. The saw cut depth should be about one quarter of the thickness of the slab. The crack control cuts should be placed at a grid spacing not exceeding the lesser of 25 times the slab thickness or 4.5 metres. The slab should be cut as soon as it is possible to work on the slab without damaging the surface of the slab. Under slab drainage is not considered necessary provided that the floor slab level is above the finished exterior ground surface level. If any areas of the proposed building are to remain unheated during the winter period or under slab insulation is to be used, thermal protection of the foundation may be required. Further details on the insulation requirements could be provided, if necessary.

5.8 Seismic Design for the Proposed Residential Building

5.8.1 Seismic Site Classification

Based on the limited information from the boreholes, for seismic design purposes, in accordance with the 2012 OBC Section 4.1.8.4, Table 4.1.8.4.A., the site classification for seismic site response for the bedrock is Site Class C.

5.9 National Building Code Seismic Hazard Calculation

The design Peak Ground Acceleration (PGA) for the site was calculated as 0.278 with a 2% probability of exceedance in 50 years based on the interpolation of the 2015 National Building Code Seismic Hazard calculation. The results of the test are attached following the text of this report.

5.9.1 Potential for Soil Liquefaction

As indicated above, the results of the boreholes indicate that the subsurface conditions consist of a thin layer of overburden followed by bedrock. The proposed building will be founded on the bedrock.

The bedrock is not considered to be liquefiable under seismic conditions.

Therefore, it is considered that no damage to the proposed residential building will occur due to liquefaction of the native subgrade under seismic conditions.

6.0 SITE SERVICES

6.1 Excavation

The excavations for the site services will be carried out through topsoil or fill materials (asphalt and crushed stone), glacial till and bedrock. For the purposes of Ontario Regulation 213/91 the soils at the site can be considered to be Type 3 soil above bedrock, and Type 1 below the bedrock surface. Work within an excavation in the bedrock should follow the requirements of Ontario Regulation 213/91 in particular O.Reg 213/91 S230 – S233. Excavation walls within bedrock may be made near vertical. The sides of the excavations in overburden materials should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Ontario Occupational Health and Safety Act.

It is expected that bedrock will be encountered during excavating for site services. Small amounts of bedrock removal, can most likely be carried out by hoe ramming and heavy excavating equipment. Where larger amounts of bedrock removal are required it may be more economically feasible to use drill and blasting techniques which should be carried out under the supervision of a blasting specialist engineer. Monitoring of the blasting should be carried out throughout the blasting period to ensure that the blasting meets the limiting vibration criteria established by the specialist engineer. Pre-blast condition surveys of nearby structures and existing utilities are essential. It is also considered that were large amounts of bedrock are removed by hoe ramming, the hoe ramming could also introduce significant vibrations through the bedrock. It is recommended that where large amounts of bedrock are to be removed by hoe ramming, line drilling techniques be combined with the hoe ramming. As such it is considered that pre-excavation surveys of nearby structures and existing utilities should also be completed before extensive hoe ramming.

Groundwater was not encountered in the test holes above the bedrock. The test holes however were not advanced into the bedrock to the expected depth of the services. As such it is uncertain where the groundwater elevation is with respect to the service elevations. Based on available information it is unlikely that a permit to take water will be required to dewater the service trench. It is considered however that an ESR may be required.

6.2 Pipe Bedding and Cover Materials

It is suggested that the service pipe bedding material consist of at least 150 millimetres of granular material meeting OPSS requirements for Granular A. A provisional allowance should, however, be made for sub-excavation of any existing fill or disturbed material encountered at sub-grade level. Granular material meeting OPSS specifications for Granular B Type II could be used as a sub-bedding material. The use of clear crushed stone as bedding or sub-bedding material should not be permitted.

Cover material, from pipe spring line to at least 300 millimetres above the top of the pipe, should consist of granular material, such as OPSS Granular A.

The sub-bedding, bedding and cover materials should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density using suitable vibratory compaction equipment.

6.3 Trench Backfill

The general backfilling procedures should be carried out in a manner that is compatible with the future use of the area above the service trenches.

In areas where the service trench will be located below or in close proximity to existing or future roadway areas, granular fill material should be used as backfill between the roadway sub-grade level and the depth of seasonal frost penetrations (i.e. 1.8 metres below finished grade) in order to reduce the potential for differential frost heaving between the area over the trench and the adjacent section of roadway.

As there is limited native material onsite, imported granular material will likely have to be used. Where imported granular materials are used, suitable frost tapers should be used OPSD 802.013.

To minimize future settlement of the backfill and achieve an acceptable sub-grade for the roadways, sidewalks, etc., the trench should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density. The specified density may be reduced where the trench backfill is not located or in close proximity to existing or future roadways, driveways, sidewalks, or any other type of permanent structure.

7.0 TREES

The site is underlain by a thin layer of glacial till over bedrock, which is not considered to be susceptible to shrinkage caused by changes to moisture content. As such, it is considered that there are not any increased separation distances or limitations to the type of trees planted onsite.

The effects of existing and future trees on the adjacent buildings, services and other ground supported structures should be considered in the landscaping design.

8.0 CONSTRUCTION CONSIDERATIONS

The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed development do not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design.

All foundation areas and any engineered fill areas for the proposed residential building should be inspected by Kollaard Associates Inc. to ensure that a suitable sub-grade has been reached and properly prepared. The placing and compaction of any granular materials beneath the foundations should be inspected to ensure that the materials used conform to the grading and compaction specifications.

The subgrade for the site services should be inspected and approved by geotechnical personnel. In situ density testing should be carried out on the service pipe bedding and backfill and the pavement granular materials to ensure the materials meet the specifications from a compaction point of view.

The native topsoil and glacial till at this site will be sensitive to disturbance from construction operations, from rainwater or snow melt, and frost. In order to minimize disturbance, construction traffic operating directly on the subgrade should be kept to an absolute minimum and the subgrade should be protected from below freezing temperatures.

We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report or if we may be of further services to you, please do not hesitate to contact our office.

Regards,
Kollaard Associates Inc.

LICENSED PROFESSIONAL ENGINEER
Jan 24, 2022
S.E. deWit
100079612
PROVINCE OF ONTARIO

Dean Tataryn, B.E.S., EP.

Steve DeWit, P.Eng.

BOREHOLE BH1

PROJECT: Proposed Residential Development
CLIENT: Lion Trade Ltd.
LOCATION: 211 Armstrong Road
PENETRATION TEST HAMMER: 63.5 kg, Drop, 0.76 mm

PROJECT NUMBER: 211169
DATE OF BORING: 22-1-19
SHEET 1 of 1
DATUM:

DEPTH SCALE (meters)	SOIL PROFILE: DESCRIPTION	DEPTH (m)	STRATA PLOT	ELEV. (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	UNDIST SHEAR STRENGTH x Cu. kPa x / REM SHEAR STRENGTH o Cu. kPa o (0 20 40 60 80 100)	DYNAMIC CONE PENETRATION TEST blows/300 mm (0 20 40 60 80 100)	MOISTURE CONTENT (%)	PIEZOMETER OR STANDPIPE INSTALLATION
	TOPSOIL	0			1	SS	22				Borehole dry at time of drilling, January 19, 2022.
0.5											
	Grey brown silty sand, some gravel, cobbles and boulders, trace clay (GLACIAL TILL)	0.61									
1.0					2	SS	15				
1.5					3	SS	100				
	Practical refusal on bedrock	1.72									

DEPTH SCALE: 1 to 10
LOGGED: CI
BORING METHOD: Power Auger
AUGER TYPE: 200 mm Hollow Stem
CHECKED: SD

GEOTECH BH KOLLAARD 211169 BOREHOLES.GPJ GINT STD CANADA.GDT 22-2-4

BOREHOLE BH2

PROJECT: Proposed Residential Development
CLIENT: Lion Trade Ltd.
LOCATION: 211 Armstrong Road
PENETRATION TEST HAMMER: 63.5 kg, Drop, 0.76 mm

PROJECT NUMBER: 211169
DATE OF BORING: 22-1-19
SHEET 1 of 1
DATUM:

DEPTH SCALE (meters)	SOIL PROFILE: DESCRIPTION	DEPTH (m)	STRATA PLOT	ELEV. (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	UNDIST SHEAR STRENGTH x Cu. kPa x / REM SHEAR STRENGTH o Cu. kPa o (0 20 40 60 80 100)	DYNAMIC CONE PENETRATION TEST blows/300 mm (0 20 40 60 80 100)	MOISTURE CONTENT (%)	PIEZOMETER OR STANDPIPE INSTALLATION
	ASPHALTIC CONCRETE	0									
	Grey crushed granular stone (FILL)	0.03									Borehole dry at time of drilling, January 19, 2022.
	Grey brown silty sand, some gravel, cobbles, boulders, trace clay (GLACIAL TILL)	0.23			1	SS	100				
0.5											
	Practical refusal on large boulder or bedrock	0.53									

DEPTH SCALE: 1 to 10
LOGGED: CI
BORING METHOD: Power Auger
AUGER TYPE: 200 mm Hollow Stem
CHECKED: SD

BOREHOLE BH3

PROJECT: Proposed Residential Development
CLIENT: Lion Trade Ltd.
LOCATION: 211 Armstrong Road
PENETRATION TEST HAMMER: 63.5 kg, Drop, 0.76 mm

PROJECT NUMBER: 211169
DATE OF BORING: 22-1-19
SHEET 1 of 1
DATUM:

DEPTH SCALE (meters)	SOIL PROFILE: DESCRIPTION	DEPTH (m)	STRATA PLOT	ELEV. (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	UNDIST SHEAR STRENGTH x Cu. kPa x / REM SHEAR STRENGTH o Cu. kPa o (0 20 40 60 80 100)	DYNAMIC CONE PENETRATION TEST blows/300 mm (0 20 40 60 80 100)	MOISTURE CONTENT (%)	PIEZOMETER OR STANDPIPE INSTALLATION
	ASPHALTIC CONCRETE	0									
	Grey crushed granular stone (FILL)	0.03									Borehole dry at time of drilling, January 19, 2022.
	Grey brown silty sand, some gravel, cobbles, boulders, trace clay (GLACIAL TILL)	0.23									
0.5											
					1	SS	100				
	Practical refusal on bedrock	0.91									

DEPTH SCALE: 1 to 10
LOGGED: CI
BORING METHOD: Power Auger
AUGER TYPE: 200 mm Hollow Stem
CHECKED: SD

LIST OF ABBREVIATIONS AND TERMINOLOGY

SAMPLE TYPES

AS auger sample
CS chunk sample
DO drive open
MS manual sample
RC rock core
ST slotted tube .
TO thin-walled open Shelby tube
TP thin-walled piston Shelby tube
WS wash sample

PENETRATION RESISTANCE

Standard Penetration Resistance, N
The number of blows by a 63.5 kg hammer dropped 760 millimeter required to drive a 50 mm drive open sampler for a distance of 300 mm. 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 hammer dropped 760 mm to drive a 50 mm diameter, 60° cone attached to 'A' size drill rods for a distance of 300 mm.

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.

SOIL TESTS

C consolidation test
H hydrometer analysis
M sieve analysis
MH sieve and hydrometer analysis
U unconfined compression test
Q undrained triaxial test
V field vane, undisturbed and remolded shear strength

SOIL DESCRIPTIONS

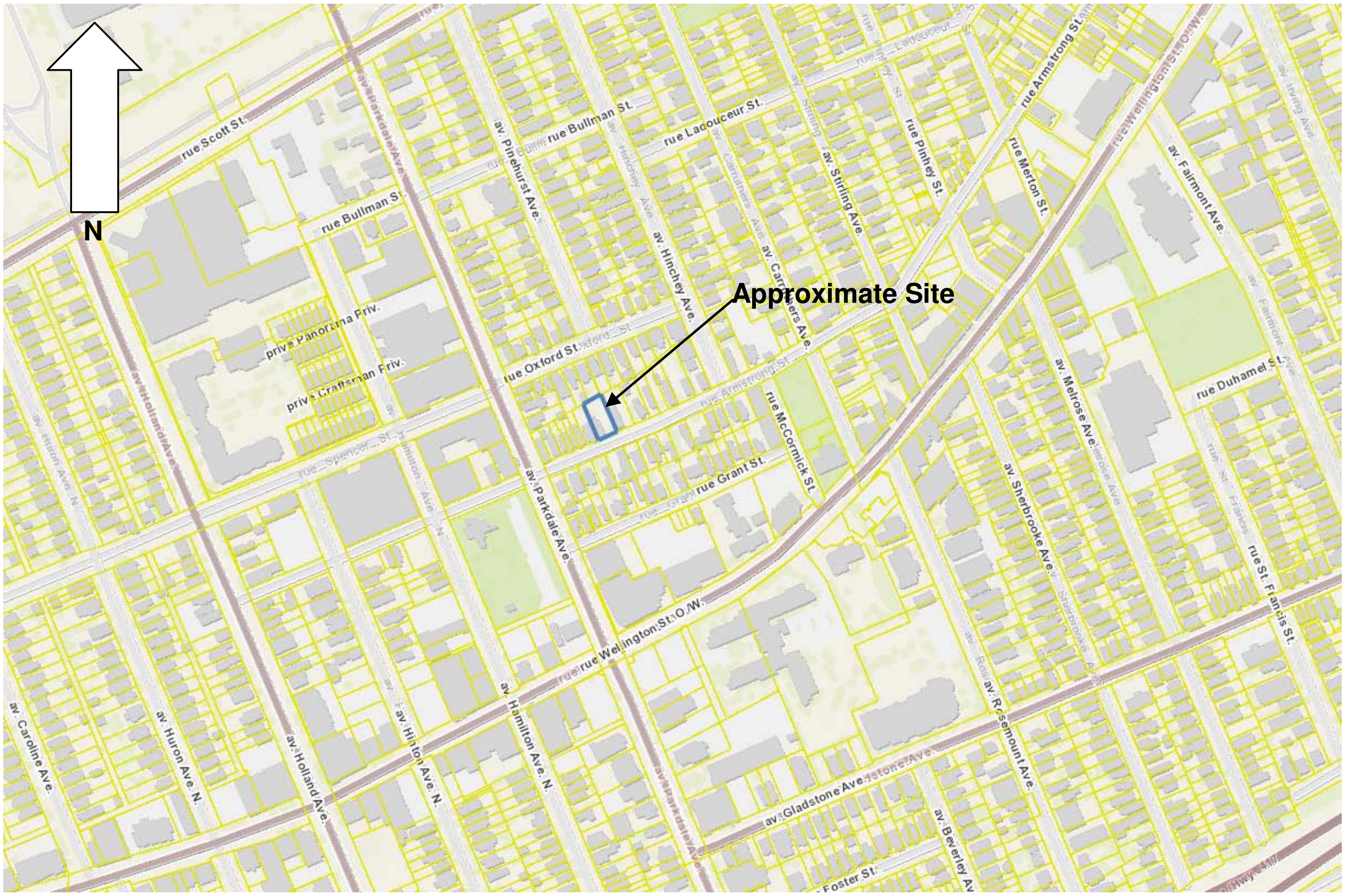
Relative Density	'N' Value
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	over 50

Consistency	Undrained Shear Strength (kPa)
Very soft	0 to 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very Stiff	over 100

LIST OF COMMON SYMBOLS

Cu undrained shear strength
e void ratio
Cc compression index
Cv coefficient of consolidation
k coefficient of permeability
Ip plasticity index
n porosity
u pore pressure
w moisture content
wL liquid limit
Wp plastic limit
$' effective angle of friction
r unit weight of soil
y' unit weight of submerged soil
cr normal stress

KEY PLAN	FIGURE 1



NOT TO SCALE

Kollaard Associates
Engineers

Project No. 211169

Date January 2022

DRAWING NUMBER:
SITE PLAN, FIGURE 2

LEGEND:

APPROXIMATE BOREHOLE LOCATION

REFERENCE: PLAN SUPPLIED BY CITY OF OTTAWA EMAPS

SPECIAL NOTE: THIS DRAWING TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

REV.	NAME	DATE	DESCRIPTION

Kollaard Associates
Engineers
PO, BOX 189, 210 PRESCOTT ST
KEMPTVILLE ONTARIO
K0G 1J0 FAX (613) 258-0475
http://www.kollaard.ca
(613) 860-0923
info@kollaard.ca

CLIENT:
LION TRADE LTD.

PROJECT:
GEOTECHNICAL INVESTIGATION FOR PROPOSED RESIDENTIAL DEVELOPMENT

LOCATION:
211 ARMSTRONG STREET
CITY OF OTTAWA, ON

DESIGNED BY: --	DATE: January 24, 2022
DRAWN BY: CI	SCALE: N.T.S

KOLLAARD FILE NUMBER:
211169

Laboratory Test Results for Physical Properties

Kollaard Associates (Kemptville)
ATTN: Dean Tataryn
210 Prescott Street Unit 1
P.O. Box 189
Kemptville ON K0G 1J0

Date Received: 25-JAN-22
Report Date: 01-FEB-22 14:26 (MT)
Version: FINAL

Client Phone: 613-860-0923

Certificate of Analysis

Lab Work Order #: L2681336

Project P.O. #:	NOT SUBMITTED
Job Reference:	211169
C of C Numbers:	
Legal Site Desc:	

Costas Farassoglou
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2681336-1 211169 BH1-SS2 2.5-4.5 FT Sampled By: CLIENT on 19-JAN-22 @ 12:00 Matrix: SOIL							
Physical Tests							
Conductivity	0.119		0.0040	mS/cm		28-JAN-22	R5711559
% Moisture	7.58		0.25	%	26-JAN-22	26-JAN-22	R5709237
pH	7.70		0.10	pH units		27-JAN-22	R5710076
Resistivity	8380		1.0	ohm*cm		28-JAN-22	
Leachable Anions & Nutrients							
Chloride	0.00771		0.00050	%	28-JAN-22	31-JAN-22	R5712341
Anions and Nutrients							
Sulphate	0.0031		0.0020	%	28-JAN-22	31-JAN-22	R5712341

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0

5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

EC-WT	Soil	Conductivity (EC)	MOEE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

MOISTURE-WT	Soil	% Moisture	CCME PHC in Soil - Tier 1 (mod)
PH-WT	Soil	pH	MOEE E3137A

A minimum 10g portion of the sample is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	APHA 2510 B

"Soil Resistivity (calculated)" is determined as the inverse of the conductivity of a 2:1 water:soil leachate (dry weight). This method is intended as a rapid approximation for Soil Resistivity. Where high accuracy results are required, direct measurement of Soil Resistivity by the Wenner Four-Electrode Method (ASTM G57) is recommended.

SO4-WT	Soil	Sulphate	EPA 300.0

5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid weight of sample
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: Kollaard Associates (Kemptville)
210 Prescott Street Unit 1 P.O. Box 189
Kemptville ON K0G 1J0
Contact: Dean Tataryn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-R511-WT	Soil							
Batch R5712341								
WG3690400-7 CRM		**AN-CRM-WT**						
Chloride			84.6		%		70-130	31-JAN-22
WG3690400-8 DUP		**WG3690400-9**						
Chloride		76.9	77.5		ug/g	0.7	30	31-JAN-22
WG3690400-6 LCS								
Chloride			101.2		%		80-120	31-JAN-22
WG3690400-5 MB								
Chloride			<5.0		ug/g		5	31-JAN-22
EC-WT	Soil							
Batch R5711559								
WG3690324-9 DUP		**WG3690324-8**						
Conductivity		1.57	1.64		mS/cm	4.6	20	28-JAN-22
WG3690324-7 IRM		**WT SAR4**						
Conductivity			111.8		%		70-130	28-JAN-22
WG3690413-1 LCS								
Conductivity			91.6		%		90-110	28-JAN-22
WG3690324-6 MB								
Conductivity			<0.0040		mS/cm		0.004	28-JAN-22
MOISTURE-WT	Soil							
Batch R5709237								
WG3689411-3 DUP		**L2681632-42**						
% Moisture		35.0	35.5		%	1.5	20	26-JAN-22
WG3689411-2 LCS								
% Moisture			100.6		%		90-110	26-JAN-22
WG3689411-1 MB								
% Moisture			<0.25		%		0.25	26-JAN-22
PH-WT	Soil							
Batch R5710076								
WG3689463-1 DUP		**L2681308-3**						
pH		8.04	7.99	J	pH units	0.05	0.3	27-JAN-22
WG3689592-1 LCS								
pH			7.00		pH units		6.9-7.1	27-JAN-22
SO4-WT	Soil							
Batch R5712341								
WG3690400-7 CRM		**AN-CRM-WT**						
Sulphate			103.8		%		60-140	31-JAN-22
WG3690400-8 DUP		**WG3690400-9**						

Quality Control Report

Workorder: L2681336 Report Date: 01-FEB-22

Client: Kollaard Associates (Kemptville)
210 Prescott Street Unit 1 P.O. Box 189
Kemptville ON K0G 1J0

Contact: Dean Tataryn

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-WT	Soil							
Batch R5712341								
WG3690400-8 DUP		**WG3690400-9**						
Sulphate		31	31		ug/g	0.9	25	31-JAN-22
WG3690400-6 LCS								
Sulphate			102.3		%		70-130	31-JAN-22
WG3690400-5 MB								
Sulphate			<20		ug/g		20	31-JAN-22

Quality Control Report

Workorder: L2681336 Report Date: 01-FEB-22

Client:	Kollaard Associates (Kemptville) 210 Prescott Street Unit 1 P.O. Box 189 Kemptville ON K0G 1J0
Contact:	Dean Tataryn

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 98

L2681336-COFC

COC Number: 17 -

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Kollaard Associates (27196)
Contact:	Dean Tataryn
Phone:	613.860.0923, ext.225
	Company address below will appear on the final report
Street:	210 Prescott Street, Unit 1 P.O. Box 189
City/Province:	Kemptville, Ontario
Postal Code:	K0G 1J0

Invoice To	
Same as Report To	☐ YES ☐ NO
Copy of Invoice with Report	☐ YES ☐ NO
Company:	
Contact:	

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report ☐ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☐ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax dean@kollaard.ca
Email 2
Email 3

Invoice Distribution
Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax mary@kollaard.ca
Email 2

Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] ☒ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] ☐ 3 day [P3-25%] ☐ 2 day [P2-50%] ☐

EMERGENCY: 1 Business day [E1 - 100%] ☐ Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:	Q71021
Job #:	211169
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only): L2681336

ALS Contact: Melanie M. Sampler:

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Corrosivity (KOLLAARD-CORR-WT)	VOC, F1-F4 (VOC-R511-F1-F4)	Metals & Inorganics (R511-Inorganics)	PAH (PAH-511-WT)	BTEX / F1-F4	SAMPLES ON HOLD	Sample is hazardous (please provide further details)	NUMBER OF CONTAINERS
	211169 BH1-SS2 2.5 4.5ft	Jan 19 2022	12 00	Soil	✓							1

Drinking Water (DW) Samples[1] (client use)
Are samples taken from a Regulated DW System? ☐ YES ☐ NO
Are samples for human consumption/ use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)
Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☒
INITIAL COOLER TEMPERATURES °C: 14.8
FINAL COOLER TEMPERATURES °C: 3.6

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: [signature]	Date: Jan 24 2022	Time: 1:30	Received by: [signature]	Date: 25 Jan	Time: 10:00	Received by: [signature]	Date: 26 JAN '22	Time: 10:30

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY SEPT 2017 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

National Building Code Seismic Hazard Calculation

2015 National Building Code Seismic Hazard Calculation

INFORMATION: **Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836**
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 45.402N 75.729W **User File Reference:** 211 Armstrong Street 2022-01-21 16:57 UT

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.442	0.244	0.146	0.044
Sa (0.1)	0.518	0.296	0.184	0.060
Sa (0.2)	0.435	0.252	0.159	0.054
Sa (0.3)	0.331	0.193	0.123	0.043
Sa (0.5)	0.235	0.137	0.087	0.031
Sa (1.0)	0.117	0.069	0.044	0.015
Sa (2.0)	0.056	0.032	0.020	0.006
Sa (5.0)	0.015	0.008	0.005	0.001
Sa (10.0)	0.005	0.003	0.002	0.001
PGA (g)	0.278	0.161	0.100	0.032
PGV (m/s)	0.195	0.110	0.067	0.021

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

Natural Resources Canada Ressources naturelles Canada

Canada