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REPORT ON

GEOTECHNICAL INVESTIGATION
PROPOSED MIXED USE DEVELOPMENT
257 McARTHUR AVENUE
CITY OF OTTAWA, ONTARIO

Project # 180140

Submitted to:

Bergeron Construction
172 St. Thomas Road
Vars, Ontario
K0A 3H0

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January 29, 2019

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RE: GEOTECHNICAL INVESTIGATION
PROPOSED MIXED USE DEVELOPMENT
257 McARTHUR AVENUE
CITY OF OTTAWA, ONTARIO

Dear Sirs:

1. INTRODUCTION

Kollaard Associates Inc was retained by Bergeron Construction to complete a geotechnical investigation for a proposed two storey, multi-use development to be located at 257 McArthur Avenue, Ottawa, Ontario. The purpose of the investigation was to: identify the subsurface conditions at the site based on a limited number of boreholes; provide geotechnical recommendations and guidelines on the geotechnical engineering aspects of the project design; including construction considerations, which could influence design decisions.

2. BACKGROUND INFORMATION AND SITE GEOLOGY

Plans are being prepared to construct a two storey multi-use building with a plan area of about 246 square metre (2646 square feet) at 257 McArthur Avenue in the City of Ottawa, Ontario (see Key Plan, Figure 1). The site has a total of about 0.07 hectares (697 square metres) and is currently occupied by an existing three storey building and a detached garage. The remainder of the property not occupied by the building or garage is asphaltic surfaced. The building is currently vacant. The site has about 22.9 metres of frontage onto McArthur Avenue. The site is located on the north side of McArthur Avenue, about 445 metres east of the intersection of Vanier Parkway and McArthur Avenue, City of Ottawa, Ontario.

Preliminary plans indicate that the proposed building will be brick clad wood framed construction with cast in place concrete foundations and a concrete slab on grade floor.

Surrounding land use is a mix of residential, commercial and institutional development. The site is bordered on the west and north by institutional development (Horizon-Jeunesse Elementary School), on the east by commercial development (Eastview Animal Hospital) and on the south by McArthur Avenue followed by a City of Ottawa office (Vanier Depot and City of Ottawa Community Police Centre).

The local topography is relatively flat with a low slope from north to south across the property. The regional topography slopes downward moving east towards the Rideau River located approximately 950 metres east of the subject site.

Based on a review of available surficial geology maps, available borehole logs and well record information, it is expected that the site is underlain by deposits of silt and clay with minor sand and gravel. Bedrock geology maps indicate that the bedrock underlying the site consists of shale of the Billings Formation. The information indicates about a 4-9 metre thickness of clay above shale bedrock.

3. FIELD INVESTIGATION

The field work for this investigation was carried out on March 28, 2018 at which time three boreholes, numbered BH1, BH2 and BH3 were put down at the site using a track mounted drill rig equipped with a hollow stem auger owned and operated by Marathon Drilling of Greely, Ontario.

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 to depths ranging from about 5.5 to 7.0 metres below the existing ground surface (ASTM D-1586 – Penetration Test and Split Barrel Sampling of Soils) and in situ vane shear testing (ASTM D-2573 Standard Test Method for Field Shear Test in Cohesive Soil).

The subsurface soil conditions at the boreholes were identified based on visual examination of the samples recovered (ASTM D2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), and standard penetration tests (ASTM D-1586) as well as laboratory test results on select samples. Groundwater conditions at the borehole was noted at the time of drilling and in a standpipe installed in BH1 at a later date. The other boreholes were loosely backfilled with the auger cuttings upon completion of drilling.

Two soil samples (BH1 and BH2) were submitted for Hydrometer testing (ASTM D422) and Moisture Content testing (ASTM D2216). The soils were classified using the Unified Soil Classification System. A sample of soil obtained from BH2 was also delivered to a chemical laboratory for testing for any indication of potential soil sulphate attack and soil corrosion on buried concrete and steel.

The field work was supervised throughout by a member 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 are 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 location of the boreholes are shown on the attached Site Plan, Figure 2.

4. 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.

The soil descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification was in general completed by visual-manual procedures in accordance with ASTM 2488 - Standard Practice for Description and

Identification of Soils (Visual-Manual Procedure) with select samples being classified by laboratory testing in accordance with ASTM 2487. 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. Asphaltic Concrete

From the ground surface at BH2 and BH3, a layer of asphaltic concrete measuring between about 30 to 40 millimetres was encountered. The asphaltic concrete was fully penetrated.

4.3. Granular Fill

Granular fill was encountered from the surface at BH1 and beneath the asphaltic concrete at BH2 and BH3. The granular fill consisted of grey crushed stone. The granular fill ranged in thickness from about 300 to 850 millimetres between the borehole locations. The fill materials were fully penetrated at the borehole locations.

4.4. Fill

Fill materials consisting of a mixture of silty sand with a trace clay or silty clay with a trace of sand and brick were encountered beneath the granular fill at all of the boreholes. The fill thickness ranged from about 0.75 metres to about 1.5 metres in the boreholes and was encountered at between about 0.3 to 1.8 metres below the existing ground surface. The results of standard penetration testing carried out in the fill materials ranged from 9 to 12 blows per 0.3 metres with an average value of 10 blows per 0.3 metres, indicating a loose to compact state of packing. The fill materials were fully penetrated at all of the boreholes.

4.5. Silty Clay

A thin layer of yellow brown silty clay was encountered below the fill materials at BH3. The borehole was terminated in the silty clay at a depth of 1.8 metres below the existing ground surface.

4.6. Glacial Till

A deposit of grey/black glacial till was encountered beneath the silty clay layer at BH1 and BH2. The glacial till consists of gravel and possible cobbles and boulders in a matrix of silty sand with some clay and shale fragments. The results of standard penetration testing carried out in the glacial till material at BH1 ranged from 11 to 37 and at BH2 ranged from 10 to 71 blows per 0.3 metres with an average value of 26 and 45 blows per 0.3 metres (for BH1 and BH2 respectively), indicating a compact to dense state of packing.

At a depth of some 6.17 and 5.94 metres at BH1 and BH2, respectively, below the existing ground surface, refusal to further advancement of the standard penetration split spoon on either large boulders or bedrock was encountered.

Two soil samples of glacial till (BH1 - SS4 - 2.28 to 2.89 metres and BH2 - SS5 - 3.05 to 3.66 metres) were submitted to Stantec for particle size analysis (ASTM D2216) and moisture content (ASTM D422). The results of the particle size analysis testing indicated that the samples consists of about 8 to 10 percent clay, 43 to 44 percent fine to coarse sand and about 18 to 25 percent gravel. Both samples are indicated to have between about 32 to 35 percent silt and clay size particles. The results are located in Attachment A.

4.7. Groundwater

Groundwater was encountered in borehole BH2 at the time of drilling on March 28, 2018 at about 4.5 metres below the existing ground surface. Groundwater was measured in a standpipe installed within BH2 at a depth of about 4.0 metres below the existing ground surface on April 11, 2018.

4.8. 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 %	0.006	Negligible
pH	5.0 < pH	7.98	Negligible concern
Resistivity	R < 20,000 ohm-cm	3450	Corrosive
Sulphates (SO_4)	SO_4 > 0.1%	0.01	Negligible concern

The results of the laboratory testing of a soil sample for sulphate gave a percent sulphate of 0.01. 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 7.98, 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 and reinforcement will not be exposed to attack from acids.

The results of the laboratory testing of a soil sample for resistivity and pH indicates the soil sample tested has an underground corrosion rate of about 0.75 loss-oz./ft^2/yr (3450 ohm-cm). Based on the findings of Fischer and Bue (1981) underground corrosion rates (loss-oz./ft^2/yr) of 0.30 and less are considered nonaggresive, from 0.30 to 0.75 the rate is considered slightly aggressive, from 0.75 to 2.0 the rate is considered aggressive and 2.0 and greater the rate is considered very aggressive. Accordingly, the above mentioned soil sample is considered to have a slightly to highly aggressive corrosion rate to reinforcement steel within below grade concrete walls.

Soil resistivity was found to be 3.45 ohm-m for the sample analyzed. Consideration to increasing the specified strength and/or adding air entrainment into any reinforced concrete in contact with the soil should be given. Protection is required for reinforcement steel within the concrete walls.

5. GEOTECHNICAL DESIGN 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 Excavation

A review of the grading plan for the proposed development prepared by Kollaard Associates Inc drawing 180140-GEC indicates that the proposed building will be founded at an elevation of about 60.50 metres or about 3.5 metres below the existing ground surface. It is understood that proposed building will be set back from the side yard property lines by about 3.0 metres and the front property line by about 2.0 metres. Since it is normal procedure to over excavate by 1 metre in order to facilitate the installation and removal of form work, it is anticipated that the excavation will extend to about 2 metres from the side yard property lines.

In accordance with O.Reg 213/91, s. 226, the upper soils at this site can be considered to be Type 2 soil. As such, open cut excavations which result in confined spaces within the upper soil deposits at this site above the ground water level should be carried out with side slopes of 1 horizontal to 1 vertical, or flatter to within 1.2 metres of the bottom of the excavation.

There should be no excavated material stockpiled with a distance from the excavation equal to the depth of excavation. If there is insufficient space to provide adequate side slopes, the excavation will require shoring on all sides. The shoring should be designed by a shoring specialist to support the lateral earth pressure ‘p’ plus the additional surcharge load of the adjacent row house building. The lateral earth pressure 'p' can be calculated using the following equation:

$$p = k(\gamma h + q) + \gamma_w H$$

Where p = the lateral earth pressure, at any depth, h, below the ground surface
k = earth pressure coefficient of 0.35
γ = unit weight of soil to be retained, estimated at 20 kN/m^3
h = the depth, in metres, at which pressure, p, is being computed
γ_w = unit weight of water (9.81 kN/m^3)
H = height of water level, in metres, from bottom of the excavation
q = the equivalent surcharge acting on the ground surface adjacent to the shoring including expected vehicular loads

Alternatively, in keeping with O.Reg 213/91, s. 234 a written opinion could be provided by a professional engineer at the time of excavation that the walls of the walls of the excavation are sufficiently stable that no worker will be endangered if no support system is used.

5.3. Ground Water in Excavation and Construction Dewatering

Groundwater inflow from the native soils into the basement excavations during construction, if any should be handled by pumping from sumps within the excavation.

Since ground water was observed at about 4.5 metres below the ground surface at time of drilling and measured at 4.0 metres below the ground surface in the stand pipe, it is considered that the excavation should not extend below the ground water level. As such a permit to take water is will not be required prior to excavation.

5.4. Effect of Dewatering of Foundation or Site Services Excavations on Adjacent Structures

Since the existing ground water level at the site is will be below the expected underside of footing elevation, dewatering of the excavation will not remove water from historically saturated soils. In addition soils encountered at the ground water level at the site consist of glacial till which is not sensitive to changing moisture conditions. As such dewatering of the foundation or site services excavations, if required, will not have a detrimental impact on the adjacent structures.

5.5. Foundation for Proposed Mixed-Use Building

5.5.1. Foundation Design and Bearing Capacity

With the exception of any surficial fill and topsoil, the subsurface conditions encountered at the boreholes advanced during the investigation are suitable for the support of the proposed multi-use building on conventional spread footing foundations. The excavations for the foundations should be taken down through any surficial fill, topsoil or otherwise deleterious material to expose the native, undisturbed glacial till. The subgrade surface should then be inspected and approved by geotechnical personnel. The excavations within the glacial till above the groundwater level should not present any serious constraints.

The allowable bearing pressure for any footings depends on the depth of the footings below original ground surface, the width of the footings, and the height above the original ground surface of any landscape grade raise adjacent to the dwelling foundation.

Strip and pad footings, a minimum 0.5 metres in width bearing on the native undisturbed glacial till at a founding depth of a minimum of 1.8 metres below the original ground surface and above the groundwater level may be designed using a maximum allowable bearing pressure of 100 kilopascals for serviceability limit states and 250 kilopascals for the factored ultimate bearing resistance.

The above allowable bearing pressure is subject to a maximum grade raise of 1.5 metres above the original ground surface and to maximum strip and pad footing widths of 1.5 metres.

Provided that any loose and/or disturbed soil is removed from the bearing surfaces prior to pouring concrete, the total and differential settlement of the footings should be less than 25 millimetres and 20 millimetres, respectively.

Any fill required to raise the footings for the proposed building to founding level should consist of imported granular material (engineered fill). To allow the spread of load beneath the footings, the engineered fill should extend down and out from the edges of the footing at 1 horizontal to 1 vertical, or flatter. The excavations for the proposed building should be sized to accommodate this fill placement. 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 98 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.

The native silty sand soils within the glacial till at this site will be sensitive to disturbance from construction operations and from rainwater or snowmelt, 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.

5.5.2. Frost Protection Requirements

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.

5.5.3. Slab on Grade Support

As stated above, it is expected that the proposed building will be founded on engineered fill or on native glacial till. For predictable performance of the proposed concrete floor slab all soft or loose and any deleterious material should be removed within the proposed building area. The exposed native sub-grade surface should then be inspected and approved by geotechnical personnel.

Engineered fill materials provided to support the concrete floor slab should consist of sand, or sand and gravel meeting the Ontario Provincial Standards Specifications (OPSS) for Granular B Type I or crushed stone meeting OPSS grading requirements for Granular B Type II. A minimum 150 millimetre thickness of crushed stone meeting OPSS Granular A should be provided immediately beneath the concrete floor slab. The engineered fill materials should be compacted in maximum 300 millimetre thick lifts to at least 98 percent of the standard Proctor maximum dry density. Alternatively clear crushed 20 mm minus stone could be used immediately below the concrete floor slab provided the clear stone is well compacted prior to concrete placement.

The concrete floor slab should be saw cut at regular intervals to minimize random cracking of the slab due to shrinkage and expansion 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..

5.5.4. Foundation Wall Backfill and Drainage

To prevent possible foundation frost jacking due to frost adhesion, the backfill against the foundation walls or isolated 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 grading requirements. Alternatively, foundations could be backfilled with native material in conjunction with the use of an approved proprietary drainage layer system such as "System Platon" against the foundation wall. It is pointed out that 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. This could be mitigated by backfilling the upper approximately 0.6 metres with non-frost susceptible granular material.

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

A conventional, perforated perimeter drain, with a 150 millimetre surround of 20 millimetre minus crushed stone, should be provided at founding level and should lead by gravity flow to a sump. The sump should be equipped with a backup pump and generator. 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 sump. The sump discharge should be equipped with a backup flow protector.

5.6. Seismic Design for the Proposed Mixed-Use Building

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 is Site Class C.

Seismic Site Response Site Class Calculation

Borehole 1					
Layer	Description	Depth (m)	d_i (m)	$N(60)_i$ (blows/0.3m)	d_i/N_i (blows/0.3m)
2	Glacial Till	3.5	2.7	30	0.090
3	Bedrock	6.2	27.3	100	0.273
$sum(d_i/N(60)_i)$					0.363
$d_c/(sum(d_i/N(60)_i)$					82.6

Since the N(60) = 82.6 > 50, the seismic site response is Site Class C.

5.6.1. Potential for Soil Liquefaction

It is considered that a soil with a normalized SPT of greater than 30 is non-liquefiable. Since the average standard penetration results of the glacial till below the proposed founding level are greater than 30 and there is less than 3 metres of soil between the underside of footing and the underlying bedrock, the underlying soils below the proposed foundation are not considered to be liquefiable.

5.6.2. National Building Code Seismic Hazard Calculation

The design Peak Ground Acceleration (PGA) for the site was calculated as 0.282 with about a 3% 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.

5.7. SITE SERVICES

5.7.1. Excavation

The excavations for the site services will be carried out through fill materials and glacial till. For the purposes of Ontario Regulation 213/91 the soils at the site can be considered to be Type 2 soil. 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. That is, open cut excavations with overburden deposits should be carried out with side slopes of 1 horizontal to 1 vertical, or flatter. Where space constraints dictate, the excavation and backfilling operations should be carried out within a tightly fitting, braced steel trench box.

Based on the depths at which groundwater was measured within the standpipe installed in boreholes BH2, significant groundwater flow into any excavation is unlikely. Any groundwater inflow into the service trenches should be handled by pumping from sumps from within the excavations.

5.7.2. 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 subgrade 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 or Granular B Type I (with a maximum particle size of 25 millimetres).

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.

5.7.3. 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 pavement areas, acceptable native materials should be used as backfill between the pavement subgrade level and the depth of seasonal frost penetration (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.

Where native backfill is used, it should match the native materials exposed on the trench walls. Some of the native materials from the lower part of the trench excavations may be wet of optimum for compaction. Depending on the weather conditions encountered during construction, some drying of materials and/or recompaction may be required. Any wet materials that cannot be compacted to the required density should either be wasted from the site or should be used outside of existing or future roadway areas. 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. If the native material is not suitable for backfill, imported granular material may have to be used. If 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 subgrade for the parking areas, 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 to 90 percent 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.

5.8. ACCESS ROADWAY AND PARKING AREA PAVEMENTS

Based on the results of the boreholes, the subsurface conditions in the access roadway and parking areas consist of existing asphaltic concrete followed by grey crushed stone overlying silty sand/silty clay fill materials overlying native glacial till. For predictable performance of the pavement structures, it is considered that all of the existing asphaltic concrete will have to be removed in preparation for pavement construction at this site. It is considered that any granular crushed stone fill material that is free of topsoil or organic debris may be stockpiled and upon approval by the engineer used to raise the subgrade of the access roadway and parking areas to the proposed underside of access roadway and subbase elevation of the parking lot.

Once existing asphaltic concrete and granular crushed stone and any deleterious material has been removed, the exposed sub-grade should be inspected and approved by geotechnical personnel and any soft areas evident should be sub-excavated and replaced with suitable earth borrow or granular crushed stone approved by the geotechnical engineer. The sub-grade should be shaped and crowned to promote drainage of the roadway area granular. Following approval of the preparation of the sub-grade, the pavement granulars may be placed.

For any areas of the site that require the sub-grade to be raised to proposed pavement sub-grade level, the material used should consist of OPSS select sub-grade material or OPSS Granular B Type I or Type II. Recycled crushed concrete meeting the grading specifications for Granular B Type II could also be used. Materials used for raising the sub-grade to proposed roadway area sub-grade level should be placed in maximum 300 millimetre thick loose lifts and be compacted to at least 95 percent of the standard Proctor maximum dry density using suitable compaction equipment.

For pavement areas subject to cars and light trucks the pavement should consist of:

50 millimetres of Superpave 12.5 asphaltic concrete over
150 millimetres of OPSS Granular A base over
300 millimetres of OPSS Granular B, Type II subbase over
(50 or 100 millimetre minus crushed stone)
Non-woven geotextile fabric (4 oz/sy) such as Terrafix 270R or Thrace-Ling 130EX or approved alternative.

For pavement areas subject to heavy truck loading the pavement should consist of:

40 millimetres of hot mix asphaltic concrete (HL3) over
40 millimetres of hot mix asphaltic concrete (HL8) over
150 millimetres of OPSS Granular A base over
350 millimetres of OPSS Granular B, Type II subbase
(50 or 100 millimetre minus crushed stone)
Non-woven geotextile fabric (4 oz/sy) such as Terrafix 270R or Thrace-Ling 130EX or approved alternative.

Performance grade PG 58-34 asphaltic concrete should be specified. Compaction of the granular pavement materials should be carried out in maximum 300 millimetre thick loose lifts to 100 percent of the standard Proctor maximum dry density value using suitable vibratory compaction equipment.

The above pavement structures will be adequate on an acceptable sub-grade, that is, one where any roadway fill and service trench backfill has been adequately compacted. If the roadway sub-grade is disturbed or wetted due to construction operations or precipitation, the granular thicknesses given above may not be adequate and it may be necessary to increase the thickness of the Granular B Type II subbase. The adequacy of the design of the pavement thickness should be assessed by the geotechnical personnel at the time of construction.

6. CONSTRUCTION CONSIDERATIONS

It is suggested that the final design drawings for the project, including the proposed site grading plan, be reviewed by the geotechnical engineer to ensure that the guidelines provided in this report have been interpreted as intended and to re-evaluate the guidelines provided in the report with respect to the actual project plans. Items such as actual foundation wall/column loads, etc could have significant impacts on foundation type, frost protection requirements, etc.

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 building should be inspected by Kollaard Associates Inc. to ensure that a suitable subgrade 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, access roadway and parking areas 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 silt and silty clay deposits within the fill materials 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
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Dean Tataryn, B.E.S., EP.

Steve DeWit, P.Eng.

Attachments: Record of Boreholes
Figures 1 and 2
Laboratory Test Results for Chemical Properties
Laboratory Test Results for Physical Properties – Stantec Laboratory Test Results for Soils

RECORD OF BOREHOLE BH1

PROJECT: Proposed Three Storey Multi Use Development
CLIENT: Bergeron Construction
LOCATION: 257 McArthur Avenue, Ottawa, ON
PENETRATION TEST HAMMER: 63.5kg, Drop, 0.76mm

PROJECT NUMBER: 180140
DATE OF BORING: March 28, 2018
SHEET 1 of 1
DATUM:

DESCRIPTION	ELEV. DEPTH (M)	NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
Ground Surface					
Grey crushed stone (FILL)	0.00	1	SS	13	
Grey brown silty clay, trace sand and brick (FILL)	0.30				
Yellow brown silty sand, trace clay (FILL)	0.60	2	SS	12	
Grey/Black silty sand, trace gravel, cobbles, boulders and clay (GLACIAL TILL)	1.80	3	SS	11	
		4	SS	33	
		5	SS	22	
		6	SS	18	Borehole dry, March 28, 2018.
		7	SS	35	
		8	SS	37	
		9		50	
End of Borehole, refusal on large boulders or bedrock	6.17				

Column headings (no values plotted): SOIL PROFILE; STRATA PLOT; SAMPLES; UNDIST. SHEAR STRENGTH × Cu, kPa × 20 40 60 80; REM. SHEAR STRENGTH ○ Cu, kPa ○ 20 40 60 80; DYNAMIC CONE PENETRATION TEST blows/300 mm 10 30 50 70 90; ADDITIONAL LAB TESTING; DEPTH SCALE (meters) 0 1 2 3 4 5 6 7 8

DEPTH SCALE: 1 to 50
BORING METHOD: Power Auger
AUGER TYPE: 200 mm Hollow Stem
LOGGED: DT
CHECKED: SD

RECORD OF BOREHOLE BH2

PROJECT: Proposed Three Storey Multi-Use Building
CLIENT: 2465070 Ontario Ltd.
LOCATION: 257 McArthur Avenue, Ottawa, ON
PENETRATION TEST HAMMER: 63.5kg, Drop, 0.76mm

PROJECT NUMBER: 180140
DATE OF BORING: March 28, 2018
SHEET 1 of 1
DATUM:

DEPTH SCALE (meters)	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	UNDIST. SHEAR STRENGTH × Cu, kPa 20 40 60 80 / REM. SHEAR STRENGTH ○ Cu, kPa 20 40 60 80	DYNAMIC CONE PENETRATION TEST blows/300 mm 10 30 50 70 90	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	Ground Surface									
0	ASPHALTIC CONCRETE		0.00							
	Grey crushed stone (FILL)			1	SS	17				
1	Yellow brown to grey brown silty clay (FILL)		0.85	2	SS	9				
2	Grey black silty sand, trace to some clay, gravel, cobbles (GLACIAL TILL)		1.82	3	SS	10				
				4	SS	45				
3				5	SS	59				
4				6	SS	31				
5				7	SS	71				
				8	SS	51				
6	Practical Refusal on Bedrock or large boulder		5.94							Water observed in borehole at approximately 4.5 metres below the existing ground surface on March 28, 2018. Water level measured in standpipe at about 4.0 metres below existing ground surface, April 11, 2018.
7										
8										

DEPTH SCALE: 1 to 50
BORING METHOD: Power Auger
AUGER TYPE: 200 mm Hollow Stem
LOGGED: DT
CHECKED: SD

RECORD OF BOREHOLE BH3

PROJECT: Proposed Three Storey Multi Use Development
CLIENT: Bergeron Construction
LOCATION: 257 McArthur Avenue, Ottawa, ON
PENETRATION TEST HAMMER: 63.5kg, Drop, 0.76mm

PROJECT NUMBER: 180140
DATE OF BORING: March 28, 2018
SHEET 1 of 1
DATUM:

DEPTH SCALE (meters)	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	UNDIST. SHEAR STRENGTH × Cu, kPa × 20 40 60 80 / REM. SHEAR STRENGTH ○ Cu, kPa ○ 20 40 60 80	DYNAMIC CONE PENETRATION TEST blows/300 mm 10 30 50 70 90	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	Ground Surface									
0	ASPHALTIC CONCRETE		0.00							
	Grey crushed stone (FILL)									
1	Yellow brown silty sand, trace clay (FILL)		0.85							
	Yellow brown SILTY CLAY		1.60							
2	End of Borehole		1.80							
3										
4										Borehole dry, March 28, 2018.
5										
6										
7										
8										

DEPTH SCALE: 1 to 50
BORING METHOD: Power Auger
AUGER TYPE: 200 mm Hollow Stem
LOGGED: DT
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 drih 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

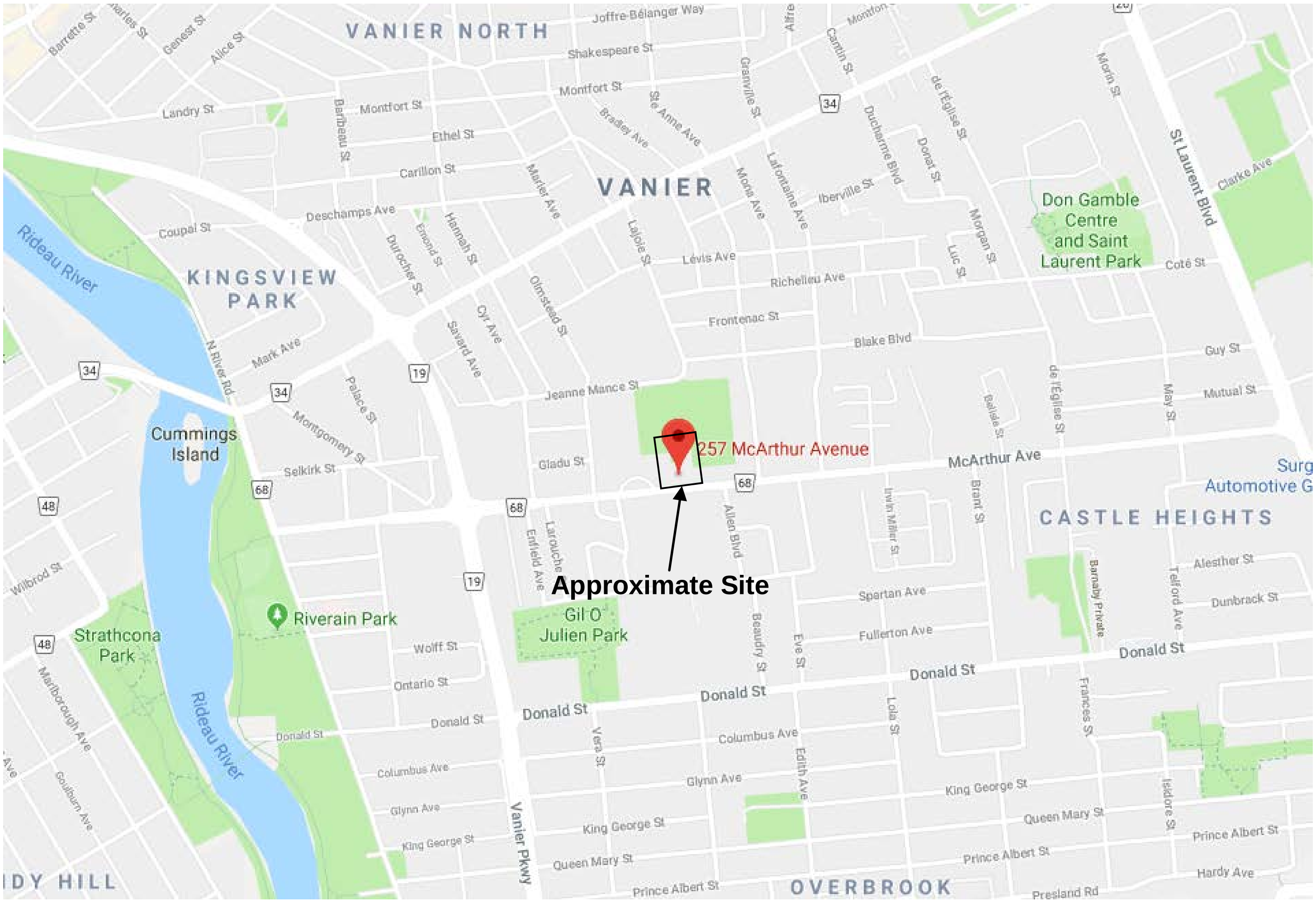
Relative Density	'N' Value
Very Loose	0 to 4
Loose	4 to10
Compact	10 to 30
Dense	30 to 50
Very Dense	over 50

Consistency	Undrained Shear Strength (kPa)
Very soft	0 to 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to100
Very Stiff	over100

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
$1 effective angle of friction
r unit weight of soil
y1 unit weight of submerged soil
cr normal stress

KEY PLAN	FIGURE 1



NOT TO SCALE

Kollaard Associates
Engineers

Project No. 180140

Date April 2018

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KOLLAARD ASSOCIATES INCORPORATED

DRAWING NUMBER:

SITE PLAN, FIGURE 2

LEGEND:

BH1 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:

BERGERON CONSTRUCTION

PROJECT:

GEOTECHNICAL INVESTIGATION FOR PROPOSED THREE STOREY MULTI-USE BUILDING

LOCATION:

257 MCARTHUR AVENUE
CITY OF OTTAWA, ONTARIO

DESIGNED BY:	DATE:
--	APRIL 13, 2018
DRAWN BY:	SCALE:
DT	N.T.S

KOLLAARD FILE NUMBER:

180140

Laboratory Test Results for Chemical Properties

Certificate of Analysis

Environment Testing

Client:	Kollaard Associates Inc. 210 Prescott St., Box 189 Kemptville, ON K0G 1J0	Report Number:	1804530
		Date Submitted:	2018-03-29
		Date Reported:	2018-04-05
		Project:	
		COC #:	194020
Attention:	Mr. Dean Tataryn		
PO#:	180140		
Invoice to:	Kollaard Associates Inc.		

Dear Dean Tataryn:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:

APPROVAL: ______________________________
Addrine Thomas, Inorganics Supervisor

All analysis is completed in Ottawa, Ontario (unless otherwise indicated).

Eurofins Ottawa is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on our CALA scope of accreditation. It can be found at http://www.cala.ca/scopes/2602.pdf.

Eurofins(Ottawa) is certified and accredited for specific parameters by OMAFRA, Ontario Ministry of Agriculture, Food and Rural Affairs (for farm soils). Licensed by Ontario MOE for specific tests in drinking water.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required.

Certificate of Analysis

eurofins Environment Testing

Client:	Kollaard Associates Inc.		Report Number:	1804530
	210 Prescott St., Box 189		Date Submitted:	2018-03-29
	Kemptville, ON		Date Reported:	2018-04-05
	K0G 1J0		Project:	
Attention:	Mr. Dean Tataryn		COC #:	194020
PO#:	180140			
Invoice to:	Kollaard Associates Inc.			

Group	Analyte	MRL	Units	Guideline	Lab I.D. 1351359 Sample Matrix Soil Sample Type Sampling Date 2018-03-28 Sample I.D. BH2 SS4 7/2-9'/2
Agri. - Soil	pH	2.00			7.98
	SO4	0.01	%		0.01
General Chemistry	Cl	0.002	%		0.006
	Electrical Conductivity	0.05	mS/cm		0.29
	Resistivity	1	ohm-cm		3450

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

Certificate of Analysis

Eurofins Environment Testing

Client:	Kollaard Associates Inc. 210 Prescott St., Box 189 Kemptville, ON K0G 1J0	Report Number:	1804530
Attention:	Mr. Dean Tataryn	Date Submitted:	2018-03-29
PO#:	180140	Date Reported:	2018-04-05
Invoice to:	Kollaard Associates Inc.	Project:	
		COC #:	194020

QC Summary

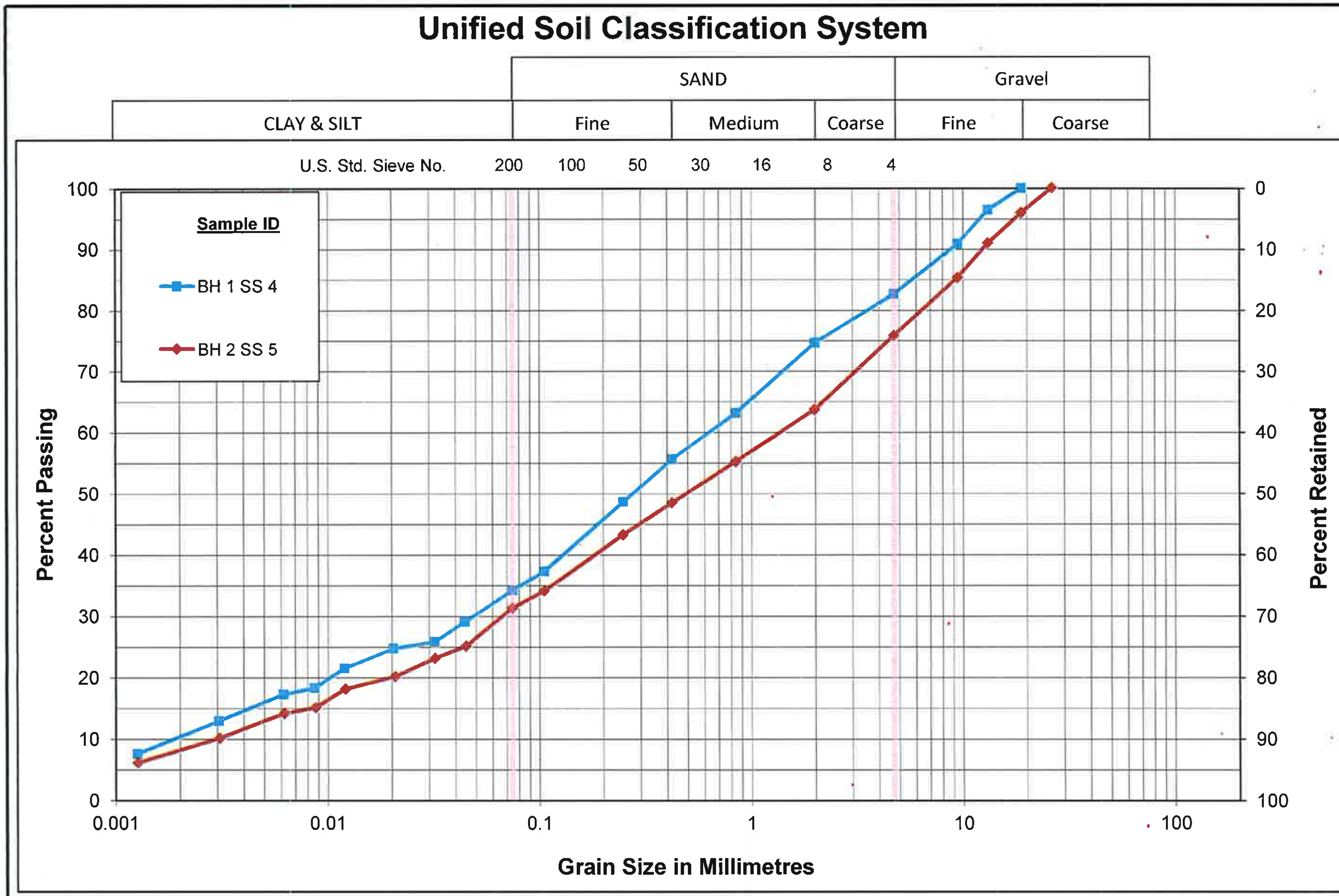
Analyte	Blank	QC % Rec	QC Limits
Run No 342828 **Analysis/Extraction Date** 2018-04-02 **Analyst** C F			
Method Ag Soil			
pH	5.43	100	90-110
Method Cond-Soil			
Electrical Conductivity	<0.05 mS/cm	100	85-115
Method Resistivity - soil			
Resistivity			
Run No 343005 **Analysis/Extraction Date** 2018-04-04 **Analyst** C F			
Method C CSA A23.2-4B			
Chloride		101	90-110
Run No 343045 **Analysis/Extraction Date** 2018-04-05 **Analyst** C F			
Method AG SOIL			
SO4	<0.01 %	90	70-130

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

Laboratory Test Results for Physical Properties



GRAIN SIZE DISTRIBUTION

Kollaard Associates Engineers, File #180140

257 McArthur Avenue

Figure No.

Project No. 122410003

Stantec 2781 Lancaster Road
Ottawa ON, K1B 1A7

Particle-Size Analysis of Soils
LS702
ASSHTO T 88

PROJECT DETAILS

Client:	Kollaard Associates Engineers, File #180140	Project No.:	122410003
Project:	257 McArthur Avenue	Test Method:	LS702
Material Type:	Soil	Sampled By:	Kollaard Associates Engineers
Source:	BH 1	Date Sampled:	March 28, 2018
Sample No.:	SS 4	Tested By:	Daniel Boateng
Sample Depth:	7'6" - 9'6"	Date Tested:	April 5, 2018

WASH TEST DATA

Oven Dry Mass In Hydrometer Analysis (g)	67.98
Sample Weight after Hydrometer and Wash (g)	37.33
Percent Passing No. 200 Sieve (%)	45.1
Percent Passing Corrected (%)	33.65

PERCENT LOSS IN SIEVE

Sample Weight Before Sieve (g)	706.70
Sample Weight After Sieve (g)	706.00
Percent Loss in Sieve (%)	0.10

SOIL INFORMATION

Liquid Limit (LL)		
Plasticity Index (PI)		
Soil Classification		
Specific Gravity (G_s)	2.750	
Sg. Correction Factor (α)	0.978	
Mass of Dispersing Agent/Litre	40	g

CALCULATION OF DRY SOIL MASS

Oven Dried Mass (W_o), (g)	126.87
Air Dried Mass (W_a), (g)	127.53
Hygroscopic Corr. Factor ($F=W_o/W_a$)	0.9948
Air Dried Mass in Analysis (M_a), (g)	68.33
Oven Dried Mass in Analysis (M_o), (g)	67.98
Percent Passing 2.0 mm Sieve (P_{10}), (%)	74.63
Sample Represented (W), (g)	91.09

SIEVE ANALYSIS

Sieve Size mm	Cum. Wt. Retained	Percent Passing
75.0		100.0
63.0		100.0
53.0		100.0
37.5		100.0
26.5		100.0
19.0	0.0	100.0
13.2	25.2	96.4
9.5	64.7	90.8
4.75	122.6	82.7
2.00	179.3	74.6
Total (C + F)[1]	706.00	
0.850	10.48	63.12
0.425	17.34	55.59
0.250	23.71	48.60
0.106	34.02	37.28
0.075	36.85	34.17
PAN	37.32	

Note 1: (C + F) = Coarse + Fine

HYDROMETER DETAILS

Volume of Bulb (V_B), (cm^3)	63.0
Length of Bulb (L_2), (cm)	14.47
Length from '0' Reading to Top of Bulb (L_1), (cm)	10.29
Scale Dimension (h_s), (cm/Div)	0.155
Cross-Sectional Area of Cylinder (A), (cm^2)	27.2
Meniscus Correction (H_m), (g/L)	1.0

START TIME 5:40 AM

HYDROMETER ANALYSIS

Date	Time	Elapsed Time T Mins	H_s Divisions g/L	H_c Divisions g/L	Temperature T_c °C	Corrected Reading $R = H_s - H_c$ g/L	Percent Passing P %	L cm	η Poise	K	Diameter D mm
05-Apr-18	5:41 AM	1	34.0	7.0	19.0	27.0	29.00	10.94191	10.3441	0.0135	0.0445
05-Apr-18	5:42 AM	2	31.0	7.0	19.0	24.0	25.78	11.40691	10.3441	0.0135	0.0321
05-Apr-18	5:45 AM	5	30.0	7.0	19.0	23.0	24.70	11.56191	10.3441	0.0135	0.0205
05-Apr-18	5:55 AM	15	27.0	7.0	19.0	20.0	21.48	12.02691	10.3441	0.0135	0.0120
05-Apr-18	6:10 AM	30	24.0	7.0	19.0	17.0	18.26	12.49191	10.3441	0.0135	0.0087
05-Apr-18	6:40 AM	60	23.0	7.0	19.0	16.0	17.19	12.64691	10.3441	0.0135	0.0062
05-Apr-18	9:50 AM	250	19.0	7.0	20.0	12.0	12.89	13.26691	10.0910	0.0133	0.0031
06-Apr-18	5:40 AM	1440	14.0	7.0	23.0	7.0	7.52	14.04191	9.3925	0.0128	0.0013

Remarks:

Reviewed By: Brian Prevost
Date: April 9/2018

Stantec 2781 Lancaster Road Ottawa ON, K1B 1A7

Particle-Size Analysis of Soils
LS702
ASSHTO T 88

PROJECT DETAILS

Client:	Kollaard Associates Engineers, File #180140	Project No.:	122410003
Project:	257 McArthur Avenue	Test Method:	LS702
Material Type:	Soil	Sampled By:	Kollaard Associates Engineers
Source:	BH 2	Date Sampled:	March 28, 2018
Sample No.:	SS 5	Tested By:	Daniel Boateng
Sample Depth	10' - 12'	Date Tested:	April 5, 2018

WASH TEST DATA

Oven Dry Mass In Hydrometer Analysis (g)	62.01
Sample Weight after Hydrometer and Wash (g)	32.02
Percent Passing No. 200 Sieve (%)	48.4
Percent Passing Corrected (%)	30.76

PERCENT LOSS IN SIEVE

Sample Weight Before Sieve (g)	370.60
Sample Weight After Sieve (g)	370.30
Percent Loss in Sieve (%)	0.08

SOIL INFORMATION

Liquid Limit (LL)		
Plasticity Index (PI)		
Soil Classification		
Specific Gravity (G_s)	2.750	
Sg. Correction Factor (α)	0.978	
Mass of Dispersing Agent/Litre	40	g

CALCULATION OF DRY SOIL MASS

Oven Dried Mass (W_o), (g)	75.10
Air Dried Mass (W_a), (g)	75.40
Hygroscopic Corr. Factor ($F=W_o/W_a$)	0.9960
Air Dried Mass in Analysis (M_a), (g)	62.26
Oven Dried Mass in Analysis (M_o), (g)	62.01
Percent Passing 2.0 mm Sieve (P_{10}), (%)	63.60
Sample Represented (W), (g)	97.50

SIEVE ANALYSIS

Sieve Size mm	Cum. Wt. Retained	Percent Passing
75.0		100.0
63.0		100.0
53.0		100.0
37.5		100.0
26.5	0.0	100.0
19.0	15.1	95.9
13.2	33.6	90.9
9.5	54.6	85.3
4.75	89.8	75.8
2.00	134.9	63.6
Total (C + F)[1]	370.30	
0.850	8.26	55.13
0.425	14.83	48.39
0.250	19.94	43.15
0.106	28.82	34.04
0.075	31.53	31.26
PAN	32.02	

Note 1: (C + F) = Coarse + Fine

HYDROMETER DETAILS

Volume of Bulb (V_B), (cm^3)	63.0
Length of Bulb (L_2), (cm)	14.47
Length from '0' Reading to Top of Bulb (L_1), (cm)	10.29
Scale Dimension (h_s), (cm/Div)	0.155
Cross-Sectional Area of Cylinder (A), (cm^2)	27.2
Meniscus Correction (H_m), (g/L)	1.0

START TIME 5:42 AM

HYDROMETER ANALYSIS

Date	Time	Elapsed Time T Mins	H_s Divisions g/L	H_c Divisions g/L	Temperature T_c °C	Corrected Reading $R = H_s - H_c$ g/L	Percent Passing P %	L cm	η Poise	K	Diameter D mm
5-Apr-18	5:43 AM	1	32.0	7.0	19.0	25.0	25.09	11.25191	10.3441	0.0135	0.0451
5-Apr-18	5:44 AM	2	30.0	7.0	19.0	23.0	23.08	11.56191	10.3441	0.0135	0.0323
5-Apr-18	5:47 AM	5	27.0	7.0	19.0	20.0	20.07	12.02691	10.3441	0.0135	0.0209
5-Apr-18	5:57 AM	15	25.0	7.0	19.0	18.0	18.06	12.33691	10.3441	0.0135	0.0122
5-Apr-18	6:12 AM	30	22.0	7.0	19.0	15.0	15.05	12.80191	10.3441	0.0135	0.0088
5-Apr-18	6:42 AM	60	21.0	7.0	19.0	14.0	14.05	12.95691	10.3441	0.0135	0.0063
5-Apr-18	9:52 AM	250	17.0	7.0	20.0	10.0	10.03	13.57691	10.0910	0.0133	0.0031
6-Apr-18	5:42 AM	1440	13.0	7.0	23	6.0	6.02	14.19691	9.3925	0.0128	0.0013

Remarks:

Reviewed By: Brian Prevost
Date: April 9/2018

V:\01216\active\laboratory_standing_offers\2018 Laboratory Standing Offers\122410003 Kollaard Associate Engineers\March 28, Two Hydos & MCs, Kollaard #180140\Hydrometer Sheet_New, Calculates 20, 5 & 2 microns-May 2017.xlsx

Stantec

2781 Lancaster Rd.
Ottawa ON, K1B 1A7

Determination of Moisture Content of Soil

LS 701 or CSA A23.2-11A
ASTM D2216

Project: Kollaard Associate, File # 180140
Project No.: 122410003

Date Tested: April 2, 2018
Tested By: Brian Prevost

Moisture Content Test Results

Borehole / Test Pit No.		BH-1		BH-2			
Sample		SS4		SS5			
Sample Depth (ft)		7'6"-9'6"		10'-12'			
Moisture Content (%)		**8.5**		**6.8**			
Borehole / Test Pit No.							
Sample							
Sample Depth (ft)							
Moisture Content (%)							
Borehole / Test Pit No.							
Sample							
Sample Depth (ft)							
Moisture Content (%)							
Borehole / Test Pit No.							
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Sample Depth (ft)							
Moisture Content (%)							
Borehole / Test Pit No.							
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Sample Depth (ft)							
Moisture Content (%)							
Borehole / Test Pit No.							
Sample							
Sample Depth (ft)							
Moisture Content (%)							
Borehole / Test Pit No.							
Sample							
Sample Depth (ft)							
Moisture Content (%)							
Borehole / Test Pit No.							
Sample							
Sample Depth (ft)							
Moisture Content (%)							
Borehole / Test Pit No.							
Sample							
Sample Depth (ft)							
Moisture Content (%)							

Reviewed By: Brian Prevost Date: April 9/2018

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

April 13, 2018

Site: 45.4316 N, 75.6583 W   User File Reference: 257 McArthur Avenue, Ottawa, ON

Requested by: ,

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	**Sa(0.2)**	Sa(0.3)	**Sa(0.5)**	**Sa(1.0)**	**Sa(2.0)**	**Sa(5.0)**	**Sa(10.0)**	**PGA (g)**	**PGV (m/s)**
0.450	0.527	**0.442**	0.335	**0.238**	**0.118**	**0.056**	**0.015**	**0.0054**	**0.282**	**0.197**

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" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. 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.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.044	0.150	0.249
Sa(0.1)	0.061	0.188	0.302
Sa(0.2)	0.055	0.162	0.256
Sa(0.3)	0.044	0.125	0.196
Sa(0.5)	0.031	0.089	0.139
Sa(1.0)	0.015	0.045	0.070
Sa(2.0)	0.0061	0.021	0.033
Sa(5.0)	0.0012	0.0047	0.0081
Sa(10.0)	0.0006	0.0019	0.0032
PGA	0.033	0.102	0.164
PGV	0.021	0.068	0.111

References

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

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
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

Aussi disponible en français