



Geotechnical Investigation

Proposed Automotive Dealership and Body Shop
5254 Bank Street
Ottawa, Ontario
Revision 1

Prepared for:

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LRL File No.: 190271

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1 INTRODUCTION

LRL Associates Ltd. (LRL) was retained by Holzman Consultants Inc. to perform a geotechnical investigation in support of a re-zoning application for the property located at 5254 Bank Street, Ottawa, Ontario. The end use will be further clarified during detailed site plan application and building design. For the purposes of this investigation, a building of approximately 200 m² with a use such as an Automotive Dealership and Body Shop has been considered.

The purpose of the investigation was to identify the subsurface conditions across the site by the completion of a borehole drilling program. Based on the visual and factual information obtained, this report will provide guidelines on the geotechnical engineering aspects of the design of the project, including construction considerations.

This report has been prepared in consideration of the terms and conditions noted above. Should there be any changes in the design features, which may relate to the geotechnical recommendations provided in the report, LRL should be advised in order to review the report recommendations.

2 SITE AND PROJECT DESCRIPTION

The site under investigation is currently used for residential purposes. The site consists of a single-storey residential dwelling, a detached double car garage, and multiple storage buildings at the rear portion of the property. The site is rectangular in shape, having a total surface area of about 1,740 m². The general topography of the eastern portion of the site is considered to be relatively flat. An approximate 3.5 m high slope is present in the north-south direction at the middle of the site. Access to the site comes by way of Bank Street, and is civically located at 5254 Bank Street, Ottawa, Ontario. The location is presented in Figure 1 included in **Appendix A**.

It is understood that the new development will consist of a proposed Automotive Dealership and Body Shop. At the time of generating this report, no preliminary information is available pertaining to the proposed building details.

3 PROCEDURE

The fieldwork for this investigation was carried out on October 8, 2019. Prior to the fieldwork, the site was cleared for the presence of any underground services and utilities. At this time, a total of five (5) boreholes will be drilled across the site, and labelled BH1 through BH5. The approximate locations of the boreholes are shown in Figure 2 included in **Appendix A**.

The boreholes were advanced using a truck mount CME 55 drill rig equipped with 200 mm diameter continuous flight hollow stem auger supplied and operated by CCC Geotechnical and Environmental Drilling Ltd. A “two man” crew experienced with geotechnical drilling operated the drill rig and equipment.

Sampling of the overburden materials encountered in the boreholes was carried out at regular depth intervals using a 50.8 mm diameter drive open conventional spoon sampler in conjunction with standard penetration testing (SPT) “N” values. The SPT were conducted following the method **ASTM D1586** and the results of SPT, in terms of the



number of blows per 0.3 m of split-spoon sampler penetration after first 0.15 m designated as “N” value.

All boreholes were advanced until practical auger refusal over bedrock. The boreholes were terminated at depths ranging from 0.7 to 3.7 m below ground surface (bgs). Upon completion, the boreholes were backfilled using the overburden cuttings, and topped with asphalt cold patch where required.

The fieldwork was supervised throughout by a member of our engineering staff who oversaw the drilling activities, cared for the samples obtained and logged the subsurface conditions encountered within each of the boreholes. All soil samples were transported back to our office for further evaluation. The recovered soil samples collected from the boreholes were classified based on visual examination of the materials recovered and the results of the in-situ testing.

Furthermore, all boreholes were located using a Garmin Etrex Legend GPS (Global Positioning System) receiver using NAD 83 datum (North American Datum). The existing grade elevations at the borehole locations were determined by interpolation from the georeferenced autoCAD file of the “Site Development Plan” generated by LRL. Ground surface elevations of boring locations are shown on their respective boreholes logs.

4 SUBSURFACE SOIL AND GROUNDWATER CONDITIONS

4.1 General

A review of local surficial geology maps provided by the Department of Energy, Mines and Resources Canada suggest that the surficial geology for this area consists of bedrock. The bedrock is of the Oxford Formation, consisting of dolomite and limestone.

The subsurface conditions encountered in the boreholes were classified based on visual and tactile examination of the materials recovered from the boreholes. The soil descriptions presented in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil were conducted according to the procedure **ASTM D2487** and judgement, and LRL does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The subsurface soil conditions encountered are given in their respective borehole logs presented in **Appendix B**. A greater explanation of the information presented in the borehole logs can be found in **Appendix C** of this report. These logs indicate the subsurface conditions encountered at a specific test location only. Boundaries between zones on the logs are often not distinct, but are rather transitional and have been interpreted as such.

4.2 Topsoil

Topsoil of thickness ranging from 100 to 450 mm was found at the surface at boring locations BH1, BH2, BH4, and BH5.

This material was classified as topsoil based on colour and the presence of organic material and is intended as identification for geotechnical purposes only. It does not constitute a statement as to the suitability of this layer for cultivation and sustaining plant growth



4.3 Asphalt

At the surface of BH3, a 50 mm thick layer of asphalt was encountered.

4.4 Fill

Underlying the topsoil in BH1, BH2, BH4, and BH5, and the asphalt in BH3, a layer of fill material was encountered, and extended to depths ranging from 0.4 and 1.5 m bgs. Generally, this material consisted of a brown sandy material, with some gravel. In BH1, the fill material contained some organic material. Standard Penetration Tests (SPT) were carried out in this layer, and the SPT “N” values were found ranging between 6 and 18, indicating loose to compact in compactness. The natural moisture content was varying between 4 and 12%.

4.5 Silt

Underlying the fill material in BH3, a layer of silt was encountered, and extended to a depth of 3.7 m bgs. This material can be described as silt, some sand, trace gravel sized stone, and brown. The SPT “N” value was found ranging between 8 and 68, indicating the material is loose, becoming dense to very dense with increased depth. The natural moisture contents were determined to be 10 and 11%.

One (1) soil sample collected from BH3 was selected for sieve analysis. The results are summarized in **Table 1** below.

Table 1: Sieve Analysis Summary

| Sample Location | Depth (m) | Percent for Each Soil Gradation | | | | | | Estimated Hydraulic Conductivity K (cm/s) |
|-----------------|-----------|---------------------------------|----------|------------|------------|----------|-----------------|---|
| | | Gravel | | Sand | | | Fines | |
| | | Coarse (%) | Fine (%) | Coarse (%) | Medium (%) | Fine (%) | Silt & Clay (%) | |
| BH3 | 2.3 – 2.9 | 0.0 | 3.4 | 0.4 | 1.6 | 17.9 | 76.7 | 7×10^{-6} |

4.6 Limestone Bedrock

Underling the fill material in BH2 and BH4, limestone bedrock was encountered, and extended to depths of 1.1 and 0.7 m bgs (end of exploration depth) respectively. This material was found to be weathered at the surface, and grey in colour.

4.7 Refusal

Practical auger refusal over bedrock was encountered in all boreholes, refusal occurred at depths ranging from 0.7 to 3.7 m bgs.

4.8 Groundwater Conditions

Groundwater was carefully monitored during this investigation, during and after completion of drilling, no groundwater was encountered.

It is anticipated that the groundwater level is within the bedrock surface, at an elevation less than 109.880 m.



It should be noted that groundwater levels could fluctuate with seasonal weather conditions, (i.e.: rainfall, droughts, spring thawing) and due to construction activities at or in the vicinity of the site.

5 GEOTECHNICAL CONSIDERATIONS

This section of the report provides general geotechnical recommendations for the design aspect of the proposed development based on our interpretation of the information gathered from the borehole data performed at this site and from the project requirements.

5.1 Foundations

Based on the subsurface soil conditions established at this site, it is recommended that the footings for any proposed buildings be founded below the frost penetration depth, on either structural fill, or bedrock. In order to limit the potential of excessive differential settlement, the footings should rest entirely on bedrock or structural fill, and not a combination of both.

Given the subsurface conditions encountered at this site, there are no restrictions for maximum footing dimensions nor grade raise restrictions. In order to have a dry and stable subgrade, ground water (if encountered), should be kept 0.3 m below the proposed underside of footing. This can be achieved by pumping from open sump pits.

5.2 Shallow Foundation on Structural Fill

Conventional strip and column footings set over properly compacted and approved structural fill having a minimum thickness of 300 mm conforming to OPSS Granular B Type II or approved equivalent may be designed for a maximum allowable bearing pressure of **150 kPa** for Serviceability Limit State (SLS) and **225 kPa** for Ultimate Limit State (ULS) factored bearing resistance. The factored ULS value includes the geotechnical resistance factor of 0.5. The structural fill shall be compacted to 98% of its Standard Proctor Maximum Dry Density (SPMDD).

Prior to placing the approved structural fill, the subgrade level should be inspected and assessed by a geotechnical engineer, or a representative to identify any localised incompetent/unstable areas of the subgrade. Any incompetent subgrade areas as identified must be sub-excavated and backfilled with approved structural fill and compacted to 98% of its SPMDD. In order to allow the spread of load beneath the footings and to prevent undermining during construction, the structural fill should extend minimum 1.2 m beyond the outside edges of the footings and then outward and downward at 1 horizontal to 1 vertical profile (or flatter) over a distance equal to the depth of the structural fill below the footing.

5.3 Shallow foundation on Bedrock

Conventional strip and column footings set over sound bedrock may be designed using a maximum allowable bearing pressure of **750 kPa** for Ultimate Limit State (**ULS**) factored bearing resistance. This maximum allowable bearing pressure is a typically, conservative value for Limestone in the Ottawa area.

Serviceability Limit State (**SLS**) does not apply for footings founded on bedrock since failure of the concrete would occur before unacceptable settlement of the foundation. Prior to pouring the footing, the rock should be free of any soil, debris or deleterious substances and should be inspected by a geotechnical engineer.



5.4 Lateral Earth Pressure

The following equation should be used to estimate the intensity of the lateral earth pressure against any earth retaining structure/foundation walls.

$$P = K (\gamma h + q)$$

Where;

P = Earth pressure at depth h;

K = Appropriate coefficient of earth pressure;

γ = Unit weight of compacted backfill, adjacent to the wall;

h = Depth (below adjacent to the highest grade) at which P is calculated;

q = Intensity of any surcharge distributed uniformly over the backfill surface (usually surcharge from traffic, equipment or soil stockpiled and typically considered 10 kPa).

The coefficient of earth pressure at rest (K_0) should be used in the calculation of the earth pressure on the storm water manhole/basement walls, which are expected to be rather rigid and not to deflect.

The above expression assumes that perimeter drainage system prevents the build-up of any hydrostatic pressure behind the foundation wall.

Table 2 below provides various material types and their respective earth pressure properties.

Table 2: Material and Earth Pressure Properties

| Type of Material | Bulk Density (kN/m ³) | Friction Angle (Φ) | Pressure Coefficient | | |
|--------------------|-----------------------------------|---------------------------|----------------------|------------------|-------------------|
| | | | At Rest (K_0) | Active (K_A) | Passive (K_P) |
| Granular A | 23.0 | 34 | 0.44 | 0.28 | 3.53 |
| Granular B Type I | 20.0 | 31 | 0.49 | 0.32 | 3.12 |
| Granular B Type II | 23.0 | 32 | 0.47 | 0.31 | 3.25 |
| Fill | 17.5 | 30 | 0.50 | 0.33 | 3.00 |

5.5 Settlement

The estimated total settlement of the shallow foundations, designed using the recommended serviceability limit state capacity value, as well as other recommendations given above, will be less than 25 mm. The differential settlement between adjacent column footings is anticipated to be 15 mm or less.

5.6 Liquefaction

For footings constructed on either bedrock or properly prepared structural fill, liquefaction is not considered to be a concern for this site.



5.7 Seismic

Based on the information of this geotechnical investigation and in accordance with the Ontario Building Code 2015 (Table 4.1.8.4.A.) and Canadian Foundation Engineering Manual (4th edition), the site can be classified for Seismic Site Response Site Class C.

The above classifications were recommended based on conventional method exercised for Site Classification for Seismic Site Response and in accordance with the generally accepted geotechnical engineering practice. A greater Site Classification might be able to be achieved by carrying out site specific seismic testing, such as shear wave velocity testing.

5.8 Frost Protection

All exterior footings located in any unheated portions of the proposed building should be protected against frost heaving by providing a minimum of 1.5 m of earth cover. Areas that are to be cleared of snow (i.e. sidewalks, paved areas, etc.) should be provided with at least 1.8 m of earth cover for frost protection purposes. Alternatively, the required frost protection could be provided using a combination of earth cover and extruded polystyrene insulation. Detailed guidelines for footing insulation frost protection can be provided upon request.

In the event that foundations are to be constructed during winter months, the foundation soils are required to be protected from freezing temperatures using suitable construction techniques. The base of all excavations should be insulated from freezing temperatures immediately upon exposure, until heat can be supplied to the building interior and the footings have sufficient soil cover to prevent freezing of the subgrade soils.

5.9 Foundation Walls Backfill (Shallow Foundations)

To prevent possible lateral loading, the backfill material against any foundation walls, grade beams, 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 or equivalent grading requirements.

The foundation wall backfill should be compacted to minimum 95% of its standard Proctor maximum dry density (SPMDD) using light compaction equipment, where no loads will be set over top. The compaction shall be increased to 98% of its SPMDD under walkways, slabs or paved areas close to the foundation or retaining walls. Backfilling against foundation walls should be carried out on both sides of the wall at the same time where applicable.

5.10 Slab-on-grade Construction

For predictable performance for a slab-on-grade, it should rest over structural fill only. Therefore, all material shall be removed from the building's footprint. The exposed subgrade surface should then be inspected and approved by geotechnical personnel.

Any underfloor fill needed to raise the general floor grade shall consist of OPSS Granular B Type I material or an approved equivalent, compacted to 95% of its SPMDD. The final lift shall be compacted to 98% of its SPMDD. A 200 mm thick layer of Granular A meeting the **OPSS 1010** shall be placed underneath the slab and compacted to 100% of its SPMDD.

It is also recommended that area of extensive exterior slab-on-grade (sidewalks, ramp etc.) shall be constructed using Granular B subbase of thickness 300 mm and Granular A



base of thickness 150 mm with incorporating subdrain facilities. The modulus of subgrade reaction (ks) for the design of the slabs set over structural fill is **24 MPa/m**.

In order to further minimize and control cracking, the floor slab shall be provided with wire or fibre mesh reinforcement and construction or control joints. The construction or control joints should be spaced equal distance in both directions and should not exceed 4.5 m. The wire or fibre mesh reinforcement shall be carried out through the joints.

If any areas of the proposed building area are to remain unheated during the winter period, thermal protection of the slab on grade may be required. The "Guide for Concrete Floor and Slab Construction", **ACI 302.1R-04** is recommended to follow for the design and construction of vapour retarders below the floor slab. Further details on the insulation requirements could be provided, if necessary.

6 EXCAVATION AND BACKFILLING REQUIREMENTS

6.1 Excavation

It is anticipated that the depth of excavation for the building or any proposed services will not extend below 1.8 – 2.4 m. Excavation must be carried-out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects.

According to the Ontario's Occupational Health and Safety Act (OHSA), O. Reg. 213/91 and its amendments, the surficial overburden expected to be excavated into at this site can be classified as Type 3 for fully drained excavations. Therefore, shallow temporary excavations in the overburden soil can be cut at 1 horizontal to 1 vertical, for a fully drained excavation from the base of the excavation and as per requirements of the OHSA regulations.

In the event that the aforementioned slopes are not possible to achieve due to space restrictions, the excavation shall be shored according to OHSA O. Reg. 213/91 and its amendments. Refer to the parameters provided in **Table 2** in **Section 5.4** for use in the design of any shoring structures.

Any excavated material stockpiled near an excavation or trench should be stored at a distance equal to or greater than the depth of the excavation/trench and construction equipment traffic should be limited near open excavation.

6.2 Groundwater Control

Based on the subsurface conditions encountered at this site, groundwater seepage or infiltration into the temporary excavations during construction is expected to be minor in nature, if any. This will be able to be controlled by pumping with open sumps. Surface water runoff into the excavation should be minimized and diverted away from the excavation.

A permit to take water (PTTW) is required from Ministry of Environment and Climate Change (MOECC), Ontario Reg. 387/04, if more than 400,000 litres per day of groundwater will be pumped during a construction period less than 30 days. Registration in the Environmental Activity and Sector Registry (EASR) is required when water takings range between 50,000 and 400,000 litres per day.

The actual amount of groundwater inflow into open excavations will depend on several factors such as the contractor's schedule, rate of excavation, the size of excavation, depth below the groundwater level, and at the time of year which the excavation is executed. It



is expected that pumping rates will be less than 50,000 litres per day. As such, EASR registration is not required for the construction at this site.

6.3 Pipe Bedding Requirements

It is anticipated that any underground services required as part of this project will be founded over properly prepared and approved structural fill. Consequently all organic material should be removed down to a suitable bearing layer. Any sub-excavation of disturbed soil should be removed and replaced with a Granular B Type II or approved equivalent, laid in loose lifts of thickness not exceeding 300 mm and compacted to 95% of its SPMDD. Bedding, thickness of cover material and compaction requirements for watermains and sewer pipes should conform to the manufacturer's design requirements and to the detailed installations outlined in the Ontario Provincial Standard Specifications (OPSS) or any other applicable standards.

6.4 Trench Backfill

All service trenches should be backfilled using compactable material, free of organics, debris and large cobbles or boulders. Acceptable native materials (if encountered and where possible) should be used as backfill between the roadway subgrade level and the depth of seasonal frost penetrations (i.e. 1.8 m below finished grade) in order to reduce the potential for differential frost heaving between the new excavated trench and the adjacent section of roadway. Where native backfill is used, it should match the native materials exposed on the trench walls. Backfill below the zone of seasonal frost penetration could consist of either acceptable native material or imported granular material conforming to OPSS Granular B Type II. Any boulders larger than 150 mm in size should not be used as trench backfill.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the roadway, the trench should be compacted in maximum 300 mm thick lifts to at least 95% of its SPMDD. The specified density may be reduced where the trench backfill is not located within or in close proximity to existing roadways or any other structures.

For trenches carried out in existing paved areas, transitions should be constructed to ensure that proper compaction is achieved between any new pavement structure and the existing pavement structure to minimize potential future differential settlement between the existing and new pavement structure. The transition should start at the subgrade level and extend to the underside of the asphaltic concrete level (if any) at a 1 horizontal to 1 vertical slope. This is especially important where trench boxes are used and where no side slopes is provided to the excavation. Where asphaltic concrete is present, it should be cut back to a minimum of 150 mm from the edge of the excavation to allow for proper compaction between the new and existing pavement structures.

7 REUSE OF ON-SITE SOILS

The existing surficial overburden materials consists mostly of a fill material. This material is considered to be frost susceptible and should not be used as backfill material directly against foundation walls or underneath unheated concrete slabs. However, it could be reused as general backfill material (service trenches, general landscaping/backfilling) if it can be compacted according to the specifications outlined herein at the time of construction and found free from any waste, organics and debris. Any imported material shall conform to OPSS Granular B – Type II or approved equivalent.



It should be noted that the adequacy of any material for reuse as backfill will depend on its water content at the time of its use and on the weather conditions prevailing prior to and during that time. Therefore, all excavated materials to be reused shall be stockpiled in a manner that will prevent any significant changes in their moisture content, especially during wet conditions, and approved for reuse by a geotechnical engineer.

8 RECOMMENDED PAVEMENT STRUCTURE

It is anticipated that the subgrade soil for any parking areas and access lanes will consist of the fill material or bedrock. The construction of access lanes and parking areas will be acceptable over these materials, once all debris, organic material, or otherwise deleterious material are removed from the subgrade area. Furthermore, the fill material subgrade must be compacted using a suitable heavy duty compacting equipment and approved by a geotechnical engineer prior to placing any granular base material.

The following **Table 3** presents the recommended pavement structures to be constructed over a stable subgrade along the proposed parking areas and access lane or driveway as part of this project.

Table 3: Recommended Pavement Structure

| Course | Material | Thickness (mm) | |
|-------------|--------------------|------------------------------|---|
| | | Light Duty Parking Area (mm) | Heavy Duty Parking Area (Access Roads, Fire Routes and Trucks) (mm) |
| Surface | HL3 A/C | 50 | 40 |
| Binder | HL8 A/C | - | 50 |
| Base course | Granular A | 150 | 150 |
| Sub base | Granular B Type II | 350 | 450 |
| Total: | | 500 | 690 |

Performance Graded Asphaltic Cement (PGAC) **58-34** is recommended for this project.

The base and subbase granular materials shall conform to **OPSS 1010** material specifications. Any proposed materials shall be tested and approved by a geotechnical engineer prior to delivery to the site and shall be compacted to 98% of its SPMDD. Asphaltic concrete shall conform to **OPSS 1150** and be placed and compacted to at least 95% of the Marshall Density. The mix and its constituents shall be reviewed, tested and approved by a geotechnical engineer prior to delivery to the site.

In areas where the subgrade will consist of bedrock, the Granular B Type II thickness may be reduced to 300 mm for both light and heavy duty areas.

8.1 Paved Areas & Subgrade Preparation

The access lanes and parking areas shall be stripped of top soil, vegetation, debris and other obvious objectionable material. Following the backfilling and satisfactory compaction of any underground service trenches up to the subgrade level, the subgrade shall be shaped, crowned and proof-rolled. A loaded Tandem axle, dual wheel dump truck or approved equivalent heavy duty smooth drum roller shall be used for proof-rolling. Any



resulting loose/soft areas should be sub-excavated down to an adequate bearing layer and replaced with approved backfill.

The preparation of subgrade shall be scheduled and carried out in manner so that a protective cover of overlying granular material (if required) is placed as quickly as possible in order to avoid unnecessary circulation by heavy equipment, except on unexcavated or protected surfaces. Frost protection of the surface shall be implemented if works are carried out during the winter season.

The performance of the pavement structure is highly dependent on the subsurface groundwater conditions and maintaining the subgrade and pavement structure in a dry condition. To intercept excess subsurface water within the pavement structure granular materials, sub-drains with suitable outlets should be installed below the pavement area's subgrade if adequate overland flow drainage is not provided (i.e. ditches). The surface of the pavement should be properly graded to direct runoff water towards suitable drainage features. It is recommended that the lateral extent of the subbase and base layers not be terminated vertically immediately behind the curb/edge of pavement line but be extended beyond the curb.

9 INSPECTION SERVICES

The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed site 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 footing areas and any structural fill areas for the proposed building should be inspected by LRL to ensure that a suitable subgrade has been reached and properly prepared. The placing and compaction of any granular materials beneath the foundations and slab-on-grade should be inspected to ensure that the materials used conform to the grading and compaction specifications.

The subgrade for the pavement areas and underground services should be inspected and approved by geotechnical personnel. In-situ density testing should be carried out on the pavement granular materials, pipe bedding and backfill to ensure the materials meet the specifications for required compaction.

If footings are to be constructed during winter season, the footing subgrade should be protected from freezing temperatures using suitable construction techniques.

10 REPORT CONDITIONS AND LIMITATIONS

It is stressed that the information presented in this report is provided for the guidance of the designers and is intended for this project only. This report has been prepared for a re-zoning application, a further investigation may be required during site plan application. The use of this report as a construction document or its use by a third party beyond the client specifically listed in the report is neither intended nor authorized by LRL Associates Ltd. 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 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 off-site sources are outside the terms of reference for this report.

The recommendations provided in this report are based on subsurface data obtained at the specific test pit locations only. Boundaries between zones presented on the test pit logs are often not distinct but transitional and were interpreted. Experience indicates that the subsurface soil and groundwater conditions can vary significantly between and beyond the test locations. For this reason, the recommendations given in this report are subject to a field verification of the subsurface soil conditions at the time of construction.

The recommendations are applicable only to the project described in this report. Any changes to the project will require a review by LRL Associates Ltd., to insure compatibility with the recommendations contained in this project.

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 the undersigned.

Yours truly,
LRL Associates Ltd.



Brad Johnson, P. Eng.
Geotechnical Engineer

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APPENDIX A
Site and Borehole Location Plan



LRJ

ENGINEERING | INGÉNIÉRIE

5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lri.ca | (613) 842-3434

PROJECT

GEOTECHNICAL INVESTIGATION
PROPOSED AUTOMOTIVE DEALERSHIP AND BODY SHOP
5254 BANK STREET
OTTAWA, ONTARIO

DRAWING TITLE

SITE LOCATION
SOURCE: GEO-OTTAWA

CLIENT

HOLZMAN CONSULTANTS INC.

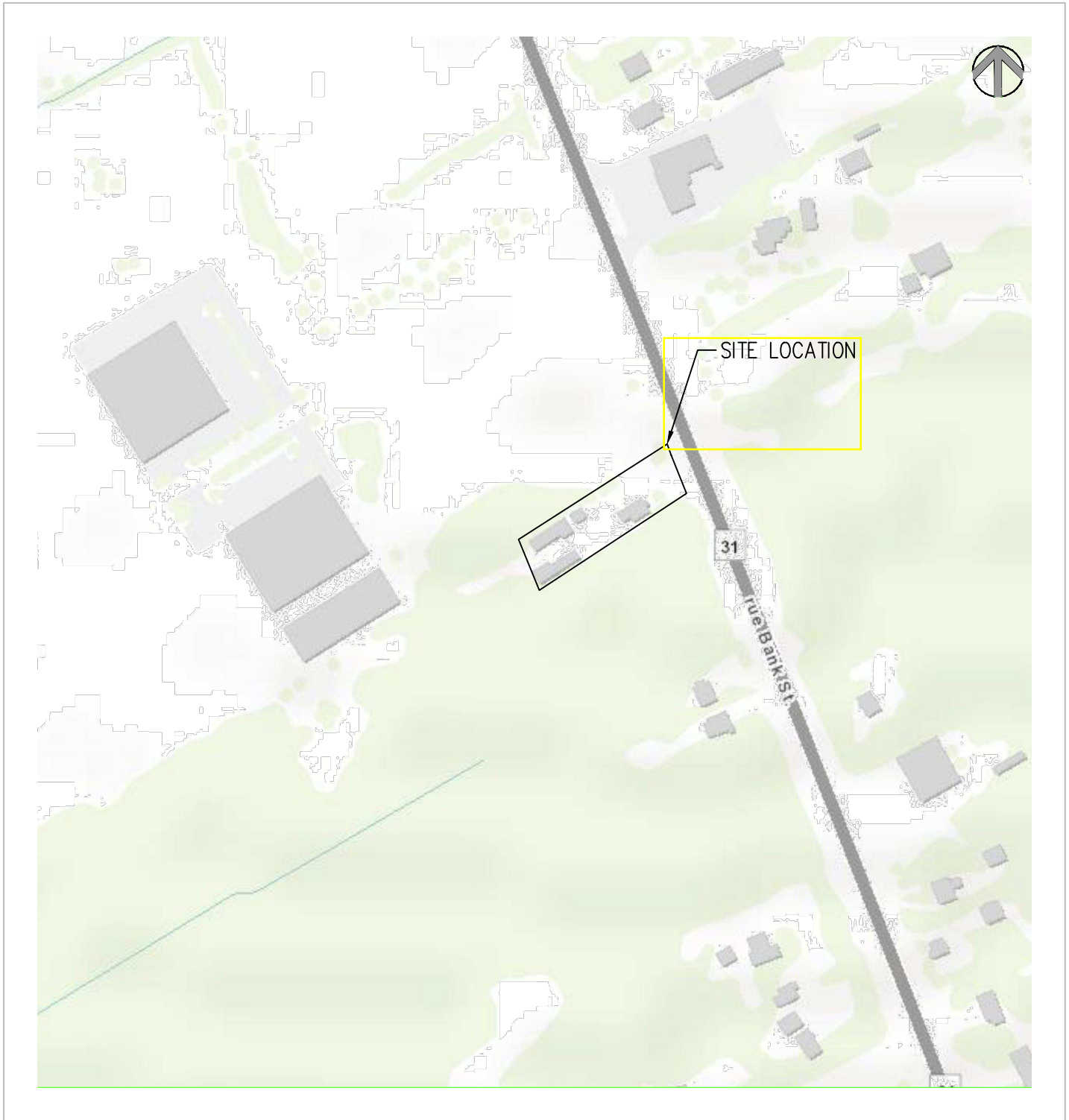
DATE

NOVEMBER, 2019

PROJECT

190271

FIGURE 1





LRJ

ENGINEERING | INGÉNIERIE

5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lri.ca | (613) 842-3434

PROJECT

GEOTECHNICAL INVESTIGATION
PROPOSED AUTOMOTIVE DEALERSHIP AND BODY SHOP
5254 BANK STREET
OTTAWA, ONTARIO

DRAWING TITLE

BOREHOLE LOCATION
SOURCE: Imagery 2019 Google, Digital Globe Map Data

CLIENT

HOLZMAN CONSULTANTS INC.

DATE

NOVEMBER, 2019

PROJECT

190271

FIGURE 2



APPENDIX B
Borehole Logs



Project No.: 190271

Client: Holzman Consultants Inc.

Date: October 8, 2019

Borehole Log: BH1

Project: Proposed Automotive Dealership and Body Shop

Location: 5254 Bank Street, Ottawa ON

Field Personnel: BJ

Driller: CCC Geotech and Enviro Drilling Ltd.

Drilling Equipment: Truck Mount CME 55

Drilling Method: HSA

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | | Shear Strength × (kPa) × 50 100 150 200 | Water Content ▽ (%) ▽ 25 50 75 | Water Level (Standpipe or Open Borehole) | |
|--------------------|---|----------------|-----------|------|---------------|----------|---|---|--|-------------------------------------|
| Depth ft m | Soil Description | Elev./Depth(m) | Lithology | Type | Sample Number | N or RQD | Recovery (%) | SPT N Value ○ (Blows/0.3 m) ○ 20 40 60 80 | | Liquid Limit □ (%) □ 25 50 75 |
| | | | | | | | | | | |
| 0 | Ground Surface | 110.17 | | | | | | | | |
| 0 | Topsoil- sandy, about 450 mm thick. | 0.00 | | | | | | | | |
| 1 | | 109.72 | | | SS1 | 7 | 42 | 7 | 9 | |
| 2 | FILL- sand, some organic material, brown, moist, compact. | 0.45 | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | SS2 | 15 | 75 | 15 | 9 | |
| 5 | End of Borehole | 1.37 | | | | | | | | |

Eastings: 454743 m

Northings: 5015270 m

Site Datum: Site Benchmark - 2 nails in utility pole - 116.310 m

Groundsurface Elevation: 110.170 m

Top of Riser Elev.: N/A

Hole Diameter: 200 mm

NOTES: Borehole terminated after practical auger refusal.



Project No.: 190271

Client: Holzman Consultants Inc.

Date: October 8, 2019

Borehole Log: BH2

Project: Proposed Automotive Dealership and Body Shop

Location: 5254 Bank Street, Ottawa ON

Field Personnel: BJ

Driller: CCC Geotech and Enviro Drilling Ltd.

Drilling Equipment: Truck Mount CME 55

Drilling Method: HSA

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | | Shear Strength × (kPa) × 50 100 150 200 | Water Content ▽ (%) ▽ 25 50 75 | Water Level (Standpipe or Open Borehole) | |
|--------------------|---|----------------|-----------|------|---------------|----------|---|---|--|-------------------------------------|
| Depth ft m | Soil Description | Elev./Depth(m) | Lithology | Type | Sample Number | N or RQD | Recovery (%) | SPT N Value ○ (Blows/0.3 m) ○ 20 40 60 80 | | Liquid Limit □ (%) □ 25 50 75 |
| | | | | | | | | | | |
| 0 | Ground Surface | 110.95 | | | | | | | | |
| 0 | Topsoil- sandy, about 450 mm thick. | 0.00 | | | | | | | | |
| 1 | FILL- sand, brown, moist, loose. | 110.65 | | | SS1 | 8 | 33 | 8 | 12 | |
| 2 | | 0.30 | | | | | | | | |
| 3 | BEDROCK- limestone, weathered at surface, grey. | 110.30 | | | | | | | | |
| 3 | | 0.65 | | | | | | | | |
| 4 | End of Borehole | 109.88 | | | SS2 | 80+ | 100 | 80+ | 13 | |
| 4 | | 1.07 | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | | | | | | | | | | |
| 12 | | | | | | | | | | |
| 13 | | | | | | | | | | |
| 14 | | | | | | | | | | |
| 15 | | | | | | | | | | |
| 16 | | | | | | | | | | |

Eastings: 454767 m

Northings: 5015273 m

Site Datum: Site Benchmark - 2 nails in utility pole - 116.310 m

Groundsurface Elevation: 110.950 m

Top of Riser Elev.: N/A

Hole Diameter: 200 mm

NOTES: Borehole terminated after practical auger refusal.



Project No.: 190271

Client: Holzman Consultants Inc.

Date: October 8, 2019

Borehole Log: BH3

Project: Proposed Automotive Dealership and Body Shop

Location: 5254 Bank Street, Ottawa ON

Field Personnel: BJ

Driller: CCC Geotech and Enviro Drilling Ltd.

Drilling Equipment: Truck Mount CME 55

Drilling Method: HSA

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | | Shear Strength × (kPa) × 50 100 150 200 | Water Content ▽ (%) ▽ 25 50 75 | Water Level (Standpipe or Open Borehole) | | | |
|--------------------|---|----------------|-------------------------|--------------------|---------------|----------|---|---|--|-------------------------------------|--|--|
| Depth ft m | Soil Description | Elev./Depth(m) | Lithology | Type | Sample Number | N or RQD | Recovery (%) | SPT N Value ○ (Blows/0.3 m) ○ 20 40 60 80 | | Liquid Limit □ (%) □ 25 50 75 | | |
| | | | | | | | | | | | | |
| 0 | Ground Surface | 113.65 | | | | | | | | | | |
| 0 | Asphalt - about 50 mm thick. | 0.00 | | | | | | | | | | |
| 1 | FILL- sand, some gravel, brown, moist, loose to compact. | | [Cross-hatched pattern] | [Hourglass symbol] | SS1 | 6 | 17 | 6 | 5 | | | |
| 2 | | | | | | | | | | | | |
| 3 | | | | | SS2 | 12 | 8 | 12 | 4 | | | |
| 4 | | | | | | | | | | | | |
| 5 | SILT- some sand, trace gravel sized stone, brown, moist, dense to very dense. | 112.20 | [Cross-hatched pattern] | [Hourglass symbol] | | | | | | | | |
| 6 | | 1.45 | | | SS3 | 8 | 17 | 8 | 10 | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | SS4 | 68 | 85 | 68 | 10 | | |
| 9 | | | | | | | | | | | | |
| 10 | | | | | SS5 | 48 | 75 | 48 | 11 | | | |
| 11 | | | | | | | | | | | | |
| 12 | End of Borehole | 109.99 | | | | | | | | | | |
| 13 | | 3.66 | | | | | | | | | | |
| 14 | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | |

Easting: 454776 m

Northing: 5015290 m

Site Datum: Site Benchmark - 2 nails in utility pole - 116.310 m

Groundsurface Elevation: 113.650 m

Top of Riser Elev.: N/A

Hole Diameter: 200 mm

NOTES: Borehole terminated after practical auger refusal.



Project No.: 190271

Client: Holzman Consultants Inc.

Date: October 8, 2019

Borehole Log: BH4

Project: Proposed Automotive Dealership and Body Shop

Location: 5254 Bank Street, Ottawa ON

Field Personnel: BJ

Driller: CCC Geotech and Enviro Drilling Ltd.

Drilling Equipment: Truck Mount CME 55

Drilling Method: HSA

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | | Shear Strength × (kPa) × 50 100 150 200 | Water Content ▽ (%) ▽ 25 50 75 | Water Level (Standpipe or Open Borehole) |
|--------------------|---|----------------|-----------|------|---------------|----------|---|---|--|
| Depth ft m | Soil Description | Elev./Depth(m) | Lithology | Type | Sample Number | N or RQD | Recovery (%) | SPT N Value ○ (Blows/0.3 m) ○ 20 40 60 80 | |
| | | | | | | | | 0 | Ground Surface |
| 0 | Topsoil- sandy, about 100 mm thick. | 0.00 | | | | | | | |
| 1 | FILL- sand, some gravel, brown, moist, compact. | 0.10 | | | SS1 | 44 | 85 | 44 | 11 |
| 1 | BEDROCK- limestone, weathered at surface, grey. | 113.73 | | | | | | | |
| 2 | End of Borehole | 113.48 | | | | | | | |
| 2 | | 0.66 | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |
| 11 | | | | | | | | | |
| 12 | | | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | | | | | | | | |
| 15 | | | | | | | | | |
| 16 | | | | | | | | | |

Eastings: 454795 m

Northings: 5015306 m

Site Datum: Site Benchmark - 2 nails in utility pole - 116.310 m

Groundsurface Elevation: 114.140 m

Top of Riser Elev.: N/A

Hole Diameter: 200 mm

NOTES: Borehole terminated after practical auger refusal.



Project No.: 190271

Client: Holzman Consultants Inc.

Date: October 8, 2019

Borehole Log: BH5

Project: Proposed Automotive Dealership and Body Shop

Location: 5254 Bank Street, Ottawa ON

Field Personnel: BJ

Driller: CCC Geotech and Enviro Drilling Ltd.

Drilling Equipment: Truck Mount CME 55

Drilling Method: HSA

| SUBSURFACE PROFILE | | SAMPLE DATA | | | | | Shear Strength × (kPa) × 50 100 150 200 | Water Content ▽ (%) ▽ 25 50 75 | Water Level (Standpipe or Open Borehole) | |
|--------------------|---|----------------|-------------------------|------------------|---------------|----------|---|---|--|-------------------------------------|
| Depth | Soil Description | Elev./Depth(m) | Lithology | Type | Sample Number | N or RQD | Recovery (%) | SPT N Value ○ (Blows/0.3 m) ○ 20 40 60 80 | | Liquid Limit □ (%) □ 25 50 75 |
| 0 | Ground Surface | 114.04 | | | | | | | | |
| 0 | Topsoil- sandy, about 250 mm thick. | 0.00 | | | | | | | | |
| 1 | FILL- sand, some gravel, brown, moist, compact. | 113.79 | [Cross-hatched pattern] | [Black triangle] | SS1 | 18 | 33 | 18 | 12 | |
| 3 | | 112.62 | | | SS2 | 16 | 75 | 16 | 12 | |
| 5 | End of Borehole | 1.42 | | | | | | | | |

Easting: 454809 m

Northing: 5015303 m

Site Datum: Site Benchmark - 2 nails in utility pole - 116.310 m

Groundsurface Elevation: 114.040 m

Top of Riser Elev.: N/A

Hole Diameter: 200 mm

NOTES: Borehole terminated after practical auger refusal.

APPENDIX C
Symbols and Terms used in Borehole Logs

Symbols and Terms Used on Borehole and Test Pit Logs

1. Soil Description

The soil descriptions presented in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves some judgement and LRL Associates Ltd. does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice. Boundaries between zones on the logs are often not distinct but transitional and were interpreted.

a. Proportion

The proportion of each constituent part, as defined by the grain size distribution, is denoted by the following terms:

| Term | Proportions |
|-----------------------------------|-------------|
| “trace” | 1% to 10% |
| “some” | 10% to 20% |
| prefix (i.e. “sandy” silt) | 20% to 35% |
| “and” (i.e. sand “and” gravel) | 35% to 50% |

b. Compactness and Consistency

The state of compactness of granular soils is defined on the basis of the Standard Penetration Number (N) as per ASTM D-1586. It corresponds to the number of blows required to drive 300 mm of the split spoon sampler using a metal drop hammer that has a weight of 62.5 kg and free fall distance of 760 mm. For a 600 mm long split spoon, the blow counts are recorded for every 150 mm. The “N” value is obtained by adding the number of blows from the 2nd and 3rd count. Technical refusal indicates a number of blows greater than 50.

The consistency of clayey or cohesive soils is based on the shear strength of the soil, as determined by field vane tests and by a visual and tactile assessment of the soil strength.

The state of compactness of granular soils is defined by the following terms:

| State of Compactness Granular Soils | Standard Penetration Number “N” | Relative Density (%) |
|-------------------------------------|---------------------------------|----------------------|
| Very loose | 0 – 4 | <15 |
| Loose | 4 – 10 | 15 – 35 |
| Compact | 10 - 30 | 35 – 65 |
| Dense | 30 - 50 | 65 - 85 |
| Very dense | > 50 | > 85 |

The consistency of cohesive soils is defined by the following terms:

| Consistency Cohesive Soils | Undrained Shear Strength (C_u) (kPa) | Standard Penetration Number “N” |
|----------------------------|--|---------------------------------|
| Very soft | <12.5 | <2 |
| Soft | 12.5 - 25 | 2 - 4 |
| Firm | 25 - 50 | 4 - 8 |
| Stiff | 50 - 100 | 8 - 15 |
| Very stiff | 100 - 200 | 15 - 30 |
| Hard | >200 | >30 |

c. Field Moisture Condition

| Description (ASTM D2488) | Criteria |
|--------------------------|---|
| Dry | Absence of moisture, dusty, dry to touch. |
| Moist | Damp, but not visible water. |
| Wet | Visible, free water, usually soil is below water table. |

2. Sample Data

a. Elevation depth

This is a reference to the geodesic elevation of the soil or to a benchmark of an arbitrary elevation at the location of the borehole or test pit. The depth of geological boundaries is measured from ground surface.

b. Type

| Symbol | Type | Letter Code |
|--------|-------------|-------------|
| ⋮ | Auger | AU |
| ⚡ | Split Spoon | SS |
| | Shelby Tube | ST |
| | Rock Core | RC |

c. Sample Number

Each sample taken from the borehole is numbered in the field as shown in this column.

LETTER CODE (as above) – Sample Number.

d. Recovery (%)

For soil samples this is the percentage of the recovered sample obtained versus the length sampled. In the case of rock, the percentage is the length of rock core recovered compared to the length of the drill run.

3. Rock Description

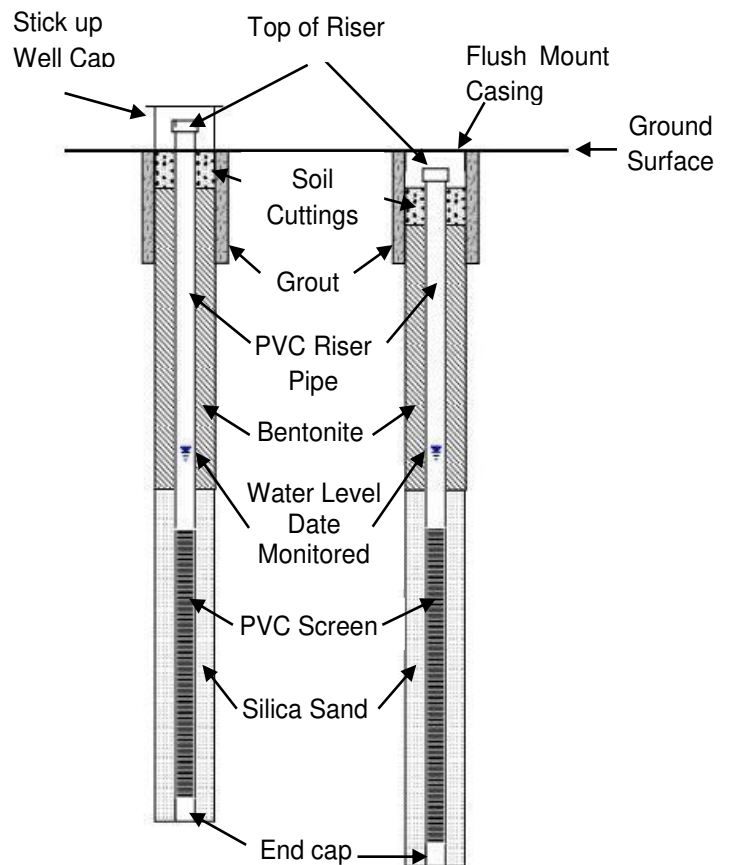
Rock Quality Designation (RQD) is a rough measure of the degree of jointing or fracture in a rock mass. The RQD is calculated as the cumulative length of rock pieces recovered having lengths of 100 mm or more divided by the length of coring. The qualitative description of the bedrock based on RQD is given below.

| Rock Quality Designation (RQD) (%) | Description of Rock Quality |
|------------------------------------|-----------------------------|
| 0 – 25 | Very poor |
| 25 – 50 | Poor |
| 50 – 75 | Fair |
| 75 – 90 | Good |
| 90 – 100 | Excellent |

Strength classification of rock is presented below.

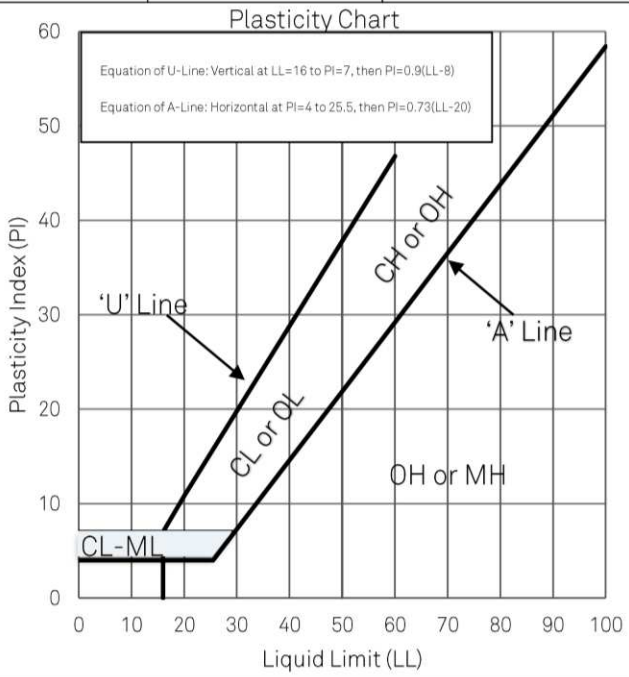
| Strength Classification | Range of Unconfined Compressive Strength (MPa) |
|-------------------------|--|
| Extremely weak | < 1 |
| Very weak | 1 – 5 |
| Weak | 5 – 25 |
| Medium strong | 25 – 50 |
| Strong | 50 – 100 |
| Very strong | 100 – 250 |
| Extremely strong | > 250 |

4. General Monitoring Well Data



**5. Classification of Soils for Engineering Purposes (ASTM D2487)
(United Soil Classification System)**

| Major divisions | | Group Symbol | Typical Names | Classification Criteria |
|---|--|-------------------------|---------------|--|
| Coarse-grained soils More than 50% retained on No. 200 sieve* (>0.075 mm) | Gravels More than 50% of coarse fraction retained on No. 4 sieve(4.75 mm) | Clean gravels <5% fines | GW | Well-graded gravel |
| | | | GP | Poorly graded gravel |
| | | Gravels with >12% fines | GM | Silty gravel |
| | | | GC | Clayey gravel |
| | Sands 50% or more of coarse fraction passes No. 4 sieve(<4.75 mm) | Clean sands <5% fines | SW | Well-graded sand |
| | | | SP | Poorly graded sand |
| | | Sands with >12% fines | SM | Silty sand |
| | | | SC | Clayey sand |
| | | | | <p>If 15% sand add "with sand" to group name.</p> <p>If 15% gravel add "with gravel to group name</p> <p>Classification on basis of percentage of fines: Less than 5% pass No. 200 sieve - GW, GP, SW, SP More than 12% pass No. 200 sieve - GM, GC, SM, SC 5 to 12% pass No. 200 sieve - Borderline classifications, use of dual symbols</p> <p>$C_u = \frac{D_{60}}{D_{10}} \geq 4$; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3</p> <p>Not meeting either C_u or C_c criteria for GW</p> <p>Atterberg limits below "A" line or PI less than 4</p> <p>Atterberg limits on or above "A" line and PI > 7</p> <p>Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols</p> <p>If fines are organic add "with organic fines" to group name</p> <p>$C_u = \frac{D_{60}}{D_{10}} \geq 6$; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3</p> <p>Not meeting either C_u or C_c criteria for SW</p> <p>Atterberg limits below "A" line or PI less than 4</p> <p>Atterberg limits on or above "A" line and PI > 7</p> <p>Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols</p> <p>If fines are organic add "with organic fines" to group name</p> |
| Fine-grained soils 50% or more passes No. 200 sieve* (<0.075 mm) | Silts and Clays Liquid Limit <50% | Inorganic | ML | Silt |
| | | | CL | Lean Clay -low plasticity |
| | Silts and Clays Liquid Limit >50% | Organic | OL | Organic clay or silt (Clay plots above 'A' Line) |
| | | Inorganic | MH | Elastic silt |
| | | | CH | Fat Clay -high plasticity |
| | Highly Organic Soils | Organic | OH | Organic clay or silt (Clay plots above 'A' Line) |
| | | PT | | Peat, muck and other highly organic soils |
| | | | | <p>If 15 to 29% coarse-grained, add "with sand" or "with gravel" as appropriate. If > 30% coarse-grained, add "sandy" or "gravelly" as appropriate. Class as organic when oven dried liquid limit is < 75% of undried liquid limit.</p> |



APPENDIX D
Laboratory Results

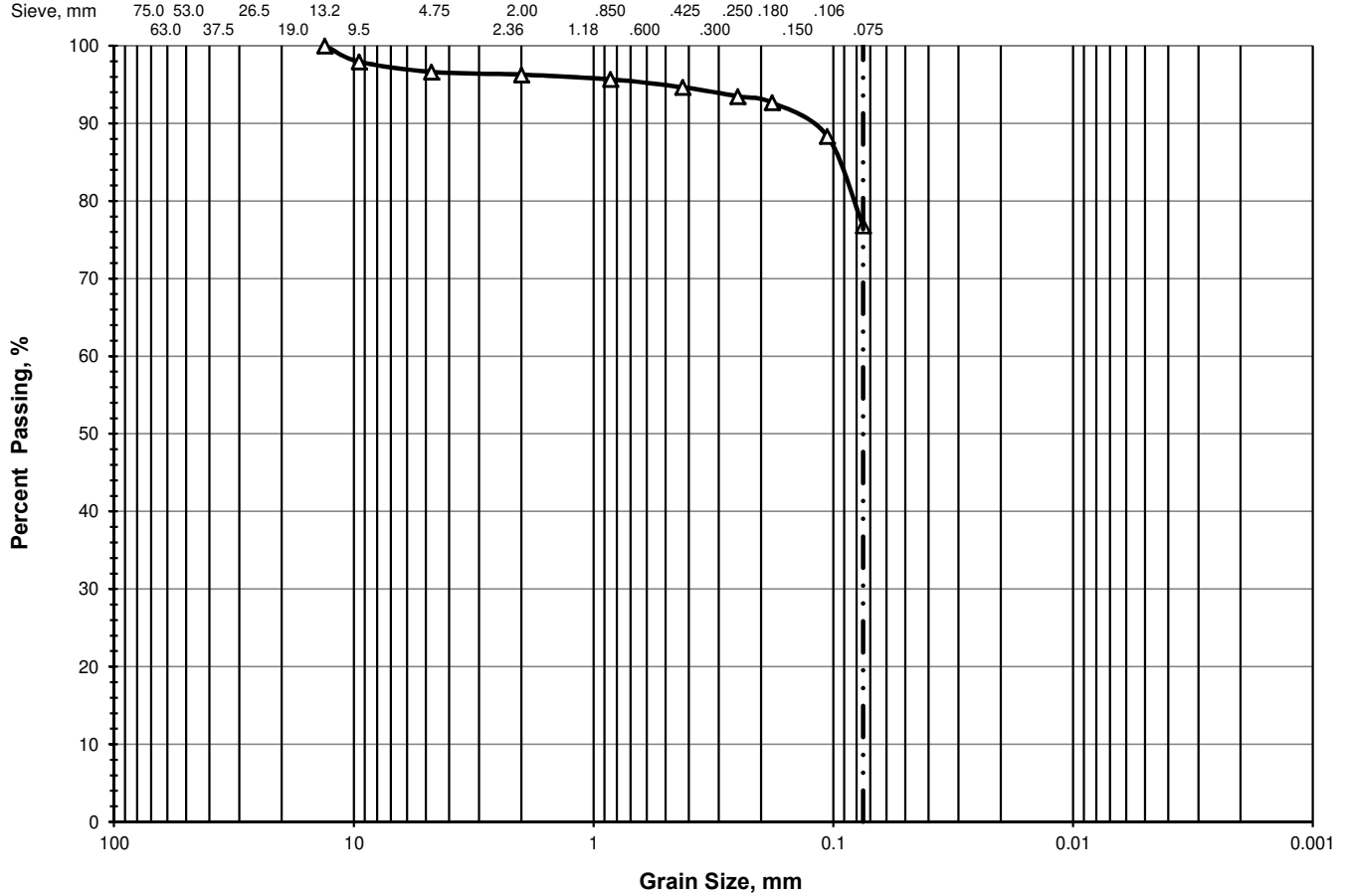


PARTICLE SIZE ANALYSIS

ASTM D 422 / LS-702

Client: Holzman Consultants Inc.
Project: Geotechnical Investigation
Location: 5254 Bank Street, Ottawa, ON.

File No.: 190271
Report No.: 1
Date: October 8, 2019



Unified Soil Classification System

| > 75 mm | % GRAVEL | | % SAND | | | % FINES |
|---------|----------|------|--------|--------|------|-------------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt & Clay |
| △ | 0.0 | 3.4 | 0.4 | 1.6 | 17.9 | 76.7 |
| | | | | | | |
| | | | | | | |
| | | | | | | |

| Location | Sample | Depth, m | D ₆₀ | D ₅₀ | D ₃₀ | D ₁₅ | D ₁₀ | C _c | C _u |
|----------|--------|----------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------|----------------|
| △ | BH 3 | SS-4 | 2.29 - 2.90 | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |



APPENDIX B
Borehole Logs

APPENDIX C
Symbols and Terms used in Borehole Logs

APPENDIX D
Laboratory Results

APPENDIX E
MASW Survey Report