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Preliminary Geotechnical Investigation
Proposed Residential Development
1368 Labrie Avenue
Ottawa, Ontario

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Submitted to:

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1 Raymond Street, Suite 200
Ottawa, Ontario
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Preliminary Geotechnical Investigation
Proposed Residential Development
1368 Labrie Avenue
Ottawa, Ontario

November 30, 2020
Project: 62649.06

experience • knowledge • integrity

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November 30, 2020 File: 62649.06

Geofirma Engineering Ltd.
1 Raymond Street, Suite 200
Ottawa, Ontario
K1R 1A2

Attention: Glen Briscoe, QP_{ESA}, P.Eng., PMP

Re: Preliminary Geotechnical Investigation
Proposed Residential Development
1368 LAbrie Avenue
Ottawa, Ontario

Please find enclosed our geotechnical investigation report for the above noted project, in accordance with our proposal dated August 25, 2020. This report was prepared by Mr. Alex Meacoe, P.Eng., and reviewed by Mr. Brent Wiebe, P.Eng.

Alex Meacoe, P.Eng. Brent Wiebe, P.Eng.

WAM/JC

Enclosures
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1.0 INTRODUCTION

This report presents the results of a preliminary geotechnical investigation carried out for the proposed residential development to be located at 1368 Labrie Avenue in Ottawa, Ontario. The purpose of the investigation was to identify the general subsurface conditions at the site by means of a borehole and, based on the factual information obtained, to provide preliminary engineering guidelines on the geotechnical design aspects of the project, including construction considerations that could influence design decisions.

2.0 BACKGROUND

2.1 Project Description

Plans are being prepared to construct a new residential development at 1368 Labrie Avenue in Ottawa, Ontario (see Key Plan, Figure 1).

The following is known about the site and the proposed development:

- The site is currently occupied with a two-storey residential house that will be demolished prior to the construction of the new development; and,
- Based on the preliminary information provided, the proposed development will likely consist of a six-storey apartment building with at grade parking at the rear of the building, and one level of underground parking.

A Phase II Environmental Site Assessment was completed at the site and the results of that investigation are provided in the following report.

- Report by Geofirma Engineering Ltd., to Dave Wallace titled "Phase II Environmental Site Assessment, 1368 Labrie Avenue, Ottawa, Ontario" dated August 13, 2020 (Report No. 20-206).

2.2 Review of Geology Maps

Based on our past investigations in the vicinity of the site, previous experience in the area, and surficial geology maps, the site is likely composed of silty clay over glacial till. Bedrock geology maps indicate that the site is underlain by shale and limestone bedrock of the Carlsbad formation. Drift thickness mapping indicates the bedrock surface is expected at depths ranging from about 5 to 10 metres. Aerial photographs of the site suggest that fill material associated with previous development should be expected.

3.0 SUBSURFACE INVESITGATION

The fieldwork for the geotechnical investigation was carried out on November 5, 2020. During that time, one borehole (numbered 20-1) was advanced at the location shown on the Site Plan, Figure 1.

The borehole was advanced with a truck-mounted hollow stem auger drill rig supplied and operated by CCC Geotechnical and Environmental Drilling of Ottawa, Ontario. The borehole was advanced to a depth of about 8.1 metres below the existing ground surface.

Standard penetration tests were carried out in the borehole at regular intervals of depth and samples of the soils encountered were recovered using a 50 millimetre diameter drive open sampler. The fieldwork was supervised throughout by a member of our engineering staff.

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

One sample of soil obtained from borehole 20-1 was sent to Paracel Laboratories Ltd. for basic chemical testing relating to corrosion of buried concrete and steel.

The results of the borehole are provided on the Record of Borehole sheet in Appendix A. The locations of the borehole from the current and previous investigations are shown on the Borehole Location Plan, Figure 1.

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

4.0 SUBSURFACE CONDITIONS

4.1 General

The soil conditions logged in the borehole from the current investigation are given on the Record of Borehole Sheet in Appendix A. The borehole logs from the previous investigation, carried out by others, are provided in Appendix B. The borehole logs indicate the subsurface conditions at the specific test locations only. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. Subsurface conditions at locations other than the borehole locations may vary from the conditions encountered in the test holes. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site.

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

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

4.2 Pavement Structure

Borehole 20-1 was advanced through the pavement structure of the gravel parking lot at the site. The pavement structure consists of about 150 millimetres of grey crushed sand and gravel.

4.3 Fill Material

Fill material was encountered below the pavement structure in borehole 20-1. The fill material extends to a depth of about 3.1 metres below ground surface (elevation of about 70.6 metres). The composition of the fill material generally consists of silty sand with some gravel. The fill material also contains probable cobbles.

Standard penetration tests carried out in the fill material encountered gave N values ranging from 9 to 20 blows per 0.3 metres of penetration, indicating a loose to compact relative density.

The water content measured on one sample of the fill material is about 12 percent.

4.4 Glacial Till

A deposit of glacial till was encountered below the fill material in borehole 20-1. The glacial till deposit was not fully penetrated, but was proven to a depth of about 8.1 metres below the ground surface (elevation of about 65.6 metres). The glacial till can generally be described as grey silty sand with some gravel. The glacial till deposit also contains possible cobbles and boulders.

Two sand seams were encountered in the glacial till deposit at depths of about 5.0 and 6.4 metres below ground surface, with thicknesses of about 0.2 and 0.6 metres, respectively. The sand seams generally consist of grey silty sand to sandy silt.

Standard penetration tests carried out in the glacial till gave N values of 7 to greater than 50 blows for less than 0.3 metres of penetration, which indicates a loose to very dense relative density. The high blow counts likely represent the presence of cobbles or boulders within the glacial till deposit or the bedrock surface rather than the relative density of the soil matrix.

One grain size distribution test was undertaken on a selected sample of the glacial till from borehole 20-1. The results are provided in Appendix C and are summarized in Table 4.1.

Table 4.1 – Summary of Grain Size Distribution Test (Glacial Till)

Borehole Number	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
20-1	6	3.8 – 4.4	15	43	23	19

The water content measured on five samples of the glacial till ranges from about 7 to 12 percent.

4.5 Auger Refusal

Auger refusal was encountered in borehole 20-1 at a depth of about 8.1 metres below the existing ground surface. The auger refusal likely represent the presence of cobbles or boulders within the glacial till deposit or the bedrock surface.

4.6 Groundwater Levels - Previous Investigation

Well screens were sealed in the overburden at monitoring wells 20-1, 20-2, 20-3, and 20-4 from the previous investigation. The groundwater levels, measured by others on March 13, 2020 and by GEMTEC staff on November 5, 2020 are summarized in Table 4.2.

Table 4.2 – Groundwater Levels (Monitoring Wells from Previous Investigation)

Borehole	Groundwater Depth (metres)	Date
MW 20-1	4.1	March 13, 2020
	4.1	November 5, 2020
MW 20-2	3.3	March 13, 2020
	4.1	November 5, 2020
MW 20-3	3.9	March 13, 2020
	4.1	November 5, 2020
MW 20-4	2.4	March 13, 2020
	1.0	November 5, 2020

Note: The monitoring wells from the previous investigation were surveyed to a local datum

The groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation.

4.7 Chemistry Relating to Corrosion

One sample of soil obtained from borehole 20-1 was sent to Paracel Laboratories for basic chemical testing relating to corrosion of buried concrete and steel. The results of chemical testing are provided in Appendix D and summarized in Table 4.3 below.

Table 4.3 – Summary of Corrosion Testing

Parameter	Borehole 20-1 Sample 3
Chloride Content (µg/g)	16
Resistivity (Ohm.m)	65.2
pH	7.65
Sulphate Content (µg/g)	18

5.0 PRELIMINARY RECOMMENDATIONS AND GUIDELINES

5.1 General

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

Depending on the location of the proposed building, the top of the excavation may extend beyond the property line in order to accommodate the excavation side slopes. Where this cannot be tolerated, temporary shoring may be required. Geotechnical guidelines for assessing the general shoring requirements could be provided, if required, as the design progresses.

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

5.2 Excavations

5.2.1 Overburden Excavations

It is understood that the residential development will likely have one basement level for below grade parking.

The excavations for the proposed residential development will be carried out through the pavement structure and topsoil, where encountered, fill material and into the native glacial till deposit. The sides of the excavations should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, the overburden soils at this site can be classified as Type 3 and, accordingly, allowance should be made for excavation side slopes of 1 horizontal to 1 vertical, or flatter, excavation slopes for soils above the groundwater level.

Based on the measured groundwater elevations, excavation below the groundwater level as part of the development is not anticipated. Excavation of the native overburden deposits above the groundwater level should not present significant constraints. Excavations below the groundwater level, if required, may result in some sloughing and should be sloped at 3 horizontal to 1 vertical, or flatter.

Cobbles and boulders should be anticipated in the fill material and glacial till. As such, allowance should be made for removal of boulders from the glacial till during excavation.

5.2.2 Excavation near Existing Structures

The foundation conditions for neighbouring structures are not currently available, but it is likely that they are founded on the native glacial till deposits.

For adjacent existing structures founded on native glacial till, the excavation for the proposed building should not encroach within a line extending downwards and outwards from the existing foundation at an inclination of 1 vertical to 1 horizontal.

Depending on the depth of the excavation, it is recommended that the foundation conditions for the adjacent buildings be obtained to identify the excavation requirements next to adjacent buildings to ensure that undermining does not occur.

5.3 Groundwater Management

The groundwater level on November 5, 2020 was reported to range from about 1.0 to 4.1 metres below existing ground surface.

Any groundwater inflow into the excavation should be handled from within the excavation by pumping from filtered sumps. Suitable detention and filtration will be required before discharging the water to a sewer or ditch. The amount of water entering the excavation for the construction of the foundations at this site should not exceed 50,000 litres per day and, therefore, it is not anticipated that an Environmental Activity and Sector Registry (EASR) will be required.

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

5.4 Footing Design

Based on the results of the investigation, and the preliminary information provided, the proposed residential development could be founded on shallow spread footings bearing on or within the native undisturbed glacial till deposits. The fill material is considered to be highly compressible and should be removed from below any foundations and slabs on grade.

The design underside of footing elevation for the residential development is not known at the time of writing this report. For preliminary design purposes, exterior footings bearing on the native, undisturbed glacial till, or on a pad of engineered fill above native, undisturbed glacial till should be sized using a geotechnical reaction at Serviceability Limit State (SLS) of 100 kilopascals and a factored geotechnical resistance at Ultimate Limit State (ULS) of 300 kilopascals.

The post construction total and differential settlement of the footings at SLS should be less than 25 and 15 millimetres, respectively, provided that all loose or disturbed soil is removed from the bearing surfaces.

5.5 Grade Raise Restrictions

The site is underlain by fill material over native deposits of glacial till. It is assumed that the existing grade at the site will be maintained to match the existing roadway and adjacent properties. The settlement due to compression of the native soils due to fill placement should be relatively small and should occur during or shortly after the fill placement. Further recommendations on grade raise restrictions can be provided as the design progresses.

5.6 Seismic Design of Proposed Structure

It is assumed that the proposed foundations will be shallow spread footing foundations supported on or within the glacial till deposit. As such, the proposed structure should be designed for seismic Site Class D. It may be possible to improve the seismic Site Class to C if shear wave velocity testing is carried out, which could result in significant cost savings in the structural and mechanical components of the building. Additional details on shear wave velocity testing could be provided as the design progresses.

There is no potential for liquefaction of the overburden deposits at this site.

5.7 Frost Protection of the Foundations

All exterior footings in unheated portions of the proposed building should be provided with at least 1.5 metres of earth cover for frost protection purposes. Isolated, unheated exterior footings adjacent to surfaces which are cleaned of snow cover during the winter months should be provided with a minimum of 1.8 metres of earth cover. Alternatively, the required frost protection could be provided by means of a combination of earth cover and extruded polystyrene insulation.

Further details regarding the insulation of foundations, if required, could be provided as the design progresses

5.8 Foundation Wall Backfill and Drainage

5.8.1 Backfill Material

Any organic material, deleterious material, or clayey material should not be used as backfill against foundations. To avoid frost adhesion and possible heaving, the foundations should be backfilled with imported, free-draining, non-frost susceptible granular material such as that meeting OPSS Granular B Type I or II requirements.

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

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

5.8.2 Foundation Wall Drainage

The foundation walls for the basement should be damp proofed and a perforated plastic foundation drain with a surround of clear crushed stone should be installed on the exterior of the foundation walls at the level of the footings. The drain should outlet by gravity to a storm sewer, ditch, or a sump from which the water is pumped. To avoid loss of fines from backfill into the voids in the clear stone (and possible post construction settlement of the ground around the building), a nonwoven geotextile should be placed between the clear stone and any sand backfill material.

5.9 Lateral Earth Pressures

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

$P_o = 0.5 K_o \gamma H^2$

where;

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

Seismic shaking can increase the forces on the retaining wall. The total "At Rest" thrust acting on the walls (P_{oe}) during a seismic event should be calculated using the following formula:

$$P_{oe} = 0.5\ K_{oe}\ \gamma\ H^2$$

where;

- P_{oe}: Total "At Rest" thrust (kN/m);
- γ: Moist material unit weight (kN/m^3);
- K_{oe}: Dynamic "At Rest" earth pressure coefficient;
- H: Wall height (m).

The static thrust component (P_o) acts at a point located H/3 above the base of the wall. During seismic shaking, the total "At Rest" thrust (P_{oe}) acts at a point located about H/2 above the base of the wall. It should be noted that the total "At Rest" thrust, P_{oe}, is composed of a static component and a dynamic component.

For design purposes, the parameters provided in Table 5.1 can be used to calculate the thrust acting on the walls during static and seismic loading conditions.

Table 5.1 – Summary of Design Parameters (Building Foundation Walls)

Parameter	OPSS Granular B Type I	OPSS Granular B Type II
Material Unit Weight, γ (kN/m^3)	22	22
Estimated Friction Angle (degrees)	34	38
"At Rest" Earth Pressure Coefficient, K_o, assuming horizontal backfill behind the structure	0.44	0.38
Dynamic "At Rest" Earth Pressure Coefficient, K_{oe}, assuming horizontal backfill behind the structure	0.50[1]	0.44[1]

Notes:

1) According to the 2015 National Building Code of Canada, the peak ground acceleration (PGA) for this site is 0.31 for Site Class D. The dynamic at rest earth pressure coefficient was calculated using the method suggested by Mononobe and Okabe, assuming a horizontal seismic coefficient, kh, of 0.31 and assuming that the vertical seismic coefficient, kv, is zero.

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

5.10 Basement Floor Slab Support

To provide predictable settlement performance of the basement slab, any fill material or disturbed soil and debris should be removed from the slab area. The base for the floor slab should consist of at least 200 millimetres of 19 millimetre clear crushed stone. Any necessary grade raise fill should consists of either 19 millimetre clear crushed stone or OPSS Granular B Type II. OPSS documents allow recycled asphaltic concrete and concrete to be used in Granular B Type II material. OPSS documents allow recycled asphaltic concrete and Portland cement concrete to be used in Granular B material. Since the source of recycled material cannot be determined or controlled, it is suggested that any imported Granular B materials be composed of 100 percent crushed rock only, for environmental reasons.

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

Underfloor drainage should be provided below the basement floor slab. If clear crushed stone is used below the floor slab, under floor drains are not considered essential provided that the clear stone can outlet to the sump and drains are installed to link any hydraulically isolated areas in the basement. The drains should outlet by gravity to a storm sewer or a sump from which the water is pumped.

The floor slab should be wet cured to minimize shrinkage cracking and slab curling. The slab should be saw cut to about 1/3 the thickness of the slab as soon as curing of the concrete permits, in order to minimized shrinkage cracks.

Proper moisture protection with a vapour retarder should be used for any slab on grade where the floor will be covered by moisture sensitive flooring material or where moisture sensitive equipment, products or environments will exist. The “Guide for Concrete Floor and Slab Construction”, ACI 302.1R-04 should be considered for the design and construction of vapour retarders below the floor slab.

5.11 Proposed Services

5.11.1 Excavation

The excavation for flexible service pipes should be in accordance with Ontario Provincial Standard Drawing (OPSD) 802.010 for Type 3 soil. The excavation for rigid service pipes should be in accordance with OPSD 802.031 for Type 3 soil. The sides of the excavations within overburden soils should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, the soils at this site can be classified as Type 3 soils. Therefore, for design purposes, allowance should be made for 1 horizontal to 1 vertical, or flatter, excavation slopes. As an alternative or where space constraints dictate, the service installations could be carried out within a tightly fitting, braced steel trench box, which is specifically designed for this purpose.

Groundwater seepage into excavations is expected and should be controlled, as necessary, by pumping from within the excavations. It is not expected that short term pumping during excavation will have a significant effect on nearby structures and services.

5.11.2 Pipe Bedding

The bedding for service pipes should be in accordance with OPSD 802.010 and 802.031 for flexible and rigid pipes in Type 3 soils, respectively. The bedding for service pipes should consist of at least 150 millimetres of crushed stone meeting OPSS requirements for Granular A.

Cover material, from spring line to at least 300 millimetres above the tops of the pipes, should consist of granular material, such as that meeting OPSS Granular A.

In areas where the subsoil is disturbed or where unsuitable material (such as fill or organic material) exists below the pipe subgrade level, the disturbed/unsuitable material should be removed and replaced with a subbedding layer of compacted granular material, such as that meeting OPSS Granular B Type I or II. To provide adequate support for the pipes in the long term in areas where subexcavation of material is required below design subgrade level, the excavations should be sized to allow a 1 horizontal to 1 vertical or 2 horizontal to 1 vertical spread of granular material down and out from the bottom of the pipes.

Cover material, from pipe spring line to at least 300 millimetres above the top of the pipe, should consist of granular material, such as OPSS Granular A. The granular bedding and subbedding materials should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value.

The use of clear crushed stone as a bedding, subbedding or cover material should not be permitted on this project.

5.11.3 Trench Backfill

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

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

5.12 Roadway and Parking Areas

5.12.1 Subgrade Preparation

In preparation for access roadway/parking lot construction at this site, all surficial topsoil, and any soft, wet or deleterious materials should be removed from the proposed roadway areas. It is not considered necessary to remove the existing silty sand fill material from below the roadway and parking areas, provided the guidelines below are followed.

Prior to placing granular material for the roads and parking lots, the exposed subgrade should be inspected and approved by geotechnical personnel. Any soft areas should be subexcavated and replaced with suitable (dry) earth borrow that is frost compatible with the materials exposed on the sides of the area of subexcavation.

In the area of the existing house, and any other areas where it will be necessary to raise the roadway/parking lot grades at this site, material which meets OPSS specifications for Select Subgrade Material, Earth Borrow or well shattered and graded rock fill material may be used.

The Select Subgrade material or Earth Borrow should be placed in maximum 300 millimetre thick lifts and compacted to at least 95 percent of the standard Proctor maximum dry density value using vibratory compaction equipment. Rock fill should be placed in maximum 500 millimetre thick lifts and suitably compacted with either a large drum roller, the haulage and spreading equipment, or a combination of both.

Truck traffic should be avoided on the native soil subgrade or the trench backfill within the roadways/parking lot areas especially under wet conditions.

5.12.2 Flexible Pavement Structure

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

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

For parking areas and access roadway to be used by heavy truck traffic, the suggested minimum pavement structure is:

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

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

If the granular pavement materials are to be used by construction traffic, it may be necessary to increase the thickness of the granular subbase layer, install a woven geotextile separator between the roadway subgrade surface and the granular subbase material, or a combination of both, to prevent pumping and disturbance to the subbase material. The contractor should be made responsible for their construction access.

5.12.3 Asphalt Cement Type

Performance grade PG 58-34 asphalt cement should be specified for Superpave asphaltic concrete mixes, based on a Traffic Category B.

5.12.4 Pavement Drainage

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

Catch basins should be equipped with minimum 3 metre long stub drains extending in two directions at the subgrade level.

5.12.5 Granular Material Compaction

The granular base and subbase materials should be compacted in maximum 300 millimetre thick lifts to at least 98 percent of the standard Proctor maximum dry density value.

5.13 Corrosion of Buried Concrete and Steel

The measured sulphate concentration in the sample of soil recovered from borehole 20-1 was 18 micrograms per gram. According to Canadian Standards Association (CSA) "Concrete Materials and Methods of Concrete Construction", the concentration of sulphate can be classified as low. Therefore any concrete in contact with the native soil could be batched with General Use (GU) cement. The effects of freeze thaw in the presence of de-icing chemical (sodium chloride) use on the roadway should be considered in selecting the air entrainment and the concrete mix proportions for any concrete.

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

6.0 ADDITIONAL CONSIDERATIONS

6.1 Winter Construction

Provision must be made to prevent freezing of any soil below the level of any footings, slabs or services. Freezing of the soil could result in heaving related damage.

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

6.2 Effects of Construction Induced Vibration

Some of the construction operations (such as granular material compaction, excavation, hoe ramming, blasting, foundation construction etc.) will cause ground vibration on and off of the site. The vibrations will attenuate with distance from the source, but may be felt at nearby structures. We recommend that preconstruction surveys be carried out on the adjacent structures so that any construction related claims can be dealt with in a fair manner.

6.3 Disposal of Excess Soil

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

6.4 Design Review and Construction Observation

The details for the proposed construction were not available to us at the time of preparation of this report. It is recommended that the final design drawings be reviewed by the geotechnical engineer as the design progresses to ensure that the guidelines provided in this report have been interpreted as intended.

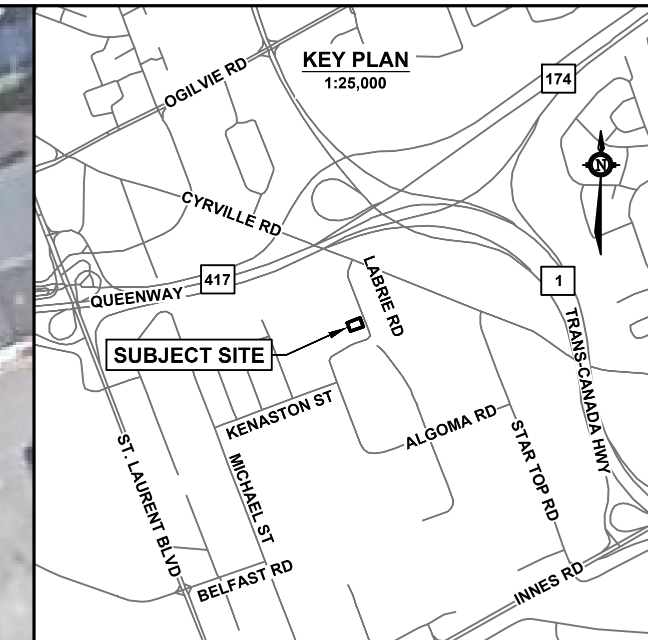
The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed excavations do not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design. The subgrade surfaces for the building, site services and roadway/parking areas should be inspected by experienced geotechnical personnel to ensure that suitable materials have been reached and properly prepared. The placing and compaction of earth fill and imported granular materials should be inspected to ensure that the materials used conform to the grading and compaction specifications. In accordance with Ontario Building Code requirements, full time compaction testing is required for engineered fill below buildings.

7.0 CLOSURE

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

Alex Meacoe, P.Eng.
Geotechnical Engineer

Brent Wiebe, P.Eng.
VP Operations - Ontario



LEGEND

BH/MW # ← BH/MW ID
XX.XX ← GROUND SURFACE ELEVATION, IN METRES GEODETIC DATUM

BOREHOLE LOCATION IN PLAN
(current investigation by GEMTEC)

MONITORING WELL IN PLAN
(previous investigation by GEOFIRMA (March,2020))

APPROXIMATE PROPERTY BOUNDARY

Scale 1:300

0 10 20m

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

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Drawing	BOREHOLE LOCATION PLAN
Client	GEOFIRMA ENGINEERING LTD.
Project	62649.06
	GEOTECHNICAL INVESTIGATON 1368 LABRIE AVENUE OTTAWA, ONTARIO
Drwn by	S.L.
Chkd by	W.A.M.
Date	NOVEMBER, 2020
Rev.	0
	FIGURE 1

APPENDIX A

Record of Borehole Sheets – Current Investigation
List of Abbreviations and Symbols

ABBREVIATIONS AND TERMINOLOGY USED ON RECORDS OF BOREHOLES AND TEST PITS

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

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

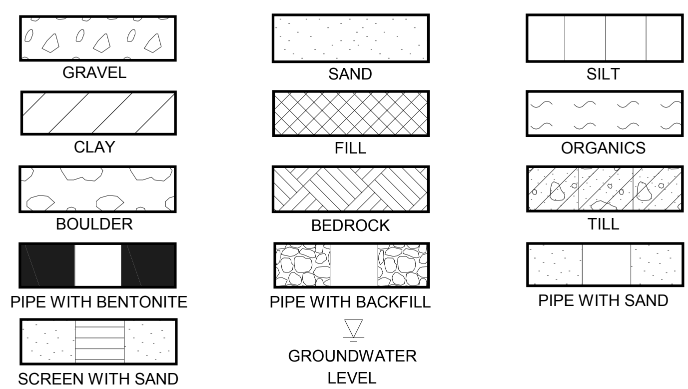
PENETRATION RESISTANCE

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

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

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

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



GRAIN SIZE

Scale (mm): 0.01, 0.1, 1.0, 10, 100, 1000mm

SILT CLAY	SAND			GRAVEL	COBBLE	BOULDER
	Fine	Medium	Coarse			
< 0.08	0.08 – 0.4	0.4 – 2	2 – 5	5 – 80	80 – 200	> 200

DESCRIPTIVE TERMINOLOGY
(Based on the CANFEM 4th Edition)

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

RECORD OF BOREHOLE 20-1

CLIENT: Geofirma Engineering Ltd.
PROJECT: Geotechnical Investigation, Proposed Residential Development, 1368 Labrie Ave
JOB#: 62649.06
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Nov 5 2020

BORING METHOD: Power Auger, Hollow Stem Auger (200mm OD)

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Ground Surface	73.61						
	Grey sand and gravel (BASE/SUBBASE)	73.46 / 0.15						Soil cuttings
	Loose to compact, dark grey silty sand, some gravel with cobbles (FILL MATERIAL)		1	SS	279	9		
1			2	SS	457	11		
			3	SS	457	20		
2			4	SS	203	13		
3	Loose to compact, dark grey silty sand, some gravel with cobbles and boulders (GLACIAL TILL)	70.56 / 3.05	5	SS	457	7	MH	
4			6	SS	508	13		
			7	SS	457	17		
5	Grey silty sand to sandy silt	68.58						
	Compact, dark grey SILTY SAND, some gravel with cobbles and boulders (GLACIAL TILL)	68.43 / 5.18	8	SS	406	29		
6	Grey silty sand (GLACIAL TILL)	67.21 / 6.40	9	SS	457	30		
7	Loose to very dense, dark grey SILTY SAND, some gravel with cobbles and boulders (GLACIAL TILL)	66.60 / 7.01	10	SS	406	10		
			11	SS	356	50 for 200mm		
8	End of Borehole Auger Refusal	65.56 / 8.05						
9								
10								

PENETRATION RESISTANCE (N), BLOWS/0.3m; DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED; WATER CONTENT, % W_P — W — W_L; 10 20 30 40 50 60 70 80 90

GEMTEC Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: W.A.M.

APPENDIX B

Borehole Records – Previous Investigaiton
Geofirma Engineering Limited Report No. 20-206

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

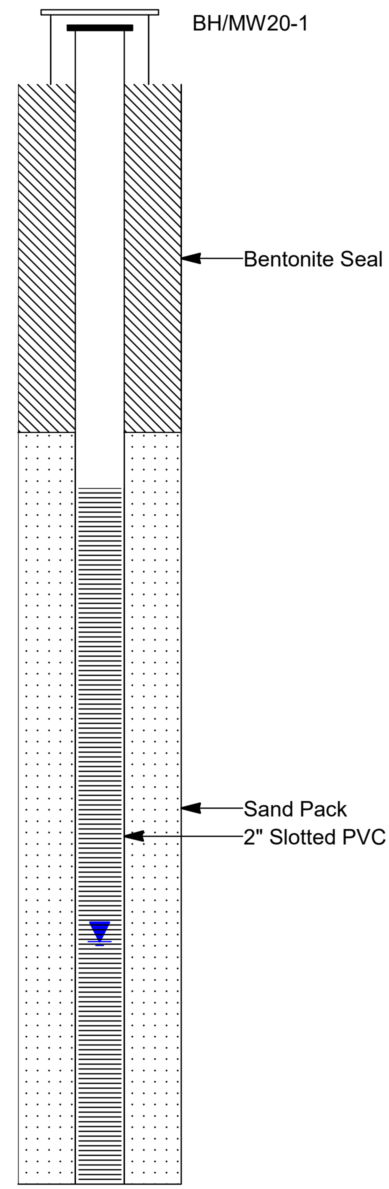
Borehole Number: BH/MW20-1

Project Number: 20-206
Client: Guzman / Wallace
Site Location: 1368 Labrie Avenue
Coordinates: 45.4199307E, -75.6231448N (UTM Zone 18)
Drilling Method: Direct Push - Blow Count
Drilling Rig: Geoprobe 7822DT

MOE Well ID:
Date Completed: March 11, 2020
Supervisor: GDB
Logged By: KAM
Ground Surface Elevation: 99.74
Date of Water Level Measurement: March 12, 2020

DEPTH BGS (ft)	DEPTH BGS (m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
0	0							GROUND SURFACE
0.5–1								FILL Gravel
1–2		sample	X	69	0	0		CLAY Silty Clay, compact, no odour, no staining, brown
2.5–4.5	1	sample		13	0	0		CLAY Clay with silt, low plasticity, no odour, dark brown, moist
5–7	2	sample		31	--	--		CLAY Clay with silt and trace till, dense, medium plasticity, red staining, brown, moist
7.5–12.5	3	sample		17	0	0		CLAY Clay with some silt and trace till, high plasticity, no odour, no staining, dark brown, moist
10–12		sample		12	0	0		
12.5–15	4	sample		13	--	--		CLAY Clay and silt, medium plasticity, no odour, grey, wet
15–17	5	sample		43	--	--		SAND Silty sand, no odour, no staining, wet
17–20	6							BOREHOLE TERMINATED Total Depth of BH/MW20-1 5.12 mBGS

INSTALLATION



Static Water Level

at 4.058 mBGS

Prepared By: MdK
Reviewed By: GDB
Doc: BH LOGS.GPJ
Template: GEOFIRMA_TEMPLATE.GDT

Geofirma Engineering Ltd

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW20-2

Project Number: 20-206
Client: Guzman / Wallace
Site Location: 1368 Labrie Avenue
Coordinates: 45.419787E, -75.6232262N (UTM Zone 18)
Drilling Method: Direct Push - Blow Count
Drilling Rig: Geoprobe 7822DT

MOE Well ID: A274716
Date Completed: March 11, 2020
Supervisor: GDB
Logged By: KAM
Ground Surface Elevation: 100.23
Date of Water Level Measurement: March 13, 2020

SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)
1	X	17	0	0
2		10	5	0
3	X	36	15	0
4		25	15	0
5		21	0	0
6		10	0	0
7		23	0	0

DEPTH BGS (ft | m)

STRATIGRAPHIC DESCRIPTION

GROUND SURFACE

TOPSOIL
Topsoil with some sand, very dense, no odour, no staining, brown, dry

FILL
Silt and Clay, slight PHC odour, red staining, black stain at 1.17m, dark brown, moist

FILL
Silt and Clay, trace brick, dense, low plasticity, slight PHC odour, black staining, dark brown, dry

CLAY
Clay with trace till, evidence of PHC staining, high plasticity, slight PHC odour, black staining, dark brown

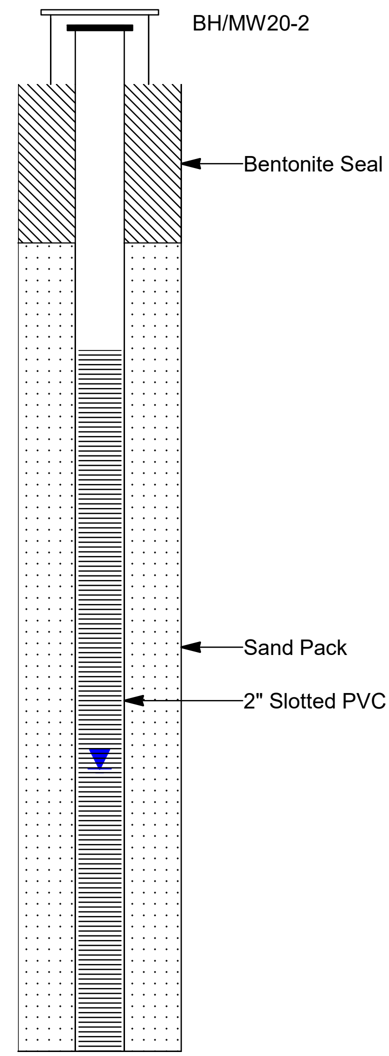
Vane Sheer Test

CLAY
Clay with trace till and shale, dense, high plasticity, black staining, black, moist

CLAY
Clay with trace till and shale, high plasticity, dark brown, moist

BOREHOLE TERMINATED
Total Depth of BH/MW20-2
5.18 mBGS

INSTALLATION



Static Water Level at 3.302 mBGS

Prepared By: MdK
Reviewed By: GDB
Doc: BH LOGS.GPJ
Template: GEOFIRMA_TEMPLATE.GDT

Geofirma Engineering Ltd

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH/MW20-3

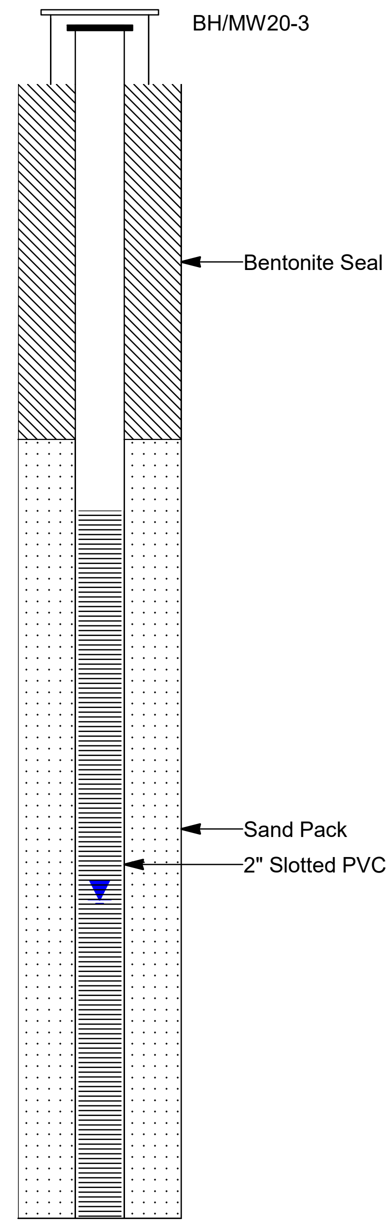
Project Number: 20-206
Client: Guzman / Wallace
Site Location: 1368 Labrie Avenue
Coordinates: 45.7198425E, -75.6230422N (UTM Zone 18)
Drilling Method: Direct Push - Blow Count
Drilling Rig: Geoprobe 7822DT

MOE Well ID: A274717
Date Completed: March 11, 2020
Supervisor: GDB
Logged By: KAM
Ground Surface Elevation: 99.75
Date of Water Level Measurement: March 13, 2020

DEPTH BGS (ft)	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	STRATIGRAPHIC DESCRIPTION
0					GROUND SURFACE
0.5–2.5	X	14	0	0	TOPSOIL Topsoil with trace, non-native fill, no odour, no staining, dark brown, dry
2.5–5		9	20	0	TOPSOIL Topsoil with some fill, trace sand, dense, low plasticity, no odour, no staining, dark brown, moist
5–7.5		8	35	0	FILL Clay with some non-native fill and shale, trace sand, slight PHC odour, dark brown, moist
7.5–10		24	50	0	FILL Clay with some non-native fill and shale, trace sand, dense, medium plasticity, no odour, slight red staining, dark brown, moist
10–12.5	X	26	65	1	FILL Clay with some non-native fill, trace sand, dense, high plasticity, no odour, slight red staining, dark brown, moist
12.5–15	X	14	40	1	CLAY Clay with trace shale, dense, high plasticity, no odour, no staining, grey, wet
15–17.3		39	0	0	CLAY Clay with trace shale, silt bottom, loose, high plasticity, no odour, no staining, dark brown, wet

BOREHOLE TERMINATED
Total Depth of BH/MW20-3
5.27 mBGS

INSTALLATION



Static Water Level

at 3.875 mBGS

Prepared By: MdK
Reviewed By: GDB
Doc: BH LOGS.GPJ
Template: GEOFIRMA_TEMPLATE.GDT

Geofirma Engineering Ltd

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

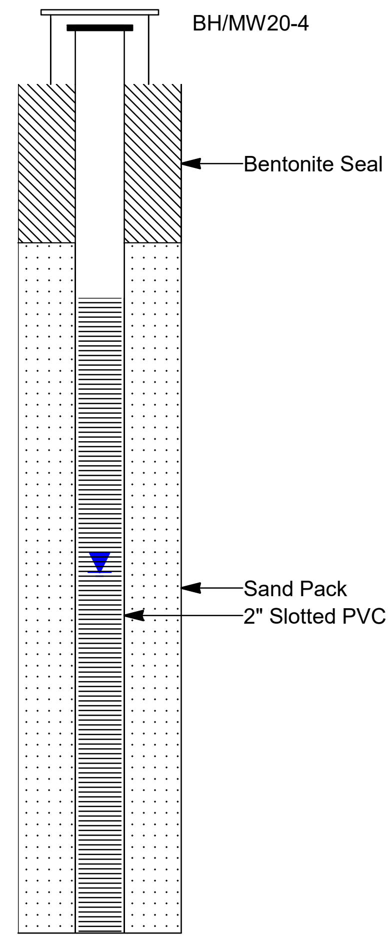
Borehole Number: BH/MW20-4

Project Number: 20-206
Client: Guzman / Wallace
Site Location: 1368 Labrie Avenue
Coordinates: 45.4198293E, -75.623466N (UTM Zone 18)
Drilling Method: Direct Push - Blow Count
Drilling Rig: Geoprobe 7822DT

MOE Well ID: A274718
Date Completed: March 11, 2020
Supervisor: GDB
Logged By: KAM
Ground Surface Elevation: 100.64
Date of Water Level Measurement: March 13, 2020

DEPTH BGS (ft)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
0							GROUND SURFACE
0–2	Sample		157	0	0	Fill	FILL Gravel fill and clay, dense, low plasticity, minor red staining, grey, dry
2.5–4.5	Sample		42	0	1	Clay	CLAY Clay with some shale and till, dense, medium plasticity, no odour, no staining, dark brown, dry
5–7	Sample		79	45	0	Clay	CLAY Clay with some shale, medium plasticity, no odour, no staining, dark brown, dry
7.5–9.5	Sample	X	40	50	0	Clay	CLAY Clay, trace till, dense, medium plasticity, no odour, no staining, dark brown, wet
10–12	Sample	X	13	0	0	Clay	high plasticity
13.2							BOREHOLE TERMINATED Total Depth of BH/MW20-4 4.02 mBGS

INSTALLATION



Static Water Level

at 2.443 mBGS

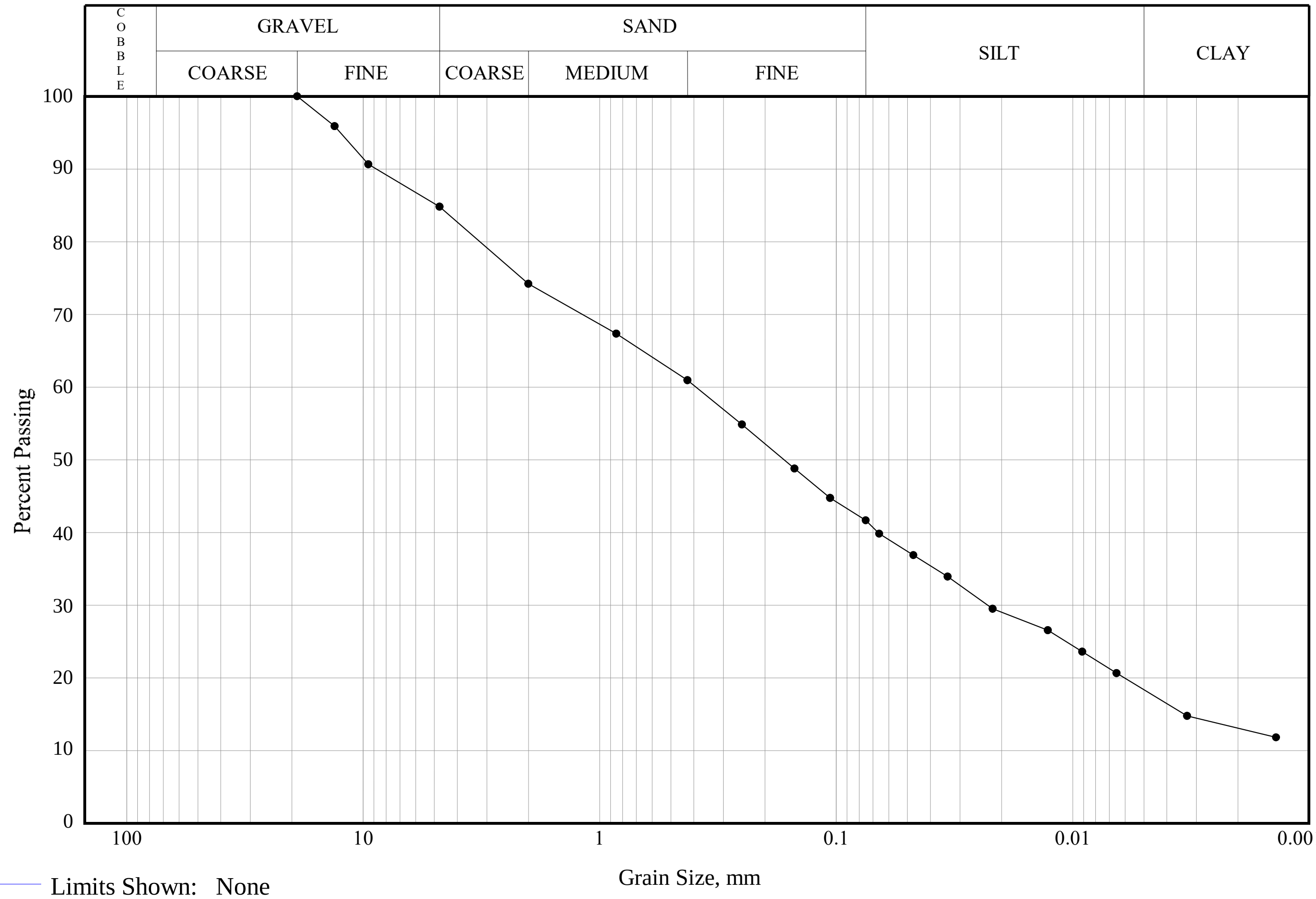
Prepared By: MdK
Reviewed By: GDB
Doc: BH LOGS.GPJ
Template: GEOFIRMA_TEMPLATE.GDT

Geofirma Engineering Ltd

APPENDIX C

Laboratory Test Results
Soils Grading Charts

GEMTEC Consulting Engineers and Scientists	Client: Geofirma Engineering Ltd.	Soils Grading Chart
	Project: Preliminary Geotechnical Investigation, Proposed Develo	
	Project #: 6264906	



Limits Shown: None

Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
—●—	Glacial Till	20-1	SA 06	3.81-4.42	15.2	43.1	23.3	18.4

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
—●—	Silty sand , some gravel, some clay	N/A	---	0.00	0.02	0.17	0.39	4.86	23.3

APPENDIX D

Chemical Analysis of Soil Sample
Samples Relating to Corrosion
(Paracel Laboratory Ltd. Order No. 2046216)

Report to: Geofirma Engineering Ltd.
Project: 62649.06 (November 30, 2020)

Certificate of Analysis

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

Client PO:

Report Date: 16-Nov-2020

Order Date: 10-Nov-2020

Project Description: 62649.06

	Client ID:	BH 20-1 SA 3	-	-	-
	Sample Date:	10-Nov-20 11:50	-	-	-
	Sample ID:	2046216-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	88.8	-	-	-
General Inorganics					
Conductivity	5 uS/cm	153	-	-	-
pH	0.05 pH Units	7.65	-	-	-
Resistivity	0.10 Ohm.m	65.2	-	-	-
Anions					
Chloride	5 ug/g dry	16	-	-	-
Sulphate	5 ug/g dry	18	-	-	-

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