GEMTEC
www.gemtec.ca

Geotechnical Investigation
Fernbank Crossing
Residential Subdivision
Block 135

Ottawa, Ontario

GEMTEC
www.gemtec.ca

Submitted to:

Novatech
240 Michael Cowpland Drive
Ottawa, Ontario
K2M 1P6

Geotechnical Investigation
Fernbank Crossing
Residential Subdivision
Block 135
Ottawa, Ontario

March 20, 2019
Project: 64153.74

experience • knowledge • integrity

GEMTEC Consulting Engineers and Scientists Limited
32 Steacie Drive
Ottawa, ON, Canada
K2K 2A9

March 20, 2019 File: 64153.74

Novatech
240 Michael Cowpland Drive
Ottawa, Ontario
K2M 1P6

Attention: Mr. Mark Bissett, P.Eng.

Re: Geotechnical Investigation
Fernbank Crossing Residential Subdivision Block 135
Ottawa, Ontario

Please find enclosed the results of our geotechnical investigation for Block 135 - Fernbank Crossing Residential Development located in Ottawa (Stittsville), Ontario.

Brett Webster, B.A.Sc.

Brent Wiebe, P.Eng.

Enclosures
P:\0. Files\64100\64153.74\PDFs\Report Update\64153.74_RPT_V03_Final_2019-03-20.docx

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed residential development on Block 135 in the Fernbank Crossing Residential Subdivision in the City of Ottawa, Ontario.

The purpose of the investigation was to advance a limited number of test pits at the site and, based on the factual information obtained, together with the results of previous test pits advanced at the site by GEMTEC Consulting Engineers and Scientists Limited (previously Houle Chevrier Engineering Ltd.), provide engineering guidelines on the geotechnical aspects of the design of the project, including construction considerations that could influence design decisions.

2.0 PROJECT DESCRIPTION

It is understood that plans are being prepared for the development of Block 135 in the Fernbank Crossing residential subdivision with six (6) blocks of attached residential houses of slab on grade (i.e. basementless) construction. Water, sanitary and storm services will be part of the proposed development.

Block 135 is on the east side of Robert Grant Avenue between Halliburton Heights and Cope Drive. The site location is shown on the attached Key Plan, Figure 1. The site is currently undeveloped and was previously used as agricultural land.

Surficial geology maps of the Ottawa area indicate that the site is underlain by offshore marine sediments of clay and silt and/or glacial till. Drift thickness maps indicate that the overburden ranges from 5 to 10 metres. Bedrock geology maps indicate that the site is underlain by interbedded dolomite and limestone bedrock of the Gull River formation. Fill associated with the past and current uses of the site should also be expected.

3.0 PREVIOUS SUBSURFACE INVESTIGATIONS

Previous test pit investigations were carried out across and in the vicinity of the subject site by Houle Chevrier Engineering Ltd. in 2008 and 2014. The findings of these investigations have been documented in our previous reports to Novatech titled:

- "Additional Test Pits, East Portion of Brookfield Property, Fernbank Community Design, Ottawa, Ontario", dated December 2008, and;
- "Geotechnical Investigation, Fernbank Crossing Residential Subdivision, Phase 3 and 4", dated December 2014.

The relevant test pit information from the 2008 investigation across and in the vicinity of the site is provided in Appendices A. The subsurface conditions encountered in the test pits advanced as part of the 2014 investigation were not identified since the test pits were advanced solely to provide additional information on the inferred depth to bedrock.

The approximate locations of the test pits advanced as part of previous investigations, along with details on refusal depths, are provided on the Test Hole Location Plan, Figure 2.

4.0 SUBSURFACE INVESTIGATION

The field work for this investigation was carried out on July 11, 2017.

At that time eight (8) test pits, numbered 17-1 through 17-8, were advanced to depths ranging from about 0.4 to 5.3 metres below surface grade using a hydraulic shovel excavator supplied and operated by Thomas Cavanaugh Construction Limited of Ottawa, Ontario.

The subsurface and groundwater conditions encountered in the test pits were identified by visual and tactile observation of the materials exposed on the sides and bottom of the test pits. The test pits were loosely backfilled with the excavated materials and tamped with the bucket of the excavator. As such, the test pits represent areas of soil disturbance.

The approximate locations of the test pits are shown on the Test Hole Location Plan, Figure 2. The approximate locations of the corresponding test pits from previous investigations are also shown on the Test Hole Location Plan, Figure 2. Descriptions of the subsurface conditions logged in the test pits are provided on the Record of Test Pit sheets in Appendix B.

The field work was supervised throughout by members of our engineering staff, who directed the excavation and logged the subsurface conditions in the test pits. Following the field work, the soil samples were returned to our laboratory for examination by a geotechnical engineer and applicable classification testing.

Select samples of the soil were tested for water content and grain size distribution and the results are provided in Appendix C. One (1) sample of the recovered soil was submitted to Paracel Laboratories Ltd. for basic chemical testing relating to corrosion of buried concrete and steel. The results of this testing is provided in Appendix D.

The locations and elevations of the test pits were determined in the field by GEMTEC using Trimble GPS surveying equipment. The elevations are referenced to geodetic datum.

5.0 SUBSURFACE CONDITIONS

5.1 General

As previously indicated, the soil and groundwater conditions logged in the test pits are given on the Record of Test Pit sheets in Appendix B. The test pit logs indicate the subsurface conditions at the specific test locations only. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. The precision with which subsurface conditions are indicated depends on the frequency and recovery of samples, the method of sampling, and the uniformity of the subsurface conditions. Subsurface conditions at other than the test locations may vary from the conditions encountered in the test pits. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site.

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

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

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

5.2 Fill Material/Topsoil Fill Material

Fill material was encountered at the surface of all test pit locations.

The upper portions of the fill material is composed dark brown silty sand with trace amounts of gravel, cobbles and organic material and is described as topsoil fill material. Plastic debris was encountered within the topsoil fill material at test pit 17-7. The topsoil fill material has a thickness ranging from about 0.2 to 0.3 metres.

At four (4) test pits (17-1, 17-3, 17-6, and 17-8), the topsoil fill material transitions at a depth of about 0.3 metres below surface grade to fill material composed of brown sandy silt, some clay, trace gravel, with cobbles and boulders. The fill material in these test pits extends to depths ranging from about 0.7 to 1.3 metres below surface grade (elevation 102.5 to 103.7 metres, geodetic datum).

5.3 Silty Clay

A native deposit of silty clay was encountered underlying the topsoil in test pit 17-4 at a depth of 0.2 metres.

The silty clay at test pit 17-4 consists of a stiff to very stiff, grey silty clay, with trace sand. The thickness of the silty clay is about 1.9 metres at this location and extends to a depth of about 2.0 metres below surface grade (elevation 103.3 metres, geodetic datum).

5.4 Clayey Silt

Native deposits of grey brown clayey silt, trace sand were encountered underlying the fill material/topsoil fill material in three (3) test pits (17-1 through 17-3) at depths ranging from about 0.3 to 1.0 metres below surface grade.

The thickness of the clayey silt deposits ranges from about 1.9 to 2.3 metres and extends to depths ranging from 2.6 to 3.2 metres below surface grade (elevation 100.3 to 101.1 metres, geodetic datum).

Moisture content testing carried out on a sample of the clayey silt indicates a moisture content of about 25 percent.

One (1) grain size distribution test was carried out on a sample of the clayey silt recovered from test pit 17-4. The results are provided on Figure C1 in Appendix C.

5.5 Glacial Till

Native deposits of glacial till were encountered below the fill material/topsoil fill material, silty clay, or clayey silt, at all test pit locations. Glacial till is typically a heterogeneous mixture of all grain sizes. For this site, the glacial till is composed of grey brown and grey sandy silt with some gravel and trace clay and was encountered at depths ranging from about 0.3 to 3.3 metres below surface grade. Cobbles and boulders were also observed in the glacial till deposits.

Test pit 17-1 was terminated within the glacial till at 5.3 metres below ground surface (elevation 98.3 metres, geodetic datum).

Moisture content testing carried out on a sample of the glacial till indicates a moisture content of about 24 percent.

5.6 Practical Refusal

Practical refusal of the hydraulic shovel was encountered on probable bedrock at seven (7) test pit locations. Refusal was not encountered in test pit 17-1. The depths and elevations of the encountered refusal are presented on Table 4.1.

Table 4.1 – Practical Refusal on Inferred Bedrock

Test Pit	Depth Below Surface Grade (metres)	Elevation of Refusal – Geodetic Datum (metres)
17-2	5.1	98.6
17-3	4.7	98.8

Test Pit	Depth Below Surface Grade (metres)	Elevation of Refusal – Geodetic Datum (metres)
17-4	3.5	101.8
17-5	0.4	103.8
17-6	4.2	99.6
17-7	0.7	104.7
17-8	0.9	103.5

It should be noted that refusal can sometimes occur on boulders within the glacial till.

5.7 Groundwater Conditions

Groundwater seepage was noted in test pits 17-1, 17-2, 17-4, and 17-6, at depths ranging from about 2.0 to 5.1 metres below surface grade (elevation 98.6 to 103.3 metres, geodetic datum).

It should be noted that groundwater seepage within test pit excavations do not represent stabilized groundwater conditions. Groundwater levels may also be higher during wet periods of the year, such as the early spring or fall or following periods of heavy precipitation.

5.8 Soil Chemistry Relating to Corrosion

The results of chemical testing of a sample of soil from test pit 17-4 sample 2 are provided in Appendix D and summarized below:

- pH 7.45
- Sulphate Content 197 micrograms per gram
- Chloride Content 6 micrograms per gram
- Resistivity 36.3 Ohm metre
- Conductivity 276 microseconds per centimetre

6.0 GEOTECHNICAL GUIDELINES AND RECOMMENDATIONS

6.1 General

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

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

6.2 Grade Raise Restrictions

Based on the results of this geotechnical investigation, together with the results of previous test pits advanced by GEMTEC there are no grade raise restrictions in Block 135, from a geotechnical perspective.

6.3 Proposed Residential Buildings

6.3.1 Overburden Excavation

The excavations for the foundations should be taken through any surficial fill, topsoil, or otherwise deleterious material to expose undisturbed soil. 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 native overburden deposits can be classified as Type 3 and, accordingly, allowance should be made for excavation side slopes of 1 horizontal to 1 vertical extending upwards from the base of the excavation.

Excavation of the native soils above the groundwater should not present any excavation constraints. In contrast, excavation in the native clayey silt or glacial till below the groundwater level could present constraints. Groundwater inflow from clayey silt and glacial till deposits could cause sloughing of the sides of the excavation and disturbance to the soils at the bottom of the excavation, flatter side slopes and or drainage measures may be required if excavation is required below the groundwater level in these deposits.

Based on our observations on site, groundwater inflow from the overburden deposits into the excavations should be controlled by pumping from filtered sumps within the excavations. It is not expected that short term pumping during excavation will have any significant affect on nearby structures and services.

6.3.2 Bedrock Excavation

Localized removal of competent bedrock at this site could be carried out using (a) drill and blasting, (b) hoe ramming techniques in conjunction with line drilling on close centres or (c) a combination of both. Provided that good bedrock excavation techniques are used, the competent bedrock could be excavated using vertical side walls.

Any blasting should be carried out under the supervision of a blasting specialist engineer. As a guideline for blasting, the suggested peak vibration limits at the nearest structure or service are provided in Table 6.1.

Table 6.1 – Peak Vibration Limits

Frequency of Vibration (Hz)	Vibration Limits (millimetres/second)
<10	5
10 to 40	5 to 50 (interpolated)
>40	50

It is pointed out that these criteria, although conservative, were established to prevent damage to existing buildings and services in good condition; more stringent criteria may be required to prevent damage to freshly placed (uncured) concrete or vibration sensitive equipment or utilities. Monitoring of the blasting should be carried out to ensure that the blasting meets the limiting vibration criteria. Pre-construction condition surveys of nearby structures and existing buried services are considered essential. The effects due to vibration from blasting can be controlled by limiting the size and amount of charge, using delayed detonation techniques, and the like. To reduce the effects of vibration on nearby services, we suggest that the separation distance between any blasting and existing underground services be at least 3 metres. Any bedrock removal within these limits could be carried out using hoe ramming techniques in conjunction with line drilling on close centres. It is noted that the cost of bedrock removal generally increases the closer the bedrock removal is to any existing structures or services.

As an alternative to blasting, bedrock removal could be carried out using large hydraulic excavation equipment in combination with hoe ramming. Line drilling on close centres could be used to reduce, not prevent, over break and under break of the bedrock excavation and to define the limit of excavation next to existing structures and services. For the bedrock at this site, it is suggested that allowance be made for line drilling 75 to 100 millimetre diameter holes on 200 to 300 millimetre centres. The vibration effects of hoe ramming are usually minor and localized. Monitoring of the hoe ramming could be carried out, at least initially, to measure the vibrations to ensure that they are below the acceptable threshold value. Provided that good bedrock excavation techniques are used, the bedrock could be excavated using vertical side walls. Any loose rock should be scaled from the side of the excavation.

The bedrock at this site has near horizontal bedding planes and near vertical inclined joints. Therefore, some vertical and horizontal over break of the bedrock should be expected. Vertical over break will naturally occur along the bedding planes; as such, additional granular bedding material should be expected for the site services and additional granular fill/concrete should be expected for the house foundations.

6.3.3 Groundwater Pumping

As indicated above, groundwater was encountered at depths ranging from 2.0 to 5.1 metres below surface grade (elevation 98.6 to 103.3 metres, geodetic datum). As such, we do not anticipate any significant groundwater pumping during excavations for the foundations. Also, since the proposed buildings are of slab on grade construction with finished floor levels above exterior grade, we do not anticipate any long term groundwater pumping requirements.

Any short term pumping should be controlled by pumping from filtered sumps within the excavations.

6.3.4 Subgrade Preparation and Placement of Engineered Fill

Any existing topsoil, organic material, fill, and/or disturbed soil should be removed from below the proposed structures. This should include the removal of organic material and/or disturbed soil along the existing agricultural ditches.

Imported granular material (engineered fill) should be used to raise the grade in areas where the proposed founding level is above the level of the native soil, or where subexcavation of material is required below proposed founding level. The engineered fill should consist of granular material meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular B Type II and should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density. To allow spread of load beneath the footings, the engineered fill should extend horizontally at least 0.3 metres beyond the footings and then down and out from the edges of the footings at 1 horizontal to 1 vertical, or flatter. The excavations should be sized to accommodate this fill placement.

The test pits represent areas of disturbed soil. Any test pits which are within the building footprints should be subexcavated and backfilled with engineered fill material as described above. The sides of the subexcavated test pits should be sloped at 1 horizontal to 1 vertical, or flatter.

6.3.5 Spread Footing Design

The proposed structures could be founded on spread footings bearing on or within the native soils/bedrock or on engineered fill above the native soils/bedrock. The topsoil and any fill materials are not considered suitable for the support of the proposed structures or concrete floor slabs and should be removed from the proposed building areas.

Based on the results of the investigation, the following may be used to size the spread footing foundations:

Table 6.2 – Allowable Bearing Pressures for Foundations

Subgrade Material	Allowable Bearing Pressure for Foundations
Weathered silty clay, clayey silt, sandy silt	100
Glacial till	150
Engineered fill material, over undisturbed native deposits, or bedrock	150
Bedrock	500

Some of the native soils at this site are sensitive to construction operations, from ponded water and frost action. The construction operations should therefore be carried out in a manner that minimizes disturbance of the subgrade surfaces.

The post construction total and differential settlement of footings should be less than 25 and 15 millimetres, respectively, provided that all loose or disturbed soil is removed from the bearing surfaces and provided that any engineered fill material is compacted to the required density.

There may be areas on this site where the subgrade material at founding level transitions from overburden to bedrock. To reduce the potential for cracking of basement foundation walls above abrupt transitions from overburden to bedrock, it is suggested that the foundation walls be suitably reinforced for a distance of at least 3 metres from the transition.

6.3.6 Frost Protection of Foundations

All exterior footings 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 could be provided at the detailed design stage, if necessary.

6.3.7 Foundation Wall Backfill

As indicated above, the proposed buildings will be of basementless (i.e. slab on grade) construction. As such, foundation drainage is not considered necessary, however, the following comments on backfill are provided to reduce the potential of adfreeze and subsequent heaving of the foundation walls:

- Backfill the walls with free draining, non-frost susceptible sand or sand and gravel such as that meeting OPSS requirements for Granular B Type I or II. OR
- Install an approved proprietary drainage material or bond break on the exterior of the foundation walls and backfill the walls with native material or imported soil. It is pointed out that the moisture content of the native material may be above the optimum moisture content for compaction. As such, in areas where hard surfacing will abut the buildings, it is suggested that imported sand or sand and gravel be used for foundation backfill material to reduce the potential for post construction settlement of the backfill and damage to the hard surfacing.

The backfill should be compacted in maximum 300 millimetres thick lifts to at least 95 percent of the standard Proctor dry density value using suitable vibratory compaction equipment.

6.3.8 Concrete Slab Support

To provide predictable settlement performance of the concrete floor slabs, all topsoil, fill material, disturbed soil, and other deleterious materials should be removed from the slab area.

The base for the floor slab should consist of 19 millimetre clear crushed stone. Nominal compaction (2 to 3 passes of a vibratory diesel plate) of the clear stone is recommended to consolidate the material into place. The clear stone should be placed and compacted in maximum 300 millimetre thick lifts.

A suitable nonwoven geotextile should be placed over the subgrade prior to the placement of clear stone to prevent ingress of fines into voids in the clear stone and possible settlement/cracking of the slab.

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

A polyethylene vapour retarder is recommended below the floor slabs.

6.3.9 Removing Agricultural Tile Drains in Proximity to Foundations

Portions of the site were previously used for agricultural purposes. As such, tile drains could be encountered in some portions of the site. Any tile drains which are encountered within the excavations could be a source of significant volumes of water, which could impact construction. It is suggested that any drainage tiles encountered be cut and removed from within 2 metres horizontal distance of the sides of the excavations. The points where the tiles entered the excavations should then be backfilled with compacted silty clay to prevent any water flow through the tiles or trenches.

Any drainage tiles that are below proposed footings and floor slabs should be removed.

6.3.10 Seismic Site Classification

According to Table 4.1.8.4.A of the Ontario Building Code, 2012, Site Class C should be used for the seismic design of the structures bearing on bedrock or on engineered fill material over bedrock.

Site Class D should be used for any structures which are founded on the native deposits of silty clay, clayey silt, or glacial till.

In our opinion the soils are not considered to be liquefiable or collapsible under seismic loads.

6.4 Site Services

6.4.1 Overburden Excavation

Based on the available subsurface information, the excavations for the services within the site will be carried out through topsoil, fill material, silty clay, clayey silt, glacial till, and bedrock.

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 within the native soils at this site. As an alternative to sloping the excavations, or if areas of significant sloughing from the sides of the excavation are encountered, all services installations could be carried out within a tightly fitting, braced steel trench box, which is specifically designed for this purpose.

Excavation below the groundwater level within clayey silt and glacial till could present some constraints. There is potential for some disturbance to the soils at the bottom of the excavation and relatively flat side slopes may be required to prevent sloughing of material into the excavation unless the groundwater level is lowered in advance of excavation. It is our experience that excavation for site service installations to shallow depth within these deposits can usually be carried out within a braced steel trench box specifically designed for this purpose, in combination, where necessary, with steel plates advanced along the sides of the trench box to below the level of excavation.

Cobbles and boulders should be anticipated in the glacial till. As such, allowance should be made for removal of boulders from the glacial till during excavation. In order to advance the trench box, even boulders that partially intrude into the sides of the excavation must be removed, which may result in a wider excavation than anticipated. Further, additional backfill and/or bedding material may be required to fill any voids left from the removal of boulders.

The groundwater inflow should be controlled throughout the excavation and pipe laying operations by pumping from sumps within the excavation. Notwithstanding, some disturbance and loosening of the subgrade materials could occur, and allowance should be made for subexcavation and additional pipe bedding (sub-bedding) material, as discussed later in this report.

6.4.2 Bedrock Excavation

In bedrock, the excavation for flexible service pipes should be in accordance with Ontario Provincial Standard Drawing (OPSD) 802.013 for bedrock. The excavation for rigid service pipes should be in accordance with OPSD 802.033 for bedrock.

Guidelines for bedrock removal are provided in Section 6.3.2 of this report.

6.4.3 Groundwater Pumping

Groundwater inflow from the overburden deposits should be controlled by pumping from within the excavations. Significant groundwater inflow was observed from the bottom of test pit 17-2 in the current investigation. Allowance should be made for significant pumping where these conditions and/or if existing agricultural tile drains are encountered. Groundwater inflow from fractured bedrock can cause disturbance of soil in the bottom of trench excavations, which could require removal and replacement of the disturbed soil.

Groundwater inflow from the bedrock into the excavations for the site services should be expected and should be handled by pumping from within the excavations.

The groundwater should be detained and filtered before it is released into any ditches or creeks.

6.4.4 Pipe Bedding

The bedding for the sanitary sewers, storm sewers and watermains should be in accordance with OPSD 802.010/802.013 and 802.031/802.033 for flexible and rigid pipes, respectively. The pipe bedding should consist of at least 150 millimetres of well graded crushed stone meeting OPSS requirements for Granular A. OPSS documents allow recycled asphaltic concrete and concrete to be used in Granular A and Granular B Type II material. Since the source of recycled material cannot be determined, it is suggested that any granular materials used in the service trenches be composed of virgin (i.e., not recycled) material only.

Allowance should be made for subexcavation of any existing fill, organic deposits, boulders, or disturbed material encountered at subgrade level.

Allowance should be made to place a subbedding layer composed of 150 to 300 millimetres of OPSS Granular B Type II in areas where wet clayey silt is encountered at the pipe subgrade level to reduce the potential for disturbance.

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 use of clear crushed stone should not be permitted for the installation of site services, since it could exacerbate groundwater lowering of the overburden materials due to “French Drain” effects.

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

6.4.5 Trench Backfill

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

In areas where the service trench will be located below or in close proximity to existing or future roadway areas, 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 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 I. The depth of frost penetration in areas that are kept clear of snow and where trench backfill consists of broadly graded shattered rock fill or earth fill is expected to be about 1.8 metres. It is our experience, however, that the frost penetration can be as much as 2.4 metres when the trench backfill consists solely of relatively open graded rock fill. Where cover requirements are not practicable, the pipes could be protected from frost using a combination of earth cover and insulation. Further details regarding insulation could be provided, if required.

It is anticipated that most of the inorganic overburden materials encountered during the subsurface investigation will be acceptable for reuse as trench backfill. Topsoil or other organic material should be wasted from the trench. If on-site blast rock is used as backfill within the service trench, it should be mostly 300 millimetres, or smaller, in size and should be well graded. To prevent ingress of fine material into voids in the blast rock, the upper surface of the blast rock should be covered with a thin layer of well graded crushed stone (e.g. OPSS Granular B Type II).

To minimize future settlement of the backfill and achieve an acceptable subgrade for the roadways, curbs, driveways, etc., the trench backfill should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value. Rock fill should be placed in maximum 500 millimetre thick lifts and compacted with a large drum roller, the haulage and spreading equipment, or a combination of both. 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.

The silty clay/clayey silt, and glacial till from the excavations may have moisture contents above optimum for compaction. Furthermore, most of the overburden deposits at this site are sensitive to changes in moisture content. Unless these materials are allowed to dry, the specified densities will not likely be possible to achieve and, as a consequence, some settlement of these backfill materials could occur. Consideration could be implementing one or a combination of the following measures to reduce post construction settlement above the trenches, depending on the weather conditions encountered during the construction:

- Allow the overburden materials to dry prior to compaction.
- Reuse any wet materials in the lower part of the trenches and make provision to defer final paving of any roadways for 6 months, or longer, to allow some the trench backfill settlement to occur and thereby improve the final roadway appearance.
- Reuse any wet materials outside hard surfaced areas and where post construction settlement is less of a concern (such as landscaped areas).

The soils that exist at this site are highly frost susceptible and are prone to significant ice lensing. In order to carry out the work during freezing temperatures and maintain adequate performance of the trench backfill as a roadway subgrade, the 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 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.

6.4.6 Seepage Barriers

The granular bedding in the service trench could act as a “French Drain”, which could promote groundwater lowering. As such, we suggest that seepage barriers be installed along the service trenches at strategic locations at a horizontal spacing of about 100 metres and at the perimeter of the property. The seepage barriers should begin at subgrade level and extend vertically through the granular pipe bedding and granular surround to within the native backfill materials, and horizontally across the full width of the service trench excavation. The seepage barriers could consist of 1.5 metre wide dykes of compacted silty clay. The silty clay should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value. The locations of the seepage barriers could be provided as the design progresses.

6.5 Access Roads

6.5.1 Subgrade Preparation

In preparation for roadway construction at this site, all surficial topsoil and any soft, wet or deleterious materials should be removed from the proposed roadway areas. This would include the removal of any organic material and/or disturbed soil along the existing agricultural ditches.

Prior to placing granular material for the access roads, the exposed subgrade should be proof rolled with a large (10 tonne) vibratory steel drum roller under dry conditions and inspected and approved by geotechnical personnel. Any soft areas evident from the proof rolling should be subexcavated and replaced with suitable (dry) earth borrow or well shattered and graded rock fill material that is frost compatible with the materials exposed on the sides of the area of subexcavation.

Similarly, should it be necessary to raise the roadway 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 also be placed in thin lifts and suitably compacted either with a large drum roller, the haulage and spreading equipment, or a combination of both.

Truck traffic should be avoided on the native soil subgrade, especially under wet conditions.

6.5.2 Pavement Structure

For the access roadways for the residential buildings, the following minimum pavement structure should be used:

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

It is noted that the above pavement structure meets City of Ottawa Standard Drawing No. R-27 (Rural Local Roadway Cross Section Over Earth) requirements.

In areas where bedrock or well shattered and graded rock fill is encountered at the pavement subgrade level, the thickness of the OPSS Granular B Type II subbase could be reduced to 150 millimetres.

6.5.3 Effects of Soil Disturbance

The above pavement structures assume that any trench backfill is adequately compacted and that the roadway subgrade surface is prepared as described in this report. If the roadway subgrade surface is disturbed or wetted due to construction operations or precipitation, the granular thickness given above may not be adequate and it may be necessary to increase the thickness of the Granular B Type II subbase and/or to incorporate a woven geotextile separator between the roadway subgrade surface and the granular subbase material. The adequacy of the design pavement thickness should be assessed by geotechnical personnel at the time of construction. In our experience, a geotextile will likely be required in most cases where the subgrade consists of overburden, if the roadway construction is planned during the wet period of the year (such as the spring or fall).

Similarly, if the granular pavement materials are to be used by construction traffic, it may be necessary to increase the thickness of the Granular B Type II, 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.

6.5.4 Granular Material Compaction

The pavement granular materials should be compacted in maximum 300 millimetre thick lifts to at least 98 percent of standard Proctor maximum dry density using suitable vibratory compaction equipment.

6.5.5 Asphaltic Concrete Types

The asphaltic concrete should consist of 40 millimetres of Superpave 12.5 over 60 millimetres of Superpave 19.0. Performance grade PG 58-34 asphaltic cement should be specified.

6.5.6 Transition Treatments and Frost Tapers

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

Granular frost tapers should be installed in accordance with OPSD 205.030 in areas where there is an abrupt transition from bedrock to overburden.

6.5.7 Pavement Drainage

The subgrade surface should be shaped and crowned to promote drainage of the roadway granular materials.

Adequate drainage of the pavement granular materials and subgrade is important for the long term performance of the pavement at this site. As such it is recommended that catch basins be provided with perforated stub drains extending about 3 metres out from the catch basins in two directions parallel to the roadway. These drains should be installed at the bottom of the subbase layer.

6.6 Other Considerations

6.6.1 Corrosion of Buried Concrete and Steel

The measured sulphate concentration in the sample of soil recovered from borehole 17-4 sample 2 was 197 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/groundwater could vary throughout the year due to the application sodium chloride for de-icing.

6.6.2 Construction Induced Vibration

Some of the construction operations (such as bedrock removal by blasting or hoe ramming, granular material compaction, excavation, 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. The magnitude of the vibrations will be much less than that required to cause damage to the nearby structures or services, but may be felt at the nearby structures. We recommend that preconstruction surveys be carried out on the adjacent structures and that vibration monitoring be carried out during bedrock removal.

Preconstruction surveys are recommended on any nearby water supply wells.

6.6.3 Winter Construction

In the event that construction is required during freezing temperatures, the soil below the footings should be protected immediately from freezing using straw, propane heaters and insulated tarpaulins, or other suitable means.

Any service trenches should be opened for as short a time as practicable and the excavations should be carried out only in lengths which allow all 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.

6.6.4 Excess Soil Management Plan

This report does not constitute an excess soil management plan. The disposal requirements for excess soil from the site have not been assessed.

6.6.5 Landscape Design

The City of Ottawa document titled: “Tree Planting in Sensitive Marine Soils - 2017 Guidelines” indicates that sensitive marine clay soils with a modified plasticity index of less than 40 percent are considered to have a low/medium potential for soil volume change. Clay soils with a modified plasticity index that exceeds 40 percent are considered to have a high potential for soil volume change.

Based on the results of the geotechnical investigation, portions of the site are underlain by deposits of silty clay (weathered crust) and clayey silt. Based on visual and tactile examination of these overburden deposits, and our previous investigations in the vicinity of the site, it is our opinion that the native clayey deposits likely have a modified plasticity index of less than 40 percent. This indicates that the potential for soil volume change, as defined by the City of Ottawa for the tested samples is low to medium.

In accordance with the City of Ottawa Tree Planting Guidelines, tree planting restrictions apply where clay soils with low/medium potential for volume change are present between the underside of footing and a depth of 3.5 metres below finished grade (refer to the City of Ottawa document titled: “Tree Planting in Sensitive Marine Soils - 2017 Guidelines”).

It is noted that the soil conditions across this site are variable and that tree planting restrictions will not apply where the subgrade conditions consist of glacial till and/or bedrock. The presence, or lack thereof, of clayey soils could be confirmed at the time of the subgrade evaluations, which will be carried out on a lot-by-lot basis.

7.0 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 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 GEMTEC 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.

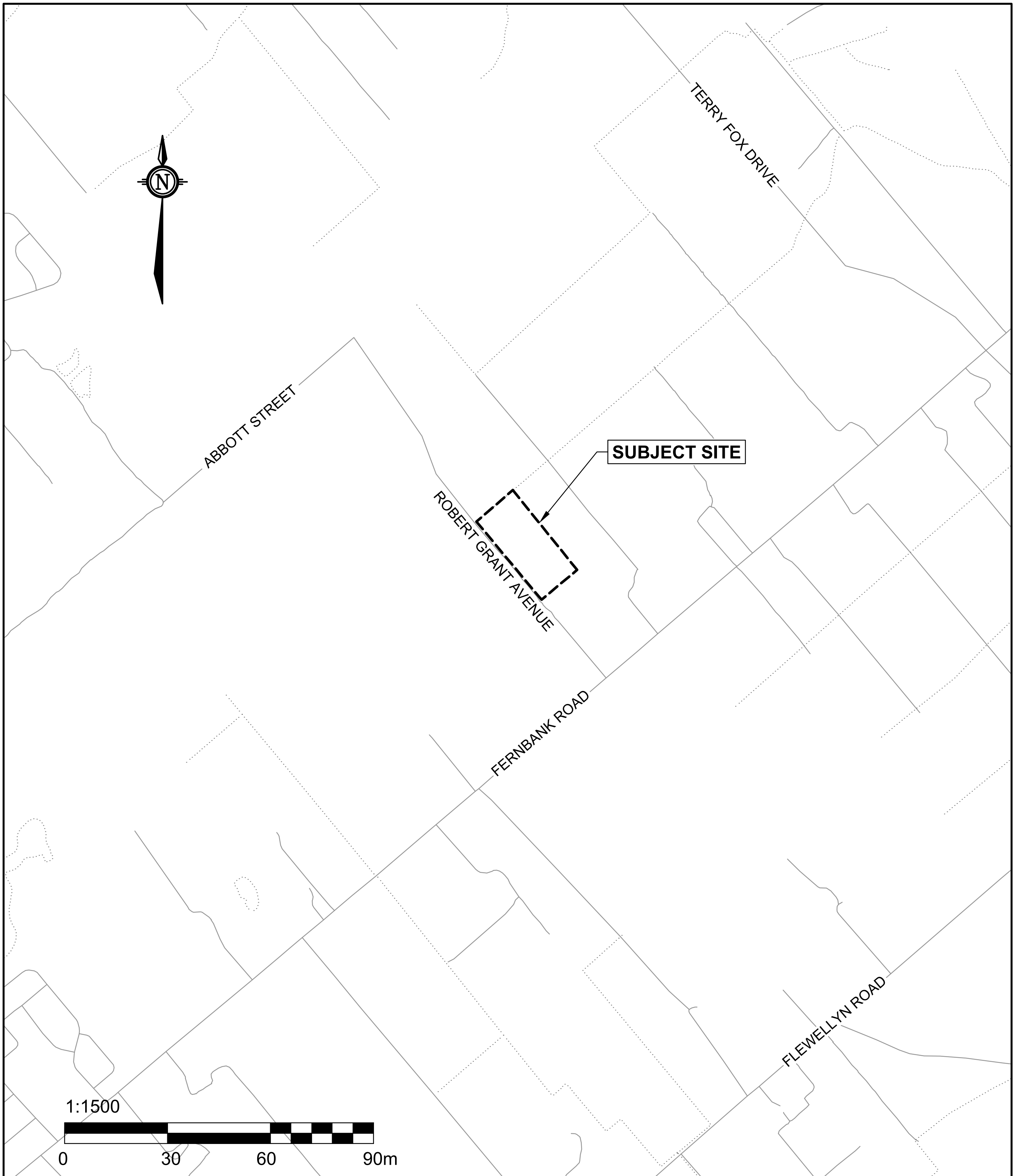
The subgrade surfaces for the proposed structures, utilities and roadways should be inspected by experienced geotechnical personnel to ensure that suitable materials have been reached and properly prepared. The placing and compaction of earth fill and imported granular materials should be inspected to ensure that the materials used conform to the grading and compaction specifications.

In accordance with City of Ottawa requirements, all foundation subgrades and footings should be inspected and approved by geotechnical personnel. In accordance with Section 4.2.2.2 of the Ontario Building Code, full time inspection is required during placing and compaction of engineered fill and imported granular materials to ensure that the materials used conform to the grading and compaction specifications.

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.

Brett Webster. B.A.Sc.

Brent Wiebe, P.Eng.
Senior Geotechnical Engineer



GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

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

Project			Drawing		
GEOTECHNICAL INVESTIGATON FERNBANK CROSSING RESIDENTIAL SUBDIVISION - PHASE 4 OTTAWA, ONTARIO			KEY PLAN		
Drwn By	Chkd By	Date	Project No.	Revision No.	
S.L.	B.V.	MARCH 2019	64153.74	0	**FIGURE 1**

LEGEND

SUBJECT SITE

TP 17-1
103.60

TEST PIT
(current investigation by Houle Chevrier Engineering Ltd.)

GROUND SURFACE ELEVATION IN METRES GEODETIC DATUM

TP 14-1
103.50

APPROXIMATE TEST PIT LOCATION
(previous investigation by Houle Chevrier Engineering Ltd. (2014))

TP 08-8

APPROXIMATE TEST PIT LOCATION IN PLAN
(previous investigation by Houle Chevrier Engineering Ltd., (2008))

ETP End of Test pit

R Depth to Practical Refusal

Scale 1:1000

0 20 40 60m

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

32 Steacie Drive
Ottawa, ON K2K 2A9
Tel: (613) 836-1422
www.gemtec.ca
ottawa@gemtec.ca

Client		Project
NOVATECH		64153.74

Location	FERNBANK CROSSING BLOCK 135 OTTAWA, ONTARIO

Drwn by	Chkd by	
S.L.	B.V.	TEST HOLE LOCATION PLAN

Date	Rev.	
MARCH 2019	0	**FIGURE 2**

APPENDIX A

List of Abbreviations and Terminology
Record of Test Pit Sheets – 2008 Investigation
by Houle Chevrier Engineering Ltd.
(Our Reference No. 08-601)

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

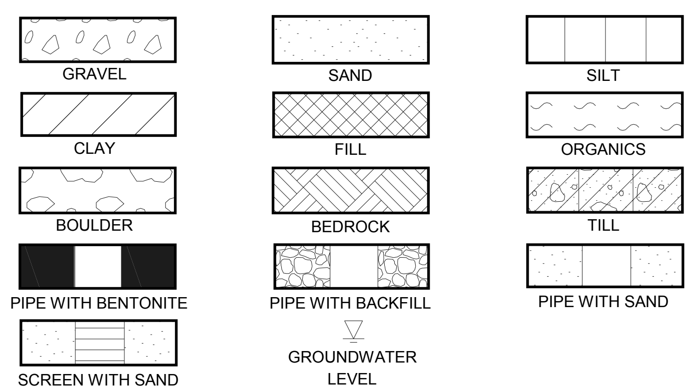
PENETRATION RESISTANCE

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: 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 TEST PIT 08-8

PROJECT: 08-601

LOCATION: See Site Plan, Figure 2

DATE OF EXCAVATION: November 6 and 7, 2008

SHEET 1 OF 1

DATUM: Not applicable

TYPE OF EXCAVATOR: CAT 320D

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SHEAR STRENGTH, Cu (kPa) Natural. V - + Remoulded. V - ⊕ 20 40 60 80	WATER CONTENT (PERCENT) Wp ⊢—o W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface							
	TOPSOIL							
	Grey brown sandy silt, some gravel, cobbles and boulders (GLACIAL TILL)		0.18					
	Practical shovel refusal on BEDROCK End of test pit		0.61					No groundwater inflow observed on completion of excavating.
1								
2								
3								
4								
5								
6								

DEPTH SCALE

1 to 30

Houle Chevrier Engineering

LOGGED: AN

CHECKED:

RECORD OF TEST PIT 08-19

PROJECT: 08-601

LOCATION: See Site Plan, Figure 2

DATE OF EXCAVATION: November 6 and 7, 2008

SHEET 1 OF 1

DATUM: Not applicable

TYPE OF EXCAVATOR: CAT 320D

DEPTH SCALE METRES	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SHEAR STRENGTH, Cu (kPa) Natural. V - + Remoulded. V - ⊕ (20 40 60 80)	WATER CONTENT (PERCENT) Wp W Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface							
	TOPSOIL							
	Very stiff to stiff grey brown SILTY CLAY (weathered crust)		0.25					
1								
	Grey brown sandy silt, some gravel, cobbles, and boulders (GLACIAL TILL)		1.25					
2	Grey sandy silt, some gravel, cobbles, and boulders (GLACIAL TILL)		2.01					
3								
	Practical shovel refusal on BEDROCK End of test pit		3.15					Groundwater inflow at 3.15 metres below ground surface on completion of excavation
4								
5								
6								

DEPTH SCALE

1 to 30

Houle Chevrier Engineering

LOGGED: AN

CHECKED:

RECORD OF TEST PIT 08-20

PROJECT: 08-601
LOCATION: See Site Plan, Figure 2
DATE OF EXCAVATION: November 6 and 7, 2008

SHEET 1 OF 1
DATUM: Not applicable
TYPE OF EXCAVATOR: CAT 320D

DEPTH SCALE METRES	SOIL PROFILE: DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	SHEAR STRENGTH, Cu (kPa) Natural. V - + Remoulded. V - ⊕ (20 40 60 80)	WATER CONTENT (PERCENT) Wp — W — Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
	Ground Surface						
0	TOPSOIL						
	Very stiff to stiff grey brown SILTY CLAY (weathered crust)	0.36					
1							
2							
3	Grey sandy silt, some gravel, cobbles, and boulders (GLACIAL TILL)	3.05					
4	End of test pit	4.27					Groundwater inflow at 2.39 metres below ground surface on completion of excavation.
5							
6							

DEPTH SCALE
1 to 30

Houle Chevrier Engineering

LOGGED: AN
CHECKED:

RECORD OF TEST PIT 08-21

PROJECT: 08-601

LOCATION: See Site Plan, Figure 2

DATE OF EXCAVATION: November 6 and 7, 2008

SHEET 1 OF 1

DATUM: Not applicable

TYPE OF EXCAVATOR: CAT 320D

DEPTH SCALE METRES	SOIL PROFILE - DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SHEAR STRENGTH, Cu (kPa) Natural. V - + Remoulded. V - ⊕ (20 40 60 80)	WATER CONTENT (PERCENT) Wp W Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface							
	TOPSOIL							
	Very stiff to stiff grey brown SILTY CLAY (weathered crust)		0.23					
1	Grey brown sandy silt, some gravel and cobbles (GLACIAL TILL)		0.86	1				
2								
	Grey sandy silt, some gravel, cobbles and boulders (GLACIAL TILL)		2.44	2				
3	Practical shovel refusal on BEDROCK End of test pit		2.84					No groundwater inflow observed on completion of excavating.
4								
5								
6								

DEPTH SCALE

1 to 30

Houle Chevrier Engineering

LOGGED: AN

CHECKED:

APPENDIX B

Record of Test Pit Sheets – Current Investigation
July 2017

RECORD OF TEST PIT 17-1

CLIENT: Novatech
PROJECT: Fernbank Crossing, Block 135
JOB#: 64153.74
LOCATION: See Test Hole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Jul 11 2017

DEPTH SCALE METRES	SOIL PROFILE: DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA (+ NATURAL ⊕ REMOULDED) / WATER CONTENT, % (W_P W W_L) 10 20 30 40 50 60 70 80 90	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface	103.60					
	Dark brown silty sand, trace gravel, with cobbles and organic material (TOPSOIL FILL MATERIAL)	103.32 0.28					Backfilled with excavated material
	Brown sandy silt, some clay, trace gravel, with cobbles and boulders (FILL MATERIAL)	102.56 1.04	1	GS			
1	Grey brown CLAYEY SILT, trace sand	100.70 2.90					
3	Grey sandy silt, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	98.27 5.33					Groundwater inflow noted at about 2.9 metres
5	End of test pit						

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

LOGGED: B.V.

CHECKED:

RECORD OF TEST PIT 17-2

CLIENT: Novatech
PROJECT: Fernbank Crossing, Block 135
JOB#: 64153.74
LOCATION: See Test Hole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Jul 11 2017

DEPTH SCALE METRES	SOIL PROFILE – DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED; WATER CONTENT, % W_P W W_L (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		103.68					
	Dark brown silty sand, trace gravel, with cobbles and organic material (TOPSOIL FILL MATERIAL)		103.38 0.30					Backfilled with excavated material
	Grey brown CLAYEY SILT, trace sand		101.09 2.59					
3	Grey sandy silt, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)		98.55 5.13					
5	End of test pit, practical refusal							Groundwater inflow noted from the bottom at about 5.1 metres

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

GEMTEC
Consulting Engineers and Scientists

LOGGED: B.V.
CHECKED:

RECORD OF TEST PIT 17-3

CLIENT: Novatech
PROJECT: Fernbank Crossing, Block 135
JOB#: 64153.74
LOCATION: See Test Hole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Jul 11 2017

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA (+ NATURAL ⊕ REMOULDED) / WATER CONTENT, % (W_P — W — W_L) 10 20 30 40 50 60 70 80 90	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		103.54					
	Dark brown silty sand, trace gravel, with cobbles and organic material (TOPSOIL FILL MATERIAL)		103.26 0.28					Backfilled with excavated material
	Brown sandy silt, some clay, trace gravel, with cobbles and boulders (FILL MATERIAL)		102.60 0.94					
1	Grey brown CLAYEY SILT, trace sand							
				1	GS			
2								
3			100.31 3.23					
	Grey sandy silt, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)							
4			98.84 4.70					
	End of test pit, practical refusal							
5								Test pit dry upon completion
6								
7								
8								
9								
10								

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

LOGGED: B.V.
CHECKED:

RECORD OF TEST PIT 17-4

CLIENT: Novatech
PROJECT: Fernbank Crossing, Block 135
JOB#: 64153.74
LOCATION: See Test Hole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Jul 11 2017

DEPTH SCALE METRES	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		105.29					
	Dark brown silty sand, trace gravel, with cobbles and organic material (TOPSOIL FILL MATERIAL)		105.14 0.15					Backfilled with excavated material
	Stiff to very stiff grey SILTY CLAY, trace sand							
1				1	GS			
2	Grey brown sandy silt, trace clay, trace gravel, with cobbles and boulders (GLACIAL TILL)		103.26 2.03	2	GS			Groundwater inflow noted at about 2.0 metres.
3	End of test pit, practical refusal		101.81 3.48					
4								
5								
6								
7								
8								
9								
10								

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

LOGGED: B.V.

CHECKED:

RECORD OF TEST PIT 17-5

CLIENT: Novatech
PROJECT: Fernbank Crossing, Block 135
JOB#: 64153.74
LOCATION: See Test Hole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Jul 11 2017

DEPTH SCALE METRES	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		104.24					
	Dark brown silty sand, trace gravel, with cobbles and organic material (TOPSOIL FILL MATERIAL)		103.91 0.33					Backfilled with excavated material
	Grey brown sandy silt, some gravel, with cobbles (GLACIAL TILL)		103.83 0.41					
	End of test pit, practical refusal							Test pit dry upon completion
1								
2								
3								

GEMTEC CONSULTING ENGINEERS AND SCIENTISTS

LOGGED: B.V.
CHECKED:

RECORD OF TEST PIT 17-6

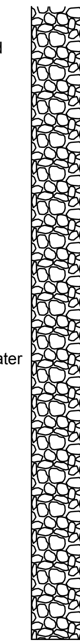
CLIENT: Novatech
PROJECT: Fernbank Crossing, Block 135
JOB#: 64153.74
LOCATION: See Test Hole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Jul 11 2017

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface	103.80			
	Dark brown silty sand, trace gravel, with cobbles and organic material (TOPSOIL FILL MATERIAL)	103.52 0.28			Backfilled with excavated material
	Brown sandy silt, some clay, trace gravel, with cobbles and boulders (FILL MATERIAL)	102.53 1.27			
1	Grey brown sandy silt, trace clay, trace gravel, with cobbles (GLACIAL TILL)	100.96 2.84			Groundwater inflow noted at about 2.3 metres
3	Grey sandy silt, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	99.61 4.19	1	GS	
4	End of test pit, practical refusal				

SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING



GEMTEC
Consulting Engineers and Scientists

LOGGED: B.V.
CHECKED:

GEO - TESTPIT LOG 64351.74_GNT_V01_2017-07-17.GPJ GEMTEC 2018.GDT 19/3/19

RECORD OF TEST PIT 17-7

CLIENT: Novatech
PROJECT: Fernbank Crossing, Block 135
JOB#: 64153.74
LOCATION: See Test Hole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Jul 11 2017

DEPTH SCALE METRES	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		105.31					
	Dark brown silty sand, trace gravel, with cobbles, plastic debris, and organic material (TOPSOIL FILL MATERIAL)		104.85 0.46					Backfilled with excavated material
	Grey brown sandy silt, some gravel, with cobbles (GLACIAL TILL)		104.65 0.66					
	End of test pit, practical refusal							Test pit dry upon completion
1								
2								
3								

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

LOGGED: B.V.
CHECKED:

RECORD OF TEST PIT 17-8

CLIENT: Novatech
PROJECT: Fernbank Crossing, Block 135
JOB#: 64153.74
LOCATION: See Test Hole Location Plan, Figure 2

SHEET: 1 OF 1
DATUM: CGVD2013
BORING DATE: Jul 11 2017

DEPTH SCALE METRES	SOIL PROFILE – DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED / WATER CONTENT, % W_P W W_L (10 20 30 40 50 60 70 80 90)	ADDITIONAL LAB. TESTING	WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION
0	Ground Surface		104.42					
	Dark brown silty sand, trace gravel, with cobbles and organic material (TOPSOIL FILL MATERIAL)							Backfilled with excavated material
	Brown sandy silt, some clay, trace gravel, with cobbles and boulders (FILL MATERIAL)		104.14 0.28					
	Grey brown sandy silt, trace clay, trace gravel, with cobbles (GLACIAL TILL)		103.73 0.69	1	GS			
	End of test pit, practical refusal		103.53 0.89					
1								Test npit dry upon completion
2								
3								

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

LOGGED: B.V.
CHECKED:

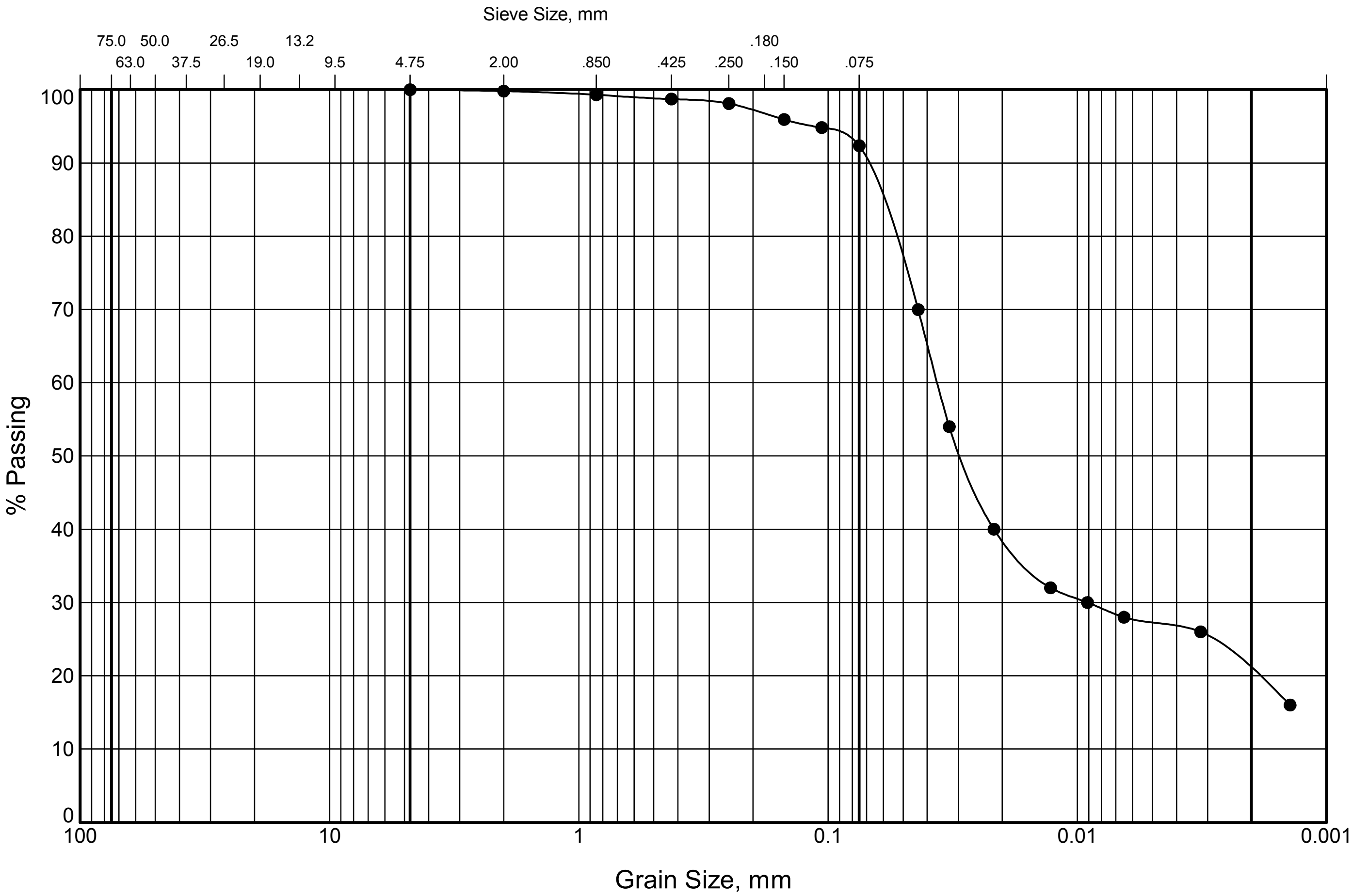
APPENDIX C

Results of Laboratory Testing
Figure C1

Report to: Novatech
Project: 64153.74 (March 20, 2019)

GRAIN SIZE DISTRIBUTION

FIGURE C1



COBBLES	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
	GRAVEL		SAND				

Legend	Test pit	Sample	Depth (m)	% Gravel	% Sand	% Silt	% Clay
●	17-3	1	0.8 - 3.2	0	8	72	20

SOILS GRAIN SIZE GRAPH UNIFIED % (HYDRO) 64351.74_GNT_V01_2017-07-17.GPJ HOULE CHEVRIER FEB 9 2011.GDT 1/8/17

Houle Chevrier Engineering

Date: August 2017

Project: 64153.74

APPENDIX D

Chemical Analysis of Soil Samples
Samples Relating to Corrosion
(Paracel Laboratories Ltd. Order No. 1729367)

PARACEL LABORATORIES LTD. | TRUSTED. RESPONSIVE. RELIABLE.

300 - 2319 St. Laurent Blvd
Ottawa, ON, K1G 4J8
1-800-749-1947
www.paracellabs.com

Certificate of Analysis

Houle Chevrier

32 Steacie Drive
Kanata, ON K2K 249
Attn: Blasco Vitayabaskaran

Client PO:
Project: 64153.74
Custody:

Report Date: 25-Jul-2017
Order Date: 19-Jul-2017

Order #: 1729367

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

Paracel ID	Client ID
1729367-01	TP 17-14 SA2

Approved By:

Dale Robertson, BSc
Laboratory Director

Certificate of Analysis
Client: Houle Chevrier
Client PO:

Report Date: 25-Jul-2017
Order Date: 19-Jul-2017
Project Description: 64153.74

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	21-Jul-17	24-Jul-17
Conductivity	MOE E3138 - probe @25 °C, water ext	24-Jul-17	24-Jul-17
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	25-Jul-17	25-Jul-17
Resistivity	EPA 120.1 - probe, water extraction	25-Jul-17	25-Jul-17
Solids, %	Gravimetric, calculation	25-Jul-17	25-Jul-17

Certificate of Analysis
Client: Houle Chevrier
Client PO:

Report Date: 25-Jul-2017
Order Date: 19-Jul-2017
Project Description: 64153.74

	Client ID:	TP 17-14 SA2	-	-	-
	Sample Date:	11-Jul-17	-	-	-
	Sample ID:	1729367-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	81.2	-	-	-
General Inorganics					
Conductivity	5 uS/cm	276	-	-	-
pH	0.05 pH Units	7.45	-	-	-
Resistivity	0.10 Ohm.m	36.3	-	-	-
Anions					
Chloride	5 ug/g dry	6	-	-	-
Sulphate	5 ug/g dry	197	-	-	-

Certificate of Analysis
Client: Houle Chevrier
Client PO:

Report Date: 25-Jul-2017
Order Date: 19-Jul-2017
Project Description: 64153.74

Method Quality Control: Blank

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

Certificate of Analysis
Client: Houle Chevrier
Client PO:

Report Date: 25-Jul-2017
Order Date: 19-Jul-2017
Project Description: 64153.74

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	51.4	5	ug/g dry	55.5			7.6	20	
Sulphate	34.3	5	ug/g dry	35.6			3.7	20	
General Inorganics									
Conductivity	338	5	uS/cm	345			2.0	6.2	
pH	7.26	0.05	pH Units	7.45			2.6	10	
Resistivity	106	0.10	Ohm.m	109			3.1	20	
Physical Characteristics									
% Solids	66.8	0.1	% by Wt.	77.4			14.7	25	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	98.8	5	ug/g	55.5	43.3	78-113			QM-07
Sulphate	115	5	ug/g	35.6	79.0	78-111			

Qualifier Notes:

QC Qualifiers :

QM-07 : The spike recovery was outside acceptance limits for the MS and/or MSD. The batch was accepted based on other acceptable QC.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

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

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

Paracel ID: 1729367

n of Custody
ab Use Only)

PARACEL LABORATORIES LTD. | TRUSTED. RESPONSIVE. RELIABLE.

p: 1-800-749-1947
e: paracel@paracellabs.com

Page __ of __

Client Name: Houle Chevrier Engineering Ltd.	Project Reference: 64153.74
Contact Name: BLASCO VJ	Quote #
Address: 32 Steacie Drive, Ottawa, Ontario, K2K 2A9	PO #
	Email Address: blasco@hceng.ca
Telephone: 613-836-1422	

Turnaround Time:
☐ 1 Day ☐ 3 Day
☐ 2 Day ☒ Regular
Date Required: ____________

Criteria: ☐ O. Reg. 153/04 (As Amended) Table __ ☐ RSC Filing ☐ O. Reg. 558/00 ☐ PWQO ☐ CCME ☐ SUB (Storm) ☐ SUB (Sanitary) Municipality: ________ ☐ Other: ________

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Paracel Order Number: 1729367

Required Analyses

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	CHLORIDE	PH/SO4	ELEC. CONDUCTIVITY	ELEC. RESISTIVITY					— 950 ml —		
1	TP 17-14 SA 2				July 11, 2017		☑	☑	☑	☑	☐	☐	☐	☐	☐	☐	☐
2							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
8							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
9							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
10							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments: Sample date as per Blasco. SC

Method of Delivery: Paracel

Relinquished By (Sign):	Received by Driver/Depot: T. Rouse	Received at Lab: Osmeporn Dowmai	Verified By: SC
Relinquished By (Print):	Date/Time: 19/07/17 3:05 PM	Date/Time: Jul 19, 2017 05.10	Date/Time: July 20/17 9:24a
Date/Time:	Temperature: ____ °C	Temperature: 16.6 °C	pH Verified [ ] By: N/A

experience • knowledge • integrity

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

expérience • connaissance • intégrité