Geotechnical Investigation
Proposed Apartment Building
67 and 71 Marquette Avenue
Ottawa, Ontario

Houle Chevrier Engineering Ltd. • 180 Wescar Lane • Ottawa, Ontario • K0A 1L0 • www.hceng.ca

Houle
Chevrier
Engineering

Submitted to:

Urban Rise Developments Inc.
132 Putman Avenue
Ottawa, Ontario
K1M 1Z7

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April 2, 2014
Project: 13-521

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Houle Chevrier Engineering Ltd.
180 Wescar Lane
Ottawa, Ontario
K0A 1L0

tel: 613.836.1422
fax: 613.836.9731
info@hceng.ca
www.hceng.ca

Urban Rise Developments Inc.
132 Putman Avenue
Ottawa, Ontario
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April 2, 2014
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Attention: Mr. Mark Larose, President

Re: Geotechnical Investigation
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67 and 71 Marquette Avenue
Ottawa, Ontario

This report presents the results of a geotechnical investigation carried out at the site of a proposed apartment building at 67 and 71 Marquette Avenue in Ottawa, Ontario. The purpose of the investigation was to identify the general subsurface conditions at the site by means of a borehole investigation and, based on the factual information obtained, to provide engineering guidelines on the geotechnical design aspects of the project, including construction considerations that could influence design decisions.

PROJECT DESCRIPTION

Plans are being prepared to construct a low rise apartment building located at 67 and 71 Marquette Avenue in Ottawa, Ontario (see Key Plan, Figure 1). It is our understanding the proposed building will have three (3) above ground floors and one (1) partial basement level. The pavement design for the proposed access roadways and parking areas in the vicinity of the proposed building is also included in the scope of the project.

SITE GEOLOGY

Surficial geology maps of the Ottawa area indicate that the overburden deposits are likely composed of glacial till. Bedrock geology and drift thickness maps indicate that the overburden deposits are underlain by limestone bedrock of the Bobcaygeon formation at depths ranging from about 3 to 5 metres.

SUBSURFACE INVESTIGATION

The borehole drilling for this investigation was carried out on November 18, 2013. At that time, four (4) boreholes, numbered 13-1 to 13-4, inclusive, were advanced at the site. Three (3) of the boreholes (boreholes 13-1 to 13-3) were advanced using a small, track mounted drill rig and one (1) borehole (borehole 13-4) was advanced using portable drilling equipment due to access limitations at this borehole location. The drill rig and portable drilling equipment were supplied and operated by Strata Soil Sampling Inc. of Ottawa, Ontario. The boreholes were advanced to depths ranging between about 4.3 to 8.7 metres below ground surface (elevations 47.6 and 52.3 metres, geodetic) in the area of the proposed building.

Standard penetration tests were carried out in boreholes 13-1, 13-2 and 13-3 at regular intervals of depth and samples of the soils encountered were recovered using a 50 millimetre diameter split barrel sampler. Borehole 13-4 was advanced using a dynamic cone. A piezometer consisting of a 1.5 metre long, 32 millimetre diameter slotted well screen and solid wall hollow riser was installed in borehole 13-3 to measure the groundwater level. The field work 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. One (1) soil sample obtained from borehole 13-3 was sent to Paracel Laboratories Ltd. for basic chemical testing relating to corrosion of buried concrete and steel.

The results of the boreholes are provided on the Record of Borehole sheets in Attachment A. The locations of the boreholes are shown on the Borehole Location Plan, Figure 2. The results of the chemical analysis on the soil sample are provided in Attachment B.

The borehole locations were selected by Houle Chevrier Engineering Ltd. personnel and positioned at the site relative to existing site features. The ground surface elevations at the locations of the boreholes were determined using a Trimble R8 global positioning system. The elevations are referenced to geodetic datum and are considered to be accurate within the tolerance of the instrument.

SUBSURFACE CONDITIONS

General

As previously indicated, the soil and groundwater conditions logged in the boreholes are given on the Record of Borehole sheets following the text of this report. The 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 other than the borehole locations may vary from the conditions encountered in the boreholes. 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 Houle Chevrier Engineering Ltd. 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 boreholes advanced during this investigation.

Pavement Structure

Boreholes 13-1 and 13-3 were advanced through the existing driveways. The pavement structure at boreholes 13-1 and 13-3 is composed of a layer of asphaltic concrete with thicknesses of about 50 and 100 millimetres, respectively. The asphaltic concrete overlies grey sand and gravel (base material) in borehole 13-1. The base material in borehole 13-1 has a thickness of about 100 millimetres.

Topsoil Fill Material

Topsoil fill material was encountered at ground surface in borehole 13-2. The topsoil fill material is dark brown sandy topsoil with a thickness of about 180 millimetres.

Fill Material

Fill material was encountered beneath the pavement structure in boreholes 13-1 and 13-3, and beneath the topsoil fill material in borehole 13-2. The fill material is variable in nature and can generally be described as brown to dark brown sand/sand and gravel with varying amounts of silt. Brick, asphaltic concrete pieces and pockets of white grey marl were also encountered within the fill material. The thickness of the fill material ranges from about 0.6 to 2.1 metres and extends to a depth of about 0.8 to 2.3 metres below ground surface (elevation 54.0 to 55.7 metres, geodetic datum).

Standard penetration tests carried out in the fill material gave N values of 3 to 15 blows per 0.3 metres of penetration, which reflect a very loose to compact relative density. The water content of a sample of the fill material is about 13 percent.

Peat/Marl

A layer of dark brown peat was encountered below the fill in boreholes 13-1 and 13-3 at depths ranging from about 0.8 to 1.1 metres below ground surface (elevation about 55.5 to 55.7 metres, geodetic datum). The thickness of the peat layer ranges from about 1.0 to 1.2 metres.

Standard penetration tests carried out in the peat gave N values of weight of hammer (‘WH’) to 4 blows per 0.3 metres of penetration. The water content of a sample of the peat is about 185 percent.

A layer of white grey marl with a thickness of about 250 millimetres was encountered beneath the peat in borehole 13-1. The water content of a sample of the marl is about 152 percent.

Sand/Silty Sand

Deposits of brown to grey brown, fine and fine to medium grained sand with varying amounts of silt and gravel were encountered beneath the peat/marl layer in boreholes 13-1 and 13-3 and beneath the fill material in borehole 13-2 at depths ranging from about 2.0 to 2.3 metres below ground surface (elevation 54.0 to 54.5 metres, geodetic datum).

A layer of silty sand with trace gravel was encountered within the sand deposits in borehole 13-3 at a depth of about 3.2 metres. The silty sand layer has a thickness of about 1.0 metre.

Standard penetration tests carried out in the sand/silty sand gave N values of 6 to 55 blows per 0.3 metres of penetration, which reflects a loose to very dense relative density.

The water content of samples of the sand material ranges from about 12 to 19 percent.

Glacial Till

Native deposits of glacial till were encountered beneath the sand deposits in borehole 13-1 at a depth of about 4.6 metres below ground surface. In general, glacial till is a mixture of all grain sizes; however, the glacial till encountered is composed of grey silty sand and gravel. Cobbles and boulders should be expected within the glacial till.

Standard penetration tests carried out in the glacial till gave N values of 17 to 31 blows per 0.3 metres of penetration, which reflects a compact to dense relative density. The water content of samples of the glacial till material ranges from about 7 to 9 percent.

Possible glacial till was encountered beneath the sand deposit in borehole 13-2 at a depth of about 4.4 metres. The possible glacial till is composed of dark grey silty sand and gravel.

Groundwater Level

The groundwater level was measured at about 3.3 metres below ground surface (elevation 53.3 metres, geodetic datum) in borehole 13-3 on November 27, 2013. The groundwater levels may be higher during wet periods of the year such as the early spring or fall, or following periods of precipitation.

Soil Chemistry Relating to Corrosion

The results of chemical testing on a soil sample recovered from borehole 13-3, at a depth of about 2.3 metres below ground, are provided in Attachment B and summarized below:

Resistivity	43.0	Ohm metre
pH	7.8	
Sulphate Content	<5.0	µg/g
Chloride Content	45.0	µg/g

PROPOSED APARTMENT BUILDING

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 off site sources are outside the terms of reference for this report.

Excavation for the Proposed Building

The excavation for the footings for the proposed building will be carried out mostly through the pavement structure, topsoil fill, fill material, peat/marl and sand/silty sand deposits. The sides of the excavation in the overburden 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 material at this site can be classified as Type 3 soil and, accordingly, allowance should be made for excavation side slopes of 1 horizontal to 1 vertical, or flatter.

No significant constraints are expected in excavating the overburden materials above the groundwater level. In contrast, excavation within the sand deposits below the groundwater level will present significant constraints. Excavation within the sandy deposits below the groundwater level could cause sloughing at the sides of the excavation and disturbance to the soils in the bottom of the excavation. We recommend, therefore, that the foundations for the proposed building be kept above the groundwater level.

The groundwater level measured in borehole 13-3 was 3.3 metres below existing ground surface, or elevation 53.3 metres on November 27, 2013. Assuming that the excavation is kept above the groundwater level we do not anticipate significant groundwater seepage within the excavation. Groundwater inflow from the overburden deposits, if any, should be controlled by pumping from filtered sumps within the excavation. It is not expected that short term pumping during excavation will have a significant effect on nearby structures and services.

Foundation Design

Based on the results of the subsurface investigation, the existing topsoil fill, fill materials and peat/marl are not considered suitable for the support of the proposed building or concrete floor slabs and should be removed from the proposed building area. The proposed structure could be founded on conventional spread footings bearing on or within the native, undisturbed deposits of sand/silty sand or on a pad of compacted granular material (engineered fill) over native, undisturbed soil deposits. Where wet conditions are encountered, the engineered fill should be underlain by a woven geotextile meeting OPSS 1860 Class II requirements.

The engineered fill, where required, should consist of granular material meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular B Type II. OPSS documents allow recycled asphaltic concrete and concrete to be used in Granular B Type II materials. Since the source of recycled material cannot be determined, it is suggested that any granular materials used beneath the proposed building be composed of virgin material only for environmental reasons. The OPSS 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. To provide adequate spread of load below the footings, the material should extend at least 0.3 metres horizontally beyond the edge of the footings and down and out from this point at 1 horizontal to 1 vertical, or flatter.

Spread footing foundations bearing on native, undisturbed deposits of sand/silty sand or on a pad of engineered fill above native soil should be sized using a net geotechnical reaction at Serviceability Limit State (SLS) of 100 kilopascals and a factored net geotechnical resistance at Ultimate Limit State (ULS) of 250 kilopascals.

The post construction total and differential settlement at SLS of footings bearing on the above noted deposits should be less than 25 and 20 millimetres, respectively, provided that the fill material and loose or disturbed soil is removed from below the bearing surfaces.

Frost Protection of the Foundations

All exterior footings in heated 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. The required depth of frost protection can be reduced by the thickness of any engineered fill beneath the foundations. Alternatively, the required frost protection could be provided by means of a combination of earth cover and extruded polystyrene insulation. An insulation detail could be provided upon request.

Foundation Wall Backfill and Drainage

The existing fill materials, peat/marl and the native sand/silty sand and glacial till deposits at this site are frost susceptible and should not be used as backfill against foundation walls. 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. If some settlement of the backfill is acceptable (for example, in landscaped areas), 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 sidewalks, etc.) abut the proposed building, 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.

A perforated plastic perimeter drain wrapped with filter cloth should be provided around the perimeter of the basement adjacent to the spread footings. The perimeter drain should be surrounded with at least 150 millimetres of 19 millimetre clear crushed stone and should drain by gravity to the storm sewer or to a sump pit from which the water is pumped. A nonwoven geotextile should be placed between the clear stone and any sandy backfill material to avoid possible loss of backfill material into the voids in the clear stone (and possible post construction settlement of the ground around the building).

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

$$P_o = K_o (\gamma H + q)$$

Where,

P_o = At rest earth pressure at the bottom of the foundation wall (kilopascals)

K_o = At rest earth pressure coefficient (0.47)

γ = Unit weight of backfill material (22 kilonewtons per cubic metre)

H = Height of foundation wall (metres)

q = Uniform surcharge at ground surface behind the wall to take into account traffic, equipment, or stockpiled soil (typically 10 kilopascals)

Where conditions dictate, allowance should be made in the structural design of the foundation walls for loads due to ground supported vehicles/equipment. For example, the horizontal active load due to a uniform, vertical live load adjacent to the foundation wall could be determined using a horizontal earth pressure coefficient, K_o, of 0.47, times the vertical live load. The effects of other vertical loads (point loads, line loads, etc.) adjacent to or near the foundation walls could be provided, if required.

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

Seismic shaking can increase the forces on the walls of structures during or following an earthquake. The increase in thrust during seismic shaking may be estimated using the following method suggested by Wood (1973) for non-yielding smooth walls which are restrained against movement:

$$\Delta P_{dy} = \gamma\, H^2\, (a_h/g)\, F_p$$

Where,

ΔP_{dy} = Dynamic thrust component (kilonewtons per metre)

γ = Unit weight of backfill material (22 kilonewtons per cubic metre)

H = Height of wall (metres)

(a_h/g) = Dimensionless horizontal pseudostatic coefficient (0.1 is typically used for the Ottawa area)

F_p = dimensionless dynamic thrust factor (typically 1.0 for walls)

The dynamic thrust component acts at approximately 0.63H above the base of the foundation wall (where H is the height of the wall).

Slab on Grade Support (Heated Areas Only)

Based on the results of the subsurface investigation, the area of the proposed building is underlain by asphaltic concrete, topsoil fill material, fill material and peat/marl followed by native deposits of sand/silty sand and glacial till. The existing asphaltic concrete, topsoil fill, fill material and peat/marl should be removed from the area of the proposed building. Any loose or organic material should also be removed.

The grade within the proposed building could be raised, where necessary, with granular material meeting OPSS requirements for Granular B Type I or II. The use of Granular B Type II material is preferred under wet conditions. The granular base for the proposed slab on grade should consist of at least 150 millimetres of OPSS Granular A.

City of Ottawa documents allow recycled asphaltic concrete and concrete to be used in Granular A and Granular B Type II materials. Since the source of recycled material cannot be determined, it is suggested that any granular materials used beneath the floor slab be composed of virgin material (100 percent crushed rock) only, for environmental reasons.

All imported granular materials placed below the proposed floor slab should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density value. Where wet subgrade conditions are encountered, the engineered fill should be underlain by a woven geotextile meeting Ontario Provincial Standard Specifications (OPSS) 1860 Class II requirements.

Basement floor slabs should be provided with a base (drainage) layer of 19 millimetre diameter clear crushed stone. The drainage layer should be hydraulically connected to the perimeter drain tile.

If any areas of the building are to remain unheated during the winter period, thermal protection of the slab on grade may be required. Further details on the insulation requirements could be provided, if necessary.

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.

Seismic Design of Proposed Structure

Based on the results of the site investigation, the underside of footing level will likely be founded within loose to very dense sand/silty sand or on a pad of compacted granular material placed above the sand/silty sand. In our opinion, the proposed building could be designed for Site Class D. There is no potential for liquefaction of the material below founding level.

Corrosion of Buried Concrete and Steel

The measured sulphate concentration in the soil sample recovered from borehole 13-3 was less than 5 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. For low exposure conditions, any concrete that will be in contact with the native soil or groundwater should be batched with General Use (formerly Type 10) cement. The effects of freeze thaw in the presence of de-icing chemical (sodium chloride) near the proposed building should be considered in selecting the air entrainment and the concrete mix proportions for any concrete.

Based on the resistivity and pH of the soil sample, the soil can be classified as nonaggressive toward unprotected steel. It is noted that the corrosivity of the soil and groundwater could vary throughout the year due to the application sodium chloride for de-icing.

Pavement Design

Subgrade Preparation

In preparation for the construction of proposed access roadways and parking areas at this site any loose/soft, wet, organic or deleterious materials should be removed from the proposed subgrade surface. Based on the borehole information it appears that a layer of highly compressible peat/marl exists in the area of the proposed access roadway and possibly the parking area. The loads imposed from the access roadway and parking area could lead to differential settlement of the pavement structure due to compression of the peat/marl. Furthermore, there is potential for total and differential settlement of the pavement structure due to long term densification and decay of the organic material in the peat. We recommend that the layer of peat/marl at this site be removed off site and be replaced with material which meets OPSS specifications for Granular B Type I or II or Select Subgrade Material to provide suitable long term performance of the proposed access roadway and parking areas.

Prior to placing granular fill for the access roadway and parking areas, the exposed subgrade should be proof rolled with a large (minimum 10 tonne) vibratory steel drum roller under dry conditions and inspected and approved by geotechnical personnel. Any soft areas that are evident from the proof rolling should be subexcavated and replaced with suitable earth borrow material.

The Granular B Type I or II or Select Subgrade Material 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.

Flexible Pavement Structures for the Access Roadway and Parking Areas

It is suggested that areas to be used by light vehicles (cars, etc.) be constructed using the following minimum pavement structure:

50 millimetres of asphaltic concrete, over

150 millimetres of OPSS Granular A base, over

300 millimetres of OPSS Granular B Type II subbase

For the access roadways and the areas that are used by trucks the suggested minimum pavement structure is:

90 millimetres of asphaltic concrete, 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 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.

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 subbbase 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.

Where the new pavement will abut 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.

Asphaltic Concrete Type

The asphaltic concrete in areas used by light vehicles should consist of 50 millimetres of Superpave 12.5. For any access roadways, the asphaltic concrete surfacing thickness should be increased to 90 millimetres (40 millimetres of Superpave 12.5 over 50 millimetres of Superpave 19.0).

Performance grade PG 58-34 asphaltic cement should be specified for Superpave asphaltic concrete mixes (Traffic Level A or B).

Granular Material Compaction

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

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 the catch basins to promote drainage of the pavement granular materials.

The catch basins should be provided with minimum 3 metre long perforated stub drains which extend in at least two directions from each catch basin at pavement subgrade level. Where ditches are used, the bottom of the OPSS Granular B Type II should be at least 0.3 metres above the bottom of the ditch and the granular material should extend to the ditch slopes.

Effects of Construction Induced Vibration

Some of the construction operations (such as excavation and granular material compaction) 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 likely be much less than that required to cause damage to the nearby structures or services that are in good condition. Nevertheless, we recommend that preconstruction surveys be carried out on the nearby structures so that any damage claims can be addressed in a fair manner.

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 the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed excavation 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 building, access roadways and 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.

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.

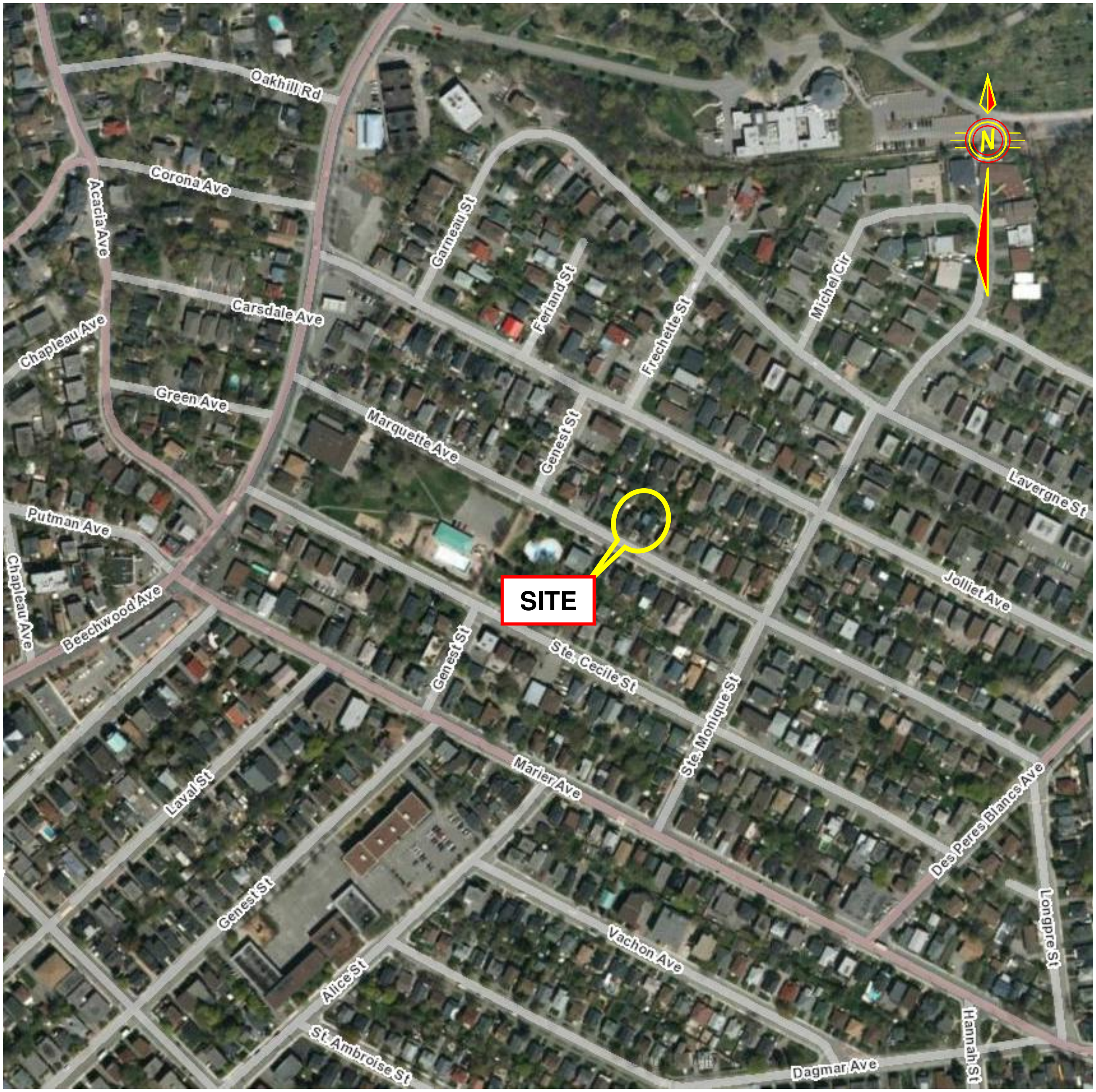
Lauren Ashe, B.Sc., E.I.T.

Andrew Chevrier, M.Eng., P.Eng.
Principal

LICENSED PROFESSIONAL ENGINEER
A.F. CHEVRIER
7974504
02 Apr 2014
PROVINCE OF ONTARIO

KEY PLAN

FIGURE 1

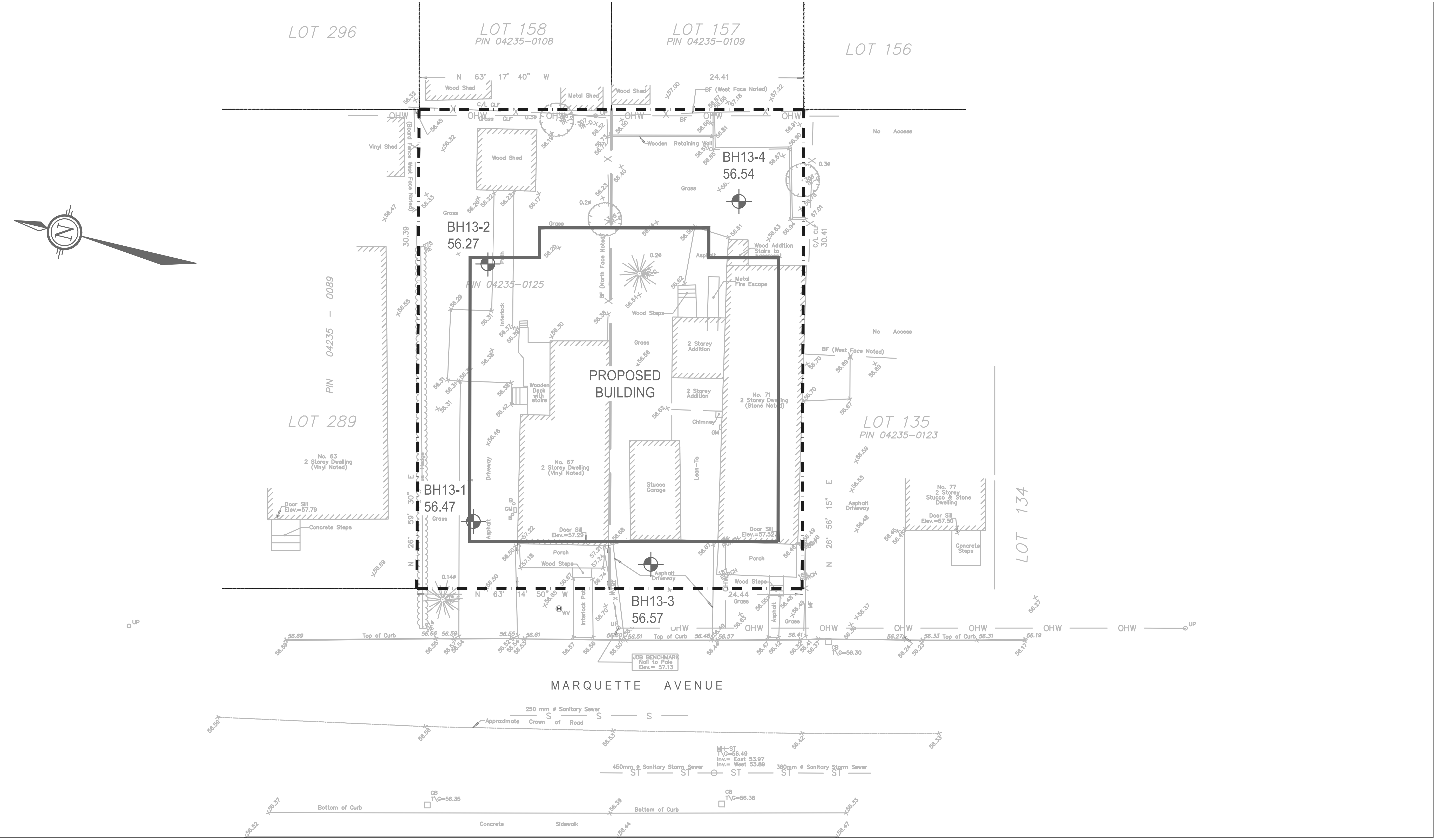


N.T.S

Houle Chevrier Engineering

Date: April 2014

Project: 13-521



LEGEND

BH13-1 ⌖	APPROXIMATE LOCATION OF BOREHOLE, CURRENT INVESTIGATION BY HOULE CHEVRIER ENGINEERING
56.47	GEODETIC ELEVATION AT GROUND SURFACE OF BOREHOLE, MEASURED IN METRES.

Client: URBAN RISE DEVELOPMENT INC.		Location: 67-71 MARQUETTE STREET OTTAWA, ON.	Revision: 0
Drawn by: M.L.	Approved by: A.C.	Project No.: 13-521	Scale: 1:250
Houle Chevrier Engineering		Title: BOREHOLE LOCATION PLAN	
		Date: APRIL 2014	FIGURE 2

ATTACHMENT A

Record of Borehole Sheets
List of Abbreviations and Terminology

Houle Chevrier Engineering

PROJECT: 13-521

RECORD OF BOREHOLE 13-1

SHEET 1 OF 1

LOCATION: See Borehole Location Plan, Figure 2

DATUM:

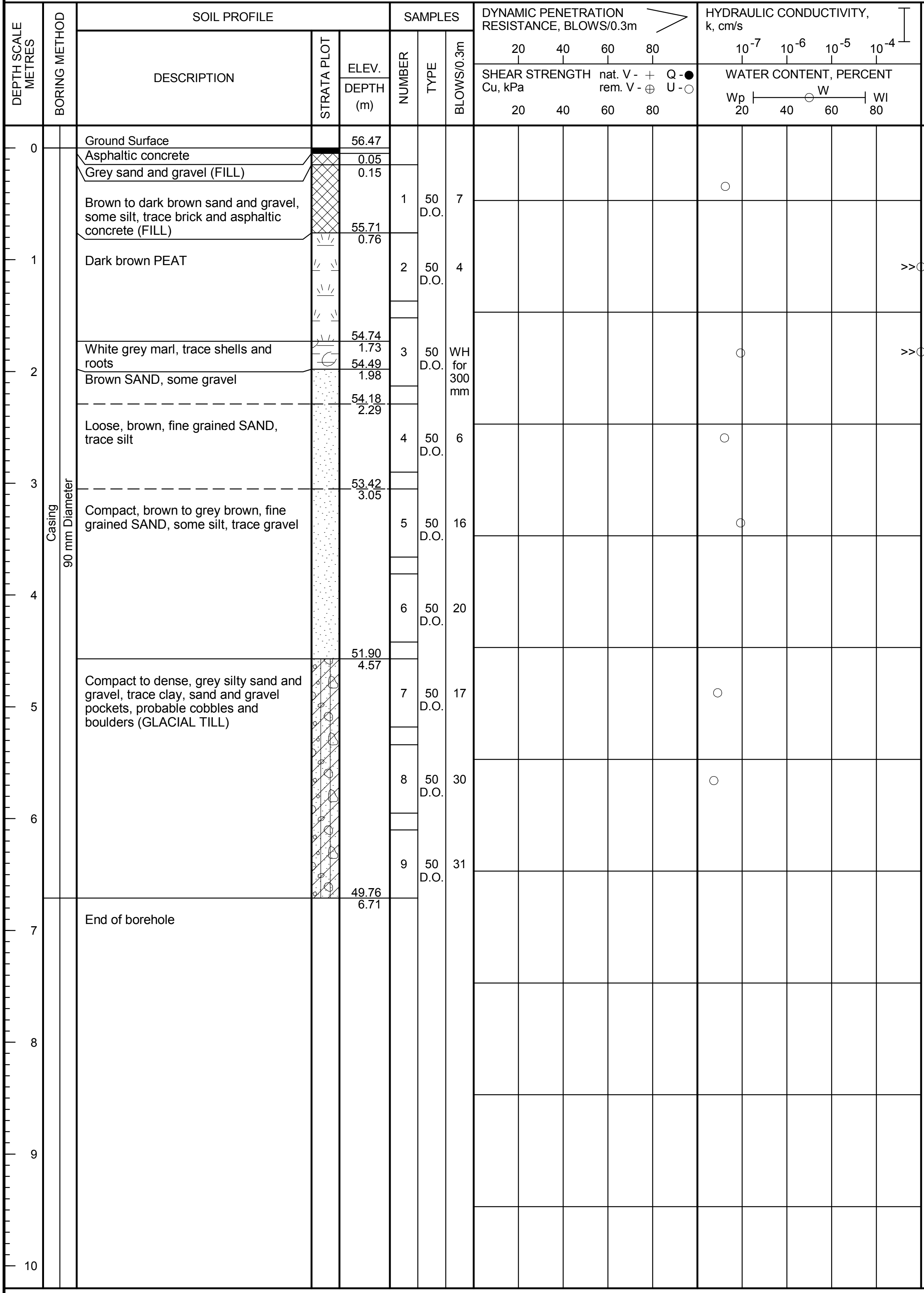
BORING DATE: November 18, 2013

SPT HAMMER: 63.5 kg; drop 0.76 metres

BORING METHOD: Casing 90 mm Diameter

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
Ground Surface	56.47
Asphaltic concrete	0.05
Grey sand and gravel (FILL)	0.15
Brown to dark brown sand and gravel, some silt, trace brick and asphaltic concrete (FILL)	55.71 0.76
Dark brown PEAT	54.74 1.73
White grey marl, trace shells and roots	54.49 1.98
Brown SAND, some gravel	54.18 2.29
Loose, brown, fine grained SAND, trace silt	53.42 3.05
Compact, brown to grey brown, fine grained SAND, some silt, trace gravel	51.90 4.57
Compact to dense, grey silty sand and gravel, trace clay, sand and gravel pockets, probable cobbles and boulders (GLACIAL TILL)	49.76 6.71
End of borehole	

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 D.O.	7
2	50 D.O.	4
3	50 D.O.	WH for 300 mm
4	50 D.O.	6
5	50 D.O.	16
6	50 D.O.	20
7	50 D.O.	17
8	50 D.O.	30
9	50 D.O.	31



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Grout cement

Backfilled with bentonite

BOREHOLE RECORD 2012 WITH LAB WC GINT LOGS 13-521.GPJ 3-31-14

DEPTH SCALE

1 to 50

Houle Chevrier Engineering Ltd.

LOGGED: M.L.

CHECKED:

PROJECT: 13-521

RECORD OF BOREHOLE 13-2

SHEET 1 OF 1

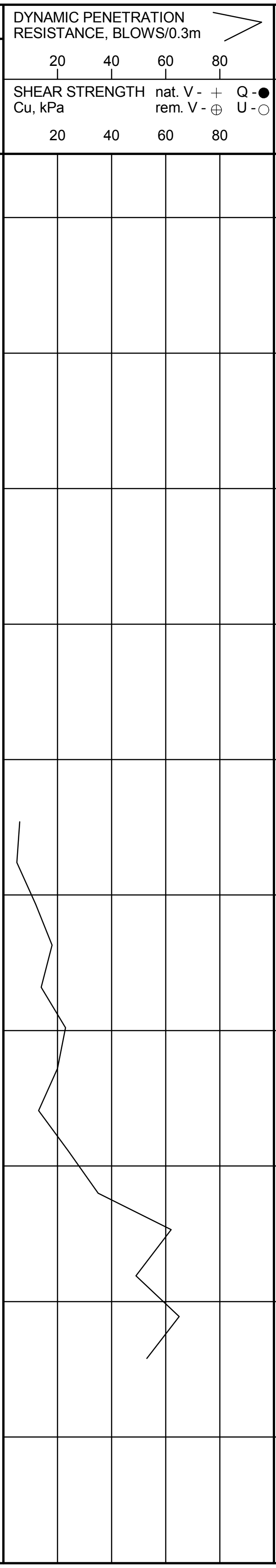
LOCATION: See Borehole Location Plan, Figure 2

DATUM:

BORING DATE: November 18, 2013

SPT HAMMER: 63.5 kg; drop 0.76 metres

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0	Casing 90 mm Diameter	Ground Surface	56.27				
		Dark brown sandy topsoil (Topsoil FILL)	56.09 0.18				
		Dark brown to brown sand, some gravel, pockets of silty sand (FILL MATERIAL)	55.37 0.90	1	50 D.O.	3	Backfilled with bentonite
1		Brown sand, some silt, some gravel, pockets of white grey marl (FILL MATERIAL)	54.77 1.50	2	50 D.O.	7	
2		Brown silty sand, some gravel, pockets of dark grey silty sand (FILL MATERIAL)	53.98 2.29	3	50 D.O.	15	
3		Compact, grey brown to grey, fine grained SAND, some silt	52.77 3.50	4	50 D.O.	13	
				5	50 D.O.	9	
4		Very dense, brown, fine to medium grained SAND, trace silt	51.90	6	50 D.O.	55	
	Dynamic Cone 32 mm Diameter Solid Point	Dark grey silty sand and gravel (Possible GLACIAL TILL)	4.42				
5		Soil conditions not recorded					
6							
7							
8			47.58 8.69				
9		End of borehole					
10							



HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-7} 10^{-6} 10^{-5} 10^{-4}

WATER CONTENT, PERCENT: Wp W Wl — 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE

1 to 50

Houle Chevrier Engineering Ltd.

LOGGED: M.L.

CHECKED:

PROJECT: 13-521

RECORD OF BOREHOLE 13-3

SHEET 1 OF 1

LOCATION: See Borehole Location Plan, Figure 2

DATUM:

BORING DATE: November 18, 2013

SPT HAMMER: 63.5 kg; drop 0.76 metres

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
0	Casing 90 mm Diameter	Ground Surface	56.57
		Asphaltic concrete	0.10
		Dark brown sand and gravel, some silt, pockets of grey brown silty sand, trace asphaltic concrete (FILL MATERIAL)	55.50 1.07
1		Dark brown PEAT	54.28 2.29
2		Compact, brown to grey brown, fine grained SAND, some silt	53.37 3.20
3		Very dense, grey brown SILTY SAND, trace gravel	52.37 4.20
4	Dynamic Cone 32 mm Diameter Solid Point	Grey brown, fine to medium grained SAND, trace gravel	50.87 5.70
5		Grey brown, medium to coarse grained SAND	50.47 6.10
6		End of borehole	

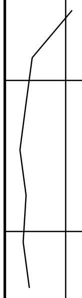
SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 D.O.	8	
2	50 D.O.	3	
3	50 D.O.	WH for 300 mm	
4	50 D.O.	11	Corrosion
5	50 D.O.	>50	
6	50 D.O.	CS	
7	50 D.O.	CS	

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

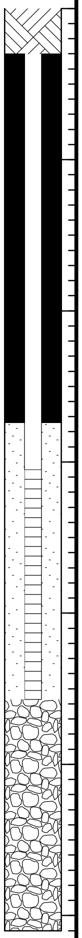
SHEAR STRENGTH Cu, kPa nat. V - + Q - ● rem. V - ⊕ U - ○: 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-7} 10^{-6} 10^{-5} 10^{-4}

WATER CONTENT, PERCENT Wp W Wl: 20 40 60 80



PIEZOMETER OR STANDPIPE INSTALLATION



Groundwater level at 3.32 metres below ground surface (elevation 53.25 metres, geodetic datum) on November 27, 2013.

DEPTH SCALE

1 to 50

Houle Chevrier Engineering Ltd.

LOGGED: M.L.

CHECKED:

PROJECT: 13-521

RECORD OF BOREHOLE 13-4

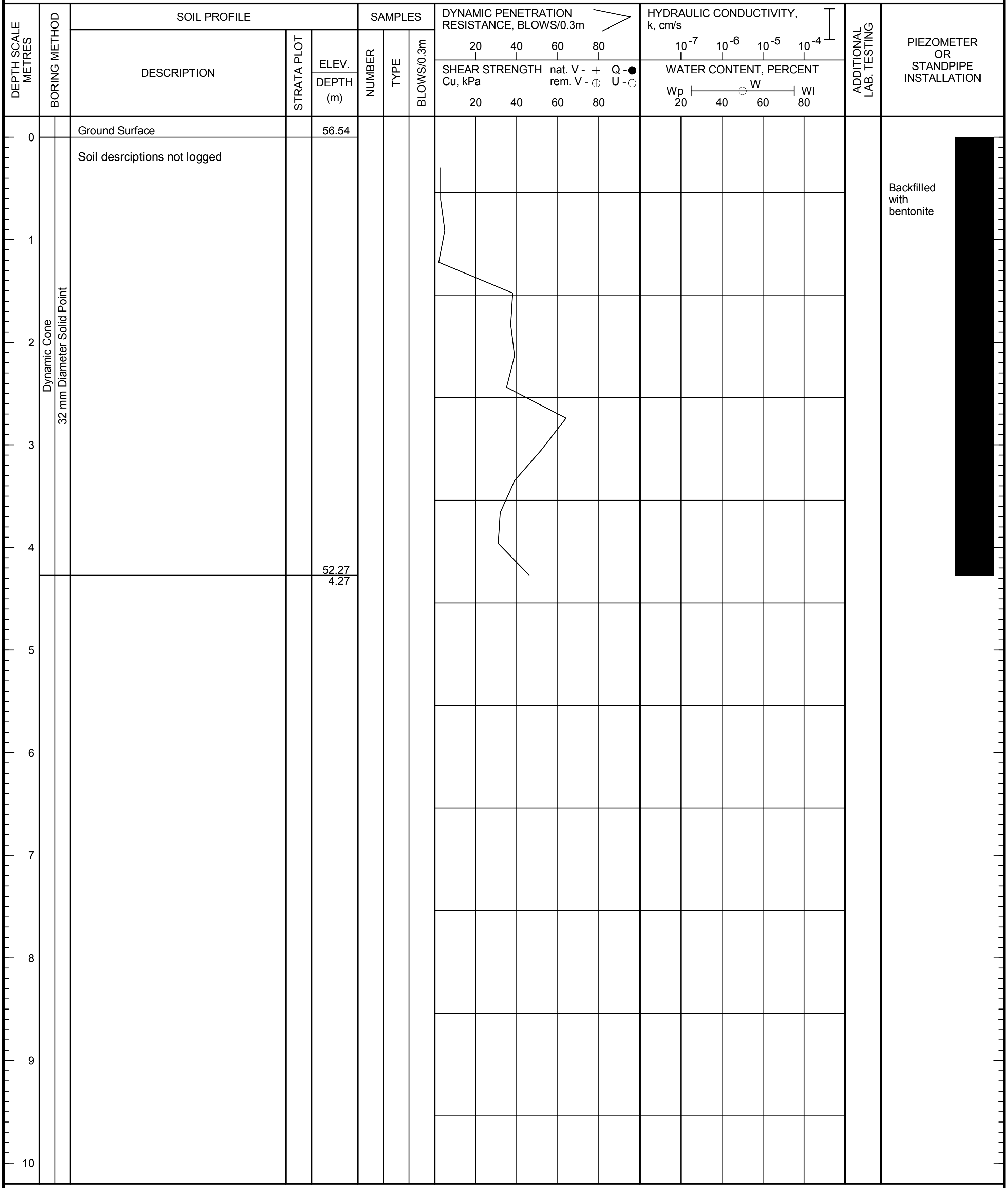
SHEET 1 OF 1

LOCATION: See Borehole Location Plan, Figure 2

DATUM:

BORING DATE: November 18, 2013

SPT HAMMER: 31.7 kg; drop 0.76 metres



DEPTH SCALE

1 to 50

Houle Chevrier Engineering Ltd.

LOGGED: M.L.

CHECKED:

LIST OF ABBREVIATIONS AND TERMINOLOGY

SAMPLE TYPES

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

PENETRATION RESISTANCE

Standard Penetration Resistance, N

The number of blows by a 63.5 kg hammer dropped 760 millimetres required to drive a 50 mm drive open sampler for a distance of 300 mm. For split spoon samples where less than 300 mm of penetration was achieved, the number of blows is reported over the sampler penetration in mm.

Dynamic Penetration Resistance

The number of blows by a 63.5 kg hammer dropped 760 mm to drive a 50 mm diameter, 60° cone attached to ‘A’ size drill rods for a distance of 300 mm.

WH

Sampler advanced by static weight of hammer and drill rods.

WR

Sampler advanced by static weight of drill rods.

PH

Sampler advanced by hydraulic pressure from drill rig.

PM

Sampler advanced by manual pressure.

SOIL TESTS

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

SOIL DESCRIPTIONS

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

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

LIST OF COMMON SYMBOLS

c_u	undrained shear strength
e	void ratio
C_c	compression index
c_v	coefficient of consolidation
k	coefficient of permeability
I_p	plasticity index
n	porosity
u	pore pressure
w	moisture content
w_L	liquid limit
w_P	plastic limit
ϕ^1	effective angle of friction
γ	unit weight of soil
γ^1	unit weight of submerged soil
σ	normal stress

ATTACHMENT B

Corrosion of Buried Concrete and Steel
Results of Soil Sample Analysis
Paracel Laboratories Ltd. Order No. 1348157

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Certificate of Analysis

Houle Chevrier
180 Wescar Lane
Ottawa, ON K0A1L0
Attn: Lauren Ashe

Phone: (613) 836-1422
Fax: (613) 836-9731

Client PO:
Project: 13-521
Custody: 12176

Report Date: 3-Dec-2013
Order Date: 27-Nov-2013
Order #: 1348157

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

Paracel ID	Client ID
1348157-01	BH13-3 SA-4

Approved By: Mark Foto

Mark Foto, M.Sc. For Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 03-Dec-2013
Order Date:27-Nov-2013

Client: **Houle Chevrier**
Client PO:
Project Description: 13-521

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	29-Nov-13	29-Nov-13
pH	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	27-Nov-13	28-Nov-13
Resistivity	EPA 120.1 - probe, water extraction	29-Nov-13	2-Dec-13
Solids, %	Gravimetric, calculation	27-Nov-13	27-Nov-13

Certificate of Analysis

Report Date: 03-Dec-2013
Order Date:27-Nov-2013

Client: **Houle Chevrier**
Client PO:

Project Description: 13-521

	Client ID:	BH13-3 SA-4	-	-	-
	Sample Date:	18-Nov-13	-	-	-
	Sample ID:	1348157-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	87.1	-	-	-
General Inorganics					
pH	0.05 pH Units	7.75	-	-	-
Resistivity	0.10 Ohm.m	43.0	-	-	-
Anions					
Chloride	5 ug/g dry	45	-	-	-
Sulphate	5 ug/g dry	<5	-	-	-

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									
Resistivity	ND	0.10	Ohm.m						

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
pH	7.08	0.05	pH Units	7.19			1.5	10	
Resistivity	22.9	0.10	Ohm.m	22.2			3.0	20	
Physical Characteristics									
% Solids	88.7	0.1	% by Wt.	88.7			0.0	25	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	9.1		mg/L	ND	91.1	78-113			
Sulphate	10.6		mg/L	ND	106	78-111			

Qualifier Notes:

None

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.

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