3604 INNES ROAD – GEOTECHNICAL REPORT

Project No.: CP-18-0050

Prepared for:

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March 2018

McINTOSH PERRY

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GEOTECHNICAL INVESTIGATION and
FOUNDATION DESIGN RECOMMENDATION REPORT
3604 Innes Road, Ottawa, Ontario

1.0 INTRODUCTION

This report presents the factual findings obtained from a geotechnical investigation performed at the above-mentioned site, for the proposed construction of a single story car wash structure in Ottawa, Ontario. The field work was carried out on March 5, 2018 and comprised of four boreholes advanced to a maximum depth of 5.1 m below existing ground surface.

The purpose of the investigation was to explore the subsurface conditions at this site and to provide anticipated geotechnical conditions influencing the design and construction of the proposed building.

McIntosh Perry Consulting Engineers Ltd (McIntosh Perry) carried out the investigation at the request of Trafalgar Environmental Consultants.

2.0 SITE DESCRIPTION

The property under considerations for proposed development is located at 3604 Innes Road, east of the intersection with Pagé Road. The property is located in the suburb of Orléans in Ottawa. Commercial properties and grassy fields can be found to the east and south of the property and residential areas can be found to the west and north. The existing property is a gravel covered lot and contains only lamppost structures. A fence runs along the western side of the property, beginning as a small chain link fence and then transitioning into a larger chain link fence with barbed wire approximately one third of the way back along the property from Innes Road. A shared driveway running along the eastern side allows access to the property. Concrete blocks run along the north side of the property and two gated entrances exist along the eastern side, one close to Innes road and another approximately half way back along the property. At the time of drilling approximately 15 cm of snow and ice covered the ground and only spare vegetation was visible in the form of grassy plants. The topography of the site was relatively flat.

It is understood the proposed structure will be a single story car wash structure.

Location of the property is shown on Figure 1, included in Appendix B.

3.0 FIELD PROCEDURES

Staff of McIntosh Perry Consulting Engineers (McIntosh Perry) visited the site before the drilling investigation to mark out the proposed borehole locations and assess drill rig access. Utility clearance was carried out by

USL-1 on behalf of McIntosh Perry. Public and private utility authorities were informed and all utility clearance documents were obtained before the commencement of drilling work.

The equipment used for drilling was owned and operated by Strata Drilling Group of Ottawa, Ontario. Boreholes were advanced using hollow stem augers aided by a track-mounted GeoProbe drilling rig. Boreholes were advanced to a maximum depth of 5.1 m below the ground level. Soil samples were obtained at 0.75 m intervals of depth in boreholes using a 50 mm outside diameter split spoon sampler in accordance with the Standard Penetration Test (SPT) procedure. Boreholes were backfilled with bentonite and were restored to match the original surface. Borehole locations are shown on Figure 2, included in Appendix B.

4.0 LABORATORY TEST PROCEDURES

Selected samples were tested for moisture content by McIntosh Perry and rock core samples were tested by LRL Associates Ltd of Ottawa, Ontario.

The soil samples recovered will be stored in McIntosh Perry storage facility for a period of one month after submission of the final report. Samples will be disposed after this period of time unless otherwise requested in writing by the Client.

5.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

5.1 Site Geology

Based on published physiography maps of the area (Ontario Geological Survey) the site is located within the Ottawa Valley Clay Plains. Surficial geology maps of southern Ontario identify the property is on Paleozoic bedrock.

The Ottawa Valley between Pembroke and Hawkesbury, Ontario consists of clay plains interrupted by ridges of rock or sand. It is naturally divided into two parts, above and below Ottawa, Ontario. Within the valley, the bedrock is further faulted so that some of the uplifted blocks appear above the clay beds. The sediments themselves in the valley are deep silty clay. Although the clay deposits are grey in color like the limestones that underlies them in part, they are only mildly calcareous and likely derived from the more acidic rock of the Canadian Shield.

5.2 Subsurface Conditions

In general, the site stratigraphy consists of fill material underlain by limestone bedrock. The soils encountered at this site can be divided into two different zones.

a) Fill
b) Limestone

The soils encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole sheets included in Appendix C. In the absence of a topography map, boreholes were referenced to a local benchmark. The southeast corner of the concrete pad for the bus stop in front of the property was measured and assumed to be 100.00 m. The elevations of the boreholes were then measured in reference to this point. Description of the strata encountered are given below.

5.2.1 Fill

A sand and gravel fill material was found in all boreholes. This fill material contained traces of silt and clay, was described as being brown to grey, dry to moist and compact to dense. This layer varied in depth from 0.76 m to approximately 1.37 m. In boreholes BH18-2 and BH18-4 this layer directly overlaid limestone bedrock. In boreholes BH18-1 and BH18-3 a layer of clayey sand fill was found underlying the sand and gravel fill. This layer was present in BH18-1 from 1.37 m to 1.83 m and in BH18-3 from 0.75 m to 2.29 m. Moisture contents within the sand and gravel layer ranged from 6% - 16%. Moisture contents within the clayey sand layer in boreholes BH18-1 and BH18-3 was found to be an average of 16%.

5.2.2 Limestone

Below the fill layer was limestone bedrock. Depth of rock occurred at 1.83 m in BH18-1, 0.76 m in BH18-2, 2.29 m in BH18-3 and 1.33 m in BH18-4. The rock appears to be faintly weathered, more weathering observed at the rock surface, however showed core recovery of 100% for all core runs in both cored boreholes. The rock was of very poor quality condition in BH18-1 from a depth of 1.83 m to 2.44 m and poor quality condition in BH18-2 from 0.76 m to 1.83 m based on RQD measurements. Below the very poor and poor quality rock in both boreholes was rock of fair to good quality condition. Very close to moderately close joints were observed within the recovered core. Joint aperture ranged from closed to open and a 25 mm mud seam was found at a depth of 3.71 m in BH18-1. Three samples of rock core underwent an unconfined compressive strength test with all three samples showing predominantly columnar failures. Core samples from BH18-2 ranged in depth from 2.44 m to 3.30 m and showed a compressive strength of 119 MPa to 140 MPa. A core sample from 1.57 m to 1.78 m in BH18-1 broke while under a 104 MPa load. Rock surface is expected to be uneven across the site.

5.3 Groundwater

No groundwater was observed in the open boreholes. Groundwater level may be expected to fluctuate due to seasonal changes.

6.0 DISCUSSIONS AND RECOMMENDATIONS

6.1 General

This section of the report provides recommendations for the design of the proposed car wash facility. The recommendations are based on interpretation of the factual information obtained from the boreholes advanced during the subsurface investigation. The discussions and recommendations presented are intended to provide sufficient information to the designer of the proposed building to select the suitable types of foundation to support the structure.

The comments made on the construction are intended to highlight aspects which could have impact or affect the detailed design of the building, for which special provisions may be required in the Contract Documents. Those requiring information on construction aspects should make their own interpretation of the factual data presented in the report. Interpretation of the data presented may affect equipment selection, proposed construction methods, and scheduling of construction activities.

6.2 Project Design

6.2.1 Existing Site Condition

The property under considerations for proposed development is located at 3604 Innes Road, east of the intersection with Pagé Road. Detailed site condition is provided in Section 2. The property is relatively flat and leveled. Commercial properties and grassy fields can be found to the east and south of the property and residential areas can be found to the west and north. Site location is shown on Figure 1, Key Plan, included in Appendix B.

6.2.2 Proposed Development

It is understood that the proposed development will be a single-story carwash facility. The detailed design is not provided to the authors of this report. However it is expected that due to the intended usage, there will be a need for sump pits and pumping equipment to be worked out below the proposed slab on grade.

6.3 Frost Protection

Based on applicable building codes, a minimum earth cover of 1.8 m, or the thermal equivalent of insulation, should be provided for all exterior footings to reduce the effects of frost action. However due to the existence of excess water during operations and a chance of seepage to the foundation level, it is preferred to found the footings below expected frost penetration depth. Unless the design can ensure proper drainage and no water accumulation around footings.

6.4 Site Classification for Seismic Site Response

Selected spectral responses in the general vicinity of the site for 10% chance of exceedance in 50 years (475 years return period) are as indicated in Table 6-1, shown below and in Appendix D;

Table 6-1: Selected Seismic Spectral Responses (10% in 50 Yrs)

Sa(0.2)	Sa(0.5)	Sa(2.0)	PGA	PGV
0.173	0.093	0.021	0.110	0.071

The site can be classified as a Site Class "B" for the purposes of site-specific seismic response to earthquakes based on Table 4.1.8.4.A OBC 2012.

6.5 Slabs-on-Grade

Free-floating Slabs-on-grade should be supported on minimum 200 mm of Granular A compacted to 100% SPMDD. In case the subgrade needs to be raised Granular B type II or Granular A needs to be compacted to minimum 96% SPMDD. If the slab-on-grade is designed to support internal columns, the fill used for the grade raise shall be compacted to minimum 100% SPMDD. The fill should be placed in horizontal lifts of uniform thickness of no more than 300 mm before compaction and it should be placed at appropriate moisture content. The requirements for fill material and compaction may be addressed with a note on the structural drawing for foundation or grading drawing and/or with a Non-Standard Special Provision (NSSP).

All slab-on-grade units shall float independently from all load-bearing structural elements.

6.6 Shallow Foundations

Considering the order of structural loads expected at the foundation level, provision of conventional strip footings or isolated pad footings will be adequate. Footings are expected to be buried to resist overturning and sliding and also to provide protection against frost action.

Contractors should refer to the Rock Quality Designation (RQD) values included in logs of boreholes BH18-1 and BH18-2. RQD at the surface, where the weathered rock encountered, is considerably lower than the rock below. Excavation is recommended to be advanced to the top of the rock and to provide the frost cover. All fill and broken pieces of rock shall be removed from the influence zone of the footings. A geotechnical staff shall attend the site upon completion of excavation and approve the subgrade. The geotechnical engineer may require rock surface stabilization by grouting if there are excessively lose and broken rock pieces at the surface. The grout reduces the risk of degradation and also improves the integrity of the rock surface. If the shale has to be over-excavated due to surficial poor quality, if chosen by the constructor, the grade can also be raised by lean concrete within the influence zone of the footing. The influence zone of the footing is defined by a line going outward and downward from the edge of the footing to the subgrade. The lean concrete shall provide compression strength equal or higher than the rock.

If adequate frost cover is not provided, the deficit of earth cover should be compensated by application of synthetic insulation material adequately projecting beyond foundation walls. However maintaining the frost cover is the preferred option.

6.6.1 Bearing Capacity

The best practice is found the footings on similar subgrade. For example all footings to be founded on rock (or lean concrete grade raise), or if grade raise is to be done by engineered fill, provide a minimum thickness of 0.3 m of engineered fill for all footings. This will provide a more uniform behaviour and site response for all footings across the site.

Assuming the strip footings are constructed through excavating the fill and exposing the weathered but relatively intact native shale, the following bearing capacity values can be used for structural design;

A factored beading pressure at Ultimate Limit State (ULS) of 400 kPa can be used for the design on approved limestone subgrade. If footings are placed on rock, the serviceability settlements are expected to be minimal and there is no relevance to serviceability limit state (SLS). For footings founded on engineered fill, given the expected grade raise requirements for this site, the same ULS value can be used as the one indicated for rock. SLS value of 150 kPa can be used for footings bearing on engineered fill.

Due to the expected size of rock fractures, strip footings shall not be less than 0.75 m in width and isolated pad footings shall not be less than 1.5 m in shorter dimension.

6.7 Lateral Earth Pressure

Free draining material should be used as backfill material for foundation walls. If the proper drainage is provided “at rest” condition may be assumed for calculation of earth pressure on foundation walls. The following parameters are recommended for the granular backfill.

Table 6-1: Backfill Material Properties

Borehole	Granular “A”	Granular “B”
Effective Internal Friction Angle, ϕ'	35°	30°
Unit Weight, γ (kN/m^3)	22.8	22.8

7.0 CONSTRUCTION CONSIDERATIONS

Any organic material and existing fill material of any kind, shall be removed from the footprint of the footings and all structurally load bearing elements. If grade raise above the native subgrade is required suitable fill material to conform to specifications of OPSS Granular criteria shall be used. The Structural Fill should be free from any recycled or deleterious material, it should not be placed in lifts thicker than 300 mm and should be compacted as specified.

It is not clear if the founding level will be below groundwater at the time of construction. If water infiltrates into the excavation, a conventional sump and pump method can be applied. The excavated subgrade must be kept dry at all times to minimize the disturbance of the subgrade. Groundwater elevation is expected to fluctuate seasonally.

A geotechnical engineer or technician should attend the site to confirm the type of the material and level of compaction.

Foundation walls, if included in the design, should be backfilled with free-draining material such as OPSS Granular types A or B. The native till is not a suitable material for backfilling. Sub-drains with positive drainage to the City sewer should be provided at foundation level.

The existing fill, as encountered through SPT samplings, does not appear suitable to be used as backfilling material. However the contractor can confirm by bulk sampling the grainsize testing by an aggregate laboratory. All material conforming to OPSS 'Granular' criteria can be used as backfill.

8.0 SITE SERVICES

At the subject site, the burial depth of water-bearing utility lines is typically 2.4 m below ground surface. If this depth is not achievable due to design restrictions or rock elevation, equivalent thermal insulation should be provided. The contractor should retain a professional engineer to provide detailed drawings for excavation and temporary support of the excavation walls during construction.

Utilities should be supported on minimum of 150 mm bedding of Granular A compacted to minimum 96% of SPMDD. Utility cover can be Granular A or Granular B type II compacted to 96% SPMDD. All covers are to be compacted to 100% SPMDD if intersecting structural elements. The engineer designing utilities shall ensure the proposed utility pipes can tolerate compaction loads.

Cut-off walls should be provided for utility trenches running below the groundwater level to mitigate the settlement risk due to groundwater lowering.

9.0 CEMENT TYPE AND CORROSION POTENTIAL

Among samples retrieved during the investigation, there was not adequate sample recovery encountered for chemical testing. It is expected the building will be founded on limestone bedrock, and backfilled with granular material. No sulphate attack is expected from bedrock; therefore General Use (Type GU) Portland cement will be adequate. Based on the composition of the proposed backfill (OPSS Granular) it is typically expected to be non-aggressive or mildly-aggressive, for buried steel elements in contact with existing fill. The contractor shall confirm with the material source.

10.0 CLOSURE

We trust this geotechnical investigation and foundation design report meets requirements of your project. The "Limitations of Report" presented in Appendix A are an integral part of this report. Please do not hesitate to contact the undersigned should you have any questions or concerns.

McIntosh Perry Consulting Engineers Ltd.

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Geotechnical Engineering Intern

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N'eem Tavakkoli, M.Eng., P.Eng.
Senior Geotechnical Engineer

11.0 REFERENCES

Canadian Geotechnical Society, "Canadian Foundation Engineering Manual", 4th Edition, 2006.

Ontario Ministry of Natural Resources (OMNR), Ontario Geological Survey, Special Volume 2, "The Physiography of Southern Ontario", 3rd Edition, 1984.

Google Earth, Google, 2015.

Ontario Provincial Standards (OPSS)

3604 INNES ROAD

APPENDIX A
LIMITATIONS OF REPORT

McINTOSH PERRY

LIMITATIONS OF REPORT

McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) carried out the field work and prepared the report. This document is an integral part of the Foundation Investigation and Design report presented.

The conclusions and recommendations provided in this report are based on the information obtained at the borehole locations where the tests were conducted. Subsurface and groundwater conditions between and beyond the boreholes may differ from those encountered at the specific locations where tests were conducted and conditions may become apparent during construction, which were not detected and could not be anticipated at the time of the site investigation. The benchmark level used and borehole elevations presented in this report are primarily to establish relative differenced in elevations between the borehole locations and should not be used for other purposes such as to establish elevations for grading, depth of excavations or for planning construction.

The recommendations presented in this report for design are applicable only to the intended structure and the project described in the scope of the work, and if constructed in accordance with the details outlined in the report. Unless otherwise noted, the information contained in this report does not reflect on any environmental aspects of either the site or the subsurface conditions.

The comments or recommendation provided in this report on potential construction problems and possible construction methods are intended only to guide the designer. The number of boreholes advanced at this site may not be sufficient or adequate to reveal all the subsurface information or factors that may affect the method and cost of construction. The contractors who are undertaking the construction shall make their own interpretation of the factual data presented in this report and make their conclusions, as to how the subsurface conditions of the site may affect their construction work.

The boundaries between soil strata presented in the report are based on information obtained at the borehole locations. The boundaries of the soil strata between borehole locations are assumed from geological evidences. If differing site conditions are encountered, or if the Client becomes aware of any additional information that differs from or is relevant to the McIntosh Perry findings, the Client agrees to immediately advise McIntosh Perry so that the conclusions presented in this report may be re-evaluated.

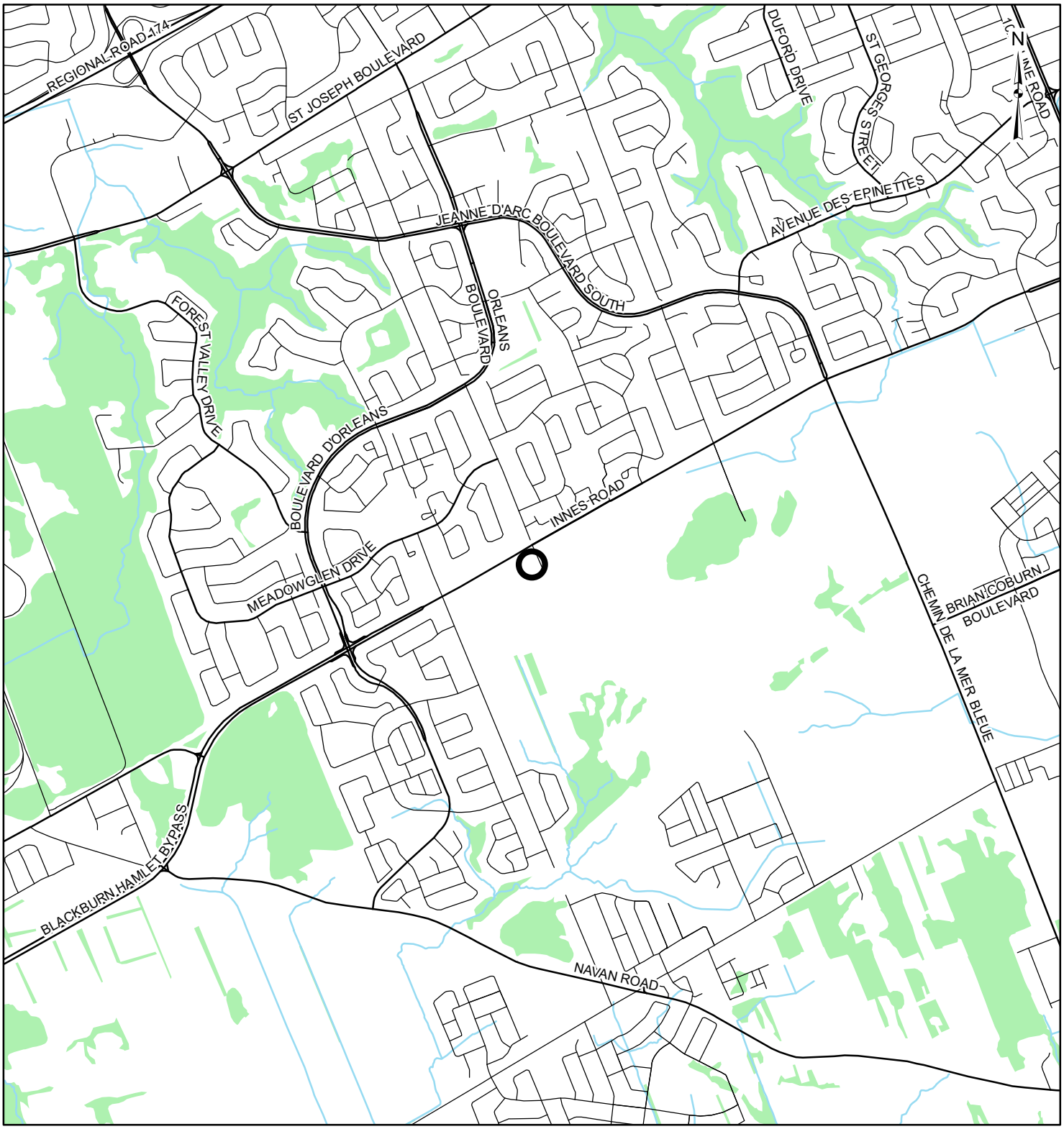
Under no circumstances shall the liability of McIntosh Perry for any claim in contract or in tort, related to the services provided and/or the content and recommendations in this report, exceed the extent that such liability is covered by such professional liability insurance from time to time in effect including the deductible therein, and which is available to indemnify McIntosh Perry. Such errors and omissions policies are available for inspection by the Client at all times upon request, and if the Client desires to obtain further insurance to protect it against any risks beyond the coverage provided by such policies, McIntosh Perry will co-operate with the Client to obtain such insurance.

McIntosh Perry prepared this report for the exclusive use of the Client. Any use which a third party makes of this report, or any reliance on or decision to be made based on it, are the responsibility of such third parties. McIntosh Perry accepts no responsibility and will not be liable for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

3604 INNES ROAD

APPENDIX B
FIGURES

McINTOSH PERRY



750 375 0 750

Scale 1:25,000 Metres

LEGEND

- Site Location
- Local Road
- Major Road
- Wooded Area
- Watercourse
- Waterbody

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.

CLIENT: TRAFALGAR ENVIRONMENTAL CONSULTANTS

PROJECT: GEOTECHNICAL INVESTIGATION 3604 INNES ROAD

TITLE: SITE LOCATION

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Tel: 613-836-2184 Fax: 613-836-3742
www.mcintoshperry.com

PROJECT NO:CP-18-0050		FIGURE:
Date	Mar., 15, 2018	1
GIS	JD	
Checked By	JU	

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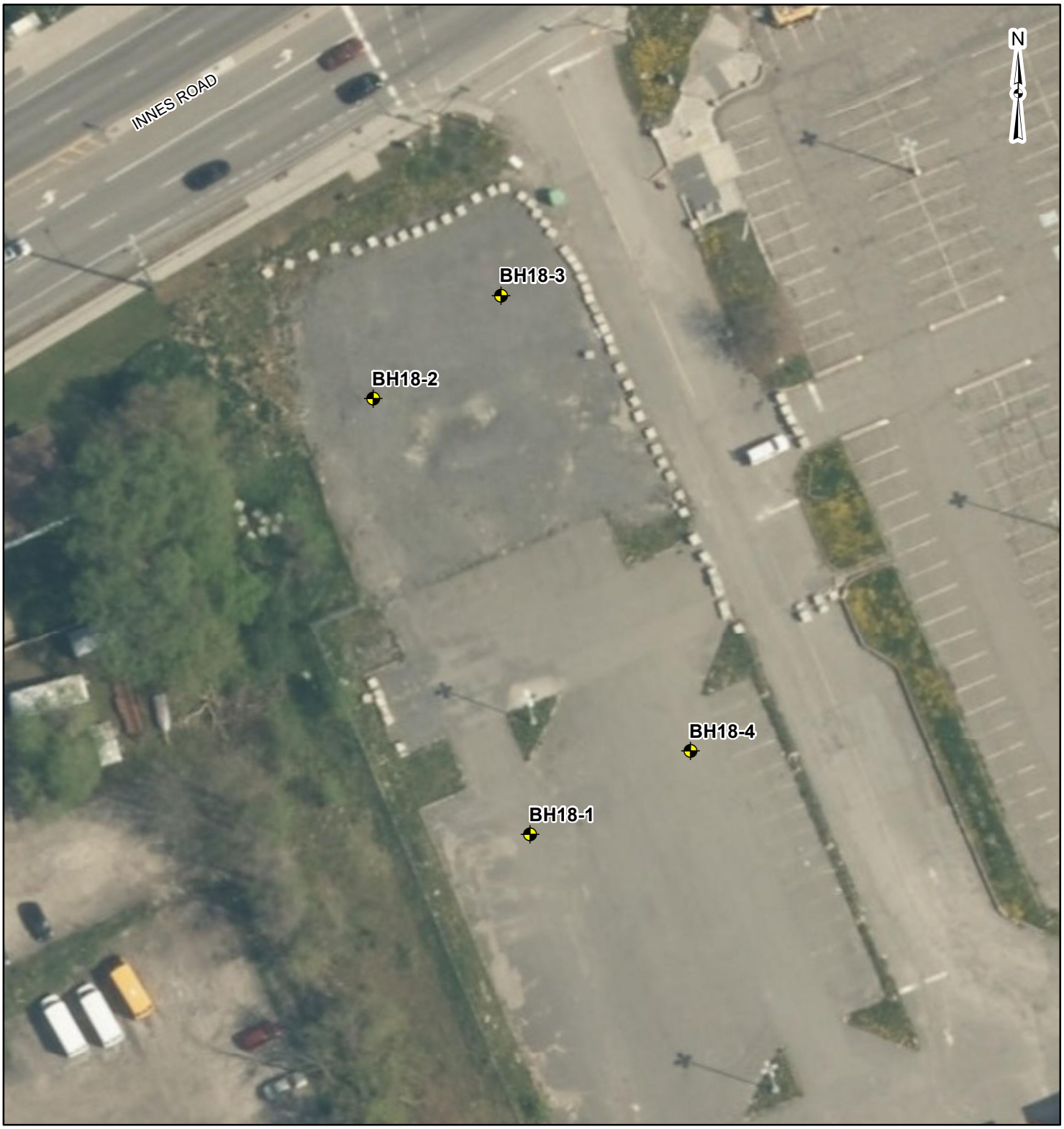

10 5 0 10

Scale 1:600 Metres

LEGEND

Borehole Location

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.

CLIENT: TRAFALGAR ENVIRONMENTAL CONSULTANTS

PROJECT: GEOTECHNICAL INVESTIGATION
3604 INNES ROAD

TITLE: BOREHOLE LOCATIONS

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PROJECT NO:	CP-18-0050
Date	Mar., 15, 2018
GIS	JD
Checked By	JU

FIGURE: 2

H:\01 Project - Proposals\2018 Jobs\CP\0CP-18-0050 Trafalgar Env. Geotech Invest. 3604 Innes Rd\7 - GIS\mxd\CP-18-0050_Geotechnical\02_BoreholeLocations3604Innes.mxd

3604 INNES ROAD

APPENDIX C
BOREHOLE LOGS

McINTOSH PERRY

EXPLANATION OF TERMS USED IN REPORT

N-VALUE: THE STANDARD PENETRATION TEST (SPT) N-VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5 kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N-VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N-VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

C_u (kPa)	0 – 12	12 – 25	25 – 50	50 – 100	100 – 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 – 5	5 – 10	10 – 30	30 – 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSION AND STRUCUTRAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINT AND BEDDING:

SPACING	50mm	50 – 300mm	0.3m – 1m	1m – 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ε	%	LINEAR STRAIN
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICALL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
c_c	1	COMPRESSION INDEX
c_s	1	SWELLING INDEX
c_a	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
Φ'	$^{-o}$	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
Φ_u	$^{-o}$	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = c_u / τ_r

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1,%	VOID RATIO	e_{min}	1,%	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1,%	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1,%	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	s_r	%	DEGREE OF SATURATION	D_n	mm	N PERCENT – DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_P	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_P	%	PLASTICITY INDEX = $(W_L - W_L)$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $(W - W_P)/ I_P$	i	1	HYDAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $(W_L - W) / 1_P$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERED SOIL	$e_{,max}$	1,%	VOID RATIO IN LOOSEST STATE	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

C:\Users\m.gleeson\Pictures\3inchlogo.jpg

RECORD OF BOREHOLE No 18-1

DATE:	05/03/2018 -	**LOCATION:**	3604 Innes Road, Ottawa, ON ()	**ORIGINATED BY:**	JU
ID:	CP-18-0050-INNESRD	**COORDINATES:**	Lat: 45.448048 , Lon: -75.522119	**COMPILED BY:**	JU
CLIENT:	Trafalgar Environmental Consultants	**DATUM:**	Local	**CHECKED BY:**	NT
ELEVATION:	99.9 m	**REMARK:**		**REPORT DATE:**	27/03/2018

DEPTH - feet	DEPTH - meters	SOIL PROFILE: ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	STATE	RECOVERY	"N" or RQD	GROUNDWATER CONDITIONS	DYNAMIC CONE PEN. RESISTANCE PLOT / SHEAR STRENGTH (kPa)	WATER CONTENT and LIMITS (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
		99.9	Natural ground surface									G S M C
		0.0	Fill : Sand and gravel, traces of clay and silt, grey to brown, dry, dense.		SS-01		58	36				
	1				SS-02		37	15				
		98.5										
5		1.4	Fill : Clayey sand, traces of silt and gravel, dark grey to brown, moist, compact.		SS-03		8	50				
		98.1										
	2	1.8	Limestone Bedrock, dark grey, very poor quality.		RC-04		100	0				SPT refusal at 1.83 m.
		97.4										
		2.4	Limestone Bedrock, dark grey, fair to good quality.									UCS : 140 MPa.
10	3				RC-05		100	80				UCS : 119 MPa
	4				RC-06		100	100				
15												
	5	94.8			RC-07		100	68				
		5.1	**END OF BOREHOLE**									Borehole backfilled with holeplug.
20	6											
	7											
25												
	8											
	9											
30												

DYNAMIC CONE PEN. RESISTANCE PLOT: 20 40 60 80

SHEAR STRENGTH (kPa): Vane test (◇ Intact, ◆ Remolded) Lab vane (□ Intact, ■ Remolded); 20 40 60 80 100

WATER CONTENT and LIMITS (%): W_P W W_L; 25 50 75

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RECORD OF BOREHOLE No 18-2

DATE: 05/03/2018 -
ID: CP-18-0050-INNESRD
CLIENT: Trafalgar Environmental Consultants
ELEVATION: 99.6 m
LOCATION: 3604 Innes Road, Ottawa, ON ()
COORDINATES: Lat: 45.448294 , Lon: -75.522195
DATUM: Local
REMARK:
ORIGINATED BY: JU
COMPILED BY: JU
CHECKED BY: NT
REPORT DATE: 27/03/2018

DEPTH - feet	DEPTH - meters	SOIL PROFILE: ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	STATE	RECOVERY	"N" or RQD	GROUNDWATER CONDITIONS	DYNAMIC CONE PEN. RESISTANCE PLOT / SHEAR STRENGTH (kPa)	WATER CONTENT and LIMITS (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
		99.6	Natural ground surface									
		0.0 / 98.9	Fill : Sand and gravel, traces of clay and silt, brown, dry, compact.		SS-01		42	24			○	
5	1	0.8 / 97.8	Limestone Bedrock, dark grey, poor quality.		RC-02		100	- *38*				SPT refusal at 0.76 m. UCS : 104 MPa
	2	1.8	Limestone Bedrock, dark grey, fair to good quality.		RC-03		100	- *70*				
10	3											
	4	95.2			RC-04		100	- *90*				
15	5	4.5	**END OF BOREHOLE**									Borehole backfilled with hole plug.
20	6											
	7											
25	8											
30	9											

DYNAMIC CONE PEN. RESISTANCE PLOT: 20 40 60 80
SHEAR STRENGTH (kPa): Vane test ◇ Intact ◆ Remolded; Lab vane □ Intact ■ Remolded; 20 40 60 80 100
WATER CONTENT and LIMITS (%): W_P W W_L; 25 50 75
REMARKS & GRAIN SIZE DISTRIBUTION (%): G S M C

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RECORD OF BOREHOLE No 18-3

DATE:	05/03/2018 -	**LOCATION:**	3604 Innes Road, Ottawa, ON ()	**ORIGINATED BY:**	JU
ID:	CP-18-0050-INNESRD	**COORDINATES:**	Lat: -75.521827 , Lon: -75.522016	**COMPILED BY:**	JU
CLIENT:	Trafalgar Environmental Consultants	**DATUM:**	Local	**CHECKED BY:**	NT
ELEVATION:	99.6 m	**REMARK:**		**REPORT DATE:**	27/03/2018

DEPTH - feet	DEPTH - meters	SOIL PROFILE: ELEVATION - m / DEPTH - m	SOIL PROFILE: DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	SAMPLES: STATE	SAMPLES: RECOVERY	SAMPLES: "N" or RQD	GROUNDWATER CONDITIONS	DYNAMIC CONE PEN. RESISTANCE PLOT / SHEAR STRENGTH (kPa)	WATER CONTENT and LIMITS (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
		99.6	Natural ground surface							DYNAMIC CONE PEN. RESISTANCE PLOT 20 40 60 80 SHEAR STRENGTH (kPa) Vane test: ◇ Intact ◆ Remolded; Lab vane: □ Intact ■ Remolded 20 40 60 80 100	W_P W W_L 25 50 75	G S M C
		0.0	Fill : Sand and gravel, some clay and silt, brown to grey, dry to moist, dense.		SS-01		58	43 -				
		98.9										
	1	0.8	Fill : Clayey sand, traces of silt and gravel, dark grey to brown, moist, loose to compact.		SS-02		42	48 -				
5					SS-03		37	12 -				
	2	97.3										
		2.3	**END OF BOREHOLE. BOREHOLE TERMINATED ON SPT REFUSAL.**		SS-04		0	50 -				SPT refusal at 2.29 m. Borehole backfilled with holeplug.
10	3											
	4											
15												
	5											
20	6											
	7											
25												
	8											
30	9											

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RECORD OF BOREHOLE No 18-4

DATE:	05/03/2018 -	**LOCATION:**	3604 Innes Road, Ottawa, ON ()	**ORIGINATED BY:**	JU
ID:	CP-18-0050-INNESRD	**COORDINATES:**	Lat: 45.448078 , Lon: -75.521827	**COMPILED BY:**	JU
CLIENT:	Trafalgar Environmental Consultants	**DATUM:**	Local	**CHECKED BY:**	NT
ELEVATION:	99.8 m	**REMARK:**		**REPORT DATE:**	27/03/2018

DEPTH - feet	DEPTH - meters	SOIL PROFILE: ELEVATION - m / DEPTH - m	SOIL PROFILE: DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	SAMPLES: STATE	SAMPLES: RECOVERY	SAMPLES: "N" or RQD	GROUNDWATER CONDITIONS	DYNAMIC CONE PEN. RESISTANCE PLOT / SHEAR STRENGTH (kPa)	WATER CONTENT and LIMITS (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
		99.8	Natural ground surface									
		0.0	Fill : Sand and gravel, some clay and silt, grey to brown, dry to moist, compact to dense.		SS-01		42	45 -				
	1				SS-02		43	50 -				
		98.5										
5		1.3	**END OF BOREHOLE. BOREHOLE TERMINATED ON SPT REFUSAL.**									SPT refusal at 1.30 m. Borehole backfilled with hole plug.
	2											
10	3											
	4											
15												
	5											
20	6											
	7											
25												
	8											
30	9											

DYNAMIC CONE PEN. RESISTANCE PLOT: 20 40 60 80

SHEAR STRENGTH (kPa): Vane test — ◇ Intact, ◆ Remolded; Lab vane — □ Intact, ■ Remolded; 20 40 60 80 100

WATER CONTENT and LIMITS (%): W_P W W_L; 25 50 75

REMARKS & GRAIN SIZE DISTRIBUTION (%): G S M C

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3604 INNES ROAD

APPENDIX D
LAB RESULTS

McINTOSH PERRY

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Certificate of Analysis

McIntosh Perry Consulting Eng. (Carp)

115 Walgreen Road
RR#3 Carp, ON K0A 1L0
Attn: Mary Ellen Gleeson

Client PO: CP-18-0050- Innes Rd.
Project: CP-18-0050
Custody: 34143

Report Date: 16-Mar-2018
Order Date: 13-Mar-2018

Order #: 1811142

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

Paracel ID	Client ID
1811142-01	CP-18-0050 BH18-4 SS-02

Approved By:

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO: CP-18-0050- Innes Rd.

Report Date: 16-Mar-2018
Order Date: 13-Mar-2018
Project Description: CP-18-0050

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	14-Mar-18	14-Mar-18
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	13-Mar-18	13-Mar-18
Resistivity	EPA 120.1 - probe, water extraction	14-Mar-18	14-Mar-18
Solids, %	Gravimetric, calculation	14-Mar-18	14-Mar-18

Certificate of Analysis

Report Date: 16-Mar-2018

Client: McIntosh Perry Consulting Eng. (Carp)

Order Date: 13-Mar-2018

Client PO: CP-18-0050- Innes Rd.

Project Description: CP-18-0050

	Client ID:	CP-18-0050 BH18-4 SS-02	-	-	-
	Sample Date:	05-Mar-18	-	-	-
	Sample ID:	1811142-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	89.3	-	-	-
General Inorganics					
pH	0.05 pH Units	7.66	-	-	-
Resistivity	0.10 Ohm.m	8.42	-	-	-
Anions					
Chloride	5 ug/g dry	30	-	-	-
Sulphate	5 ug/g dry	1490	-	-	-

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						

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO: CP-18-0050- Innes Rd.

Report Date: 16-Mar-2018
Order Date: 13-Mar-2018
Project Description: CP-18-0050

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	14.4	5	ug/g dry	13.9			3.4	20	
Sulphate	39.5	5	ug/g dry	37.7			4.6	20	
General Inorganics									
pH	5.93	0.05	pH Units	5.93			0.0	10	
Resistivity	51.2	0.10	Ohm.m	53.7			4.8	20	
Physical Characteristics									
% Solids	87.3	0.1	% by Wt.	87.7			0.4	25	

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Carp)
Client PO: CP-18-0050- Innes Rd.

Report Date: 16-Mar-2018
Order Date: 13-Mar-2018
Project Description: CP-18-0050

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	110	5	ug/g	13.9	95.9	78-113			
Sulphate	136	5	ug/g	37.7	98.5	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.

LRL Associates Ltd.

Unconfined Compressive Strength of Intact Rock Core

ASTM D 7012: Method C

Client: McIntosh Perry Consulting Engineers
Project: Materials Testing
Location: 3604 Innes Road, Ottawa, ON.

Reference No.: CP-18-0050
File No.: 170496-25
Report No.: 1

Drill Core Information

Date(s) Sampled: March 5, 2018
Sampled By: McIntosh Perry Consulting Engineers
Date Received: March 13, 2018

Laboratory Identification	Core No.	Field Identification	Borehole	Run	Depth	Location / Description
C0683	1		18-1	RC-05	2.44 m - 2.82 m	3604 Innes Road
C0684	2		18-1	RC-05	2.82 m - 3.30 m	3604 Innes Road
C0685	3		18-2	RC-02	1.57 m - 1.78 m	3604 Innes Road

Rock Core Unconfined Compressive Strength Test Data

Laboratory Identification	Core No.	Conditioning	Length, mm	Diameter, mm		MPa	Description of Failure
C0683	1	As received	100.8	47.3		139.6	Predominantly columnar
C0684	2	As received	99.9	47.3		118.7	Predominantly columnar
C0685	3	As received	100.5	47.3		103.5	Predominantly columnar

Comments:

Date Issued: March 15, 2018

Reviewed By: W.A.M^cLaughlin

W.A.M^cLaughlin, Geo.Tech., C.Tech.

3604 INNES ROAD

APPENDIX E
SEISMIC HAZARD CALCULATION

McINTOSH PERRY

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

March 26, 2018

Site: 45.448 N, 75.522 W User File Reference:

Requested by: ,

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

Sa(0.05)	Sa(0.1)	**Sa(0.2)**	Sa(0.3)	**Sa(0.5)**	**Sa(1.0)**	**Sa(2.0)**	**Sa(5.0)**	**Sa(10.0)**	**PGA (g)**	**PGV (m/s)**
0.491	0.570	**0.474**	0.358	**0.252**	**0.124**	**0.058**	**0.015**	**0.0055**	**0.304**	**0.209**

Notes. Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. ***These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.047	0.162	0.272
Sa(0.1)	0.065	0.202	0.326
Sa(0.2)	0.058	0.173	0.275
Sa(0.3)	0.046	0.132	0.209
Sa(0.5)	0.032	0.093	0.146
Sa(1.0)	0.016	0.046	0.072
Sa(2.0)	0.0062	0.021	0.034
Sa(5.0)	0.0013	0.0048	0.0083
Sa(10.0)	0.0006	0.0019	0.0032
PGA	0.035	0.110	0.177
PGV	0.022	0.071	0.117

References

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

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français