APPENDIX C - GEOTECHNICAL REPORT

GeoPro Consulting Limited

Geotechnical-Hydrogeology-Environmental-Materials-Inspection

Interim Report
Geotechnical Investigation

Proposed Replacement of Niagara Street Bridge over Welland River and Watermain Installation, between Riverbank Street to Mill Street

City of Welland, The Regional Municipality of Niagara, Ontario

Prepared For:

Associated Engineering (Ontario) Limited

GeoPro Project No.: 19-2795GH01

Report Date: August 20, 2020

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GeoPro CONSULTING LIMITED

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1 INTRODUCTION

GeoPro Consulting Limited (GeoPro) was retained by Associated Engineering Limited (the Client) to conduct a geotechnical investigation for the proposed replacement of Niagara Street Bridge over Welland River and the extension of the 600mm diameter watermain on Niagara Street between Mill Street and Riverbank Street, in the City of Welland, the Regional Municipality of Niagara, Ontario.

The purpose of this geotechnical investigation was to obtain information on the existing subsurface conditions by means of a limited number of boreholes, in-situ tests and laboratory tests of soil samples to provide required geotechnical design information. Based on GeoPro's interpretation of the obtained data, geotechnical comments and recommendations related to the project designs are provided.

This report is prepared with the condition that the design will be in accordance with all applicable standards and codes, regulations of authorities having jurisdiction, and good engineering practice. Furthermore, the recommendations and opinions in this report are applicable only to the proposed project as described above. On-going liaison and communication with GeoPro during the design stage and construction phase of the project is strongly recommended to confirm that the recommendations in this report are applicable and/or correctly interpreted and implemented. Also, any queries concerning the geotechnical aspects of the proposed project shall be directed to GeoPro for further elaboration and/or clarification.

This report is provided on the basis of the terms of reference presented in our approved proposal prepared based on our understanding of the project. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this report can be relied upon.

This report deals with geotechnical issues only. The geo-environmental (chemical) aspects of the subsurface conditions, including the consequences of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources were not investigated and were beyond the scope of this assignment. However, limited chemical testing was carried out on selected soil samples for disposal purposes.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. Laboratory testing follows ASTM or CSA Standards or modifications of these standards that have become standard practice in Ontario.

This report has been prepared for the Client only. Third party use of this report without GeoPro's consent is prohibited. The limitations to the report presented above form an integral part of the report and they must be considered in conjunction with this report.

2 PROJECT DESCRIPTION

According to the information provided, the Niagara Street Bridge carries Regional Road 50 (Niagara Street) over the Welland River in the City of Welland and the bridge is to be replaced. The extension of the 600mm diameter watermain on Niagara Street between Riverbank St and Mill St is considered and the watermain crossing the river using trenchless method is proposed.

3 INVESTIGATION PROCEDURE

The field work for the geotechnical investigation was carried out on July 3 and 14 to 17, 2020 during which time five (5) boreholes (Boreholes BH1, BH2, BH5, BH7 and BH8) were advanced to depths ranging from about 0.6 m to 29.0 m below the existing ground surface. In addition, the pavement was cored at one (1) location (Corehole CH1) using a core drill in order to obtain samples of the existing pavement concrete for asbestos analytical testing. The borehole and corehole locations are shown on attached Drawings.

A proposed borehole location plan prepared by GeoPro was provided to the Client for review prior to the field investigation work. The approved borehole locations were staked in the field by GeoPro; the borehole locations in the field were adjusted according to the drill rig accessibility and the underground utility conditions. The field work for this investigation was monitored by a member of our engineering staff who logged the boreholes and cared for the recovered samples.

The boreholes were advanced using a continuous flight auger drilling equipment supplied by a drilling specialist subcontracted to GeoPro. Samples were retrieved with a 51 mm (2 inches) O.D. split-barrel (split spoon) sampler driven with a hammer weighing 624 N and dropping 760 mm (30 inches) in accordance with the Standard Penetration Test (SPT) method.

Groundwater condition observations were made in the boreholes during drilling and upon completion of drilling. A monitoring well (51 mm in diameter) was installed in selected borehole(s) to measure the groundwater table. The remaining borehole(s) were backfilled and sealed upon completion of drilling.

All soil samples obtained during this investigation were brought to our laboratory for further examination. These soil samples will be stored for a period of three (3) months after the day of issuing draft report, after which time they will be discarded unless we are advised otherwise in writing. Geotechnical classification testing (including water content, grain size distribution and Atterberg Limits, when applicable) was carried out on selected soil samples. The laboratory test results are attached to Figures.

The ground surface elevations at the as drilled borehole locations were not available at the time of preparing this report. Therefore, the stratigraphy at each borehole location has been referenced to the current grade level. Contractors performing the work should confirm the elevations prior to construction. The borehole locations plotted on Borehole Location Plan were based on the measurements of the site features and should be considered to be approximate.

4 SUBSURFACE CONDITIONS

4.1 Soil Conditions

Notes on sample descriptions are presented in Enclosure 1A. Explanations of terms used in the borehole logs are presented in Enclosure 1B. The subsurface conditions in the boreholes are presented in the individual borehole logs. Detailed descriptions of the major soil strata encountered in the boreholes drilled at the site are provided as follows.

Pavement Structure on the Entrance of Parking Lot of 51 Niagara Street (Borehole BH7)

The composition thickness of pavement structure at borehole location is summarized in the following table:

BH No./CH No.	Pavement Structure (mm)	
	Asphalt	Granular Base/Granular Subbase
BH7	100	500*

Note: Due to the generally silty/sandy/gravelly nature of the existing subgrade soils, the exact depth of granular base/subbase was difficult to distinguish; *granular base/subbase materials are likely cement treated.

Pavement Structure on the Niagara Street (Borehole BH2 and BH5)

The composition thickness of pavement structure at borehole location is summarized in the following table:

BH No./CH No.	Pavement Structure (mm)	
	Asphalt	Granular Base/Subbase
BH2	160	460*
BH5	190	310*
Range (Average)	160 – 190 (175)	310 – 460 (390)

Note: Due to the generally silty/sandy nature of the existing subgrade soils, the exact depth of granular base/subbase was difficult to distinguish in some boreholes; *granular base/subbase materials are likely cement treated.

Pavement Structure on Mill Street (Borehole BH1 and Corehole CH1)

The composition thickness of pavement structure at borehole/corehole location is summarized in the following table:

BH No./CH No.	Pavement Structure (mm)	
	Asphalt	Portland Cement Concrete
BH1	115	140
CH1	110	150
Range (Average)	110 – 115 (115)	140 – 150 (145)

Topsoil

Topsoil with a thickness of about 250 mm was encountered surficially in Borehole BH8. In general, the topsoil consists of high contents of organics with trace to some rootlets. It should be noted that the thickness of the topsoil explored at the borehole locations may not be representative for the site and should not be relied on to calculate the amount of topsoil at the site.

Fill Materials

Fill materials consisting of clayey silt, sandy silt, silty sand and silty gravelly sand were encountered below the topsoil or granular base/subbase in Boreholes BH1, BH2, BH5, BH7 and BH8, and extended to depths ranging from about 0.3 m to 4.0 m below the existing ground surface. For the cohesive fill materials, SPT N values ranging from 4 to 22 blows per 300 mm penetration indicated a soft to very stiff consistency. For the cohesionless fill materials, SPT N values ranging from 5 to 12 blows per 300 mm penetration indicated a loose to compact compactness. The in-situ moisture content measured in the soil samples ranged from approximately 6% to 25%.

Organic Silt

Organic silt deposit was encountered below the fill materials in Borehole BH7, and extended to a depth of about 6.5 m below the existing ground surface. SPT N values ranging from weight of hammer to 5 blows per 300 mm penetration indicated a very loose to loose compactness. The natural moisture content measured in the soil sample was approximately 90%.

Clayey Silt and Silty Clay

clayey silt and silty clay deposits were encountered below the fill materials and/or organic silt deposit in Boreholes BH1, BH2, BH5 BH7 and BH8, and extended to depths ranging from about 0.6 m to 21.6 m below the existing ground surface. Boreholes BH1, BH2 and BH5 were terminated in these deposits. SPT N values ranging from 1 to 30 blows per 300 mm penetration indicated a very soft to very stiff consistency. The natural moisture content measured in the soil samples ranged from approximately 17% to 45%.

(Fine) Sand and Silt, Silty (Fine) Sand, Silty Gravelly Sand and Sand and Gravel

(Fine) sand and silt, silty (fine) sand, silty gravelly sand, and sand and gravel deposits were encountered below the clayey silt to silty clay deposits in Boreholes BH7 and BH8, and extended to depths ranging from about 25.2 m to 25.4 m below existing ground surface. SPT N values ranging from 6 to greater than 100 blows per 300 mm penetration indicated a loose to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 7% to 16%.

Sandy Silt Till and Sand and Silt Till

Sandy silt till and sand and silt till deposits were encountered below the sand and silt to silty sand and/or sand and gravel deposits in Boreholes BH7 and BH8, and extended to depths ranging from about 23.0 m to 27.7 m below the existing ground surface. SPT N values ranging from 42 to greater than 100 blows per 300 mm penetration indicated a dense to very dense compactness. The natural moisture content measured in the soil samples was approximately 9%.

Sand/Shale Complex

Sand/shale complex was encountered below the sand and silt to silty sand deposits in Borehole BH7, and extended to a depth of about 29.0 m below the existing ground surface.

The “sand/shale complex” consists of a heterogeneous sand matrix, containing extensive broken bedrock (shale and limestone) slabs and fragments. An SPT N value of greater than 100 blows per 300 mm penetration indicated a compact compactness. The natural moisture content measured in the soil sample was approximately 21%.

The “sand/shale complex” exists as a transitional deposit between the bedrock and the overlying soils. This deposit has characteristics of both the sand and of the shale/limestone bedrock. The deposits are very difficult to excavate through due to the fragmented shale/limestone content and the anticipated very high density/hardness conditions. The bedrock slabs anticipated within the soil complex may be quite large (over 1 m in length/thickness).

Probable Limy Shale to Shaly Limestone and Limestone

As best could be practically determined, limy shale to shaly limestone and limestone presumed to coincide with the bedrock surface was encountered in Boreholes BH7 and BH8 below the native soils at depths ranging from about 27.7 to 29.0 m below the existing ground surface. Exploration of the bedrock was not carried out as part of this assignment, however based on samples recovered from the penetration testing, the bedrock beneath the site appeared to consist of weathered grey limy shale to shaly limestone and limestone. It should be noted that it is often difficult to distinguish where the "soil/shale" complex ends and bedrock begins, particularly where the bedrock surface is weathered. As such, a variation of greater than ±2m may be expected for the inferred bedrock surface depths/elevations.

4.2 Groundwater Conditions

Groundwater condition observations made in the boreholes during and immediately upon completion of drilling are shown in the borehole logs and are also summarized in the following table.

Borehole No.	BH Depth (m)	Depth of Water Encountered during Drilling (mBGS)	Water Level upon Completion of Drilling (mBGS)	Cave-in Depth upon Completion of Drilling (mBGS)
BH1	0.6	-	Dry	Open
BH2	5.0	4.6	-	4.3
BH3	5.0	-	-	4.9
BH7	29.0	5.2	-*	-*
BH8	27.8	7.6	-*	-*

Note: mBGS = meters below ground surface
* Water level was not measured upon completion of drilling due to use of drilling mud

Monitoring wells construction details and the measured groundwater level are shown in the borehole logs and also summarized in the following table.

Monitoring Well ID	Screen Interval (mBGS)	Water Level (mBGS)
		August 19, 2020
BH5	3.1 – 4.6	2.12
BH6	24.7 – 27.7	4.17

Note: mBGS = meters below ground surface

It should be noted that groundwater levels can vary and are subject to seasonal fluctuations in response to weather events.

5 REVIEW OF SUBSURFACE CONDITIONS AND RECOMMENDATIONS OF SOIL PARAMETERS

The main findings of the soil strata are summarized as follows:

- A pavement structure was intercepted in Boreholes BH1, BH2, BH5 and BH7;
- Fill materials with varying thicknesses were encountered at all borehole locations up to depths varying from 0.3 m (Borehole BH1, i.e. Mill Street) to 4.0 m (Borehole BH7, i.e. south of the existing bridge);
- Underlying the fill materials, native cohesive clayey deposits, cohesionless sandy/silty/gravelly deposits, glacial tills and soil/shale complex were encountered;
- Probable limy shale to shaly limestone and probable limestone were encountered in Boreholes BH7 and BH8;
- Groundwater table measured in the boreholes ranged from 2.12 m to 4.17 m below the ground surface.

The recommended soil parameters are summarized in the following Table 1:

Table 1: Recommended Unfactored Soil Parameters

Material Type	γ (kN/m³)	γ' (kN/m³)	Φ'	n_h (MN/m³)	K_a	K_o	K_p	C_u (kPa)
Fill Materials	18	8	28°	1.3	0.36	0.53	2.8	-
Very Soft Clayey Silt to Silty Clay	15	5	25°	-	0.40	0.57	2.5	2
Soft Clayey Silt to Silty Clay	16	6	26°	-	0.39	0.56	2.6	12
Firm Clayey Silt to Silty Clay	17	7	27°	-	0.38	0.55	2.7	25
Stiff Clayey Silt and Silty Clay	18	8	27°	-	0.38	0.55	2.7	50
Very Stiff Clayey Silt and Silty Clay	18	8	28°	-	0.36	0.53	2.8	100
Loose Fine Sand and Silt to Silty Fine Sand	19	9	29°	1.3	0.35	0.52	2.9	-
Compact (Fine) Sand and Silt to Silty (Fine) Sand	20	10	30°	4.4	0.33	0.50	3.0	-
Dense to Very Dense (Fine) Sand and Silt to Silty (Fine) Sand	21	11	31°	11	0.32	0.49	3.1	-
Dense to Very Dense Sandy Silt Till and Sand and Silt Till	22	12	31°	11	0.32	0.49	3.1	-
Compact Sand and Gravel	22	12	32°	4.4	0.31	0.47	3.3	-
Very Dense Silty Sand and Gravel	23	13	33°	11	0.30	0.46	3.4	-

Very Dense Sand/Shale Complex	22	12	32°	11	0.31	0.47	3.3	-

Notes: c_u = Undrained shear strength of soil (kPa);
ϕ' = Effective angle of friction of soil (degrees);
K_a = Coefficient of active earth pressure;
K_o = Coefficient of earth pressure at rest;
K_p = Passive earth pressure coefficient;
γ = Bulk unit weight of soil (kN/m^3);
γ' = Effective unit weight of soil below the groundwater level (kN/m^3);
n_h = Parameter for Horizontal Subgrade Reaction (MN/m^3)

6 DISCUSSION AND RECOMMENDATIONS

This report contains the geotechnical engineering recommendations and comments. These recommendations and comments are based on factual information and are intended only for use by the design engineers. The number of boreholes and test pits may not be sufficient to determine all the factors that may affect construction methods and costs. Subsurface conditions between and beyond the boreholes may differ from those encountered at the borehole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The anticipated construction conditions are also discussed, but only to the extent that they may influence design decisions. Construction methods discussed, however, express GeoPro's opinion only and are not intended to direct the contractors on how to carry out the construction. Contractors should also be aware that the data and their interpretation presented in this report may not be sufficient to assess all the factors that may have an effect on the construction.

The design drawings of the project were not available when this report was prepared. Once the design drawings and detailed site plan are available, this report will be reviewed by GeoPro, and further recommendations will be provided as needed.

6.1 Bridge Foundation Design Considerations

Based on the borehole information, shallow foundations are not considered to be a desirable option since the soil strengths in the vicinity of Boreholes BH7 and BH8 are not considered to be sufficient to support the proposed bridge on a spread footing. Augered caissons (bored piles) are also considered to be not feasible due to the high groundwater tables and the presence of the cohesionless soils at the site. Therefore, consideration could be given to supporting the bridge abutments on driven steel H piles founded in the competent very dense sand/shale complex or limy shale to shaly limestone and limestone bedrock. The driven steel H-pile foundation would also permit integral abutment design.

6.1.1 Driven H Piles

The vertical axial geotechnical resistance of an HP pile driven to an adequate set in the limy shale to shaly limestone and limestone bedrock are shown in the following table.

Pile Section	Factored Axial Resistance at Ultimate Limit States (ULS) (kN)
HP 310x110	1600
HP 310x132	1900
HP 310 x 152*	2200

*Due to the proposed driving depth, HP310x152 is recommended

The Serviceability Limit States (SLS) condition will not govern for piles founded on bedrock. The bedrock depth in the vicinity of Borehole BH7 may vary from the bedrock depth in Borehole BH8, which shall be considered in the contract. The contractor shall be warned about the bedrock variation which may cause additional length of piles and additional splicing.

The horizontal spacing of the piles should be at least 30 inches or 3.0 times the pile size. For end bearing driven piles, the vertical resistances will not be significantly affected by the pile spacing. Pile interaction should be considered with reference to applicable Canadian Highway Bridge Design Code (CHBDC).

The structural resistance of the pile should be checked by the structural designer. At any time, the pile stresses should not exceed 85% of the pile steel yield stress or follow the requirement in Canadian Highway Bridge Design Code (CHBDC). Plumbness and location of the driven pile should follow the requirements of the design specification provided by the structural engineer. Any misaligned or damaged piles should be replaced. The possibility of the piles encountering potential obstructions, such as cobbles and boulders and other debris in fill should be anticipated.

It should be noted that the recommended foundation type, founding depths, and bearing resistances were based on the borehole information only. The geotechnical recommendations and comments are necessarily on-going as new information of the underground conditions becomes available. For example, more specific information is available with respect to the subsurface conditions between and beyond the boreholes when foundation construction is underway. The interpretation between and beyond the boreholes and the recommendations of this report **must** therefore be checked through field inspections provided by a qualified geotechnical engineer from GeoPro to validate the information for use during the construction stage. Due to the anticipated variation of the subsurface conditions at this specific site, the geotechnical engineer who carried out the geotechnical investigation shall be retained during the construction stage to avoid the potential misinterpretation of the soil information presented in the report.

6.1.2 Downdrag (Negative Skin Friction)

Downdrag or negative skin friction of piles may occur wherever piles are on or adjacent to, recently placed fills or existing fill which undergoes ongoing settlement. This can occur at the abutment locations should any grade raise be considered.

6.1.3 Lateral Resistances

The design of piles subjected to lateral loads should take into account such factors as the batter of the piles (if any), the relative rigidity of the pile to the surrounding soils, the fixity condition at the head of the pile (pile cap level), the structural capacity of the pile to withstand bending moments, the soil resistance that can be mobilized, the tolerable lateral deflections at the head of the pile and pile group effects. For a longer, more flexible pile, the maximum yield moment of the pile may be reached prior to mobilization of the lateral geotechnical resistance. For design purposes, both the structural and geotechnical resistances should be evaluated to establish the governing case. The lateral resistance of the piles can be supplemented, if desired, by horizontal components of battered components of battered piles.

Ultimate Lateral Earth Resistance

The equations presented in the following may be used to analyze the interaction between a pile and the surrounding soil. The lateral pressures obtained from the analysis must not exceed the ultimate lateral resistance or the factored structural flexural resistance of the pile. For preliminary assessment purposes, the assessed horizontal passive resistance and geotechnical reaction at SLS in accordance with CHBDC shall be referenced.

For cohesive soils, the passive earth pressure on the pile at a depth Z can be determined from the following expression:

$$p_{ult} = 6C_u$$

For cohesionless soils, the p_{ult} value can be calculated using the following equation:

$$p_{ult} = 3\gamma Z K_p$$

The ultimate lateral earth resistance (force) on a short pile section of length l_z at depth Z can be expressed as

$$\Delta R_u = l_z B p_{ult}$$

Where

p_{ult} = the passive earth pressure on the pile at a depth Z, in kPa.

ΔR_u = ultimate lateral earth resistance on a pile section of length l_z and at depth Z, in kN.

Z = depth below final grade, in metre.

L = length of pile, in metre. Should be limited within six times the pile diameter/size

B = size (diameter) of pile, in metre

γ = unit weight of soil, in kN/m^3

K_p = passive earth pressure coefficient

C_u = undrained shear strength of clayey silt and bedrock, in kPa.

The passive lateral resistance of the soils within the frost depth should be ignored.

The direction of the lateral earth resistance (ΔR_u) is opposite to the direction of the lateral movement of the pile at depth *Z*.

The lateral capacity of the pile itself depends on the lateral earth resistance (ΔR_u) along the pile, and on the constraint conditions at the top of the pile. For analyses of the proposed piles founded in the limy shale to shaly limestone and limestone or long piles, it can be assumed that the base (bottom) of the piles will not move in both the vertical and horizontal directions.

For a short pile section of length l_z at depth Z, the factored lateral geotechnical resistance (ΔR_{ULS}) at the ultimate limit states (ULS) can be determined from the following expression:

$$\Delta R_{ULS} = \Phi_h \Delta R_u$$

where Φ_h is the lateral earth resistance factor. According to the Canadian Foundation Engineering Manual, 4th Edition (CFEM, 2006), the lateral earth resistance factor can be taken as Φ_h = 0.5.

The lateral capacity of piles at SLS should be determined according to the lateral deflection of the piles calculated using the modulus of horizontal subgrade reaction of the soil (k_h) described in the following sections.

Modulus of Horizontal Subgrade Reaction (k_h)

The modulus of horizontal subgrade reaction of the soil (k_h) can be used to evaluate the lateral deflection and bending of the proposed piles, where k_h is determined as given in the section below.

In the model of pile-soil interaction, the lateral earth resistance of soil can be simulated by a series of linear springs, and the stiffness coefficient of the springs or spring constant (K_{spr}) can be obtained from the calculated values of the modulus of horizontal subgrade reaction (k_h). For a pile with a diameter of *B* and a distance of *t* between two adjacent springs, the value of K_{spr} can be calculated using

$$K_{spr} = B \cdot t \cdot k_h.$$

The unit of K_{spr} is kN/m, and the unit of *t* is metre (m).

Cohesive Clayey Soils:

The modulus of horizontal subgrade reaction (k_h) of the cohesive soils can be calculated using the following equation:

$$k_h = \frac{67 C_u}{B}$$

where *B* represents the diameter of the pile and C_u is the undrained shear strength of the cohesive soils as given in **Table 1** in Section 5.

Non-cohesive Silty/Sandy/Gravelly Soils:

For the non-cohesive silty/sandy/gravelly soils, the value of the modulus of horizontal subgrade reaction k_h can be estimated using

$$k_h = n_h \frac{Z}{B}$$

Where *Z* is the depth, *B* is the diameter of pile, and n_h is a coefficient related to soil density, as listed on **Table 1** in Section 5.

It should be noted that the lateral resistance of soil is limited and the linear springs used in the analysis should not be loaded beyond the allowable passive lateral resistance of the corresponding soil.

The SLS resistance should be taken as that corresponding to a horizontal deflection of 10 mm at the underside of the pile cap for units supporting abutments, piers or retaining walls. The SLS resistance will normally be greater than the ULS resistance for pile embedded in very stiff or dense soils. This 10 mm limitation of horizontal movement does not apply where an analysis of the structure including the foundation indicates that a horizontal movement of more than 10 mm can be accommodated by both the foundation and the structure at SLS. In many cases, integral abutment bridges may have total lengths that result in SLS horizontal deflection that are greater than 10 mm.

Geotechnical Parameters for Lateral Resistance Design

For the lateral resistance design, pile-soil interaction analysis may be carried out using the geotechnical parameters provided in the following **Table 1** in Section 5.

Group Effect

For lateral soil/pile group interaction analysis, the modulus of subgrade reaction (k_h) may have to be reduced based on pile spacing.

Where a pile group is oriented **parallel** to the direction of loading, the group action may be considered by reducing the values of coefficient of horizontal subgrade reaction (k_h) by a reduction factor, R as follows:

Pile Spacing in direction of Loading (B = Pile Diameter)	Subgrade Reaction Reduction Factor (R)*
8B	1.0
6B	0.7
4B	0.4
3B	0.25

*Intermediate values may be obtained by interpolation.

Where a pile group is oriented **perpendicular** to the direction of loading, the group action may be considered by reducing the values of the coefficient of horizontal subgrade reaction (k_h) by a reduction factor (R), which can be expressed as

$$R = 0.5\left(1+\frac{x}{3B}\right)$$

In the above equation, *x* represents the centre-to-centre distance between adjacent piles, and B is the diameter of the pile. If the centre-to-centre distance between the adjacent piles is equal to or greater than 3 times its diameter (3B), the group action effect can be ignored.

6.1.4 Pile Driving

Pile installation should be in accordance with the OPSS 903, April 2016. The contractor who is performing the pile driving should retain a qualified geotechnical engineers as the QVE engineer.

As noted above, cobbles and boulders should be anticipated in the subsoils and as such, prospective foundation contractors should be alerted to this in the tender documents. If required by the engineer, the use of driving shoes or other means of stiffening of the tips of the piles in accordance with OPSD 3000 should be considered to minimize potential damage to the pile toes when driving into the dense to very dense and hard native strata, which should be included in the tender documents. For piles socketed in limy shale to shaly limestone and limestone bedrock, rock point (such as Hard Bite HP7780-B or the equivalent) shall be considered. All points are to be installed in accordance with OPSS 903.

Note No.2 from Article 3.3.3 Pile Driving Notes in the MTO Structural Manual should be used on the Foundation Design Drawing, i.e. “Piles to be driven in accordance with Standard SS-103-11 using an ultimate geotechnical resistance of two times of the factored Axial Resistance at ULS

presented in Section 6.1.1 per pile but must be driven until sound bedrock in accordance with OPSS 903, April 2016".

The piling contractor should ensure that the pile-driving hammer is powerful enough to achieve the required bearing resistances and required pile driven depths, but will not cause damage of the piles during the pile driving. Care must be taken to avoid overdriving and damaging the pile. The pile driving should be observed, on a full time basis, by an experienced geotechnical technician, who will record penetration resistance and pile tip elevation, etc. The technician must be supervised by a professional engineer experienced in this type of work.

As a preliminary guideline, pile should be driven with a suitable hammer capable of delivering at least 30 kilojoules/blow but less than 100 kilojoules/below (i.e. subject to designed pile length and founding soils in limy shale to shaly limestone and limestone bedrock) with an energy transfer (efficiency) in the order of 50%. Effective refusal can generally be assumed to have been obtained when at least 10 blows have been recorded for 1 inch of pile penetration using a suitable sized hammer. The contractor should retain a geotechnical consultant for a driveability analysis to determine the proper rated energy of the hammer to be used for the driving to achieve the effective refusal. The type of the hammer selected by the Contractor should be approved by the engineers prior to construction.

Due to the variation of the soil/bedrock conditions encountered in the boreholes at the designed founding depths, the actual pile penetration depths to achieve the above provided bearing resistances may be greatly variable. As noted above, the selection of a suitable hammer is critical for the successful pile driving. The contractor should allow for some variation in pile length and this aspect should be taken into consideration when ordering the piles. The unit price of driving extra length of piles including additional pile splicing should be included in the contract.

During the driving process, piles that have already been driven will need to be monitored in order to determine if heaving occurred due to the effect of the driving of adjacent piles. If pile heaving occurs, the affected piles will need to be re-driven. Re-tapping to check that relaxation has not occurred will also be necessary. Furthermore, it may be necessary to stagger the driving of the piles.

In consideration of the anticipated presence of the cohesionless silty/sandy/gravelly deposits at the proposed founding depths, waiting time for the pore pressures to dissipate and repeating pile driving test should be considered in the contract. For project schedule purpose, a waiting period of about two weeks may be considered for the pile set up and re-tap.

Conventional pile driving operations may cause vibrations that could affect nearby structures. An evaluation of existing surrounding foundation types and a pre-construction condition survey should be carried out, if applicable, prior to pile driving operations.

6.1.5 Integral Abutment

Should an integral abutment structure be designed for the proposed bridge, the piles should be end bearing on the limy shale to shaly limestone and limestone bedrock, using the geotechnical bearing resistance discussed above in this report. HP 310x110 or other sizes depending on the design axial loads may be considered for the integral abutments. Piles should be installed with their weak axis perpendicular to the center line of the beams. Piles may be fitted with driving points to protect the toes and improve penetration as discussed before. The designer shall design the H-piles considering the structural resistance of the piles and the geotechnical resistance of the pile. The structural resistance check should include checking axial, lateral, and flexural resistance. The design of the H-piles at the service limit state shall consider tolerable horizontal movement of the piles, overall stability of the pile group in consideration of the scour.

To accommodate movement of the integral abutment system, two concentric Corrugated Steel Pipes (CSPs) that extend at least 3 m below the bottom of the abutment should be placed around the pile to create an annular space. The inner CSP should be filled with granular material meeting the gradation requirements of Granular B Type I. Alternatively, a single CSP filled with loose uniform sand meeting the requirements shown in the table below may be used. Refer to MTO Report SO 96-01 for further details.

MTO SIEVE DESIGNATION		PERCENTAGE PASSING BY MASS
2 mm	#10	100
600 μm	#30	80 – 100
425 μm	#40	40 – 80
250 μm	#60	5 – 25
150 μm	#100	0 – 6

The CSP or auger hole constructed as part of the integral abutment will be carried out in various soils below the groundwater tables. The groundwater table should be lowered to about 1 m below the base of the CSP and the excavation may have to be supported by a steel liner to prevent caving of the excavation side walls.

Integral bridge abutments experience stresses due to the cyclic thermal expansion and contraction of the bridge deck, pushing the abutments into and out of the bridge embankment. The abutment stem wall and diaphragm should be designed to withstand a passive earth pressure state, which may not be fully mobilized in consideration of the length of the bridge. The cyclic expansion can develop into large lateral earth pressures on the abutments as the expansion of the superstructure occurs. The lateral earth pressures increase over time as the soil behind the abutment fills the void and becomes increasingly wedged in. Granular materials such as OPSS Granular A and Granular B Type II should be used as backfill materials behind the abutment wall to at least 1 m beyond the edge of the approach slabs.

Use of an approach slab is required. The existing soils are considered to be frost susceptible and should be removed and replaced with OPSS Granular A or Granular B Type II as noted above. The

granular base should also extend to at least 1 m beyond the edge of the approach slabs and sufficient drainage should be provided for the granular base. When a structural approach slab is specified, reduction, not elimination, of the surcharge loads on abutments is permitted. All abutment designs shall include a drainage system behind the abutments to intercept any groundwater. To avoid water intrusion behind the abutment the approach slab should be connected directly to the abutment.

6.2 Earth Pressures and Retaining Structures

Backfilling behind bridge abutments and any retaining (wing) walls should consist of granular materials in accordance with the applicable Standards. Free draining backfill materials, weepholes, etc. should be provided in order to prevent hydrostatic pressure build-up.

Computation of earth pressures acting against bridge abutments, retaining walls and any wing walls should be in accordance with the Canadian Highway Bridge Design Code (CHBDC). For design purposes, the following properties can be assumed for level and upward sloping backfill.

Compacted Granular 'A' or Granular 'B' Type II

Angle of Internal Friction ϕ=35° (unfactored)

Unit weight = 22 kN/m^3

Coefficient of Lateral Earth Pressure:

Level Backfill	Backfill Sloping at 3H:1V	Backfill Sloping at 2H:1V
K_a=0.27	K_a=0.34	K_a=0.40
K_b=0.35	K_b=0.44	K_b=0.50
K_o=0.43	K_o=0.56	K_o=0.62
K*=0.45	K*=0.60	K*=0.66

Compacted Granular 'B' Type I

Angle of Internal Friction ϕ=32° (unfactored)

Unit Weight = 21 kN/m^3

Coefficient of Lateral Earth Pressure:

Level Backfill	Backfill Sloping at 3H:1V	Backfill Sloping at 2H:1V
K_a=0.31	K_a=0.39	K_a=0.47
K_b=0.39	K_b=0.49	K_b=0.57
K_o=0.47	K_o=0.62	K_o=0.69
K*=0.54	K*=0.68	K*=0.78

Note: K_a is the coefficient of active earth pressure

K_b is the backfill earth pressure coefficient for an unrestrained structure including compaction efforts

K_o is the coefficient of earth pressure at rest

K* is the earth pressure coefficient for a soil loading a fully restrained structure and includes compaction effects

These values are based on the assumption that the backfill behind the retaining structures is free-draining granular material and adequate drainage is provided.

The earth pressure coefficient to be adopted will depend on whether the retaining structure is restrained or some movement can occur such that the active state of earth pressure can develop. The effect of compaction should also be taken into account in the selection of the appropriate earth pressure coefficients. The use of vibratory compaction equipment behind the abutments and the retaining walls should be restricted in size.

As an alternative to conventional retaining walls, consideration could be given to Retained Soil System in which case the designer will have to include the geometric, performance and appearance requirements. The Retained Soil System must be designed and constructed by a specialized contractor.

6.3 Seismic Considerations

6.3.1 Seismic Design Parameters

Based on the results of site investigation and in accordance with Section the CHBDC (2006), the following seismic parameters may be considered for the designs:

- Velocity Related Seismic Zone: 0
- Zonal Velocity Ratio: 0.00
- Acceleration Related Seismic Zone: 1
- Zonal Acceleration Ratio: 0.05
- Peak Horizontal Acceleration: 0.08

The soil profile type at this site may be classified as Type IV. Therefore, according to Table 4.4 of the CHBDC, a Site Coefficient "S" (Ground Motion Amplification Factor) of 2.0 may be considered in the seismic design.

6.4 Frost Protection

All foundations exposed to seasonal freezing conditions must have at least 1.2 m of soil cover or its thermal equivalent for frost protection. Abutment stems, pier caps, and any associated concrete wing walls/retaining wall footings, should be founded at a minimum depth of 1.2 m below the lowest surrounding grade, to provide adequate protection against frost penetration. It should be noted that the scour protection, such as rip rap and rock blocks should not be considered as earth cover for frost protection purposes.

6.5 Excavation and Groundwater Control

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, the very dense glacial tills deposits can be classified as Type 1 Soil above groundwater table and as Type 3 soil below the water table; the native very stiff clayey soils and dense glacial tills deposits can be classified as Type 2 Soil above groundwater table and as Type 3 soil below the water table; the existing firm to very stiff/loose to compact fill materials, native firm to stiff clayey soils and native cohesionless loose to very dense silty/sandy/gravelly soils can be classified as Type 3 Soil above groundwater table and as Type 4 Soil below the water table; the existing soft fill materials, native very soft to soft clayey soils and native organic silt deposit can be classified as Type 4 Soil.

Cobbles/Boulders are anticipated in the native soils. Provisions must be made in the excavation contract for the removal of possible cobbles and boulders in the native soil or potential obstructions in the fill materials.

The excavations for proposed abutments and removal of unsuitable soil at the approach embankment areas may extend to a maximum depth of about 6 to 7 m below the existing ground surface through the existing fill materials, native organic silt and native clayey silt to silty clay soils below the groundwater tables. If space permits, open-cut excavations to the proposed depths may be carried out in accordance with the guidelines outlined in the Occupational Health and Safety Act (OHSA) for Construction Activities. However, the high groundwater table may make the excavation very difficult. The presence of the cobbles and boulders in the native soils may make the sheet pile driving difficult.

Groundwater control during excavations within the native stiff to very stiff clayey deposits and dense to very dense glacial tills can be handled, as required, by pumping from properly constructed and filtered sumps located within the excavations. Perched groundwater may be expected in the fill materials, native organic silt, native very soft to firm clayey soils and native silty/sandy/gravelly soils above the groundwater tables at various depths which can be handled, as required, by pumping from properly constructed and filtered sumps located within the excavations. However, more significant seepage should be expected once the excavations extend below the prevailing groundwater tables in the fill materials, native organic silt, native very soft to firm clayey soils and native silty/sandy/gravelly soils and any wet silty/sandy layers/zones within the native clayey soils and glacial tills. Depending upon the actual thickness and extent of these water bearing soils, the finalized design excavation depths and the prevailing groundwater tables at the time of construction, some form of positive groundwater control, in addition to pumping from sump, may be required to maintain the stability of the base and side slopes of the excavations in these areas. In order to maintain a dry work space, the prevailing groundwater table should be drawn down to at least 1 m below the bottom elevation of the excavation. It should be noted that any construction dewatering or water taking in Ontario is governed by Ontario Regulation 387/04 - Water Taking and Transfer, made under the Ontario Water Resources Act (OWRA), and/or Ontario Regulation 63/16 – Registrations under Part II.2 of the Act – Water

Taking, made under Environmental Protection Act. Based on these regulations, water taking of more than 400,000 L/day is subject to a Permit to Take Water (PTTW), while water taking of 50,000 L/day to 400,000 L/day is to be registered through the Environmental Activity and Sector Registry (EASR)

Groundwater control at these locations would be required to allow for construction of foundation elements in a dry condition. Groundwater control measures or dewatering should be carried out by a specialist contractor to draw down the groundwater level to at least 1.0 m below the base level of the excavation to ensure stable conditions during excavation.

The existing fill materials, native organic silt and native clayey/silty/sandy/gravelly soils are extremely easy to be disturbed and may not be able to provide a sufficient support for construction equipment. A sufficient thickness of mud slab consisting of lean concrete will have to be considered to provide a stable work plat form.

6.6 Approach Embankment Design

The final design elevations of the proposed bridge approach embankments are unknown. It is anticipated that the existing roadway will remain in place with no grade raise. Settlement may occur should any grade raise be considered for the existing embankment due to the presence of the soft to firm clayey soils.

7 ENVIRONMENTAL SOIL ANALYTICAL RESULTS

7.1 Soil Sample Submission

Selected soil samples were submitted to a laboratory which is a member of Canadian Association for Laboratory Accreditation ("CALA") for chemical analyses. Descriptions of the selected soil samples and analytical parameters are presented in the following table:

Sample ID	Soil Depth (mBGS)	Primary Soil	Analytical Parameters
BH2 AS1B+AS2	0.6 – 1.2	Fill: Sandy Silt	M&I; PAHs; PHCs; VOCs
BH5 AS1B	0.5 – 0.8	Fill: Clayey Silt	M&I; PAHs; PHCs; VOCs
BH7 AS1B+SS2	0.6 – 1.2	Fill: Sandy Silt, Silty Sand and Silty Gravelly Sand	M&I; PAHs; PHCs; VOCs
BH8 SS1+SS2	0.3 – 1.2	Fill: Clayey silt, Silty Sand	M&I; PAHs; PHCs; VOCs

Note: M&I = Metals and Inorganics
PAHs = Polycyclic aromatic hydrocarbons
PHCs = Petroleum Hydrocarbons Fractions F1 to F4
VOCs = Volatile Organic Compounds

7.2 Soil Analysis Results

Selected soil samples were analysed for the parameters of M&I, PAHs, VOCs and PHCs, under Ontario Regulation 153/04 ("O. Reg. 153/04") as amended. A copy of the soil analytical results is provided in the Laboratory Certificates of Analyse, attached to Appendix A.

The soil analytical results were compared with the Ministry of the Environment, Conservation and Parks ("MECP") "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act", April 2011, Table 1: Full Depth Background Site Condition Standards for Residential/Parkland/Institutional/Industrial/Commercial/Community Property Uses (2011 MECP Table 1 Standards); Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition (2011 MECP Table 2 Standards), and Table 3: Full Depth Generic Site Condition Standards in a non-potable Ground Water Condition (2011 MECP Table 3 Standards).

Based on the comparison, exceedances of MECP Table 1, Table 2 and Table 3 standards were noted in the tested soil samples. The exceedance values detected in the soil samples are summarized in the following table.

Soil Sample ID	Parameter	Detected Value / Unit	MECP Table 1 Standards Guideline Value	MECP Table 2 and 3 Standards (R/P/I) Guideline Value	MECP Table 2 and 3 Standards (I/C/C) Guideline Value
BH2 AS1B+AS2	SAR	19.3	**2.4**	**5**	**12**
	EC	1.40 mS/cm	**0.57** mS/cm	**0.7** mS/cm	1.4 mS/cm
	Cobalt	38 ug/g	**21 ug/g**	**22 ug/g**	80 ug/g
	Chromium Total	122 ug/g	**70 ug/g**	160 ug/g	160 ug/g
	Copper	95 ug/g	**92 ug/g**	140 ug/g	230 ug/g
	Mercury	0.5 ug/g	**0.27 ug/g**	**0.27 ug/g**	3.9 ug/g
BH5 AS1B	SAR	22.7	**2.4**	**5**	**12**
	EC	1.3 mS/cm	**0.57** mS/cm	**0.7** mS/cm	1.4 mS/cm
	Copper	171 ug/g	**92 ug/g**	**140** ug/g	230 ug/g
	Lead	214 ug/g	**120 ug/g**	**120 ug/g**	**120 ug/g**
	Antimony	18 ug/g	**1.3 ug/g**	**7.5 ug/g**	40 ug/g
BH7 AS1B+SS2	SAR	3.06	**2.4**	5	12
	EC	0.74 mS/cm	**0.57** mS/cm	**0.7** mS/cm	1.4 mS/cm
	Petroleum Hydrocarbons F2	40 ug/g	**10 ug/g**	98 ug/g	230 ug/g
	Petroleum Hydrocarbons F4	270 ug/g	**120 ug/g**	2800 ug/g	3300 ug/g

Soil Sample ID	Parameter	Detected Value / Unit	MECP Table 1 Standards Guideline Value	MECP Table 2 and 3 Standards (R/P/I) Guideline Value	MECP Table 2 and 3 Standards (I/C/C) Guideline Value
	Petroleum Hydrocarbons F4g	900 ug/g	**120 ug/g**	2800 ug/g	3300 ug/g
	Chromium Total	98 ug/g	**70 ug/g**	160 ug/g	160 ug/g
	Molybdenum	6 ug/g	**2 ug/g**	6.9 ug/g	40 ug/g
	Antimony	2 ug/g	**1.3 ug/g**	7.5 ug/g	40 ug/g
BH8 SS1+SS2	Petroleum Hydrocarbons F4g	200 ug/g	**120 ug/g**	2800 ug/g	3300 ug/g
	Lead	522 ug/g	**120 ug/g**	**120 ug/g**	**120 ug/g**
	Antimony	5 ug/g	**1.3 ug/g**	7.5 ug/g	40 ug/g
	Xylene Mixture	0.33 ug/g	**0.05 ug/g**	3.1 ug/g	26 ug/g

Note: R/P/I = Residential, Parkland and Institutional Property Use
I/C/C = Industrial, Commercial and Community Property Use
0.57 = standard value exceeded by the analytical result

7.3 Discussion of Analytical Results

Based on the analytical results, exceedances of MECP Table 1, Table 2 and Table 3 Standards were noted in the tested soil samples. It should be noted that the samples with exceedances of EC and SAR values were taken from the borehole located on the roadway. The elevated EC and SAR values in the tested soil samples may likely be attributed to the application of de-icing salt on the road. The potential source of the other elevated parameters is unknown.

Based on the results of soil sample analysis, GeoPro would recommend the following disposal options:

1) The soils generated at the same tested sample depth from Borehole BH2 may be disposed at facilities, which are suitable to accept salt-impacted excess soil (i.e., certain former aggregate sites, mines, etc.) or at a licensed landfill site. However, additional chemical testing may be required by these facilities.
2) The soils generated at the same tested sample depth from Borehole BH7 can be re-used at a receiving site which is not considered as an environmental sensitive site and not a residential/parkland/institution property, provided that the soils will not be in contact with groundwater and would accept soil as per the test results. Additional chemical testing may be required by these sites.

3) The soils generated at the Site at the same tested sample depths from Boreholes BH5 and BH8 may be disposed at a licensed landfill site; however, additional chemical testing under O. Reg. 347/558 may be required by the landfill site; and

It should be noted that the analytical results of the chemical test refer only to the soil samples tested, which were obtained from specific sampling locations and sampling depths, and that the soil chemistry may vary between and beyond the location and depth of the samples taken. Therefore, soil materials to be used on site or transported to other sites must be inspected during excavation for indication of variance in composition or any chemical/environmental constraints. If conditions indicate significant variations, further chemical testing should be carried out.

Please note that the level of testing outlined herein is meant to provide a broad indication of soil quality based on the limited soil samples tested. The analytical results contained in this report should not be considered a warranty with respect to the soil quality or the use of the soil for any specific purpose. Furthermore, it must be noted that our scope of work was only limited to the review of the analytical results of the limited number of samples. The scope of work did not include any environmental evaluation or assessment of the subject site (such as a Phase One or Phase Two Environmental Site Assessment).

Sites accepting fill may have requirements relating to its aesthetic or engineering properties in addition to its chemical quality. Some receiving sites may have specific chemical testing protocols, which may require additional tests to meet the requirements. The requirements for accepting the fill at an off-site location must be confirmed in advance. GeoPro would be pleased to assist once the receiving sites are determined and the requirements of the receiving sites are available.

8 CORROSIVITY POTENTIAL

Selected soil samples were submitted to a laboratory which is a member of Canadian Association for Laboratory Accreditation (“CALA”) for corrosivity potential analysis. The sulphate (SO_4) resistance requirements for concrete in contact with the site soils were evaluated by performing water-soluble sulphate test on selected samples taken from Boreholes BH7 SS12 and BH8 SS6 with depth shown in the following table. The analytical data are attached to Appendix B.

The test revealed that the sulphate concentrations in tested soil samples ranged from 68 mg/kg to 912 mg/kg (0.0068% to 0.0912%). The category of severity of attack is “negligible” based on CSA Standard A23.1, Concrete Materials and Methods of Concrete Construction. The final selection of the type of concrete should be made by the Engineer taking into account all aspects of design considerations.

The corrosivity of soils towards ferrous metal was evaluated by performing corrosivity tests on same soil samples. The corrosivity of soils was evaluated using the 10 points method which is based on five soil properties: sulphides, resistivity, pH, Redox potential and moisture content. The following table summarizes the ANSI/AWWA rating for the tested soil sample for the potential for

corrosion towards buried grey or ductile cast iron pipe. A score of ten (10) points or more indicates potential for corrosion.

BH No. Sample No.	Parameter (Score)							
	Depth (m)	Soil Type	PH	Resistivity (ohm.cm)	Sulfide (mg/kg)	Redox potential (mV)	Moisture Content (%)	Total Points
BH7 SS12	18.3 – 18.7	Silty Gravelly Sand	7.92 (0)	712 (10)	<0.20 (2)	255 (0)	12.0% (2)	14
BH8 SS6	4.5 – 5.0	Clayey Silt to Silty Clay	7.86 (0)	4810 (0)	<0.20 (2)	234 (0)	19% (2)	4

According to the ANSI/AWWA rating system, the tested sample BH8 SS6 indicate low to moderate potential for corrosion of grey ductile iron pipe. However, the tested sample BH7 SS12 indicated that soils are corrosive to ductile iron pipes, the anti-corrosion protection is needed. Further provision of recommendations for corrosion protection is outside of the scope of GeoPro's terms of reference.

Note that there may be other overriding factors in the assessment of corrosion potential, such as the application of de-icing salts on the roadway and subsequent leaching into the subsoils, stray currents, etc.

9 MONITORING AND TESTING

The geotechnical aspects of the final design drawings and specifications should be reviewed by GeoPro prior to tendering and construction, to confirm that the intent of this report has been met. During construction, full-time engineered fill monitoring and sufficient foundation inspections, subgrade inspections, in-situ density tests and materials testing should be carried out to confirm that the conditions exposed are consistent with those encountered in the boreholes, and to monitor conformance to the pertinent project specifications.

10 CLOSURE

We trust that this interim report provides sufficient geotechnical engineering information to meet the requirements of the terms of reference. We will update the report once the other boreholes are complete. If you have any questions regarding the contents of this report or require additional information, please do not hesitate to contact this office.

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DRAWINGS

Legend:

- Borehole Location
- Corehole Location
- Monitoring Well Location
- Borehole To be Drilled
- Monitoring Well To be Drilled

Client:	Associated Engineering (Ont.) Ltd.	Project No.: 19-2795G01	Drawing No.: 1
Drawn: SY	Approved: DL	Title:	Borehole Location/Monitoring Location Plan
Date: August 2020	Scale: N.T.S.	Project:	Getechnical Investigation Replacement of Niagara Street Bridge Niagara St over Welland River, Niagara Region, Ontario
Original Size: Letter	Rev: SY		GeoPro Consulting Limited

ENCLOSURES

Enclosure 1A: Notes on Sample Descriptions

1. Each soil stratum is described according to the *Modified Unified Soil Classification System*. The compactness condition of cohesionless soils (SPT) and the consistency of cohesive soils (undrained shear strength) are defined according to Canadian Foundation Engineering Manual, 4th Edition. Different soil classification systems may be used by others. Please note that a description of the soil stratums is based on visual and tactile examination of the samples augmented with field and laboratory test results, such as a grain size analysis and/or Atterberg Limits testing. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional preliminary geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (75 to 300 mm) or boulders (over 300 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Enclosure 1B: Explanation of Terms Used in the Record of Boreholes

Sample Type

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO	Drive open
DS	Dimension type sample
FS	Foil sample
NR	No recovery
RC	Rock core
SC	Soil core
SS	Spoon sample
SH	Shelby tube Sample
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

Penetration Resistance

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) required to drive a 50 mm (2 in) drive open sampler for a distance of 300 mm (12 in).

PM – Samples advanced by manual pressure
WR – Samples advanced by weight of sampler and rod
WH – Samples advanced by static weight of hammer

Dynamic Cone Penetration Resistance, N_d:

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

Piezo-Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60 degree conical tip and a projected end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurement of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

Textural Classification of Soils (ASTM D2487)

Classification	Particle Size
Boulders	> 300 mm
Cobbles	75 mm - 300 mm
Gravel	4.75 mm - 75 mm
Sand	0.075 mm – 4.75 mm
Silt	0.002 mm-0.075 mm
Clay	<0.002 mm(*)

(*) Canadian Foundation Engineering Manual (4th Edition)

Coarse Grain Soil Description (50% greater than 0.075 mm)

Terminology	Proportion
Trace	0-10%
Some	10-20%
Adjective (e.g. silty or sandy)	20-35%
And (e.g. sand and gravel)	> 35%

Soil Description

a) Cohesive Soils (*)

Consistency	Undrained Shear Strength (kPa)	SPT "N" Value
Very soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very stiff	100-200	15-30
Hard	>200	>30

(*) Hierarchy of Shear Strength prediction

1. Lab triaxial test
2. Field vane shear test
3. Lab. vane shear test
4. SPT "N" value
5. Pocket penetrometer

b) Cohesionless Soils (*)

Compactness Condition (Formerly Relative Density)	SPT "N" Value
Very loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	>50

Soil Tests

w	Water content
w_p	Plastic limit
w_l	Liquid limit
C	Consolidation (oedometer) test
CID	Consolidated isotropically drained triaxial test
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement
D_R	Relative density (specific gravity, Gs)
DS	Direct shear test
ENV	Environmental/ chemical analysis
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
U	Unconsolidated Undrained Triaxial Test
V	Field vane (LV-laboratory vane test)
γ	Unit weight

LOG OF BOREHOLE BH1

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge

CLIENT: Associated Engineering Limited

PROJECT LOCATION: Over Welland River, Wellland, Niagara Region, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: DYL

SAMPLE REVIEW: CK

CHECKED: DX

DIAMETER: 155 mm

DATE: 2020-07-03

REF. NO.: 19-2795GH

ENCL. NO.: 2

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	"N" BLOWS/0.3m	GROUND WATER ELEVATION	DYNAMIC PENETRATION TEST: ○ SPT, ≳ Cone, blows/0.3m; SHEAR STRENGTH (kPa): ● Unconfined, ▲ Quick Triaxial, ✕ Field Vane & Sensitivity, ⊠ Penetrometer, + Lab Vane	Plastic Limit w_P / Natural Moisture Content w / Liquid Limit w_L; WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT:** (115 mm)									
0.1	**PORTLAND CEMENT CONCRETE:** (140 mm)									
0.3	**FILL:** clayey silt, trace sand, layers of silt, reddish brown, wet		1A	AS						
0.3	**CLAYEY SILT:** trace sand, reddish brown, moist to wet		1B	AS				○ at 20		
0.6	**END OF BOREHOLE**									

Note:

1) Borehole was open and dry upon completion of drilling.

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε_f=3% Strain at Failure

LOG OF BOREHOLE BH2

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge

CLIENT: Associated Engineering Limited

PROJECT LOCATION: Over Welland River, Wellland, Niagara Region, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: FX

SAMPLE REVIEW: CK

CHECKED: DX

DIAMETER: 155 mm

DATE: 2020-07-15

REF. NO.: 19-2795GH

ENCL. NO.: 3

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	"N" BLOWS/0.3m	GROUND WATER ELEVATION	DYNAMIC PENETRATION TEST (SPT / Cone, blows/0.3m) / SHEAR STRENGTH (kPa) (Unconfined, Quick Triaxial, Field Vane & Sensitivity, Penetrometer, Lab Vane)	WATER CONTENT (%) (Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L)	UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT:** (160 mm)									
0.2	**GRANULAR BASE/SUBBASE:** (460 mm) (likely cement treated, containing rock fragments/pieces and wire mesh)		1A	AS						22 62 16
0.6	**FILL:** sandy silt, some clay, organic inclusions, layers of organic silt, containing charcoal fragments, dark brown, moist to wet		1B	AS						
1			2	AS						
1.2	**FILL:** clayey silt, trace to some sand, organic inclusions, seams of sand, containing wood fragments/pieces, hydrocarbon like odour, brown, moist, soft to firm		3	SS	4					
2										
2.1	**CLAYEY SILT:** trace sand, trace gravel, pockets/seams/layers of sand, seams/layers of silt, reddish brown, moist to wet, stiff to very stiff		4	SS	16					
3			5	SS	14					
4	--- auger grinding									
5	--- seams/layers of wet silt		6	SS	10					
5.0	**END OF BOREHOLE**									

Note:

1) Water encountered at a depth of 4.6 m below ground surface (mBGS) during drilling.
2) Borehole caved at a depth of 4.3 m below ground surface (mBGS) upon completion of drilling.

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH5

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge

CLIENT: Associated Engineering Limited

PROJECT LOCATION: Over Welland River, Wellland, Niagara Region, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: FX

SAMPLE REVIEW: CK

CHECKED: DX

DIAMETER: 155 mm

DATE: 2020-07-15

REF. NO.: 19-2795GH

ENCL. NO.: 4

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**ASPHALT:** (190 mm)			
0.2	**GRANULAR BASE/SUBBASE:** (310 mm) (likely cement treated)	1A	AS	
0.5	**FILL:** clayey silt, sandy, trace gravel, containing red brick fragments, brown, moist to wet	1B	AS	
0.8	**CLAYEY SILT:** trace sand, trace gravel, seams/layers of silt, pockets of sand, reddish brown, moist, firm to very stiff	2	SS	7
		3	SS	16
		4	SS	13
		5	SS	14
		6	SS	13
5.0	**END OF BOREHOLE**			

Notes:

1) Borehole caved at a depth of 4.9 m below ground surface (mBGS) upon completion of drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading

Date	W. L. Depth (mBGS)
Aug.19, 2020	2.12

Concrete

Bentonite

2.1mBGS Aug 19

Sand

Screen

Natural pack

DYNAMIC PENETRATION TEST
○ SPT ≳ Cone blows/0.3m
20 40 60 80

SHEAR STRENGTH (kPa)
● Unconfined ✕ Field Vane & Sensitivity
▲ Quick Triaxial ⊠ Penetrometer + Lab Vane
20 40 60 80

Plastic Limit w_P | Natural Moisture Content w | Liquid Limit w_L

WATER CONTENT (%)
10 20 30 40

17.7 33.8

UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH7

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge

CLIENT: Associated Engineering Limited

PROJECT LOCATION: Over Welland River, Wellland, Niagara Region, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: DYL

SAMPLE REVIEW: CK

CHECKED: DX

DIAMETER: 205 mm

DATE: 2020-07-14

REF. NO.: 19-2795GH

ENCL. NO.: 5

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER ELEVATION	DYNAMIC PENETRATION TEST (SPT / Cone, blows/0.3m) & SHEAR STRENGTH (kPa)	WATER CONTENT (%) (Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT:** (100 mm)									
0.1	**GRANULAR BASE/SUBBASE:** (500 mm) (likely cement treated, containing tile fragments)		1A	AS						
0.6	**FILL:** silty gravelly sand, layers of sandy silt, containing rock fragments, brown, moist		1B	AS						
0.7			2A	SS	12					
1.1	**FILL:** silty sand, trace gravel, organic inclusions, layers of sandy silt, dark brown, moist, compact		2B	SS						
1.4	**FILL:** sandy silt, trace clay, layers of silty sand, layers/zones of clayey silt, containing slag fragments, brown, moist, compact		3	SS	10					
2.1	**FILL:** clayey silt, some sand, trace gravel, layers of silty sand, layers of organic silt, containing slag fragments, brown, moist, stiff		4	SS	9					
2.9	**FILL:** sandy silt, some clay, trace gravel, layers of silty sand, layers/zones of clayey silt, containing slag fragments, brown, moist, loose		5	SS	7					
	FILL: clayey silt, trace to some sand, layers of sand and silt, layers of silty sand, brown, moist, firm									
4.0	**NO SAMPLE RECOVERY**		6	NR	4					
5.1	**ORGANIC SILT:** some clay, trace sand, containing peat fragments, containing cobbles and boulders, dark brown, moist to wet, very loose to loose		7	SS	WH					
			8A	SS	5					
6.5	--- auger grinding		8B	SS						0 1 56 43
	CLAYEY SILT TO SILTY CLAY: trace sand, organic inclusion, seams/layers of silt, containing cobbles and boulders, grey, moist, firm									
	--- auger grinding from 7.6 m to 9.1 m									
7.9	**CLAYEY SILT TO SILTY CLAY:** trace sand, seams/layers of silt, reddish brown, wet, very soft to firm		9	SS	4					

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^{3}$, $\times^{3}$: Numbers refer to Sensitivity; ▲ ε_f=3% Strain at Failure

LOG OF BOREHOLE BH7

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge

CLIENT: Associated Engineering Limited

PROJECT LOCATION: Over Welland River, Wellland, Niagara Region, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: DYL

SAMPLE REVIEW: CK

CHECKED: DX

DIAMETER: 205 mm

DATE: 2020-07-14

REF. NO.: 19-2795GH

ENCL. NO.: 5

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" BLOWS/0.3m	GROUND WATER ELEVATION	DYNAMIC PENETRATION TEST (O SPT, ≈ Cone, blows/0.3m) / SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane)	Plastic Limit w_P / Natural Moisture Content w / Liquid Limit w_L — WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT TO SILTY CLAY: trace sand, seams/layers of silt, reddish brown, wet, very soft to firm(Continued)									
			10	SS	1					
13.9	**FINE SAND AND SILT TO SILTY FINE SAND:** reddish brown, wet, loose									
			11	SS	6					
17.0	**SILTY GRAVELLY SAND:** containing cobbles and boulders, brown, wet, very dense									
			12	SS	85					
	--- auger grinding from 18.9 m to 20.7 m									

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ε=3% Strain at Failure

LOG OF BOREHOLE BH7

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge
CLIENT: Associated Engineering Limited
PROJECT LOCATION: Over Welland River, Wellland, Niagara Region, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: DYL
SAMPLE REVIEW: CK
CHECKED: DX
DIAMETER: 205 mm
DATE: 2020-07-14
REF. NO.: 19-2795GH
ENCL. NO.: 5

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" BLOWS/0.3m	GROUND WATER ELEVATION	DYNAMIC PENETRATION TEST (SPT / Cone, blows/0.3m) / SHEAR STRENGTH (kPa)	WATER CONTENT (%) (Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
20.0	**SAND AND GRAVEL:** trace silt, containing cobbles and boulders, brown, wet, very dense									
21	--- auger grinding		13A	SS	50 / 130 mm		> >100			
21.6	**SANDY SILT TILL:** some clay, trace gravel, layers of sandy silt, containing cobbles and boulders, brown, moist, very dense		13B	SS						
22										
23	--- auger grinding									
23.0	**SAND AND SILT TO SILTY SAND:** some gravel, layers of gypsum, containing cobbles and boulders, brown, wet, very dense									
24										
	---auger grinding		14	SS	50 / 50 mm		> >100			
25										
25.2	**SAND/SHALE COMPLEX:** some gravel, containing shale fragments, cobbles and boulders, grey, wet, very dense									
26			15	SS	73 / 200 mm		> >100			
27										
28										
29.0	**PROBABLE LIMESTONE:** grey		16	SS	50 / 30 mm		> >100			
29.0	**END OF BOREHOLE DUE TO AUGER REFUSAL ON PROBABLE LIMESTONE**									
	Note:									

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
▲ ε=3% Strain at Failure

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge

CLIENT: Associated Engineering Limited

PROJECT LOCATION: Over Welland River, Wellland, Niagara Region, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: DYL

SAMPLE REVIEW: CK

CHECKED: DX

DIAMETER: 205 mm

DATE: 2020-07-14

REF. NO.: 19-2795GH

ENCL. NO.: 5

SOIL PROFILE			SAMPLES			GROUND WATER	ELEVATION	DYNAMIC PENETRATION TEST / SHEAR STRENGTH (kPa)	Plastic Limit / Natural Moisture Content / Liquid Limit / WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3m			○ SPT ≳ Cone blows/0.3m; 20 40 60 80; ● Unconfined ✕ Field Vane & Sensitivity ▲ Quick Triaxial ⊠ Penetrometer + Lab Vane; 20 40 60 80	w_P w w_L; 10 20 30 40		GR SA SI CL
	1) Water encountered at a depth of 5.2 m below ground surface (mBGS) during drilling.										

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^{3}$, $\times^{3}$: Numbers refer to Sensitivity; ▲ε=3% Strain at Failure

LOG OF BOREHOLE BH8

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge
CLIENT: Associated Engineering Limited
PROJECT LOCATION: Over Welland River, Wellland, Niagara Region, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: AR
SAMPLE REVIEW: CK
CHECKED: DX
DIAMETER: 205 mm
DATE: 2020-07-17
REF. NO.: 19-2795GH
ENCL. NO.: 6

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	ELEVATION
0.0	**TOPSOIL:** (250 mm)				Concrete
0.3	**FILL:** clayey silt, trace to some sand, trace gravel, organic inclusions, layers/zones of silty sand, containing slag fragments, brown, moist, very stiff	1	SS	22	
0.7	**FILL:** silty sand, some gravel, organic inclusions, rootlet inclusions, layers/zones of clayey silt, containing slag fragments, dark brown to brown, moist, loose	2	SS	5	
1.4	**FILL:** clayey silt, trace sand, brown, moist, very stiff	3	SS	13	
	--- organic inclusions, rootlet inclusions, containing rock pieces, hydrocarbon like odour	4	SS	19	
2.9	**CLAYEY SILT TO SILTY CLAY:** trace sand, trace gravel, layers/pockets of silt, brown, moist to wet, firm to very stiff	5	SS	15	
		6	SS	30	
		7	SS	23	
		8	SS	7	
		9	SS	8	

GROUND WATER: 4.2mBGS Aug 19

DYNAMIC PENETRATION TEST
○ SPT ≳ Cone blows/0.3m
20 40 60 80

SHEAR STRENGTH (kPa)
● Unconfined ✕ Field Vane & Sensitivity
▲ Quick Triaxial ⊠ Penetrometer + Lab Vane
20 40 60 80
1.0
1.8

Plastic Limit w_P — Natural Moisture Content w — Liquid Limit w_L
WATER CONTENT (%)
10 20 30 40

UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
1	5	61	33

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
▲ ε=3% Strain at Failure

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge

CLIENT: Associated Engineering Limited

PROJECT LOCATION: Over Welland River, Wellland, Niagara Region, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: AR

SAMPLE REVIEW: CK

CHECKED: DX

DIAMETER: 205 mm

DATE: 2020-07-17

REF. NO.: 19-2795GH

ENCL. NO.: 6

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
11	**CLAYEY SILT TO SILTY CLAY:** trace sand, trace gravel, layers/pockets of silt, brown, moist to wet, firm to very stiff(Continued)	10	SS	7
12		11	SS	5
13		12	SS	6
14		13	SS	7
15		14	SS	5
16		15	SS	7
17				
18				
19				
20				

DYNAMIC PENETRATION TEST: ○ SPT, ≳ Cone, blows/0.3m; 20 40 60 80

SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane; 20 40 60 80

Plastic Limit w_P — Natural Moisture Content w — Liquid Limit w_L

WATER CONTENT (%): 10 20 30 40

1.1

1.9

19.9 44.1

UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^{3}$, $\times^{3}$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH8

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge
CLIENT: Associated Engineering Limited
PROJECT LOCATION: Over Welland River, Wellland, Niagara Region, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: AR
SAMPLE REVIEW: CK
CHECKED: DX
DIAMETER: 205 mm
DATE: 2020-07-17
REF. NO.: 19-2795GH
ENCL. NO.: 6

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	ELEVATION
21	--- zones of silt **CLAYEY SILT TO SILTY CLAY:** trace sand, trace gravel, layers/pockets of silt, brown, moist to wet, firm to very stiff(Continued)	16	SS	7	
21.6 22	**SAND AND GRAVEL:** some silt, containing cobbles and boulders, brown, saturated, compact --- auger grinding from 22.0 m to 22.4 m				
23		17A	SS		
23.0	**SAND AND SILT TO SILTY SAND:** trace to some clay, some gravel, layers of silty sand, layers of sand and gravel, brown, wet, compact	17B	SS	26	
24					
25		18	SS	22	
25.4 26	**SAND AND SILT TILL:** trace to some clay, trace gravel, layers of sand and gravel, containing cobbles and boulders, brown, moist to wet, dense --- auger grinding	19	SS	42	
27					
27.7	--- auger grinding	20	SS	65 / 30 mm	
27.8	**PROBABLE LIMY SHALE TO SHALY LIMESTONE:** grey **END OF BOREHOLE DUE TO AUGER REFUSAL ON PROBABLE LIMY SHALE TO SHALY LIMESTONE**				

Notes:

1) Water encountered at a depth of 7.6 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Sand
Screen
Natural pack

DYNAMIC PENETRATION TEST
○ SPT ≳ Cone blows/0.3m
20 40 60 80

SHEAR STRENGTH (kPa)
● Unconfined ✕ Field Vane & Sensitivity
▲ Quick Triaxial ⊠ Penetrometer + Lab Vane
20 40 60 80

Plastic Limit w_P | Natural Moisture Content w | Liquid Limit w_L

WATER CONTENT (%)
10 20 30 40

UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
11	40	40	9

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
▲ε=3% Strain at Failure

LOG OF BOREHOLE BH8

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge

CLIENT: Associated Engineering Limited

PROJECT LOCATION: Over Welland River, Wellland, Niagara Region, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: AR

SAMPLE REVIEW: CK

CHECKED: DX

DIAMETER: 205 mm

DATE: 2020-07-17

REF. NO.: 19-2795GH

ENCL. NO.: 6

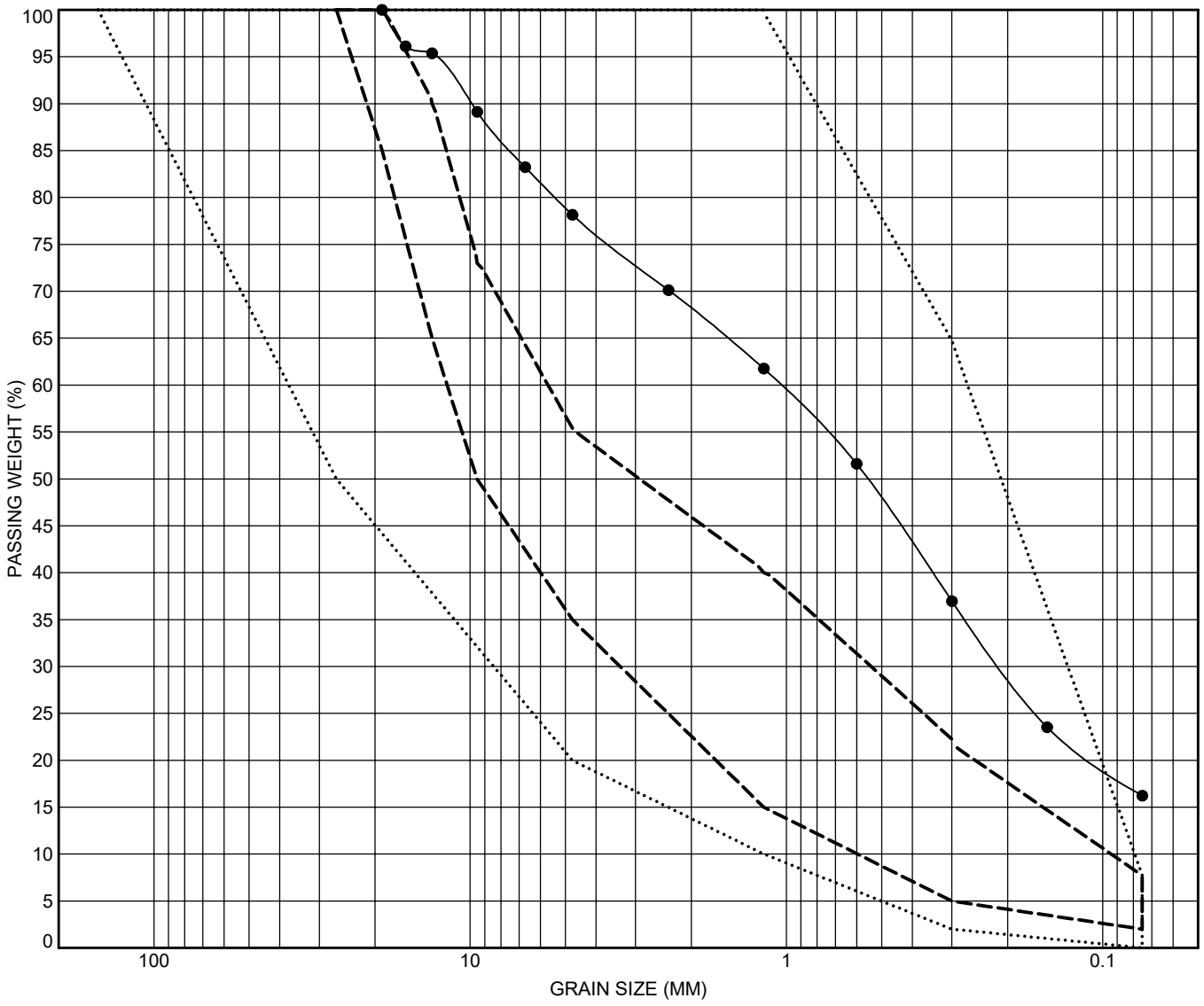
SOIL PROFILE			SAMPLES						DYNAMIC PENETRATION TEST / SHEAR STRENGTH (kPa)			NATURAL MOISTURE CONTENT / WATER CONTENT (%)					
ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	ELEVATION		○ SPT ≳ Cone blows/0.3m; 20 40 60 80			Plastic Limit w_P	Natural Moisture Content w	Liquid Limit w_L	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
									SHEAR STRENGTH (kPa): ● Unconfined ✕ Field Vane & Sensitivity ▲ Quick Triaxial ⊠ Penetrometer + Lab Vane; 20 40 60 80			WATER CONTENT (%): 10 20 30 40				GR SA SI CL	
	Water Level Reading Date W. L. Depth (mBGS) Aug.19, 2020 4.17																

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

FIGURES



COBBLES	GRAVEL		SAND			FINES
	coarse	fine	coarse	medium	fine	

OPSS 1010 GRANULAR A

OPSS 1010 GRANULAR B TYPE I

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Fines
● **BH2 AS1A 0.16**	**19**	**1.05**	**0.21**		**21.9**	**61.9**	**16.2**

GeoPro CONSULTING LIMITED

Unit 57, 40 Vogell Road, Richmond Hill, Ontario L4B 3N6
Tel: 905-237-8336 Fax: 905-248-3699
office@geoproconsulting.ca www.geoproconsulting.ca

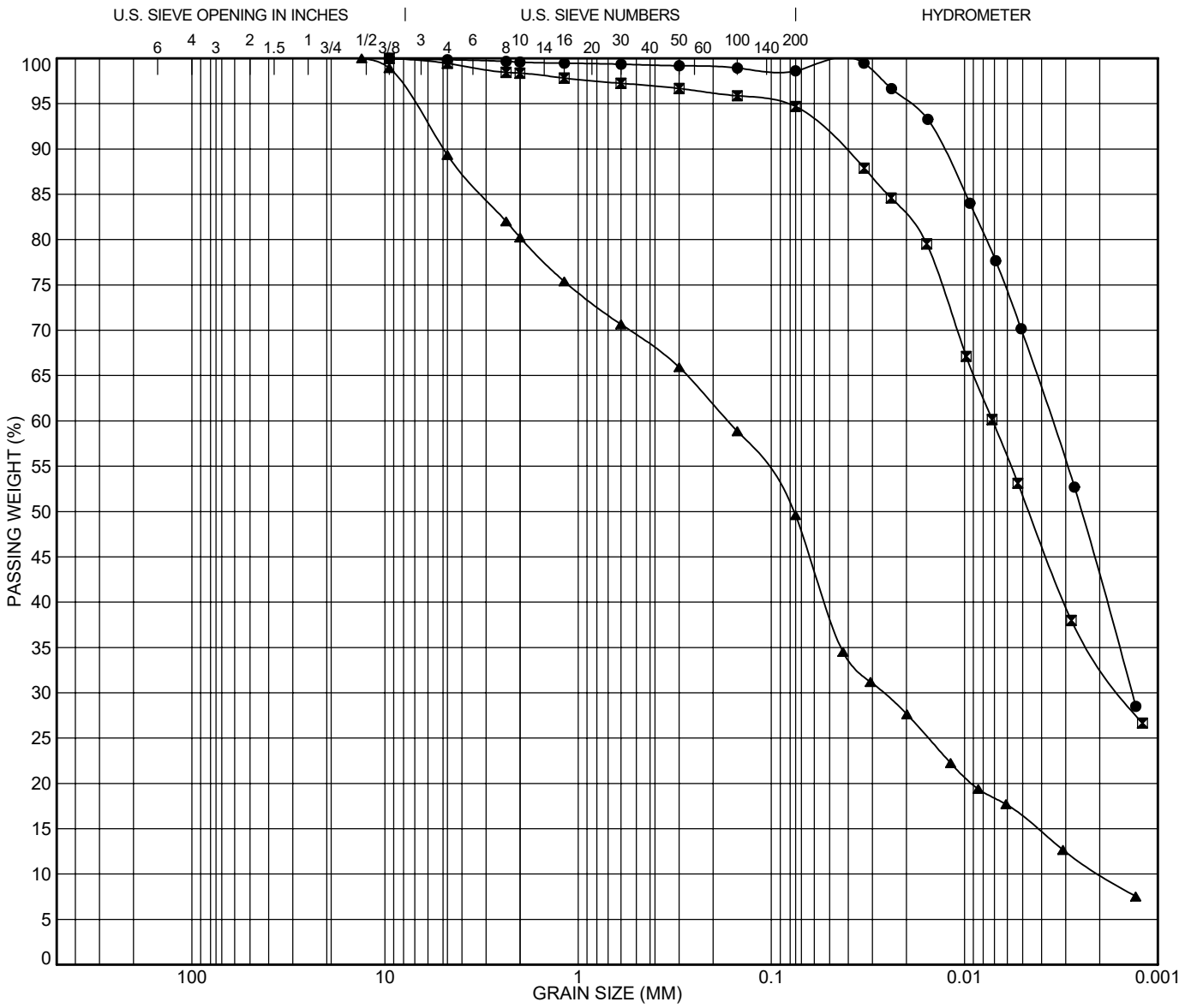
GRAIN SIZE DISTRIBUTION

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge

LOCATION: Over Welland River, Wellland, Niagara Region, Ontario

PROJECT NO.: 19-2795GH | SAMPLED ON: 2020-07-15

FIGURE NO.: 1 | TESTED ON: 2020-08-03



COBBLES	GRAVEL		SAND			SILT	CLAY
	coarse	fine	coarse	medium	fine		

	Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**BH7**	**SS8B**	**6.45**						
⊠	**BH8**	**SS5**	**3.05**						
▲	**BH8**	**SS18**	**24.38**					**2.13**	**84.91**

	Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH7**	**SS8B**	**6.45**	**9.5**	**0.004**	**0.001**		**0.2**	**1.2**	**55.9**	**42.8**
⊠	**BH8**	**SS5**	**3.05**	**9.5**	**0.007**	**0.002**		**0.6**	**4.8**	**61.2**	**33.5**
▲	**BH8**	**SS18**	**24.38**	**13.2**	**0.168**	**0.027**	**0.002**	**10.7**	**39.7**	**39.5**	**10.1**

GeoPro CONSULTING LIMITED
Unit 57, 40 Vogell Road, Richmond Hill, Ontario L4B 3N6
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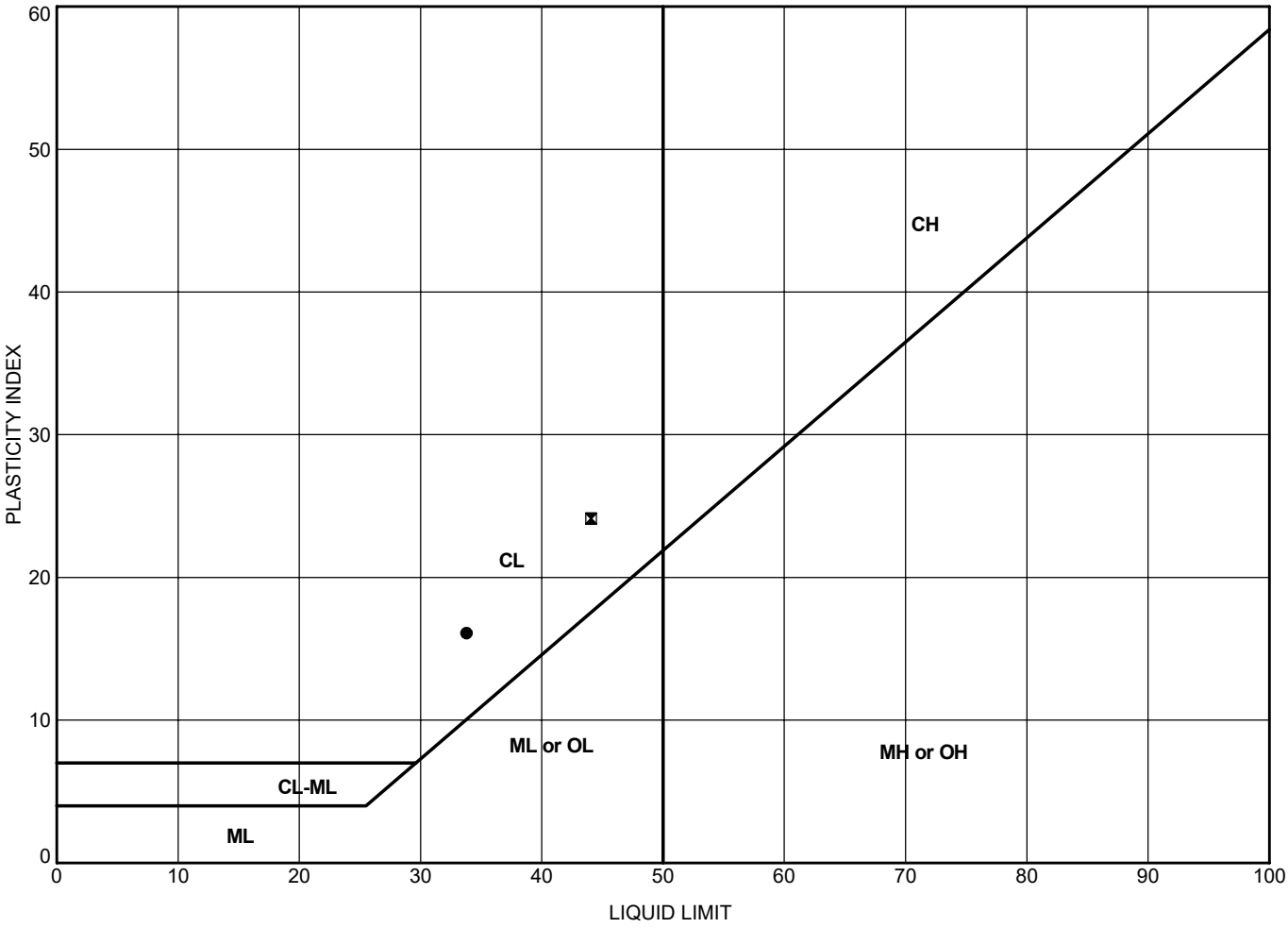
GRAIN SIZE DISTRIBUTION

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge

LOCATION: Over Welland River, Wellland, Niagara Region, Ontario

PROJECT NO.: 19-2795GH | SAMPLED ON: 2020-07-17

FIGURE NO.:2 | TESTED ON: 2020-08-03



	Specimen Identification			LL	PL	PI	Fines	Classification
●	**BH5**	**SS2**	**0.76**	**34**	**18**	**16**		
⊠	**BH8**	**SS14**	**16.76**	**44**	**20**	**24**		

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ATTERBERG LIMITS' RESULTS

PROJECT: Geotechnical Investigation for Replacement of Niagara Street Bridge

LOCATION: Over Welland River, Wellland, Niagara Region, Ontario

PROJECT NO.: 19-2795GH	SAMPLED ON: 2020-07-17
FIGURE NO.: 3	TESTED ON: 2020-08-03

APPENDIX A

Certificate of Analysis

Environment Testing

Client: Geo Pro Consulting
40 Vogell Rd, Unit 57
Richmond Hill, Ontario
L4B 3K6
Attention: Ms. Dylan X
Invoice to: Geo Pro Consulting
PO#:

Report Number: 1935256
Date Submitted: 2020-07-24
Date Reported: 2020-08-04
Project: 19-2795G01-0499
COC #: 859039
Temperature (C): 11
Custody Seal:

Dear Dylan X:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Sample Comment Summary

Sample ID: 1506470 BH2 AS1B+AS2 CN (free) MRL elevated due to matrix interference (dilution was done).
Sample ID: 1506471 BH5 AS1B CN (free) MRL elevated due to matrix interference (dilution was done).The result for F4 (C34-C50) gravimetric must be substituted if it is greater than the result for F4 (C34-C50).
Sample ID: 1506472 BH8 SS1+SS2 CN (free) MRL elevated due to matrix interference (dilution was done).The Ion Balance is outside Eurofins acceptable tolerance levels. All results have been confirmed.
Sample ID: 1506473 BH7 AS1B+SS2 CN (free) MRL elevated due to matrix interference (dilution was done).The result for F4 (C34-C50) gravimetric must be substituted if it is greater than the result for F4 (C34-C50).

Report Comments:

Long Qu, Organics Supervisor

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise stated
.
Eurofins Environment Testing Canada Inc. is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accrteditation. The scope is available at http://www.cala.ca/scopes/2602.pdf

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline or regulatory limits listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official guideline or regulation as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Certificate of Analysis

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40 Vogell Rd, Unit 57
Richmond Hill, Ontario
L4B 3K6
Attention: Ms. Dylan X
PO#:
Invoice to: Geo Pro Consulting

Report Number: 1935256
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Date Reported: 2020-08-04
Project: 19-2795G01-0499
COC #: 859039

O.Reg 153-T1-All Other Soils

Exceedence Summary

Sample I.D.	Analyte	Result	Units	Criteria
Hydrocarbons				
BH7 AS1B+SS2	Petroleum Hydrocarbons F2	40	ug/g	STD 10
BH7 AS1B+SS2	Petroleum Hydrocarbons F4	270	ug/g	STD 120
BH7 AS1B+SS2	Petroleum Hydrocarbons F4g	900	ug/g	STD 120
BH8 SS1+SS2	Petroleum Hydrocarbons F4g	200	ug/g	STD 120
Inorganics				
BH2 AS1B+AS2	Electrical Conductivity	1.40	mS/cm	STD 0.57
BH2 AS1B+AS2	Sodium Adsorption Ratio	19.3		STD 2.4
BH5 AS1B	Electrical Conductivity	1.30	mS/cm	STD 0.57
BH5 AS1B	Sodium Adsorption Ratio	22.7		STD 2.4
BH7 AS1B+SS2	Electrical Conductivity	0.74	mS/cm	STD 0.57
BH7 AS1B+SS2	Sodium Adsorption Ratio	3.06		STD 2.4
Metals				
BH2 AS1B+AS2	Cobalt	38	ug/g	STD 21
BH2 AS1B+AS2	Chromium Total	122	ug/g	STD 70
BH2 AS1B+AS2	Copper	95	ug/g	STD 92
BH2 AS1B+AS2	Mercury	0.5	ug/g	STD 0.27
BH5 AS1B	Copper	171	ug/g	STD 92
BH5 AS1B	Lead	214	ug/g	STD 120
BH5 AS1B	Antimony	18	ug/g	STD 1.3
BH7 AS1B+SS2	Chromium Total	98	ug/g	STD 70
BH7 AS1B+SS2	Molybdenum	6	ug/g	STD 2
BH7 AS1B+SS2	Antimony	2	ug/g	STD 1.3
BH8 SS1+SS2	Lead	522	ug/g	STD 120
BH8 SS1+SS2	Antimony	5	ug/g	STD 1.3
Volatiles				
BH8 SS1+SS2	Xylene Mixture	0.33	ug/g	STD 0.05

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Hydrocarbons

Analyte	Batch No	MRL	Units	Guideline	1506470 Soil153 2020-07-15 BH2 AS1B+AS2	1506471 Soil153 2020-07-15 BH5 AS1B	1506472 Soil153 2020-07-16 BH8 SS1+SS2	1506473 Soil153 2020-07-14 BH7 AS1B+SS2
Lab I.D. / Sample Matrix / Sample Type / Sample Date / Sampling Time / Sample I.D.								
PHC's F1	387045	10	ug/g	STD 25	<10	<10	<10	<10
PHC's F1-BTEX	387045	10	ug/g		<10	<10	<10	<10
PHC's F2	386965	10	ug/g	STD 10	10	10	10	40*
PHC's F3	386965	20	ug/g	STD 240	20	40	50	210
PHC's F4	386965	20	ug/g	STD 120	<20	30	30	270*
PHC's F4g	387031	100	ug/g	STD 120		<100	200*	900*

Metals

Analyte	Batch No	MRL	Units	Guideline	1506470 Soil153 2020-07-15 BH2 AS1B+AS2	1506471 Soil153 2020-07-15 BH5 AS1B	1506472 Soil153 2020-07-16 BH8 SS1+SS2	1506473 Soil153 2020-07-14 BH7 AS1B+SS2
Lab I.D. / Sample Matrix / Sample Type / Sample Date / Sampling Time / Sample I.D.								
Antimony	386874	1	ug/g	STD 1.3	<1	18*	5*	2*
Arsenic	386874	1	ug/g	STD 18	3	11	11	9
Barium	386874	1	ug/g	STD 220	50	167	178	92
Beryllium	386874	1	ug/g	STD 2.5	<1	<1	<1	<1
Boron (Hot Water Soluble)	386885	0.5	ug/g		<0.5	<0.5	<0.5	<0.5
Boron (total)	386874	5	ug/g	STD 36	8	13	14	8
Cadmium	386874	0.4	ug/g	STD 1.2	<0.4	<0.4	<0.4	<0.4
Chromium Total	386874	1	ug/g	STD 70	122*	41	51	98*
Chromium VI	386899	0.20	ug/g	STD 0.66	<0.20	<0.20	<0.20	<0.20
Cobalt	386874	1	ug/g	STD 21	38*	19	13	8
Copper	386874	1	ug/g	STD 92	95*	171*	72	43
Lead	386874	1	ug/g	STD 120	12	214*	522*	58
Mercury	386874	0.1	ug/g	STD 0.27	0.5*	0.2	0.2	0.1

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Metals

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Lab I.D. / Sample Matrix / Sample Type / Sample Date / Sampling Time / Sample I.D.								
Molybdenum	386874	1	ug/g	STD 2	1	1	2	6*
Nickel	386874	1	ug/g	STD 82	68	36	44	69
Selenium	386874	1	ug/g	STD 1.5	<1	1	<1	<1
Silver	386874	0.2	ug/g	STD 0.5	<0.2	<0.2	<0.2	<0.2
Thallium	386874	1	ug/g	STD 1	<1	<1	<1	<1
Uranium	386874	0.5	ug/g	STD 2.5	0.6	0.8	0.8	<0.5
Vanadium	386874	2	ug/g	STD 86	16	45	40	22
Zinc	386874	2	ug/g	STD 290	82	137	132	104

PAH

Analyte	Batch No	MRL	Units	Guideline	1506470 Soil153 2020-07-15 BH2 AS1B+AS2	1506471 Soil153 2020-07-15 BH5 AS1B	1506472 Soil153 2020-07-16 BH8 SS1+SS2	1506473 Soil153 2020-07-14 BH7 AS1B+SS2
Lab I.D. / Sample Matrix / Sample Type / Sample Date / Sampling Time / Sample I.D.								
1+2-methylnaphthalene	208523	0.05	ug/g		<0.05	<0.05	<0.05	<0.05
Acenaphthene	386938	0.05	ug/g	STD 0.072	<0.05	<0.05	<0.05	<0.05
Acenaphthylene	386938	0.05	ug/g	STD 0.093	<0.05	<0.05	<0.05	<0.05
Anthracene	386938	0.05	ug/g	STD 0.16	<0.05	<0.05	0.13	<0.05
Benz[a]anthracene	386938	0.05	ug/g	STD 0.36	<0.05	0.12	0.14	<0.05
Benzo[a]pyrene	386938	0.05	ug/g	STD 0.3	<0.05	0.10	0.16	<0.05
Benzo[b]fluoranthene	386938	0.05	ug/g	STD 0.47	<0.05	0.06	0.35	<0.05
Benzo[ghi]perylene	386938	0.05	ug/g	STD 0.68	<0.05	0.07	0.11	<0.05
Benzo[k]fluoranthene	386938	0.05	ug/g	STD 0.48	<0.05	0.08	0.26	<0.05
Chrysene	386938	0.05	ug/g	STD 2.8	<0.05	0.09	0.14	<0.05
Dibenz[a h]anthracene	386938	0.05	ug/g	STD 0.1	<0.05	<0.05	<0.05	<0.05

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				Lab I.D. / Sample Matrix / Sample Type / Sample Date / Sampling Time / Sample I.D.				
Fluoranthene	386938	0.05	ug/g	STD 0.56	<0.05	0.21	0.23	<0.05
Fluorene	386938	0.05	ug/g	STD 0.12	<0.05	<0.05	<0.05	<0.05
Indeno[1 2 3-cd]pyrene	386938	0.05	ug/g	STD 0.23	<0.05	0.06	0.11	<0.05
Methlynaphthalene, 1-	386938	0.05	ug/g	STD 0.59	<0.05	<0.05	<0.05	<0.05
Methlynaphthalene, 2-	386938	0.05	ug/g	STD 0.59	<0.05	<0.05	0.05	<0.05
Naphthalene	386938	0.05	ug/g	STD 0.09	<0.05	<0.05	0.06	<0.05
Phenanthrene	386938	0.05	ug/g	STD 0.69	<0.05	0.18	0.12	<0.05
Pyrene	386938	0.05	ug/g	STD 1	<0.05	0.19	0.20	<0.05

Volatiles

Analyte	Batch No	MRL	Units	Guideline	1506470 Soil153 2020-07-15 BH2 AS1B+AS2	1506471 Soil153 2020-07-15 BH5 AS1B	1506472 Soil153 2020-07-16 BH8 SS1+SS2	1506473 Soil153 2020-07-14 BH7 AS1B+SS2
				Lab I.D. / Sample Matrix / Sample Type / Sample Date / Sampling Time / Sample I.D.				
Acetone	387047	0.50	ug/g	STD 0.5	<0.50	<0.50	<0.50	<0.50
Benzene	387041	0.02	ug/g	STD 0.02	<0.02	<0.02	<0.02	
	387044	0.02	ug/g	STD 0.02				<0.02
Bromodichloromethane	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Bromoform	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Bromomethane	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Carbon Tetrachloride	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05

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Volatiles

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Lab I.D.								
Sample Matrix								
Sample Type								
Sample Date								
Sampling Time								
Sample I.D.								
Chlorobenzene	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Chloroform	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Dibromochloromethane	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Dichlorobenzene, 1,2-	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Dichlorobenzene, 1,3-	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Dichlorobenzene, 1,4-	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Dichlorodifluoromethane	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Dichloroethane, 1,1-	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Dichloroethane, 1,2-	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Dichloroethylene, 1,1-	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Dichloroethylene, 1,2-cis-	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Dichloroethylene, 1,2-trans-	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05

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Dichloropropane, 1,2-	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Dichloropropene,1,3-	387047	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	<0.05
Dichloropropene,1,3-cis-	387041	0.05	ug/g		<0.05	<0.05	<0.05	
	387044	0.05	ug/g					<0.05
Dichloropropene,1,3-trans-	387041	0.05	ug/g		<0.05	<0.05	<0.05	
	387044	0.05	ug/g					<0.05
Ethylbenzene	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Ethylene dibromide	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Hexane (n)	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Methyl Ethyl Ketone	387047	0.50	ug/g	STD 0.5	<0.50	<0.50	<0.50	<0.50
Methyl Isobutyl Ketone	387047	0.50	ug/g	STD 0.5	<0.50	<0.50	<0.50	<0.50
Methyl tert-Butyl Ether (MTBE)	387047	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	<0.05
Methylene Chloride	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Styrene	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Tetrachloroethane, 1,1,1,2-	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Tetrachloroethane, 1,1,2,2-	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05

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Volatiles

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Tetrachloroethylene	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Toluene	387041	0.20	ug/g	STD 0.2	<0.20	<0.20	<0.20	
	387044	0.20	ug/g	STD 0.2				<0.20
Trichloroethane, 1,1,1-	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Trichloroethane, 1,1,2-	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Trichloroethylene	387041	0.05	ug/g	STD 0.05	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.05				<0.05
Trichlorofluoromethane	387041	0.05	ug/g	STD 0.25	<0.05	<0.05	<0.05	
	387044	0.05	ug/g	STD 0.25				<0.05
Vinyl Chloride	387041	0.02	ug/g	STD 0.02	<0.02	<0.02	<0.02	
	387044	0.02	ug/g	STD 0.02				<0.02
Xylene Mixture	387042	0.05	ug/g	STD 0.05	<0.05	<0.05	0.33*	
	387044	0.05	ug/g	STD 0.05				<0.05
Xylene, m/p-	387041	0.05	ug/g		<0.05	<0.05		
	387044	0.05	ug/g				0.17	<0.05
Xylene, o-	387041	0.05	ug/g		<0.05	<0.05		
	387044	0.05	ug/g				0.16	<0.05

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Date Submitted: 2020-07-24
Date Reported: 2020-08-04
Project: 19-2795G01-0499
COC #: 859039

Guideline = O.Reg 153-T1-All Other Soils

Inorganics

Analyte	Batch No	MRL	Units	Guideline	Lab I.D. 1506470	1506471	1506472	1506473
Sample Matrix					Soil153	Soil153	Soil153	Soil153
Sample Type								
Sample Date					2020-07-15	2020-07-15	2020-07-16	2020-07-14
Sampling Time								
Sample I.D.					BH2 AS1B+AS2	BH5 AS1B	BH8 SS1+SS2	BH7 AS1B+SS2
Cyanide (CN-)	386916	0.02	ug/g	STD 0.051	<0.02	<0.02	<0.02	<0.02
Electrical Conductivity	386848	0.05	mS/cm	STD 0.57	1.40*	1.30*	0.32	0.74*
pH - CaCl2	386875	2.00			8.03	7.77	7.80	7.86
Sodium Adsorption Ratio	386886	0.01		STD 2.4	19.3*	22.7*	1.62	3.06*

Moisture

Analyte	Batch No	MRL	Units	Guideline	Lab I.D. 1506470	1506471	1506472	1506473
Sample Matrix					Soil153	Soil153	Soil153	Soil153
Sample Type								
Sample Date					2020-07-15	2020-07-15	2020-07-16	2020-07-14
Sampling Time								
Sample I.D.					BH2 AS1B+AS2	BH5 AS1B	BH8 SS1+SS2	BH7 AS1B+SS2
Moisture-Humidite	386965	0.1	%		25.7	19.9	13.4	7.3

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L4B 3K6
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PHC Surrogate

Analyte	Batch No	MRL	Units	Guideline	Lab I.D. / Sample Matrix / Sample Type / Sample Date / Sampling Time / Sample I.D.			
					1506470 Soil153 2020-07-15 BH2 AS1B+AS2	1506471 Soil153 2020-07-15 BH5 AS1B	1506472 Soil153 2020-07-16 BH8 SS1+SS2	1506473 Soil153 2020-07-14 BH7 AS1B+SS2
Alpha-androstrane	386965	0	%		74	83	63	80

VOCs Surrogates

Analyte	Batch No	MRL	Units	Guideline	Lab I.D. / Sample Matrix / Sample Type / Sample Date / Sampling Time / Sample I.D.			
					1506470 Soil153 2020-07-15 BH2 AS1B+AS2	1506471 Soil153 2020-07-15 BH5 AS1B	1506472 Soil153 2020-07-16 BH8 SS1+SS2	1506473 Soil153 2020-07-14 BH7 AS1B+SS2
1,2-dichloroethane-d4	387041	0	%		118	119	123	
	387044	0	%					121
4-bromofluorobenzene	387041	0	%		101	109	101	
	387044	0	%					103
Toluene-d8	387041	0	%		102	104	102	
	387044	0	%					104

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Quality Assurance Summary

Batch No	Analyte	Blank	QC % Rec	QC Limits	Spike % Rec	Spike Limits	Dup % RPD	Duplicate Limits
208523	1+2-methylnaphthalene							
386848	Electrical Conductivity	<0.05	97	90-110			1	0-10
386874	Silver	<0.2 ug/g	99	70-130	113	70-130	0	0-20
386874	Arsenic	<1 ug/g	104	70-130	116	70-130	0	0-20
386874	Boron (total)	<5 ug/g	114	70-130	123	70-130	0	0-20
386874	Barium	<1 ug/g	104	70-130	224	70-130	6	0-20
386874	Beryllium	<1 ug/g	112	70-130	119	70-130	0	0-20
386874	Cadmium	<0.4 ug/g	107	70-130	115	70-130	0	0-20
386874	Cobalt	<1 ug/g	107	70-130	118	70-130	8	0-20
386874	Chromium Total	<1 ug/g	112	70-130	120	70-130	5	0-20
386874	Copper	<1 ug/g	114	70-130	128	70-130	11	0-20
386874	Mercury	<0.1 ug/g	100	70-130	97	70-130	0	0-20
386874	Molybdenum	<1 ug/g	101	70-130	105	70-130	0	0-20
386874	Nickel	<1 ug/g	113	70-130	111	70-130	4	0-20
386874	Lead	<1 ug/g	109	70-130	129	70-130	7	0-20
386874	Antimony	<1 ug/g	83	70-130	99	70-130	0	0-20
386874	Selenium	<1 ug/g	113	70-130	112	70-130	0	0-20
386874	Thallium	<1 ug/g	107	70-130	113	70-130	0	0-20
386874	Uranium	<0.5 ug/g	101	70-130	111	70-130	0	0-20
386874	Vanadium	<2 ug/g	104	70-130	161	70-130	8	0-20
386874	Zinc	<2 ug/g	105	70-130	151	70-130	11	0-20
386875	pH - CaCl2	6.56	100	90-110			0	
386885	Boron (Hot Water Soluble)	<0.5 ug/g	90	70-130	91	75-125	0	0-30
386886	Sodium Adsorption Ratio	<0.01					1	
386899	Chromium VI	<0.20 ug/g	100	80-120	88	70-130	0	0-35
386916	Cyanide (CN-)	<0.02 ug/g	112	75-125	120	70-130	0	0-20
386938	Methlynaphthalene, 1-	<0.05 ug/g	67	50-140	71	50-140	0	0-40
386938	Methlynaphthalene, 2-	<0.05 ug/g	66	50-140	70	50-140	0	0-40
386938	Acenaphthene	<0.05 ug/g	84	50-140	76	50-140	0	0-40
386938	Acenaphthylene	<0.05 ug/g	82	50-140	76	50-140	0	0-40
386938	Anthracene	<0.05 ug/g	92	50-140	78	50-140	0	0-40
386938	Benz[a]anthracene	<0.05 ug/g	106	50-140	93	50-140	0	0-40
386938	Benzo[a]pyrene	<0.05 ug/g	97	50-140	73	50-140	0	0-40

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COC #: 859039

Quality Assurance Summary

Batch No	Analyte	Blank	QC % Rec	QC Limits	Spike % Rec	Spike Limits	Dup % RPD	Duplicate Limits
386938	Benzo[b]fluoranthene	<0.05 ug/g	87	50-140	76	50-140	0	0-40
386938	Benzo[ghi]perylene	<0.05 ug/g	91	50-140	78	50-140	0	0-40
386938	Benzo[k]fluoranthene	<0.05 ug/g	107	50-140	82		0	0-40
386938	Chrysene	<0.05 ug/g	84	50-140	71	50-140	0	0-40
386938	Dibenz[a h]anthracene	<0.05 ug/g	82	50-140	73	50-140	0	0-40
386938	Fluoranthene	<0.05 ug/g	96	50-140	81	50-140	0	0-40
386938	Fluorene	<0.05 ug/g	86	50-140	73	50-140	0	0-40
386938	Indeno[1 2 3-cd]pyrene	<0.05 ug/g	89	50-140	75	50-140	0	0-40
386938	Naphthalene	<0.05 ug/g	71	50-140	65	50-140	0	0-40
386938	Phenanthrene	<0.05 ug/g	94	50-140	79	50-140	0	0-40
386938	Pyrene	<0.05 ug/g	98	50-140	82	50-140	0	0-40
386965	PHC's F2	<10 ug/g	84	80-120	98	60-140	0	0-30
386965	PHC's F3	<20 ug/g	84	80-120	98	60-140	0	0-30
386965	PHC's F4	<20 ug/g	84	80-120	98	60-140	0	0-30
386965	Moisture-Humidite		100	80-120			4	
387031	PHC's F4g	<100 ug/g		80-120		60-140		0-30
387041	Tetrachloroethane, 1,1,1,2-	<0.05 ug/g	101	60-130	93	50-140	0	0-50
387041	Trichloroethane, 1,1,1-	<0.05 ug/g	104	60-130	96	50-140	0	0-50
387041	Tetrachloroethane, 1,1,2,2-	<0.05 ug/g	112	60-130	97	50-140	0	0-30
387041	Trichloroethane, 1,1,2-	<0.05 ug/g	104	60-130	90	50-140	0	0-50
387041	Dichloroethane, 1,1-	<0.05 ug/g	115	60-130	94	50-140	0	0-50
387041	Dichloroethylene, 1,1-	<0.05 ug/g	109	60-130	73	50-140	0	0-50
387041	Dichlorobenzene, 1,2-	<0.05 ug/g	103	60-130	87	50-140	0	0-50
387041	Dichloroethane, 1,2-	<0.05 ug/g	109	60-130	90	50-140	0	0-50
387041	Dichloropropane, 1,2-	<0.05 ug/g	97	60-130	100	50-140	0	0-50
387041	Dichlorobenzene, 1,3-	<0.05 ug/g	103	60-130	118	50-140	0	0-50
387041	Dichlorobenzene, 1,4-	<0.05 ug/g	115	60-130	113	50-140	0	0-50
387041	Benzene	<0.02 ug/g	104	60-130	94	50-140	0	0-50
387041	Bromodichloromethane	<0.05 ug/g	89	60-130	100	50-140	0	0-50
387041	Bromoform	<0.05 ug/g	104	60-130	93	50-140	0	0-50
387041	Bromomethane	<0.05 ug/g	79	60-130	91	50-140	0	0-50
387041	Dichloroethylene, 1,2-cis-	<0.05 ug/g	118	60-130	88	50-140	0	0-50
387041	Dichloropropene,1,3-cis-	<0.05 ug/g	103	60-130	82	50-140	0	0-50

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Quality Assurance Summary

Batch No	Analyte	Blank	QC % Rec	QC Limits	Spike % Rec	Spike Limits	Dup % RPD	Duplicate Limits
387041	Carbon Tetrachloride	<0.05 ug/g	113	60-130	97	50-140	0	0-50
387041	Chloroform	<0.05 ug/g	97	60-130	94	50-140	0	0-50
387041	Dibromochloromethane	<0.05 ug/g	120	60-130	100	50-140	0	0-50
387041	Dichlorodifluoromethane	<0.05 ug/g	81	60-130	92	50-140	0	0-50
387041	Methylene Chloride	<0.05 ug/g	105	60-130	113	50-140	0	0-50
387041	Ethylbenzene	<0.05 ug/g	113	60-130	99	50-140	0	0-50
387041	Ethylene dibromide	<0.05 ug/g	110	60-130		50-140		0-50
387041	Hexane (n)	<0.05 ug/g	101	60-130	88	50-140	0	0-50
387041	Xylene, m/p-	<0.05 ug/g	113	60-130	103	50-140	0	0-50
387041	Chlorobenzene	<0.05 ug/g	111	60-130	100	50-140	0	0-50
387041	Xylene, o-	<0.05 ug/g	108	60-130	107	50-140	0	0-50
387041	Styrene	<0.05 ug/g	102	60-130	95	50-140	0	0-50
387041	Dichloroethylene, 1,2-trans-	<0.05 ug/g	114	60-130	82	50-140	0	0-50
387041	Dichloropropene,1,3-trans-	<0.05 ug/g	103	60-130	81	50-140	0	0-50
387041	Tetrachloroethylene	<0.05 ug/g	110	60-130	101	50-140	0	0-50
387041	Toluene	<0.20 ug/g	86	60-130	96	50-140	0	0-50
387041	Trichloroethylene	<0.05 ug/g	108	60-130	115	50-140	0	0-50
387041	Trichlorofluoromethane	<0.05 ug/g	113	60-130	80	50-140	0	0-50
387041	Vinyl Chloride	<0.02 ug/g	99	60-130	73	50-140	0	0-50
387042	Xylene Mixture							
387044	Tetrachloroethane, 1,1,1,2-	<0.05 ug/g	101	60-130	93	50-140	0	0-50
387044	Trichloroethane, 1,1,1-	<0.05 ug/g	104	60-130	96	50-140	0	0-50
387044	Tetrachloroethane, 1,1,2,2-	<0.05 ug/g	112	60-130	97	50-140	0	0-30
387044	Trichloroethane, 1,1,2-	<0.05 ug/g	104	60-130	90	50-140	0	0-50
387044	Dichloroethane, 1,1-	<0.05 ug/g	115	60-130	94	50-140	0	0-50
387044	Dichloroethylene, 1,1-	<0.05 ug/g	109	60-130	73	50-140	0	0-50
387044	Dichlorobenzene, 1,2-	<0.05 ug/g	103	60-130	87	50-140	0	0-50
387044	Dichloroethane, 1,2-	<0.05 ug/g	109	60-130	90	50-140	0	0-50
387044	Dichloropropane, 1,2-	<0.05 ug/g	97	60-130	100	50-140	0	0-50
387044	Dichlorobenzene, 1,3-	<0.05 ug/g	103	60-130	118	50-140	0	0-50
387044	Dichlorobenzene, 1,4-	<0.05 ug/g	115	60-130	113	50-140	0	0-50
387044	Benzene	<0.02 ug/g	104	60-130	94	50-140	0	0-50
387044	Bromodichloromethane	<0.05 ug/g	89	60-130	100	50-140	0	0-50

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Quality Assurance Summary

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387044	Bromoform	<0.05 ug/g	104	60-130	93	50-140	0	0-50
387044	Bromomethane	<0.05 ug/g	79	60-130	91	50-140	0	0-50
387044	Dichloroethylene, 1,2-cis-	<0.05 ug/g	118	60-130	88	50-140	0	0-50
387044	Dichloropropene,1,3-cis-	<0.05 ug/g	103	60-130	82	50-140	0	0-50
387044	Carbon Tetrachloride	<0.05 ug/g	113	60-130	97	50-140	0	0-50
387044	Chloroform	<0.05 ug/g	97	60-130	94	50-140	0	0-50
387044	Dibromochloromethane	<0.05 ug/g	120	60-130	100	50-140	0	0-50
387044	Dichlorodifluoromethane	<0.05 ug/g	81	60-130	92	50-140	0	0-50
387044	Methylene Chloride	<0.05 ug/g	105	60-130	113	50-140	0	0-50
387044	Ethylbenzene	<0.05 ug/g	113	60-130	99	50-140	0	0-50
387044	Ethylene dibromide	<0.05 ug/g	110	60-130		50-140		0-50
387044	Hexane (n)	<0.05 ug/g	101	60-130	88	50-140	0	0-50
387044	Xylene, m/p-	<0.05 ug/g	113	60-130	103	50-140	0	0-50
387044	Chlorobenzene	<0.05 ug/g	111	60-130	100	50-140	0	0-50
387044	Xylene, o-	<0.05 ug/g	108	60-130	107	50-140	0	0-50
387044	Styrene	<0.05 ug/g	102	60-130	95	50-140	0	0-50
387044	Dichloroethylene, 1,2-trans-	<0.05 ug/g	114	60-130	82	50-140	0	0-50
387044	Dichloropropene,1,3-trans-	<0.05 ug/g	103	60-130	81	50-140	0	0-50
387044	Tetrachloroethylene	<0.05 ug/g	110	60-130	101	50-140	0	0-50
387044	Toluene	<0.20 ug/g	86	60-130	96	50-140	0	0-50
387044	Trichloroethylene	<0.05 ug/g	108	60-130	115	50-140	0	0-50
387044	Trichlorofluoromethane	<0.05 ug/g	113	60-130	80	50-140	0	0-50
387044	Vinyl Chloride	<0.02 ug/g	99	60-130	73	50-140	0	0-50
387044	Xylene Mixture	<0.05 ug/g						
387045	PHC's F1	<10 ug/g	97	80-120	94	60-140	0	0-30
387045	PHC's F1-BTEX							
387047	Dichloropropene,1,3-							
387047	Acetone	<0.50 ug/g	80	60-130	88	50-140	0	0-50
387047	Methyl Ethyl Ketone	<0.50 ug/g	84	60-130	101	50-140	0	0-50
387047	Methyl Isobutyl Ketone	<0.50 ug/g	99	60-130	96	50-140	0	0-50
387047	Methyl tert-Butyl Ether (MTBE)	<0.05 ug/g	119	60-130	90	50-140	0	0-50

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Certificate of Analysis

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Test Summary

Batch No	Analyte	Instrument	Prep aration Date	Analysis Date	Analyst	Method
208523	1+2-methylnaphthalene	GC-MS	2020-07-31	2020-07-31	C_M	P 8270
386848	Electrical Conductivity	Electrical Conductivity Mete	2020-07-29	2020-07-29	SG	Cond-Soil
386874	Silver	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Arsenic	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Boron (total)	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Barium	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Beryllium	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Cadmium	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Cobalt	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Chromium Total	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Copper	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Mercury	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Molybdenum	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Nickel	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Lead	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Antimony	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Selenium	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Thallium	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Uranium	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Vanadium	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386874	Zinc	ICAPQ-MS	2020-07-29	2020-07-29	H_D	EPA 200.8
386875	pH - CaCl2	pH Meter	2020-07-29	2020-07-29	Z_S	Ag Soil
386885	Boron (Hot Water Soluble)	iCAP OES	2020-07-29	2020-07-29	Z_S	MOECC E3470
386886	Sodium Adsorption Ratio	iCAP OES	2020-07-29	2020-07-29	Z_S	Ag Soil
386899	Chromium VI	FAA	2020-07-30	2020-07-30	Z_S	M US EPA 3060A
386916	Cyanide (CN-)	Skalar CN Analyzer	2020-07-29	2020-07-29	QT	MOECC E3015
386938	Methlynaphthalene, 1-	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Methlynaphthalene, 2-	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Acenaphthene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Acenaphthylene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Anthracene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Benz[a]anthracene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Benzo[a]pyrene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270

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Methods references and/or additional QA/QC information available on request.

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Client: Geo Pro Consulting
40 Vogell Rd, Unit 57
Richmond Hill, Ontario
L4B 3K6
Attention: Ms. Dylan X
PO#:
Invoice to: Geo Pro Consulting

Report Number: 1935256
Date Submitted: 2020-07-24
Date Reported: 2020-08-04
Project: 19-2795G01-0499
COC #: 859039

Test Summary

Batch No	Analyte	Instrument	Prep aration Date	Analysis Date	Analyst	Method
386938	Benzo[b]fluoranthene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Benzo[ghi]perylene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Benzo[k]fluoranthene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Chrysene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Dibenz[a h]anthracene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Fluoranthene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Fluorene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Indeno[1 2 3-cd]pyrene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Naphthalene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Phenanthrene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386938	Pyrene	GC-MS	2020-07-28	2020-07-30	C_M	P 8270
386965	PHC's F2	GC/FID	2020-07-30	2020-07-31	A_A	CCME
386965	PHC's F3	GC/FID	2020-07-30	2020-07-31	A_A	CCME
386965	PHC's F4	GC/FID	2020-07-30	2020-07-31	A_A	CCME
386965	Moisture-Humidite	Oven	2020-07-30	2020-07-31	A_A	ASTM 2216
387031	PHC's F4g	GC/FID	2020-07-31	2020-07-31	A_A	CCME
387041	Tetrachloroethane, 1,1,1,2-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Trichloroethane, 1,1,1-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Tetrachloroethane, 1,1,2,2-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Trichloroethane, 1,1,2-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Dichloroethane, 1,1-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Dichloroethylene, 1,1-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Dichlorobenzene, 1,2-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Dichloroethane, 1,2-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Dichloropropane, 1,2-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Dichlorobenzene, 1,3-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Dichlorobenzene, 1,4-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Benzene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Bromodichloromethane	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Bromoform	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Bromomethane	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Dichloroethylene, 1,2-cis-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Dichloropropene,1,3-cis-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B

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Client: Geo Pro Consulting
40 Vogell Rd, Unit 57
Richmond Hill, Ontario
L4B 3K6
Attention: Ms. Dylan X
PO#:
Invoice to: Geo Pro Consulting

Report Number: 1935256
Date Submitted: 2020-07-24
Date Reported: 2020-08-04
Project: 19-2795G01-0499
COC #: 859039

Test Summary

Batch No	Analyte	Instrument	Prep aration Date	Analysis Date	Analyst	Method
387041	Carbon Tetrachloride	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Chloroform	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Dibromochloromethane	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Dichlorodifluoromethane	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Methylene Chloride	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Ethylbenzene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Ethylene dibromide	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Hexane (n)	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Xylene, m/p-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Chlorobenzene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Xylene, o-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Styrene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Dichloroethylene, 1,2-trans-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Dichloropropene,1,3-trans-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Tetrachloroethylene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Toluene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Trichloroethylene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Trichlorofluoromethane	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387041	Vinyl Chloride	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387042	Xylene Mixture	GC-MS	2020-08-03	2020-08-03	TJB	V 8260B
387044	Tetrachloroethane, 1,1,1,2-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Trichloroethane, 1,1,1-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Tetrachloroethane, 1,1,2,2-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Trichloroethane, 1,1,2-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Dichloroethane, 1,1-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Dichloroethylene, 1,1-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Dichlorobenzene, 1,2-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Dichloroethane, 1,2-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Dichloropropane, 1,2-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Dichlorobenzene, 1,3-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Dichlorobenzene, 1,4-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Benzene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Bromodichloromethane	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B

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Client: Geo Pro Consulting
40 Vogell Rd, Unit 57
Richmond Hill, Ontario
L4B 3K6
Attention: Ms. Dylan X
PO#:
Invoice to: Geo Pro Consulting

Report Number: 1935256
Date Submitted: 2020-07-24
Date Reported: 2020-08-04
Project: 19-2795G01-0499
COC #: 859039

Test Summary

Batch No	Analyte	Instrument	Prep aration Date	Analysis Date	Analyst	Method
387044	Bromoform	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Bromomethane	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Dichloroethylene, 1,2-cis-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Dichloropropene,1,3-cis-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Carbon Tetrachloride	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Chloroform	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Dibromochloromethane	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Dichlorodifluoromethane	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Methylene Chloride	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Ethylbenzene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Ethylene dibromide	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Hexane (n)	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Xylene, m/p-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Chlorobenzene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Xylene, o-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Styrene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Dichloroethylene, 1,2-trans-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Dichloropropene,1,3-trans-	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Tetrachloroethylene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Toluene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Trichloroethylene	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Trichlorofluoromethane	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Vinyl Chloride	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387044	Xylene Mixture	GC-MS	2020-08-04	2020-08-04	TJB	V 8260B
387045	PHC's F1	GC/FID	2020-08-03	2020-08-03	TJB	CCME
387045	PHC's F1-BTEX	GC/FID	2020-08-03	2020-08-03	TJB	CCME
387047	Dichloropropene,1,3-	GC-MS	2020-08-03	2020-08-03	TJB	V 8260B
387047	Acetone	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387047	Methyl Ethyl Ketone	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387047	Methyl Isobutyl Ketone	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B
387047	Methyl tert-Butyl Ether (MTBE)	GC-MS	2020-07-31	2020-07-31	TJB	V 8260B

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COC #: 859039

Petroleum Hydrocarbons - CCME Checklist

Samples were analysed by Eurofins Ottawa Method AMCCME2, "Petroleum Hydrocarbons in Water and Soil, CCME/TPH", "Petroleum Hydrocarbons in Water and Soil, CCME/TPH". These methods comply with the reference method for the CCME CWS PHC and are validated for use in the laboratory. Eurofins Ottawa is accredited by CALA (ISO 17025) for all CCME F1-F4 fractions as listed in this report. Eurofins Mississauga is accredited by SCC (ISO 17025) for all CCME F1-F4 fractions as listed in this report. Data for QC samples (blank, duplicate, spike) are available on request

Holding/Analysis Times	Yes/No	If NO, then reasons
All fractions analyzed within recommended hold times/analysis times?	Yes	
F1		
nC6 and nC10 response factors within 30% of toluene	Yes	
BTEX was subtracted from F1 fraction	Yes	
If YES, was F1-BTEX (C6-C10) reported	Yes	
F2		
nC10, nC16 and nC34 response factors within 10% of their average (F2-F4)	Yes	
Linearity within 15% (F2-F4)	Yes	
Napthalene was subtracted from F2 fraction		
If YES was F2-Napthalene reported		
F3		
PAH (selected compounds) subtracted from F3 fraction		
If YES was F3-PAH reported		
F4		
C50 response factor within 70% of nC10+nC16+nC34 average	Yes	
Chromatogram descended to baseline by retention time of C50	No	
if NO was F4 (C34-C50) gravimetric reported	Yes	

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8S9039

eurofins

STANDARD CHAIN-OF-CUSTODY

146 Colonnade Road, Unit #8, Ottawa, ON, K2E 7Y1 - Phone: 613-727-5692, Fax: 613-727-5222

Eurofins Workorder #: 19352

CLIENT INFORMATION

Company:	GeoPro Consulting Limited
Contact:	ELab elab@geoproconsulting.ca
Address:	40 Vogell Road, unit 23, Richmond Hill, ON L4B 3N6
Telephone:	905-237-8336
Cell:	
Email: #1:	dylanx@geoproconsulting.ca
Email: #2:	elab@geoproconsulting.ca; chriske@geoproconsulting.ca
Project:	19-2795G01-0499
Quote #:	190500

INVOICE INFORMATION (SAME AS CLIENT INFORMATION: YES ✔ NO ☐)

Company:	
Contact:	
Address:	
Telephone:	
Fax:	
Email: #1:	
Email: #2:	
PO #:	

TURN-AROUND TIME (Business Days)

☐ 1 Day* (100%) ☐ 2 Day** (50%) ☐ 3-5 Days (25%) ✔ 5-7 Days (Standard)

Please contact Lab in advance to determine rush availability.

*For results reported after rush due date, surcharges will apply: before 12:00 - 100%, after 12:00 - 50%.

**For results reported after rush due date, surcharges will apply: before 12:00 - 50%, after 12:00 - 25%.

REGULATION/GUIDELINE REQUIRED

☐ Sanitary Sewer, City:

☐ Storm Sewer, City:

☐ ODWSOG

☐ PWQO

☐ O. Reg 347/558

☐ Other: Asbestos

☐ None

✔ O. Reg 153

Table # ___, Course / Fine, Surface / subsurface.

Type: Com-Ind / Res-Park / Agri / GW / All Other / Sediment

☐ Excess Soil, Table: 1 Type:

The sample results from this submission will form part of a formal Record of Site Condition (RSC) under O.Reg. 153/04

☐ Yes ☐ No

The optimal temperature conditions during transport should be less than 10°C. Sample(s) cannot be frozen, unless otherwise indicated or agreed upon with the Laboratory. Note that this COC is not to be used for drinking water samples. **The COC must be complete upon submission of the samples, there will be a $25 surcharge if required information is missing** (required fields are shaded in grey).

Sample Details			Sample Analysis Required																		
Field Filtered -->			O.Reg.153 parameters							Asbestos											RN# (Lab Use Only)
Sample ID	Date/Time Collected	Sample Matrix	# of Containers	PHC F1 - F4	BTEX	VOCs	PAHs	PCBs	Metals + Inorganics	Metals only											
BH2 AS1B+AS2	2020-07-15	Soil	4	✔		✔	✔		✔												1506470
BH5 AS1B	2020-07-15	Soil	4	✔		✔	✔		✔												71
BH8 SS1+SS2	2020-07-16	Soil	4	✔		✔	✔		✔												72
BH7 AS1B+SS2	2020-07-14	Soil	4	✔		✔	✔		✔												73

	PRINT	SIGN	DATE/TIME	TEMP (°C)
Sampled By:				
Relinquished By:	Chris		July 24, 2020	
Received By:	Victor Gallant	N.D	07/24/20 3:09pm	10.6°C

COMMENTS:

CUSTODY SEAL: ☐ YES ☐ NO Ice packs submitted: ✔ Yes ☐ No

401 Magnetic Drive, Unit #1, North York, ON, M3J 3H9 - Telephone: 416-661-5287 • 380 Vansickle Road, Unit #630, St. Catharines, ON, L2S 0B5 - Telephone: 905-640-8887 • 608 Norris Court, Kingston, ON, K7P 2R9 - Telephone: 613-634-9307

APPENDIX B

GeoPro Consulting Limited (Richmond Hill)
ATTN: Sarena Medina
40 Vogell Road
Unit 22
Richmond Hill ON L4B 3N6

Date Received: 27-JUL-20
Report Date: 14-AUG-20 09:29 (MT)
Version: FINAL REV. 2

Client Phone: 905-237-8336

Certificate of Analysis

Lab Work Order #: L2480152

Project P.O. #: NOT SUBMITTED
Job Reference: TORONTO
C of C Numbers:
Legal Site Desc:

Jennifer Barkshire-Paterson
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2480152-1 BH7 SS12 Sampled By: CLIENT on 14-JUL-20 Matrix: SOIL							
Physical Tests							
Conductivity	1.41		0.0040	mS/cm		31-JUL-20	R5173189
% Moisture	10.0		0.25	%	28-JUL-20	29-JUL-20	R5170097
pH	7.92		0.10	pH units		31-JUL-20	R5173197
Redox Potential	255		-1000	mV		29-JUL-20	R5171711
Resistivity	712		1.0	ohm*cm		31-JUL-20	
Leachable Anions & Nutrients							
Chloride	11.0		5.0	ug/g	30-JUL-20	31-JUL-20	R5174204
Anions and Nutrients							
Sulphate	912		20	mg/kg	29-JUL-20	29-JUL-20	R5172206
Inorganic Parameters							
Acid Volatile Sulphides	<0.20		0.20	mg/kg	28-JUL-20	28-JUL-20	R5168376
L2480152-2 BH8 SS6 Sampled By: CLIENT on 14-JUL-20 Matrix: SOIL							
Physical Tests							
Conductivity	0.208		0.0040	mS/cm		31-JUL-20	R5173189
% Moisture	16.4		0.25	%	28-JUL-20	29-JUL-20	R5170097
pH	7.86		0.10	pH units		31-JUL-20	R5173197
Redox Potential	234		-1000	mV		29-JUL-20	R5171711
Resistivity	4810		1.0	ohm*cm		31-JUL-20	
Leachable Anions & Nutrients							
Chloride	11.9		5.0	ug/g	30-JUL-20	31-JUL-20	R5174204
Anions and Nutrients							
Sulphate	68		20	mg/kg	29-JUL-20	29-JUL-20	R5172206
Inorganic Parameters							
Acid Volatile Sulphides	<0.20		0.20	mg/kg	28-JUL-20	28-JUL-20	R5168376

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0

5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

EC-WT	Soil	Conductivity (EC)	MOEE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

MOISTURE-WT	Soil	% Moisture	CCME PHC in Soil - Tier 1 (mod)
PH-WT	Soil	pH	MOEE E3137A

A minimum 10g portion of the sample is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580

This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	APHA 2510 B

"Soil Resistivity (calculated)" is determined as the inverse of the conductivity of a 2:1 water:soil leachate (dry weight). This method is intended as a rapid approximation for Soil Resistivity. Where high accuracy results are required, direct measurement of Soil Resistivity by the Wenner Four-Electrode Method (ASTM G57) is recommended.

SO4-WT	Soil	Sulphate	EPA 300.0

5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

SULPHIDE-WT	Soil	Sulphide, Acid Volatile	APHA 4500S2J

This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H2S) is carried into a basic solution by inert gas. The acid volatile sulfide is then determined colourimetrically.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid weight of sample
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2480152 Report Date: 14-AUG-20

Client: GeoPro Consulting Limited (Richmond Hill)
40 Vogell Road Unit 22
Richmond Hill ON L4B 3N6
Contact: Sarena Medina

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-R511-WT	**Soil**							
Batch R5174204								
WG3374206-3 CRM		**AN-CRM-WT**						
Chloride			91.0		%		70-130	31-JUL-20
WG3374206-4 DUP		**L2480152-2**						
Chloride		11.9	12.0		ug/g	0.4	30	31-JUL-20
WG3374206-2 LCS								
Chloride			101.1		%		80-120	31-JUL-20
WG3374206-1 MB								
Chloride			<5.0		ug/g		5	31-JUL-20
EC-WT	**Soil**							
Batch R5173189								
WG3374236-9 DUP		**WG3374236-8**						
Conductivity		0.0925	0.0925		mS/cm	0.0	20	31-JUL-20
WG3374236-7 IRM		**WT SAR4**						
Conductivity			101.8		%		70-130	31-JUL-20
WG3374489-1 LCS								
Conductivity			100.5		%		90-110	31-JUL-20
WG3374236-6 MB								
Conductivity			<0.0040		mS/cm		0.004	31-JUL-20
MOISTURE-WT	**Soil**							
Batch R5170097								
WG3371582-3 DUP		**L2478919-4**						
% Moisture		10.8	11.5		%	5.7	20	29-JUL-20
WG3371582-2 LCS								
% Moisture			100.6		%		90-110	29-JUL-20
WG3371582-1 MB								
% Moisture			<0.25		%		0.25	29-JUL-20
PH-WT	**Soil**							
Batch R5173197								
WG3373346-1 DUP		**L2479682-2**						
pH		7.51	7.52	J	pH units	0.01	0.3	31-JUL-20
WG3374595-1 LCS								
pH			6.97		pH units		6.9-7.1	31-JUL-20
REDOX-POTENTIAL-WT	**Soil**							
Batch R5171711								
WG3372639-1 CRM		**WT-REDOX**						
Redox Potential			101.1		%		80-120	29-JUL-20
WG3372365-2 DUP		**L2479497-9**						

Quality Control Report

Client: GeoPro Consulting Limited (Richmond Hill)
40 Vogell Road Unit 22
Richmond Hill ON L4B 3N6
Contact: Sarena Medina

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
REDOX-POTENTIAL-WT	**Soil**							
Batch R5171711								
WG3372365-2 DUP		**L2479497-9**						
Redox Potential		194	186		mV	4.2	25	29-JUL-20
SO4-WT	**Soil**							
Batch R5172206								
WG3372455-9 CRM		**AN-CRM-WT**						
Sulphate			99.6		%		60-140	29-JUL-20
WG3372455-8 DUP		**L2476661-7**						
Sulphate		25	25		mg/kg	3.0	30	29-JUL-20
WG3372455-7 LCS								
Sulphate			102.2		%		80-120	29-JUL-20
WG3372455-6 MB								
Sulphate			<20		mg/kg		20	29-JUL-20
SULPHIDE-WT	**Soil**							
Batch R5168376								
WG3371601-3 DUP		**L2480152-2**						
Acid Volatile Sulphides		<0.20	<0.20	RPD-NA	mg/kg	N/A	45	28-JUL-20
WG3371601-2 LCS								
Acid Volatile Sulphides			99.3		%		70-130	28-JUL-20
WG3371601-1 MB								
Acid Volatile Sulphides			<0.20		mg/kg		0.2	28-JUL-20

Quality Control Report

Workorder: L2480152 Report Date: 14-AUG-20

Client: GeoPro Consulting Limited (Richmond Hill)
40 Vogell Road Unit 22
Richmond Hill ON L4B 3N6
Contact: Sarena Medina

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L2480152-COFC

COC Number:

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	GeoPro Consulting Ltd.
Contact:	Elab elab@geoproconsulting.ca
Phone:	(905) 237-8336
	Company address below will appear on the final report
Street:	40 Vogell Road, Unit 57
City/Province:	Richmond Hill, ON
Postal Code:	L4B 3N6
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	
Contact:	

Report Format / Distribution	
Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report	☑ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	dylanx@geoproconsulting.ca
Email 2	elab@geoproconsulting.ca
Email 3	chriske@geoproconsulting.ca

Invoice Distribution	
Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	dylanx@geoproconsulting.ca
Email 2	elab@geoproconsulting.ca

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply			
Regular [R]	☑ Standard TAT if received by 3 pm - business days - no surcharges apply		
PRIORITY (Business Days)	4 day [P4] ☐	EMERGENCY	1 Business day [E1] ☐
	3 day [P3] ☐		Same Day, Weekend or Statutory holiday [E0] ☐
	2 day [P2] ☐		
Date and Time Required for all E&P TATs:			
For tests that can not be performed according to the service level selected, you will be contacted.			

Project Information	
ALS Account # / Quote #:	Q71931
Job #:	19-2795G01-0506
PO / AFE:	
LSD:	Toronto
ALS Lab Work Order # (lab use only)	L2480152 R0

Oil and Gas Required Fields (client use)		
AFE/Cost Center:	PO#	
Major/Minor Code:	Routing Code:	
Requisitioner:		
Location:		
ALS Contact: Rick	Sampler:	

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Corrosivity	Number of Containers
	BH7 SS11	14-Jul-20		Soil	R	1
	BH8 SS6	17-Jul-20		Soil	R	1

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? ☐ YES ☑ NO	
Are samples for human drinking water use? ☐ YES ☑ NO	Invoice to : dylanx@geoproconsulting.ca, elab@geoproconsulting.ca chriske@geoproconsulting.ca

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C	
22.9			2.7	

SHIPMENT RELEASE (client use)		
Released by: CK	Date:Date:2019-07-27	Time:

INITIAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date: July 27/20	Time: 14:25

FINAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date: 7-27-20	Time: 18:15

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

LIMITATIONS TO THE REPORT

This report is intended solely for the Client named. The report is prepared based on the work has been undertaken in accordance with normally accepted geotechnical engineering practices in Ontario.

The comments and recommendations given in this report are based on information determined at the limited number of the test hole and test pit locations. The boundaries between the various strata as shown on the borehole logs are based on non-continuous sampling and represent an inferred transition between the various strata and their lateral continuation rather than a precise plane of geological change. Subsurface and groundwater conditions between and beyond the test holes and test pits may differ significantly from those encountered at the test hole and test pit locations. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole and test pit locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

It should be noted that the results of the designated substance and chemical analysis refer only to the sample analyzed which was obtained from specific sampling location and sampling depth, and the presence of designated substance and soil chemistry may vary between and beyond the location and depth of the sample taken. Please note that the level of chemical testing outlined herein is meant to provide a broad indication of soil quality based on the limited soil samples tested. The analytical results contained in this report should not be considered a warranty with respect to the soil quality or the use of the soil for any specific purpose or the acceptability of the soils for any excess soil receiving sites.

The report reflects our best judgment based on the information available to GeoPro Consulting Limited at the time of preparation. Unless otherwise agreed in writing by GeoPro Consulting Limited, it shall not be used to express or imply warranty as to any other purposes. No portion of this report shall be used as a separate entity, it is written to be read in its entirety. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated.

The design recommendations given in this report are applicable only to the project designed and constructed completely in accordance with the details stated in this report. Otherwise, our responsibility is limited to interpreting the subsurface information at the borehole or test pit locations.

Should any comments and recommendations provided in this report be made on any construction related issues, they are intended only for the guidance of the designers. The number of test holes and test pits may not be sufficient to determine all the factors that may affect construction activities, methods and costs. Such as, the thickness of surficial topsoil or fill layers may vary significantly and unpredictably; the amount of the cobbles and boulders may vary significantly than what described in the report; unexpected water bearing zones/layers with various thickness and extent may be encountered in the fill and native soils. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and make their own conclusions as to how the subsurface conditions may affect their work and determine the proper construction methods.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. GeoPro Consulting Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.