GeoPro Consulting Limited

Geotechnical-Hydrogeology-Environmental-Materials-Inspection

Preliminary Geotechnical Investigation

Regional Road 25 Transportation Corridor Improvement

From Steeles Avenue (Regional Road 8) to 5 Sideroad

Town of Milton, Halton Region, Ontario

Prepared For:

Stantec Consulting Limited

GeoPro Project No.: 17-1758GH
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GeoPro CONSULTING LIMITED

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1 INTRODUCTION

GeoPro Consulting Limited (GeoPro) was retained by Stantec Consulting Limited (the Client) to conduct a preliminary geotechnical investigation for the proposed improvements of Regional Road 25 transportation corridor from Steeles Avenue (Regional Road 8) to 5 Sideroad, Town of Milton, Halton Region, 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 excess soil 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 SITE AND PROJECT DESCRIPTION

This preliminary geotechnical investigation is to support the Municipal Class Environmental Assessment (MCEA) study for Regional Road 25 transportation corridor improvement from Steeles Avenue (Regional Road 8) to 5 Sideroad, in the Town of Milton, Halton Region, Ontario. The required road improvements for Regional Road 25 include widening of the existing roadway from four (4) lanes to six (6) lanes with an urban cross-section, the improvements to the overpass (rail over road) at the Canadian National Railway (CNR) and a replacement or extension of an existing culvert. The existing CNR overpass bridge is located approximately 300 meters north of Steeles Avenue. It consists of a 23 m wide Through-Girder structural steel span with abutments and retaining walls. As part of the transportation corridor improvement, the CNR overpass bridge is to be improved to accommodate the six (6) lane cross-section including active transportation. The existing rectangular reinforced concrete and soil-steel Ellipse Culvert, which is located approximately 150 m south of Chisholm Drive intersection on Regional Road 25 may be replaced or extended.

3 INVESTIGATION PROCEDURE

3.1 Existing Pavement Condition Survey

The subject section of Regional Road 25 from Steeles Avenue (Regional Road 8) to 5 Sideroad was visited on May 9, 2018 by a GeoPro pavement engineer who carried out a detailed visual pavement condition survey of the existing pavement. The survey was conducted in general accordance with MTO SP-022 Flexible Pavement Condition Rating Guidelines for Municipalities. During the site visit, key pavement distresses were observed (noting the type, severity and general density of surface distresses); the general site and pavement drainage conditions were also noted. Photographs, including descriptions of the typical pavement distresses, are enclosed in Appendix A.

3.2 Borehole and Corehole Investigation

Field work for the geotechnical investigation was carried out from June 11 to November 1, 2018, during which time twenty-nine (29) boreholes (Boreholes BH1 to BH11, BH101 to BH115, BH201, BH202, and BH301) were advanced to depths ranging from about 2.0 m to 17.2 m below the existing ground surface. In addition, the pavement was cored at six (6) locations (Coreholes CH1 to CH6) using a core drill in order to obtain samples of the existing asphalt concrete for thickness measurements and visual examination. The borehole and corehole locations are shown on attached Drawings.

The requested borehole locations were provided by the Client. The boreholes were located and staked in the field by GeoPro according to the requested borehole location plan provided by the Client; 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 truck-mounted continuous flight auger equipment supplied by a drilling specialist subcontracted to GeoPro. Soil samples were recovered at regular intervals of depth using a 50 mm O.D. split-spoon sampler driven into the soil in accordance with the Standard Penetration Test (SPT) procedure described in ASTM D1586 - 11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. In some boreholes, the types and approximate depths of the subgrade soil were obtained using an auger sampling technique.

Groundwater condition observations were made in the boreholes during drilling and upon completion of drilling. All boreholes except BH106, BH110, BH115, BH201, BH202 and BH301 were backfilled and sealed upon completion of drilling. A monitoring well (51 mm in diameter) was installed in each of the Boreholes BH106, BH110, BH115, BH201, BH202 and BH301 to measure the groundwater tables and to facilitate the in-situ hydrogeological investigations.

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 tests (including water content, grain size distribution and Atterberg Limits, when applicable) were carried out on selected soil samples. The laboratory test results are provided in attached Figures.

It should be noted the elevations at the as-drilled borehole locations were not available at the time of preparing the report. The borehole and corehole locations plotted on the Borehole/Corehole Location Plan, Drawings 1A to 1I were based on the measurement of the site features and should be considered to be approximate.

4 PAVEMENT AND SUBSURFACE CONDITIONS

4.1 Existing Pavement Conditions

In general, the existing pavement of Regional Road 25 from Steeles Avenue to 5 Sideroad excluding the section from High Point Drive to Chisholm Drive was observed to be in good condition. The major distresses were few slight to moderate longitudinal and transverse cracking (partially sealed), few slight to moderate construction joint cracking, few slight ravelling. The ride quality of this section was generally considered to be good with few slight bumps.

This existing roadway has an urban cross-section (curb and catchbasins). The overall surface drainage was generally considered to be good. Observations along roadway within the project limits indicated that the pavement surface water generally flows along the existing pavement grades to the concrete curbs and to catch basins. However, drainage was impaired by surface distresses, with unsealed cracks allowing surface water to infiltrate into the underlying pavement and subgrade. The catch basins were observed to be in good condition.

4.2 Subsurface 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.

4.2.1 Existing Pavement and Widening Areas (Boreholes BH1 to BH11 and BH111 to BH115)

Existing Pavement Structure

Eleven (11) boreholes were advanced through the pavement structure of the existing lanes, fifteen (15) boreholes were advanced on the existing boulevard. The range and average thickness of pavement structure of the existing lanes are summarized in the following table.

Section	Pavement Structure		
	Asphalt Concrete Range (Average) (mm)	Granular Base/Subbase Range (Average) (mm)	Total Thickness (Average) (mm)
5 Sideroad to Peddie Rd and Chisholm Dr to Market Dr	160 – 245 (195)	470 – 590 (530)	630 – 800 (705)
Peddie Rd to Hwy 401 WB O-R	180 – 300 (220)	520 – 1020 (740)	740 – 1220 (940)
Market Dr to Steeles Ave	290 – 390 (340)	380 – 520 (450)	670 – 910 (790)

Topsoil

Topsoil with thicknesses ranging from 50 mm to 290 mm were encountered surficially in Boreholes BH7, BH102, BH104, BH106 to BH108, and BH110 to BH115. 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 and probable fill materials consisting of clayey silt, organic silt, sandy silt, sand and silt, gravelly sand, sand and gravel and asphalt fragments/pieces were encountered below the topsoil and granular base/subbase materials in all boreholes, and extended to depths ranging from about 0.6 m to 3.8 m below the existing ground surface. Boreholes BH2, BH6 and BH8 to BH11 were terminated in these materials. For cohesionless fill materials, SPT N values ranging from 4 to 46 blows per 300 mm penetration indicated a loose to dense compactness. For cohesive fill materials, SPT N values ranging from 4 to 26 blows per 300 mm penetration indicated a soft to

firm consistency. The in-situ moisture content measured in the soil samples ranged from approximately 1% to 31%.

Silt, Sandy Silt and Fine Sand and Silt

Silt, sandy silt and fine sand and silt deposits were encountered below the (probable) fill materials, clayey silt till and sandy silt till deposits in Boreholes BH1 and BH101 to BH103, and extended to depths ranging from about 2.0 m to 5.0 m below the existing ground surface. BH1, BH101 and BH102 were terminated in these materials. SPT N values ranging from 11 to 29 blows per 300 mm penetration indicated a compact compactness. The natural moisture content measured in the soil samples ranged from approximately 13% to 22%.

Clayey Silt Till

Clayey silt till deposit was encountered below the (probable) fill materials, clayey silt and silt deposits in Boreholes BH3 to BH5, BH7, BH101, BH103 to BH115, and extended to depths ranging from about 2.0 m to 5.0 m below the existing ground surface. Boreholes BH3 to BH5, BH7, BH103 to BH110, BH12, BH114 and BH115 were terminated in this deposit. SPT N values ranging from 6 to greater than 100 blows per 300 mm penetration indicated a firm to hard consistency. The natural moisture content measured in the soil samples ranged from approximately 6% to 20%.

Sandy Silt Till

Sandy silt till deposit was encountered below or within the fill materials and clayey silt till deposits in Boreholes BH102, BH111 and BH112, and extended to depths ranging from about 2.1 m to 5.0 m below the existing ground surface. Borehole BH111 was terminated in this deposit. SPT N values ranging from 17 to 56 blows per 300 mm penetration indicated a compact to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 8% to 13%.

Clayey Silt

Clayey silt deposit was encountered below the fill materials in Borehole BH105, and extended to a depth of about 2.1 m below the existing ground surface. An SPT N value of 14 blows per 300 mm penetration indicated a stiff consistency. The natural moisture content measured in the soil sample was approximately 14%.

Probable Weathered Shale

As best could be practically determined, shale presumed to coincide with the bedrock surface was encountered in Borehole BH113 below the native soil and extended to a depth of about 5.0 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 consisted of weathered reddish-brown shale. A variation of greater than ±1m may be expected for the inferred bedrock surface depths/elevations.

4.2.2 Culvert (Boreholes BH201 and BH202)

Topsoil

Topsoil with a thickness of about 200 mm was encountered surficially in all boreholes. 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 and sandy silt were encountered below the topsoil in all boreholes, and extended to depths ranging from about 0.9 m to 1.4 m below the existing ground surface. For cohesionless fill materials, SPT N values ranging from 10 to 23 blows per 300 mm penetration indicated a loose to compact compactness. For cohesive fill materials, an SPT N value of 17 blows per 300 mm penetration indicated a very stiff consistency. The in-situ moisture content measured in the soil samples ranged from approximately 14% to 16%.

Upper Clayey Silt

Upper clayey silt deposit was encountered below the fill materials in Borehole BH201, and extended to a depth of about 1.4 m below the existing ground surface. An SPT N value of 17 blows per 300 mm penetration indicated a very stiff consistency. The natural moisture content measured in the soil sample was approximately 16%.

Upper Silt, Sandy Silt and Sand and Silt

Upper silt, sandy silt and sand and silt deposits were encountered below the clayey silt and clayey silt till deposits in all boreholes, and extended to depths ranging from about 1.8 m to 4.0 m below the existing ground surface. SPT N values ranging from 18 to 25 blows per 300 mm penetration indicated a compact compactness. The natural moisture content measured in the soil samples ranged from approximately 10% to 19%.

Clayey Silt Till

Clayey silt till deposit was encountered below the fill materials and upper silt deposits in all boreholes, and extended to depths ranging from about 2.1 m to 7.1 m below the existing ground surface. SPT N values ranging from 18 to 59 blows per 300 mm penetration indicated a very stiff to hard consistency. The natural moisture content measured in the soil samples ranged from approximately 8% to 14%.

Sandy Silt Till

Sandy silt till deposit was encountered below the sandy silt to sand and silt deposit in Borehole BH202, and extended to a depth of about 10.1 m below the existing ground surface. SPT N values ranging from 39 to 91 blows per 300 mm penetration indicated a dense to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 8% to 9%.

Lower Silt

Lower silt deposit was encountered below the clayey silt till and sandy silt till deposits in all boreholes, and extended to depths ranging from about 8.6 m to 12.3 m below the existing ground surface. SPT N values ranging from 36 to 37 blows per 300 mm penetration indicated a dense compactness. The natural moisture content measured in the soil samples ranged from approximately 14% to 18%.

Lower Clayey Silt

Lower clayey silt deposit was encountered below the lower silt deposit in all boreholes, and extended to depths ranging from about 11.3 m to 12.7 m below the existing ground surface. All boreholes were terminated in this deposit. SPT N values ranging from 35 to 37 blows per 300 mm penetration indicated a hard consistency. The natural moisture content measured in the soil samples ranged from approximately 13% to 16%.

4.2.3 CN Railway (Borehole BH301)

Topsoil

Topsoil with a thickness of about 120 mm was encountered surficially in Borehole BH301. 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 and sandy silt were encountered below the topsoil in Borehole BH301, and extended to a depth of about 2.9 m below the existing ground surface. For cohesionless fill materials, SPT N values ranging from 8 to 13 blows per 300 mm penetration indicated a loose to compact compactness. For cohesive fill materials, an SPT N value of 4 blows per 300 mm penetration indicated a soft to firm consistency. The in-situ moisture content measured in the soil samples ranged from approximately 12% to 19%.

Upper Silt

Upper silt deposit was encountered below the fill materials in Borehole BH301, and extended to a depth of about 4.0 m below the existing ground surface. An SPT N value of 15 blows per 300 mm penetration indicated a compact compactness. The natural moisture content measured in the soil sample was approximately 20%.

Upper Clayey Silt Till

Upper clayey silt till deposit was encountered below the upper silt deposit in Borehole BH301, and extended to a depth of about 5.6 m below the existing ground surface. An SPT N value of 32 blows per 300 mm penetration indicated a hard consistency. The natural moisture content measured in the soil sample was approximately 11%.

Sandy Silt Till

Sandy silt till deposit was encountered below the upper clayey silt till deposit in Borehole BH301, and extended to a depth of about 7.1 m below the existing ground surface. SPT N values ranging from 43 blows per 300 mm penetration indicated a dense compactness. The natural moisture content measured in the soil sample was approximately 8%.

Middle Silt and Sandy Silt

Middle silt to sandy silt deposits were encountered below the sandy silt till deposit in Borehole BH301, and extended to a depth of about 11.7 m below the existing ground surface. SPT N values ranging from 23 to 56 blows per 300 mm penetration indicated a compact to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 11% to 13%.

Lower Clayey Silt Till

Lower clayey silt till deposit was encountered below the middle silt and sandy silt deposit in Borehole BH301, and extended to a depth of about 13.2 m below the existing ground surface. SPT N values ranging from 23 to 58 blows per 300 mm penetration indicated a very stiff to hard consistency. The natural moisture content measured in the soil samples ranged from 11% to 14%.

Lower Silt

Lower silt deposit was encountered below the lower clayey silt till in Borehole BH301, and extended to a depth of about 14.7 m below the existing ground surface. An SPT N value of 65 blows per 300 mm penetration indicated a very dense compactness. The natural moisture content measured in the soil sample was approximately 18%.

Sandy Silt Till/Shale Complex

Sandy silt till/shale complex deposit was encountered below the lower silt deposit in Borehole BH301, and extended to a depth of about 16.1 m below the existing ground surface.

The "sandy silt till/shale complex" consists of a heterogeneous, very dense sandy silt till, containing extensive bedrock (shale) fragments. SPT N value greater than 100 blows per 300 mm penetration indicated a very dense compactness. The natural moisture content measured in the soil sample was approximately 9%.

Sand and Silt/Shale Complex

Sand and silt/shale complex deposit was encountered below the sandy silt till/shale complex in Borehole BH301, and extended to a depth of about 17.2 m below the existing ground surface. Borehole BH301 was terminated in this deposit.

The "sand and silt/shale complex" consists of a heterogeneous, very dense sand and silt, containing extensive bedrock (shale) fragments. SPT N value greater than 100 blows per 300 mm penetration indicated a very dense compactness. The natural moisture content measured in the soil sample was approximately 12%.

4.3 Groundwater Conditions

Groundwater condition observations were 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.

BH No.	BH Depth (m)	Depth of Water Encountered during Drilling (mBGS)	Cave-in Depth upon Completion of Drilling (mBGS)	Depth of Water upon Completion of Drilling (mBGS)
BH1	2.0	-	Open	Dry
BH2	2.0	-	Open	Dry
BH3	2.0	-	Open	Dry
BH4	2.0	-	Open	Dry
BH5	2.0	-	Open	Dry
BH6	2.0	-	Open	Dry
BH7	2.3	0.8	1.8	1.2
BH8	2.0	-	Open	Dry
BH9	2.0	-	Open	Dry
BH10	2.0	-	Open	Dry
BH11	2.0	-	Open	Dry
BH101	5.0	3.0	Open	4.6
BH102	5.0	4.6	4.3	Dry

BH103	5.0	3.0	-	-
BH104	5.0	-	Open	Dry
BH105	5.0	-	Open	Dry
BH106	5.0	-	Open	Dry
BH107	5.0	-	Open	Dry
BH108	5.0	-	Open	Dry
BH109	5.0	-	Open	Dry
BH110	2.7	-	Open	Dry
BH111	5.0	-	Open	Dry
BH112	5.0	-	3.6	-
BH113	5.0	-	Open	Dry
BH114	5.0	-	Open	Dry
BH115	5.0	1.5	Open	4.5
BH201	11.3	-	Open	10.7
BH202	12.7	-	Open	Dry
BH301	17.2	7.6	6.1	1.5

Note: mBGS = meters below ground surface

Six (6) monitoring wells (51 mm O.D.) were installed to monitor groundwater levels. The monitoring well construction details and measured groundwater levels are shown in the following table.

Monitoring Well ID	**Screen Interval (mBGS)**	**Water Level (mBGS) Date of Monitoring**		
		August 24, 2018	**November 8, 2018**	**November 28, 2018**
BH106	3.0 – 4.6	-	3.93	-
BH110	1.2 – 2.7	-	0.13	-
BH115	3.0 – 4.6	-	3.41	2.88
BH201	8.2 – 11.3	- 0.27*	- 0.75*	-
BH202	9.6 – 12.7	0.66	0.90	-
BH301	13.7 – 16.8	2.74	2.65	-

Note: mBGS = meters below ground surface
*artesian conditions

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

4.4 Laboratory Testing Results

In the laboratory, each soil sample was examined as to its visual and textural characteristics by the Project Engineer. Moisture content determinations were carried out on all granular base/subbase and subgrade soil samples.

Sieve analysis was completed on selected samples of the recovered granular base/subbase materials, and the results were compared to TS 1010 Granular A and Granular B Type I specifications. The gradation distribution curve for the sample is presented in Figure 1, and a summary of the results is provided in the following table.

Sample	OPSS 1010 Granular A	OPSS 1010 Granular B Type I
BH2 AS1	Does not meet requirements due to excessive percentages passing most sieves	Does not meet requirements due to excessive fines (21.8% passing 0.075 mm sieve)
BH5 AS1A	Does not meet requirements due to excessive percentages passing some sieves	Does not meet requirements due to excessive fines (12.1% passing 0.075 mm sieve)
BH11 AS1A	Does not meet requirements due to excessive percentages passing most sieves	Does not meet requirements due to excessive fines (24.8% passing 0.075 mm sieve)
BH105 AS1	Does not meet requirements due to excessive percentages passing most sieves	Meets the requirements

Grain size analysis was carried out on selected samples to confirm the visual descriptions of the subgrade soils. The summarized results are provided in the following table, and the grain size distribution curves of these samples are presented in Figures 2 and 3.

Soil Sample ID	Soil Depth (m)	Description	Susceptibility of Frost Heaving
BH4 SS3B	1.7 – 2.0	Clayey Silt Till	Low
BH5 SS3	1.5 – 2.0	Clayey Silt Till	Moderate
BH101 SS5	3.0 – 3.5	Silt	High
BH104 SS3A	1.5 – 1.7	Clayey Silt Till	Low
BH106 SS3	1.5 – 2.0	Clayey Silt Till	Moderate
BH108 SS5	3.0 – 3.5	Clayey Silt Till	Moderate
BH201 SS3A	1.5 – 1.8	Silt	High
BH202 SS3	1.5 – 2.0	Clayey Silt Till	Low
BH301 SS6	4.5 – 5.0	Clayey Silt Till	Low
BH301 SS8B	7.8 – 8.1	Clayey Silt Till	Moderate

5 DISCUSSION AND RECOMMENDATIONS

This report contains the findings of GeoPro's geotechnical investigation, together with 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 may not be sufficient to determine all 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 that 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. The construction methods discussed, however, express GeoPro's opinion only and are not intended to direct contractors on how to carry out construction. Contractors should also be aware that the data and interpretation presented in this report may not be sufficient to assess all factors that may have an effect on 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.

5.1 Pavement Designs for the Proposed Improvements

5.1.1 Traffic Data Analysis

Annual Average Daily Traffic (AADT) data in 2016 and predicted AADT in 2031 for Regional Road 25 were provided by the Client in an e-mail dated August 27, 2018. Traffic growth rate was approximately assumed by GeoPro based on the provided two years' AADT data. Should there be any more accurate traffic growth rates be available from any traffic study reports or other sources, the report should be reviewed by GeoPro and modifications to the recommendations in the report may be required.

The above mentioned traffic data were used to estimate the design Equivalent Single Axle Loads (ESALs). The traffic volumes were determined for a 20-year pavement design life, which is considered typical for pavements of this type. On this basis, the ESAL applications during design period were calculated in accordance with the MTO MI-183 Adaption and Verification of AASHTO Pavement Design Guide for Ontario Conditions. The total design ESALs anticipated over the 20-year design life period are summarized in the following table. The detailed traffic analysis and estimated ESALs for 20-year pavement design life are attached in Appendix C, Traffic Data Analyses.

Regional Road 25		**Parameters**				
Segment Name		**AADT (Year of 2016)**	**Commercial Vehicle**	**Annual Growth Rate**	**Combined Truck Factor**	**Estimated Total Design ESALs (20-Year)**
From	**To**					
Steeles Ave	Market Dr	31,500	5 %	3.3 %	1.21	9,650,000

Market Dr	Chisholm Dr	35,000	7 %	3.2 %	1.21	14,810,000
High Point Dr	James Snow Pkwy	21,000	15 %	3.7 %	1.21	20,510,000
James Snow Pkwy	Peddie Rd	19,000	18 %	3.3 %	1.21	21,110,000
Peddie Rd	5 Sideroad	16,000	15 %	3.6 %	1.21	15,360,000

5.1.2 Pavement Design

The subgrade soils within the project limits generally consisted of fill materials, clayey silt and silty/sandy soils based on GeoPro's borehole information. The resilient modulus of subgrade has been assumed to be 25 MPa. The pavement designs were developed based on the 1993 AASHTO Guide for Design of Pavement Structures and MTO MI-183 Adaption and Verification of AASHTO Pavement Design Guide for Ontario Conditions. Based on the estimated ESALs and the percentage of heavy traffics, the Regional Road 25 within the project limits has been divided into three (3) Sections for the pavement design as follows.

- Section 1: from Peddie Rd to 5 Sideroad and from Market Dr to Chisholm Dr;
- Section 2: Peddie Rd to High Point Dr; and
- Section 3: Steeles Ave to Market Dr.

The pavement design parameters are summarized in the following table.

Design Parameters	**Values**		
	Section 1	**Section 2**	**Section 3**
Design Life	20 Years	20 Years	20 Years
ESALs over Analysis Period (million)	15.4	21.2	9.7
Initial Serviceability Index	4.5	4.5	4.5
Terminal Serviceability Index	2.5	2.5	2.5
Reliability Level, %	90	90	90
Overall Standard Deviation	0.45	0.45	0.45
Design Subgrade Resilient Modulus, MPa	25	25	25
Design Structure Number	160	167	151
Existing Pavement			
Layer Coefficient of Hot Mix Asphalt	0.30		
Layer Coefficient of Granular Base/Subbase Course	0.09		
Drainage Coefficients of Base and Subbase Courses	1		
Reconstructed/Widening Pavements			
Layer Coefficient of Hot Mix Asphalt	0.42		

Layer Coefficient of Granular Base Course	0.14
Layer Coefficient of Granular Subbase Course Type II	0.14
Layer Coefficient of Granular Subbase Course Type I	0.09
Drainage Coefficients of Base and Subbase Courses	1.0

5.1.2.1 Existing Pavement Rehabilitation

Based on the visual condition survey and borehole information, the existing pavement generally appeared to be structurally adequate for the current/anticipated future traffic load for its remaining design life. Therefore, consideration may be given to partial-depth hot mix asphalt mill and overlay to address the primary distresses and restore the functional serviceability of the existing pavement structure to meet the proposed design life of the proposed improvements.

5.1.2.2 Conventional Mill and Overlay Rehabilitation for Existing Lanes with Grade Raise

The construction procedure may be considered as follows:

- Section 1 and 2: mill and remove 50 mm existing asphalt concrete and dispose off-site;
- Section 3: mill and remove 40 mm existing asphalt concrete and dispose off-site;
- Complete crack repairs to any longitudinal or transverse cracks;
- Section 1: Place 170 mm of hot-mix asphalt (130 mm of OPSS 1150 HDBC binder course in two lifts and one 40 mm lift of OPSS 1150 HL 1 surface course or 130 mm of OPSS 1151 SP19.0 binder course in two lifts and one lift of 40 mm OPSS SP12.5 FC2 surface course). The surface of the completed pavement should be provided with a grade of 2 percent. This option will result in a grade raise of 120 mm;
- Section 2: Place 120 mm of hot-mix asphalt (80 mm of OPSS 1150 HDBC binder course in one lift and one 40 mm lift of OPSS 1150 HL 1 surface course or 80 mm of OPSS 1151 SP19.0 binder course in one lift and one lift of 40 mm OPSS SP12.5 FC2 surface course). The surface of the completed pavement should be provided with a grade of 2 percent. This option will result in a grade raise of 70 mm; and
- Section 3: Place 80 mm of hot-mix asphalt (40 mm of OPSS 1150 HDBC binder course in one lift and one 40 mm lift of OPSS 1150 HL 1 surface course or 40 mm of OPSS 1151 SP19.0 binder course in one lift and one lift of 40 mm OPSS SP12.5 FC2 surface course). The surface of the completed pavement should be provided with a grade of 2 percent. This option will result in a grade raise of 40 mm.

Following the completion of milling, the exposed pavement surface should be inspected and any additional repairs (full-depth repairs to moderate to severe longitudinal and alligator cracking areas) should be completed prior to overlay placement. Any cross-fall improvements that may be required should be addressed by placement of an OPSS 1150 HL 3 HS levelling/padding course prior to placement of the HDBC binder course and HL 1 surface course. The milled surface should

be properly cleaned (power broomed and/or washed, as necessary) and tack coated using SS-1 emulsified asphalt prior to placement of any new hot mix asphalt.

This mill and overlay option should be adequate to restore the pavement ride quality and address the major distresses. However, some reflective cracking should be expected to occur within the first two to three years that will require crack sealing to prevent the ingress of moisture into the pavement.

The constructed pavement Structural Number is 162 at Section 1, 168 at Section 2 and 164 at Section 3, which are greater than the Design Structural Numbers (160/167/151). As such, the pavement is structurally adequate for the expected traffic load of 20-year design life with a regular maintenance.

5.1.2.3 Full-Depth Reclamation (Pulverization) with HMA Overlay for Existing Lanes with Grade Raise

It is understood that the proposed installations of underground utilities within the existing roadway are anticipated. As an alternative option, a full-depth reclamation (pulverization) with hot-mix asphalt overlay may be considered to rehabilitate the existing pavement structure.

The full-depth reclamation pavement structures are shown in the following table:

Material	Structural Layer Coefficient (αi)	Drainage Coefficient (mi)	Thickness of Pavement (mm)		
			Section 1	Section 2	Section 2
Hot-Mix Asphalt (OPSS 1150/ OPSS 1151)	0.42	1.0	180 HL 1/SP12.5 FC2 (50) HDBC/SP19.0 (130)	180 HL 1/SP12.5 FC2 (50) HDBC/SP19.0 (130)	180 HL 1/SP12.5 FC2 (50) HDBC/SP19.0 (130)
New Granular A Base (OPSS.MUNI 1010)	0.14	1.0	150	70	150
Pulverized Materials	0.12	1.0	240	200	200
Remaining Granular Base/Subbase	0.09	1.0	410	640	350
Total Thickness			**980**	**1090**	**880**

The construction procedure may be considered as follows:

- Section 1: mill and remove 75 mm existing asphalt concrete by milling and dispose off-site;
- Section 2: mill and remove 120 mm existing asphalt concrete by milling and dispose off-site;

- Section 3: mill and remove 240 mm existing asphalt concrete by milling and dispose off-site;
- Pulverize remaining asphalt concrete including the underlying granular base/subbase material to a depth of 240 mm (Section 1) and 200 mm (Sections 2 and 3) from the pavement centreline to the edge of the pavement; grade and compact to 100 percent of SPMDD;
- The exposed pulverized base should be carefully proofrolled using a heavily loaded truck in conjunction with the inspection by the geotechnical engineer from GeoPro; any soft, segregated or wet spots shall be repaired in accordance with the instructions provided in the section **"**Full-Depth Base Repairs";
- Section 1: place 150 mm of OPSS.MUNI 1010 Granular A or 19 mm Crusher Run Limestone base course and compact to 100 percent of SPMDD;
- Section 2: place 70 mm of OPSS.MUNI 1010 Granular A or 19 mm Crusher Run Limestone base course and compact to 100 percent of SPMDD;
- Section 3: place 150 mm of OPSS.MUNI 1010 Granular A or 19 mm Crusher Run Limestone base course and compact to 100 percent of SPMDD; and
- Place 180 mm of hot-mix asphalt (130 mm of OPSS 1150 HDBC binder course in two lifts and one 50 mm lift of OPSS 1150 HL 1 surface course; or 130 mm of OPSS 1151 SP19.0 binder course in two lifts and one lift of 50 mm OPSS SP12.5 FC2 surface course). The surface of the completed pavement should be provided with a grade of 2 percent. This option will result in a grade raise of 255 mm, 130 mm and 90 mm at Section 1, 2 and 3 respectively.

Adoption of this pavement rehabilitation option will result in a grade raise of about 90 mm to 255 mm. The grade raise will impact the intersection roads and side entrances, which should be considered by the design engineer.

The rehabilitated pavement Structural Number is 162 for Section 1, 167 for Section 2 and 152 for Section 3, which is greater than or equal to the Design Structural Number (160/167/151). As such, the proposed pavement structure will be structurally adequate for the expected traffic loads over the 20-year design period with regular maintenance.

5.1.2.4 New Pavement Structure on Widening Areas and Full-Depth Reconstruction for Existing Lanes at Road Section 1 ,2 and 3.

Based on the anticipated traffic volumes on the Regional Road 25 within the project limits, the recommended new pavement structure for the widening areas is shown in the following table.

Material		Thickness of Pavement (mm)		
		Section 1	**Section 2**	**Section 3**
Hot-Mix Asphalt (OPSS 1150/ OPSS 1151)	HL 1/SP12.5 FC2 Surface Course	50	50	50
	HDBC/SP19.0 Binder Course	130 (2 lifts)	130 (2 lifts)	130 (2 lifts)
Granular Material (OPSS.MUNI 1010)	Granular A Base (19 mm Crusher Run Limestone)	150	150	150
	Granular B Type II/ Type I Subbase (or 50 mm Crusher Run Limestone)	460/715 *	510/795 *	400/625 *
Total Pavement Thickness (mm)		790/1045	840/1125	730/955
Prepared and Approved Subgrade				

* Minimum thickness of subbase; the subbase thickness should match the existing subbase depth of the adjacent pavement structure to be rehabilitated.

Should a full-depth reconstruction be considered for Regional Road 25 within the project limits, the recommended pavement structure for the full-depth reconstruction may be considered using the new pavement structure shown in the table above.

The construction procedure may be considered as follows:

- Existing Lanes (if required): completely remove the existing asphalt concrete, granular base/subbase and subgrade soils to the depth required to accommodate the new pavement structure (about 790 mm (Section 1), 840 mm (Section 2) and 730 mm (Section 3) below the proposed pavement surface for pavement with Granular B Type II Subbase; about 1045 mm (Section 1), 1125 mm (Section 2) and 955 mm (Section 3) below the proposed pavement surface for pavement with Granular B Type I Subbase);
- Widening Areas: completely remove the existing topsoil, organic matter and any other obviously deleterious materials to the depth required to accommodate the new pavement structure (about 790 mm (Section 1), 840 mm (Section 2) and 730 mm (Section 3) below the proposed pavement surface for pavement with Granular B Type II Subbase; about 1045 mm (Section 1), 1125 mm (Section 2) and 955 mm (Section 3) below the proposed pavement surface for pavement with Granular B Type I Subbase);
- The exposed subgrade surface should be graded and compacted to 98 percent of SPMDD;
- The prepared subgrade should be carefully proofrolled using a heavily loaded truck in conjunction with the inspection by the geotechnical engineer from GeoPro; any soft/loose or wet areas or other obviously deleterious materials must be excavated and properly replaced with material similar to the existing subgrade soils or other granular soils approved by the geotechnical engineer;
- All backfill materials should be placed in uniform loose lifts not exceeding 200 mm thickness and compacted to at least 98 percent of SPMDD. The finished subgrade should be provided with a grade of 3 percent towards the positive drainages;

- Place a minimum of 460 mm (Section 1), 510 mm (Section 2) and 400 mm (Section 3) OPSS.MUNI 1010 Granular B Type II subbase or a minimum of 715 mm (Section 1), 795 mm (Section 2) and 625 mm (Section 3) OPSS.MUNI 1010 Granular B Type I subbase or 50 mm Crusher Run Limestone subbase course in loose lifts not exceeding 200 mm thickness, compact to 100 percent of SPMDD;
- Place 150 mm of OPSS.MUNI 1010 Granular A or 19 mm Crusher Run Limestone base course and compact to 100 percent of SPMDD; and
- Place 180 mm of hot-mix asphalt (130 mm of OPSS 1150 HDBC binder course in two lifts and one 50 mm lift of OPSS 1150 HL 1 surface course; or 130 mm of OPSS 1151 SP19.0 binder course in two lifts and one lift of 50 mm OPSS SP12.5 FC2 surface course). The surface of the completed pavement should be provided with a grade of 2 percent.

The constructed pavement Structural Number is 161 (Section 1), 168 (Section 2) and 152 (Section 3) which is greater than the Design Structural Number (160/167/151). As such, the proposed pavement structure would be structurally adequate for the expected traffic load of the 20-year design life with regular maintenance.

5.1.2.5 Full-Depth Base Repairs

For the existing lanes rehabilitation, any soft or wet spots observed during proof-rolling and the areas which exhibit severe pavement distresses (i.e. severe alligator cracking, longitudinal cracking and depression) will require full-depth repairs discussed as follows.

- The granular base/subbase materials should be removed to expose the subgrade;
- The exposed subgrade surface should be graded and compacted to 98 percent of SPMDD, the surface of the subgrade should be provided with a minimum cross-fall of 3 percent;
- The exposed subgrade should be inspected and sub-excavated as necessary to provide a competent subgrade for the specified base repair. Any soft, loose, disturbed, wet, organic soils and any other deleterious materials must be removed and replaced with material similar to the subgrade soils or other granular soils approved by the geotechnical engineer. The subexcavations must be inspected by the geotechnical engineer from GeoPro. The backfill materials should be placed in loose lifts not exceeding 200 mm and compacted to at least 98 percent of SPMDD; and

Place OPSS.MUNI 1010 Granular B Type I to match the adjacent granular subbase thickness in uniform loose lifts not exceeding 200 mm on the approved subgrade. This should be followed by OPSS.MUNI 1010 Granular A placed on the approved granular subbase in uniform loose lift thickness not exceeding 200 mm to match the adjacent granular base thickness. All granular materials should be compacted to 100 percent of SPMDD.

5.1.3 Drainage Improvements

Control of surface water is an important factor in achieving a good pavement service life. Therefore, we recommend that provisions be made to drain the new pavement subgrade and its granular layers. It is understood that the proposed improvements are anticipated to consist of typical urban section (concrete curb/gutter and catchbasins). To provide positive drainage across the pavement platform, the pavement surface should be sloped at a grade of 2 percent and the pavement subgrade should be sloped at a grade of 3 percent towards the subdrains. Subdrains should be designed and constructed in accordance with OPSS or local municipality specifications, and the subdrain pipe should be connected to a positive outlet.

5.1.4 General Pavement Recommendations

5.1.4.1 Pavement Materials

The following hot-mix asphalt mix types should be selected:

- HL 1 & SP12.5FC2 Surface Course; and
- HDBC & SP19.0 Binder Course

These hot mix asphalt mixes should be designed and produced in conformance with OPSS 1150 or OPSS 1151 requirements.

Granular A and Granular B Type I materials should be used as base course and subbase course, respectively. Both the Granular A and Granular B Type II/Type I materials should meet OPSS.MUNI 1010 specifications and local municipality specifications.

5.1.4.2 Asphalt Cement Grade

Performance graded asphalt cement PGAC 64-28 conforming to OPSS 1101 requirements is recommended for the HMA surface and binder course.

5.1.4.3 Tack Coat

A tack coat (SS1) should be applied to all construction joints prior to placing hot mix asphalt to create an adhesive bond. Prior to placing hot mix asphalt, SS1 tack coat must also be applied to all existing surfaces and between all new lifts in accordance with OPSS 308 requirements.

5.1.4.4 Compaction

All granular base and subbase materials should be placed in uniform lifts not exceeding 200 mm loose thickness and compacted to 100 percent of the material's SPMDD at ±2 percent of the materials Optimum Moisture Content (OMC). Hot mix asphalt should be placed and compacted in accordance with OPSS 310 specifications.

5.1.4.5 Pavement Tapers

At the limits of construction, appropriate tapering of the pavement thickness to match the existing pavement structure should be implemented in accordance with OPSS and the applicable local municipality specifications.

5.1.4.6 Subgrade Preparation

All topsoil, and any organic or other unsuitable soils should be stripped from the subgrade area. Following stripping, the site should be graded to the subgrade level and approved. The subgrade should then be proofrolled by a heavily loaded truck, in the presence of the geotechnical engineer from GeoPro. Any soft spots exposed during the proofroll should be completely removed and replaced by selected fill materials, similar to the existing subgrade soils and approved by the geotechnical engineer from GeoPro. The subgrade should then be re-compacted from the surface to at least 98% of its SPMDD. If the moisture contents of the local soil materials cannot be maintained at ±2% of the OMC, imported select materials may need to be used.

The final subgrade should be properly shaped to facilitate rapid drainage and to prevent the accumulation of water. Proper shaping which allows the water to escape towards the sides (where it can be formation of local depressions in which water could be removed by means of subdrains or ditches) should be considered for the project. Otherwise, any water trapped in the granular base material may cause problems due to softened subgrade, and differential frost heave, etc.

Any fill materials required for re-grading the site or backfill should be free of topsoil, organic or any other unsuitable matter and must be approved by the geotechnical engineer from GeoPro. The approved fill materials should be placed in thin layers not exceeding 300 mm (uncompacted loose lift thickness) and compacted to at least 98% of its SPMDD or as per local municipal standards. The placing, spreading and rolling of the subgrade should be in accordance with OPSS or local municipal standards.

Frequent field density tests or full-time inspection should be carried out by the geotechnical engineer from GeoPro based on the project specifications or follow OPSS or local municipal standards.

5.1.4.7 Reuse and Disposal of Existing Pavement Materials

It should be noted that gradation analyses indicated that most of the selected samples of the existing granular base and subbase materials do not meet the OPSS 1010 granular A and B Type I gradation specifications as they contained an excessive content of fines. Therefore, the existing excavated granular materials could not be reused as subbase/base materials, however, they can be reused as subgrade material to replace soft, wet or otherwise disturbed areas identified during proofrolling.

5.1.4.8 Maintenance

Systematic routine preventative maintenance is strongly recommended for all newly constructed pavements. Crack routing and sealing will generally be required within 2 to 3 years after pavement construction. As the pavement ages, it will also be necessary to patch areas of medium to high severity distresses, such as potholes and ravelling. Routine maintenance should also be considered to extend the life of the pavement.

5.2 Proposed Culvert Replacement (Boreholes BH201 and BH202)

5.2.1 Site and Project Description

The existing rectangular Reinforced Concrete and Soil-Steel Ellipse Culverts is located on the Reginal Road 25 between Market Drive and Chisholm Drive. It is understood that the culvert will be replaced with a new culvert structure. However, the information of the dimension and type of the proposed new culvert was not available at the time of preparing the report. It is understood that the culvert replacement will be designed in accordance with the 2006 Canadian Highway Bridge Design Code (CHBDC).

5.2.2 Foundation Design Considerations

Based on the results of this investigation, the fill materials are considered unsuitable to support the proposed culvert/wing wall and should be completely removed within the footprint of the culvert. The proposed culvert may be founded in the native, undisturbed and competent soil deposits. The soil bearing resistances at the Serviceability Limit State (SLS) and a factored bearing resistances at the Ultimate Limit State (ULS), together with the corresponding founding depths at the borehole locations and the anticipated soils are provided in the following table.

Borehole No.	Bearing Resistance at SLS (kPa)	Factored Geotechnical Resistance at ULS (kPa)	Minimum Depth Below Existing Ground (m)	Anticipated Bearing Soil
BH201	200	300	2.0	Clayey silt till
BH202	200	300	1.6	Clayey silt till

The proposed founding soils to be exposed at the founding/subgrade level are susceptible to disturbance from construction traffic and ponded water, leading to degradation of the founding soils. To limit this detrimental condition, a working mat of consisting of at least 100 mm lean concrete (i.e. 10 MPa) should be placed on the subgrade as soon as possible after the base of excavation has been inspected and approved by the geotechnical engineer from GeoPro, unless the foundation concrete is to be placed immediately.

Box Culvert Option

Alternatively, consideration may be given to box culvert founded at shallow depths on granular engineered fill materials. The existing fill materials and obviously deleterious materials shall be excavated to a minimum depth of 0.5 m below the proposed founding elevation and replaced with engineered fill bedding materials consisting of Granular A and Granular B Type I. The subgrade should then be proofrolled, in the presence of the geotechnical engineer from GeoPro. Any soft spots exposed during the proofroll should be completely removed and replaced by Granular B Type I fill materials. The subgrade should then be re-compacted from the surface to at least 98% of its SPMDD. Following the approval of the subexcavated subgrade by a geotechnical engineer from GeoPro, the engineered granular fill pad (i.e. at least upper 200 mm of Granular A over at least 300 mm of Granular B Type I) should be placed in layers not exceeding 200 mm loose thickness and compacted to a minimum of 100 percent of the material's standard Proctor maximum dry density (SPMDD). The engineered granular fill pad should extend at least 0.5 m beyond the edge of box culvert with a minimum thickness of 0.5 m on the approved subgrade soils. A full time inspection and compaction testing should be carried out by GeoPro during construction stage. A geotechnical bearing resistance of 200 kPa at Serviceability Limit States (SLS) and a factored geotechnical bearing resistance of 300 kPa at Ultimate Limit States (ULS) may be used for the design of the box culvert bearing on the engineered granular fill pad.

It is recommended that a 75 mm thick levelling pad of Granular A or concrete fine aggregate (meeting the gradation requirements in OPSS 1002) be placed on top of the approved subgrade to facilitate positioning and seating of the culvert segment(s).

All foundation bases must be inspected by GeoPro prior to pouring concrete to confirm the design bearing values.

Foundations designed to the specified bearing resistance values at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 19 mm differential.

Where it is necessary to place foundations at different levels, the upper foundation must be founded below an imaginary 7 vertical to 10 horizontal (7V:10H) line drawn up from the base of the lower foundation. The lower footing must be installed first to help minimize the risk of undermining the upper footing.

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.

5.2.3 Subgrade Protection, Frost Protection and Scour Protection

The existing fill materials 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 may have to be considered to provide a stable work plat form.

It should be noted that the proposed founding level should be at least 1.2 m below the proposed final grade to provide sufficient earth cover for frost protection unless the culvert is designed to withstand the frost pressures. 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.

If the water course flow velocities are sufficiently high, provision should be made for scour and erosion protection for the new culvert. For culvert protection, there are two treatment zones to be considered, namely the embankment and the creek channel. If required, a seal of compacted cohesive clayey soil at least 300 mm thick may be placed in front and at the sides of the culvert inlet to prevent water infiltrations to the sides and below the culvert which could wash out the granular base and backfill material. The culvert inlet should also be protected with at least 0.6 m thick rip rap and extending to a minimum 1 m beyond the clay seal. Clay seal may not be required at the outlet but it should also be protected with at least 0.6 m rip rap.

The requirements for design of erosion protection measures for the inlet and outlet of the proposed culvert should be considered by design engineers. As a minimum, rip rap treatment for the outlet of the culvert should be consistent with the standard presented in OPSD 810.010 (Rip-Rap Treatment for Sewer and Culvert Outlets).

Frost treatment (i.e. frost taper) should be designed and constructed as per OPSD 803-030 and 803-031.

5.2.4 Sliding Resistance

Resistance to lateral forces / sliding resistance between the culvert footing base concrete and the subgrade should be calculated in accordance with Section 6.7.5 of the CHBDC. The coefficient of friction may be considered as follows:

- Coefficient of friction between Pour-in-place concrete footings and native soils = 0.35 (unfactored)

- Coefficient of friction between precast concrete footings and native soils = 0.25 (unfactored)

- Coefficient of friction between pour-in-place concrete footings and Granular A Pad = 0.55 (unfactored)

- Coefficient of friction between precast concrete footings and Granular A pad = 0.45 (unfactored)

It should be noted that the values are unfactored; and in accordance with CHBDC, a factor of 0.8 may be applied in calculating the horizontal resistance.

5.2.5 Temporary Excavations and Groundwater Control

It is anticipated that foundation excavations at the site will consist of temporary open cuts with side slopes not steeper than 1.5 horizontal to 1 vertical (1.5H:1V). However, depending on the construction procedures adopted by the contractor and weather conditions at the time of construction, some local flattening of the slopes should be required, especially in looser/softer zones (i.e. in fills) or where localized seepage is encountered. All excavations should be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. According to the Act, the existing fills and native silty/sandy deposits would be classified as Type 3 soils above groundwater table and Type 4 below the groundwater table; the very stiff to hard clayey deposits would be classified as Type 2 soil above groundwater table and Type 3 soil below groundwater table.

The excavations for proposed culvert are anticipated to go through the existing fill materials, native clayey silt, silt and clayey silt till deposits. If space permits, open-cut excavations to the proposed depths are anticipated to be carried out in accordance with the guidelines outlined in the occupational Health and Safety Act (OHSA) for Construction Activities. In addition, care must be taken during excavation to ensure that adequate support is provided for any existing structures and underground services located adjacent to the excavations.

Should adjacent structures and/or utilities be susceptible to damage from construction induced settlement, a more positive excavation support system may be considered.

As shown above, measured groundwater levels at the site range from 0.75 m above the existing ground surface to 0.9 m below the existing ground surface. Excavation is anticipated to occur mostly below prevailing groundwater table. Groundwater control at the site should be required to allow for construction of foundation elements in a dry condition. Groundwater control during excavation within the very stiff to hard clayey till deposits 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 and native silty/sandy soils above the groundwater tables at various depths. Groundwater control during excavation within the fill materials and silty/sandy deposits above the groundwater tables at the site can be handled, as required, by pumping from properly constructed and filtered sumps located within the excavations. However, more significant groundwater seepage should be expected from any water bearing fill materials and cohesionless sandy/silty deposits below the prevailing groundwater tables during the time of construction and any wet silty/sandy layers/zones within clayey silt till deposits. Depending on the thickness and extent of the wet soil deposits/layers, some form of positive groundwater control (well points or eductors) may be required to maintain the stability of the excavations in addition to pumping from sumps. The groundwater level should be lowered to at least 1 m below the excavation base prior to excavating for the site services. 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).

Depending on the construction procedures and groundwater control measures adopted by the contractor and weather conditions at the time of construction, cut off measures, such as sheet pile wall may be required to improve the effectiveness of the groundwater control measures in addition to pumping from sumps. Subject to the effectiveness of the groundwater control measures, sheet pile wall in conjunction with tremie concrete may be considered to achieve a stable work platform; a provisional cost may be considered in the contract.

Pumping discharges should conform to the guidelines from local municipality, MOECC, conversation authority and other relevant agencies.

Control of the surface flow water, if any, at the base of the excavation from the existing water course may be necessary at the culvert site in order for foundation construction to be carried out in dry conditions. Depending on the water flow at the time of construction, surface water could flow through the culvert area by means of a temporary pipe, if required.

Surface water should be directed away from the excavation area, to prevent ponding of water that could result in disturbance and weakening of the foundation subgrade.

Depending on the construction staging sequence and schedule, temporary roadway protection may be required along the roadway to facilitate the culvert construction works.

5.2.6 Lateral Earth Pressures for Culvert Designs

The following recommendations are made concerning the design of the wing walls, assuming that the backfill to the culvert and wing walls consists of free-draining granular fill meeting the requirements of OPSS 1010 Granular A or Granular B Type II. This fill should be compacted in loose lifts not greater than 200 mm in thickness to 95 per cent of the material's Standard Proctor maximum dry density in accordance with OPSS 501. The fill materials should be benched into the existing roadway embankment side slopes. Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill. Other aspects of the granular backfill requirements with respect to subdrains and frost taper should be in accordance with applicable Ontario Provincial Standard Drawings.

Computation of earth pressures acting against any wing walls should be in accordance with the applicable Canadian Highway Bridge Design Code (CHBDC). For design purposes, the following properties can be assumed for 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.

A minimum compaction surcharge of 12 kPa should be included in the lateral earth pressures for the structural design of the walls, according to CHBDC Section 6.9.3 and Figure 6.6. Other surcharge loadings should be accounted for in the design as required.

The above calculation yields lateral pressures due to soil loading only. If the culvert is intended to become partially submerged during the design flood event, then appropriate hydrostatic pressures below the water table should be added to the earth pressures calculated as above in order to obtain the total lateral pressure acting on the culvert.

The fill depth during placement should be maintained equal on both sides of the culvert walls, with one side not exceeding the other by more than 500 mm.

The use of heavy vibratory equipment behind the culvert and any other below-grade structures should be limited within a lateral distance equal to the height of the backfill (at the time of compaction) above the base of the structure. If required, GeoPro can provide additional assistance with the refinement of design earth pressure parameters based on the type of culvert selected, dimensions, etc.

5.3 Preliminary Geotechnical Input for Proposed CNR Overpass Bridge

The existing CNR overpass bridge is located on the Reginal Road 25 approximately 300 meters north of Steeles Avenue. It consists of a 23 m wide Through-Girder structural steel span with abutments and retaining walls. As part of the transportation corridor improvement, the CNR overpass bridge is to be improved to accommodate the six (6) lane cross-section including active transportation. The upgraded overpass bridge is assumed to be supported by the retaining-wing walls and abutments similar to the existing bridge. A detour and a temporary bridge may be required to maintain the railway active transportation. A detailed geotechnical investigation shall be carried out once the planning and preliminary designs of the proposed overpass bridge are available.

Based on the limited borehole in the vicinity of the bridge location, preliminary foundation design input and comments are provided as follows.

- Based on the subsurface conditions, the following preliminary foundation options have been considered for the replacement / modification of the existing railway bridge structure. Railway detour and staging or a temporary bridge should be considered as part of the preliminary designs.

  Shallow Foundations in Hard/Dense Till Deposits

  All spread footings should be provided with a minimum of 1.2 m of soil cover for frost protection (in accordance with Section 3.3.1 of the American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering). Based on the results of this preliminary investigation, the proposed upgraded retaining-wing walls and abutments may be founded on conventional shallow spread and/or continuous strip footings bearing in the native, undisturbed, competent clayey silt till deposits at a minimum depth of 4.0 m below ground surface. Assuming a minimum 1.5 m width for

the footings, the preliminary soil bearing resistances at Serviceability Limit State (SLS) of 300 kPa may be considered.

The artesian groundwater conditions present at the site shall be considered in the detailed design in determining the founding elevation of the shallow foundation in conjunction with the considerations of excavations and groundwater control.

Steel H-Piles Founded in the Probable Shale

Steel H-piles driven to refusal into the shale bedrock may be considered to support the bridge foundations, however, driving piles through the till containing cobbles and boulders will be difficult, which should be considered in the design.

The preliminary vertical axial geotechnical resistance of an HP pile driven to an adequate set in the sound shale 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*

*in the sound shale bedrock; a detailed geotechnical investigation including rock coring shall be considered during the detailed design stage to confirm the above provided bearing resistances.

The Serviceability Limit States (SLS) condition will not govern for piles founded on bedrock.

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

The structural resistance of the pile must 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 the Canadian Highway Bridge Design Code (CHBDC) and/or American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering and relevant requirements from CNR.

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 the applicable CHBDC and/or AREMA manuals. Additionally, there is a potential for upward flow of groundwater and migration of fine soil particles due to the artesian groundwater

conditions present at the site, which shall be further evaluated and investigated during the detailed design stage.

Caissons Founded in the Probable Shale

The preliminary vertical concentric geotechnical resistance of augered piles (caissons) socketed in the sound bedrock for at least 2 m can be designed using a factored bearing resistance of 3.0 MPa to 4.0 MPa at Ultimate Limit State (ULS). Sound bedrock is considered to be unyielding. The geotechnical resistance under Serviceability Limit State (SLS) corresponding to 25 mm settlement is anticipated to be higher than the factored geotechnical resistance at ULS. The design is governed by the factored ULS. A detailed geotechnical investigation including rock coring shall be considered during the detailed design stage to confirm the above provided bearing resistances.

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 the applicable CHBDC and/or AREMA manuals. Additionally, there is a potential for upward flow of groundwater and migration of fine soil particles due to the artesian groundwater conditions present at the site, which shall be further evaluated and investigated during the detailed design stage.

The minimum diameter of the caisson should be 0.75 m to facilitate the downhole inspection. All pile caps should be provided with at least 1.2 m of earth cover after final grading, in order to minimize the potential for damage due to frost action. Due to the presence of water-bearing cohesionless deposits and presence of artesian groundwater conditions, temporary or permanent liners would be required to maintain the caisson hole open, but there is still a risk of loosening the soils at the base of the caisson. In addition, caisson installation through the till containing cobbles and boulders will be difficult, which shall be considered in the designs.

- The final railway bridge abutment walls, piers, wingwalls and permanent side wall support system and detouring consideration will need to be determined during detailed design when more details are available. 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.

- 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.

- 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 and certified by their engineers. The global stability of the Retained Soil System should be checked by a geotechnical engineer.

- The type of the retaining wall was not available at the time of preparing the report. Sliding resistance between the proposed retaining wall base and subgrade should be calculated in accordance with applicable manual(s) or guidelines. For preliminary design purposes, the coefficients of friction summarized in the following table may be assumed between the retaining wall base and the subgrade soils. This value is unfactored and a sufficient factor of safety should be applied in calculating the horizontal resistance.

Coefficient of friction between pour-in-place concrete footings and native soils	μ= 0.35 (unfactored)
Coefficient of friction between precast concrete footings and native soils	μ= 0.25 (unfactored)

- The external modes of failure, such as overturning and global instability (circular failures), should be checked in conjunction with sliding and bearing capacity modes of failures by the engineer/designer. Global stability analysis must be carried out by the geotechnical engineer once the detailed retaining wall design is available. The required minimum factor of safety for sliding and overturning should be 1.5 and 2.0 respectively. The required minimum factor of safety for global stability should be 1.5. The applicable factor of safety shall satisfy the requirements of CHBDC and/or AREMA.

- The surcharge from the compaction and the railway traffic in accordance with the requirements of CHBDC and AREMA shall be included in the lateral earth pressures for the structural design of the permanent walls as well as temporary shoring structures and embankment. Other surcharge loadings including the construction equipment and material stockpile should be accounted for in the design as required.

- Open cutting may be considered for the spread footings for the abutments, potential piers and retaining walls. All excavations should be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. According to the Act, the existing fills and native silty/sandy deposits would be classified as Type 3 soils above groundwater table and Type 4 below the groundwater table; the hard clayey deposits and dense till deposits would be classified as Type 2 soil above groundwater table and Type 3 soil below groundwater table. Should adjacent structures and/or utilities be susceptible to damage from construction induced settlement, a more positive excavation support system may be considered.

- Groundwater control at the site should be required to allow for construction of foundation elements in a dry condition. Groundwater control during excavation within the hard clayey deposits and dense till soils 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 and native silty/sandy soils above the groundwater tables at various depths. Groundwater control during excavation within the fill materials and silty/sandy deposits above the groundwater tables at the site can be handled, as required, by pumping from properly constructed and filtered sumps located within the excavations. However, more significant groundwater seepage should be expected from any water bearing fill materials and cohesionless sandy/silty deposits below the prevailing groundwater tables during the time of construction and any wet silty/sandy layers/zones within clayey silt till deposits. Depending on the thickness and extent of the wet soil deposits/layers, some form of positive groundwater control (well points or eductors) may be required to maintain the stability of the excavations in addition to pumping from sumps. The groundwater level should be lowered to at least 1 m below the excavation base prior to excavating for the site services. 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).

  Pumping discharges should conform to the guidelines from local municipality, MOECC, conversation authority and other relevant agencies.

  Surface water should be directed away from the excavation area, to prevent ponding of water that could result in disturbance and weakening of the foundation subgrade.

  Depending on the construction staging sequence and schedule, temporary roadway protection and detour arrangement would be required along the roadway to facilitate the construction works.

- Construction of the new abutments and potential piers will require soil excavation and partial or full removal of the existing abutments and existing elevated railway embankment. Construction activities may require temporary earth support systems. In some locations the native sandy soils and fills may become saturated under wet weather conditions. There may be localized sloughing and surface instability in some soil slopes. The Contractor should control groundwater, surface water infiltration and soil erosion during construction. The reuse of the excavated native soils or fill materials as structural backfill is not recommended. The existing fill materials and native soils may only be used as common earth borrow materials for approach embankment construction at this site,

subject to the environmental quality of the soils. Boreholes on the existing elevated railway embankment should be considered in the detailed geotechnical investigation.

- In view of the limited space at the site, excavations supported by a temporary shoring system consisting of soldier piles and timber lagging or sheet pile walls may be required. Unsupported open cut excavation may be utilized in areas where sufficient space exists. The potential impacts and suitable protection for the nearby buried service utilities should also be considered in the design and construction of a temporary support system. The shoring system must be designed in accordance with the 4th Edition of the Canadian Foundation Engineering Manual as well as the requirements of applicable CHBDC and AREMA.

- Any topsoil, existing fill materials and existing native soils should not be reused as backfill materials of the retaining walls. A geotextile/fabric should be placed between retaining wall granular backfill materials and existing soils to mitigate the migration of fines. Subject to the type of the retaining walls, a geotextile/fabric should be placed between retaining walls and the granular backfill materials to mitigate the migration of fines.

- As a minimum requirement, the granular backfill should be placed in the wedge-shaped zone defined by a 45 degree line extending up and back from the bottom of the rear face of the bottom of the retaining wall footing.

  Should any flexible retaining wall system (such as armour stone walls, concrete block walls and gabion walls) be considered, the extent of granular backfill should be greater than the height of the retaining wall and geogrid reinforcement in the granular backfill must be considered. These types of retaining walls must be designed by a professional engineer who is familiar with this type of design.

- Following approval of the founding subgrade by a geotechnical engineer from GeoPro, free-draining granular fill, in accordance with the OPSS Granular A and Granular B, or as specified by the retaining wall designer, should be used as backfill immediately behind the retaining wall. In this regard, the existing soils are considered unsuitable for this purpose. The granular backfill materials shall be placed in layers not exceeding 200 mm loose thickness and uniformly compacted to at least 98 percent of its SPMDD. If only a small sized compaction machine can be used due to the site restriction, the granular backfill shall be placed in thinner loose lifts such as 100 mm to 150 mm.

  The use of vibratory compaction equipment behind the retaining walls should be restricted in size. Heavy compaction equipment, however, should not be used within the lateral distance behind any structure equal to the current height of the fill above the base of the structure.

- The existing elevated embankment may need to be widened to accommodate the potential needs for railway detouring. Embankment slopes less than 4.0 m in height and

constructed using local or imported fills are expected to have a sufficient deep seated factor of safety provided the slope angle is not steeper than 2H:1V and all soft/loose materials and any other deleterious materials are completely removed from the embankment areas. A global stability analysis shall be considered for the fill embankments higher than 4.0 m or for slopes that are steeper than 2H:1V. Earth grading and compaction for the embankment should be carried out in accordance with the requirements from the applicable OPSS, OPSD, CHBDC and AREMA.

Geotechnical evaluation of embankment stability should be carried out for fill embankments in consideration of the surcharge load from the railway traffic and other applicable requirements of AREMA.

- Engineered fills using clean earth fill compacted to 100% of Standard Proctor Maximum Dry Density (SPMDD) will settle under its own weight approximately 0.25% to 0.75% of the fill thickness on a non-yielding subgrade. The settlement of the engineered fill will occur with time. For engineered fill consisting of sandy silt to silty sand material, about 75% of the settlement is expected to occur within 3 months after the placement of the engineered fill; for engineered fill consisting of clayey silt to silty clay material, about 75% of the settlement is expected to occur within 3 to 6 months or longer after the placement of the engineered fill.

- Consideration should be given to removing and replacing the existing fill materials prior to placing embankment fills. For the embankment found on hard clayey silt till the magnitude of settlement in the hard clayey silt till is anticipated to be negligible.

- Settlement monitoring shall be carried out for the high fill embankment, to monitor the magnitude and rate of settlement during fill placement. The monitoring program should consist of installation of a series of settlement plates within the embankment areas, which would be surveyed by GeoPro at regular intervals for the duration of the engineered fill placement.

- The monitoring of track settlement and stability of the railway should be considered by means of surface and subsurface settlement points. The intent of subsurface settlement points is to measure any soil movement potentially caused by construction.

- The 2012 Ontario Building Code (OBC 2012) came into effect on January 1, 2014 and contains updated seismic analysis and design methodology. The seismic site classification methodology outlined in the new code is based on the subsurface conditions within the upper 30 m below grade. Two methods of defining the site class are presented in the following sections for the proposed development: a conservative approach based on shallow boreholes (i.e. boreholes less than 30 m in depth) with using local geological/physiographical experience; and a method based on geophysical testing in accordance with the Section 4.1.8.4 of the OBC 2012.

The conservative site classification is based on physical borehole information obtained at depths of less than 30 m and based on general knowledge of the local geology and physiography. Based on the borehole information and our local experience, a Site Class D may be used for the design.

6 MONITORING AND TESTING

The geotechnical aspects of the final design drawings and specifications should be reviewed by this office 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, materials testing and settlement monitoring 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 specification.

7 CLOSURE

We appreciate the opportunity to be of service to you and trust that this report provides sufficient geotechnical engineering information to facilitate the detailed design of this project. We look forward to providing you with continuing service during the construction stage. Please do not hesitate to contact our office should you wish to discuss, in further detail, any aspects of this project.

Yours very truly,

GEOPRO CONSULTING LIMITED

Tim Yu, B.Eng., EIT,
Geotechnical Group

Frank Liu, P.Eng. Senior Geotechnical Engineer
Geotechnical Group

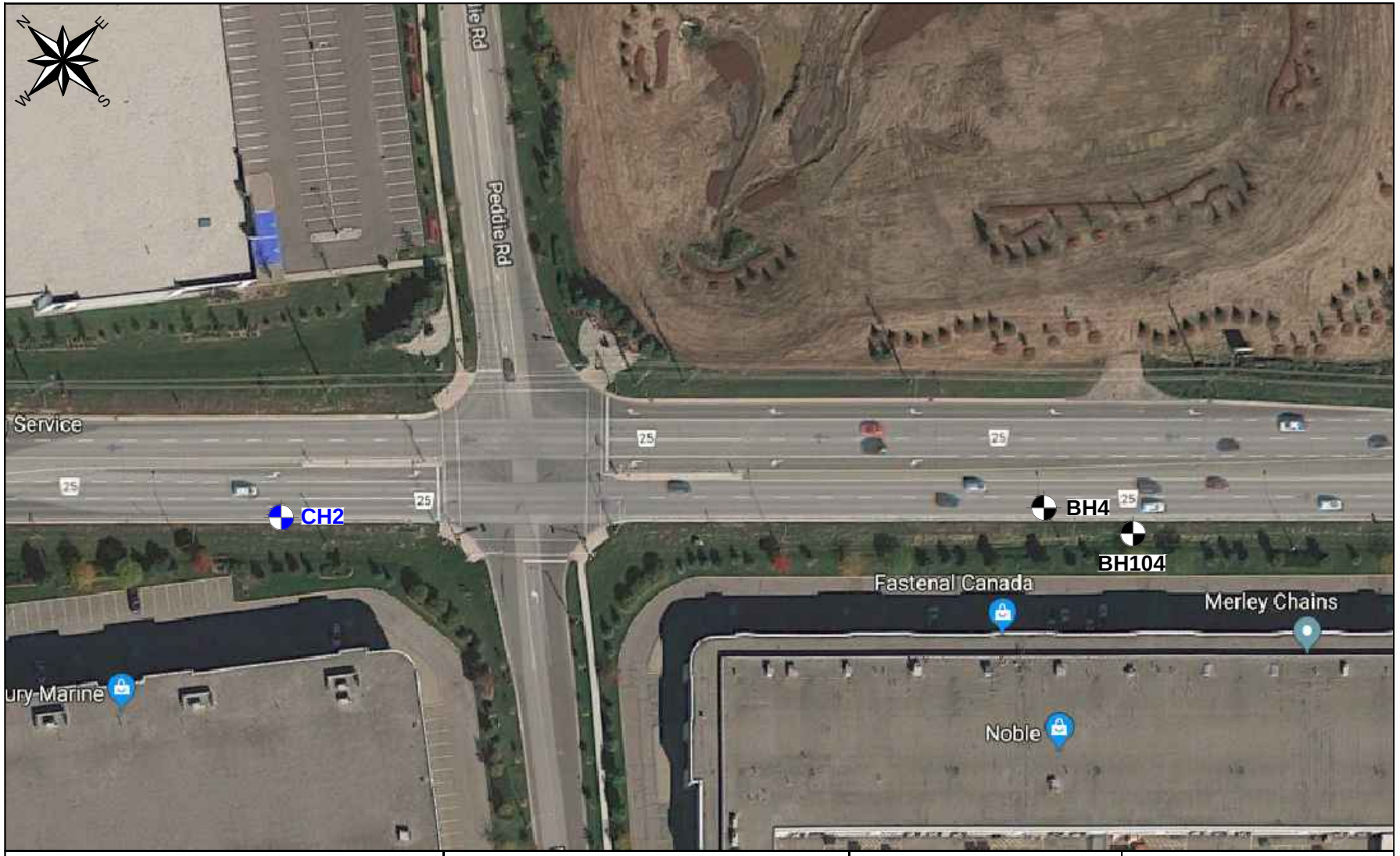
David B. Liu, P.Eng., Principal

DRAWINGS

Legend:

- **BH1 - BH11 on existing pavement**
- **BH101 - BH115 on boulevard and field area**
- **CH1 - CH6 on existing pavement**

Client: **Stantec Consulting Limited**		Project No.: **17-1758GH**	Drawing No.: **1A**
Drawn: **VS**	Approved: **DL**	Title: **Borehole**/Corehole **Location Plan**	
Date: **September 2018**	Scale: **N.T.S**	Project: **Geotechnical and Hydrogeological Investigations for the Proposed Class EA Study for Regional Road 25 Transportation Corridor Improvements from Steeles Avenue (Regional Road 8) to 5 Side Road, Town of Milton, Region of Halton RFP - #P720-17**	
Original Size: **Letter**	Rev: **MR**	*GeoPro* Consulting Limited	



Legend:

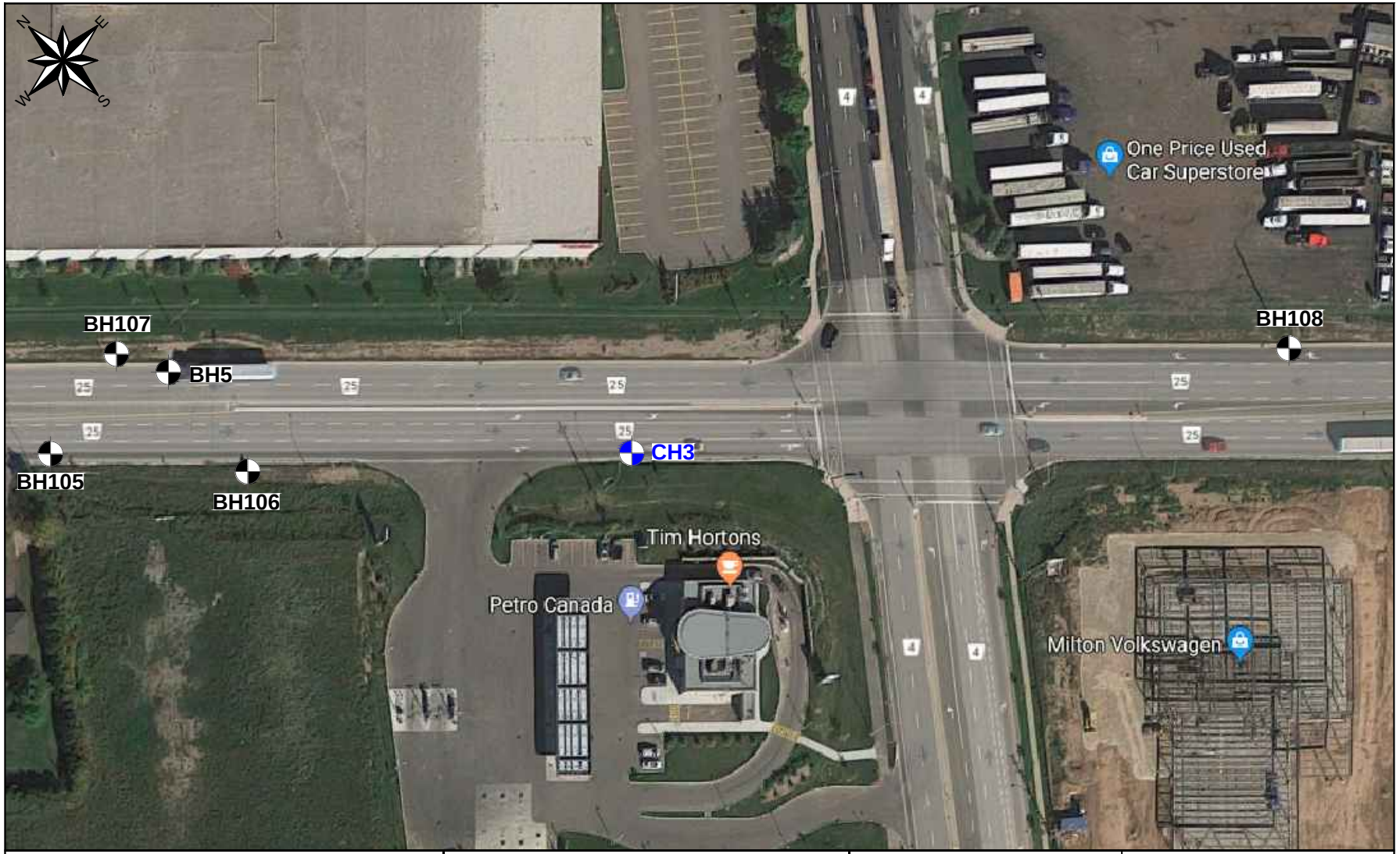
- BH1 - BH11 on existing pavement
- BH101 - BH115 on boulevard and field area
- CH1 - CH6 on existing pavement

Client: **Stantec Consulting Limited**		Project No.: **17-1758GH**	Drawing No.: **1B**
Drawn: **VS**	Approved: **DL**	Title: **Borehole**/Corehole **Location Plan**	
Date: **September 2018**	Scale: **N.T.S**	Project: **Geotechnical and Hydrogeological Investigations for the Proposed Class EA Study for Regional Road 25 Transportation Corridor Improvements from Steeles Avenue (Regional Road 8) to 5 Side Road, Town of Milton, Region of Halton RFP - #P720-17**	
Original Size: **Letter**	Rev: **MR**	*GeoPro* Consulting Limited	

Legend:

- **BH1 - BH11 on existing pavement**
- **BH101 - BH115 on boulevard and field area**

Client: **Stantec Consulting Limited**		Project No.: **17-1758GH**	Drawing No.: **1C**
Drawn: **VS**	Approved: **DL**	Title: **Borehole**/Corehole **Location Plan**	
Date: **September 2018**	Scale: **N.T.S**	Project: **Geotechnical and Hydrogeological Investigations for the Proposed Class EA Study for Regional Road 25 Transportation Corridor Improvements from Steeles Avenue (Regional Road 8) to 5 Side Road, Town of Milton, Region of Halton RFP - #P720-17**	
Original Size: **Letter**	Rev: **MR**	*GeoPro* Consulting Limited	



Legend:

- BH1 - BH11 on existing pavement
- BH101 - BH115 on boulevard and field area
- CH1 - CH6 on existing pavement

Client: **Stantec Consulting Limited**		Project No.: **17-1758GH**	Drawing No.: **1D**
Drawn: **VS**	Approved: **DL**	Title: **Borehole**/Corehole **Location Plan**	
Date: **September 2018**	Scale: **N.T.S**	Project: **Geotechnical and Hydrogeological Investigations for the Proposed Class EA Study for Regional Road 25 Transportation Corridor Improvements from Steeles Avenue (Regional Road 8) to 5 Side Road, Town of Milton, Region of Halton RFP - #P720-17**	
Original Size: **Letter**	Rev: **MR**	GeoPro Consulting Limited	

Legend:

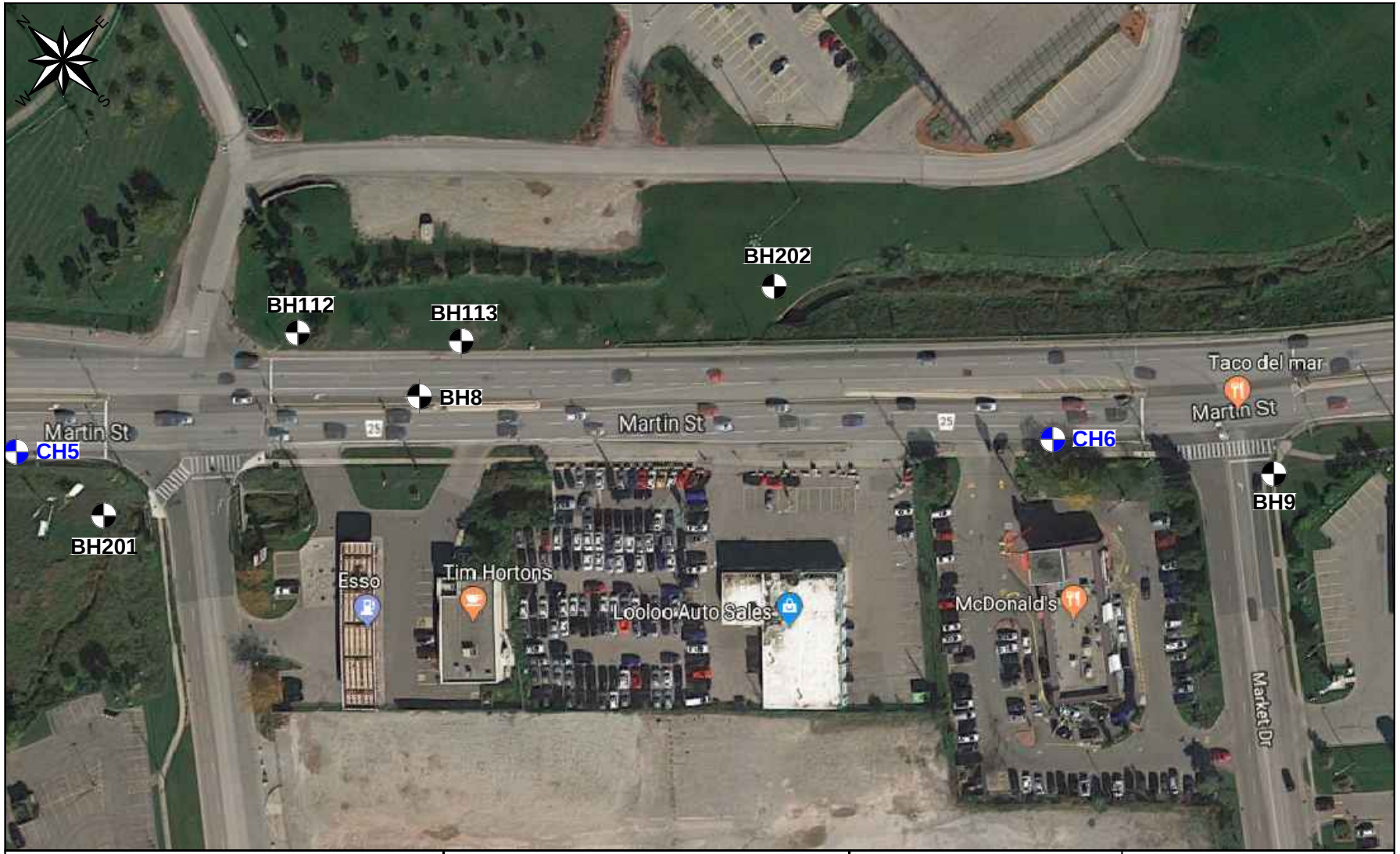
- BH1 - BH11 on existing pavement
- BH101 - BH115 on boulevard and field area
- CH1 - CH6 on existing pavement

Client:	**Stantec Consulting Limited**	Project No.: **17-1758GH**	Drawing No.: **1E**
Drawn: **VS**	Approved: **DL**	Title:	**Borehole**/Corehole **Location Plan**
Date: **September 2018**	Scale: **N.T.S**	Project:	**Geotechnical and Hydrogeological Investigations for the Proposed Class EA Study for Regional Road 25 Transportation Corridor Improvements from Steeles Avenue (Regional Road 8) to 5 Side Road, Town of Milton, Region of Halton RFP - #P720-17**
Original Size: **Letter**	Rev: **MR**		GeoPro Consulting Limited

Legend:

BH101 - BH115 on boulevard and field area

Client: **Stantec Consulting Limited**		Project No.: **17-1758GH**	Drawing No.: **1F**
Drawn: **VS**	Approved: **DL**	Title: **Borehole**/Corehole **Location Plan**	
Date: **September 2018**	Scale: **N.T.S**	Project: **Geotechnical and Hydrogeological Investigations for the Proposed Class EA Study for Regional Road 25 Transportation Corridor Improvements from Steeles Avenue (Regional Road 8) to 5 Side Road, Town of Milton, Region of Halton RFP - #P720-17**	
Original Size: **Letter**	Rev: **MR**	GeoPro Consulting Limited	



Legend:

- BH1 - BH11 on existing pavement
- BH101 - BH115 on boulevard and field area
- BH201 - BH202 near existing culvert
- CH1 - CH6 on existing pavement

Client: **Stantec Consulting Limited**		Project No.: **17-1758GH**	Drawing No.: **1G**
Drawn: **VS**	Approved: **DL**	Title: **Borehole**/Corehole **Location Plan**	
Date: **September 2018**	Scale: **N.T.S**	Project: **Geotechnical and Hydrogeological Investigations for the Proposed Class EA Study for Regional Road 25 Transportation Corridor Improvements from Steeles Avenue (Regional Road 8) to 5 Side Road, Town of Milton, Region of Halton RFP - #P720-17**	
Original Size: **Letter**	Rev: **MR**	GeoPro Consulting Limited	

Legend:

- **BH1 - BH11 on existing pavement**
- **BH101 - BH115 on boulevard and field area**
- **BH301 near CN Railway**

Client: **Stantec Consulting Limited**		Project No.: **17-1758GH**	Drawing No.: **1H**
Drawn: **VS**	Approved: **DL**	Title: **Borehole**/Corehole **Location Plan**	
Date: **September 2018**	Scale: **N.T.S**	Project: **Geotechnical and Hydrogeological Investigations for the Proposed Class EA Study for Regional Road 25 Transportation Corridor Improvements from Steeles Avenue (Regional Road 8) to 5 Side Road, Town of Milton, Region of Halton RFP - #P720-17**	
Original Size: **Letter**	Rev: **MR**	GeoPro Consulting Limited	

Legend:

- **BH1 - BH11 on existing pavement**
- **BH101 - BH115 on boulevard and field area**
- **BH301 near CN Railway**

Client: **Stantec Consulting Limited**		Project No.: **17-1758GH**	Drawing No.: **1l**
Drawn: **VS**	Approved: **DL**	Title: **Borehole**/Corehole **Location Plan**	
Date: **September 2018**	Scale: **N.T.S**	Project: **Geotechnical and Hydrogeological Investigations for the Proposed Class EA Study for Regional Road 25 Transportation Corridor Improvements from Steeles Avenue (Regional Road 8) to 5 Side Road, Town of Milton, Region of Halton RFP - #P720-17**	
Original Size: **Letter**	Rev: **MR**	*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 (60 to 200 mm) or boulders (over 200 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.

GeoPro Consulting Limited

Geotechnical-Hydrogeology-Environmental-Materials-Inspection

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	0-2
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	<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 BH001

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-06-20

REF. NO.: 17-1758GH

ENCL. NO.: 2

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): Unconfined, Field Vane & Sensitivity, Quick Triaxial, Penetrometer, Lab Vane	Plastic Limit / Natural Moisture Content / Liquid Limit; WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT:** (200 mm)										
0.2	**GRANULAR BASE/SUBBASE:** (450 mm)		1A	AS							
0.7	**FILL:** clayey silt, some sand to sandy, trace gravel, organic inclusions, layers of sandy silt, brown, moist, very stiff		1B	AS							
			2A	SS							
1 0.9			2B	SS	17						
	PROBABLE FILL: sandy silt, some clay to clayey, trace gravel, layers of clayey silt, containing shale fragments, brown, moist, compact										
1.4											
	SANDY SILT TO SILT: trace to some clay, trace gravel, layers/zones of clayey silt, brown, moist, compact		3	SS	29						
2.0	**END OF BOREHOLE**										

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

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH002

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-06-20

REF. NO.: 17-1758GH

ENCL. NO.: 3

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" BLOWS/0.3m	GROUND WATER ELEVATION	DYNAMIC PENETRATION TEST / SHEAR STRENGTH (kPa)	WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
0.0	**ASPHALT:** (210 mm)									
0.2	**GRANULAR BASE/SUBBASE:** (590 mm)		1	AS						GR 31 SA 47 SI 22 CL
0.8	**FILL:** clayey silt, trace to some sand, trace gravel, trace organics, rootlet inclusions, layers of sandy silt, dark brown, moist, stiff		2A / 2B	SS / SS	9					
1.4	**FILL:** sandy silt to sand and silt, trace to some clay, trace to some gravel, brown, moist, dense		3	SS	32					
2.0	**END OF BOREHOLE**									

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

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH003

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2118-06-20

REF. NO.: 17-1758GH

ENCL. NO.: 4

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" BLOWS/0.3m	GROUND WATER ELEVATION
0.0	**ASPHALT:** (160 mm)					
0.2	**GRANULAR BASE/SUBBASE:** (470 mm)		1A	AS		
0.6	**FILL:** clayey silt, trace to some sand, trace gravel, trace organics, layers of sandy silt, zones of silt, dark brown, moist, stiff		1B	AS		
1			2	SS	13	
1.4	**FILL:** clayey silt, some sand to sandy, trace gravel, organic inclusions, brown, moist, very stiff		3A	SS	26	
1.8	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, containing shale fragments, cobbles and boulders, brown, moist, very stiff		3B	SS		
2.0	**END OF BOREHOLE**					

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

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

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 BH004

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2118-06-20

REF. NO.: 17-1758GH

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/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT:** (200 mm)									
0.2	**GRANULAR BASE/SUBBASE:** (1020 mm)		1	AS						
1			2	SS	22					
1.4	**FILL:** clayey silt, some sand to sandy, trace gravel, layers of sandy silt, containing shale fragments, brown, moist, very stiff		3A	SS						
1.7	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, containing shale fragments, cobbles and boulders, brown, moist, very stiff		3B	SS	17					4 16 52 28
2.0	**END OF BOREHOLE**									

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

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH005

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-07-03

REF. NO.: 17-1758GH

ENCL. NO.: 6

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 (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
0.0	**ASPHALT:** (220 mm)										
0.2	**GRANULAR BASE/SUBBASE:** (520 mm)		1A	AS							43 45 12
0.7	**FILL:** clayey silt, some sand to sandy, trace gravel, layers of sandy silt, containing shale fragments, brown, moist, firm		1B 2A	AS SS	7			○			
1.2	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, layers of clayey silt, layers of silt, layers/zones of sandy silt, containing shale fragments, cobbles and boulders, brown, moist, very stiff		2B 3	SS SS	19			○			5 16 54 25
2.0	**END OF BOREHOLE** Note: 1) Borehole was open and dry upon completion of drilling.										

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

LOG OF BOREHOLE BH006

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-07-03

REF. NO.: 17-1758GH

ENCL. NO.: 7

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 (20, 40, 60, 80); SHEAR STRENGTH (kPa): ● Unconfined ▲ Quick Triaxial ✕ Field Vane & Sensitivity ⊠ 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
0.0	**ASPHALT:** (180 mm)										
0.2	**GRANULAR BASE/SUBBASE:** (680 mm)		1	AS							
			2A	SS					○		
0.9	**FILL:** gravelly sand, some silt to silty, layers of sandy silt, brown, moist, compact		2B	SS	20			○		○	
1.4	**FILL:** clayey silt, trace to some sand, trace gravel, organic inclusions, rootlet inclusions, layers of sand and silt, organic odour, dark brown, moist, firm		3	SS	6			○		○	
2.0	**END OF BOREHOLE** Note: 1) Borehole was open and dry upon completion of drilling.										

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

LOG OF BOREHOLE BH007

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: NS

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-11-01

REF. NO.: 17-1758GH

ENCL. NO.: 8

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) (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/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**TOPSOIL:** (50 mm)									
0.1	**FILL:** sandy silt, some clay to clayey, trace gravel, organic inclusions, rootlet inclusions, layers of clayey silt, pockets of sand, brown, moist to wet, loose		1	SS	4					
0.8	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, containing shale fragments, cobbles and boulders, brown, moist, stiff to hard		2	SS	13					
1			3	SS	32					
2										
2.3	**END OF BOREHOLE**									

Notes:
1) Water encountered at a depth of 0.8 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 1.2 mBGS upon completion of drilling.
3) Borehole caved at a depth of 1.8 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 BH008

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-07-03

REF. NO.: 17-1758GH

ENCL. NO.: 9

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): Unconfined, Field Vane & Sensitivity, Quick Triaxial, Penetrometer, Lab Vane	Plastic Limit / Natural Moisture Content / Liquid Limit; WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT:** (160 mm)										
0.2	**GRANULAR BASE/SUBBASE:** (60 mm)										
0.2			1A	AS							
0.4	**ASPHALT BLOCK LAYER:** (180 mm)										
0.7	**GRANULAR BASE/SUBBASE:** (290 mm)		1B	AS							
0.8	**FILL:** clayey silt, some sand, trace gravel, layers of sandy silt, brown, moist		2	SS	29						
1											
1.4	**FILL:** sandy silt to sand and silt, trace clay, trace gravel, organic inclusions, zones of clayey silt, containing shale fragments/pieces and asphalt fragments/pieces, dark brown to brown, moist, compact		3	SS	12						
2.0	**FILL:** clayey silt, some sand to sandy, trace gravel, layers/zones of sandy silt,, containing shale fragments, brown, moist, stiff										
	END OF BOREHOLE										

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

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH009

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-07-03

REF. NO.: 17-1758GH

ENCL. NO.: 10

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
0.0	**ASPHALT:** (170 mm)										
0.2	**GRANULAR BASE/SUBBASE:** (530 mm)		1A	AS							
0.7	**FILL:** gravelly sand, trace silt, brown, moist, loose to compact		1B	AS							
1			2	SS	15			○	○		
			3	SS	6			○	○		
2.0	**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=3% Strain at Failure

LOG OF BOREHOLE BH010

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-07-03

REF. NO.: 17-1758GH

ENCL. NO.: 11

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): Unconfined, Field Vane & Sensitivity, Quick Triaxial, Penetrometer, Lab Vane	WATER CONTENT (%): Plastic Limit, Natural Moisture Content, Liquid Limit	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT:** (390 mm)										
0.4	**GRANULAR BASE/SUBBASE:** (520 mm)		1	AS							
			2A	SS	9						
0.9	**FILL:** clayey silt, some sand to sandy, trace gravel, organic inclusions, seams of organic silt, layers of sandy silt, containing shale fragments, dark brown to brown, moist, stiff		2B	SS							
1.4	**FILL:** clayey silt, trace to some sand, trace gravel, trace organics, rootlet inclusions, layers of sandy silt, layers of sand and silt, layers of organic silt, dark brown, moist, firm		3	SS	6						
2.0	**END OF BOREHOLE**										

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

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH011

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2118-06-20

REF. NO.: 17-1758GH

ENCL. NO.: 12

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 (20 40 60 80) / SHEAR STRENGTH (kPa): ● Unconfined ✕ Field Vane & Sensitivity ▲ Quick Triaxial ⊠ Penetrometer + Lab Vane (20 40 60 80)	Plastic Limit / Natural Moisture Content / Liquid Limit (w_P w w_L) WATER CONTENT (%) (10 20 30 40)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT:** (290 mm)										
0.3	**GRANULAR BASE/SUBBASE:** (380 mm)		1A	AS							26 50 25
0.7	**FILL:** clayey silt, some sand to sandy, trace gravel, organic inclusions, rootlet inclusions, layers of sand and silt, dark brown to brown, moist, soft to firm		1B 2	AS SS	 4			○			
1.4	**FILL:** clayey silt, trace to some sand, trace gravel, trace to some organics, dark grey, moist, firm		3	SS	5			○			
2.0	**END OF BOREHOLE**										

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

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

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

LOG OF BOREHOLE BH101

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-06-11

REF. NO.: 17-1758GH

ENCL. NO.: 13

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**GRANULAR BASE/SUBBASE:** (800 mm)	1	SS	20	
0.8	**FILL:** gravelly sand, trace to some silt, zones of clayey silt, containing asphalt fragments, brown, moist, loose	2A / 2B	SS / SS	8	
1.4	**CLAYEY SILT TILL:** sandy, trace gravel, rootlet inclusions, layers of sandy silt, containing shale fragments, cobbles and boulders, brown, moist, stiff	3	SS	10	
2.1	**SILT:** trace to some clay, trace sand, seams/layers of clayey silt, brown to grey, moist to wet, compact	4	SS	11	
		5	SS	21	0 2 93 5
	--- grey	6	SS	22	
5.0	**END OF BOREHOLE**				

Notes:
1) Water encountered at a depth of 3.0 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 4.6 mBGS upon completion of drilling.
3) Borehole was open upon completion of drilling.

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

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

UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

LOG OF BOREHOLE BH102

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-06-11

REF. NO.: 17-1758GH

ENCL. NO.: 14

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**TOPSOIL:** (100 mm)			
0.1	**FILL:** gravelly sand, some silt, brown, moist, compact	1	SS	28
0.7	**FILL:** clayey silt, some sand to sandy, trace gravel, organic inclusions, rootlet inclusions, dark brown, moist, stiff	2	SS	9
1.4	**SANDY SILT TILL:** some clay, trace gravel, layers/zones of sandy silt, containing shale fragments, brown, moist, compact	3	SS	17
2.1	**SILT:** some clay, trace to some sand, layers of clayey silt, layers of sandy silt, brown to grey, moist to wet, compact	4	SS	17
		5	SS	25
	--- grey	6	SS	29
5.0	**END OF BOREHOLE**			

Notes:
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 mBGS upon completion of drilling.

GROUND WATER ELEVATION

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

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

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

LOG OF BOREHOLE BH103

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DC

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-08-29

REF. NO.: 17-1758GH

ENCL. NO.: 15

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" BLOWS/0.3m	GROUND WATER ELEVATION
0.0	**ASPHALT:** (300 mm)					
0.3	**GRANULAR BASE/SUBBASE:** (570 mm)		1A	AS		
0.6	**FILL:** clayey silt, some sand, trace gravel, organic inclusions, layers of sandy silt, layers of organic silt, brown, moist		1B	AS		
0.8	**FILL:** sandy silt, trace clay, trace gravel, layers of silt, brown, moist, compact		2	SS	20	
1.4	**FILL:** clayey silt, sandy, trace gravel, organic inclusions, brown, moist, stiff		3A	SS		
1.7	**FILL:** clayey silt, sandy, trace gravel, brown, moist, stiff		3B	SS	11	
2.1	**FINE SAND AND SILT:** some clay, trace gravel, layers of silt, brown, wet, compact		4	SS	20	
2.9	**SILT:** some clay, trace gravel, seams of sand, pockets of sand, brown, moist, compact		5A	SS	20	
3.4	**CLAYEY SILT TILL:** sandy, trace gravel, seams of sand, containing shale fragments, cobbles and boulders, brown, moist, very stiff		5B	SS		
			6	SS	29	
5.0	**END OF BOREHOLE**					

Note:
1) Water encountered at a depth of 3.0 m below ground surface (mBGS) during drilling.

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

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 BH104

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-06-20

REF. NO.: 17-1758GH

ENCL. NO.: 16

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) (● 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	**TOPSOIL:** (220 mm)									
0.2	**FILL:** gravelly sand, some silt, organic inclusions, layers/zones of clayey silt, brown, moist, compact		1	SS	11		○ 11			
			2	SS	23		○ 23	○		
1.4	**PROBABLE FILL:** clayey silt, some sand, organic inclusions, rootlet inclusions, brown, moist, stiff		3A	SS	12					1 13 57 29
1.7	**CLAYEY SILT TILL:** sandy, zones/layers of sandy silt, seams of sand, containing shale fragments, cobbles and boulders, brown to grey, moist, stiff to hard		3B	SS			○			
			4	SS	24		○ 24	○		
			5	SS	35		○ 35	○		
	--- grey		6	SS	70 / 255 mm		> >100 ○	○		
5.0	**END OF BOREHOLE**									

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

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

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

LOG OF BOREHOLE BH105

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DC

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-08-29

REF. NO.: 17-1758GH

ENCL. NO.: 17

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" BLOWS/0.3m	GROUND WATER ELEVATION	DYNAMIC PENETRATION TEST / SHEAR STRENGTH (kPa)	WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT:** (250 mm)									
0.3	**GRANULAR BASE/SUBBASE:** (510 mm)		1	AS						38 61 1
0.8	**FILL:** clayey silt, some sand to sandy, trace gravel, layers of organic clayey silt, containing shale fragments, brown, moist, firm		2	SS	7					
1.4	**CLAYEY SILT:** sandy, trace gravel, rootlet inclusions, layers of silt, containing shale fragments, brown, moist, stiff		3	SS	14					
2.1	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, layers of sandy silt till, seams of sand, containing shale fragments, cobbles and boulders, brown to grey, moist, stiff to hard		4	SS	21					
			5	SS	31					
	--- grey		6	SS	14					
5.0	**END OF BOREHOLE** Note: 1) Borehole was open and dry upon completion of drilling.									

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

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

LOG OF BOREHOLE BH106

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DC

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-08-29

REF. NO.: 17-1758GH

ENCL. NO.: 18

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**TOPSOIL:** (220 mm)	1A	SS	28
0.2 / 0.3	**FILL:** sandy silt, trace clay, trace gravel, organic inclusions, rootlet inclusions, layers of clayey silt, brown, moist, compact	1B	SS	
0.7	**FILL:** gravelly sand, trace clay, trace silt, brown, moist, compact	2	SS	13
1	**FILL:** sandy silt, some clay, trace gravel, layers of silty sand, seams of sand, containing shale fragments, brown, moist, compact			
1.4	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, layers of clayey silt, layers of sandy silt till, containing shale fragments, cobbles and boulders, brown to grey, moist, stiff to hard	3	SS	15
2		4	SS	31
3	--- grey	5	SS	16
4				
5.0	**END OF BOREHOLE**			

Notes:
1) Borehole was open and dry upon completion of drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Readings

Date	W. L. Depth (mBGS)
Nov. 8, 2018	3.93

Bentonite

Sand

Screen
3.9mBGS Nov 08

Natueal 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	
	4	20	53	23	

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

01 - GEOPRO SOIL LOG GEOPRO BH LOG DATA 17-1758GH 20181213-MYB-LAB(MYB) - MBS - LABJV - MYB-MB.GPJ 2018-12-13 17:27

LOG OF BOREHOLE BH107

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-06-11

REF. NO.: 17-1758GH

ENCL. NO.: 19

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	"N" BLOWS/0.3m	GROUND WATER ELEVATION
0.0	**TOPSOIL:** (120 mm)					
0.1	**FILL:** gravelly sand, some silt to silty, rootlet inclusions, layers of sandy silt, containing rock fragments, organic odour, brown, moist, compact		1A	SS	19	
0.5			1B	SS		
0.7	**FILL:** clayey silt, some sand to sandy, trace gravel, brown, moist, very stiff		2A	SS	7	
1.0	**FILL:** gravelly sand, some silt, layers of clayey silt, containing rock fragments, brown, moist, loose		2B	SS		
1.4	**FILL:** sandy silt to sand and silt, some clay, trace gravel, organic inclusions, zones of clayey silt, brown, moist, loose		3	SS	7	
	FILL: clayey silt, trace to some sand, trace gravel, organic inclusions, brown, moist, firm to stiff		4	SS	12	
2.9	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, containing shale fragments, cobbles and boulders, brown to grey, moist, very stiff		5	SS	23	
	--- grey		6	SS	21	
5.0	**END OF BOREHOLE**					

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

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

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

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

LOG OF BOREHOLE BH108

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-06-11

REF. NO.: 17-1758GH

ENCL. NO.: 20

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	ELEVATION	DYNAMIC PENETRATION TEST: SPT / Cone blows/0.3m (20 40 60 80)	SHEAR STRENGTH (kPa): Unconfined, Quick Triaxial, Field Vane & Sensitivity, 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/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**TOPSOIL:** (120 mm)											
0.1	**FILL:** gravelly sand to sand and gravel, some silt, layers of sandy silt, brown, moist, loose to dense		1	SS	42							
			2A	SS	12							
1			2B	SS								
1.0	**FILL:** clayey silt, some sand to sandy, trace gravel, organic inclusions, rootlet inclusions, layers of sandy silt, brown, moist, firm to stiff		3	SS	6							
2												
	--- zones of sandy silt, containing shale fragments		4	SS	11							
2.9	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, layers of sandy silt, containing shale fragments, cobbles and boulders, brown, moist, very stiff to hard		5	SS	21							4 20 56 20
4												
	--- layers/zones of sandy silt till		6	SS	32							
5												
5.0	**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 BH109

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DC

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-08-29

REF. NO.: 17-1758GH

ENCL. NO.: 21

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" BLOWS/0.3m	GROUND WATER ELEVATION	DYNAMIC PENETRATION TEST / SHEAR STRENGTH (kPa)	WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT:** (140 mm)									
0.1	**GRANULAR BASE/SUBBASE:** (360 mm)		1A	AS						
0.5	**FILL:** sandy silt, clayey, trace gravel, organic inclusions, brown, moist		1B	AS						
0.8	**FILL:** clayey silt, sandy, trace gravel, layers of sandy silt, containing shale fragments, brown, moist, loose		2	SS	4					
1.4	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, layers of sandy silt, seams of sand, containing shale fragments, cobbles and boulders, brown, moist, firm to very stiff		3	SS	6					
			4	SS	18					
			5	SS	17					
			6	SS	27					
5.0	**END OF BOREHOLE** Note: 1) Borehole was open and dry upon completion of drilling.									

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, Natural Moisture Content, Liquid Limit; w_P, w, w_L

WATER CONTENT (%): 10, 20, 30, 40

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH110

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer | DIAMETER: 155 mm

FIELD ENGINEER: HR | DATE: 2018-10-30

SAMPLE REVIEW: DC | REF. NO.: 17-1758GH

CHECKED: DL | ENCL. NO.: 22

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER / ELEVATION	DYNAMIC PENETRATION TEST (SPT / Cone, blows/0.3m) & SHEAR STRENGTH (kPa)	Plastic Limit / Natural Moisture Content / Liquid Limit — WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**TOPSOIL:** (130 mm)									
0.1	**FILL:** clayey silt, some sand to sandy, trace gravel, organic inclusions, pockets of sandy silt, brown, moist, soft to firm		1	SS	4	0.1mBGS Nov 08; Bentonite				
0.6	**CLAYEY SILT TILL:** some sand, trace gravel, layers of silt, containing cobbles and boulders, reddish brown, moist, stiff to hard		2	SS	15					
			3	SS	25	Sand				
						Screen				
			4	SS	33					
2.7	**END OF BOREHOLE**									

Notes:
1) Borehole was open and dry upon completion of drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Readings

Date	W. L. Depth (mBGS)
Nov. 8, 2018	0.13

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH111

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-06-19

REF. NO.: 17-1758GH

ENCL. NO.: 23

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**TOPSOIL:** (290 mm)			
0.3	**FILL:** sandy silt, trace clay, organic inclusions, rootlet inclusions, dark brown to brown, moist, loose	1	SS	7
0.7	**FILL:** clayey silt, some sand, trace gravel, organic inclusions, layers of sandy silt, containing shale fragments, brown, moist, stiff	2	SS	9
1.4	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, containing shale fragments, brown, moist, very stiff to hard	3	SS	16
		4	SS	38
		5	SS	28
4.0	**SANDY SILT TILL:** trace gravel, some clay, layers of clayey silt till, layers of sandy silt, containing cobbles and boulders, grey, moist, very dense	6	SS	56
5.0	**END OF BOREHOLE** Note: 1) Borehole was open and dry upon completion of drilling.			

GROUND WATER ELEVATION

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

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH112

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-06-11

REF. NO.: 17-1758GH

ENCL. NO.: 24

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 (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
0.0	**TOPSOIL:** (170 mm)									
0.2	**FILL:** sandy silt to sand and silt, trace clay, organic inclusions, rootlet inclusions, brown, moist, compact		1	SS	29					
0.7	**FILL:** asphalt fragments/pieces, trace sand, trace gravel, black, moist, compact		2A	SS	11					
1.1	**FILL:** sandy silt, trace to some clay, trace gravel, rootlet inclusions, containing rock fragments, brown, moist, loose to compact		2B	SS						
2	--- seams of organic silt, zones of clayey silt, containing shale fragments/pieces		3	SS	10					
2.1	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, layers of sandy silt, containing shale fragments, cobbles and boulders, brown, moist, hard		4	SS	32					
3 2.9	**SANDY SILT TILL:** some clay, trace gravel, layers of sand and silt, containing shale fragments/pieces, cobbles and boulders, brown, moist, dense		5	SS	41					
4 4.0	**CLAYEY SILT TILL:** sandy, trace gravel, layers of sandy silt, containing cobbles and boulders, grey, moist to wet, stiff		6	SS	13					
5 5.0	**END OF BOREHOLE** Notes: 1) Borehole caved at a depth of 3.6 m below ground surface (mBGS) upon completion of drilling.									

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

LOG OF BOREHOLE BH113

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DC

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-08-29

REF. NO.: 17-1758GH

ENCL. NO.: 25

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**TOPSOIL:** (280 mm)			
0.3	**FILL:** sandy silt, trace clay, trace gravel, organic inclusions, rootlet inclusions, brown, moist, compact	1A	SS	11
0.6	**FILL:** asphalt fragments, compact	1B	SS	
0.8	**FILL:** sandy silt, some clay to clayey, trace gravel, layers of clayey silt, layers/seams of sand, containing shale fragments, brown, moist, compact	2A	SS	
		2B	SS	11
1.4	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, layers of sandy silt till, seams of sand, containing shale fragments, cobbles and boulders, brown, moist, very stiff to hard	3	SS	17
		4	SS	20
		5	SS	36
		6A	SS	21
4.9	**PROBABLE WEATHERED SHALE:** reddish brown	6B	SS	
5.0	**END OF BOREHOLE**			

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

GROUND WATER ELEVATION

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

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH114

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-06-20

REF. NO.: 17-1758GH

ENCL. NO.: 26

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 (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
0.0	**TOPSOIL:** (220 mm)									
0.2	**FILL:** gravelly sand, silty, organic inclusions, rootlet inclusions, brown, moist, dense		1	SS	32					
0.7	**FILL:** silty sand, some gravel, layers of sand and silt, brown, moist, dense		2	SS	46					
1.4	**FILL:** organic silt, some clay, some sand, rootlet inclusions, dark brown, moist, loose		3	SS	7					
2.1	**FILL:** sandy silt, some clay, trace gravel, organic inclusions, layers of clayey silt, pockets of organic silt, containing shale fragments, brown, moist, compact		4A	SS	14					
2.7	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, seams of sand, layers of sandy silt, containing cobbles and boulders, brown, moist, hard		4B	SS						
			5	SS	32					
			6	SS	48					
5.0	**END OF BOREHOLE** Note: 1) Borehole was open and dry upon completion of drilling.									

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

LOG OF BOREHOLE BH115

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer | DIAMETER: 155 mm

FIELD ENGINEER: HR | DATE: 2018-06-20

SAMPLE REVIEW: DX | REF. NO.: 17-1758GH

CHECKED: DL | ENCL. NO.: 27

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**TOPSOIL:** (120 mm)			
0.1	**FILL:** silty sand, trace to some gravel, containing metal pieces, brown, moist, dense	1	SS	33
0.7	**FILL:** gravelly sand, some silt to silty, brown, moist, loose	2	SS	9
1.4	**FILL:** sand and silt, some clay to clayey, organic inclusions, rootlet inclusions, layers of clayey silt, dark brown to brown, moist to wet, loose	3	SS	9
2.1	**FILL:** clayey silt, some sand to sandy, trace gravel, organic inclusions, rootlet inclusions, layers of silt, zones of sandy silt, dark brown to brown, moist, stiff	4	SS	12
2.9	**FILL:** sandy silt, some clay to clayey, trace gravel, containing shale fragments, brown, moist, compact	5A	SS	18
3.4	**PROBABLE FILL:** clayey silt, sandy, trace gravel, containing shale fragments, reddish brown, moist, very stiff	5B	SS	
3.8	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, layers of sandy silt, containing shale fragments, cobbles and boulders, brown, moist, hard	6	SS	50
5.0	**END OF BOREHOLE**			

Notes:
1) Water encountered at a depth of 1.5 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 4.5 mBGS upon completion of drilling.
3) Borehole was open upon completion of drilling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Readings

Date	W. L. Depth (mBGS)
Nov. 8, 2018	3.41
Nov. 28, 2018	2.88

Bentonite

2.9 mBGSNov 28

3.4mBGS Nov 08

Sand

Screen

Natural Pack

DYNAMIC PENETRATION TEST: 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/m^3)

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

GROUNDWATER ELEVATIONS

Measurement: 1st, 2nd, 3rd, 4th

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

LOG OF BOREHOLE BH201

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer | DIAMETER: 155 mm

FIELD ENGINEER: HR | DATE: 2018-06-19

SAMPLE REVIEW: DX | REF. NO.: 17-1758GH

CHECKED: DL | ENCL. NO.: 28

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**TOPSOIL:** (200 mm)			
0.2	**FILL:** sandy silt, some clay, trace gravel, trace organics, trace rootlets, dark brown to brown, moist, compact	1	SS	11
0.7	**FILL:** clayey silt, some sand to sandy, trace gravel, trace rootlets, brown, moist, very stiff	2A	SS	17
0.9	**CLAYEY SILT:** some sand to sandy, trace gravel, trace rootlets, layers/zones of silt, brown, moist, very stiff	2B	SS	
1.4	**SILT:** trace to some clay, trace sand, layers of clayey silt, brown, moist, compact	3A	SS	25
1.8	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, containing cobbles and boulders, brown, moist, very stiff to hard	3B	SS	
	--- auger grinding	4	SS	18
		5	SS	30
		6	SS	59
	--- auger grinding	7	SS	46
7.1	**SILT:** trace sand, layers/zones of clayey silt, containing cobbles and boulders, reddish brown to grey, moist, dense	8	SS	36

GROUND WATER ELEVATION: -0.8 mBGSNov 08; -0.3mBGS Aug 24

Bentonite

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/m^3)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
0	3	73	24

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 BH201

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: HR

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-06-19

REF. NO.: 17-1758GH

ENCL. NO.: 28

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" BLOWS/0.3m	GROUND WATER ELEVATION	DYNAMIC PENETRATION TEST / SHEAR STRENGTH (kPa)	WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILT: trace sand, layers/zones of clayey silt, containing cobbles and boulders, reddish brown to grey, moist, dense(Continued)									
8.6	**CLAYEY SILT:** trace to some sand, trace gravel, layers of silt, grey, moist, hard		9	SS	35	Sand / Screen		16.6 / 26.0		
			10	SS	37					
11.3	**END OF BOREHOLE** Notes: 1) Water was at a depth of 10.7 m below ground surface (mBGS) upon completion of drilling. 2) Borehole was open upon completion of drilling. 3) 51 mm dia. monitoring well was installed in borehole upon completion of drilling. Water Level Readings Date W. L. Depth (mBGS) Aug. 24, 2018 -0.27 (above ground) Nov. 8, 2018 -0.75 (above ground)									

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

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

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH202

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: RR

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-06-15

REF. NO.: 17-1758GH

ENCL. NO.: 29

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**TOPSOIL:** (200 mm)			
0.2	**FILL:** sandy silt, some clay, trace gravel, trace rootlets, brown, moist, loose to compact	1	SS	23
1	--- layers of clayey silt	2	SS	10
1.4	**CLAYEY SILT TILL:** sandy, trace gravel, containing shale fragments, cobbles and boulders, reddish brown, moist, very stiff	3	SS	19
2.1	**NO SAMPLE RECOVERY DUE TO SHALE PIECES:** likely clayey silt till, very stiff	4	SS	25
2.9	**SILT:** trace clay, trace sand, brown, wet, compact	5A	SS	18
3.3	**SANDY SILT TO SAND AND SILT:** trace to some gravel, zones of sand, zones of gravelly sand, brown, wet, compact	5B	SS	
4.0	**SANDY SILT TILL:** some clay, trace gravel, containing cobbles and boulders, brown, moist to wet, dense to very dense	6	SS	39
		7	SS	78
		8	SS	91

GROUND WATER: 0.7mBGS Aug 24; 0.9 mBGSNov 08

Bentonite

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
3	16	51	30

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 BH202

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: RR

SAMPLE REVIEW: DX

CHECKED: DL

DIAMETER: 155 mm

DATE: 2018-06-15

REF. NO.: 17-1758GH

ENCL. NO.: 29

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
	SANDY SILT TILL: some clay, trace gravel, containing cobbles and boulders, brown, moist to wet, dense to very dense(Continued)			
9	--- layers of sandy silt	9	SS	56
10				
10.1	**SILT:** some clay, trace sand, layers of clayey silt, reddish brown, moist, dense	10	SS	36
11				
12				
12.3	**CLAYEY SILT:** some sand, trace gravel, layers/zones of silt, grey, moist, hard	11A 11B	SS SS	37
12.7	**END OF BOREHOLE**			

Notes:
1) Borehole was open and dry upon completion of drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Readings

Date	W. L. Depth (mBGS)
Aug. 24, 2018	0.66
Nov. 8, 2018	0.90

GROUND WATER: Sand; Screen

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

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH301

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer | DIAMETER: 155 mm

FIELD ENGINEER: RR | DATE: 2018-06-14

SAMPLE REVIEW: DX | REF. NO.: 17-1758GH

CHECKED: DL | ENCL. NO.: 30

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER ELEVATION	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**TOPSOIL:** (120 mm)						
0.1	**FILL:** sandy silt, some clay, trace gravel, trace organics, trace rootlets, brown, moist, loose to compact	1	SS	13	Concrete		
		2	SS	8			
1.4	**FILL:** clayey silt, some sand to sandy, trace gravel, trace organics, trace rootlets, layers of sandy silt, dark brown to brown, moist, soft to firm	3	SS	4			
		4	SS	4	2.7 mBGSNov 08 2.7mBGS Aug 24		
2.9	**SILT:** some sand, trace gravel, layers/zones of clayey silt, containing shale fragments, cobbles and boulders, brown to reddish brown, moist to wet, compact	5	SS	15			
4.0	**CLAYEY SILT TILL:** sandy, trace gravel, seams of sand, containing shale fragments, cobbles and boulders, reddish brown, moist, hard --- auger grinding	6	SS	32			6 25 44 25
5.6	**SANDY SILT TILL:** some clay, zones of sandy silt, containing cobbles and boulders, brown, moist, dense	7	SS	43	Bentonite		
7.1	**SANDY SILT:** some clay, trace gravel, containing shale fragments, brown, wet, compact	8A	SS				
7.8		8B	SS	23			6 22 50 22

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

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

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 BH301

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer | DIAMETER: 155 mm

FIELD ENGINEER: RR | DATE: 2018-06-14

SAMPLE REVIEW: DX | REF. NO.: 17-1758GH

CHECKED: DL | ENCL. NO.: 30

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	ELEVATION
9	**CLAYEY SILT TILL:** some sandy to sandy, trace gravel, layers of sandy silt, containing shale fragments, cobbles and boulders, brown, moist to wet, compact to very dense(Continued)				
10		9	SS	58	
10.1	**SILT:** some clay, trace to some sand, trace gravel, layers/zones of clayey silt, grey, moist, very dense				
11		10	SS	56	
11.7	**CLAYEY SILT TILL:** trace to some sand, trace gravel, layers of silt, grey, moist, hard				
12					
13		11	SS	37	
13.2	**SILT:** trace to some clay, trace sand, zones/layers of clayey silt, reddish brown to grey, moist, very dense				
14		12	SS	65	
	--- auger grinding				
14.7	**SANDY SILT TILL/SHALE COMPLEX:** trace to some clay, trace gravel, layers of sand and silt, containing shale fragments, cobbles and boulders, reddish brown, moist to wet, very dense				
15					
		13	SS	50 / 100 mm	
16					

Sand

Screen

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

WATER CONTENT (%)
10 20 30 40

16.9 23.7

> >100

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

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

CLIENT: Stantec Consulting Limited

PROJECT LOCATION: Regional Road 25, Milton, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer | DIAMETER: 155 mm

FIELD ENGINEER: RR | DATE: 2018-06-14

SAMPLE REVIEW: DX | REF. NO.: 17-1758GH

CHECKED: DL | ENCL. NO.: 30

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): Unconfined, Field Vane & Sensitivity, Quick Triaxial, Penetrometer, Lab Vane	WATER CONTENT (%): Plastic Limit, Natural Moisture Content, Liquid Limit	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL
16.1	**SAND AND SILT/SHALE COMPLEX:** trace to some clay, trace gravel, containing shale fragments, reddish brown, wet, very dense --- auger grinding										
17			14	SS	72 / 405 mm	← Natural Pack		> >100			
17.2	**END OF BOREHOLE**										

Notes:
1) Water encountered at a depth of 7.6 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 1.5 mBGS upon completion of drilling.
3) Borehole caved at a depth of 6.1 mBGS upon completion of drilling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

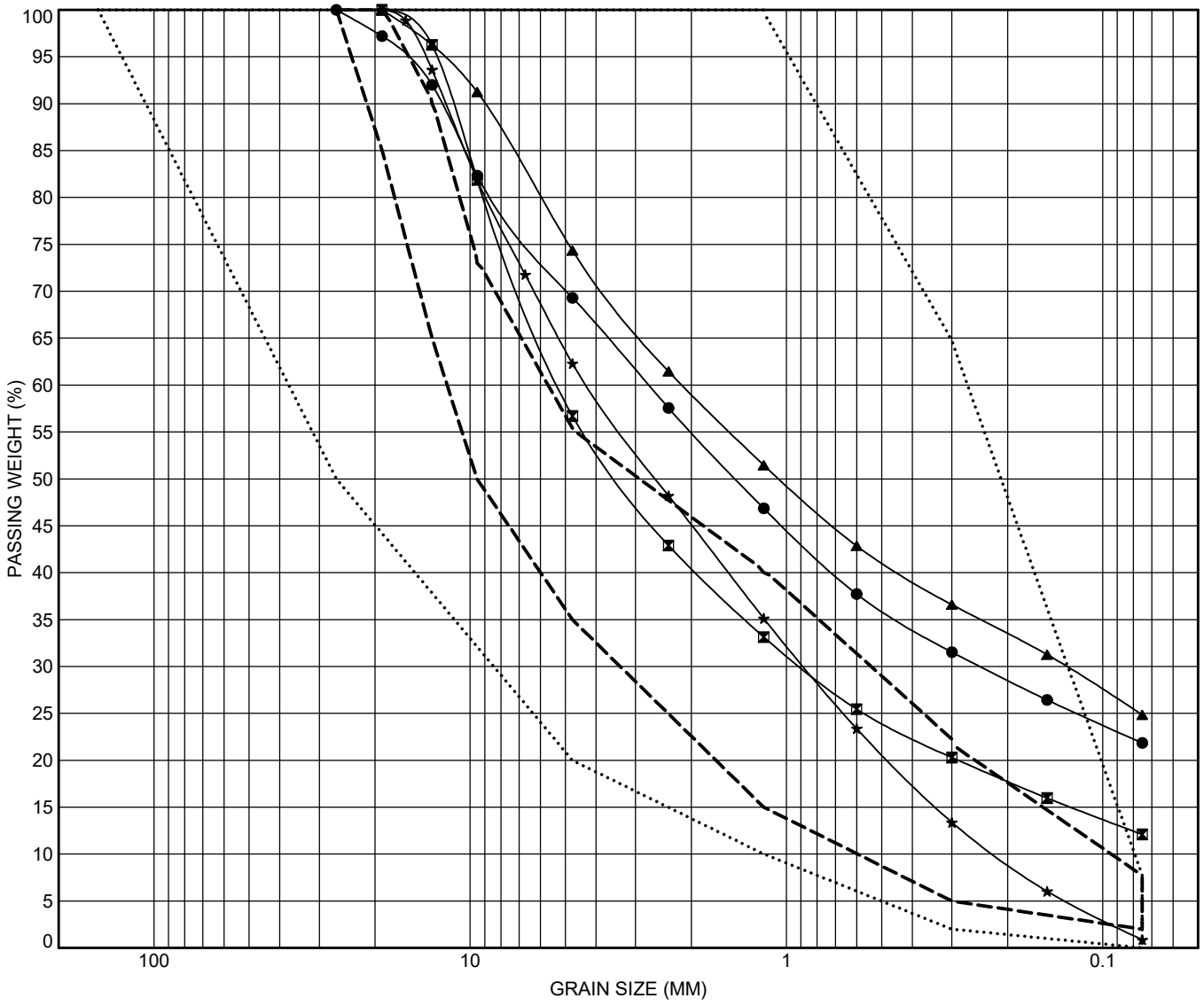
Water Level Readings

Date	W. L. Depth (mBGS)
Aug. 24, 2018	2.74
Nov. 8, 2018	2.65

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

GRAPH NOTES: + 3, × 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
●	**BH002**	**AS1**	**0.21**	**26.5**	**2.73**	**0.244**		**30.7**	**47.5**	**21.8**
⊠	**BH005**	**AS1A**	**0.22**	**19**	**5.201**	**0.896**		**43.3**	**44.6**	**12.1**
▲	**BH011**	**AS1A**	**0.29**	**19**	**2.134**	**0.131**		**25.6**	**49.5**	**24.8**
★	**BH105**	**AS1**	**0.25**	**19**	**4.239**	**0.879**	**0.218**	**37.7**	**61.4**	**0.9**

GeoPro CONSULTING LIMITED

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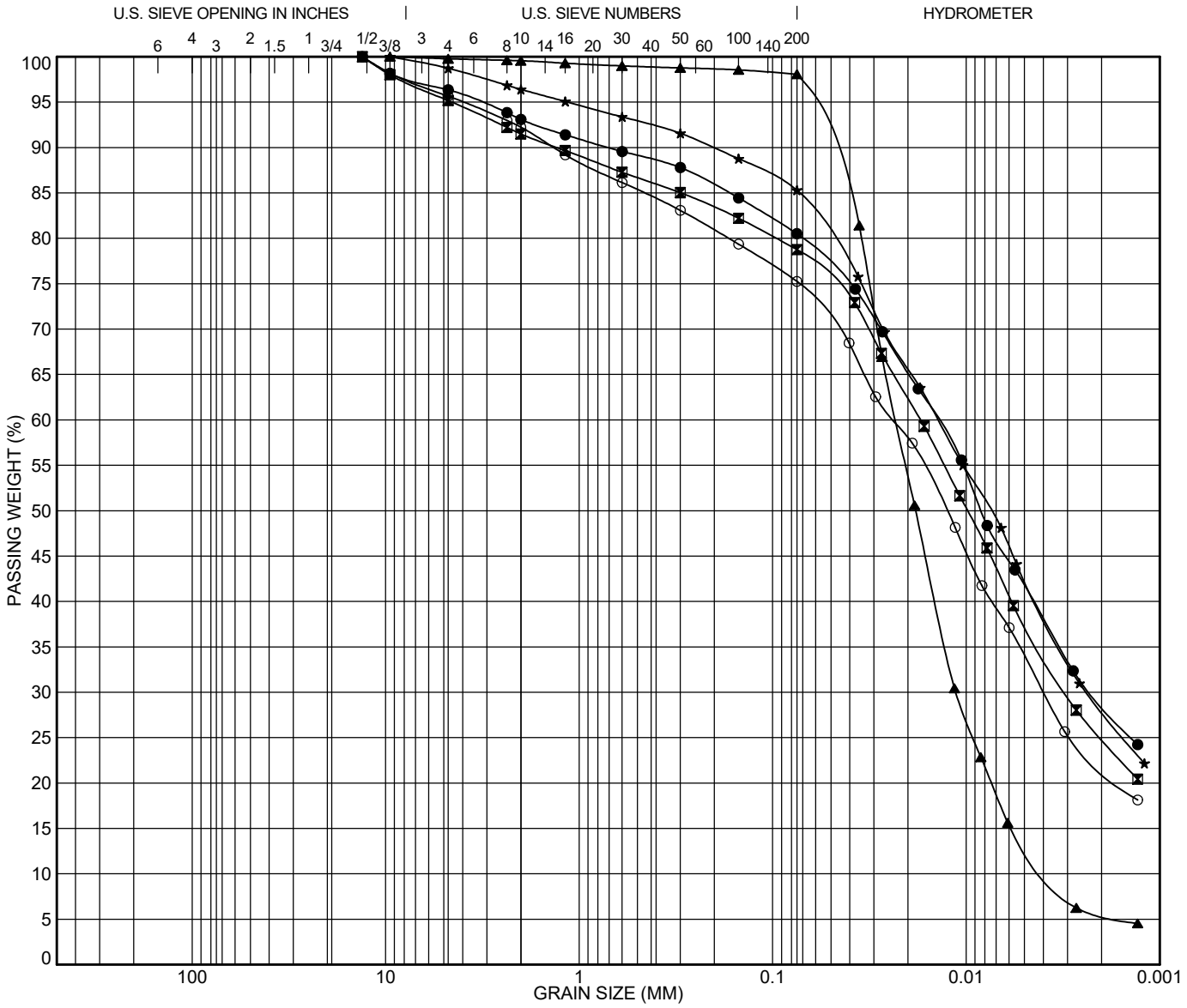
GRAIN SIZE DISTRIBUTION

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

LOCATION: Regional Road 25, Milton, Ontario

PROJECT NO.: 17-1758GH | SAMPLED ON: 2018-08-29

FIGURE NO.: 1 | TESTED ON:



COBBLES	GRAVEL		SAND			SILT	CLAY
	coarse	fine	coarse	medium	fine		

	Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	BH004	SS3B	1.68						
⊠	BH005	SS3	1.52						
▲	BH101	SS5	3.05					1.48	6.17
★	BH104	SS3A	1.52						
⊙	BH106	SS3	1.52						

	Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH004	SS3B	1.68	13.2	0.014	0.002		3.7	15.8	51.7	28.8
⊠	BH005	SS3	1.52	13.2	0.017	0.003		4.8	16.4	53.8	24.9
▲	BH101	SS5	3.05	9.5	0.023	0.011	0.004	0.2	1.7	92.5	5.5
★	BH104	SS3A	1.52	9.5	0.014	0.002		1.3	13.4	57.3	28.0
⊙	BH106	SS3	1.52	13.2	0.024	0.004		4.3	20.4	53.4	21.9

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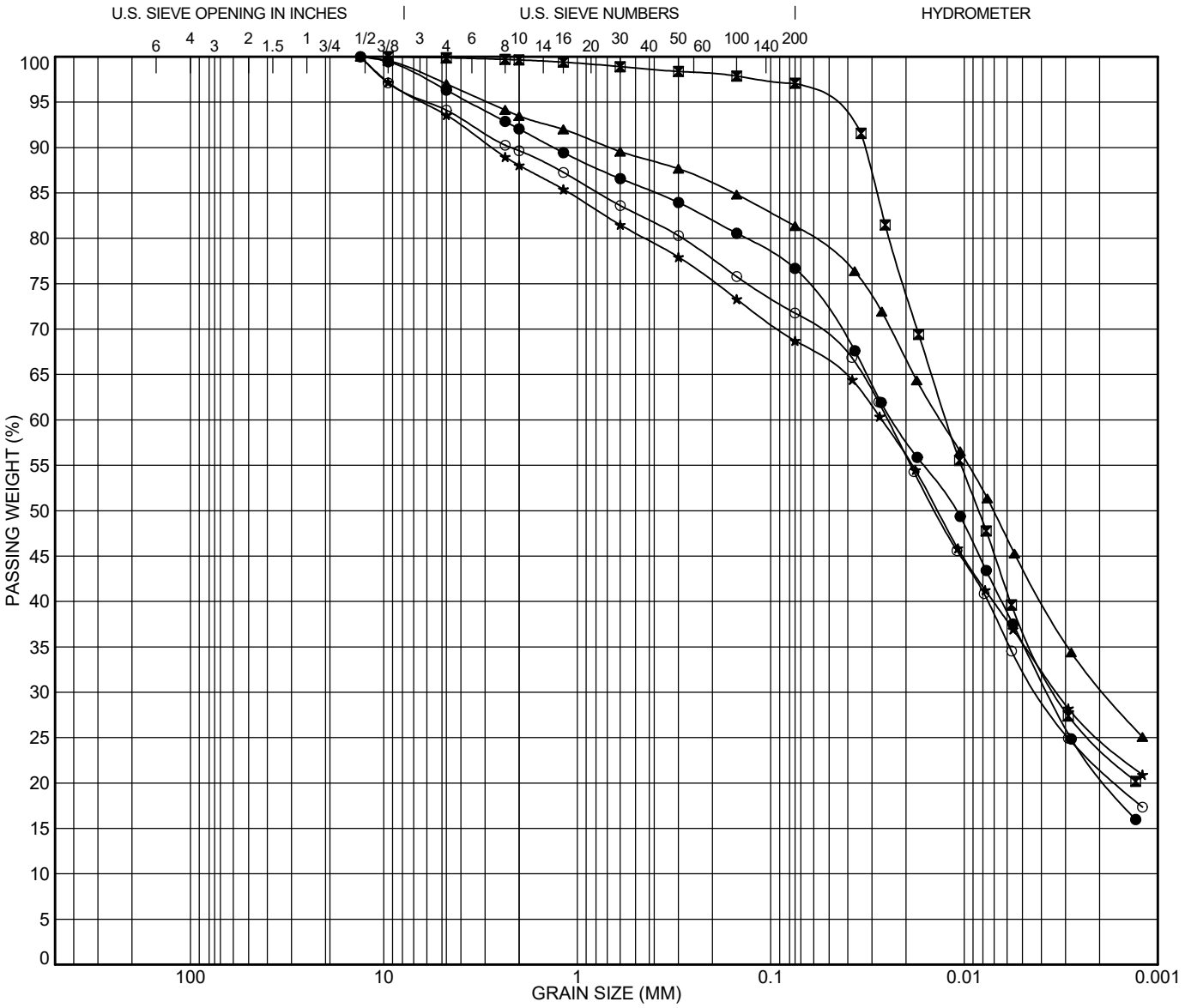
GRAIN SIZE DISTRIBUTION

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

LOCATION: Regional Road 25, Milton, Ontario

PROJECT NO.: 17-1758GH | SAMPLED ON: 2018-08-29

FIGURE NO.:2 | TESTED ON:



COBBLES	GRAVEL		SAND			SILT	CLAY
	coarse	fine	coarse	medium	fine		

	Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	BH108	SS5	3.05						
⊠	BH201	SS3A	1.52						
▲	BH202	SS3	1.52						
★	BH301	SS6	4.57						
⊙	BH301	SS8B	7.77						

	Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH108	SS5	3.05	13.2	0.023	0.004		3.7	19.6	55.7	21.0
⊠	BH201	SS3A	1.52	9.5	0.012	0.003		0.1	2.8	73.0	24.1
▲	BH202	SS3	1.52	13.2	0.013	0.002		3.0	15.6	50.7	30.7
★	BH301	SS6	4.57	13.2	0.027	0.003		6.4	24.9	43.6	25.1
⊙	BH301	SS8B	7.77	13.2	0.025	0.004		5.9	22.3	50.0	21.7

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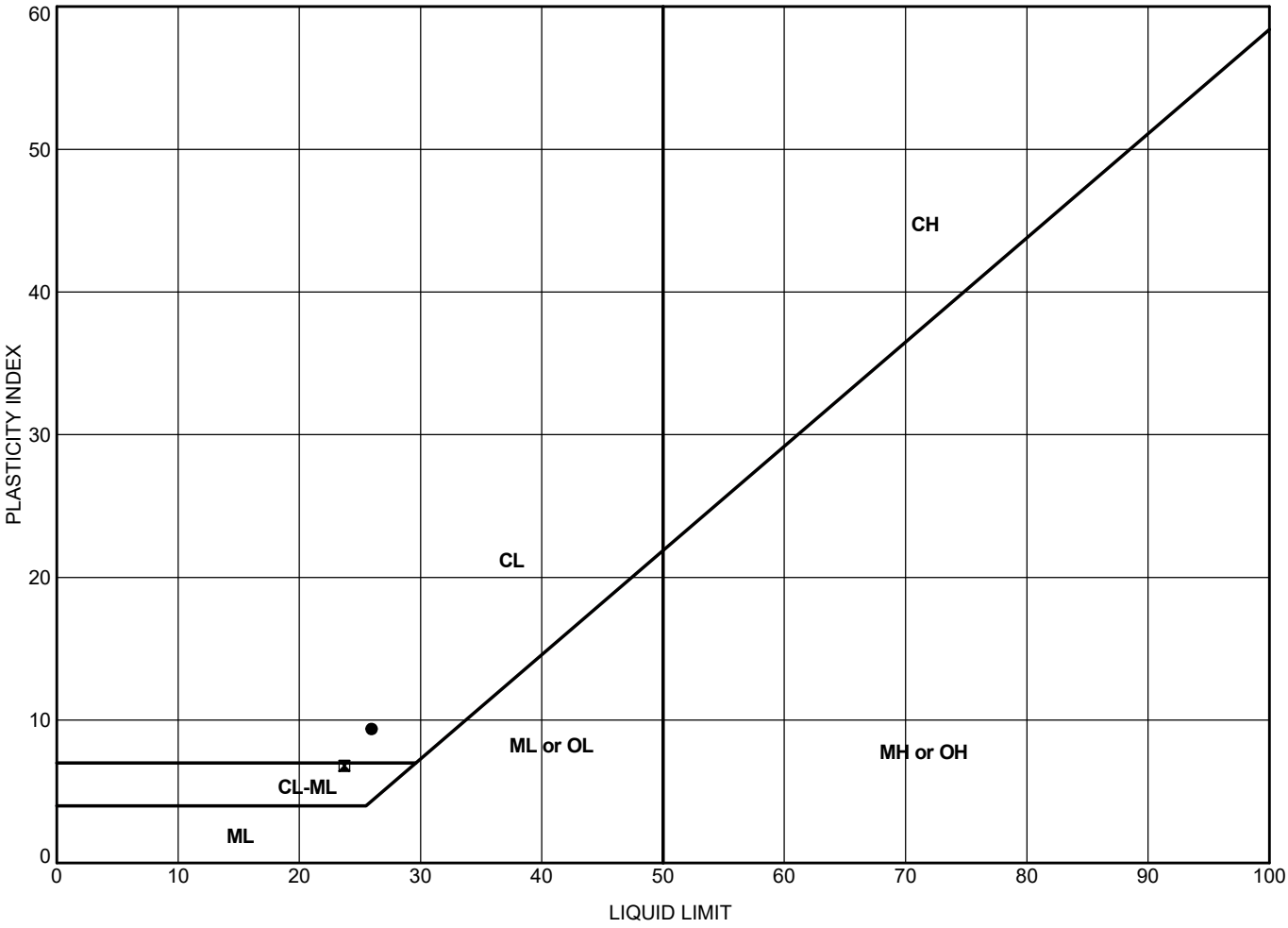
GRAIN SIZE DISTRIBUTION

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

LOCATION: Regional Road 25, Milton, Ontario

PROJECT NO.: 17-1758GH | SAMPLED ON: 2018-06-14

FIGURE NO.:3 | TESTED ON: 2018-07-20



	Specimen Identification			LL	PL	PI	Fines	Classification
●	**BH201**	**SS9**	**9.14**	**26**	**17**	**9**		
⊠	**BH301**	**SS10**	**10.67**	**24**	**17**	**7**		

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ATTERBERG LIMITS' RESULTS

PROJECT: Geotechnical and Hydrogeological Investigations for Proposed Road Improvements

LOCATION: Regional Road 25, Milton, Ontario

PROJECT NO.: 17-1758GH	SAMPLED ON: 2018-06-14
FIGURE NO.: 1	TESTED ON: 2018-07-20

APPENDIX A

Photograph 1 – Region Road 25, Southbound, 10m North of Steeles Avenue East, looking south, showing few moderate wheel track cracking and transverse cracking.

Photograph 2 – Region Road 25, Southbound, 20m North of Steeles Ave, looking south, showing slight to moderate longitudinal cracking and slight ravelling.

Photograph 3 – Region Road 25, Southbound, 100m North of Steeles Ave, looking south, showing slight pothole and slight to moderate ravelling.

Photograph 4 – Region Road 25, Southbound, 20m South of Market Drive, looking south, showing slight longitudinal cracking.

Photograph 5 – Region Road 25, Northbound, 20m South of Chisholm Drive, looking north, showing slight transvers cracking and slight wheel track rutting.

Photograph 6 – Region Road 25, Southbound, 10m South of Chisholm Drive, looking south, showing slight transverse cracking, slight ravelling and slight pavement edge cracking

Photograph 7 – Region Road 25, Northbound, 15m north of Highpoint Drive, looking north, showing slight to moderate longitudinal and transverse cracking and slight random cracking around the maintenance hole.

Photograph 8 – Region Road 25, Northbound, 30m north of High Point Drive, looking north, showing slight longitudinal and transverse cracking.

Photograph 9 – Region Road 25, Northbound, 70m north of High Point Drive, looking north, showing slight to moderate transverse cracking.

Photograph 10 – Region Road 25, Northbound, 70m south of James Snow Parkway North, looking north, showing slight to moderate transverse cracking around the maintenance hole.

Photograph 11 – Region Road 25, Northbound, 15m north of James Snow Parkway, looking north, showing slight longitudinal cracking and slight transverse cracking around the maintenance hole.

Photograph 12 – Region Road 25, Northbound, 50m north of James Snow Parkway, looking north, showing slight to moderate longitudinal and transverse cracking.

Photograph 13 – Region Road 25, Northbound, 70m north of James Snow Parkway, looking north, showing slight transverse cracking and slight ravelling.

Photograph 14 – Region Road 25, Northbound, 100m north of James Snow Parkway, looking north, showing slight transverse cracking around the maintenance hole.

Photograph 15 – Region Road 25, Northbound, 110m north of James Snow Parkway, looking north, showing slight to moderate longitudinal and transverse cracking.

Photograph 16 – Region Road 25, Northbound, 200m north of James Snow Parkway, looking north, showing slight longitudinal and transverse cracking.

Photograph 17 – Region Road 25, Northbound, 300m south of Peddie Road, looking north, showing slight transverse cracking around the maintenance hole.

Photograph 18 – Region Road 25, Northbound, 200m south of Peddie Road, looking north, showing slight to moderate transverse and random cracking around the maintenance holes and slight ravelling.

Photograph 19 – Region Road 25, Northbound, 70m south of Peddie Road, looking north, showing slight to moderate transverse and random cracking around the maintenance holes.

Photograph 20 – Region Road 25, Northbound, 15m north of Peddie Road, looking north, showing slight to moderate longitudinal and transverse cracking.

Photograph 21 – Region Road 25, Northbound, 70m north of Peddie Road, looking north, showing slight to moderate longitudinal and transverse cracking.

Photograph 22 – Region Road 25, Northbound, 90m north of Peddie Road, looking north, showing slight to moderate longitudinal and transverse cracking.

Photograph 23 – Region Road 25, Northbound, 110m north of Peddie Road, looking north, showing slight to moderate longitudinal and transverse cracking.

Photograph 24 – Region Road 25, Southbound, 110m south of 5 Sideroad, looking south, showing slight to moderate longitudinal and transverse cracking.

APPENDIX B

Photo 1 – CH1

Photo 2 – CH2

Photo 3 – CH3

Photo 4 – CH4

Photo 5 – CH5

Photo 6 – CH6

APPENDIX C

TRAFFIC DATA AND ESTIMATED ESALs
Regional Road 25
(From Steeles Ave to Market Drive)

Year	Annual Average Daily Traffic	Estimated Cumulative Annual ESALs
2020	35,819	-
2021	36,988	326,700
2022	38,196	664,100
2023	39,443	1,012,500
2024	40,730	1,372,300
2025	42,060	1,743,800
2026	43,433	2,127,400
2027	44,851	2,523,600
2028	46,315	2,932,700
2029	47,827	3,355,200
2030	49,388	3,791,400
2031	51,000	4,241,900
2032	52,665	4,707,100
2033	54,384	5,187,500
2034	56,159	5,683,600
2035	57,993	6,195,800
2036	59,886	6,724,800
2037	61,841	7,271,000
2038	63,859	7,835,100
2039	65,944	8,417,600
2040	68,097	9,019,100
2041	70,320	9,640,200

Directional Factor (DF)	0.5
Lane Distribution Factor (LDF)	0.8
Combined Truck Factor (CTF)	1.21
Percent Commercial Vehicles	5.0%
Traffic Growth Rate	3.3%
Days Per Year for Truck Traffic	365
Number of Lanes in one Direction	2

TRAFFIC DATA AND ESTIMATED ESALs
Regional Road 25
(From Market Drive to Chisholm Drive)

Year	Annual Average Daily Traffic	Estimated Cumulative Annual ESALs
2020	39,674	-
2021	40,936	506,200
2022	42,239	1,028,500
2023	43,584	1,567,500
2024	44,971	2,123,600
2025	46,403	2,697,400
2026	47,879	3,289,500
2027	49,403	3,900,400
2028	50,976	4,530,800
2029	52,599	5,181,200
2030	54,273	5,852,300
2031	56,000	6,544,800
2032	57,783	7,259,400
2033	59,622	7,996,700
2034	61,520	8,757,500
2035	63,478	9,542,500
2036	65,498	10,352,500
2037	67,583	11,188,200
2038	69,734	12,050,600
2039	71,954	12,940,400
2040	74,244	13,858,500
2041	76,608	14,805,800

Directional Factor (DF)	0.5
Lane Distribution Factor (LDF)	0.8
Combined Truck Factor (CTF)	1.21
Percent Commercial Vehicles	7.0%
Traffic Growth Rate	3.2%
Days Per Year for Truck Traffic	365
Number of Lanes in one Direction	2

TRAFFIC DATA AND ESTIMATED ESALs
Regional Road 25
(High Point Drive to James Snow Parkway)

Year	Annual Average Daily Traffic	Estimated Cumulative Annual ESALs
2020	24,246	-
2021	25,134	666,000
2022	26,053	1,356,400
2023	27,007	2,072,000
2024	27,995	2,813,800
2025	29,019	3,582,800
2026	30,081	4,379,900
2027	31,181	5,206,200
2028	32,322	6,062,700
2029	33,505	6,950,600
2030	34,731	7,870,900
2031	36,002	8,824,900
2032	37,319	9,813,800
2033	38,685	10,838,900
2034	40,100	11,901,500
2035	41,567	13,003,000
2036	43,088	14,144,800
2037	44,665	15,328,400
2038	46,299	16,555,300
2039	47,993	17,827,100
2040	49,749	19,145,400
2041	51,570	20,511,900

Directional Factor (DF)	0.5
Lane Distribution Factor (LDF)	0.8
Combined Truck Factor (CTF)	1.21
Percent Commercial Vehicles	15.0%
Traffic Growth Rate	3.7%
Days Per Year for Truck Traffic	365
Number of Lanes in one Direction	2

TRAFFIC DATA AND ESTIMATED ESALs
Regional Road 25
(From James Snow Parkway to Peddie Road)

Year	Annual Average Daily Traffic	Estimated Cumulative Annual ESALs
2020	21,649	-
2021	22,367	711,300
2022	23,109	1,446,100
2023	23,876	2,205,300
2024	24,668	2,989,700
2025	25,486	3,800,100
2026	26,331	4,637,400
2027	27,205	5,502,500
2028	28,107	6,396,300
2029	29,039	7,319,700
2030	30,003	8,273,700
2031	30,998	9,259,400
2032	32,026	10,277,800
2033	33,088	11,330,000
2034	34,186	12,417,100
2035	35,320	13,540,200
2036	36,491	14,700,600
2037	37,702	15,899,500
2038	38,952	17,138,100
2039	40,244	18,417,800
2040	41,579	19,740,000
2041	42,958	21,106,000

Directional Factor (DF)	0.5
Lane Distribution Factor (LDF)	0.8
Combined Truck Factor (CTF)	1.21
Percent Commercial Vehicles	18.0%
Traffic Growth Rate	3.3%
Days Per Year for Truck Traffic	365
Number of Lanes in one Direction	2

TRAFFIC DATA AND ESTIMATED ESALs
Regional Road 25
(From Peddie Road to 5 Side Road)

Year	Annual Average Daily Traffic	Estimated Cumulative Annual ESALs
2020	18,396	-
2021	19,049	504,800
2022	19,725	1,027,500
2023	20,425	1,568,800
2024	21,151	2,129,300
2025	21,901	2,709,700
2026	22,679	3,310,700
2027	23,484	3,933,000
2028	24,318	4,577,400
2029	25,181	5,244,700
2030	26,075	5,935,700
2031	27,000	6,651,200
2032	27,959	7,392,100
2033	28,952	8,159,300
2034	29,979	8,953,700
2035	31,044	9,776,300
2036	32,146	10,628,100
2037	33,287	11,510,200
2038	34,468	12,423,600
2039	35,692	13,369,400
2040	36,959	14,348,800
2041	38,271	15,362,900

Directional Factor (DF)	0.5
Lane Distribution Factor (LDF)	0.8
Combined Truck Factor (CTF)	1.21
Percent Commercial Vehicles	15.0%
Traffic Growth Rate	3.6%
Days Per Year for Truck Traffic	365
Number of Lanes in one Direction	2

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.