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A REPORT TO
BOLTON MIDTOWN DEVELOPMENTS INC.

HYDROGEOLOGICAL ASSESSMENT

PROPOSED RESIDENTIAL DEVELOPMENT
13247 AND 13233 NUNNVILLE ROAD

TOWN OF CALEDON (BOLTON)

REFERENCE NO. 1905-W182

REVISED JANUARY 2020

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January 22, 2020 Reference No. 1905-W182

Bolton Midtown Developments Inc.
6198 Tremaine Court
Mississauga, ON
L5V 1B5

Attention; Mr. Sam Morra

Re: Revised Hydrogeological Study
Proposed Residential Development
13247 and 13233 Nunnville Road
Town of Caledon (Bolton)

Dear Sir:

Enclosed, please the revised Hydrogeological Study Report for the captioned project. The report was revised to address questions and comments provided by various agencies based on their review. The follow revisions have been made:

-The description of the proposed development has been revised to reflect the latest Draft Plan of Subdivision (section 7.1, page 21)

-A section discussing the long-term foundation drainage for the developed site has been added on page 24 to address comment number 77 from the Toronto and Region Conservation Authority (TRCA)

-A sentence has been added to the end of section 7.2 (page 25) to address comment number 41 from the Town of Caledon Development Engineering, Community Services department, regarding the monitoring of nearby water supply wells

-Section 7.5 Low Impact Development (LID) has been added on page 26 of the report to address comment 38 from the Town of Caledon Development Engineering, Community Services Department. A summary of this section was also included in the conclusion section of the report (page 28, conclusion number 11) to address comment number 39 from the Town of Caledon.

Should you have any queries concerning the above, please feel free to contact the undersigned at your earliest convenience.

Yours truly,
SOIL ENGINEERS LTD.

Gavin O'Brien, M.Sc., P.Geo.

Encl.

LIMITATIONS OF LIABILITY

This report was prepared by Soil Engineers Ltd. (SEL) for the account of Bolton Midtown Developments Inc. and for review by their designated agents, financial institutions and government agencies, and can be used for development approval purposes by the Town of Caledon and the Ontario Ministry of the Environment, Conservation and Parks who may rely on the results of the report. The material in it reflects the judgement of Vivian Yu, B.Sc. and Gavin O'Brien, M.Sc., P.Geo. Any use which a Third Party makes of this report and/or any reliance on decisions to be made based on it is the responsibility of such Third Parties. Soil Engineers Ltd. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

One must understand that the mandate of Soil Engineers Ltd. is to obtain readily available current and past information pertinent to the subject site for a Hydrogeological Assessment only. No other warranty or representation, expressed or implied, as to the accuracy of the information is included or intended by this assessment. Site conditions are not static and this report documents site conditions observed at the time of the site reconnaissance.

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1.0 EXECUTIVE SUMMARY

Soil Engineers Ltd. has conducted a hydrogeological assessment for a proposed development site located at 13247 and 13233 Nunnville Road in the Town of Caledon (Bolton). Surrounding land use includes; residential properties to the north, Albion Vaughan Road to the east, residential properties to the south and Nunnville Road and residential subdivisions to the west. The site is currently occupied by two existing residential buildings.

The subject site lies within the Physiographic Region of Southern Ontario known as the South Slope on the drumlinized till plain physiographic feature. The site is underlain by the Halton Till unit, consisting, predominantly of silt to silty clay matrix, high in matrix calcium carbonate, considered as being clast poor.

The subject site is located within the Humber River Watershed and the Main Humber Sub-watershed. The Humber River and its associated wooded areas are located approximately 200 m north and also 250 m east of subject site. The closest wetland feature is found approximately 100 m southeast of the site.

A review of the topography shows that the site is relatively hilly exhibiting a decline in elevation relief towards the north and east. Based on the topographic map for the area and the surveyed ground surface elevations, the elevation relief across the subject site is about 30 m to the north and 7 m to the east.

This study has disclosed that beneath the layer of topsoil and earth fill materials, the native soils underlying the site consists of silty clay, silty clay till, silt and silty fine sand extending to the termination depth of the investigation at 27.9 mbgs.

The findings of this study confirm that the groundwater level elevations range from El. 241.60 to El. 243.67 masl, (or from 1.08 to 4.93 mbgs) and that shallow groundwater flows towards the southeast.

The single well response tests yielded estimated hydraulic conductivity (K) values that range between 7.4×10^{-8} and 2.5×10^{-7} m/sec for the silty clay/silty clay till at the depths of the well screens. These results suggests that low groundwater seepage rates can be anticipated into open excavations below the water table.

The estimated preliminary construction dewatering flow rate to lower the groundwater levels for future earthworks could reach a daily rate of 11,541.2 L/day, by applying a safety factor of 3 it could reach a maximum daily rate of 34,623.5 L/day. Since the estimated dewatering flow rate is lower than 50,000 L/day, the registering or applying for an EASR or a PTTW with the MECP as approvals to facilitate any proposed groundwater-taking for construction will not be required.

The zone of influence for any conceptual dewatering wells or dewatering array used during construction could reach a maximum of 7.2 m away from the dewatering array or wells. There are no water bodies, wetlands or watercourses located within the conceptual zone of influence. However, three water supply wells are situated within the conceptual zone of influence for construction dewatering. Two of these wells are located within the site's boundaries and one is located outside. It is recommended that the two wells located within the subject site be decommissioned prior to construction, if/when they are no longer in use. The water well that is located outside of the site's boundary is screened at a depth below the underground servicing invert elevations for the proposed development. As such, there are no interference concerns for this well as a result of proposed construction, and the monitoring of this well is not likely required.

Based on the measured shallow groundwater levels, the proposed underground services and basements may be constructed below the shallow groundwater levels. As such, it may be necessary to lower the perched shallow groundwater table temporarily during earthwork and construction. However, the subject site is underlain by low permeable subsoil, and any impact from any temporary construction dewatering for basement construction or underground services installation to the shallow groundwater function of the site is anticipated to be minor to negligible, with no long-term impacts being anticipated.

2.0 INTRODUCTION

2.1 Project Description

In accordance with authorization from Sam Morra of Bolton Midtown Developments Inc., Soil Engineers Ltd. (SEL) has conducted a hydrogeological assessment for a proposed residential development, located at 13247 and 13233 Nunnville Road in the Town of Caledon (Bolton). The location of the site is shown on Drawing No. 1.

The subject site is located approximately 600 m south of the intersection of Albion Vaughan Road and King Street East. Surrounding land use includes; residential properties to the north, Albion Vaughan Road to the east, residential properties to the south and Nunnville Road and residential subdivisions to the west. The site is currently occupied by two existing residential buildings.

This report summarizes the findings of the field study and the associated groundwater monitoring and testing programs, and provides a description and characterization of the interpreted hydro-geostratigraphy for the site and surrounding area. The current study provides preliminary recommendations for any construction-related, or permanent dewatering needs prior to detailed design.

2.2 Project Objectives

The major objectives of this Hydrogeological Study Report are as follows:

1. Establish the local hydrogeological setting for the site and local surrounding areas;
2. Interpretation of shallow groundwater flow and runoff patterns;

3. Identify zones of higher groundwater yield as potential sources for ongoing shallow groundwater seepage;
4. Characterizing the hydraulic conductivity (K) for the groundwater-bearing sub soil strata;
5. Prepare an interpreted hydrostratigraphic cross-section for the subject site;
6. Estimate the anticipated temporary dewatering flows that may be required to lower the water table to facilitate construction, or for any permanent, foundation drainage, following construction and;
7. Evaluate potential impacts to any nearby groundwater receptors within the anticipated zone of influence of dewatering; and to develop preliminary estimation for any dewatering flow rates that may be required to facilitate excavation and construction.

2.3 **Scope of Work**

The scope of work for the Hydrogeological Study is summarized below:

1. Installation of three (3) monitoring wells within the site's development footprint;
2. Monitoring well development and groundwater level measurements at the three (3) monitoring wells;
3. Performance of Single Well Response Tests (SWRTs) at the monitoring wells to estimate the hydraulic conductivity (K) for the groundwater-bearing subsoil strata at the depths of the well screens;
4. Describing the geological and hydrogeological setting for the site and local surrounding area; and,
5. Review of the findings of the concurrent geotechnical study; review of available engineering development plans and profiles for any proposed

underground structures and housing basements and services and assessing preliminary dewatering needs and estimation of any anticipated dewatering flows to lower groundwater levels to facilitate construction.

3.0 METHODOLOGY

3.1 Borehole Advancement and Monitoring Well Installation

Borehole drilling and monitoring well construction were conducted between June 11 and June 14, 2019. The program consisted of the drilling of five (5) boreholes (BHs) and the installation of three (3) monitoring wells (MW), one within or adjacent to each of three (3) selected boreholes drilled for the soil investigation report. It should be noted that an additional deep monitoring well (BH/MW 1) was installed as a part of the geotechnical study for the slope stability analysis, but this deep well was not monitored for our hydrogeological assessment. The locations of the boreholes/monitoring wells are shown on Drawing No. 2.

The drilling and monitoring well construction were completed by the licensed water well contractor, Pontil Drilling, under the full-time supervision of a field technician from SEL, who also logged the soil strata encountered during borehole advancement and collected representative soil samples for soil classification. The boreholes were drilled using continuous flight power augers. Detailed descriptions of the encountered subsurface soil and groundwater conditions are presented on the borehole and monitoring well logs, on the enclosed Figures 1 to 5, inclusive.

The monitoring wells were constructed using 50-mm diameter PVC riser pipes and screens, which were installed in each of the boreholes in accordance with Ontario Regulation (O. Reg.) 903. All of the monitoring wells were provided with steel flush mount protective casings. The details of the monitoring well construction are provided on the enclosed Borehole Logs (Figures 1 to 5).

The UTM coordinates and ground surface elevations at the borehole/monitoring well locations, together with the monitoring well construction details, are provided on Table 3-1.

Table 3-1 - Monitoring Well Installation Details

Well ID	Installation Date	UTM Coordinates		Ground El. (masl)	Borehole Depth (mbgs)	Well Screen Interval (mbgs)	Well Casing Dia. (mm)
		East (m)	North (m)				
BH/MW 2	June 13, 2019	603009.25	4859766.15	244.26	15.7	3.1-6.1	50
BH/MW 3	June 14, 2019	603101.36	4859732.22	243.26	8.1	3.1-6.1	50
BH/MW 5	June 14, 2019	602994.33	4859642.06	248.15	6.6	3.1-6.1	50

Notes:
mbgs -- metres below ground surface
masl -- metres above sea level

It should be noted that the measured ground surface elevations at the borehole and monitoring well locations were adopted from the survey plan prepared by Rady-Pentek & Edward Surveying Ltd., Job No. 19-095, dated June 20, 2019.

3.2 Groundwater Monitoring

The groundwater levels in the monitoring wells were measured manually on June 27, July 9, and July 15, 2019.

3.3 Mapping of Ontario Water Well Records

SEL received the Ministry of Environment, Conservation and Parks (MECP) Water Well Records (WWRs) for registered wells located on the subject site and within 500 m of the site boundaries (study area). The records indicate that thirty-three (33) registered wells are located within the study area. The well locations are shown on Drawing No. 3, and the WWRs reviewed for this study are listed in Appendix 'A'.

3.4 **Monitoring Well Development and Single Well Response Tests**

The monitoring wells underwent development in preparation for single well response tests (SWRT) to estimate the hydraulic conductivity (K) for saturate subsoil strata at the depths of the well screens. Well development involved the purging and removal of several casing volumes of groundwater from each monitoring well to remove remnants of clay, silt and other debris introduced into the wells during construction, and to induce the flow of fresh formation groundwater through the well screens, thereby improving the transmissivity of the strata formation at the well screen depths.

The K values derived from the SWRT's provide an indication of the yield capacity for the ground water-bearing subsoil strata and can be used to estimate the flow of groundwater through the water-bearing subsoil strata.

The SWRT involves the placement of a slug of known volume into the well, below the water table, to displace the groundwater level upward. The rate at which the groundwater level recovers to static conditions (falling head) is tracked using a data logger/pressure transducer, and/or manually using a water level tape. The rate at which the water table recovers to static conditions is used to estimate the K value for the water-bearing subsoil formation at the well screen depth. BH/MWs 2, 3 and 5 underwent a SWRT on July 9, 2019. The K test estimate results are provided in Appendix 'B', with a summary of the findings provided in Table 6-2.

3.5 **Review Summary of Concurrent Report**

The following concurrent geotechnical report, prepared by SEL was reviewed in preparation of this hydrogeological study:

"A Report to Bolton Midtown Developments Inc., A Geotechnical Investigation and Slope Stability Assessment for Proposed Residential Development, 13247 and 13233 Nunnville Road, Town of Caledon (Bolton)", Reference No. 1905-S182, dated July 2019.

4.0 REGIONAL AND LOCAL SETTING

4.1 Regional Geology

The subject site lies within the Physiographic Region of Southern Ontario known as the South Slope, and is situated on the Till Plains (Drumlinized) physiographic feature. The South Slope which is the southern slope of the Oak Ridges Moraine, includes a land strip south of the Peel Plain. It rises 90 to 120 m in elevation to the line of contact with the moraine at elevations ranging from 240 to 300 masl. The south slope exhibits an average width of 9.6 to 11.3 km, extending from the Niagara Escarpment to the Trent River. It covers an area of approximately 2,400 km^2. The South Slope is smoothed, faintly drumlinized, and scarred at intervals by valleys and tributaries of the Rouge, Don, and Humber River systems (Chapman and Putnam, 1984).

The surface geological map of Ontario shows that the subject site is located on the Halton Till unit, consisting predominantly of silt to silty clay matrix, high in matrix calcium carbonate content, considered as being clast-poor. Drawing No. 4, as reproduced from Ontario Geological Survey (OGS) mapping, illustrates the quaternary surface soil geology for the site and surrounding area.

The underlying bedrock is comprised mainly of shale, limestone, dolostone and siltstone of the Georgian Bay formation which were deposited during the Upper Ordovician Epoch (Bedrock Geology of Ontario, 1993). The approximate elevation for the top of the bedrock beneath the site is about 145 masl, which is about 100 m below the subject site.

4.2 Physical Topography

A review of the topography shows that the subject site is relatively hilly with a decline in elevation relief towards the east and north. Runoff from the site is expected to drain predominantly towards the southeast portion of the property, towards the Albion Vaughan Road right of way. A small portion of the northern section of the property will drain towards the Humber River ravine. Based on the topographic map for the area and from the ground surface elevations at the borehole and monitoring well locations, the elevation relief at the north limit of the subject site is about 30 m. A ravine demarks the north corner of the site which slopes downward to the north, towards the Humber River. Drawing No. 5 shows the mapped topographical contours for the site and surrounding area.

4.3 Watershed Setting

The subject site is located in the Humber River Watershed and Main Humber sub-watershed. The Humber River watershed occupies an area of approximately 911 square kilometers, making it the largest watershed in the Greater Toronto Area. The headwaters of the Humber River begin within the Oak Ridges Moraine and the Niagara Escarpment. The River flows through many municipalities, including, but not limited to; the Town of Caledon, The City of Vaughan, and the City of Toronto. It consists of five principal tributaries which are known as the Main Humber, West Humber, East Humber, Lower Humber, and Black Creek.

The Humber River Watershed is bounded to the west by the Mimico Creek Watershed and Etobicoke Creek Watershed, to the east by the Don River Watershed, and by the Rouge River Watershed, and to the south by the Waterfront Watershed. Drawing No. 6 shows the location of the subject site within the Humber River Watershed.

4.4 **Local Surface Water and Natural Features**

The Humber River and its associated wooded areas are located approximately 200 m north, and also 250 m east of the subject site. The closest wetland feature is found approximately 100 m southeast of the site. This wetland has not been evaluated based on the Ontario Wetland Evaluation System (OWES) as being Provincially Significant. The locations of the site and the noted natural features are shown on Drawing No. 7.

5.0 SOIL LITHOLOGY

This study has disclosed that beneath the topsoil horizon and existing earth fill layer materials, the native soils underlying the subject site consists of silty clay, silty clay till, silt and silty fine sand. A Key Plan and the interpreted geological cross-sections along the delineated northwest to southeast and northeast to southwest transects across the site are presented on Drawing No's. 8-1 and 8-2.

5.1 **Topsoil** (All BH and BH/MW locations)

Topsoil, 10 to 23 cm thick, was observed at the ground surface at all of the borehole locations.

5.2 **Earth Fill (Silty Sand Fill)** (BH 4 and BH/MW3)

Earth fill, 0.7 and 1.7 m thick, was observed below the topsoil horizon at BH 4 and BH/MW 3 respectively. It consists of silty clay with traces to some sand and traces of gravel.

5.3 **Silty Clay** (All BH and BH/MW locations except BH/MW 3)

Silty clay was encountered at all of the BH and BH/MW locations, except at BH/MW 3, at depths ranging between 1.5 and 27.4 m. The silty clay is grey in colour at BH/MWs 1 and 2 and is brown in colour at BH 4 and BH/MW 5. The thickness of the layer ranges from 0.5 to 3.0 m. The moisture content for the retrieved subsoil samples ranges from 18% to 25%, indicating moist to saturated conditions. The estimated permeability for the silty clay at a depth of 2.5 mbgs is about 10^{-7} cm/sec.

A grain size analysis was performed on one (1) sample, and the soil gradation is plotted on Figure 6.

5.4 **Silty Clay Till** (All BH and BH/MW locations)

Silty clay till was encountered beneath the topsoil and/or earth fill horizons at all of the BH and BH/MW locations. At BH 4 and BH/MWs 2 and 5, a second deeper layer of silty clay till was encountered. The silty clay till is brown or grey in colour and is soft to very stiff in consistency, having a trace to some sand, a trace of gravel and occasional wet sand and silt seams and layers, cobbles and boulders. The moisture content for the retrieved subsoil samples ranges from 12% to 24%, indicating moist to saturated conditions. The estimated permeability for the silty clay till at a depth of 2.5 mbgs is about 10^{-7} cm/sec. A grain size analysis was performed on one (1) sample, and the soil gradation is plotted on Figure 7.

5.5 **Silt** (BH/MW 1)

Silt was encountered at two different depths at BH/MW 1. The upper layer is grey and was encountered at a depth of 19.8 m, and the lower layer is brown and was encountered at a depth of 22.9 m. The silt is very dense in consistency, having traces to some clay and sand, and a trace of gravel. The moisture contents for the retrieved subsoil samples ranges from 19% to 22%, indicating moist to very moist conditions. The estimated permeability for the silt at a depth of 23.0 mbgs is about 10^{-6} cm/sec. A grain size analysis was performed on one (1) sample, and the soil gradation is plotted on Figure 8.

5.6 **Silty Fine Sand** (BH/MW 1)

A thin layer of silty fine sand was encountered at BH/MW 1 between the upper and lower silt layers, at a depth of 21.3 m. The silty fine sand is brown in colour and very dense in consistency, having a trace of clay. The moisture content for the retrieved subsoil samples was 11%, indicating damp conditions.

6.0 GROUNDWATER STUDY

6.1 Review Summary of Concurrent Report

A review of the findings from the concurrent geotechnical investigation report (SEL Reference No. 1905-S182) has disclosed that beneath a layer of top soil and earth fill, the site is underlain by silty clay till, interstratified by a deposit of silty clay at various locations and depths. Deposits of silt and silty fine sand were also encountered in the deep borehole. All of the boreholes were dry and no cave-in was recorded upon completion of the borehole drilling program. The groundwater yield from the silty clay till and silty clay will be small and limited in quantity, due to its low permeability, and the yield, if encountered, from any silt or sand deposits will be moderate to appreciable.

6.2 Review of Ontario Water Well Records

The Ministry of the Environment, Conservation and Parks (MECP) water well records for the subject site and for the properties within a 500 m radius of the boundaries of the subject site (study area) were reviewed.

The records indicate that thirty-three (33) well records are located within the study area. The locations of these well records, based on the UTM coordinates provided by the records, are shown on Drawing No 3. Details of the MECP water well records that were reviewed are provided in Appendix ‘A’.

A review of the final status of the well records within the study area reveals that twenty-five (25) are registered as water supply wells, two (2) are unfinished wells, two (2) are test holes and four (4) are registered as abandoned-supply wells.

A review of the first use of the well records reveals that twenty-five (25) are registered as domestic wells, four (4) are not being used and four (4) wells have an unknown status.

6.3 **Groundwater Monitoring**

The groundwater levels in the monitoring wells were measured on June 25, July 9 and July 15, 2019 to record the fluctuation of the shallow groundwater table beneath the site. The recorded water levels and their corresponding elevations are given in Table 6-1.

Table 6-1 - Groundwater Level Measurements

Well ID		June 25, 2019	July 9, 2019	July 15, 2019	Average	Fluctuation (m)
BH/MW 2	mbgs	1.08	1.55	1.76	1.46	0.68
	masl	243.18	242.71	242.50	242.80	
BH/MW 3	mbgs	1.44	1.50	1.66	1.53	0.22
	masl	241.82	241.76	241.60	241.73	
BH/MW 5	mbgs	4.93	4.72	4.48	4.71	0.45
	masl	243.22	243.43	243.67	243.44	

Notes
mbgs -- metres below ground surface
masl -- metres above sea level

As shown above, the groundwater levels at BH/MWs 2 and 3 generally declined during the monitoring period, exhibiting small fluctuations in between, while the groundwater levels at BH/MW 5 generally increased over the monitoring period. The greatest fluctuation was observed at BH/MW 2 where the groundwater levels changed by 0.68 m over the monitoring period.

6.4 Shallow Groundwater Flow Pattern

The shallow groundwater flow pattern for the site was interpreted based on the average of the groundwater level elevations, as measured at all of the BH/MW locations. This interpretation suggests that it flows mainly in a southeasterly direction. The interpreted shallow groundwater flow pattern for the subject site is illustrated on Drawing No. 9.

6.5 Single Well Response Test Analysis

BH/MWs 2, 3 and 5 underwent a single well response test (SWRT) to assess the hydraulic conductivity (K) for saturated aquifer subsoils at the depths of the well screens. The results of the SWRTs are presented in Appendix 'B', with a summary of the findings shown in Table 6-2.

Table 6-2 - Summary of SWRT Results

Well ID	Ground El. (masl)	Monitoring Well Depth (mbgs)	Borehole Depth (mbgs)	Well Screen Interval (mbgs)	Screened Soil Strata	Hydraulic Conductivity (K) (m/sec)
BH/MW 2	244.26	6.1	15.7	3.1-6.1	Silty Clay Till, Silty Clay	7.4×10^{-8}
BH/MW 3	243.26	6.1	8.1	3.1-6.1	Silty Clay Till	2.5×10^{-7}
BH/MW 5	248.15	6.1	6.6	3.1-6.1	Silty Clay Till	6.3×10^{-8}

Notes
mbgs -- metres below ground surface
masl -- metres above sea level

As shown above, the K estimate for the silty clay/silty clay till is between 7.4×10^{-8} and 2.5×10^{-7} m/sec. The results of the SWRT provide an indication of the yield capacity for the groundwater-bearing subsoil strata at the depths of the screens. The

above results suggest that the hydraulic conductivity for the groundwater-bearing soils at the depths of the well screens is low, with corresponding low anticipated groundwater seepage rates expected into open excavations, below the water table.

7.0 GROUNDWATER CONTROL DURING CONSTRUCTION

The estimated hydraulic conductivity (K) for the screened subsoil strata suggests that groundwater seepage rates into open excavations below the groundwater table will be low. To provide safe, dry and stable conditions from earthworks and for excavations for construction of the proposed underground basement structures and for underground services, the groundwater table may need to be lowered in advance of, or during construction. The preliminary estimates for construction dewatering flows required to locally lower the shallow groundwater table, based on the K test results, are discussed in the following sections.

7.1 Groundwater Construction Dewatering Rates

The Draft Plan of Subdivision prepared by WSP, dated January 17, 2020, was reviewed in the preparation of this report. The proposed development will consist of the construction of twenty-nine lots, having associated residential housing and potential underground basement structures. Based on the shallow groundwater level elevations, temporary dewatering is anticipated for the earthworks portion of the underground structures and services construction. The construction dewatering flow rate estimations are discussed below:

Dewatering Flow Rate Estimates for Underground Basement Structure Construction

The Preliminary Site Grading Plan, prepared by C.F. Crozier & Associates Consulting Engineers, Drawing No. C103, dated July 26, 2019, was reviewed for this assessment. The preliminary grading plan indicates that the site will be regraded to elevations ranging from 241.00 to 250.26 masl. By considering a 3.0 m depth below the lowest proposed grade for the proposed underground basement structures, a base elevation of 238.00 masl was considered for current construction dewatering needs assessment. To facilitate excavation and construction in dry and stable subsoil

conditions, it is proposed that the water table be lowered to an elevation of 237.00 masl, which is about 1.0 m below the lowest proposed excavation depth. The highest shallow groundwater level measured during the monitoring period was at El. 243.67 masl. The subsoil profile consists of silty clay and silty clay till, extending to the maximum anticipated excavation depth. As such, the estimated dewatering flow rates are anticipated to reach rates of 11,383.7 L/day for the proposed underground basement structures; by considering a 3x safety factor, this rate could reach an approximate daily maximum of 34,151.1 L/day. It should be noted that a rectangular excavation footprint having a length of 25 m and width of 10 m was considered for this dewatering needs assessment.

Construction Dewatering Flow Rate Estimates for Underground Infrastructure Servicing

The Preliminary Site Servicing Plan, prepared by C.F. Crozier & Associates Consulting Engineers, Drawing No. C102, dated July 26, 2019, was reviewed for this assessment. The preliminary site servicing plan indicates that the northeast invert elevation for a proposed sanitary sub trunk at MH 1 is at an elevation of 238.55 masl. To facilitate excavation and construction in dry and stable subsoil conditions, it is proposed that the water table be lowered to an elevation of 237.55 masl, which is 1.0 m below the lowest proposed servicing invert elevation. The highest shallow groundwater level measured during our monitoring period was at an elevation of 243.67 masl. The subsoil profile consists of silty clay and silty clay till, extending to the maximum anticipated excavation depth. As such, the estimated dewatering flow rate could reach a rate of 11,541.2 L/day; by considering a 3x safety factor, it could reach an approximate daily maximum rate of 34,623.5 L/day. It should be noted that an active dewatering array for a servicing trench length of 50 m was considered for this assessment.

In accordance with the current policy of the Ministry of the Environment, Conservation and Parks (MECP), where the dewatering flow rate is lower than 50,000 L/day, there is no need to register for a proposed groundwater-taking approval for construction by means of the filing an Environmental Activity and Sector Registry (EASR), or through a Permit-To-Take water (PTTW) application with the MECP. Since the estimated maximum dewatering flow rate is lower than 50,000 L/day in which it could reach a maximum daily rate of 34,623.5 L/day, the registering or applying for and EASR, or a PTTW with the MECP as approvals to facilitate any proposed groundwater-taking for construction will not be required. There may be a need to remove temporary runoff accumulation within housing excavations and servicing trenches follow high storm events. It is anticipated that any removal of accumulated runoff can be accomplished without the need for an EASR.

It should be noted that shallow groundwater level was monitored over the summer season and it is anticipated that it will rise over the high precipitation spring season. As such, it is recommended that shallow groundwater levels be monitored again over the spring if the excavation and construction is planned for this season. It is also recommended that the construction dewatering needs estimation be revised and updated, once finalized development plans, showing the proposed finished floor elevations, the basement structure elevations and the underground servicing invert elevations become available for review, and/or if there are any significant differences between the above assumptions and the final proposed finished floor elevations, underground basements and servicing invert elevations.

Long-Term Foundation Drainage

Detailed design plans showing the basement floor elevations were not available at the time of this report preparation. As such, the long-term foundation drainage volume estimates and the associated hydrological impacts resulting from the groundwater table lowering could not be determined. However, given the low permeability for shallow subsoil, comprised mainly of silty and clay rich tills, where the proposed housing basements will be established, occasional minor groundwater seepage may be realized within basement sumps at certain times of the year, with no permanent long-term seepage and no associated long-term impacts being anticipated.

7.2 Mitigation of Potential Impacts Associated with Dewatering

The zone of influence for any conceptual dewatering wells or dewatering array used during construction could reach a maximum of 7.2 m away from the dewatering array. There are no water bodies, wetlands or watercourses located within the conceptual zone of influence for construction dewatering. However, three water supply wells are situated within the conceptual zone of influence for construction dewatering. Two of these wells are located within the site's boundaries and one is located outside the boundaries. These water supply wells, having MECP IDs of 4900444, 4900445 and 4905773, which are shown as Well Nos. 21, 22 and 26 on Drawing No. 3. They were installed to depths of 79.25, 56.39 and 93.53 mbgs, respectively, having static groundwater levels of 36.58, 41.15 and 39.01 mbgs. As the proposed new development is expected to be connected to the Region of Peel municipal water supply, it is recommended that the two wells located within the site be decommissioned in advance of construction. The water well that is located outside of the site's boundary is screened at a depth below the proposed invert elevations for underground services at this proposed development. As such, there are no

interference concerns for this well as a result of the construction, and monitoring is not likely required. However, should a future well canvassing program determine that the well is still being used and there is a requirement to monitor it as a condition of approval, the well owner will be requested to participate in a monitoring program prior to during and after servicing of the subject site to confirm no adverse impacts to the well as a result of the construction.

7.3 Groundwater Function for the Subject Site

The subject site is located within an existing residential neighbourhood. There are no natural heritage features such as watercourses, bodies of water, or wetlands within, or in close proximity to the subject site. However, there are records for two (2) existing water supply wells within the subject site and one (1) existing water supply well just outside the site's boundaries. Based on the measured shallow groundwater levels, the proposed underground services and basement structures may be constructed below the shallow groundwater level. As such, it may be necessary to lower the perched shallow groundwater table temporarily during earthworks and construction. However, the subject site is underlain by low permeable subsoil, and any impacts from any temporary dewatering for basement construction or underground services installation on the shallow groundwater function of the site is anticipated to be minor to negligible, with no long-term impacts being anticipated.

7.4 Ground Settlement

Potential ground settlement concerns associated with construction dewatering should be assessed by a geotechnical engineer prior to earthworks and construction.

7.5 **Low Impact Development (LID)**

Given the low permeability for shallow native soil, expected to be less than 7.5 mm/hr., no conventional LIDS are being proposed for the developed site, other than the proposed thickening of topsoil to max of 400 mm as a best effort measure to maintain the site's water balance following development.

8.0 **CONCLUSION**

1. The subject site lies on mapped till plains within the Physiographic Region of Southern Ontario known as the South Slope, on the drumlinized till plain Physiographic Feature.
2. Based on review of the surface geological map of Ontario, the subject site is underlain by the Halton Till unit, consisting predominantly of silt to silty clay matrix, high in matrix calcium carbonate, considered as being clast poor.
3. A review of the topography shows that the site is relatively hilly with a decline in elevation relief towards the east and north.
4. The subject site is located within the Humber River Watershed and Main Humber Sub-watershed.
5. This study has disclosed that beneath the topsoil horizon and earth fill materials layer, the native soils underlying the subject site consists of silty clay, silty clay till, silt and silty fine sand.
6. The findings of this study confirm that the groundwater level elevations range from El. 241.60 to El. 243.67 masl, (or from 1.08 to 4.93 mbgs), and that shallow groundwater flows towards the southeast.
7. The single well response test yielded estimated hydraulic conductivity (K) values of between 7.4×10^{-8} and 2.5×10^{-7} m/sec for the silty clay/silty clay till at the depths of the well screens.
8. The estimated preliminary construction dewatering flow rate to lower the groundwater levels for future earthworks could reach a daily rate of 11,541.2 L/day, by applying a safety factor of 3 it could reach a maximum daily rate of 34,623.5 L/day. Since the estimated dewatering flow rate is lower than 50,000 L/day, the registering, or applying for an EASR or a PTTW with the MECP to facilitate any proposed groundwater-taking for construction will not be required.

9. The zone of influence for any conceptual dewatering wells or dewatering array used during construction could reach a maximum of 7.2 m away from the dewatering array or wells. There are no water bodies, wetlands or watercourses located within the conceptual zone of influence. However, three water supply wells are situated within the conceptual zone of influence for construction dewatering. Two of these wells are located within the site's boundaries and one is located outside. It is recommended that the two wells located within the site be decommissioned prior to construction, if/when they are no longer in use at the site. The water well that is located outside of the site's boundary is screened at a depth below the conceptual servicing invert elevations for the proposed development. As such, there are no interference concerns for this well as a result of this proposed construction, and monitoring is not likely required.
10. Based on the measured shallow groundwater levels, the proposed underground services and basements may be constructed below the shallow groundwater level. As such, it may be necessary to lower the perched shallow groundwater table temporarily during earthwork and construction. However, the subject site is underlain by low permeable soil, and any impacts from any temporary dewatering for basement construction or underground services installation on the shallow groundwater function of the site is anticipated to be minor to negligible, with no long-term impacts being anticipated.
11. Given the low permeability of native shallow soil, no conventional LIDS are being proposed for the developed site other than the proposed thickening of topsoil as a best effort measure to maintain the site's water balance following development.

SOIL ENGINEERS LTD.

GAVIN R. O'BRIEN
PRACTISING MEMBER
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January 21, 2020
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9.0 REFERENCES

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2. Bedrock Geology of Ontario, 1993, Data set 6, Ministry of Northern Development
3. D.P. Rogers, R.C. Ostry and P.F. Karrow, 1961, Metropolitan Toronto Bedrock Contours, Ontario Department of Mines, Preliminary Map 102.
4. Highland Creek Watershed Report Card, 2013, Toronto Region Conservation Authority.

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FIGURES 1 to 8

BOREHOLE LOGS AND GRAIN SIZE DISTRIBUTION GRAPHS

REFERENCE NO. 1905-W182

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS Auger sample
CS Chunk sample
DO Drive open (split spoon)
DS Denison type sample
FS Foil sample
RC Rock core (with size and percentage recovery)
ST Slotted tube
TO Thin-walled, open
TP Thin-walled, piston
WS Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—●—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

WH Sampler advanced by static weight
PH Sampler advanced by hydraulic pressure
PM Sampler advanced by manual pressure
NP No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/ft)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (ksf)	'N' (blows/ft)	Consistency
less than 0.25	0 to 2	very soft
0.25 to 0.50	2 to 4	soft
0.50 to 1.0	4 to 8	firm
1.0 to 2.0	8 to 16	stiff
2.0 to 4.0	16 to 32	very stiff
over 4.0	over 32	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0 Field vane test in borehole; the number denotes the sensitivity to remoulding

△ Laboratory vane test

□ Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres
1lb = 0.454 kg
1 inch = 25.4 mm
1ksf = 47.88 kPa

JOB NO.: 1905-W182

LOG OF BOREHOLE NO.: BH/MW 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Tricone

PROJECT LOCATION: 13247 and 13233 Nunnville Road
Town of Caledon (Bolton)

DRILLING DATE: June 11 to 13, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
243.3	Ground Surface							
0.0	**15 cm TOPSOIL**				0			
0.2	Firm to very stiff — organic inclusions	1A	DO	6			18	
		1B						
	SILTY CLAY TILL — weathered							
	a trace to some sand a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	2	DO	17	1		21	
		3	DO	20	2		16	
		4	DO	19			22	
		5	DO	23	3		16	
		6	DO	16	4		22	
		7	DO	15	5		24	
	— brown grey	8	DO	18	6		17	
		9	DO	28	7		17	
233.3	*(Continued on next page)*				8 9 10			No W.L. on completion of field work due to use of water to drill borehole

JOB NO.: 1905-W182

LOG OF BOREHOLE NO.: BH/MW 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Tricone

PROJECT LOCATION: 13247 and 13233 Nunnville Road
Town of Caledon (Bolton)

DRILLING DATE: June 11 to 13, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
10.0	*(Continued)* Grey, very stiff to hard **SILTY CLAY TILL** a trace to some sand a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	10	DO	26	10		18	
		11	DO	28	12		13	
		12	DO	23	14		17	
		13	DO	30	15		18	
		14	DO	29	17		15	
	— grey / brown	15A 15B	DO	50/15	18		12 14	
223.5 ~~19.8~~ ~~223.3~~	Grey **SILT** *(Continued on next page)*	16	DO	50/15	20		19	

JOB NO.: 1905-W182

LOG OF BOREHOLE NO.: BH/MW 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Tricone

PROJECT LOCATION: 13247 and 13233 Nunnville Road
Town of Caledon (Bolton)

DRILLING DATE: June 11 to 13, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
20.0	*(Continued)* Grey, very dense **SILT** some clay and sand a trace of gravel				20			
222.0					21			
21.3	Brown, very dense **SILTY FINE SAND** a trace of clay	17	DO	50/10			11	
220.4					22			
22.9	Brown, very dense **SILT** traces to some clay and sand a trace of gravel	18	DO	50/13	23		22	
		19	DO	50/13	24		18	
		20	DO	50/10	25		19	
215.9					26			
27.4	Grey, hard **SILTY CLAY** a trace of sand	21	DO	38	27		22	
215.4					28			
27.9	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 27.4 m (3.0 m screen) Sand backfill from 23.8 to 27.4 m Bentonite holeplug from 0.0 to 23.8 m Provided with a 4x4 steel monument casing with top and bottom caps, and a lock				29			W.L. @ El. 218.7 m on June 27, 2019
					30			

JOB NO.: 1905-W182

LOG OF BOREHOLE NO.: BH/MW 2

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Auger

PROJECT LOCATION: 13247 and 13233 Nunnville Road
Town of Caledon (Bolton)

DRILLING DATE: June 13 and 21, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
245.0	Ground Surface							
0.0	**10 cm TOPSOIL**				0			
0.1	Brown, firm to very stiff **SILTY CLAY TILL** organic inclusions/ weathered a trace to some sand a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	1	DO	5			25	
		2	DO	20	1		18	
		3	DO	26	2		19	
		4	DO	24			20	
		5	DO	19	3		22	
240.4					4			
4.6	Grey, firm to stiff **SILTY CLAY** a trace of sand	6	DO	8	5		22	
		7	DO	9	6		25	
237.4					7			
7.6	Grey, stiff **SILTY CLAY TILL** a trace to some sand a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	8	DO	13	8		21	
		9	DO	16	9		19	
235.0	*(Continued on next page)*				10			

W.L. @ El. 243.18 m on June 27, 2019
W.L. @ El. 242.71 m on July 9, 2019
W.L. @ El. 242.50 m on July 15, 2019

JOB NO.: 1905-W182

LOG OF BOREHOLE NO.: BH/MW 2

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Auger

PROJECT LOCATION: 13247 and 13233 Nunnville Road
Town of Caledon (Bolton)

DRILLING DATE: June 13 and 21, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
10.0	*(Continued)* Grey, very stiff **SILTY CLAY TILL** a trace to some sand a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	10	DO	22	10	○	16	
		11	DO	22	11	○	17	
		12	DO	24	12	○	16	
229.3		13	DO	25	13	○	18	
15.7	**END OF BOREHOLE** Well installed approximately 10 m northeast of the borehole Ground surface elevation at well location = 244.3 m Installed 50 mm Ø PVC monitoring well to 6.1 m 3.0 m screen from 3.1 to 6.1 m Sand backfill from 2.4 to 6.1 m Bentonite holeplug from 0.0 to 2.4 m Provided with a 4x4 steel monument casing with top and bottom caps, and a lock				14 15 16 17 18 19 20			

JOB NO.: 1905-W182

LOG OF BOREHOLE NO.: BH/MW 3

FIGURE NO.: 3

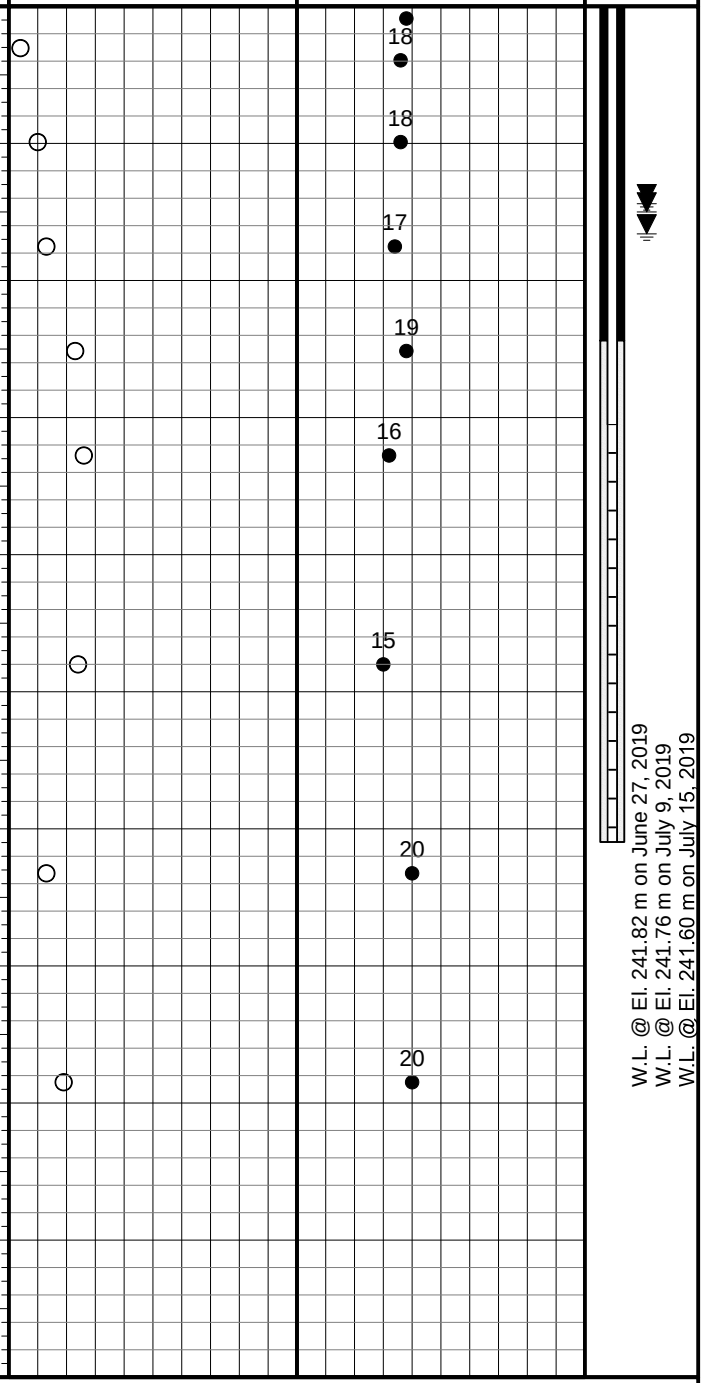
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Auger

PROJECT LOCATION: 13247 and 13233 Nunnville Road
Town of Caledon (Bolton)

DRILLING DATE: June 14, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)
243.3 / 0.0	Ground Surface				
0.0 / 0.2	**18 cm TOPSOIL**	1A			0
	Brown/grey	1B	DO	4	
	EARTH FILL (Silty Clay)	2	DO	10	1
	traces of sand and gravel	3	DO	13	
241.4 / 1.9	Stiff to very stiff				2
	SILTY CLAY TILL	4	DO	23	
	a trace to some sand a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	5	DO	26	3
	brown / grey	6	DO	24	4
		7	DO	13	5
		8	DO	19	6
235.2 / 8.1	**END OF BOREHOLE**				7
	Installed 50 mm Ø PVC monitoring well to 6.1 m 3.0 m screen from 3.1 to 6.1 m Sand backfill from 2.4 to 6.1 m Bentonite holeplug from 0.0 to 2.4 m Provided with a 4x4 steel monument casing with top and bottom caps, and a lock				8
					9
					10



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JOB NO.: 1905-W182

LOG OF BOREHOLE NO.: BH 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Auger

PROJECT LOCATION: 13247 and 13233 Nunnville Road
Town of Caledon (Bolton)

DRILLING DATE: June 14, 2019

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
246.1	Ground Surface							
0.0	**20 cm TOPSOIL**	1A	DO	3	0		30	
0.2	Brown **EARTH FILL** **(Silty Clay)**	1B						
245.2	some sand, a trace of gravel	2	DO	8	1		18	
0.9	with organic inclusions Brown, firm to very stiff **SILTY CLAY TILL** traces of sand and gravel weathered							
	occ. wet sand and silt seams and layers, cobbles and boulders	3	DO	21	2		17	
243.8								
2.3	Brown, very stiff to hard **SILTY CLAY** a trace of sand	4	DO	27			20	
		5	DO	44	3		18	
241.5					4			
4.6	Grey, stiff to very stiff **SILTY CLAY TILL** traces of sand and gravel occ. wet sand and silt seams and layers, cobbles and boulders	6	DO	14	5		17	
		7	DO	17	6		21	
239.5					7			
6.6	**END OF BOREHOLE**				8			
					9			
					10			

Dry on completion of field work

JOB NO.: 1905-W182

LOG OF BOREHOLE NO.: BH/MW 5

FIGURE NO.: 5

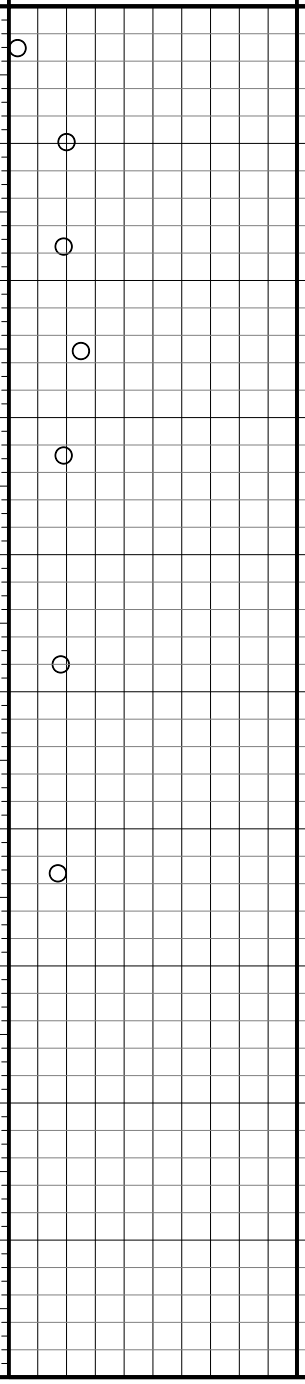
PROJECT DESCRIPTION: Proposed Residential Development

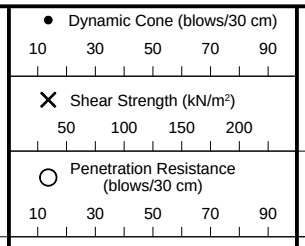
METHOD OF BORING: Solid Stem Auger

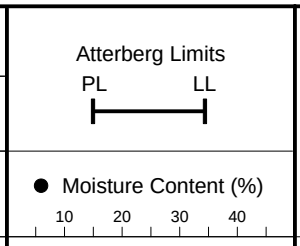
PROJECT LOCATION: 13247 and 13233 Nunnville Road
Town of Caledon (Bolton)

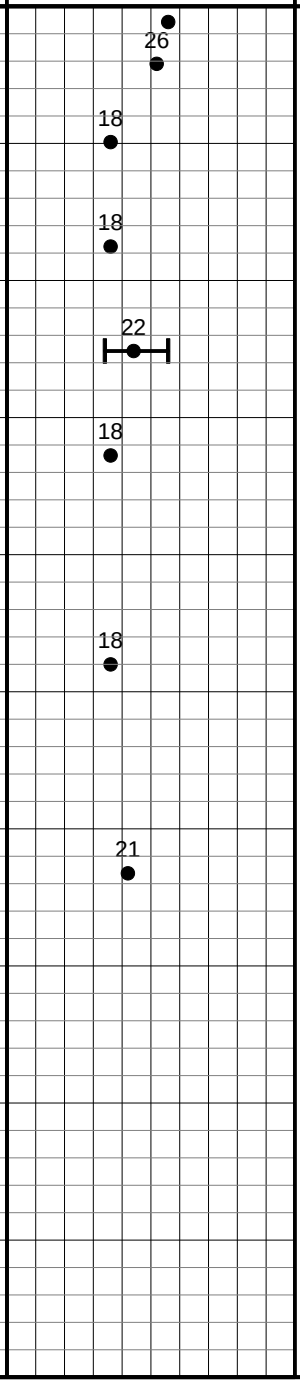
DRILLING DATE: June 14, 2019

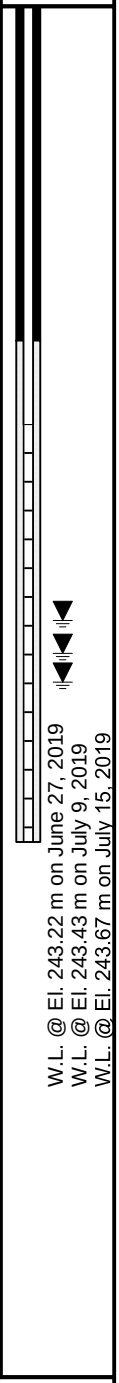
El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
248.2	Ground Surface			
0.0	**23 cm TOPSOIL**	1A	DO	3
0.2	Brown, soft to very stiff **SILTY CLAY TILL** a trace to some sand a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders organic inclusions/ weathered	1B		
		2	DO	20
246.7				
1.5	Brown, very stiff **SILTY CLAY** a trace of sand	3	DO	19
245.9				
2.3	Very stiff **SILTY CLAY TILL** a trace to some sand a trace of gravel occ. wet sand and silt seams and layers, cobbles and boulders	4	DO	25
		5	DO	19
		6	DO	18
	brown / grey	7	DO	17
241.6				
6.6	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 6.1 m 3.0 m screen from 3.1 to 6.1 m Sand backfill from 2.4 to 6.1 m Bentonite holeplug from 0.0 to 2.4 m Provided with a 4x4 steel monument casing with top and bottom caps, and a lock			











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GRAIN SIZE DISTRIBUTION

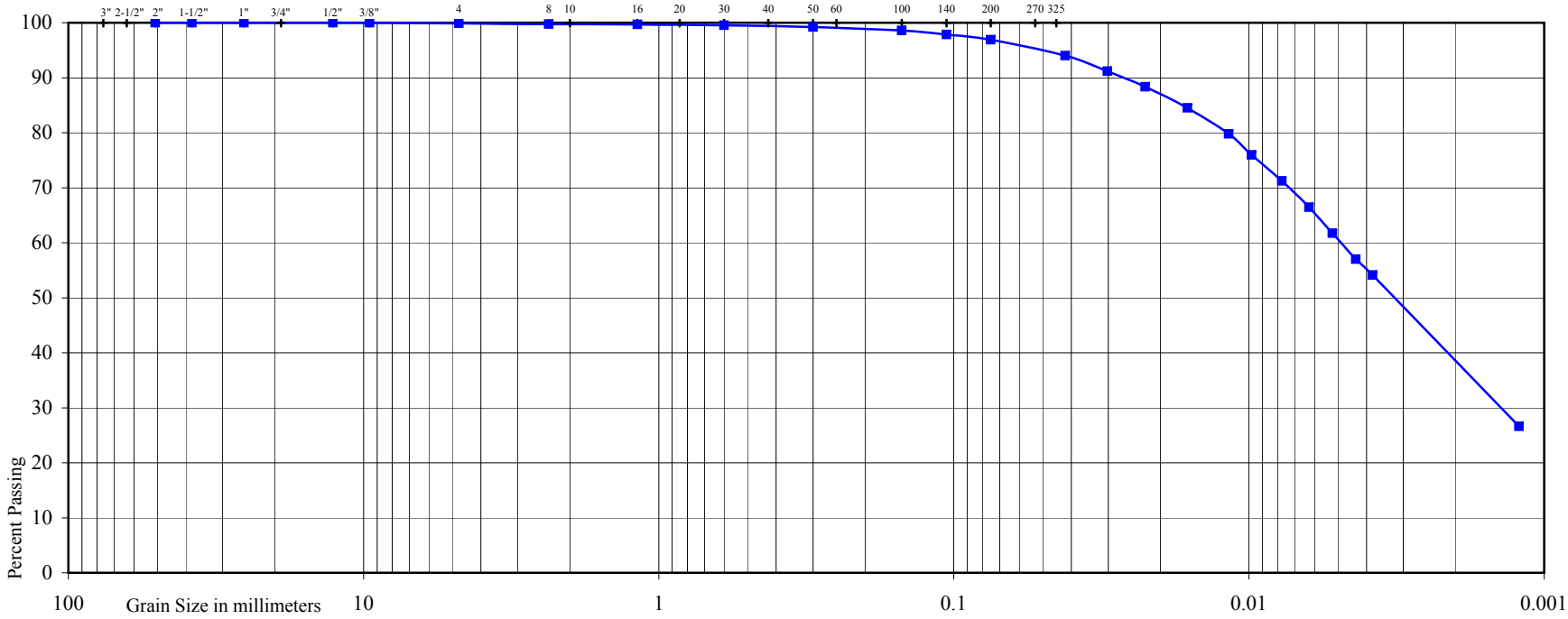
Reference No: 1905-W182

U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL		SAND				SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Project: Proposed Residential Development

Location: 13233 and 13247 Nunnville Road, Town of Caledon (Bolton)

Borehole No: 4

Sample No: 4

Depth (m): 2.5

Elevation (m): 243.6

Estimated Permeability (cm./sec.) = 10^{-7}

Classification of Sample [& Group Symbol]: SILTY CLAY

a trace of fine sand

Figure: 6

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

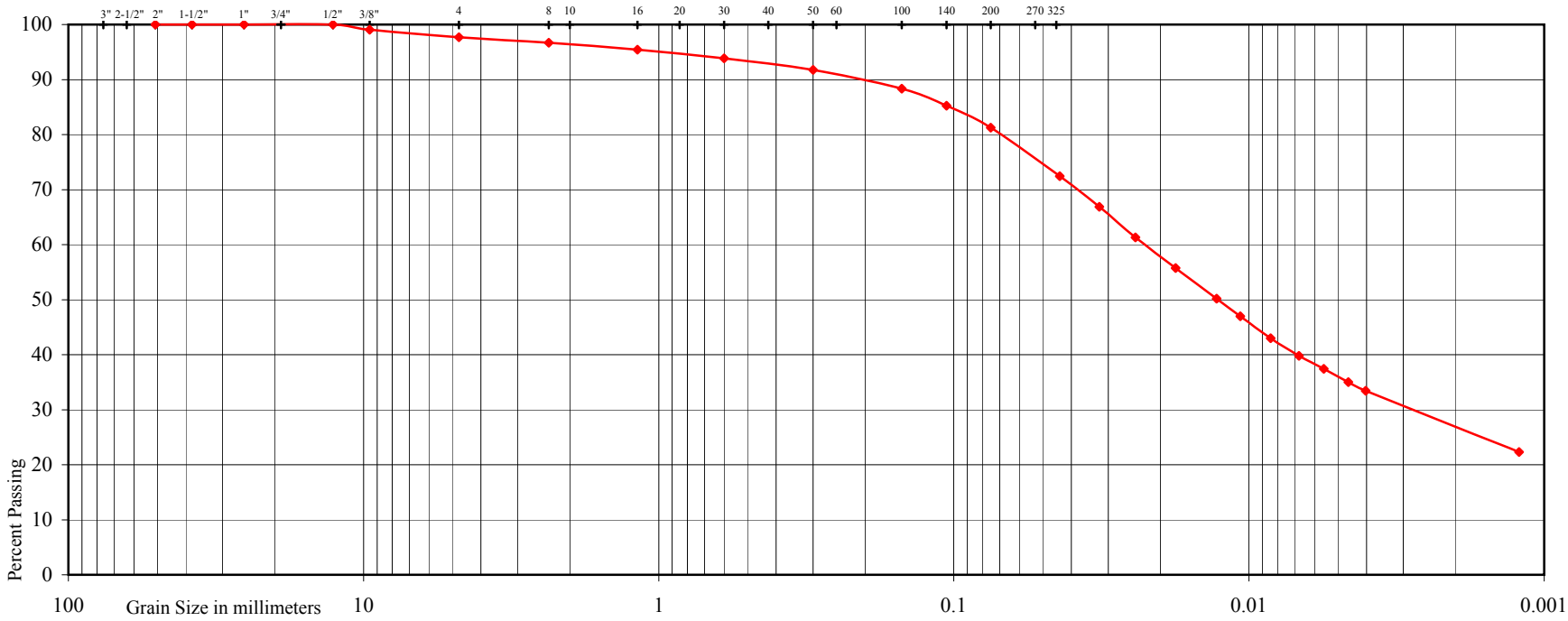
Reference No: 1905-W182

U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL		SAND				SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Project: Proposed Residential Development

Location: 13233 and 13247 Nunnville Road, Town of Caledon (Bolton)

Borehole No: 5

Sample No: 4

Depth (m): 2.5

Elevation (m): 245.7

Estimated Permeability (cm./sec.) = 10^{-7}

Classification of Sample [& Group Symbol]: SILTY CLAY TILL

some sand, a trace of gravel

Figure: 7

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

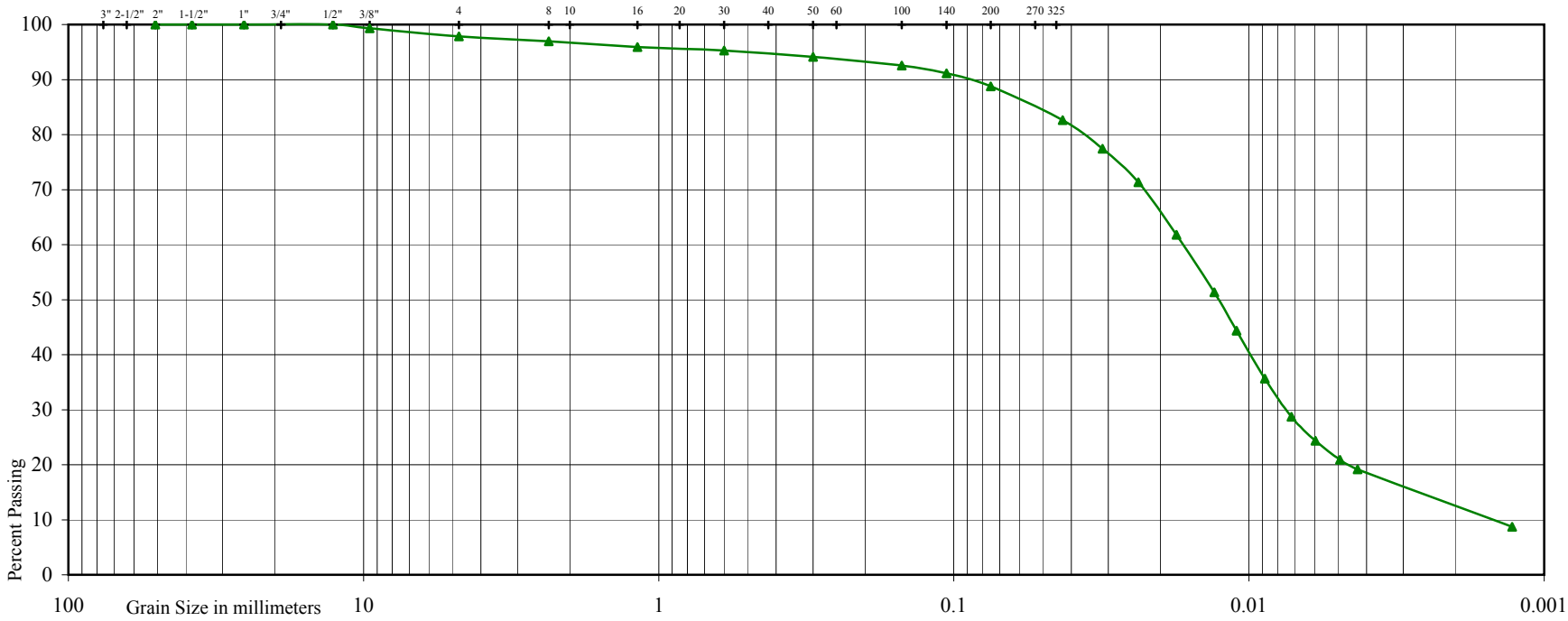
Reference No: 1905-W182

U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL		SAND				SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Project: Proposed Residential Development

Location: 13233 and 13247 Nunnville Road, Town of Caledon (Bolton)

Borehole No: 1

Sample No: 18

Depth (m): 23.0

Elevation (m): 220.3

Estimated Permeability (cm./sec.) = 10^{-6}

Classification of Sample [& Group Symbol]: SILT

some clay to clayey, traces of sand and gravel

Figure: 8

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FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 725-1315	FAX: (905) 542-2769

DRAWINGS 1 to 9

REFERENCE NO. 1905-W182

C:\GIS\2019\1905-W182\

Source: Water Course, Ontario Ministry of Natural Resources and Forestry
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Source: Water Body, Ontario Ministry of Natural Resources and Forestry
© Queen's Printer for Ontario

N

Approximate Boundary of Subject Site
Waterbody
Watercourse
Major Road
Local Road

Soil Engineers Ltd.

Title: Site Location Plan

Project:

Hydrogeological Assessment
Proposed Residential Development
13233 and 13247 Nunnville Road
Town of Caledon (Bolton)

Reference No. 1905-W182

Date: June 28, 2019

Scale:
0 50 100 200 300 400 500
Metres

Drawing No. 1

Source: Water Course, Ontario Ministry of Natural Resources and Forestry
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Source: Water Body, Ontario Ministry of Natural Resources and Forestry
©Queen's Printer for Ontario

N

Approximate Boundary of Subject Site

Borehole

Borehole with Monitoring Well

Local Road

Soil Engineers Ltd.

Title: Borehole and Monitoring Well Location Plan

Project:

Hydrogeological Assessment
Proposed Residential Development
13233 and 13247 Nunnville Road
Town of Caledon (Bolton)

Reference No. 1905-W182

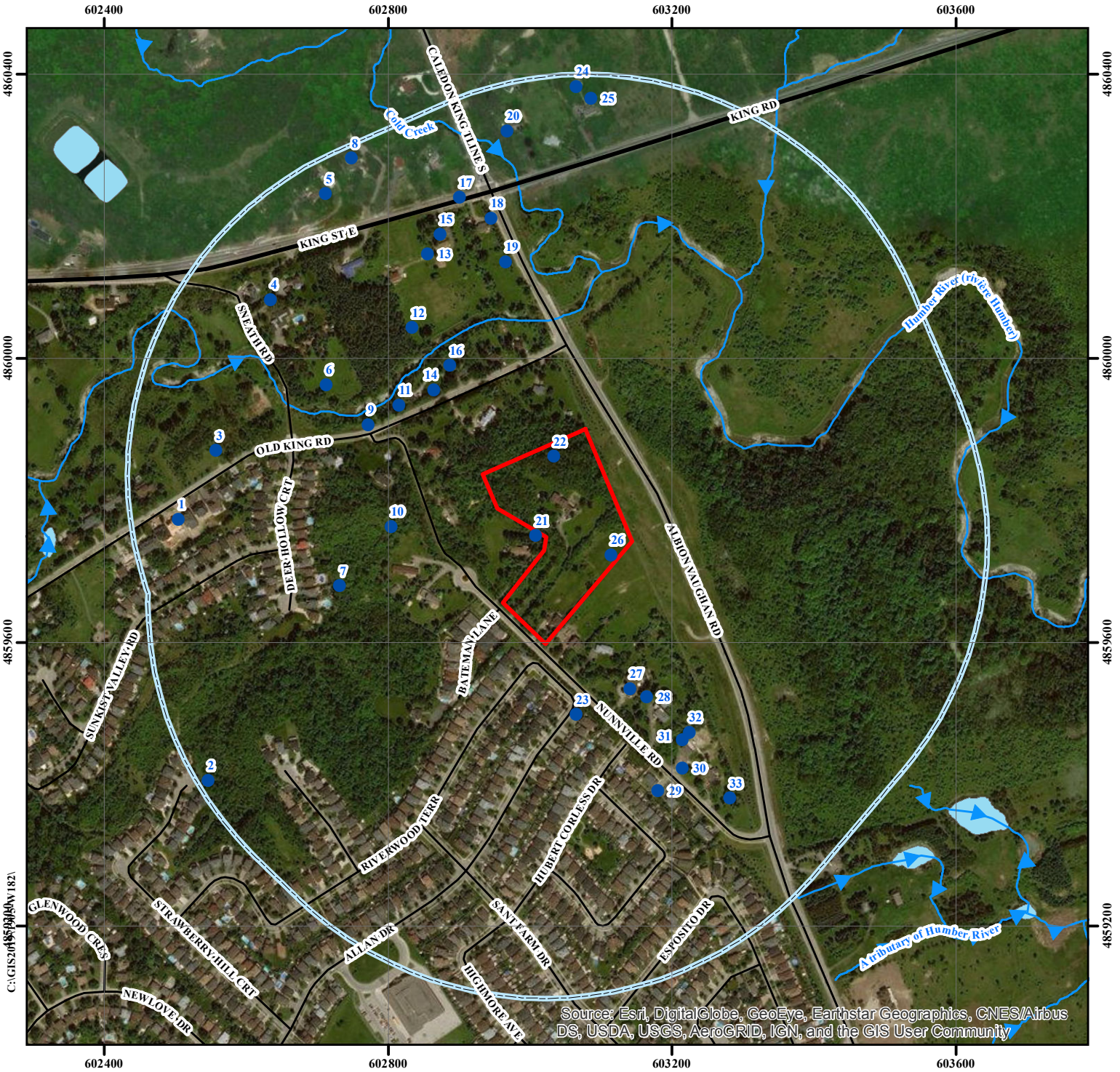
Date: July 17, 2019

Scale:

0 5 10 20 30 40 50

Metres

Drawing No. 2



Source: Water Course, Ontario Ministry of Natural Resources and Forestry
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Source: Water Body, Ontario Ministry of Natural Resources and Forestry
©Queen's Printer for Ontario

N

Approximate Boundary of Subject Site

500 metres from Subject Site Boundary

1 Well Location from MECP Well Records (see Appendix 'A')

Waterbody

Watercourse

Major Road

Local Road

Soil Engineers Ltd.

Title: MECP Well Location Plan

Project:

Hydrogeological Assessment
Proposed Residential Development
13233 and 13247 Nunnville Road
Town of Caledon (Bolton)

Reference No. 1905-W182

Date: June 28, 2019

Scale:

0 40 80 160 240 320 400

Metres

Drawing No. 3

N

Approximate Boundary of Subject Site

Halton Till
Material: predominantly silt to silty clay matrix, high in matrix carbonate content and clast poor

Major Road

Local Road

Source:Ontario Geological Survey, 1997, Surface Geology of Ontario; Ontario Geological Survey, Miscellaneous Released-Data 0014

Soil Engineers Ltd.

Title: Quarternary and Surface Geology Map

Project:

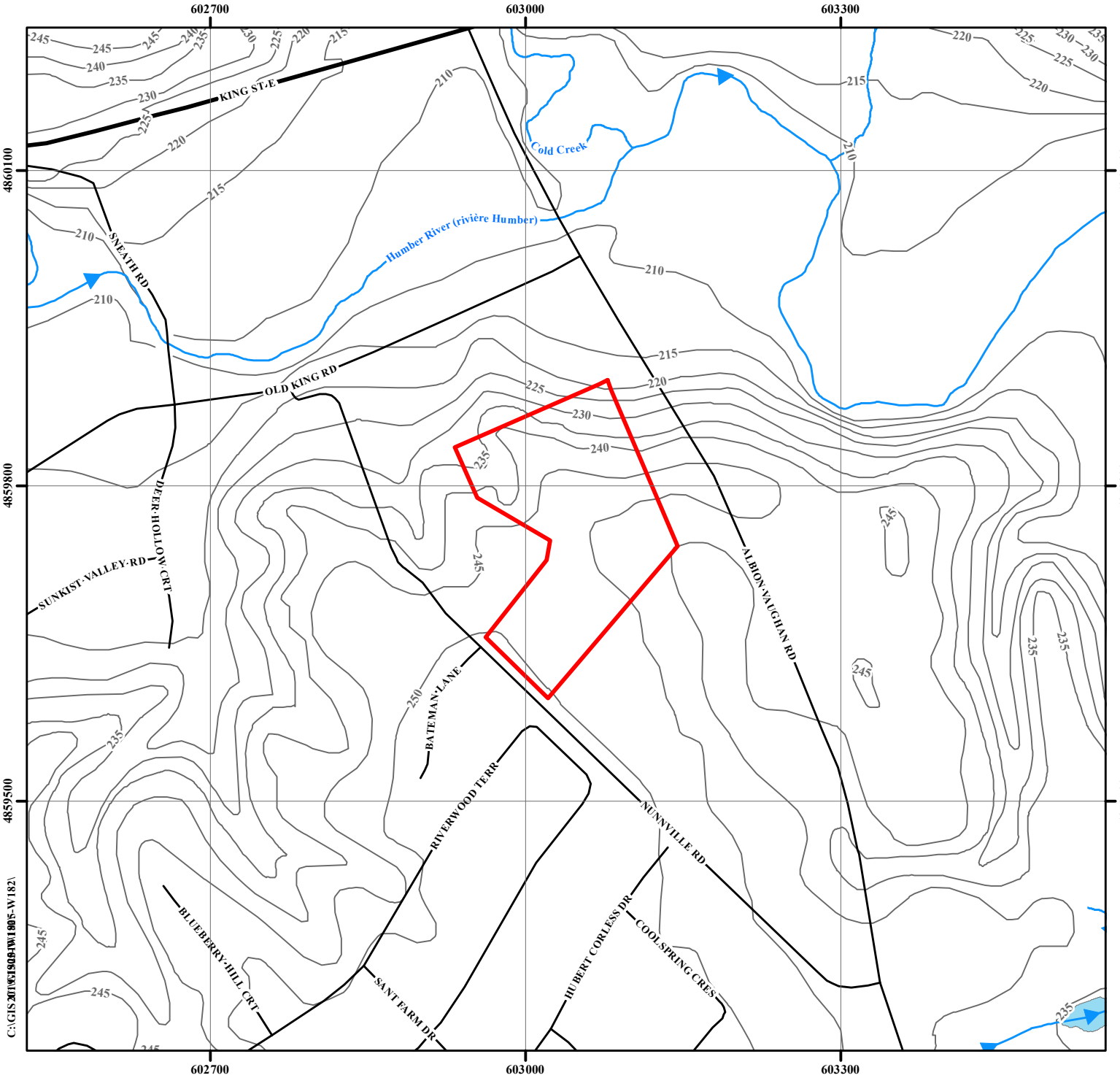
Hydrogeological Assessment
Proposed Residential Development
13233 and 13247 Nunnville Road
Town of Caledon (Bolton)

Reference No. 1905-W182

Date: June 28, 2019

Scale:
0 155 310 620 930 1,240 1,550
Metres

Drawing No. 4



Source: Contour, Ontario Ministry of Natural Resources and Forestry, 2015
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Source: Water Body, Ontario Ministry of Natural Resources and Forestry, 2015
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Source: Water Course, Ontario Ministry of Natural Resources and Forestry, 2015
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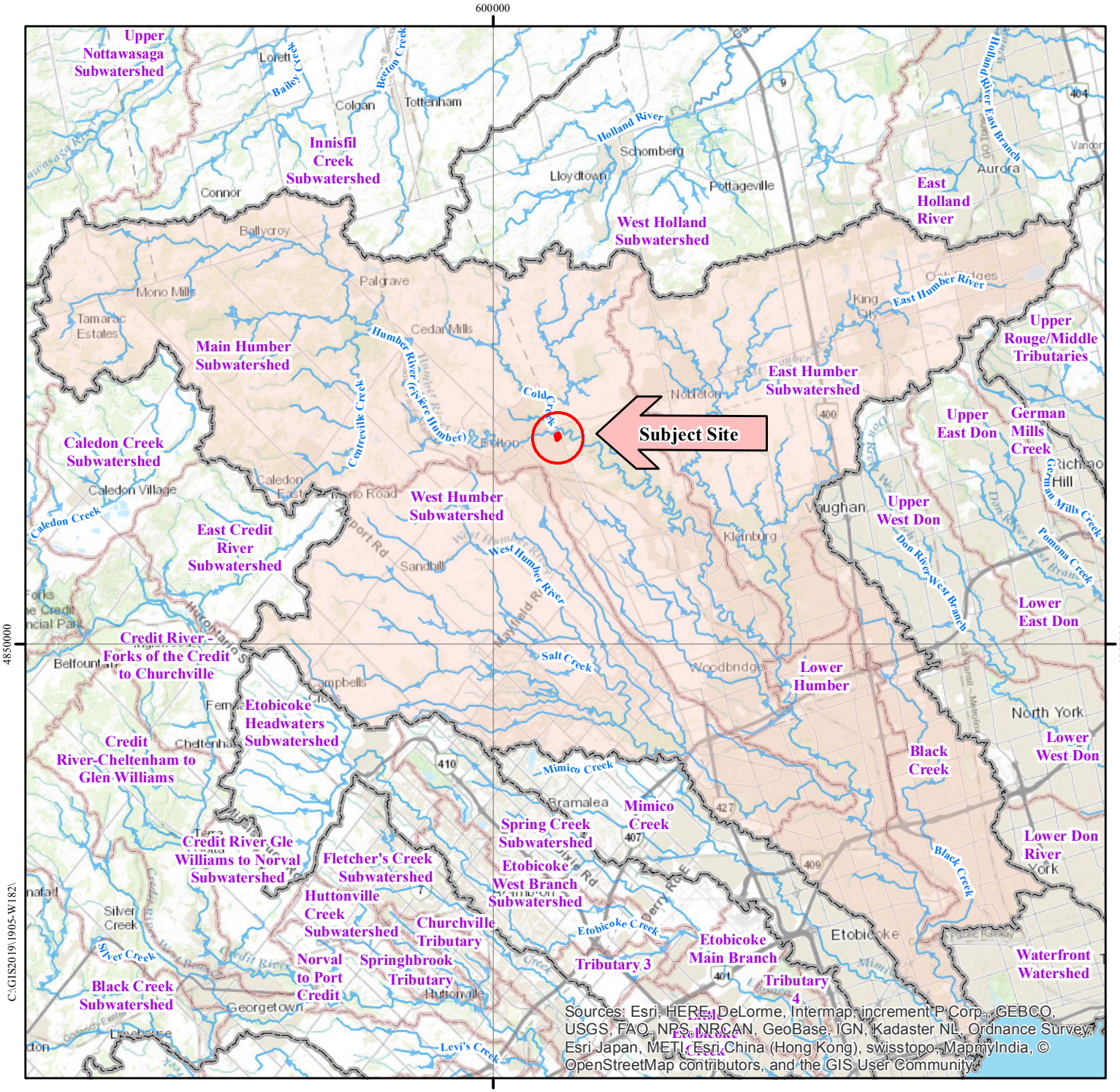
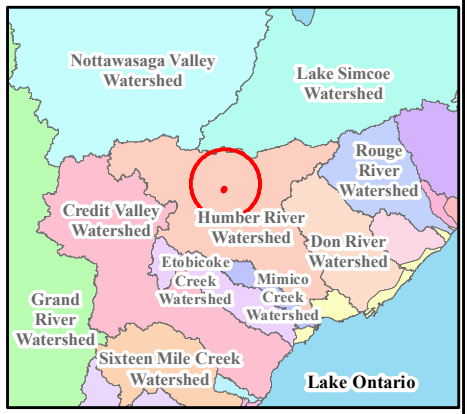


N

Watershed:



Approximate Boundary of the Subject Site

Watershed Boundaries

Waterbody

Watercourse

Expressway/Major Road

Soil Engineers Ltd.

Title: Watershed and Subwatershed Map

Project:

Hydrogeological Assessment
Proposed Residential Development
13233 and 13247 Nunnville Road
Town of Caledon (Bolton)

Reference No. 1905-W182

Date: June 28, 2019

Scale:

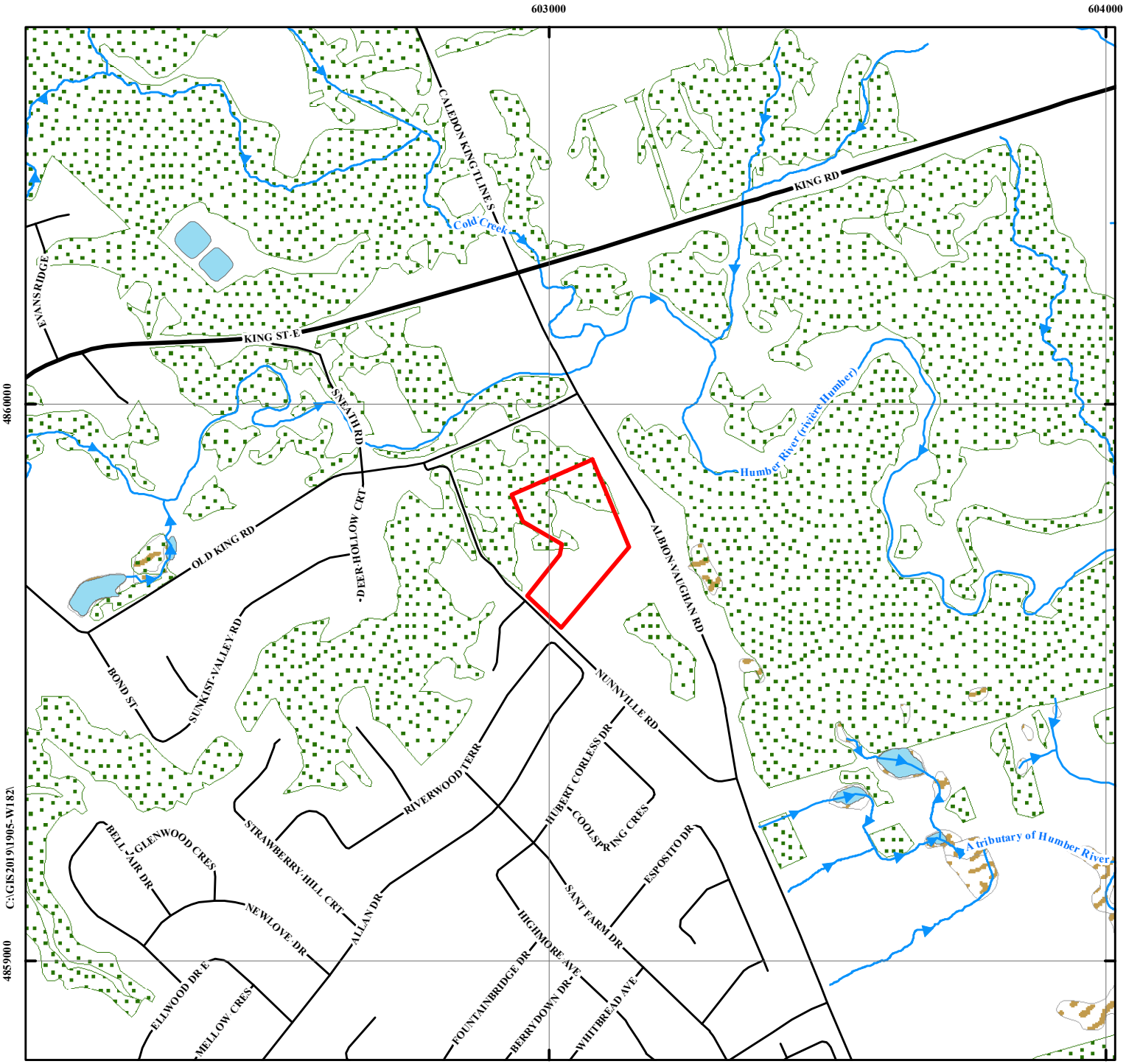
0 8,000 16,000 32,000 48,000 64,000 80,000

Metres

Drawing No. 6

C:\GIS2019\1905-W182\

this mapping was produced by SEL and should be used for information purposes only.
Data sources used in its production are of varying quality and accuracy and all boundaries should be considered approximate.



N

Approximate Boundary of Subject Site
Wetland (Not Evaluated per OWES)
Wooded Area
Water Body
Watercourse
Major Road
Local Road

Soil Engineers Ltd.

Title: Natural Features and Protection Area Plan

Project:

Hydrogeological Assessment
Proposed Residential Development
13233 and 13247 Nunnville Road
Town of Caledon (Bolton)

Reference No. 1905-W182

Date: June 28, 2019

Scale:
0 50 100 200 300 400 500
Metres

Drawing No. 7

Source: Contour, Ontario Ministry of Natural Resources and Forestry, 2015
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Source: Water Body, Ontario Ministry of Natural Resources and Forestry, 2015
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Source: Water Course, Ontario Ministry of Natural Resources and Forestry, 2015
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N

- Approximate Boundary of Subject Site
- Borehole
- Borehole with Monitoring Well
- Local Road
- A A' Cross-Section Direction
- 230 Topographic Contour (masl)

Soil Engineers Ltd.

Title: Cross-Section Key Plan

Project:

Hydrogeological Assessment
Proposed Residential Development
13233 and 13247 Nunnville Road
Town of Caledon (Bolton)

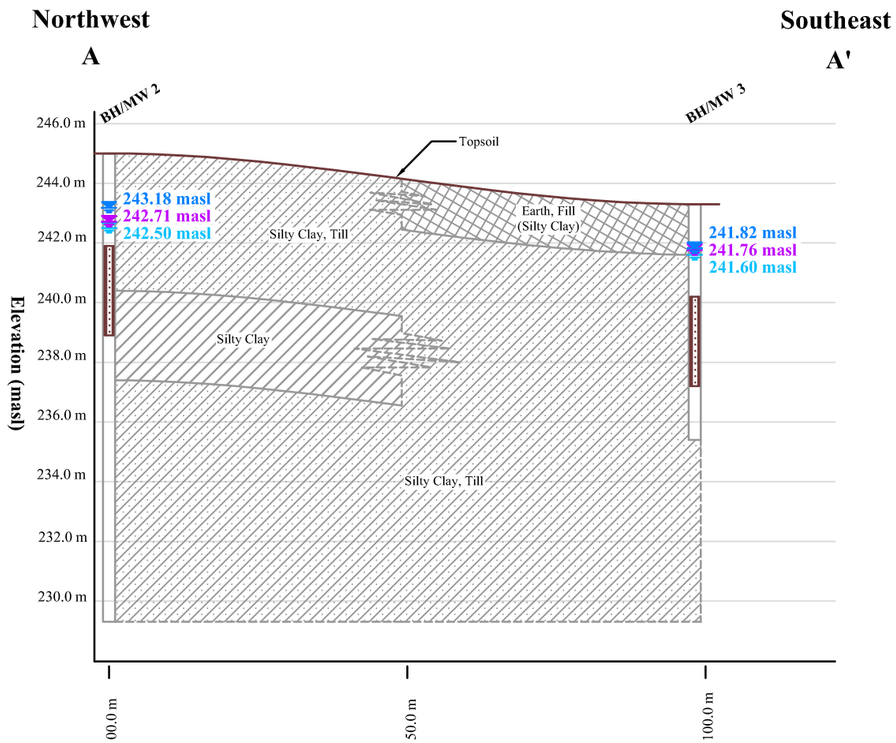
Reference No. 1905-W182

Date: July 17, 2019

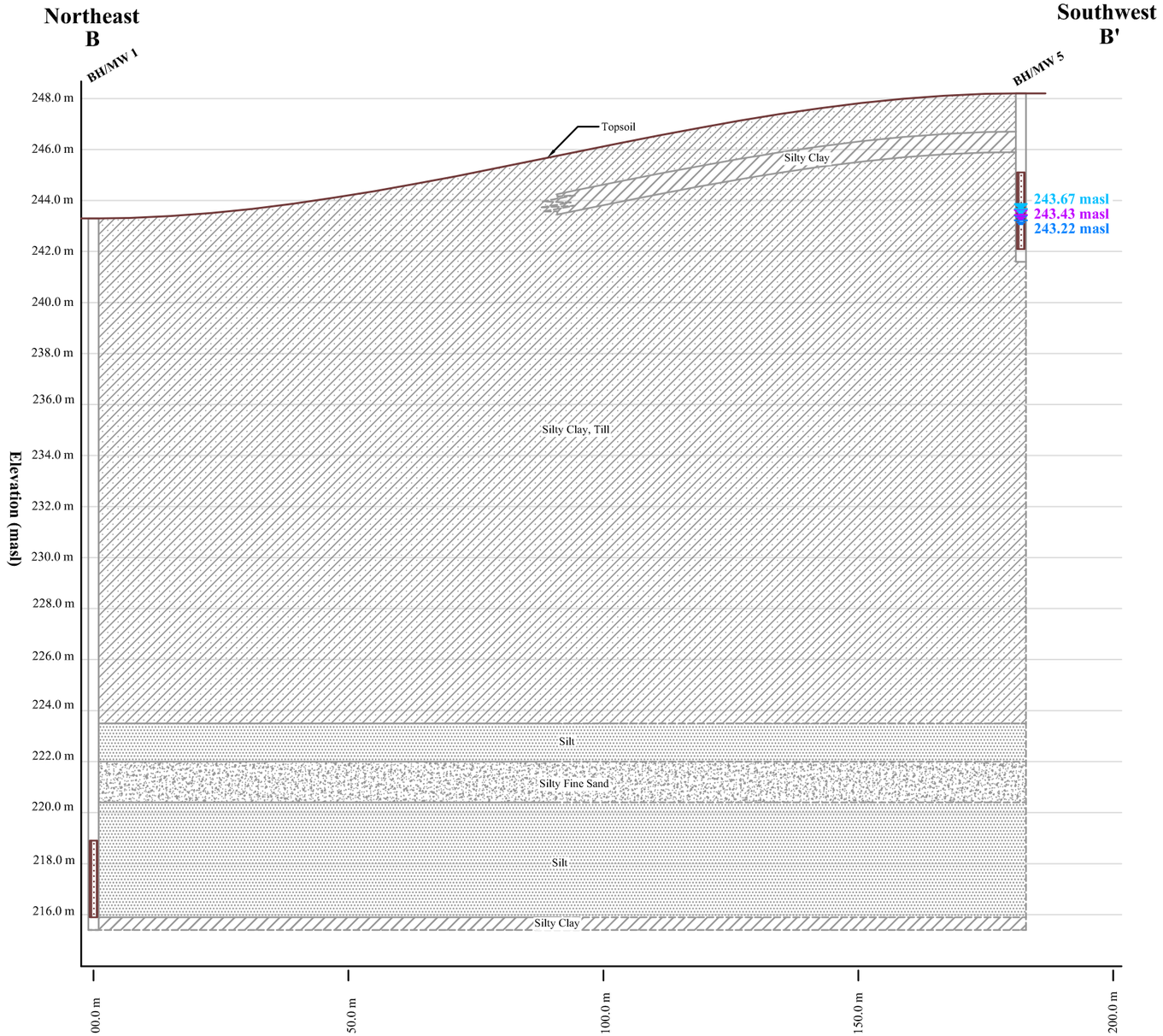
Scale:

0 5 10 20 30 40 50
Metres

Drawing No. 8-1



Section A-A'



Section B-B'

C:Projects/2019 Jobs/1905-W182

- Earth, Fill (Silty Clay)
- Silt
- Silty Fine Sand
- Silty Clay
- Silty Clay, Till
- 3.0 m Screen
- Water Table on June 27, 2019
- Water Table on July 9, 2019
- Water Table on July 15, 2019

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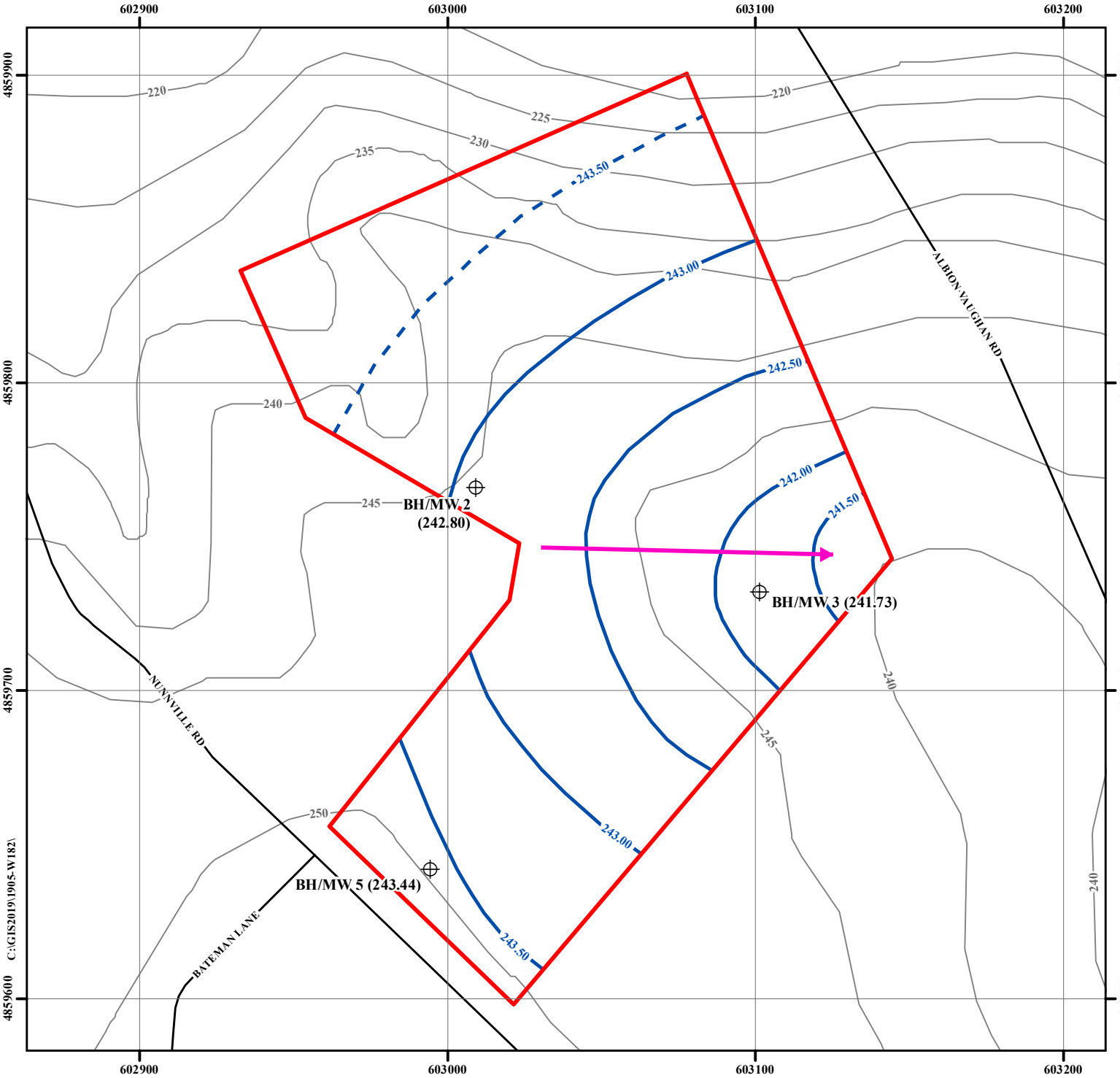
Title: Geological Cross-Section (A-A' and B-B')

Project: Hydrogeological Assessment
Proposed Residential Development
13233 and 13247 Nunnville Road, Town of Caledon (Bolton)

Reference No:	Date:	Scale: V	Scale: H	Drawing No.
1905-W182	July, 2019	1:200	1:1000	8-2



N

Approximate Boundary of Subject Site

Borehole with Monitoring Well

Interpreted Shallow Groundwater Flow Direction

Interpreted Shallow Groundwater Level Elevation (masl)

Inferred Shallow Groundwater Level Elevation (masl)

Local Road

230 Topographic Contour (masl)

241.73 Average Shallow Groundwater Level Elevation (masl)

Soil Engineers Ltd.

Title: Shallow Groundwater Flow Pattern Plan

Project:

Hydrogeological Assessment
Proposed Residential Development
13233 and 13247 Nunnville Road
Town of Caledon (Bolton)

Reference No. 1905-W182

Date: July 17, 2019

Scale:

0 5 10 20 30 40 50
Metres

Drawing No. 9

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APPENDIX 'A'

MECP WATER WELL RECORDS SUMMARY

REFERENCE NO. 1905-W182

Ontario Water Well Records

WELL ID	MECP WWR ID	Construction Method	Well Depth (m)**	Well Usage		Water Found (m)**	Static Water Level (m)**	Top of Screen Depth (m)**	Bottom of Screen Depth (m)**
				Final Status	First Use				
1	4903447	Boring	3.96	Water Supply	Domestic	3.96	2.44	-	-
2	4904206	Boring	8.53	Water Supply	Domestic	8.53	3.05	-	-
3	4900381	Boring	13.56	Water Supply	Domestic	13.56	9.14	-	-
4	4904422	Cable Tool	73.76	Unfinished	Domestic	73.15	-	-	-
5	4907985	Cable Tool	64.00	Water Supply	Domestic	62.18	31.09	62.48	64.00
6	4904452	Rotary (Convent.)	33.53	Water Supply	Domestic	13.72	5.49	32.61	33.53
7	4904237	Cable Tool	102.41	Water Supply	Domestic	94.79	40.54	94.79	95.71
8	4900446	Cable Tool	63.70	Water Supply	Domestic	62.48	17.37	62.48	63.70
9	4900375	Boring	8.53	Test Hole	Not Used	7.32	5.79	-	-
10	4903685	Cable Tool	91.44	Water Supply	Domestic	89.92	41.15	90.22	91.44
11	4900443	Cable Tool	48.79	Abandoned-Supply	-	-	-	-	-
12	4909057	Cable Tool	42.37	Water Supply	Domestic	38.71	-	40.54	42.06
13	4908651	Cable Tool	41.45	Water Supply	Domestic	38.71	14.94	39.32	40.84
14	4900376	Boring	8.08	Test Hole	Not Used	7.01	5.49	-	-
15	4907987	Cable Tool	49.38	Water Supply	Domestic	46.33	8.23	47.24	49.07
16	7223334	Boring	3.05	Water Supply	-	-	2.03	-	-
17	4900378	Cable Tool	41.15	Unfinished	Not Used	40.84	18.29	39.62	40.84
18	4908077	Rotary (Convent.)	41.45	Water Supply	Domestic	41.45	7.01	39.62	41.45
19	6927633	Other Method	11.89	Abandoned-Supply	Not Used	-	-	-	-
20	6923561	Cable Tool	61.26	Water Supply	Domestic	60.05	9.45	60.05	61.26
21	4900444	Cable Tool	79.25	Water Supply	Domestic	76.81	36.58	78.03	79.25
22	4900445	Cable Tool	56.39	Water Supply	Domestic	53.95	41.15	55.17	56.39
23	4903814	Cable Tool	99.67	Water Supply	Domestic	98.76	38.71	98.45	99.67
24	6909858	Cable Tool	49.38	Water Supply	Domestic	46.33	3.66	48.16	49.38
25	6902578	Cable Tool	14.63	Abandoned-Supply	-	-	-	-	-
26	4905773	Rotary (Convent.)	93.53	Water Supply	Domestic	91.44	39.01	90.53	91.44
27	4900441	Cable Tool	99.06	Water Supply	Domestic	70.71	21.95	97.84	99.06
28	4904675	Cable Tool	96.01	Water Supply	Domestic	74.68	39.01	91.14	92.05
29	4900374	Cable Tool	87.78	Water Supply	Domestic	85.04	38.40	86.56	87.78
30	4905208	Rotary (Convent.)	101.80	Water Supply	Domestic	61.57	41.15	100.58	101.80
31	4903547	Boring	15.24	Abandoned-Supply	-	-	-	-	-
32	4903559	Cable Tool	86.26	Water Supply	Domestic	84.73	36.58	84.73	85.95
33	4900442	Cable Tool	88.39	Water Supply	Domestic	85.95	33.53	87.17	88.39

*MECP WWID: Ministry of the Environment, Conservation and Parks Water Well Records Identification
**metres below ground surface

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APPENDIX 'B'

SINGLE WELL RESPONSE TEST RESULTS

REFERENCE NO. 1905-W182

Falling Head Test (Slug Test)

Test Date:		9-Jul-19	
Piezometer/Well No.:		BH/MW 2	
Ground level:		244.26	m
Screen top level:		241.21	m
Screen bottom level:		238.16	m
Test El. (at midpoint of screen):		239.69	m
Test depth (at midpoint of screen):		4.57	m
Screen length	L=	3	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.516	m
Initial water depth		1.37	m
Aquifer material:		**Silty Clay Till, Silty Clay**	

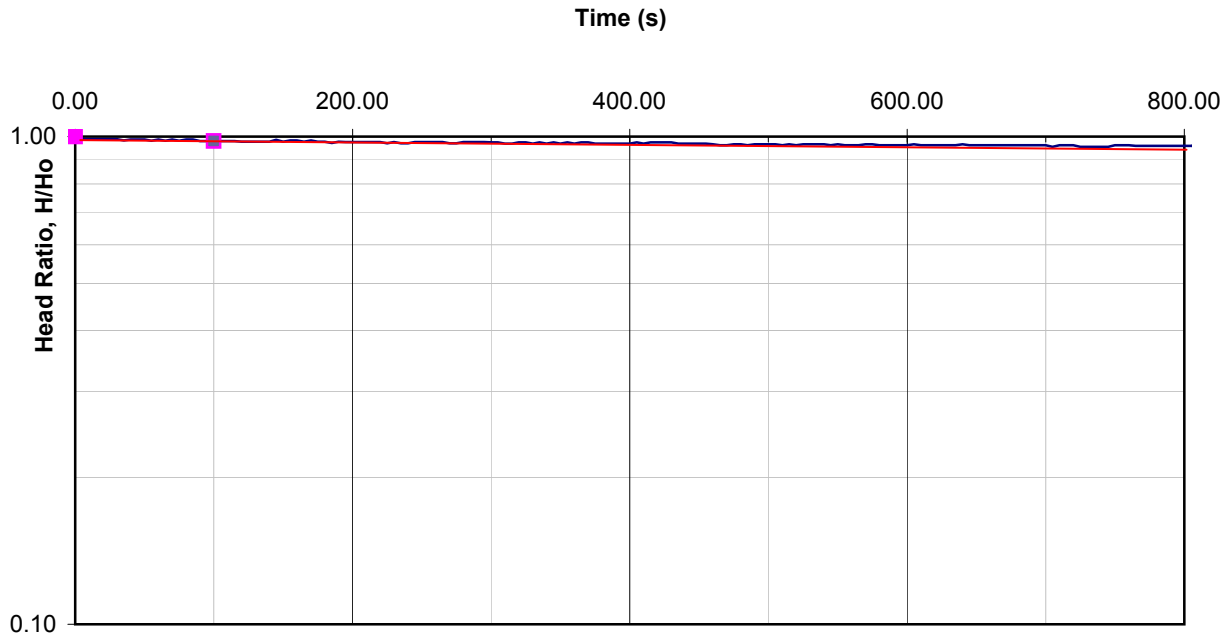
Shape factor $F = \frac{2 \times 3.14 \times L}{\ln(L/R)} = 5.701815$ m

Permeability $K = \frac{3.14 \times r2}{F \times (t2 - t1)} \times \ln(H1/H2)$ (Bouwer and Rice Method)

$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.000215483$

K= **7.4E-06** cm/s

7.4E-08 m/s



Falling Head Test (Slug Test)

Test Date:		9-Jul-19	
Piezometer/Well No.:		BH/MW 3	
Ground level:		234.26	m
Screen top level:		231.21	m
Screen bottom level:		228.16	m
Test El. (at midpoint of screen):		229.69	m
Test depth (at midpoint of screen):		4.57	m
Screen length	L=	3.05	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.529	m
Initial water depth		1.41	m
Aquifer material:		**Silty Clay Till**	

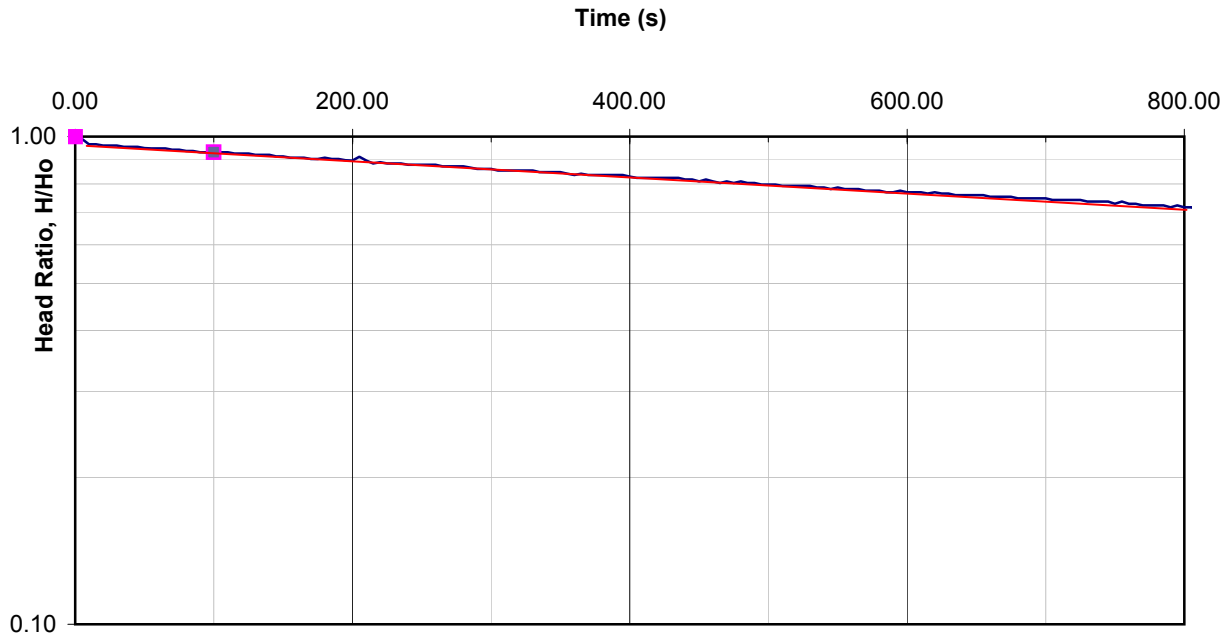
Shape factor $F = \frac{2 \times 3.14 \times L}{\ln(L/R)} = 5.768005$ m

Permeability $K = \frac{3.14 \times r2}{F \times (t2 - t1)} \times \ln(H1/H2)$ (Bouwer and Rice Method)

$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.000745443$

K= **2.5E-05** cm/s

2.5E-07 m/s



Falling Head Test (Slug Test)

Test Date:		9-Jul-19	
Piezometer/Well No.:		BH/MW 5	
Ground level:		248.15	m
Screen top level:		245.10	m
Screen bottom level:		242.05	m
Test El. (at midpoint of screen):		243.58	m
Test depth (at midpoint of screen):		4.57	m
Screen length	L=	3.05	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.273	m
Initial water depth		4.53	m
Aquifer material:		**Silty Clay Till**	

Shape factor $F = \frac{2 \times 3.14 \times L}{\ln(L/R)} = 5.768005$ m

Permeability $K = \frac{3.14 \times r2}{F \times (t2 - t1)} \times \ln(H1/H2)$ (Bouwer and Rice Method)

$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.000184848$

K= **6.3E-06** cm/s

6.3E-08 m/s