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A REPORT TO
HIGHGLEN HOMES LIMITED

# HYDROGEOLOGICAL ASSESSMENT FOR PROPOSED RESIDENTIAL DEVELOPMENT

## 230 FINCH AVENUE

## CITY OF PICKERING

REFERENCE NO. 1911-W057

FEBRUARY 2021

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## 1.0 EXECUTIVE SUMMARY

Soil Engineers Ltd. (SEL) has completed a Hydrogeological Assessment for a proposed residential development site, located at 230 Finch Avenue, in the City of Pickering.

The subject site is located within the Physiographic Region of Southern Ontario known as the Iroquois plain, where sand plains are the predominant physiographic feature. The native surface geological soil unit consists of Halton Till Unit, which consists, predominantly, of silt to silty clay matrix, being high in matrix calcium carbonate content, considered as being clast poor.

A review of the topography shows that the subject site is relatively flat, with the surrounding area exhibiting a gentle decline in elevation relief towards the south, towards Petticoat Creek and its tributaries.

The proposed development site is located within the Petticoat Creek Watershed. Review of available mapping indicates that Petticoat Creek, which flows from north-to-south, lies approximately 30 m east of the subject site. A west-to-east flowing tributary for the Creek lies approximately 75 m north of the site. Bodies of water surrounded by wetland features can also be found, about 350 m west of the subject site. In addition, a Provincially Significant Wetland (PSW) is located, approximately 100 m south of and 200 m west of the subject site and wooded areas are located immediately north and east of the site.

This study has revealed that beneath a layer of topsoil and fill, the native soils underlying the subject site consists of sandy silt, silty sand till and sands, extending to the maximum depth for the investigation at 6.6 m below the existing grade.

The groundwater monitoring program indicates that the measured groundwater levels ranged from 2.43 to 3.79 m below the prevailing ground surface, or at the elevations ranging from 135.76 to 138.54 masl. The interpreted shallow groundwater flow pattern suggests that it flows south/south-easterly, towards Petticoat Creek and its associated tributaries and wetlands.

The Single Well Response Tests (SWRT) estimates for hydraulic conductivity (K) for the underlying sand and/or silty sand till units ranged from $6.8 \times 10^{-7}$ to $5.2 \times 10^{-6}$ m/sec. These results suggest that the hydraulic conductivity (K) estimates for the groundwater bearing sand and/or silty sand till units range from low to moderate with correspondingly low to moderate anticipated groundwater seepage rates being anticipated into open excavations, below the water table.

The estimated construction dewatering flow rates for proposed underground housing basement construction and for underground services installation are expected reach a maximum of 23,423.61 L/day and 6,778.8 L/day, respectively; by applying 3 times safety factor they could reach a maximum of 70,270.7 L/day and 20,336.5 L/day for construction of proposed underground housing basements and services, respectively. As such, approval for any construction related groundwater taking would be through an Environmental Activity and Sector Registry (EASR) and its filing with the Ministry of the Environment, Conservation and Parks (MECP).

The estimated zone of influence for temporary construction dewatering could reach a maximum of 17.8 m away from the conceptual dewatering array around the excavation footprints. The closest records for water supply wells, wetlands, water bodies or other natural heritage features are located outside of the zone of influence for construction dewatering. However, existing residential buildings are present west and east of the site, and both Finch Avenue and Nature Haven Crescent may be situated within the conceptual zones of influence for temporary construction dewatering.

# 2.0 INTRODUCTION

## 2.1 Project Description

In accordance with authorization from Mr. John Perciasepe of Highglen Homes Limited, we have carried out a hydrogeological study for a property located at 230 Finch Avenue, which is located approximately 350 m west of the intersection of Finch Avenue East and Altona Road in the City of Pickering. The location of the site is shown on Drawing No. 1.

The subject site currently comprises of vacant land. The surrounding land use consists of a wooded area to the north, a residential property and wooded areas to the east, Finch Avenue and existing residential properties to the south, and Nature Haven Crescent and existing residential properties to the west.

This Hydrogeological Study summarizes findings of a field study and the associated groundwater monitoring and testing programs, and provides a description and characterization for the site's hydrogeological setting. The current study provides preliminary recommendations for any construction dewatering needs and for any need to acquire an Environmental Activity and Sector Registry (EASR) approval, or a Permit-To-Take Water (PTTW) to facilitate a construction dewatering program in support of proposed earthworks.

## 2.2 Project Objectives

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

1. Establish the local and regional hydrogeological setting for the site and local surrounding areas;
2. Interpret the site's shallow groundwater flow patterns;
3. Identify zones of higher groundwater yield as potential sources for on-going groundwater seepage from the site's subsoil strata;
4. Characterize the hydraulic conductivity (K) for groundwater-bearing subsoil strata;
5. Prepare interpreted hydrogeostratigraphic cross-sections across the subject site;
6. Estimate the temporary dewatering flows that may be required to lower the water table to facilitate earthworks and construction;
7. Estimate the anticipated zones of influence associated with any construction dewatering, if required, and to provide mitigation recommendations to safeguard nearby groundwater receptors from potential impacts, and;

8. Provide comments regarding any need to file an Environmental Activity and Sector Registry (EASR), or to acquire a Permit-To-Take Water (PTTW) for approval to facilitate a construction dewatering program.

## 2.3 Scope of Work

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

1. Clearance of underground services, drilling of five (5) boreholes within the site's development footprint, and installation of monitoring wells at each of the five advanced borehole locations;
2. Monitoring well development, groundwater level monitoring and measurements at the installed monitoring wells;
3. Monitoring well development and performance of Single Well Response Tests (SWRTs) at the monitoring wells to estimate the hydraulic conductivity (K) for groundwater-bearing subsoil strata at the depths of the well screens;
4. Reviewing plotting and mapping of Ministry of the Environment, Conservation and Parks (MECP) water well records within 500 m of the subject site;
5. Describing the geological and hydrogeological setting for the subject site and nearby surrounding areas;
6. Assessing the preliminary dewatering needs to determine any anticipated temporary dewatering flows necessary to lower groundwater levels to facilitate earthworks and construction;
7. Review of groundwater receptors in the vicinity of the development site, and providing of preliminary recommendations for any monitoring, mitigation and discharge management plans to safeguard nearby groundwater receptors from potential adverse impacts associated with any construction dewatering, and;
8. Providing comments regarding any need to register an Environmental Activity and Sector Registry (EASR) approval or to apply for and obtain a Permit-To-Take Water (PTTW) as groundwater taking approvals to facilitate any temporary construction dewatering or any long-term foundation drainage.

# 3.0 METHODOLOGY

## 3.1 Borehole Advancement and Monitoring Well Installation

The field work for borehole drilling and monitoring well construction were performed on December 12, 2019. It consisted of five (5) drilled boreholes (BH) and the installation of five (5) monitoring wells (MW), one in each of the advanced boreholes at the locations shown on Drawing No. 2. The boreholes were drilled using solid stem flight-augers. The drilling and monitoring well construction were completed by a licensed well contractor, DBW Drilling Limited, under the full-time supervision of a geotechnical technician from SEL, who also logged the subsoil strata encountered during borehole advancement and collected representative soil samples to confirm the subsoil profile. The Borehole and Monitoring Well Logs are enclosed as Figures 1 to 5, inclusive.

The monitoring wells, consisting of 50 mm diameter PVC riser pipes and screen sections, were installed in the boreholes in accordance with Ontario Regulation (O. Reg.) 903. All wells were equipped with above-ground, monument-type, steel protective casings. The well construction details are shown on the Borehole/Monitoring Well Logs and the details are summarized in Table 3-1.

The UTM coordinates and ground surface elevations at the borehole and monitoring well locations, together with the well construction details, are provided in Table 3-1. The ground surface elevations at the borehole and monitoring well locations, which were adopted for this study area are based on the Survey Plan prepared for Part of Lot 33, Concession 2, City of Pickering, Regional Municipality of Durham, by Ertl Surveyors, dated February 23, 2018.

**Table 3-1 -** Monitoring Well Installation Details

| Well ID | Installation Date | East (m) | North (m) | Ground El. (masl) | Borehole Depth (mbgs) | Screen Interval (mbgs) | Casing Dia. (mm) |
|---|---|---|---|---|---|---|---|
| BH/MW 1 | December 12, 2019 | 648746.9 | 4855202.1 | 141.6 | 6.6 | 3.0-6.0 | 50 |
| BH/MW 2 | December 12, 2019 | 648774.7 | 4855192.1 | 141.5 | 6.6 | 3.0-6.0 | 50 |
| BH/MW 3 | December 12, 2019 | 648763.2 | 4855170.2 | 139.7 | 6.6 | 3.0-6.0 | 50 |
| BH/MW 4 | December 12, 2019 | 648799.3 | 4855157.4 | 139.1 | 6.6 | 3.0-6.0 | 50 |
| BH/MW 5 | December 12, 2019 | 648775.4 | 4855132.5 | 139.3 | 6.6 | 3.0-6.0 | 50 |

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

## 3.2 Groundwater Monitoring

The groundwater levels in the monitoring wells were measured by our representative on January 8, 14 and 28, 2020.

## 3.3 Mapping of Ontario Water Well Records

SEL reviewed the MECP Water Well Records (WWRs) for registered wells on the subject site, and within 500 m of the site boundaries (study area). The records indicate that thirty-eight (38) wells are located within the 500 m study area relative to the subject site. A summary of the Ontario WWRs reviewed for this study is provided in Appendix ‘A’ with the locations of the well records shown on Drawing No. 3.

## 3.4 Monitoring Well Development and Single Well Response Tests

All of the monitoring wells underwent well development to prepare them for SWRTs to estimate the hydraulic conductivity (K) for the saturated aquifer soils at the well screen depths. The well development involved purging and removing 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 formation groundwater through the well screens, thereby improving the transmissivity of the groundwater bearing formation at the well screen depth intervals.

The K estimates provide an indication of the yield (seepage) capacity for the groundwater-bearing strata and can be used to estimate the flow of groundwater through the groundwater-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, with this rate being used to estimate the K value for the water-bearing subsoil formation at the well screen depths. All of the BH/MWs underwent a SWRT (Falling Head Tests) on January 28, 2020. The results for the tests are provided in Appendix ‘B’.

## 3.5 Review of Previous or Concurrent Reports

The following SEL report was reviewed for the preparation of this hydrogeological study:

A Report to High Glen Homes, A Geotechnical Investigation for Proposed Residential Development, 230 Finch Avenue (Part 4, Plan #40 R-29767), City of Pickering, Reference No. 1911-S057, dated February 2020.

# 4.0 REGIONAL AND LOCAL SETTING

## 4.1 Regional Geology

The subject site lies within the Physiographic Region of Southern Ontario known as the Iroquois Plain, where the sand plain and beaches are the predominant physiographic features beneath the site. The Iroquois Plain occupies the north shore of Lake Ontario, where it extends from Scarborough to Trenton and is considered an area of considerable complexity, not easily divisible into well-marked geological units. The Highland Creek and the Rouge River deposited sand into a former glacial lake to build the present-day sand plain in the southeast corner of the City of Scarborough and within the adjacent portions of the Cities of Pickering, Ajax and Whitby. Across the Regional Municipality of Durham, the Iroquois plain has a fairly consistent pattern (Chapman and Putnam, 1984).

Based on a review of a surface Geological Map of Ontario, the subject site is located on the Halton Till deposits, consisting, predominantly of silt to silty clay matrix, being high in matrix calcium carbonate content, considered as being clast poor that were deposited adjacent to near shore beach environments at the end of the last glaciation of the southern Ontario. Drawing No. 4, reproduced from Ontario Geological Survey mapping, illustrates the Quaternary surface soil geology for the subject site and surrounding areas.

The top of bedrock beneath the subject site lies at an elevation of approximately 78.0 masl (Bedrock Topography of the Markham Area, Southern Ontario, 1992) and consists of Upper Ordovician aged shale, limestone, dolostone and siltstone of the Georgian Bay Formation, the Blue Mountain Formation, the Billings Formation, the Collingwood Member and the Eastview Member (Ontario Ministry of Northern Department and Mines, 1991).

## 4.2 Physical Topography

A review of the topographic map for the subject site and surrounding area shows that it is relatively flat, with the overall area descending, gently to the south, towards Petticoat Creek and its tributaries. Drawing No. 5 shows the mapped topographic contours for the subject site and surrounding areas.

## 4.3 Watershed Setting

The subject site is located within the Petticoat Creek Watershed, as shown, mapped, on Drawing No. 6. The Petticoat Creek river system has a total length of about 49 km and drains an area of approximately 27 square km, with portions of the associated watershed being within the Cities of Pickering, Markham, and Toronto. In contrast with many of the watersheds in the Greater Toronto Area (GTA), Petticoat Creek does not originate on the Oak Ridges Moraine. Its headwaters, or upper reaches, are located south of the Oak Ridges Moraine, between the larger Rouge River and Duffins Creek watersheds. Petticoat Creek flows south and empties into Lake Ontario at the Petticoat Creek Conservation Area (Toronto and Region Conservation Authority, 2012).

### 4.4 Local Surface Water and Natural Features

Records show wooded areas being scattered around the subject site, with the nearest wooded area being immediately north and east of the subject site.

There are wetlands, approximately 100 m south of and 200 m west of the site that are classified as being Provincially Significant Wetland (PSW), based on the Ontario Wetland Evaluation System (OWES). Wetlands that have not been evaluated as per OWES are also scattered within areas northwest, northeast, east, southeast and south of the subject site.

Petticoat Creek, which flows from north-to-south, lies approximately 30 m east of the site. A west-to-east tributary lies approximately 75 m north of the site. Bodies of water surrounded by wetland also occur, about 350 m west of the site.

Drawing No. 7 shows the locations of the natural features around the subject site.

## 5.0 SOIL LITHOLOGY

This study has revealed that beneath a layer of topsoil, and the disturbed/weathered fill soil horizon, the native soils underlying the subject site consists sandy silt, silty sand till and sands. A Key Plan and the interpreted geological cross-sections along north-to-south, northwest-to-southeast and north/northwest-to-south transects are presented on Drawing Nos. 8-1, 8-2 and 8-3.

### 5.1 Topsoil (All BH/MW locations)

Topsoil was found at the surface at all of the BH/MW locations. The thickness for the topsoil ranges from 25 to 36 cm.

### 5.2 Disturbed/Weathered Soils (All BH/MW locations)

A layer of disturbed and weathered subsoil was observed beneath topsoil horizon at all of the BH/MW locations. It consists, predominantly of sand with gravel and ranges in thickness from 0.3 to 1.1 m.

### 5.3 Sands (All BH/MW locations)

Sands were encountered beneath the disturbed/weathered soils at all of the BH/MW locations. The sands are generally fine to coarse in texture, and gravelly in places, with some silt to being silty. The thickness of the layer ranges from 0.8 to 2.2 m for the fine to coarse sand, from 0.4 to 1.5 m for the gravelly sand and 1.1 to m for the silty sand. The moisture content for the retrieved subsoil samples ranged from 3% to 21%, indicating damp to saturated conditions. The estimated permeability for this layer at is $10^{-3}$ cm/sec for the gravelly sand at a depth of 0.3 m and $10^{-3}$ cm/sec for the fine to coarse sand at a depth of 2.5 m. Grain size analyses were performed on two (2) samples, and the gradations are plotted on Figures 6 and 7.

### 5.4 Sandy Silt (BH/MW 5)

A thin stratum of sandy silt was encountered between the fine to coarse sand layers at BH/MW 5. It is brown in colour, loose in consistency and is approximately 0.8 m thick. The moisture content for the retrieved subsoil samples was 21%, indicating saturated conditions. The estimated permeability for this layer at a depth of 2.5 mbgs is $10^{-4}$ cm/sec.

A grain size analysis was performed on one (1) sample, and the gradation is plotted on Figure 8.

### 5.5 **Silty Sand Till** (All BH/MW locations)

Silty sand till was observed beneath the sand layer where it extends to the maximum depth of investigation at all of the BH/MW locations. It is dense to very dense in consistency and the moisture content for the retrieved samples ranged from 9% to 14%, indicating moist to very moist conditions. The estimated permeability for this layer at a depth of 6.3 mbgs is $10^{-6}$ cm/sec. A grain size analysis was performed on one (1) sample, and the gradation is plotted on Figure 9.

# 6.0 GROUNDWATER STUDY

## 6.1 Review Summary of Previous Report

A review of the findings from the geotechnical soil investigation, prepared by SEL (Reference No. 1911-S057) has indicated that beneath the topsoil and earth fill horizon and/or disturbed/weathered soils, the underlying subsoils consist of sandy silt, silty sand till and sands. All of the boreholes remained dry upon completion of the drilling program, with the exception of BHs 4 and 5, where groundwater was detected at a depth of 5.5 m below the prevailing ground surface.

## 6.2 Review of Ontario Water Well Records

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

The records indicate that thirty-eight (38) wells are located within the 500 m study area relative to the site boundaries. The locations of these wells, based on the UTM coordinates provided by the records, are shown on Drawing No. 3. A detailed summary of the MECP WWRs is provided in Appendix 'A'.

A review of the final status of the wells within the study area reveals that thirteen (13) wells are registered as test holes, eleven (11) are registered as abandoned-other wells, one (1) is listed as an abandoned-quality well, six (6) are water supply wells, three (3) are dewatering wells, one (1) is an observation well, and three (3) are monitoring and test hole wells.

A review of the first status of the wells shows that twelve (12) are registered as monitoring wells, eight (8) are registered as domestic wells, one (1) is a test hole well, four (4) are monitoring and test hole wells, nine (9) as wells that are not being used, and four (4) wells have an unidentified status.

## 6.3 Groundwater Monitoring

Groundwater levels were measured in the monitoring wells to record the fluctuation of the groundwater table beneath the site over the monitoring period, covering the dates, between January 8 and January 28, 2020. The groundwater level measurements and corresponding elevations are summarized in Table 6-1.

**Table 6-1 -** Water Level Measurements

| **Well ID** | | **January 8, 2020** | **January 14, 2020** | **January 28, 2020** | **Average** | **Fluctuation** |
|---|---|---|---|---|---|---|
| BH/MW 1 | mbgs | 3.79 | 3.40 | 3.67 | 3.62 | 0.39 |
| | masl | 137.81 | 138.20 | 137.93 | 137.98 | |
| BH/MW 2 | mbgs | 3.53 | 2.96 | 3.20 | 3.23 | 0.57 |
| | masl | 137.97 | 138.54 | 138.30 | 138.27 | |
| BH/MW 3 | mbgs | 2.92 | 2.58 | 2.43 | 2.64 | 0.49 |
| | masl | 136.78 | 137.12 | 137.27 | 137.06 | |
| BH/MW 4 | mbgs | 3.34 | 2.96 | 2.86 | 3.05 | 0.48 |
| | masl | 135.76 | 136.14 | 136.24 | 136.05 | |
| BH/MW 5 | mbgs | 3.39 | 3.01 | 2.90 | 3.10 | 0.49 |
| | masl | 135.91 | 136.29 | 136.40 | 136.20 | |

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

As shown above, the groundwater levels generally increased at all of the BH/MW locations over the monitoring period, with the exception of BH/MW 2 where the groundwater level increased from January 8th to 14th, 2020 but decreased from January 14th to the 28th, 2020. The highest shallow groundwater level fluctuation was recorded at BH/MW 2, which exhibiting a 0.57 m difference in groundwater level during the monitoring period. The measured groundwater levels ranged from 2.43 to 3.79 m below the prevailing ground surface or at the Elevations of 135.76 to 138.54 masl and the time of the field monitoring.

## 6.4 Single Well Response Test Analysis

All of the BH/MWs underwent Falling Head Tests (SWRT's) to assess the hydraulic conductivity (K) for saturated aquifer subsoils at the well screen depths. The results of the SWRT analysis 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) | Screen Interval (mbgs) | Screened Soil Strata | Hydraulic Conductivity (K) (m/sec) |
|---|---|---|---|---|---|---|
| BH/MW 1 | 141.6 | 6.0 | 6.6 | 3.0-6.0 | Medium to Coarse Sand and Silty Sand Till | $2.2 \times 10^{-6}$ |
| BH/MW 2 | 141.5 | 6.0 | 6.6 | 3.0-6.0 | Silty Sand Till | $6.8 \times 10^{-7}$ |
| BH/MW 3 | 139.7 | 6.0 | 6.6 | 3.0-6.0 | Silty Fine Sand and Silty Sand Till | $3.7 \times 10^{-6}$ |
| BH/MW 4 | 139.1 | 6.0 | 6.6 | 3.0-6.0 | Silty Fine Sand, Gravelly Sand and Silty Sand Till | $5.2 \times 10^{-6}$ |
| BH/MW 5 | 139.3 | 6.0 | 6.6 | 3.0-6.0 | Fine to Coarse Sand, Gravelly Sand and Silty Sand Till | $3.5 \times 10^{-6}$ |

The SWRT results provide an indication of the yield capacity for the groundwater-bearing subsoil strata at the depths of the well screens. The results of the field investigation indicate that low to moderate anticipated seepage rates are associated with the subsoils at the depths of the monitoring well screens.

## 6.5 Shallow Groundwater Flow Pattern

The average groundwater levels measured at the monitoring wells were used to interpret the shallow groundwater flow pattern across the subject site. Review of the groundwater table data indicates that shallow groundwater flows south/south-easterly, towards Petticoat Creek and its associated tributaries and wetlands. The interpreted groundwater flow pattern for the subject site is illustrated on Drawing No. 9.

## 7.0 GROUNDWATER CONTROL DURING CONSTRUCTION

The hydraulic conductivity (K) estimates suggest that groundwater seepage rates into open excavations below the groundwater table, within the till soils will range from low to moderate. To provide safe, dry and stable conditions for excavation and construction of the underground services and any proposed housing basement structures, the groundwater table may need to be lowered in advance of construction. The preliminary estimates for the temporary construction dewatering flows required to locally lower the groundwater table, based on the K test results are discussed in the following sections.

### 7.1 Groundwater Construction Dewatering Rates

Proposed development plans were not available for our review for the preparation of this report. However, based on review of the surrounding area, it is assumed that the proposed development will consist of a subdivision with detached residential housing buildings. The construction dewatering flow rate estimation is discussed below:

### Dewatering Flow Rate Estimates for Construction of Housing Basement Structure

Development plans, showing the finished floor elevations were not available for our review at the time of this current report preparation. As such, the average of the existing ground surface elevations, as recorded at the BH and BH/MW locations was considered as the finished ground surface grade elevations for this preliminary construction dewatering needs assessment. By considering a finished floor elevation of 140.2 masl, and a 3.0 m depth for any proposed housing basement structures, a base elevation of 137.2 masl was considered for this construction dewatering needs assessment. To facilitate excavation and construction in dry and stable subsoil conditions, it is proposed that the groundwater table be lowered to an elevation of 136.2 masl, which is about 1.0 m below the lowest proposed excavation depth. The highest shallow groundwater level within the monitoring wells was measured at an El. 138.54 masl. The subsoil profile consists of sands and silty sand till extending to the maximum anticipated excavation depth. The housing dimensions were considered based on a rectangular footprint, being 25 m x 15 m in length and width for an estimated perimeter of 80 m. Using this information and the highest K estimate of $2.2 \times 10^{-6}$m/sec, for the silty sand till at the well screen depth the estimated dewatering flow rates are anticipated to reach a daily rate of 23,423.6 L/day for any proposed underground housing basement structure; by considering a 3x safety factor, this rate could reach an approximate daily maximum of 70,270.7 L/day. It should be noted that the above dewatering estimation was based on construction of a single detached housing unit.

## Construction Dewatering Flow Rate Estimates for Underground Infrastructure Servicing

The proposed invert elevations for installation of underground services were not available for our review at the time of this current report preparation. As such, the lowest underground servicing invert elevation of 135.2 masl was considered, based on an installation depth of 5.0± m beneath the assumed finished floor elevation of 140.2 masl for this current construction dewatering needs assessment. To facilitate excavation and construction in dry and stable subsoil conditions, it is proposed that the shallow groundwater table be lowered to an elevation of 134.2 masl, which is about 1.0 m below the lowest considered excavation depth. The highest shallow groundwater level was measured at an elevation of 138.54 masl. The subsoil profile consists of sands and silty sand till, extending to the maximum anticipated excavation depth. By considering an active dewatering array for an open servicing trench length of 25 m, and the highest K estimate of 3.7 x $10^{-6}$ m/sec for the silty sand till subsoil at the considered depth, the estimated construction dewatering flow rate is anticipated to reach a daily rate of 6,778.8 L/day; by considering a 3 x safety factor, it could reach an approximate daily maximum of 20,336.5 L/day.

In accordance with the current policy of the Ministry of the Environment, Conservation and Parks (MECP), where the construction dewatering flow rate is between 50,000 L/day and 400,000 L/day, the registering for proposed groundwater-taking for construction is by means of the filing an Environmental Activity and Sector Registry (EASR) with the MECP. Since the estimated dewatering flow rate exceeds 50,000 L/day, in which it is expected to reach a maximum daily rate of 70,270.7 L/day, the registering for any proposed groundwater-taking for construction would be through an EASR, and its filing with the MECP. It is recommended that the EASR should be filed for the maximum allowable construction dewatering flow rate of 400,000 L/day, to also account for the management and removal of any accumulated runoff within the construction excavations following high rainfall events.

It should be noted that shallow groundwater levels were monitored over the early winter season and it is anticipated that they will increase over the high precipitation, spring season. As such, it is recommended that shallow groundwater levels be monitored again, over the spring season, and that the dewatering estimates be updated if the excavation and construction are planned for this season. It is also recommended that the construction dewatering needs assessment be revised and updated, once finalized development plans, showing the proposed finished floor and underground structure elevations and housing dimensions become available for review, and/or if there are any significant differences between the above considered assumptions and the final finished floor and servicing depth elevations for the proposed development.

## 7.2 Groundwater Control Methodology

Low to moderate groundwater seepage rates which may be encountered in open excavations below the water table can likely be controlled by occasional pumping from sumps. Well points can be employed to lower water table if wet subsoil is unstable and seepage cannot be controlled via sump pumping. The final designs for the dewatering system will be the responsibility of the construction contractors.

## 7.3 Mitigation of Potential Impacts Associated with Dewatering

The conceptual zone of influence for any dewatering well or dewatering array used during construction is approximately 17.8 m away from the conceptual dewatering wells or array around the excavation footprints/servicing trenches. The closest records for water supply wells, wetlands, water bodies or other natural heritage features are located outside the conceptual zone of influence for temporary construction dewatering. However, existing housing buildings are present west and east of the site, and both Finch Avenue and Nature Haven Crescent may be situated within the conceptual zones of influence for temporary construction dewatering. As such, concerns regarding any ground settlement associated with construction dewatering should be assessed by a geotechnical engineer prior to construction.

## 7.4 Groundwater Function for the Subject Site

The subject site is located within an existing, developed residential neighbourhood. The proposed housing structures and associated services will be constructed below the shallow groundwater level. As such, the local shallow groundwater flow pattern for the area may be locally impacted on a temporary basis from the proposed development. In addition, there are records for natural heritage features such as Petticoat Creek and its associated tributaries, as well as various wetlands scattered around the subject site. However, the closest natural features are located outside of the considered, conceptual zone of influence for construction dewatering. As such, any interference impacts from any temporary construction dewatering on the shallow groundwater function of the subject site are anticipated to be minor to negligible, with no long-term impacts being anticipated.

## 7.5 **Ground Settlement**

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

## 7.6 **Low Impact Development Infrastructure (LIDs)**

The subject site is underlain by pervious sand and weathered, shallow subsoil which could facilitate the infiltration of precipitation received at the developed site to the subsurface to meet the storm water management planning objectives for the proposed development. The prevailing groundwater levels range from 2.43 to 5.79 m below existing grades, or from the elevations ranging from 135.76 to 138.54 masl. If a 1 m separation can be maintained between the base of any proposed LID infrastructure and the high groundwater table, it may be feasible to implement LID infrastructure to redirect received precipitation to recharge the groundwater table at the developed site. The storm water management engineer for the project would be tasked with any proposed LID infrastructure designs and implementation for the developed site.

## 8.0 CONCLUSIONS

Based on the findings of this Hydrogeological Study, the following summary of conclusions and recommendations are provided:

1. The subject site is located within the Physiographic Region of Southern Ontario known as the Iroquois Plain.
2. The geological surface soil unit underlying the site is mapped as Halton Till deposits, consisting, predominantly of silt to silty clay matrix.
3. A review of the local topography shows that the subject site is relatively flat, exhibiting a gentle decline in elevation relief towards the south, towards Petticoat Creek and its associated tributaries.
4. Petticoat Creek, which flows from north-to-south, lies approximately 30 m east of the site. A west-to-east tributary of the Creek also lies approximately 75 m north of the site. Bodies of water surrounded by wetlands can also be found about 350 m west of the site. In addition, Provincially Significant Wetlands (PSW) are located approximately 100 m south of and 200 m west of the site, and wooded areas are also located immediately north and east of the subject site.
5. This study has revealed that beneath a layer of topsoil, and disturbed/ weathered soil, the native soils underlying the subject site consists sandy silt, silty sand till and sands.
6. Based on the results of the groundwater monitoring program the measured groundwater levels ranged from 2.43 to 3.79 m below the prevailing ground surface or at the Elevations of 135.76 to 138.54 masl and the time of the field monitoring. The interpreted shallow groundwater flow pattern suggests that it flows south/south easterly, towards Petticoat Creek and its associated tributaries and wetlands.
7. The Single Well Response Test (SWRT) estimates for hydraulic conductivity (K) for the underlying sand and/or silty sand till units ranged from 6.8 x $10^{-7}$ to 5.2 x $10^{-6}$ m/sec. The results suggest that the hydraulic conductivity estimates for the groundwater bearing sand and/or silty sand till subsoil units is low to moderate with correspondingly low to moderate anticipated groundwater seepage rates in open excavations, below the water table.
8. The estimated construction dewatering flow rates for proposed underground housing basement construction and for underground services installation are expected reach daily rates of 23,423.61 L/day and 6,778.8 L/day, respectively; by applying 3 times safety factor they could reach maximums of 70,270.7 L/day and 20,336.5 L/day for construction of proposed underground housing basements and services, respectively. As such, the recommended approval for any construction related groundwater taking would be through an Environmental Activity and Sector Registry (EASR) and its

filing with the Ministry of the Environment, Conservation and Parks (MECP).

9. The estimated zone of influence for temporary construction dewatering could reach a maximum of 17.8 m away from the conceptual dewatering array. The closest records for water supply wells, wetlands, water bodies or other natural heritage features are located outside of the zone of influence. However, existing residential buildings are present west and east of the site, and both Finch Avenue and Nature Haven Crescent may be situated within the conceptual zones of influence for temporary construction dewatering.

Yours Truly,
**SOIL ENGINEERS LTD.**

Vivian Yu, B.Sc.

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VY/GO

PROFESSIONAL GEOSCIENTISTS ONTARIO
GAVIN R. O'BRIEN
PRACTISING MEMBER
1267
February 18, 2021

## 9.0 REFERENCES

1. The Physiography of Southern Ontario (Third Edition), L. J. Chapman and D. F. Putnam, 1984

2. Pettitcoat Creek Watershed Action Plan, 2012, Toronto and Region Conservation Authority

3. Bedrock Topography of the Markham Area, Southern Ontario, 1992, Open File Map 196, Mines and Minerals Division, Ontario Geological Survey

# FIGURES 1 TO 9

## BOREHOLE LOGS AND GRAIN SIZE DISTRIBUTION GRAPHS

## REFERENCE NO. 1911-W057

# 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

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GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE

**JOB NO.:** 1911-W057

# LOG OF BOREHOLE NO.: BH/MW 1

**FIGURE NO.:** 1

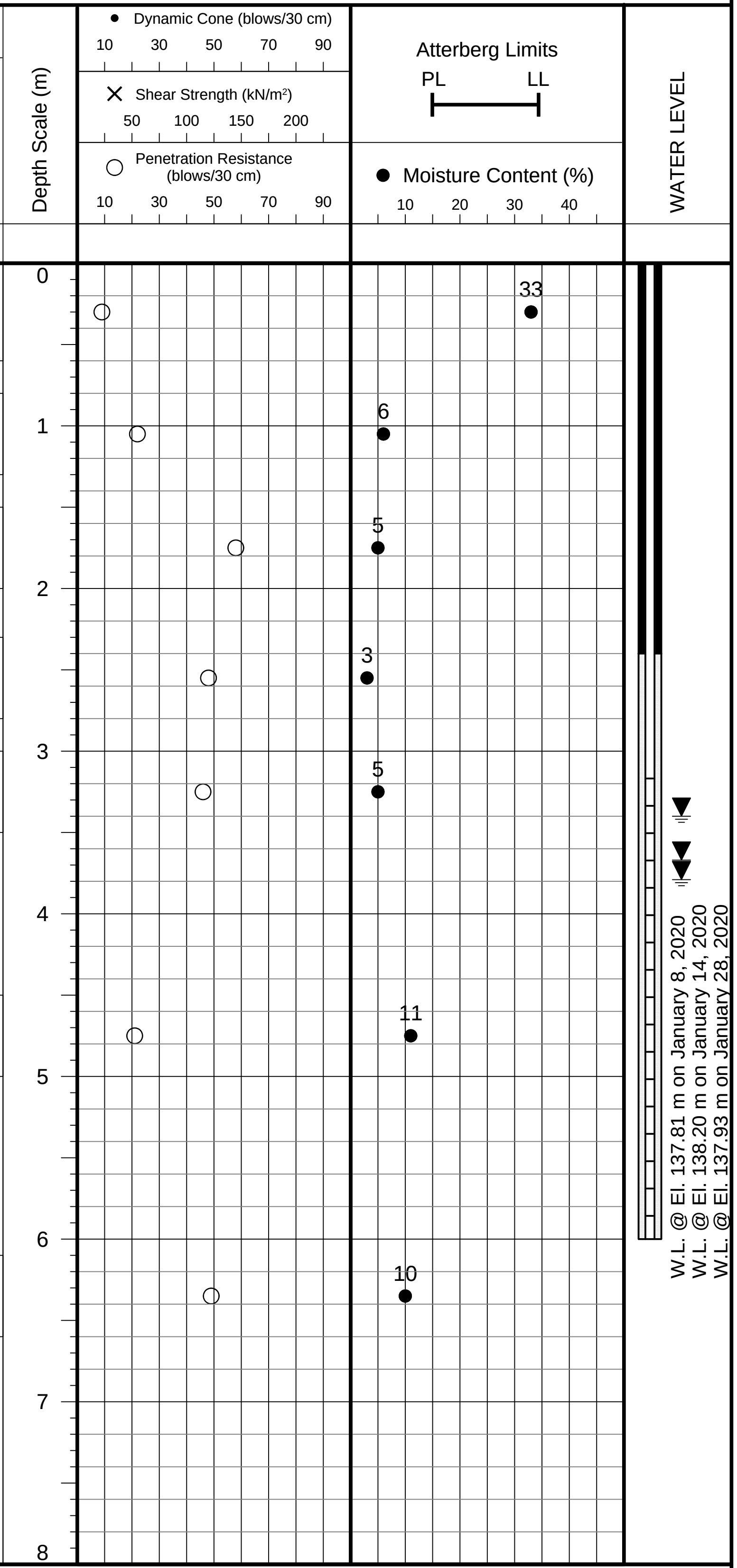
**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Flight-Auger

**PROJECT LOCATION:** 230 Finch Avenue
(Part 4, Plan #40 R-29767)
City of Pickering

**DRILLING DATE:** December 12, 2019

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | Type | N-Value |
|---|---|---|---|---|
| 141.6 | Ground Surface | | | |
| 0.0 | **30 cm TOPSOIL** | | | |
| 0.3 | Brown<br>**DISTURBED/WEATHERED SOIL**<br>sand with gravel and rock fragments | 1<br>2 | DO<br>DO | 9<br>22 |
| 140.2<br>1.4 | Brown, dense to very dense<br>**GRAVELLY SAND** | 3<br>4 | DO<br>DO | 58<br>48 |
| 138.7<br>2.9 | Brown, dense<br>**MEDIUM TO COARSE SAND**<br>some silt | 5 | DO | 46 |
| 137.6<br>4.0 | Grey, compact to dense<br>**SILTY SAND TILL**<br>occ. wet sand and silt seams and layers cobbles and boulders | 6<br>7 | DO<br>DO | 21<br>49 |
| 135.0<br>6.6 | **END OF BOREHOLE**<br>Installed 50 mm Ø monitoring well to 6.0 m<br>3.0 m screen from 3.0 to 6.0 m<br>Sand backfill from 2.4 to 6 m<br>Bentonite from 0 to 2.4 m<br>Provided with a steel protective casing | | | |



W.L. @ El. 137.81 m on January 8, 2020
W.L. @ El. 138.20 m on January 14, 2020
W.L. @ El. 137.93 m on January 28, 2020

**Soil Engineers Ltd.**

**JOB NO.:** 1911-W057

# LOG OF BOREHOLE NO.: BH/MW 2

**FIGURE NO.:** 2

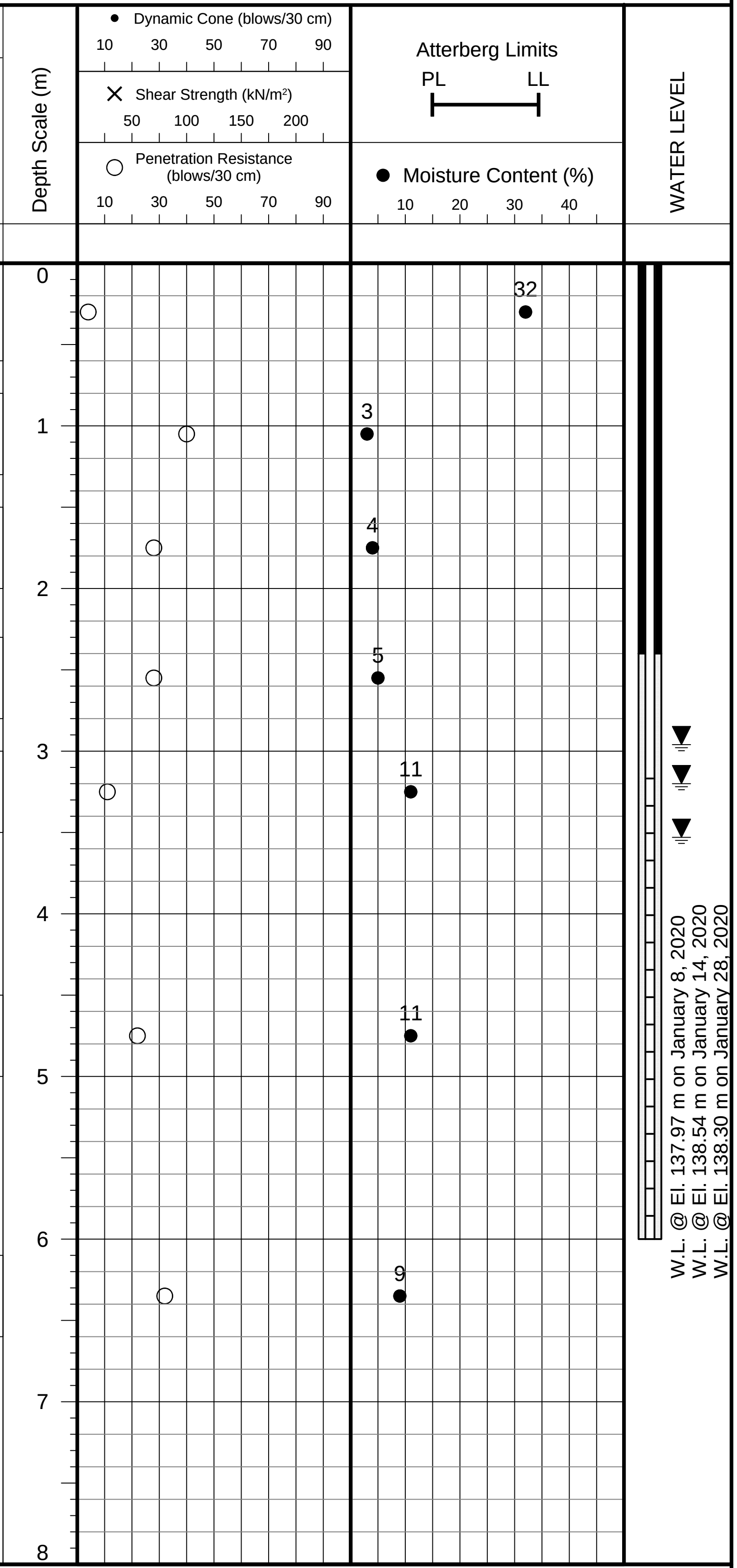
**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Flight-Auger

**PROJECT LOCATION:** 230 Finch Avenue
(Part 4, Plan #40 R-29767)
City of Pickering

**DRILLING DATE:** December 12, 2019

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | Type | N-Value |
|---|---|---|---|---|
| 141.5 | Ground Surface | | | |
| 0.0 | **36 cm TOPSOIL** | 1 | DO | 4 |
| 0.4 | Brown<br>**DISTURBED/WEATHERED SOIL**<br>sand with gravel and cobbles | | | |
| 140.8<br>0.7 | Brown, compact to dense<br>**GRAVELLY SAND** | 2 | DO | 40 |
| | | 3 | DO | 28 |
| 139.4<br>2.1 | Brown, compact<br>**FINE TO COARSE SAND**<br>some silt | 4 | DO | 28 |
| 138.6<br>2.9 | Compact to dense<br>**SILTY SAND TILL**<br>occ. wet sand and silt seams and layers cobbles and boulders | 5 | DO | 11 |
| | — brown<br>grey | 6 | DO | 22 |
| | | 7 | DO | 32 |
| 134.9<br>6.6 | **END OF BOREHOLE**<br>Installed 50 mm Ø monitoring well to 6.0 m<br>3.0 m screen from 3.0 to 6.0 m<br>Sand backfill from 2.4 to 6 m<br>Bentonite from 0 to 2.4 m<br>Provided with a steel protective casing | | | |



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**JOB NO.:** 1911-W057

# LOG OF BOREHOLE NO.: BH/MW 3

**FIGURE NO.:** 3

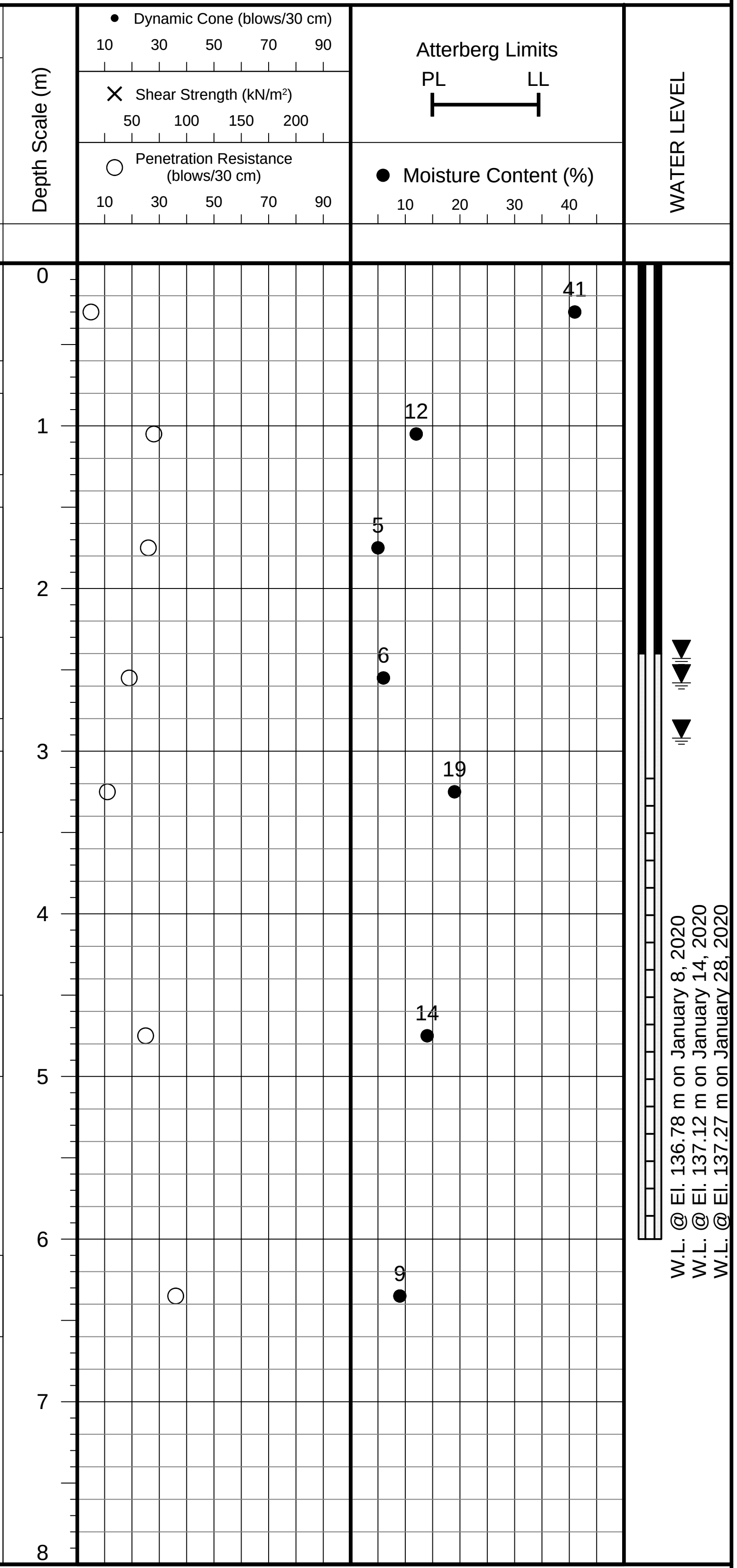
**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Flight-Auger

**PROJECT LOCATION:** 230 Finch Avenue
(Part 4, Plan #40 R-29767)
City of Pickering

**DRILLING DATE:** December 12, 2019

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | Type | N-Value |
|---|---|---|---|---|
| 139.7 | Ground Surface | | | |
| 0.0 | **36 cm TOPSOIL** | 1 | DO | 5 |
| 0.4 | Brown<br>**DISTURBED/WEATHERED SOIL**<br>sand with gravel | | | |
| 139.0<br>0.7 | Brown, compact<br>**FINE TO COARSE SAND**<br>some silt | 2 | DO | 28 |
| | | 3 | DO | 26 |
| | | 4 | DO | 19 |
| 136.8<br>2.9 | Brown, compact<br>**SILTY FINE SAND** | 5 | DO | 11 |
| 135.7<br>4.0 | Compact to dense<br>**SILTY SAND TILL**<br>occ. wet sand and<br>silt seams and layers<br>cobbles and boulders | 6 | DO | 25 |
| | brown<br>grey | 7 | DO | 36 |
| 133.1<br>6.6 | **END OF BOREHOLE**<br>Installed 50 mm Ø monitoring well to 6.0 m<br>3.0 m screen from 3.0 to 6.0 m<br>Sand backfill from 2.4 to 6 m<br>Bentonite from 0 to 2.4 m<br>Provided with a steel protective casing | | | |



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Page: 1 of 1

**JOB NO.:** 1911-W057

# LOG OF BOREHOLE NO.: BH/MW 4

**FIGURE NO.:** 4

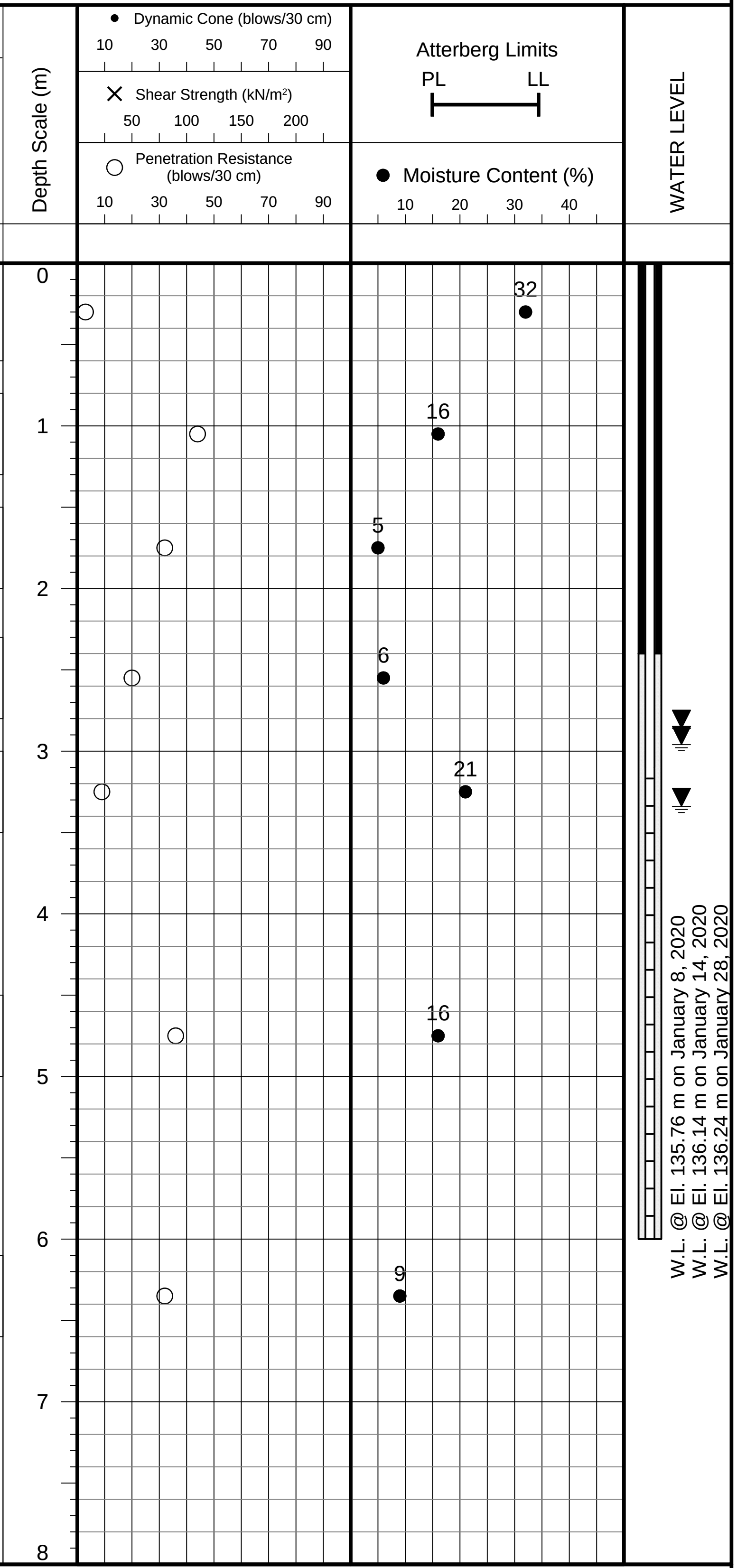
**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Flight-Auger

**PROJECT LOCATION:** 230 Finch Avenue
(Part 4, Plan #40 R-29767)
City of Pickering

**DRILLING DATE:** December 12, 2019

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | Type | N-Value |
|---|---|---|---|---|
| 139.1 | Ground Surface | | | |
| 0.0 | **30 cm TOPSOIL** | 1 | DO | 3 |
| 0.3 | Brown<br>**DISTURBED/WEATHERED SOIL**<br>sand, a trace of gravel | | | |
| 138.4<br>0.7 | Brown, compact to dense<br>**FINE TO COARSE SAND**<br>some silt | 2<br>3<br>4 | DO<br>DO<br>DO | 44<br>32<br>20 |
| 136.2<br>2.9 | Brown, loose<br>**SILTY FINE SAND** | 5 | DO | 9 |
| 135.1<br>4.0 | Grey, dense<br>**GRAVELLY SAND** | 6 | DO | 36 |
| 133.6<br>5.5 | Grey, dense<br>**SILTY SAND TILL** | 7 | DO | 32 |
| 132.5<br>6.6 | **END OF BOREHOLE**<br>Installed 50 mm Ø monitoring well to 6.0 m<br>3.0 m screen from 3.0 to 6.0 m<br>Sand backfill from 2.4 to 6 m<br>Bentonite from 0 to 2.4 m<br>Provided with a steel protective casing | | | |



W.L. @ El. 135.76 m on January 8, 2020
W.L. @ El. 136.14 m on January 14, 2020
W.L. @ El. 136.24 m on January 28, 2020

**Soil Engineers Ltd.**

**JOB NO.:** 1911-W057

# LOG OF BOREHOLE NO.: BH/MW 5

**FIGURE NO.:** 5

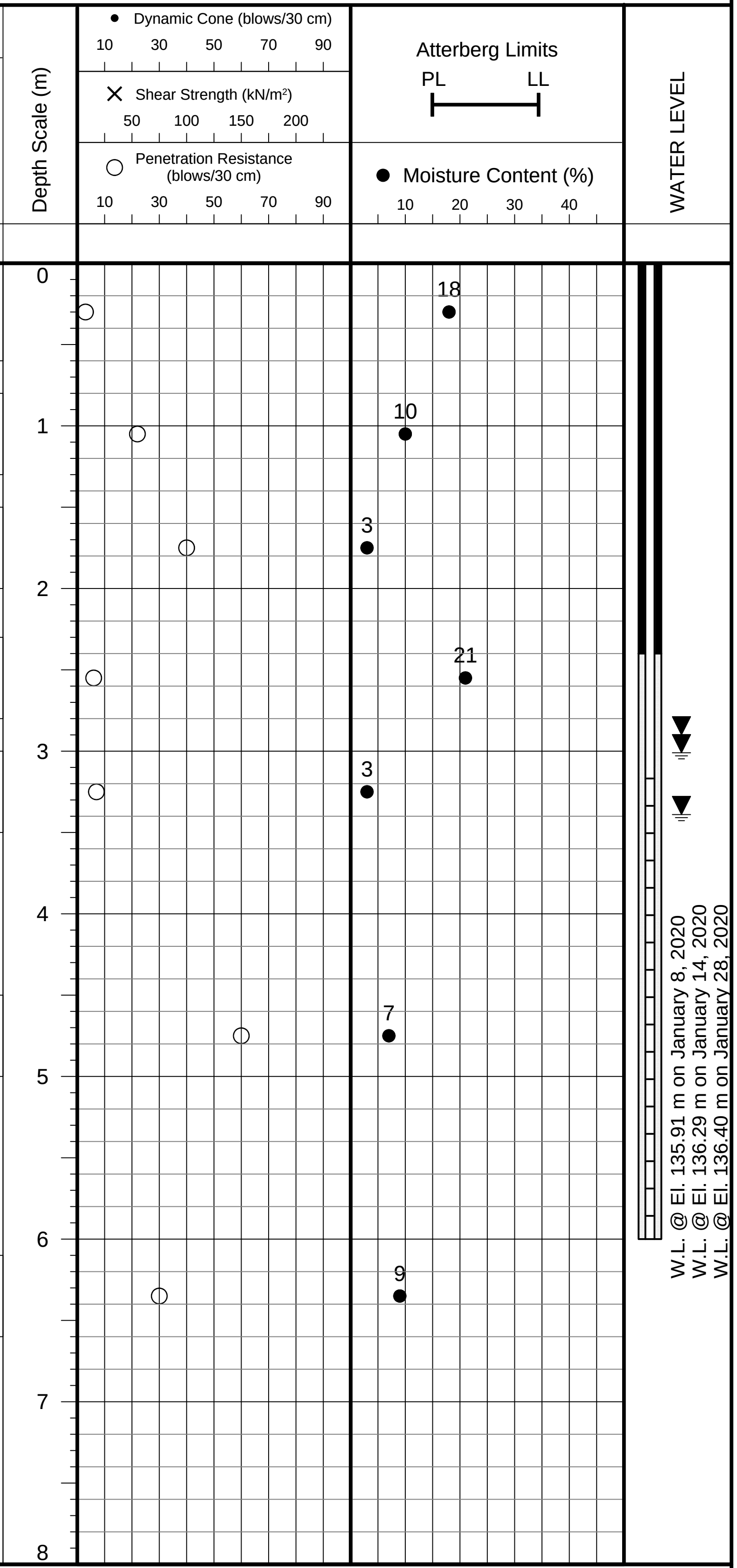
**PROJECT DESCRIPTION:** Proposed Residential Development

**METHOD OF BORING:** Flight-Auger

**PROJECT LOCATION:** 230 Finch Avenue
(Part 4, Plan #40 R-29767)
City of Pickering

**DRILLING DATE:** December 12, 2019

| El. (m)<br>Depth (m) | SOIL DESCRIPTION | SAMPLES Number | Type | N-Value |
|---|---|---|---|---|
| 139.3 | Ground Surface | | | |
| 0.0 | **25 cm TOPSOIL** | | | |
| 0.3 | Brown<br>**DISTURBED/WEATHERED SOIL**<br>sand, a trace of gravel | 1 | DO | 3 |
| 138.6<br>0.7 | Brown, compact to dense<br>**FINE TO COARSE SAND**<br>some silt | 2 | DO | 22 |
| | | 3 | DO | 40 |
| 137.2<br>2.1 | Brown, loose<br>**SANDY SILT** | 4 | DO | 6 |
| 136.4<br>2.9 | Brown, loose<br>**FINE TO COARSE SAND**<br>some silt | 5 | DO | 7 |
| 135.3<br>4.0 | Brown, very dense<br>**GRAVELLY SAND** | 6 | DO | 60 |
| 133.8<br>5.5 | Grey, compact<br>**SILTY SAND TILL** | 7 | DO | 30 |
| 132.7<br>6.6 | **END OF BOREHOLE**<br>Installed 50 mm Ø monitoring well to 6.0 m<br>3.0 m screen from 3.0 to 6.0 m<br>Sand backfill from 2.4 to 6 m<br>Bentonite from 0 to 2.4 m<br>Provided with a steel protective casing | | | |



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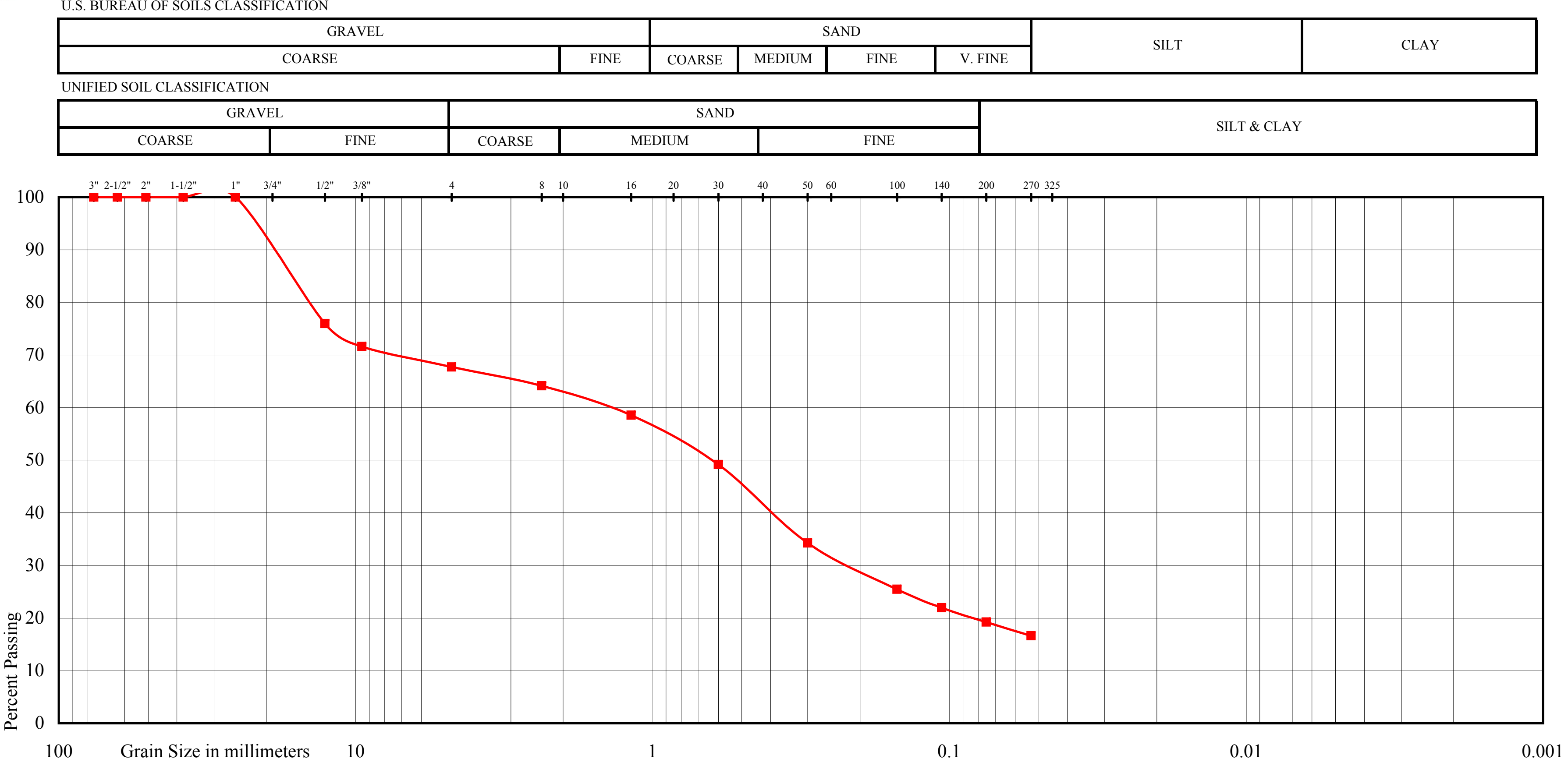
# GRAIN SIZE DISTRIBUTION

Reference No: 1911-W057



Project: Proposed Residential Development

Location: 230 Finch Avenue, City of Pickering

Borehole No: 1

Sample No: 1

Depth (m): 0.3

Elevation (m): 141.3

Estimated Permeability (cm./sec.) = $10^{-3}$

Classification of Sample [& Group Symbol]: GRAVELLY SAND

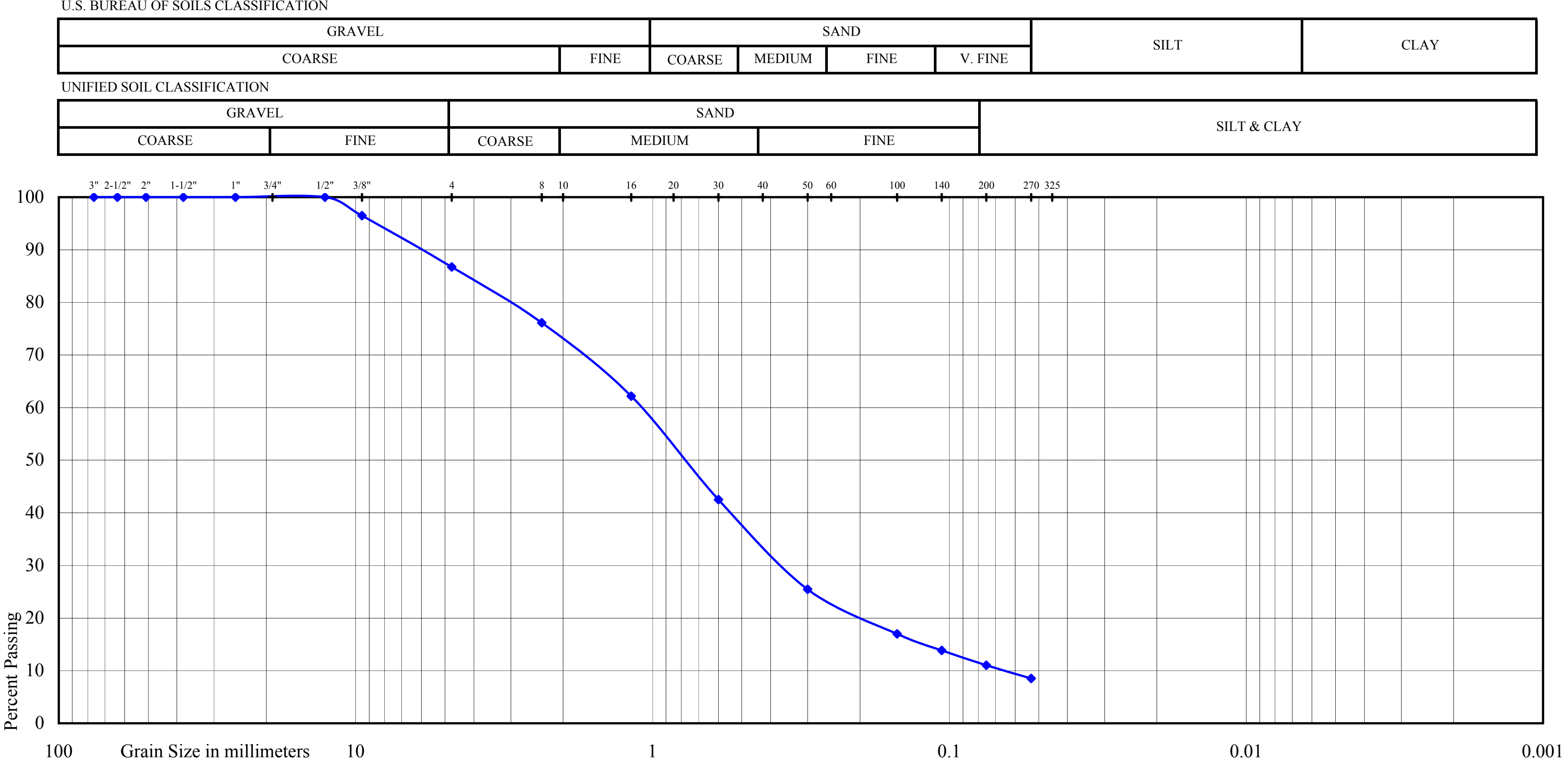
some silt

Figure: 6

**Soil Engineers Ltd.**

# GRAIN SIZE DISTRIBUTION

Reference No: 1911-W057



Project: Proposed Residential Development

Location: 230 Finch Avenue, City of Pickering

Borehole No: 2

Sample No: 4

Depth (m): 2.5

Elevation (m): 139.0

Estimated Permeability (cm./sec.) = $10^{-2}$

Classification of Sample [& Group Symbol]: FINE TO COARSE SAND
some silt and gravel

Figure: 7

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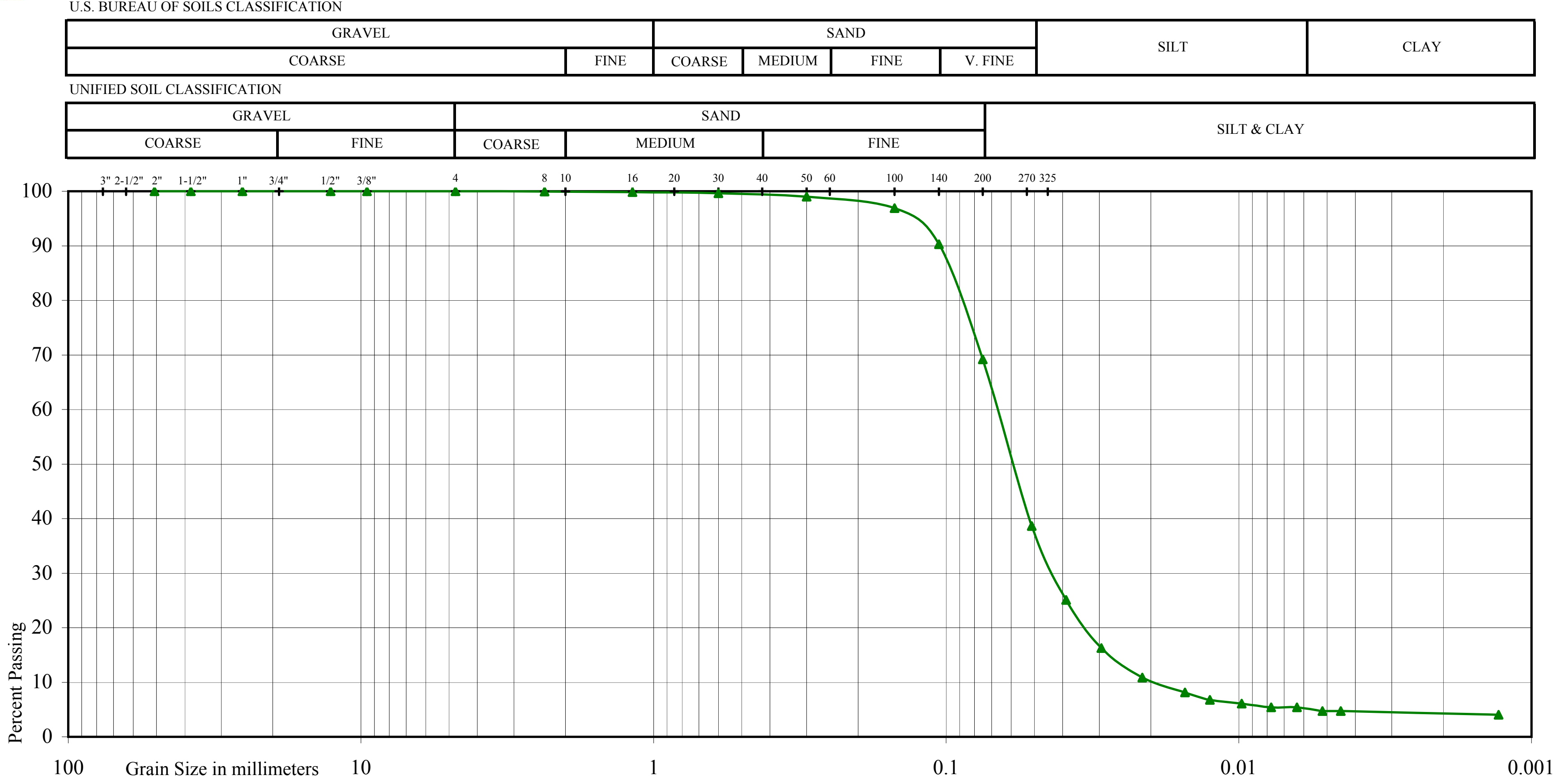
# GRAIN SIZE DISTRIBUTION

Reference No: 1911-W057



Project: Proposed Residential Development

Location: 230 Finch Avenue, City of Pickering

Borehole No: 5

Sample No: 4

Depth (m): 2.5

Elevation (m): 136.8

Estimated Permeability (cm./sec.) = $10^{-3}$

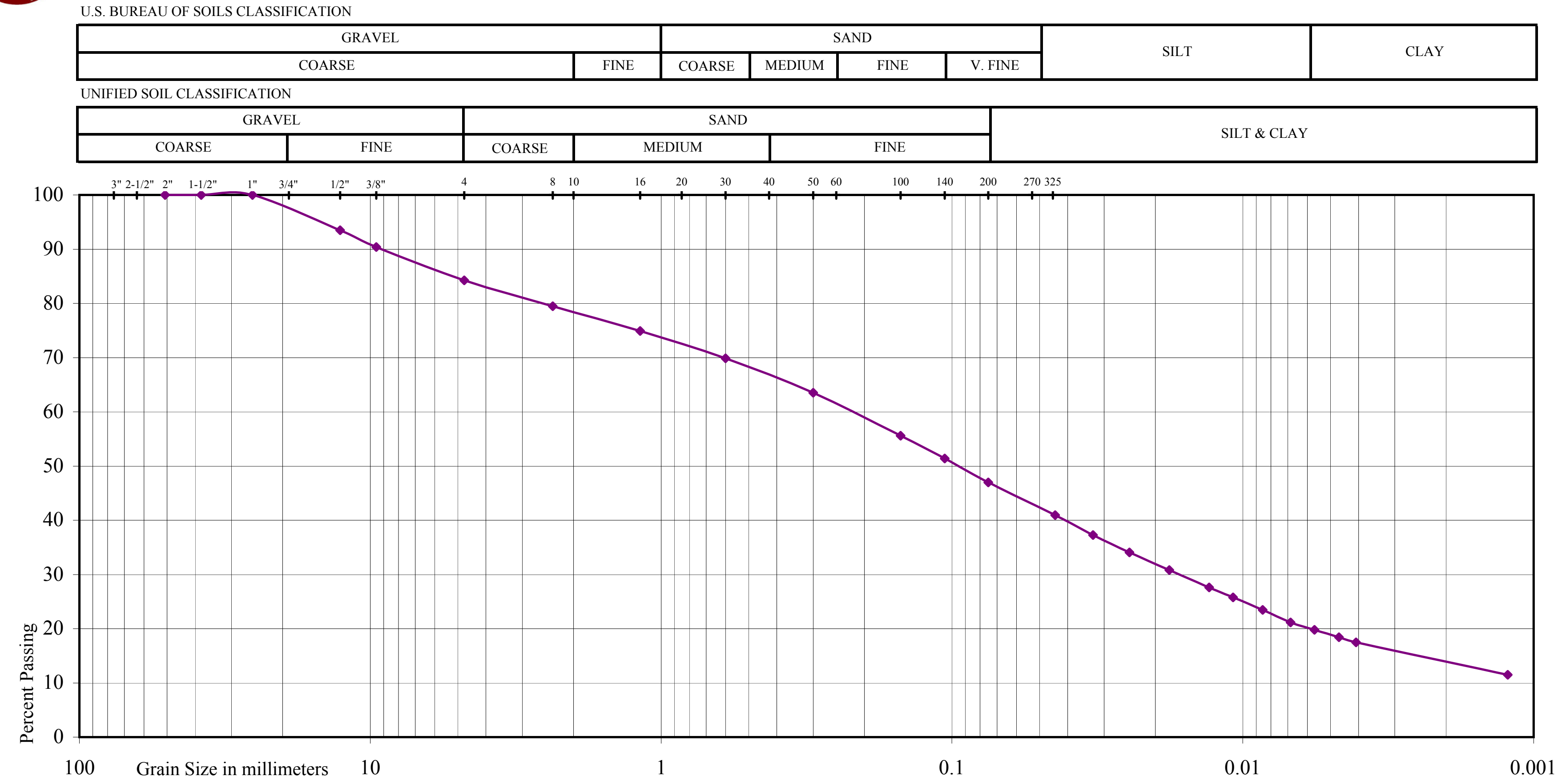
Classification of Sample [& Group Symbol]: SANDY SILT

a trace of clay

Figure: 8

# GRAIN SIZE DISTRIBUTION

Reference No: 1911-W057



Project: Proposed Residential Development

Location: 230 Finch Avenue, City of Pickering

Borehole No: 1

Sample No: 7

Depth (m): 6.3

Elevation (m): 135.3

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

| | |
|---|---|
| Classification of Sample [& Group Symbol]: | SILTY SAND, TILL<br>some clay and gravel |

# DRAWINGS 1 TO 9

## REFERENCE NO. 1911-W057

Source: Ministry of Natural Resources and Forestry
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🟥 Approximate Boundary of Subject Site

➤ Watercourse

— Local Road

**Soil Engineers Ltd.**

Title: Site Location Plan

Project:

Hydrogeological Assessment
Proposed Residential Development
230 Finch Avenue
City of Pickering

Reference No. 1911-W057

Date: March 30, 2020

Scale:

Drawing No. 1

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Source: Ministry of Natural Resources and Forestry
©Queen's Printer for Ontario, 2019

N

🟥 Approximate Boundary of Subject Site
⊕ Borehole with Monitoring Well
→ Watercourse
— Local Road

**Soil Engineers Ltd.**

Title: Borehole and Monitoring Well Location Plan

Project:

Hydrogeological Assessment
Proposed Residential Development
230 Finch Avenue
City of Pickering

Reference No. 1911-W057

Date: March 18, 2020

Scale:
0 2.5 5 10 15 20 25
Metres

Drawing No. 2

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

C:\GIS2019\1911-W057\

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

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 |
| 🟦 | Waterbody |
| → | Watercourse |
| ━ | Major Road |
| ─ | Local Road |
| ═ | Railway |

**Soil Engineers Ltd.**

Title: MECP Well Location Plan

Project:

Hydrogeological Assessment
Proposed Residential Development
230 Finch Avenue
City of Pickering

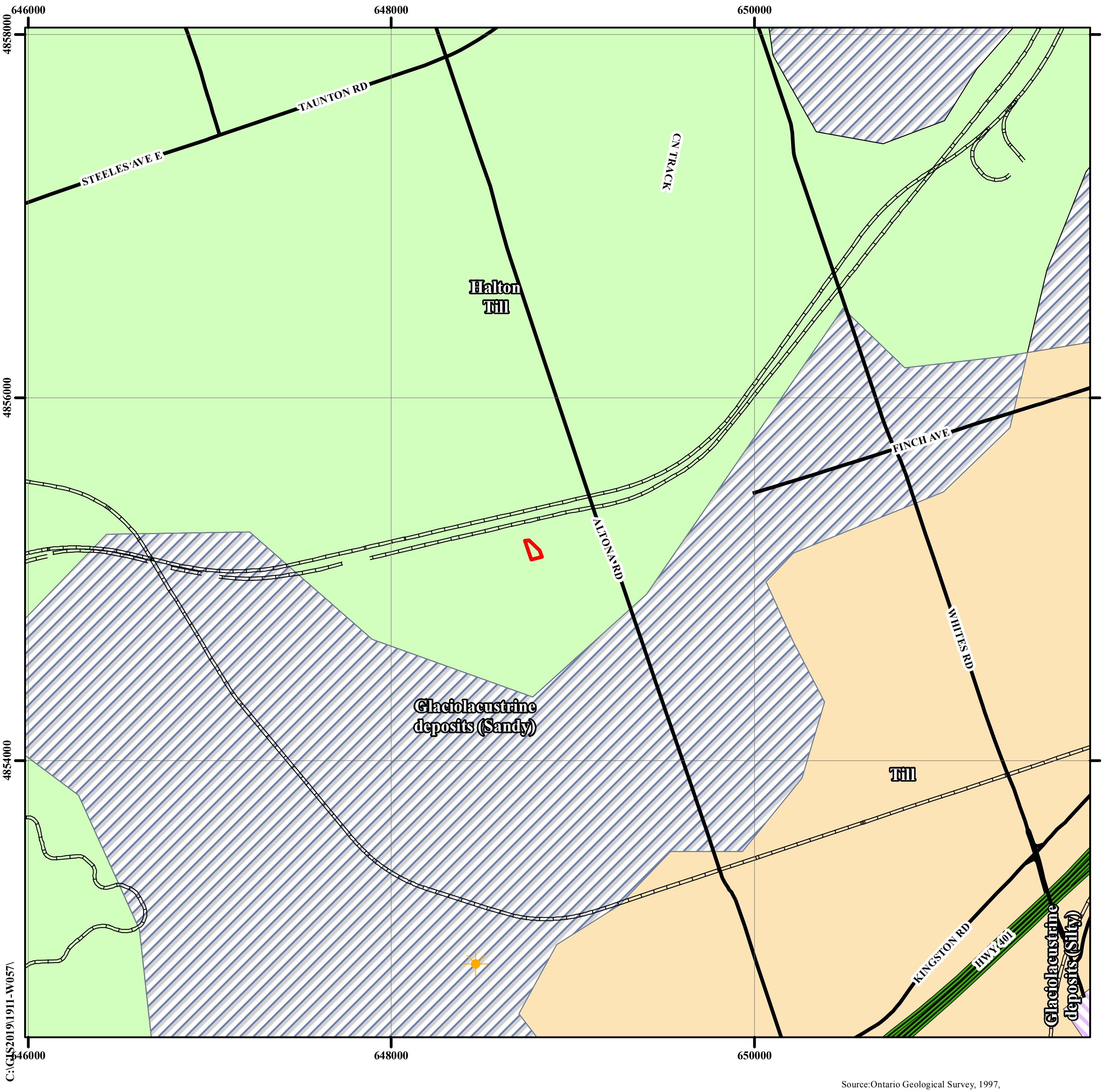
Reference No. 1911-W057

Date: December 31, 2019

Scale:

0 25 50 100 150 200 250
Metres

Drawing No. 3



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

N

| | |
|---|---|
| ▭ | Approximate Boundary of Subject Site |
| ▨ | Glaciolacustrine deposits (Sandy)<br>Material: sand, gravelly sand and gravel, nearshore and beach deposits |
| ▨ | Glaciolacustrine deposits (Silty)<br>Material: silt and clay, minor sand, basin and quiet water deposits |
| 🟩 | Halton Till<br>Material: predominantly silt to silty clay matrix, high in matrix carbonate content and clast poor |
| 🟧 | Till<br>Material: undifferentiated, predominantly sandy silt to silt matrix, commonly rich in clasts, often high in total matrix carbonate content |
| ✹ | Oil and Gas Wells |
| ═ | Expressway/Freeway |
| ━ | Major Road |
| ═ | Railway |

**Soil Engineers Ltd.**

Title: Quarternary and Surface Geology Map

Project:

Hydrogeological Assessment
Proposed Residential Development
230 Finch Avenue
City of Pickering

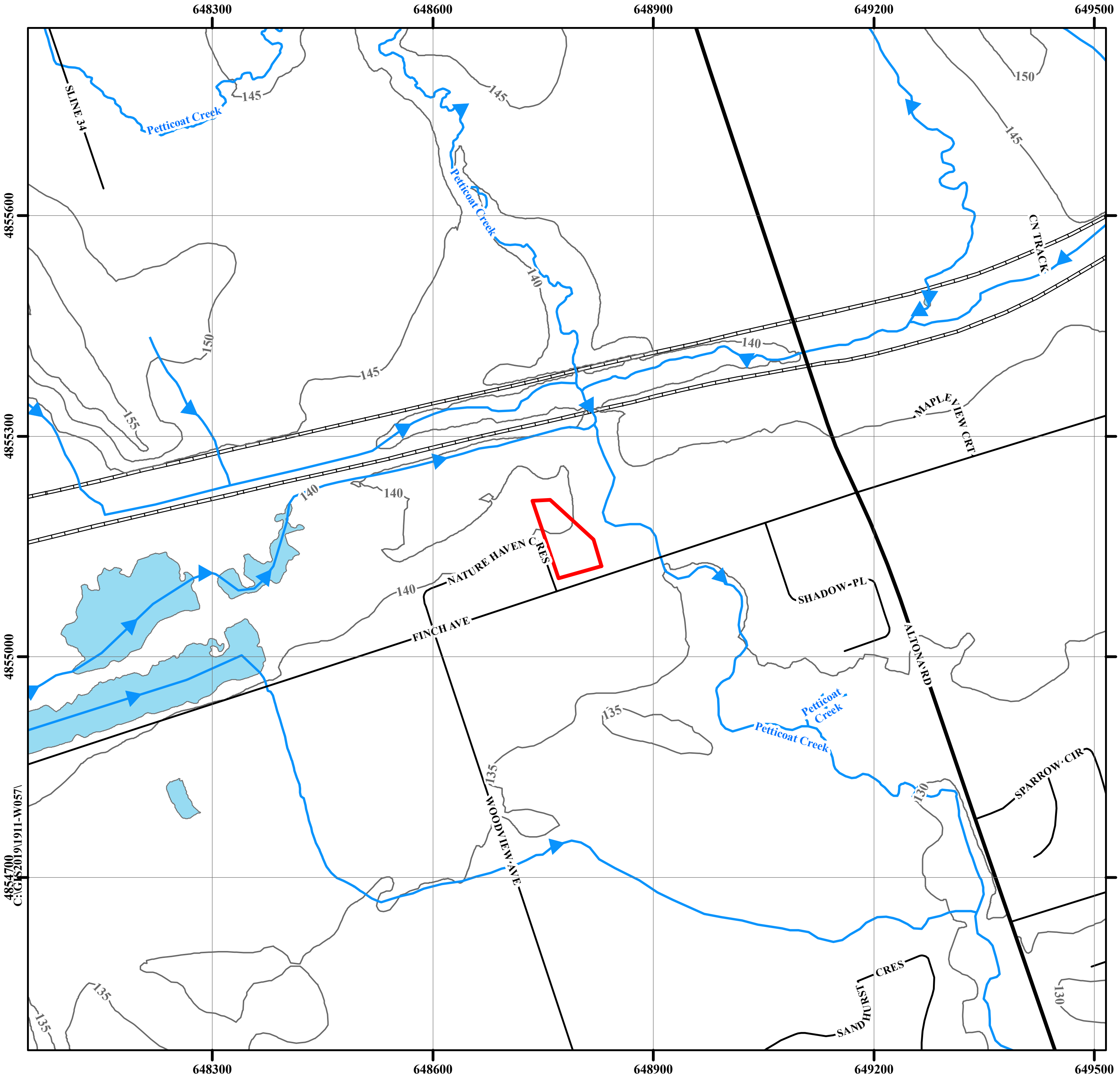
Reference No. 1911-W057

Date: December 31, 2019

Scale:

0 100 200 400 600 800 1,000
Metres

Drawing No. 4



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N

▭ Approximate Boundary of Subject Site

▨ Waterbody

→ Watercourse

━ Major Road

— Local Road

▭ Railway

—205— Topographic Contour (masl)

**Soil Engineers Ltd.**

Title: Topographic Map

Project:

Hydrogeological Assessment
Proposed Residential Development
230 Finch Avenue
City of Pickering

Reference No. 1911-W057

Date: December 31, 2019

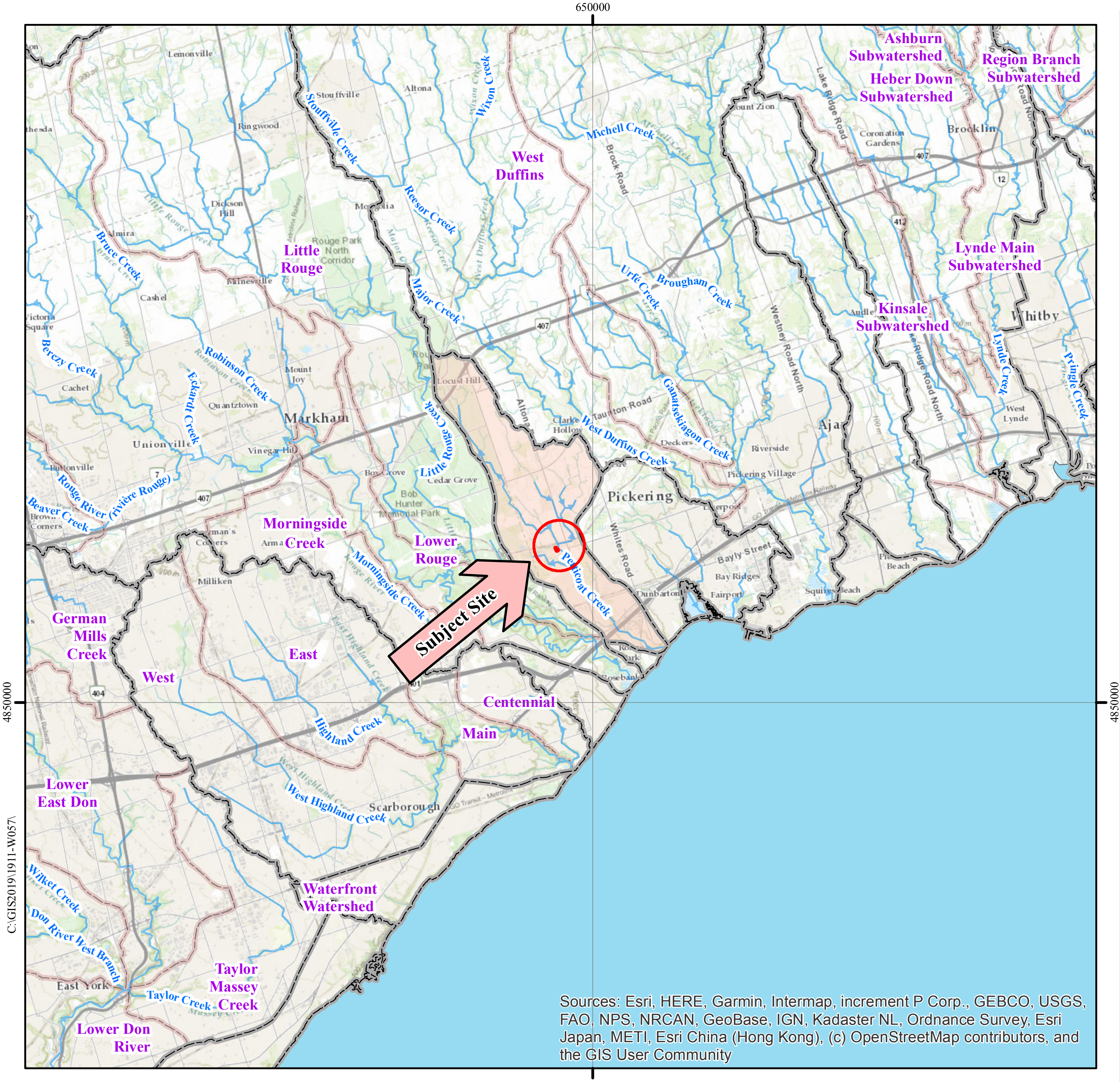
Scale:
0 25 50 100 150 200 250
Metres

Drawing No. 5

Source: Water Body, Ontario Ministry of Natural Resources and Forestry, 2015
©Queen's Printer for Ontario, 2015

Source: Contour, Ontario Ministry of Natural Resources and Forestry, 2015
©Queen's Printer for Ontario, 2015

Source: Water Course, Ontario Ministry of Natural Resources and Forestry, 2015
©Queen's Printer for Ontario, 2015



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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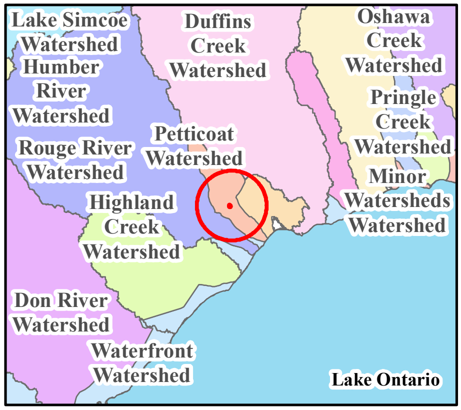
this mapping was produced by SEL and should be used for information purposes only.
Data sources used in its production are of varying quality and accuracy and all boundaries should be considered approximate.

N

**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
230 Finch Avenue
City of Pickering

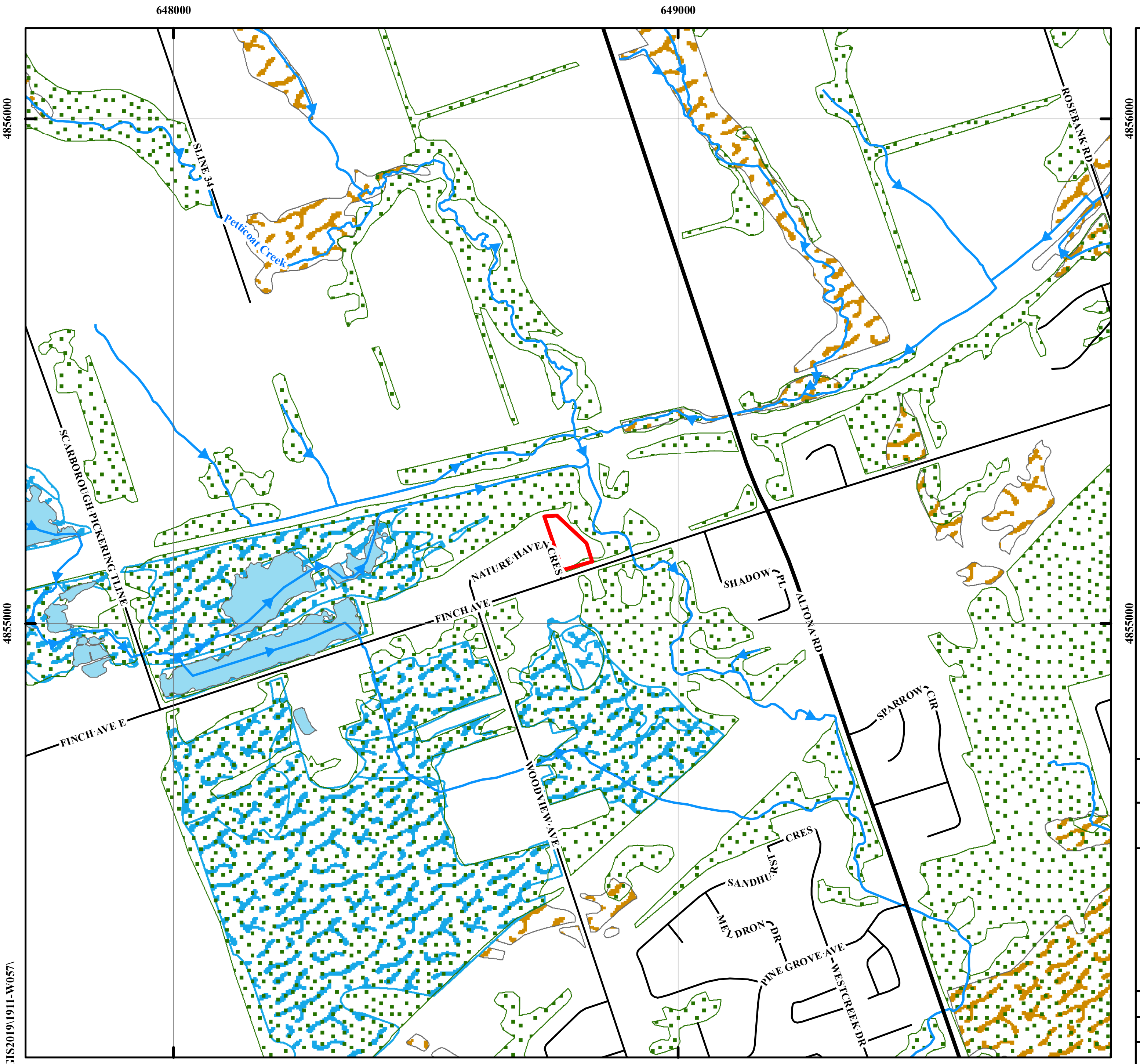
Reference No. 1911-W057

Date: December 31, 2019

Scale:

0 5,000 10,000 20,000 30,000 40,000
Metres

Drawing No. 6



- 🟥 Approximate Boundary of Subject Site
- ▨ Wetland (classified as Provincial)
- ▨ 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
230 Finch Avenue
City of Pickering

Reference No. 1911-W057

Date: December 31, 2019

Scale:
0 50 100 200 300 400 500
Metres

Drawing No. 7

C:\GIS2019\1911-W057\

Contains information licensed under the Open Government Licence – Ontario, 2019
Includes information: Provincial Park, Conservation Reserve, Area of Natural and Scientific Interest, Wetland, Niagara Escarpment Protection Area, Oak Ridges Moraine Conservation and Wilderness Areas

Source: Ministry of Natural Resources and Forestry
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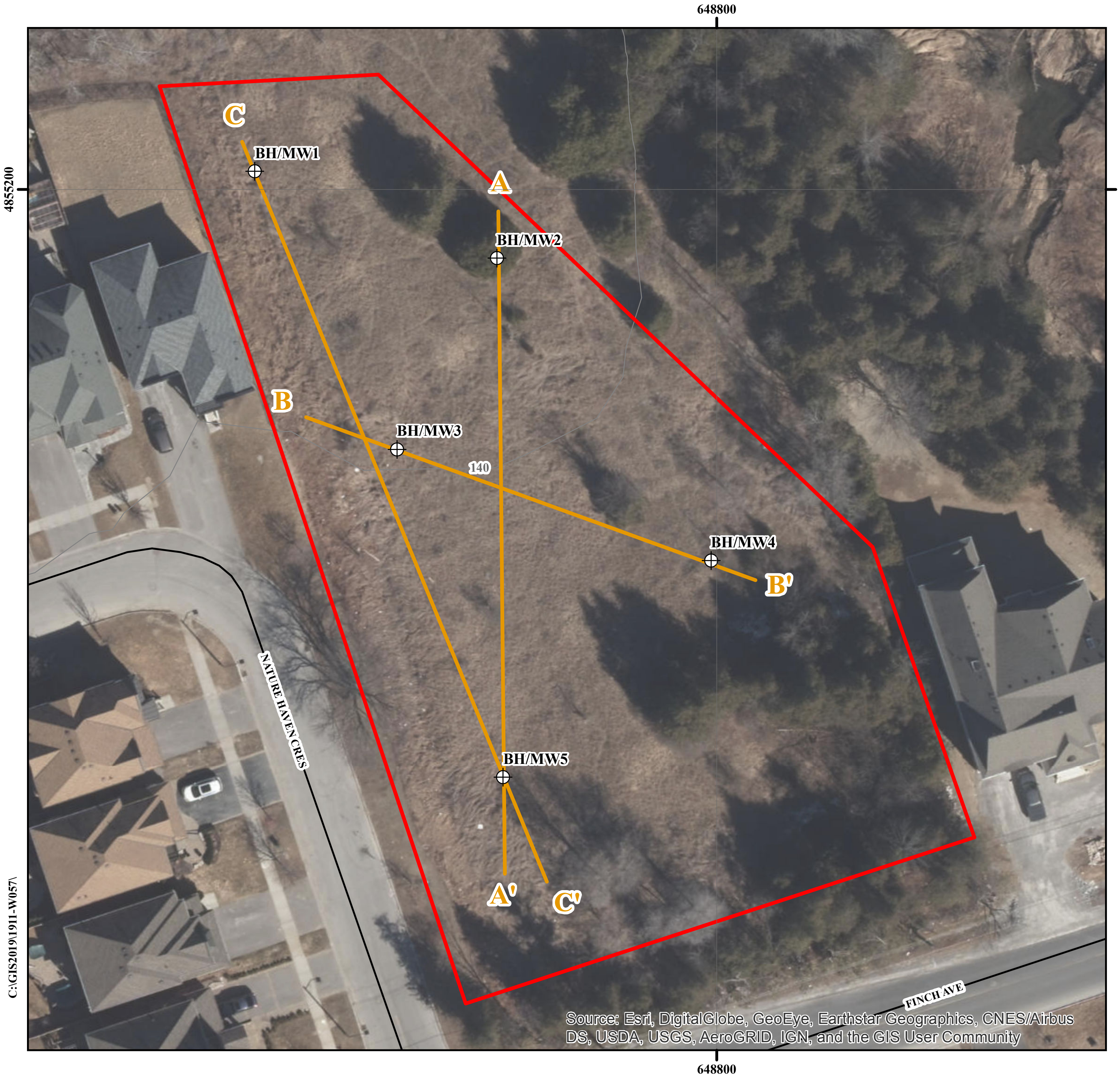


Source: Ministry of Natural Resources and Forestry
ⒸQueen's Printer for Ontario, 2019

**Soil Engineers Ltd.**

Title: Cross-Section Key Plan

Project:

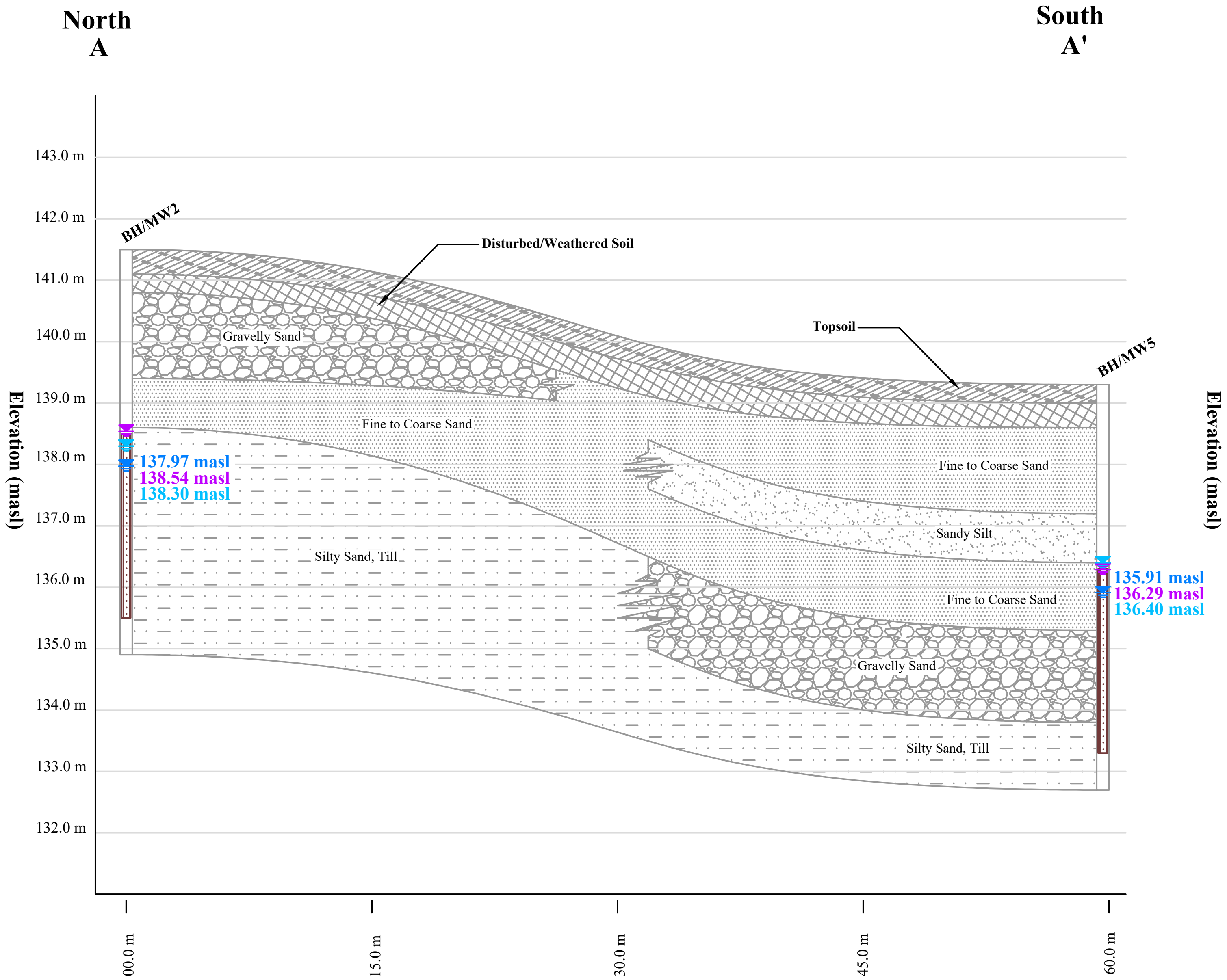
Hydrogeological Assessment
Proposed Residential Development
230 Finch Avenue
City of Pickering

Reference No. 1911-W057

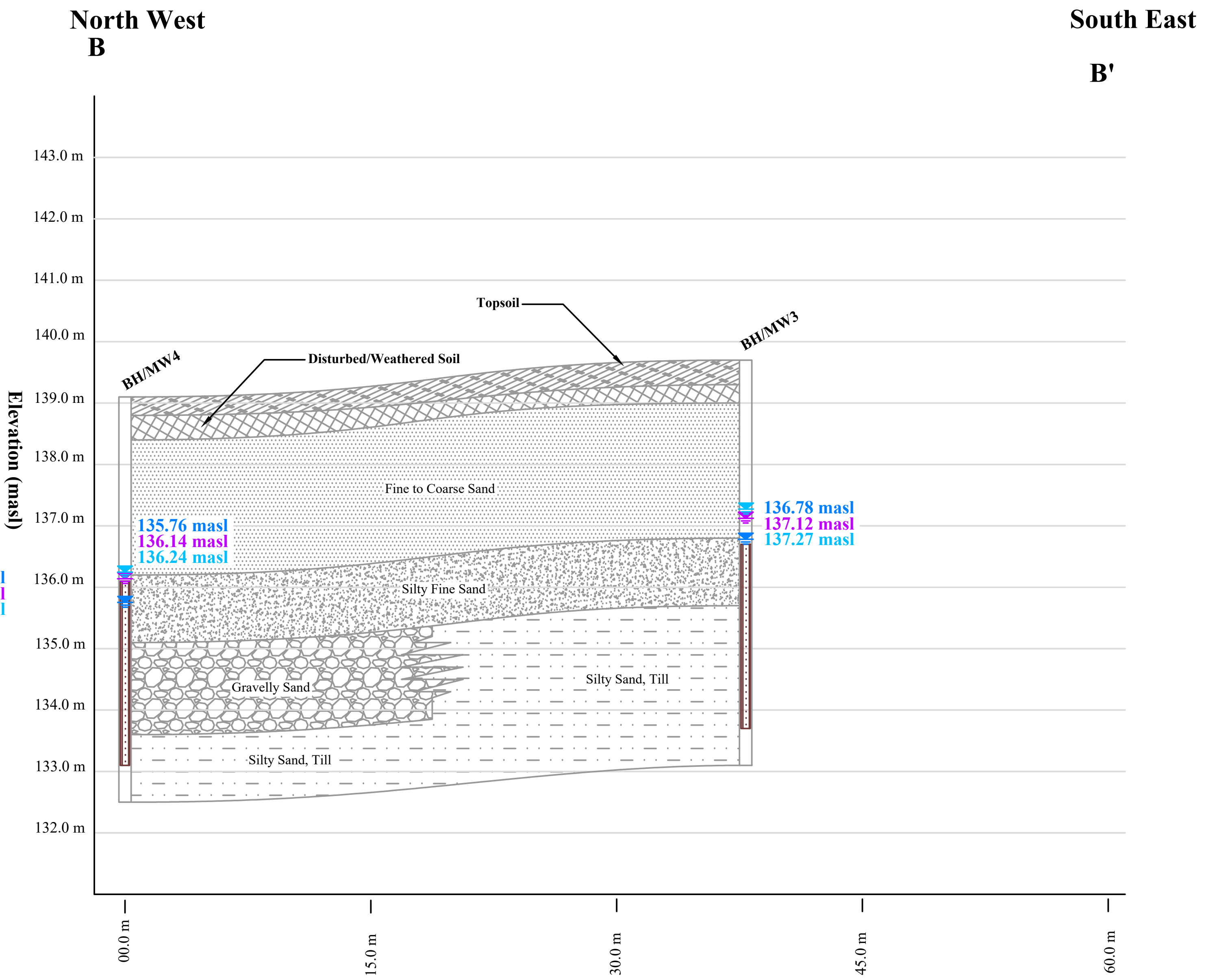
Date: March 27, 2020

Scale:

Drawing No. 8-1



## Section A-A'



## Section B-B'

▨ **Topsoil**

▨ **Disturbed/Weathered Soil**

▨ **Fine to Coarse Sand**

▨ **Silty Fine Sand**

▨ **Sandy Silt**

▨ **Silty Sand, Till**

▨ **Gravelly Sand**

▯ **3.0 m Screen**

▼ **Water Table on January 8, 2020**

▼ **Water Table on January 14, 2020**

▼ **Water Table on January 28, 2020**

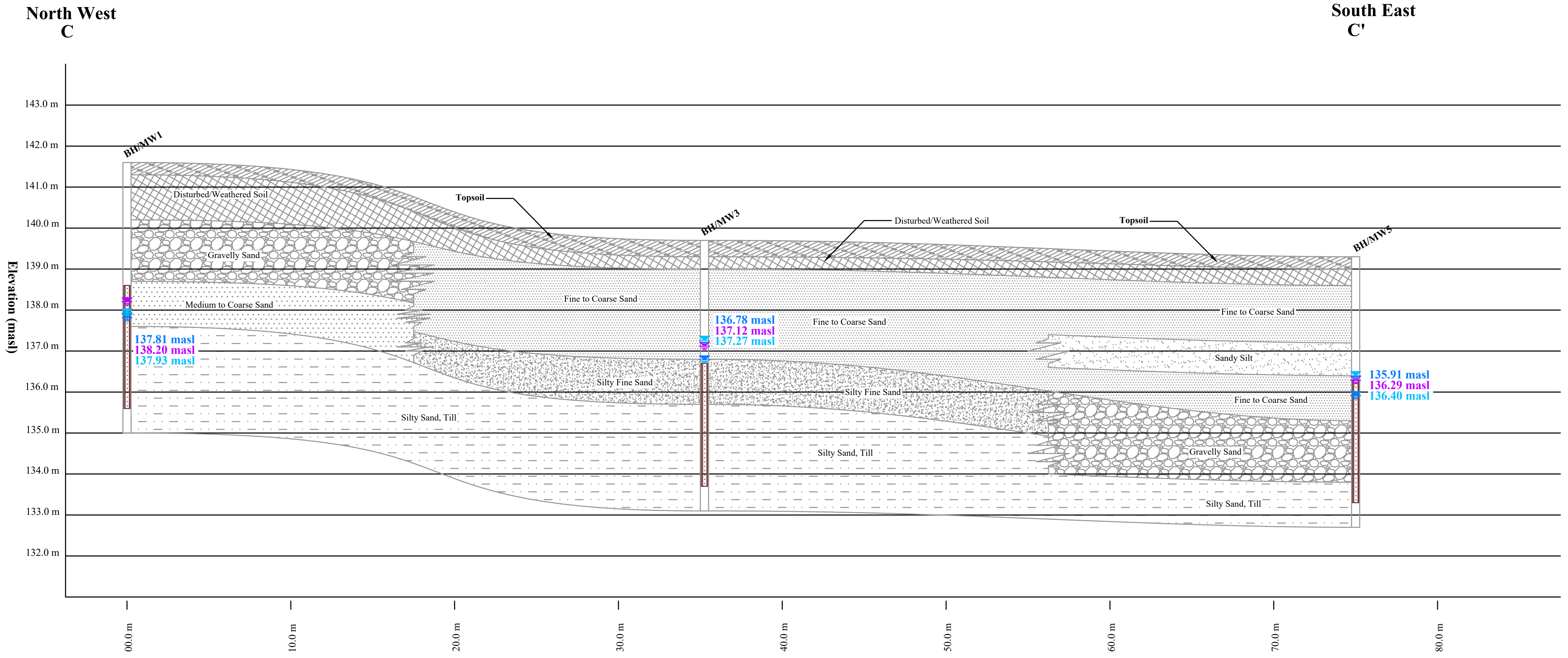
C:Projects/2019 Jobs/1903–W079

Soil Engineers Ltd.
CONSULTING SOIL, FOUNDATION & ENVIRONMENTAL ENGINEERS

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

Project: Hydrogeological Assessment
Proposed Residential Development
230 Finch Avenue, City of Pickering

| Reference No: | Date: | Scale: V | Scale: H | Drawing No. |
|---|---|---|---|---|
| 1911-W057 | March, 2020 | 1:100 | 1:1500 | 8-2 |



## Section C-C'

▨ **Topsoil**

▨ **Disturbed/Weathered Soil**

▨ **Fine to Coarse Sand**

▨ **Silty Fine Sand**

▨ **Sandy Silt**

▨ **Silty Sand, Till**

▨ **Gravelly Sand**

▨ **Medium to Coarse Sand**

▯ **3.0 m Screen**

▼ **Water Table on January 8, 2020**

▼ **Water Table on January 14, 2020**

▼ **Water Table on January 28, 2020**

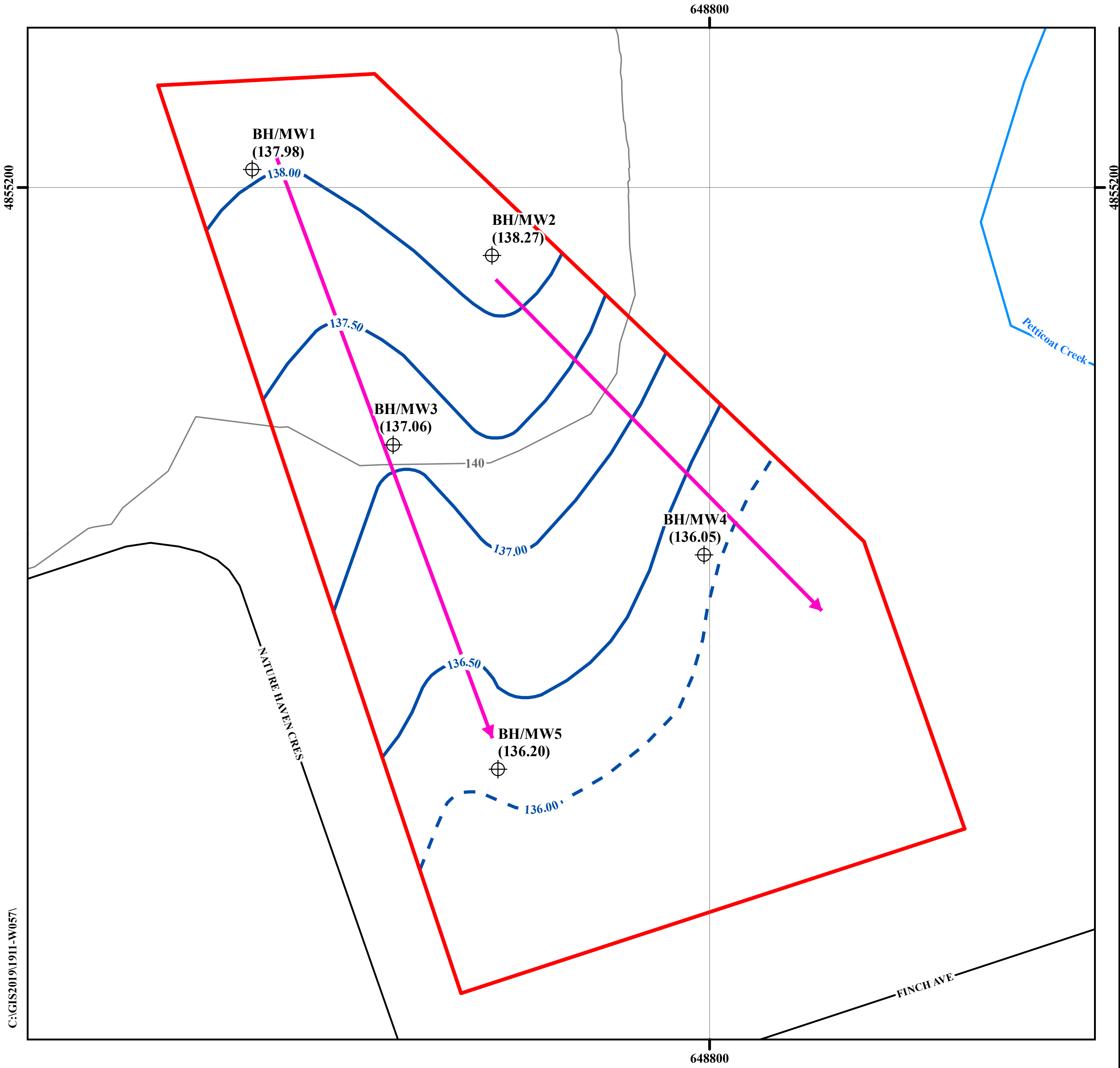
C:Projects/2019 Jobs/1903-W079

Soil Engineers Ltd.
CONSULTING SOIL, FOUNDATION & ENVIRONMENTAL ENGINEERS

Title: Geological Cross-Section (C-C')

Project: Hydrogeological Assessment
Proposed Residential Development
230 Finch Avenue, City of Pickering

| Reference No: | Date: | Scale: V | Scale: H | Drawing No. |
|---|---|---|---|---|
| 1911-W057 | March, 2020 | 1:100 | 1:1000 | 8-3 |



Source: Ministry of Natural Resources and Forestry
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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) |
| ➔ | Watercourse |
| — | Local Road |
| —205— | Topographic Contour (masl) |
| 197.24 | Average Shallow Groundwater Level Elevation (masl) |

*Soil Engineers Ltd.*

Title: Shallow Groundwater
Flow Pattern Plan

Project:

Hydrogeological Assessment
Proposed Residential Development
230 Finch Avenue
City of Pickering

Reference No. 1911-W057

Date: March 27, 2020

Scale:
0 2.5 5 10 15 20 25
Metres

Drawing No. 9

**Soil Engineers Ltd.**
CONSULTING ENGINEERS
GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE
90 WEST BEAVER CREEK ROAD, SUITE 100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

| BARRIE | MISSISSAUGA | OSHAWA | NEWMARKET | GRAVENHURST | HAMILTON |
|---|---|---|---|---|---|
| TEL: (705) 721-7863 | TEL: (905) 542-7605 | TEL: (905) 440-2040 | TEL: (905) 853-0647 | TEL: (705) 684-4242 | TEL: (905) 777-7956 |
| FAX: (705) 721-7864 | FAX: (905) 542-2769 | FAX: (905) 725-1315 | FAX: (905) 881-8335 | FAX: (705) 684-8522 | FAX: (905) 542-2769 |

# APPENDIX ‘A’

## MECP WATER WELL RECORDS SUMMARY

## REFERENCE NO. 1911-W057

# Appendix 'A'

## 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 | 4603705 | Boring | - | Water Supply | Domestic | 3.05 | 3.05 | 9.46 | 10.98 |
| 2 | 1918520 | - | - | Abandoned-Other | Not Used | - | - | - | - |
| 3 | 1918398 | Jetting | 5.00 | Dewatering | Not Used | - | - | 4.00 | 5.00 |
| 4 | 4604702 | Boring | - | Water Supply | Domestic | 3.97 | 2.14 | - | - |
| 5 | 4604749 | Boring | - | Water Supply | Domestic | 1.22 | 0.61 | - | - |
| 6 | 4601246 | Boring | - | Water Supply | Domestic | 1.53 | 0.61 | - | - |
| 7 | 1918488 | Rotary (Convent.) | 5.00 | Dewatering | Not Used | 1.20 | | 4.00 | 5.00 |
| 8 | 7261537 | - | - | Abandoned-Other | - | - | 0.92 | - | - |
| 9 | 7259819 | Rotary (Convent.) | 6.10 | Monitoring and Test Hole | Monitoring and Test Hole | 1.83 | - | 4.58 | 6.10 |
| 10 | 7042514 | - | - | Abandoned-Other | - | - | - | - | - |
| 11 | 7261538 | - | - | Abandoned-Other | - | - | 0.61 | - | - |
| 12 | 4603817 | Boring | - | Water Supply | Domestic | 1.83 | 1.83 | - | - |
| 13 | 7106459 | Auger | 3.05 | Test Hole | Monitoring | - | - | 1.52 | 3.05 |
| 14 | 7106459 | Auger | 7.63 | Test Hole | Monitoring | - | - | 6.10 | 7.63 |
| 15 | 7106459 | - | 3.05 | Test Hole | Monitoring | - | - | 1.53 | 3.05 |
| 16 | 7277997 | - | - | Abandoned-Other | - | 4.60 | - | 4.60 | 7.60 |
| 17 | 7274751 | Rotary (Convent.) | 7.63 | Test Hole | Test Hole | - | - | 4.58 | 7.63 |
| 18 | 7252165 | - | 3.97 | Abandoned-Other | Not Used | - | - | - | - |
| 19 | 7106458 | Auger | 9.15 | Test Hole | Monitoring | - | - | 7.63 | 9.15 |
| 20 | 7106458 | Auger | 5.49 | Test Hole | Monitoring | - | - | 3.97 | 5.49 |
| 21 | 7283592 | Rotary (Convent.) | 0.00 | Monitoring and Test Hole | Monitoring and Test Hole | 6.10 | - | 2.13 | 5.18 |
| 22 | 1917695 | Boring | 4.10 | Abandoned-Quality | Domestic | - | - | - | - |
| 23 | 7217575 | Rotary (Convent.) | 7.63 | Test Hole | Monitoring and Test Hole | 3.97 | - | 4.58 | 7.63 |
| 24 | 7109576 | Auger | 6.00 | Test Hole | Monitoring | - | - | 3.00 | 6.00 |
| 25 | 7107053 | Auger | 5.40 | Abandoned-Other | Not Used | - | - | - | - |
| 26 | 7109576 | Auger | 7.60 | Test Hole | Monitoring | - | - | 4.50 | 7.60 |
| 27 | 7109576 | Auger | 5.10 | Test Hole | Monitoring | - | - | 2.10 | 5.10 |
| 28 | 1913896 | Cable Tool | - | Dewatering | Domestic | 7.02 | 2.14 | - | - |
| 29 | 7107053 | Auger | 5.70 | Abandoned-Other | Not Used | - | 1.00 | - | - |
| 30 | 7109576 | Auger | 5.40 | Test Hole | Monitoring | - | - | - | - |

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

## 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** | | | | |
| 31 | 7107053 | Auger | 5.40 | Abandoned-Other | Not Used | - | - | - | - |
| 32 | 7106461 | Auger | 21.35 | Observation Wells | Monitoring | - | - | - | - |
| 33 | 7107053 | Auger | 7.50 | Abandoned-Other | Not Used | - | - | - | - |
| 34 | 7252164 | - | 21.03 | Abandoned-Other | Not Used | - | - | - | - |
| 35 | 7272400 | Rotary (Convent.) | 10.68 | Monitoring and Test Hole | Monitoring and Test Hole | 4.58 | - | 7.63 | 10.68 |
| 36 | 7106460 | Auger | 6.10 | Test Hole | Monitoring | - | - | 4.58 | 6.10 |
| 37 | 7106460 | Auger | 2.75 | Test Hole | Monitoring | - | - | 1.22 | 2.75 |
| 38 | 1913485 | Cable Tool | 5.18 | Water Supply | Domestic | - | - | - | - |

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

# APPENDIX 'B'

## SINGLE WELL RESPONSE TEST RESULTS

## REFERENCE NO. 1911-W057

## Falling Head Test (Slug Test)

Test Date: 28-Jan-20
Piezometer/Well No.: BH/MW 1
Ground level: 141.60 m
Screen top level: 138.60 m
Screen bottom level: 135.60 m
Test El. (at midpoint of screen): 137.10 m
Test depth (at midpoint of screen): 4.5 m
Screen length L= 3 m

Diameter of undisturbed portion of aquifer 2R= 0.22 m
Standpipe diameter 2r= 0.05 m
Initial unbalanced head Ho= -0.105 m
Initial water depth 4.44 m
Aquifer material: **Medium to coarse sand, Silty sand till**

Shape factor

$$F= \frac{2 \text{ x } 3.14 \text{ x } L}{\ln(L/R)} = 5.701815 \text{ m}$$

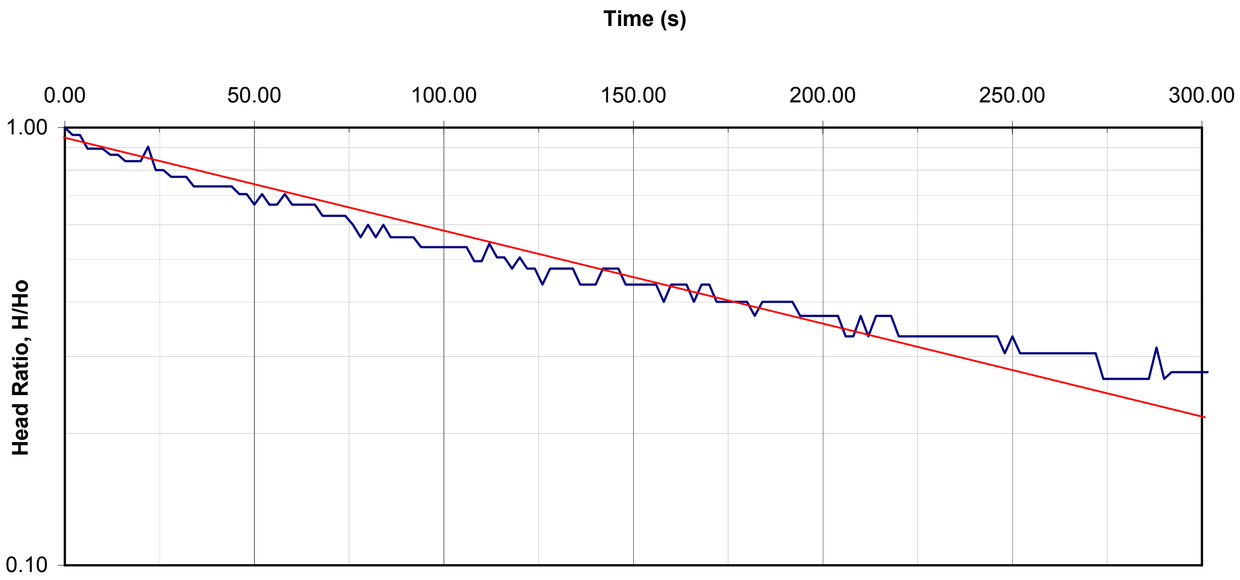
Permeability

$$K= \frac{3.14 \text{ x } r2}{F \text{ x } (t2 - t1)} \text{ x } \ln(H1/H2)$$

(Bouwer and Rice Method)

$$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.006286087$$

K= **2.2E-04** cm/s
**2.2E-06** m/s



# Falling Head Test (Slug Test)

| | | | |
|---|---|---|---|
| Test Date: | | 28-Jan-20 | |
| Piezometer/Well No.: | | BH/MW 2 | |
| Ground level: | | 141.50 | m |
| Screen top level: | | 138.50 | m |
| Screen bottom level: | | 135.50 | m |
| Test El. (at midpoint of screen): | | 137.00 | m |
| Test depth (at midpoint of screen): | | 4.5 | m |
| Screen length | L= | 3 | m |
| Diameter of undisturbed portion of aquifer | 2R= | 0.22 | m |
| Standpipe diameter | 2r= | 0.05 | m |
| Initial unbalanced head | Ho= | -0.156 | m |
| Initial water depth | | 3.95 | m |
| Aquifer material: | | **Silty sand till** | |

Shape factor F= 2 x 3.14 x L / ln(L/R) = 5.701815 m

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

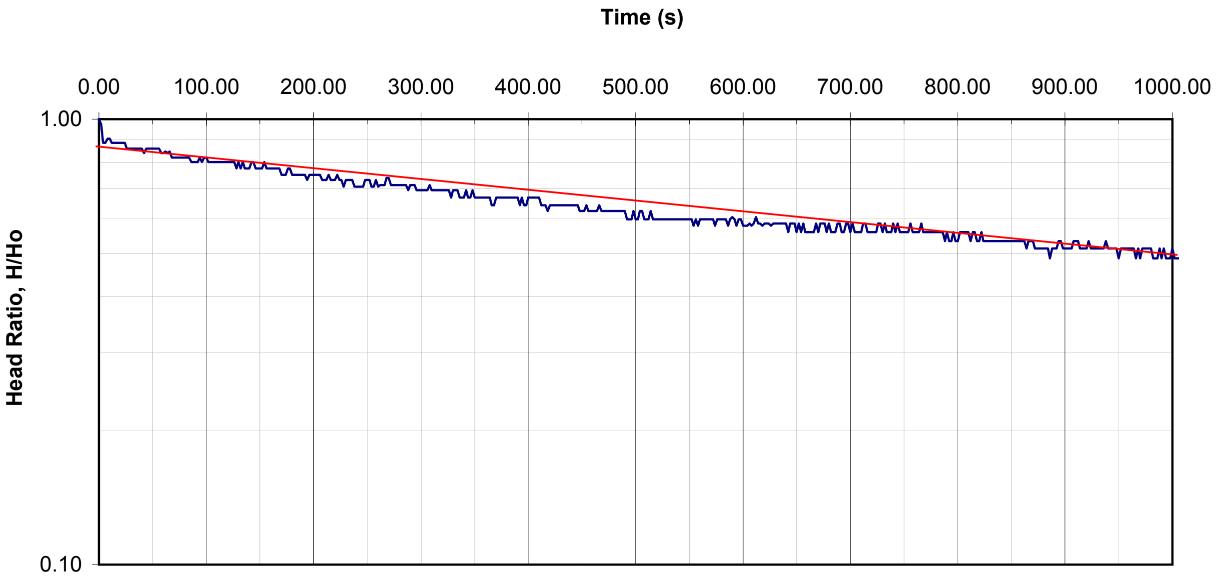
Permeability

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

(Bouwer and Rice Method)

$$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.001978257$$

K= **6.8E-05** cm/s
**6.8E-07** m/s



## Falling Head Test (Slug Test)

| | | | |
|---|---|---|---|
| Test Date: | | 28-Jan-20 | |
| Piezometer/Well No.: | | BH/MW 3 | |
| Ground level: | | 139.70 | m |
| Screen top level: | | 136.70 | m |
| Screen bottom level: | | 133.70 | m |
| Test El. (at midpoint of screen): | | 135.20 | m |
| Test depth (at midpoint of screen): | | 4.5 | m |
| Screen length | L= | 3 | m |
| | | | |
| Diameter of undisturbed portion of aquifer | 2R= | 0.22 | m |
| Standpipe diameter | 2r= | 0.05 | m |
| Initial unbalanced head | Ho= | -0.024 | m |
| Initial water depth | | 3.24 | m |
| Aquifer material: | | **Silty fine sand, Silty sand till** | |

Shape factor F= 2 x 3.14 x L / ln(L/R) = 5.701815 m

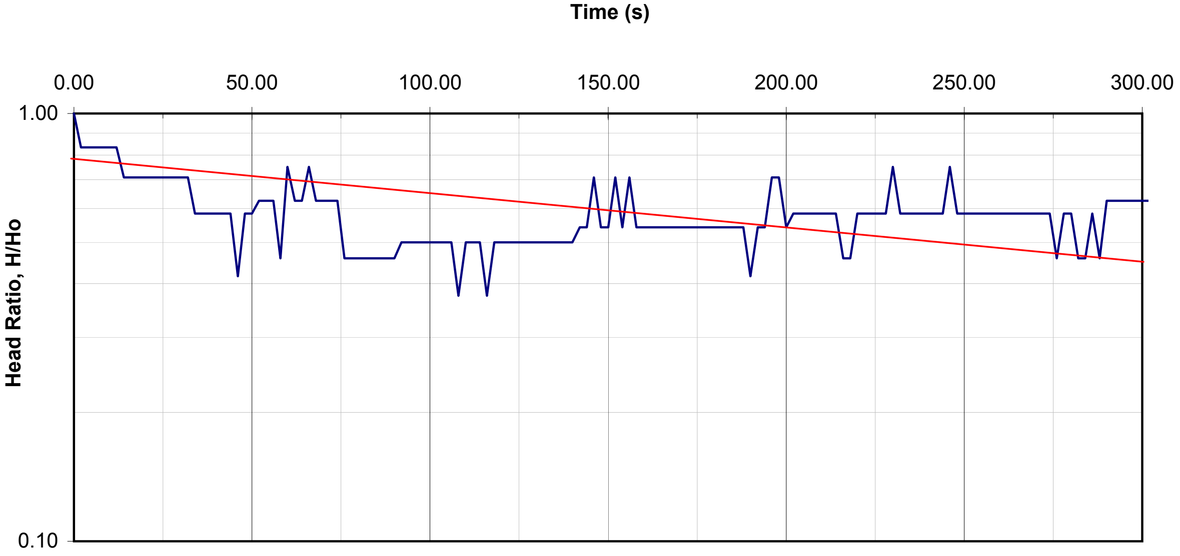
$$F = \frac{2 \times 3.14 \times L}{\ln(L/R)} = 5.701815 \text{ m}$$

Permeability

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

$$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.01077993$$

K= **3.7E-04** cm/s
**3.7E-06** m/s



## Falling Head Test (Slug Test)

| | | | |
|---|---|---|---|
| Test Date: | | 28-Jan-20 | |
| Piezometer/Well No.: | | BH/MW 4 | |
| Ground level: | | 139.10 | m |
| Screen top level: | | 136.10 | m |
| Screen bottom level: | | 133.10 | m |
| Test El. (at midpoint of screen): | | 134.60 | m |
| Test depth (at midpoint of screen): | | 4.5 | m |
| Screen length | L= | 3 | m |
| Diameter of undisturbed portion of aquifer | 2R= | 0.22 | m |
| Standpipe diameter | 2r= | 0.05 | m |
| Initial unbalanced head | Ho= | -0.248 | m |
| Initial water depth | | 3.72 | m |
| Aquifer material: | | **Silty fine sand, Gravelly sand, Silty sand till** | |

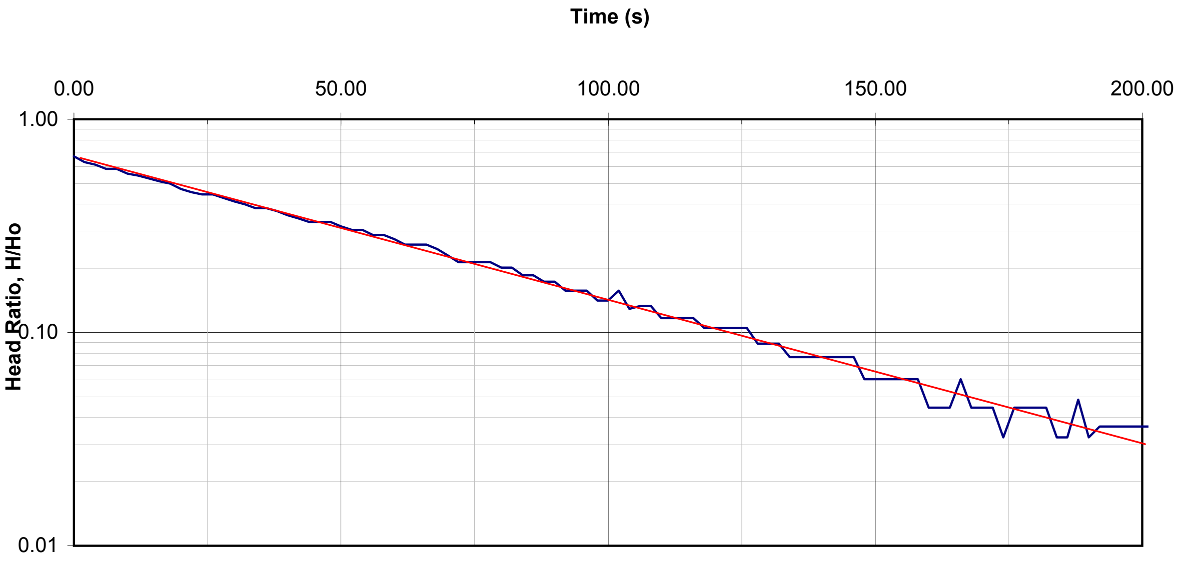
Shape factor F= $\frac{2 \times 3.14 \times L}{\ln(L/R)}$ = 5.701815 m

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

$\frac{\ln (H1/H2)}{(t2 - t1)}$ = 0.015105579

K= **5.2E-04** cm/s

**5.2E-06** m/s



## Falling Head Test (Slug Test)

| | | | |
|---|---|---|---|
| Test Date: | | 28-Jan-20 | |
| Piezometer/Well No.: | | BH/MW 5 | |
| Ground level: | | 139.30 | m |
| Screen top level: | | 136.20 | m |
| Screen bottom level: | | 133.20 | m |
| Test El. (at midpoint of screen): | | 134.70 | m |
| Test depth (at midpoint of screen): | | 4.6 | 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= | -0.043 | m |
| Initial water depth | | 3.66 | m |

Aquifer material: **Fine to coarse sand, Gravelly sand, Silty sand till**

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

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

$$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.010062072$$

K= **3.5E-04** cm/s
**3.5E-06** m/s