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A REPORT TO
HIGH LEVEL CONSTRUCTION LTD.

HYDROGEOLOGICAL STUDY

PROPOSED RESIDENTIAL DEVELOPMENT
3879 TOWN LINE

CITY OF ORILLIA

REFERENCE NO. 1606-W168

NOVEMBER 2017
(REVISION OF REPORT DATED APRIL 2017)

DISTRIBUTION

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1.0 EXECUTIVE SUMMARY

Soil Engineers Ltd. (SEL) conducted a Hydrogeological Study for a proposed development site located at 3879 Town Line, in the City of Orillia. Surrounding land use includes Town Line Road and agricultural properties to the west, residential properties to the north, residential properties and wooded areas which are situated to the east and south of the subject site.

The subject site is located within the physiographic region of Southern Ontario known as the Simcoe Lowlands, where the native surface geological soil unit consists of till deposits. The site is located within the Nottawasaga River Watershed and the Severn Sound subwatershed.

A review of the local topography shows that there is a gentle decline in grade to the northeast and the northwest, with an elevation relief of approximately 11 m.

Review of mapping records show that 3879 Town Line is wooded, and wooded areas are situated adjacent to the subject site. A seasonal tributary of the North River originates from the northwest corner of the site.

This study has disclosed that beneath a layer of topsoil, native soils underlying the subject site consist of sand, silty sand till, and sandy silt till.

The findings of this study confirm that local groundwater levels range from El. 258.99 to 268.23 masl and shallow groundwater flows in northeasterly and southwesterly directions from a groundwater mound located within the southern portion of the site.

The Single Well Response Tests (SWRT's) yielded estimated hydraulic conductivity (K) values ranging from 3.0×10^{-7} to 8.9×10^{-8} for the silty sand till and sandy silt till at the depths of the well screens. These results suggest that low groundwater seepage rates can be anticipated into open excavations below the water table.

The Hazen Equation calculated results indicates a K value of 6.76×10^{-6} m/sec for the sandy silt till and 1.60×10^{-7} m/sec for the sandy silt till. The K estimate determined from the Hazen equation suggests low to moderate hydraulic conductivity and associated seepage rates for groundwater bearing layers beneath the subject site.

Preliminary dewatering flow estimates for the site suggest that the dewatering flow rate for the site could reach a maximum of 12,691 L/day; by applying a safety factor of three, the dewatering flow rate could reach a maximum of 38,072 L/day for housing construction. These estimates are based on conventionally side sloped excavations.

The estimated zone of influence for dewatering could reach a maximum of 27 m from the conceptual dewatering alignment for proposed construction. Neighbouring residential properties and a seasonal tributary of the North River that originates on site are within the zone of influence of conceptual dewatering for the proposed development. The local groundwater flow pattern and surface flow in the tributary may be temporarily impacted during construction.

The anticipated long-term foundation drainage from both an under-slab basement floor drainage network and perimeter subdrains for side sloped excavations together give drainage flow estimates ranging from 0.13 L/day to 5,780 L/day respectively, by applying a safety factor of five, it could reach a maximum of 28,900 L/day.

MOECC water well records indicate that there are approximately 186 domestic supply wells drilled within a 500 m radius of the site. Well yields vary between 3,600 and 927,000 liters per day based on review of available well records. Most of the domestic wells are screened in the deeper aquifer at depths between 25 m and 62 m below grade, with only a few wells screened in the shallow aquifer.

The nitrate impact loading assessment modelled concentrations for nitrate at the hydraulically downgradient property boundary for 19 proposed lots is 13.07 mg/L based on use of conventional sewage system loading and is 8.07 mg/L for tertiary sewage loading. The maximum number of lots that can be accommodated using tertiary septic systems based on loading for sewage at 20 mg/L nitrate is 30. The predicted nitrate result based on use of a conventional sewage system loading exceeds the Ontario Drinking Water Standard of 10 mg/L. As such, use of tertiary sewage treatment is recommended for each proposed lot.

Proposed Low Impact Development measures being considered to maintain the pre-development water balance for the site after development should consider opportunities to re-infiltrate storm water into the shallow sands and till soils that are present on site. Some runoff can be redirected to the proposed storm water management pond located at the northeast corner of the site. Roof generated runoff should be considered for direction to any proposed low impact development infrastructure, such as soak away pits or a communal infiltration gallery.

2.0 INTRODUCTION

2.1 Project Description

In accordance with authorization from Mr. David Meeks, President of High Level Construction Ltd., Soil Engineers Ltd. (SEL) has conducted a Hydrogeological Assessment at 3879 Town Line, City of Orillia. The location of the site is shown on Drawing No. 1.

The subject site is located in a wooded area where the surrounding neighbouring areas consist of Town Line, Old Coldwater Road and Highway 12. Agricultural properties lie to the west, and residential properties are situated to the north, and residential properties and wooded areas are situated both east and south of the site. A residential development consisting of 19 lots has been proposed for the site.

This hydrogeological assessment summarizes the findings of the field study and associated groundwater monitoring and analysis program, and provides a description and characterization of the interpreted hydro-geostratigraphy for the site, with a preliminary assessment of construction- related and permanent dewatering needs prior to the detailed design. Further, the study will provide recommendations for implementation of any low impact development (LID) infrastructure to enhance infiltration and to maintain the pre-development water balance.

2.2 Project Objectives

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

1. Establish the hydrogeological setting of the site and the surrounding area in support of a proposed residential subdivision development;

2. Identify zones of higher groundwater yield as potential sources of ongoing shallow groundwater seepage;
3. Characterize the hydraulic conductivity (K) for groundwater-bearing soil strata;
4. Estimate the anticipated dewatering flows that may be required to lower the water table to facilitate construction, or for any permanent, long-term dewatering needs to facilitate foundation drainage after housing construction;
5. Evaluate potential impacts to groundwater receptors within the anticipated zone of influence; and to provide preliminary estimation of dewatering flow rates to lower the water table to facilitate excavation and construction and;
6. Evaluate potential impacts to groundwater receptors within the anticipated zone of influence;
7. Carry out a nutrient impact assessment to evaluate the attenuation capacity of the site to accommodate in-ground septic systems based on proposed lot level septic sewage systems.

2.3 **Scope of Work**

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

1. Installation of four (4) monitoring wells within the site’s development footprint;
2. Monitoring well development and groundwater level measurements at four (4) monitoring wells;
3. Performance of Single Well Response Tests (SWRTs) at the monitoring wells to estimate the hydraulic conductivity (K) for groundwater-bearing subsoil at the depths of the well screens;
4. Describing the geological and hydrogeological setting for the site and local area;

5. Review of available engineering development plans and profiles; and completion of preliminary calculations to estimate the anticipated dewatering flows necessary to lower the groundwater level for construction;
6. Review of MOECC water well records to develop recommendations on the potential to develop groundwater to supply individual wells to service proposed new housing.
7. Conducting a nutrient assessment using baseline levels of nitrate in shallow groundwater to assess the attenuation capacity of the site to accommodate lot level septic systems for the sewage servicing at the proposed new subdivision.

3.0 METHODOLOGY

3.1 Borehole Advancement and Monitoring Well Installation

The field work for the borehole drilling and monitoring well construction was performed on July 27 2016. It consisted of four (4) drilled boreholes (BH) and the installation of a monitoring well (MW); one in each of the boreholes, at the locations shown on Drawing No. 2.

The drilling and monitoring well construction were completed by a licensed contractor, DBW Drilling Limited, under the full-time supervision of a geotechnical technician from SEL, who also logged the soil strata encountered during borehole advancement and collected representative soil samples. The boreholes were drilled using continuous-flight power augers. The logs for the boreholes showing monitoring well construction details are presented on Figures 1 to 4, inclusive.

The monitoring wells were all constructed using 50 mm diameter PVC riser pipes and screens, and installed in the boreholes in accordance with Ontario Regulation (O. Reg.) 903. All monitoring wells were provided with monument type steel protective casings. The details for monitoring well construction are provided on the Borehole Logs.

The UTM coordinates and ground surface elevation at the borehole/monitoring well locations, together with the well 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)	Screen Interval (mbgs)	Casing Dia. (mm)
		East (m)	North (m)				
BH/MW 1	July 27, 2016	617849.5	4942409.9	268.59	6.3	3.1-6.1	50
BH/MW 2	July 27, 2016	618024.1	4942508.7	270.55	7.8	4.4-7.4	50
BH/MW 3	July 27, 2016	618193.7	4942615.5	264.19	6.3	2.9-5.9	50
BH/MW 4	July 27, 2016	618332.7	4942759.7	261.91	6.3	1.6-4.6	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 manually on August 5, 19 and 26, 2016.

3.3 Mapping of Ontario Water Well Records

SEL received the Ministry of Environment and Climate and Change (MOECC) 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 one hundred ninety-six (196) 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 test (SWRT) to estimate the hydraulic conductivity (K) for soil strata at the depths of the well screens. Well development involved the purging and removal of several casing volumes of groundwater from each 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 into the well screens, thereby improving the transmissivity of the soil formation at the well screen depths.

The K values derived from the SWRT's provide an indication of the groundwater yield capacity for the water-bearing strata and can be used to estimate the flow of groundwater through granular water-bearing soil 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 water 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 formation at the well screen depth. BH/MWs 1, 2, 3 and 4 underwent SWRT's on August 19, 2016. The test results are provided in Appendix 'B', with a summary of the results provided in Table 6-2.

3.5 **Estimating Hydraulic Conductivity based on Hazen Equation Method**

The Hazen equation estimation method was also used to estimate the hydraulic conductivity for saturated subsoils at the anticipated water level depths beneath the subject site. The method provides alternative hydraulic conductivity (K) estimates which are derived from the grain size diameter, whereby 10% by weight of the soil particles are finer and 90% are coarser (Freeze and Cherry, 1979).

3.6 **Review Summary of Previous Report**

The following report was reviewed in preparation of this hydrogeological study:

A Report to High Level Construction Ltd., a Soil Investigation for Residential Development, 3879 Town Line, City of Orillia, Reference No. 1606-S168, August 2016.

4.0 REGIONAL AND LOCAL SETTING

4.1 Regional Geology

The subject site lies within the physiographic region of Southern Ontario known as the Simcoe Lowlands. The area was flooded by the former glacial Lake Algonquin where the former lake is bordered by shore cliffs, beaches, and bouldery terraces. As such, the low area is floored by sand, silt, and clay (Chapman and Putnam, 1984). It covers an area of approximately 2850 square kilometers and lies at an elevation ranging from 177 to 259 masl. Remnant, physiographic landforms, including sand plains and beaches can also be found at the subject site.

Based on review of the surface geological map of Ontario, the subject site is located on till deposits, described as undifferentiated and consisting predominantly of sandy silt to silt matrix, commonly rich in clasts and often high in total matrix carbonate content. Drawing No. 4, reproduced from Ontario Geological Survey (OGS) mapping, illustrates the Quaternary surface soil geology for the area.

The bedrock elevation is at approximately 263-266 masl (Bedrock Topography of the Orr Lake Area, Southern Ontario, 1974), and consists of Middle Ordovician limestone, dolostone, shale, arkose and sandstone of the Ottawa Group, Simcoe Group and the Shadow Lake Formation (Ontario Ministry of Northern Department and Mines, 1991).

4.2 Physical Topography

A review of the topography shows that the subject site exhibits an undulating topography with a gradual decline in relief towards the northeast and north. Runoff from the site is expected to drain in north-eastern and northern directions. Based on the topographic map for the area and from review of the ground surface elevations at borehole and monitoring well locations, the elevation relief across the subject site is approximately 11 m. Drawing No. 5 shows the mapped topographic contours for the site.

4.3 **Watershed Setting**

The subject site is located within the Nottawasaga River Watershed and Severn Sound subwatershed, which are mapped as shown on Drawing No. 6. The Nottawasaga River watershed occupies an area of approximately 3,700 square kilometers, with the associated conservation authority having jurisdiction in 18 municipalities. This watershed is the source for watercourses that flow into Georgian Bay at Wasaga Beach, Collingwood and Severn Sound. The Severn Sound subwatershed consists of five main watercourses - Wye River, Hogg Creek, Sturgeon River, Coldwater River and North River - that discharge directly into Severn Sound between Midland and Coldwater (Nottawasaga Valley Conservation Authority, 2007).

4.4 **Local Surface Water and Natural Features**

The subject site is located in a densely-wooded area with related vegetation present on the ground surface. A seasonal tributary of the North River, originates northwest of the subject site. 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 a layer of topsoil, the native soils underlying the subject site consist of sand, silty sand till and sandy silt till. A Key Plan and the interpreted geological cross-section along a northeast to southwest transect is presented on Drawing No. 8.

5.1 **Topsoil** (All BH/MWs)

Topsoil, 20 to 25 cm thick, was observed at the ground surface at all BH/MW locations. It is dark in colour and exhibits appreciable amounts of roots and humus.

5.2 **Sand** (BH/MWs 1, 3 and 4)

A sand unit, 0.5 to 1.1 m thick was encountered immediately beneath the topsoil at BH/MW 1, 3 and 4. It is brown in colour, is fine to medium grained, has a loose texture and is weathered. The water content for the unit ranges from 4% to 12%, indicating damp to moist conditions.

5.3 **Silty Sand Till** (All BH/MWs)

A layer of silty sand till, 2.2 to 2.7 m thick was found at all the BH/MW locations. It is brown in colour, has some clay, gravel, occasional sand and silt seams and layers, cobbles and boulders with occasional sand pockets. The moisture content for the unit ranges from 8% to 30%, indicating moist to saturated conditions. The estimated permeability for the sand seam within the till layer at a depth of 3.2 mbgs is about 10^{-3} cm/sec. A grain size analysis was performed on one (1) sample, and the gradation is plotted on Figure 4.

5.4 **Sandy Silt Till** (All BH/MWs)

Sandy silt till was encountered at all the BH/MWs extending to the maximum investigated depth of 7.8 m. It is brown to grey in colour, very dense with a trace of clay, gravel and has occasional cobbles and boulders. The thickness of the layer ranges from 2.6 to 4.9 m, with moisture content ranging from 5% to 14%, indicating damp to moist conditions.

6.0 GROUNDWATER STUDY

6.1 Review of Previous and Concurrent Reports

A review of the findings of the previous soil investigation report (SEL Reference No. 1606-S168) indicates that beneath the layer of topsoil, the site is underlain by sand, silty sand till and sandy silt till extending to the maximum investigated depth of 7.8 mbgs.

Based on this report, groundwater seepage was encountered in all the boreholes where the water levels were measured within the open boreholes at depths of 1.9 to 3.1 mbgs, upon completion of the drilling.

6.2 Review of Ontario Water Well Records

The Ministry of Environment and Climate Change (MOECC) water well records (WWRs) 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 one hundred ninety-six (196) wells are located within the study area. The locations of these wells, based on the UTM coordinates provided by the well records, are shown on Drawing No 3. A detailed summary of the MOECC WWRs reviewed is provided in Appendix ‘A’.

A review of the final status of the wells within the study area reveals that one hundred ninety-two (192) wells are registered as water supply wells, and four (4) wells are registered as abandoned wells.

A review of the first status of the wells shows that one hundred eighty-six (186) wells are registered as domestic wells, two (2) are livestock wells, five (5) are public supply wells, two (2) wells are listed as not being used and one (1) well is listed as having an unknown status.

Most of the records for water supply wells in the area, indicate that they are screened between 25 m and 62 m below grade, with only a few wells screened in the shallow aquifer at depths of 9 to 15 m below grade.

6.3 Groundwater Monitoring

The groundwater level in the monitoring wells was measured on three occasions over the period from August 5 to August 26, 2016, to record the fluctuation of the groundwater table beneath the site. The water levels and corresponding elevations are summarized in Table 6-1.

Table 6-1 - Water Level Measurements

Well ID		August 5, 2016	August 19, 2016	August 26, 2016	Average Elevation	Fluctuation (m)
BH/MW 1	mbgs	1.31	0.95	1.00	1.09	0.36
	masl	267.28	267.64	267.59	267.50	
BH/MW 2	mbgs	3.10	2.32	2.76	2.73	0.78
	masl	267.45	268.23	267.79	267.82	
BH/MW 3	mbgs	2.63	3.03	3.08	2.91	0.45
	masl	261.56	261.16	261.11	261.28	
BH/MW 4	mbgs	2.32	2.85	2.92	2.70	0.60
	masl	259.59	259.06	258.99	259.21	

Notes:

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

As shown above, the groundwater levels at BH/MW 1 and BH/MW 2 fluctuated where the groundwater level increased between August 5 and August 19, and decreased between August 19 and August 26, 2016. The groundwater levels at BH/MW 3 and BH/MW 4 exhibited a consistent decline throughout the monitoring period. The average measured groundwater levels were also interpreted to illustrate the horizontal flow patterns for shallow groundwater across the site, as illustrated on Drawing No. 9.

6.4 Single Well Response Test Analysis

All monitoring wells underwent single well response tests (SWRTs) to assess the hydraulic conductivity (K) for saturated aquifer soils at the depths of the well screens. The results of the SWRT analysis are presented in Appendix ‘B’, with a summary of the findings provided 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	268.59	6.1	6.3	3.1-6.1	Sandy Silt, Till	$3.0x10^{-7}$
BH/MW 2	270.55	7.4	7.8	4.4-7.4	Sandy Silt, Till	$8.9x10^{-8}$
BH/MW 3	264.19	5.9	6.3	2.9-5.9	Silty Sand, Till, Sandy Silt, Till	$4.7x10^{-7}$
BH/MW 4	261.91	4.6	6.3	1.6-4.6	Silty Sand, Till, Sandy Silt, Till	$5.7x10^{-7}$

Notes:

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

As shown above, the K values range from 3.0×10^{-7} to 8.9×10^{-8} m/s. The results of the SWRT provide an indication of the yield capacity for the shallow groundwater-bearing 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 correspondingly low anticipated groundwater seepage rates.

6.5 Assessment of Hydraulic Conductivity based on Hazen Equation

The Hazen Equation method was adopted to estimate the hydraulic conductivity (K) for different soil layers which may contain groundwater during the seasonal high water table spring period, or if encountered within the services excavations. These layers are primarily above the well screen depths.

The Hazen equation relies on the interrelationship between hydraulic conductivity and effective grain size diameter, d_{10}, in the soil media. This empirical relation predicts a power-law relation with K, as follow:

$$\boldsymbol{K = Ad_{10}^{2}}$$

where;

d_{10}: Value of the grain size gradation curve as determined by sieve analysis, whereby 10% by weight of the soil particles are finer and 90% by weight of the soil particles are coarser.

A: Coefficient; it is equal to 1 when K in cm/sec and d_{10} is in mm

The Hazen Equation results provide an indication of the yield capacity for groundwater-bearing strata at the vicinity and the depths where the soils samples were collected for grain size analysis. The calculated result indicates that the K value estimate for analysed soil ranges from 6.76×10^{-6} m/sec for the sand seam within the silty sand, till unit retrieved from a depth of 3.2 m (El. 258.71 masl) at BH/MW 4 to 1.6×10^{-7} m/sec for the sandy silt till unit for the sample retrieved from a depth of 2.5 mbgs (El. 268.05 masl) at BH/MW2. The K estimate determined from the Hazen method suggests low to moderate hydraulic conductivity for groundwater bearing soil layers beneath the subject site, primarily for shallow soil strata above the prevailing water table which may exhibit perched groundwater conditions.

6.6 **Shallow Groundwater Flow Pattern**

The shallow groundwater flow pattern was interpreted from the average for groundwater levels measured at BH/MWs 1, 2, 3 and 4, suggesting that groundwater flows in a northeasterly and southwesterly direction from a groundwater mound located at the southern section of the site. The interpreted shallow groundwater flow pattern for the site area is illustrated on Drawing No. 9.

It should be noted that, locally, shallow groundwater flow mimics the topographic relief across the subject site.

7.0 GROUNDWATER CONTROL DURING CONSTRUCTION

The estimated hydraulic conductivity (K) suggests that groundwater seepage rates into excavations below the groundwater table will be low to moderate. To provide safe, dry and stable conditions for excavations and construction of the proposed housing basements, the water table will need to be lowered in advance of, or during construction. Preliminary estimates for construction dewatering flow required to locally lower the water table, based on the K test results, are discussed in the following section.

7.1 Groundwater Construction Dewatering Rates

Development plans showing the depths of the proposed underground housing structures and servicing depths were not available for review at the time of report preparation. However, it is understood that the proposed residential development will include a basement structure to a proposed excavation depth of about 2.54 m below grade. The size of the development is approximately 9.71 hectares with lot sizes varying from 4,000.8 m^2 to 4,144.8 m^2. Excavation is also anticipated to construct the storm water management pond at Block 1.

The elevation of the proposed residential lots ranges between 263.5 masl and 272.5 masl. Because of the differences in site elevation, the dewatering calculation assessment utilizes an average surface elevation of 264 masl for sections of the site which lie at low elevations, an elevation of 268 masl for site sections at the average site elevation and an elevation of 271 masl was considered for site sections that are at higher elevation. The average surface elevation at low elevations was also used to evaluate the dewatering needs for the storm water management pond. The details for each portion of the site are discussed in the following sections:

Sections of site at an elevation of 264 masl:

For site sections, which lie at low elevation, the grading plan elevation is estimated at 264 masl. The proposed lowest excavation depth is 261.46. To facilitate excavation and construction in dry and stable subsoil conditions, it is proposed that the water table be lowered to an elevation of 260.46 masl, which is about 1 m below the lowest proposed excavation depth. The subsoil comprises silty sand and till to the maximum proposed depth of excavation. Comparison of the proposed lowest excavation depth with the highest measured water level indicates that the proposed excavation elevation is about 0.1 m below the highest shallow groundwater level elevation of 261.56 masl as measured at the BH/MW 3 location and with anticipated water table lowered by one additional meter, it is anticipated that construction dewatering will be required for construction of these sections of the development.

Assuming an approximate rectangular excavation for an average lot size of approximately 4,058 m^2 with a house size of approximately 1,623 m^2 having a perimeter of about 161 m, the dewatering flow rate could reach an estimated maximum rate of 3,242 L/day. By applying a safety factor of three, the dewatering flow rate could reach a maximum of 9,727 L/day.

Storm water management pond:

For construction of the storm water pond, the grading plan elevation is based on an elevation of 263 masl with an anticipated depth of 2 m below grade. The lowest excavation depth was estimated at 261 masl. The subsoil is comprised of loose sand at the proposed excavation depth. Comparison of the proposed lowest excavation depth with the highest measured water level indicates that the proposed excavation elevation is about 1.41 m above the highest shallow groundwater level elevation of 259.59 masl as measured at the BH/MW 4 location, therefore it is anticipated that construction dewatering will not be required for the construction of the proposed SWM Pond.

Sections of site at an elevation of 268 masl:

For sections, which lie at average elevation, the grading plan elevation was based on an elevation of 268 masl. The proposed lowest excavation depth is 265.46 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 264.46 masl, which is about 1 m below the lowest proposed excavation depth. The subsoil comprises sandy silt till to the maximum proposed depth of excavation. Comparison of the proposed lowest excavation depth with lots in close proximity to BH/MW 1 location, indicate that the highest shallow groundwater level elevation of 267.64 masl is 3.2 m above the proposed excavation elevation of 265.46 m and for lots in close proximity to BH/MW 2 location, the highest shallow groundwater level elevation of 268.23 masl which is 3.8 m above the proposed excavation depth. Based on this, it is anticipated that construction dewatering will be required for construction of these sections of the development.

Assuming an approximate rectangular excavation for an average lot size of approximately 4,058 m^2 with a house size of approximately 1,623 m^2 having a perimeter of about 161 m, the dewatering flow rates range from 11,148 L/day to a maximum rate of 11,768 L/day. By applying a factor of safety of three, the dewatering flow rates could range from 33,445 L/day to 35,303 L/day.

Sections of site at an elevation of 271 masl:

For sections of the site which are at higher elevation, the grading plan elevation was considered at an elevation of 271 masl. The proposed lowest excavation depth is 268.46 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 267.46 masl, which is about 1 m below the lowest proposed excavation depth. The subsoil comprises sandy silt, till to the maximum depth of proposed excavation. Comparison of the proposed lowest excavation depth with the highest measured water level indicates that the proposed excavation elevation is about 0.23 m above the highest shallow groundwater level elevation of 268.23 masl as measured at the BH/MW 2 location and to maintain the water level about 1.0 m below the lowest proposed excavation, it is anticipated that minor construction dewatering will be required for construction of these sections of the development.

Assuming an approximate rectangular excavation for an average lot size of approximately 4,058 m^2 with a house size of approximately 1,623 m^2 having a perimeter of about 161 m, the temporary dewatering flow rate could reach an estimated maximum rate of 12,690 L/day. By applying a safety factor of three, the dewatering flow rate could reach a maximum of 38,072 L/day.

The calculated flow rates may only occur at the beginning of the dewatering process, and include any rapid removal of runoff following a high intensity storm. It is anticipated that, following localized lowering of the water table, groundwater seepage removed via dewatering from the open excavation will be a fraction of the above estimate since much of the groundwater in the proposed development area will have been removed from local storage. Further, upon excavation, the perched groundwater within the shallow soil horizons is expected to dissipate relatively quickly. If construction is completed during the dry season (Summer), there may only be minimal construction dewatering required as perched groundwater conditions may not be present during the dry season.

7.2 **Groundwater Control Methodology**

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

The dewatering estimates should be revised once the available plans and profiles for the site have been finalized and are available for review.

7.3 Mitigation of Potential Impacts Associated with Dewatering

The zone of influence for dewatering for the areas of the development which lie at the low average surface elevation of 264 masl, could reach a maximum of 24 m from the dewatering wells, for areas at an average surface elevation of 268 masl it could reach a maximum of 27m and for areas at higher surface elevation of 271 masl it could reach a maximum of 24 m from the sumps or dewatering wells. There is a seasonal surface water feature that originates from the northwestern part of the site which could be temporarily impacted by dewatering activities. In addition, several residential properties are within the zone of influence and may be affected by potential ground settlement associated with dewatering. A geotechnical engineer should be consulted to review potential ground settlement concerns prior to construction.

7.4 Permanent Drainage for Underground Structures

Based on the conceptual plan for the development, a single detached house having a conventional basement will be constructed on each lot. The calculations for permanent drainage are based on an average house size of 1,623 m^2 having a perimeter of about 161 m. For lots at average elevation, the shallow groundwater is about 2.77 m above the proposed basement floor elevation.

Given the low groundwater seepage rate estimates for long-term foundation drainage, conventionally side sloped excavations can be completed for the proposed house basements. Conventional perimeter footings drains can be included for the house footings along with a simple basement under-slab drainage network to address any long-term seepage to the excavation and underground basement structures. These systems can be drained to independent sump pits, one for the perimeter drains and one for the under-slab network.

As an alternative to foundation drainage and perimeter drainage networks, the option exists to raise the site grades prior to construction.

In order to estimate the long-term dewatering needs for the foundation drainage and perimeter drainage network at the subject site, Darcy’s Equation was used, as described below:

Lots at an average elevation of 268 masl:

$$Q = KiA$$

Where:

Q = Estimated dewatering flow rate (m^3/day)

K = 3.0×10^{-7} m/sec (highest hydraulic conductivity (K) assessed for silty sand till and sandy silt till encountered during the study)

A = 445.97 m^2 for the Mira Drain foundation walls and 0.25 m^2 for the under-slab floor drainage network, which are the approximate areas used to estimate groundwater seepage below the water table (cross-sectional area of flow) (m).

iv = 0.019 [unitless], Vertical Hydraulic Gradient for groundwater considered for the under-slab floor basement drainage system

ih = 0.50 [unitless], Horizontal Hydraulic Gradient for groundwater considered for the perimeter foundation drainage system

Based on the proposed housing basement structure, the long-term drainage flow rate for the perimeter foundation drainage network for a conventionally side sloped excavation is 5,780 L/day. The long-term average drainage flow for the under-slab basement floor drainage network is 0.13 L/day. The combined long-term drainage flow rate for both the perimeter drainage weeper and the under-slab basement floor drainage is estimated at 5,780.13 L/day. Applying a safety factor of 5, the combined drainage flow rate is estimated at 28,900 L/day.

The sump pit and pump systems should be designed for the maximum expected flow rate. The drainage piping should be properly constructed using weepers surrounded by filter cloth, in turn surrounded by bedding stone or concrete sand to minimize loss of fines. Over time, the foundation drainage flow for the underground basement structure may diminish to a lower or possibly negligible steady state rate, but more likely to a low steady state rate that will remain relatively constant over time. It is recommended that the long-term seepage drainage estimations be revised, if any required based on final development and grading plans, once they become available for review.

7.5 **Ground Settlement**

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

8.0 POTENTIAL WATER SUPPLY EVALUATION

Hydrogeological investigation indicates the presence of a shallow silty sand till and a sandy silt till aquifer which underlies the subject site. MOECC water well records indicate that this aquifer is underlain by a low permeability clay layer which is approximately 27 to 47 m thick. This clay layer is in turn underlain by a sand layer which is approximately 2 m to 6 m thick. This lower sand layer is the main aquifer in the area. The well records indicate that there are approximately 186 supply wells drilled within a 500 m radius of the site. Well depths are between 5.5 m and 86 m and fresh water was encountered at depths varying between 1.83 m and 86 m. Well yield varied between 3,600 and 927,000 liters per day.

Interpretation of the lithology of the MOECC water well records indicate that the water in the deep sandy aquifer is confined by the overlying low permeability clay layer. The groundwater below the confining layer is under sub-pressure and when penetrated by wells the water rises above the top of the aquifer. This rise in water level was observed in all of the supply wells drilled within the aquifer in the vicinity of the subject site.

Most domestic water wells are screened between 25 m and 62 m below grade, suggesting that plentiful well yields can be developed for wells in this depth range.

Given that the area is located in a similar hydrogeological setting, it is anticipated that a similar groundwater yield will be achieved if a domestic supply well were to be drilled to similar depths within the confined sand aquifer.

9.0 NUTRIENT LOADING IMPACT

9.1 Reasonable Use Criteria

Nitrate-nitrogen is considered the critical contaminant in this model and is considered a conservative anion which it is not adsorbed by soil in the subsurface, nor does it degrade quickly in a groundwater environment. The maximum permitted nitrate level at the hydraulically downgradient property boundary is 10 mg/L (based on the Ontario Drinking Water Objectives for nitrate).

The background concentration for nitrate adopted from the site's up-gradient property boundary was 3.0 mg/L. The up-gradient background nitrate concentration in groundwater was incorporated into the mass balance loading assessment as an additional to the modelled concentration for the predicted Nitrate based on proposed number of lots and site area for attenuation in order to maintain a conservative approach for the prediction.

9.2 Nitrate Loading Mass Balance

A mass balance assessment was conducted for nitrate to determine the anticipated concentration that can be predicted at the hydraulically down gradient property boundary based on establishment of 19 lots each serviced by individual on-site septic sewage systems. The assessment assumes natural attenuation for nitrate in shallow groundwater through dilution from the input of precipitation recharge to groundwater and from sewage system loading from the proposed established homes.

A monthly water balance model (the Thornthwaithe water-balance program) provided by the U.S. Geological Survey (USGS, 2007) was used to determine the average infiltration rate at the subject site. Long term precipitation data was collected from the

Canadian Climate Normals between 1981 and 2010 from the Government of Canada website for the Shant Bay weather station (Climate ID No. 6117684). The approximate infiltration rate for the subject site was determined based on the 30-year climate normal for precipitation, as presented in Appendix ‘C’, pages 1 to 3. A mass balance calculation was conducted for nitrate at the subject site which is based on use of both conventional and tertiary treatment for sewage effluent input to septic leaching beds, with the concentration of nitrate loading to groundwater set at 40 mg/L for conventional effluent treatment and at 20 mg/L for tertiary effluent treatment, respectively. The mass balance calculation is provided in Appendix ‘C’, pages 1, 2 and 3 with the expression defined below.

$$C_{pb} = [(Ci \text{ x } Vi) + (Cs \text{ x} Vs)]/[Vi + Vs]$$

Where:

Ci = concentration of nitrate in precipitation, taken at 0.1 mg/L

Vi= Annual volume of recharge (i.e. Site Area less impervious surfaces x annual infiltration rate (litres))

Cs = Nitrate concentration in sewage set at 40 mg/L for conventional septic systems and at 20 mg/l for septic systems having tertiary treatment

Vs = Volume of sewage x No. of proposed lots, where 1100 litres/day of sewage is taken for estate lots where 19 lots are proposed.

Cpb = Concentration modeled for the property boundary based on the mass balance approach

Based on the mass balance calculation, the nitrate concentration assessed for the down gradient property boundary is 8.07 mg/L based on use of tertiary sewage systems loading, and it is 13.07 mg/L for conventional sewage systems loading. These values include the 3.0 mg/L Nitrate for the upgradient background concentration added to the assessed Nitrate concentration at the downgradient property boundary. The predicted nitrate based on use of 20 mg/L standard tertiary treatment loading for the 19 proposed lots is 5.07 mg/L; by applying the 3.0 mg/L nitrate as a background, it could reach to 8.07 mg/L. As such, the predicted result is below the Ontario Drinking Water Standard of 10 mg/L limits (Appendix ‘C’, page 1). Based on the assessment, however up to 30 proposed lots could be accommodated based on use of tertiary septic system loading (Appendix ‘C’, page 3) even though only 19 lots have been proposed. For this assessment, additional dilution from assessed groundwater underflow beneath the site has not been considered for the assessment, so the results are considered a conservative evaluation.

Proposed LID measures should be considered for the moderate to high permeability of the existing surface soil, comprised of sand and silty sand till having moderate to high infiltration to the subsurface. Based on the location of the subject site and type of the soils coverage of the entire subject site, the collection of roof top runoff for reinfiltration at the surface to recharge shallow groundwater is recommended; however, applying the same process for runoff collected from driveways and streets is not suggested to avoid infiltration of runoff impacted by deicing salt

10.0 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 Simcoe Lowlands.
2. The surface soil consists of predominantly sandy silt to silt matrix, commonly rich in clasts and often high in total matrix carbonate content.
3. The subject site exhibits a decline in relief towards the northeast and northwest portion of the site with a total elevation relief of about 11 m.
4. The site is located within the Nottawasaga River Watershed and the Severn Sound subwatershed.
5. A seasonal tributary of the North River originates from the northwest portion of the site. The main branch of the North River is situated approximately 300 m north of the site.
6. This study has disclosed that beneath a layer of topsoil, sand, silty sand, till and sandy silt till underlie the subject site.
7. The groundwater level at the time of the study ranged from El. 258.99 to El. 268.23 masl. The shallow groundwater levels represent locally perched groundwater within the sandy silt, till horizons.
8. The findings of this study confirm that local groundwater levels range from El. 258.99 to 268.23 masl and that shallow groundwater flows in a northeasterly and southwesterly direction away from an interpreted groundwater mound located within the southern portion of the site.
9. The single well response tests yielded estimated hydraulic conductivity (K) values ranging from 3.0×10^{-7} m/sec to 8.9×10^{-8} m/sec for the sandy silt till and the silty sand till at the depths of the well screens. These results suggest

that low groundwater seepage rates can be anticipated into open excavations below the water table. Any seepage that is encountered is expected to dissipate shortly after excavation commences.

10. The Hazen Equation calculated results indicates a K estimate of 6.76×10^{-6} m/sec for the sandy silt till and 1.60×10^{-7} m/sec for the sandy silt till. The K estimate determined from the Hazen equation suggests low to moderate hydraulic conductivity for groundwater bearing layers beneath the subject site.
11. The preliminary dewatering estimation suggests that the construction dewatering flow rate could reach a maximum of 12,691 L/day, and by applying a safety factor of three, the dewatering rate could reach a maximum of 38,072 L/day. Depending on the season of earthworks, dewatering many not be realized due to seasonal low water table during summer and early fall.
12. The anticipated zone of influence for a dewatering array to lower the water table to facilitate underground basement structure construction could reach a maximum of 27 m from the dewatering wells. There are adjacent residential properties and a watercourse that are within the conceptual zone of influence for dewatering.
13. The anticipated long-term foundation drainage from both an under-slab floor drainage network and a perimeter foundation sub drainage network for a conventionally sloped excavation together give flow estimates ranging from 0.13 L/day to 5,780 L/day, by applying a safety factor of five, it could reach a maximum of 28,900 L/day.
14. Proposed monitoring for any construction dewatering program should include periodic effluent water quality monitoring to verify that it meets the City of Orillia Storm or Sanitary Sewer use Discharge by-law requirements.
15. MOECC water well records indicate that there are approximately 186 domestic supply wells drilled within a 500 m radius of the site development.

Well yields for these wells varies between 3,600 and 927,000 liters per day. Most domestic wells are screened in the depth range of between 25 m and 62 m below the prevailing grade.

16. Based on the mass balance calculation for the 19 proposed lots, the nitrate concentration assessed for the downgradient property boundary is 13.07 mg/L based on use of conventional sewage system loading and it is 8.07 mg/L for use of tertiary treatment sewage system loading from individual septic systems at each proposed lot. The maximum number of lots that can be accommodated using tertiary treatment system loading, at 20 mg/L nitrate is 30. For conventional sewage system loading, the predicted result exceeds the Ontario Drinking Water Standard of 10 mg/L. For this assessment, additional dilution from groundwater underflow beneath the site has not been considered, so the results are considered a conservative evaluation.
17. Proposed LID measures to maintain the pre-development water balance for the post-development site should consider opportunities to re-infiltrate storm water into the shallow sand and silty sand till soils encountered on site. Excess runoff can be directed to the proposed storm water management pond located at the northeast corner of the site.
18. It is recommended that seasonal groundwater levels be measured to confirm the spring high groundwater levels for the site.
19. It is recommended that consideration be given to raising site grades to maintain proposed house basements above the anticipated high groundwater table. Proposed on-site septic sewage systems should consider the

construction of raised effluent leaching beds to allow for sewage leaching and associate effluent bacterial breakdown above the high groundwater table.

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11.0 REFERENCES

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FIGURES 1 to 4

BOREHOLE AND MONITORING WELL LOGS

REFERENCE NO. 1606-W168

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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Job Number: 1606-W168

LOG OF BOREHOLE NO.: BH/MW 1

Figure No.: 1

Project Description: Proposed Residential Development

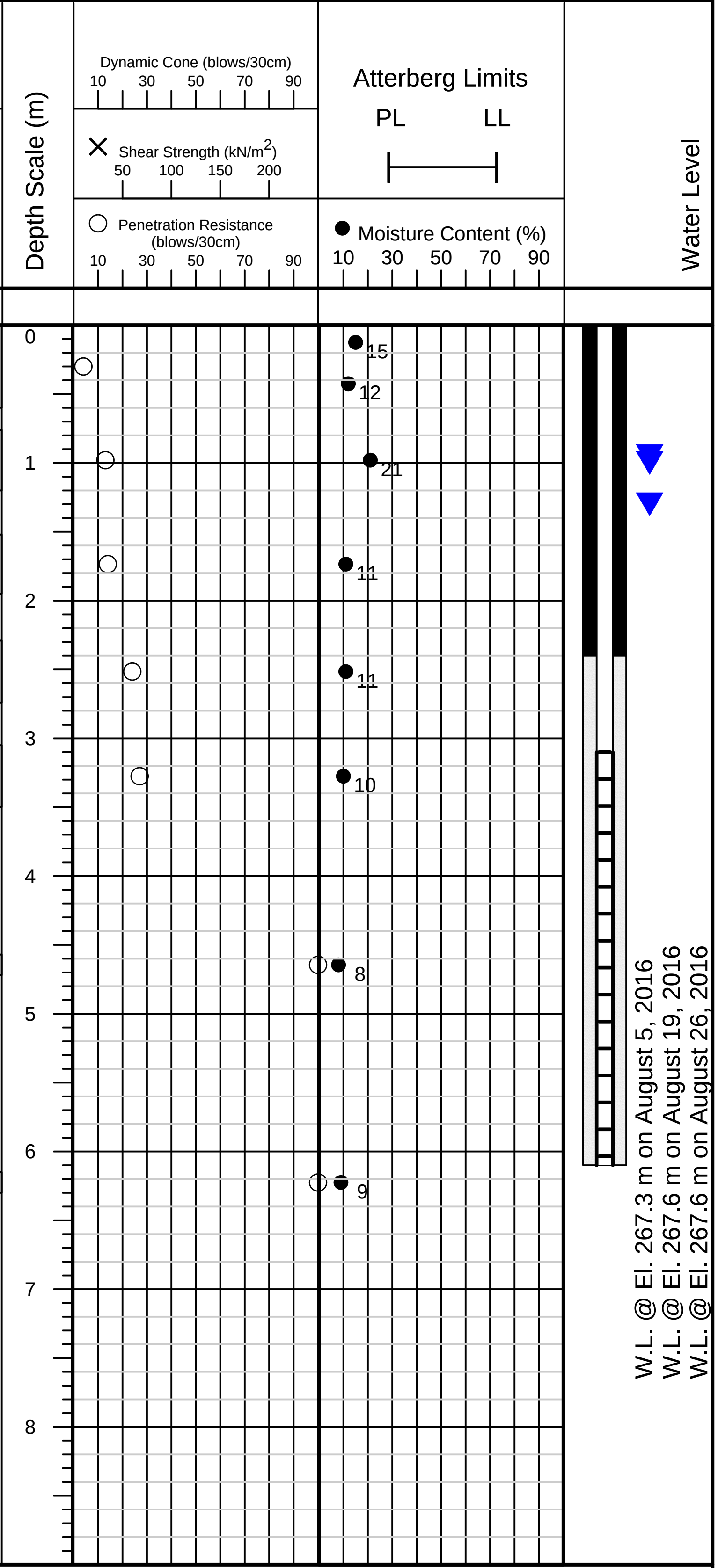
Job Location: 3879 Town Line, City of Orillia

Method of Boring: Flight-Auger

Drilling Date: July 19, 2016

Elev. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
268.6	Ground Surface			
0.0	25 cm TOPSOIL	1A	DO	4
	Brown, very loose **SAND** fine grained	1B		
267.9 0.7	Brown, compact SILTY SAND, Till a trace to some clay some gravel occ. sand and silt seams and layers, cobbles and boulders occ. sand pockets	2	DO	13
		3	DO	14
		4	DO	24
265.7 2.9	boulder	5	DO	27
	Brown, compact to very dense SANDY SILT, Till a trace of clay and gravel occ. cobbles and boulders	6	DO	100
		7	DO	100
262.3 6.3	End of Borehole			

Installed 50 mm dia. monitoring well to 6.1 m (3.0 m screen). Sand backfill from 2.4 m to 6.1 m. Bentonite seal from 0 to 2.4 m. Provided with steel monument casing.



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Job Number: 1606-W168

LOG OF BOREHOLE NO.: BH/MW 2

Figure No.: 2

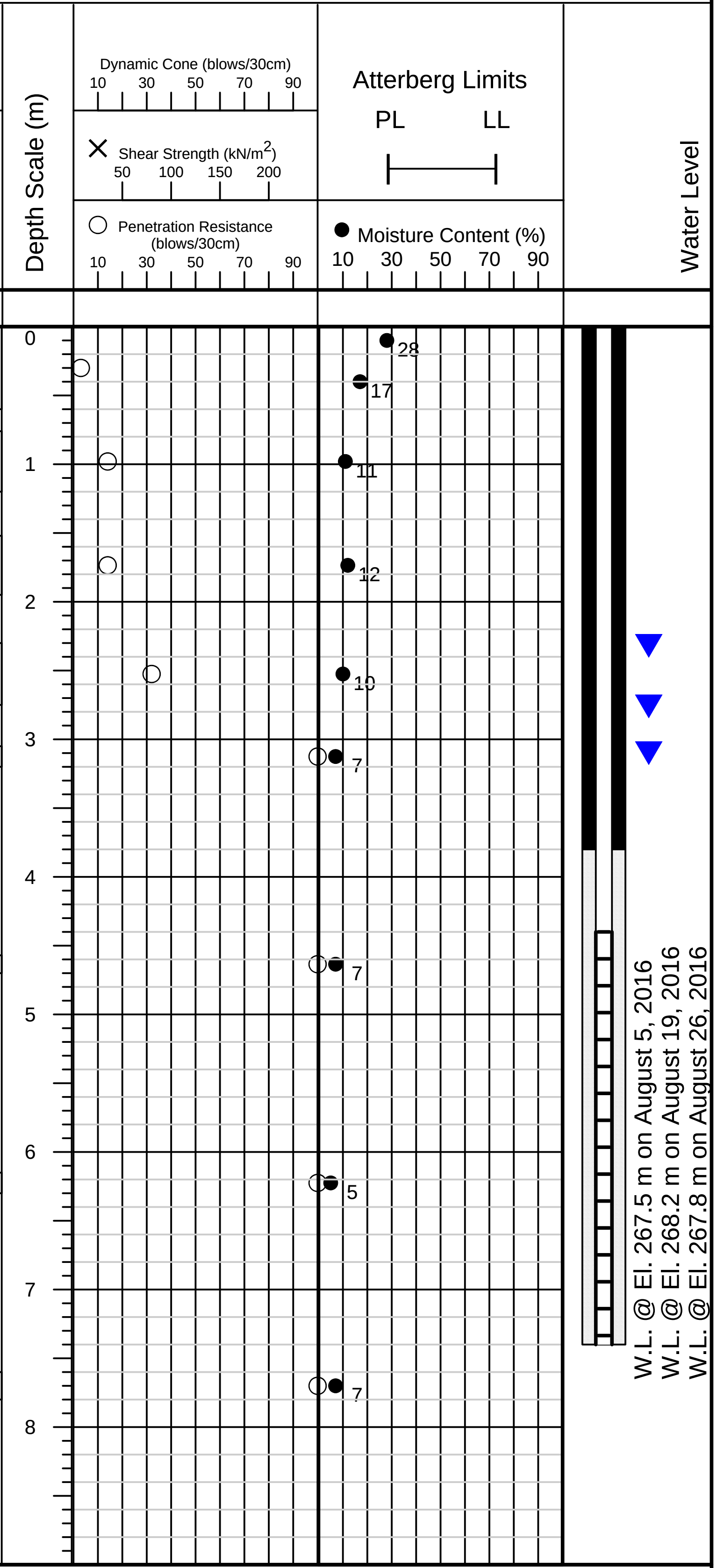
Project Description: Proposed Residential Development

Job Location: 3879 Town Line, City of Orillia

Method of Boring: Flight-Auger

Drilling Date: July 19, 2016

Elev. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
270.6	Ground Surface			
0.0	20 cm TOPSOIL	1A 1B	DO	3
	Brown, very loose to dense SILTY SAND, Till a trace to some clay some gravel occ. sand and silt seams and layers, cobbles and boulders occ. sand pockets	2	DO	14
		3	DO	14
		4	DO	32
267.7 2.9	sand and rock fragments	5	DO	100
	Very dense SANDY SILT, Till a trace of clay and gravel occ. cobbles and boulders	6	DO	100
	brown grey	7	DO	100
		8	DO	100
262.8 7.8	End of Borehole Installed 50 mm dia. monitoring well to 7.4 m (3.0 m screen). Sand backfill from 3.8 m to 6.1 m. Bentonite seal from 0 to 3.8 m. Provided with steel monumount casing.			



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Job Number: 1606-W168

LOG OF BOREHOLE NO.: BH/MW 3

Figure No.: 3

Project Description: Proposed Residential Development

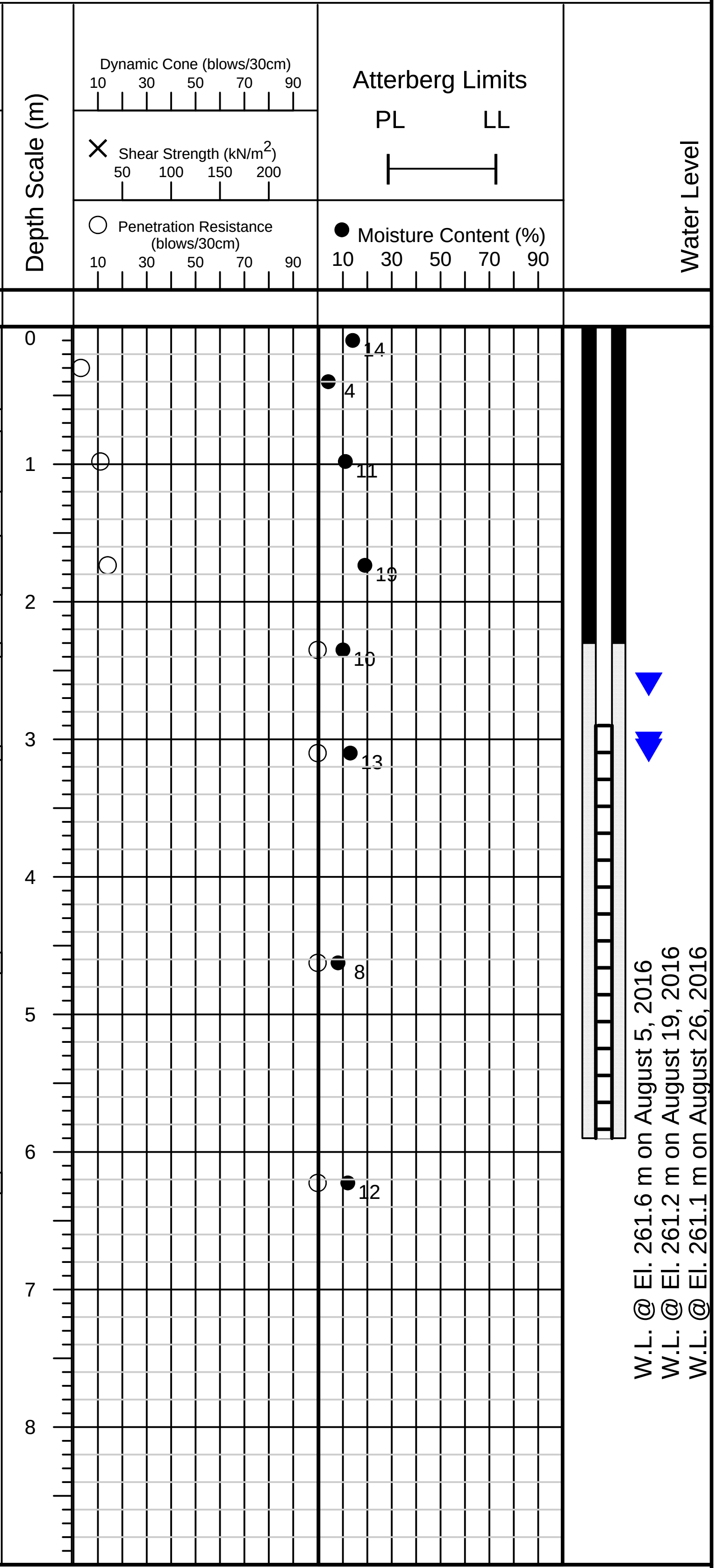
Job Location: 3879 Town Line, City of Orillia

Method of Boring: Flight-Auger

Drilling Date: July 19, 2016

Elev. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
264.2	Ground Surface			
0.0	20 cm TOPSOIL	1A	DO	3
	Brown, very loose SAND, fine grained	1B		
263.5 0.7	Brown, compact to very dense SILTY SAND, Till a trace to some clay some gravel occ. sand and silt seams and layers, cobbles and boulders occ. sand pockets	2	DO	11
		3	DO	14
		4	DO	100
	boulder			
261.3 2.9		5	DO	100
	brown grey			
	Very dense SANDY SILT, Till a trace of clay and gravel occ. cobbles and boulders	6	DO	100
		7	DO	100
257.9 6.3	End of Borehole			

Installed 50 mm dia. monitoring well to 5.9 m (3.0 m screen). Sand backfill from 2.3 m to 5.9 m. Bentonite seal from 0 to 2.3 m. Provided with steel monument casing.



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Job Number: 1606-W168

LOG OF BOREHOLE NO.: BH/MW 4

Figure No.: 4

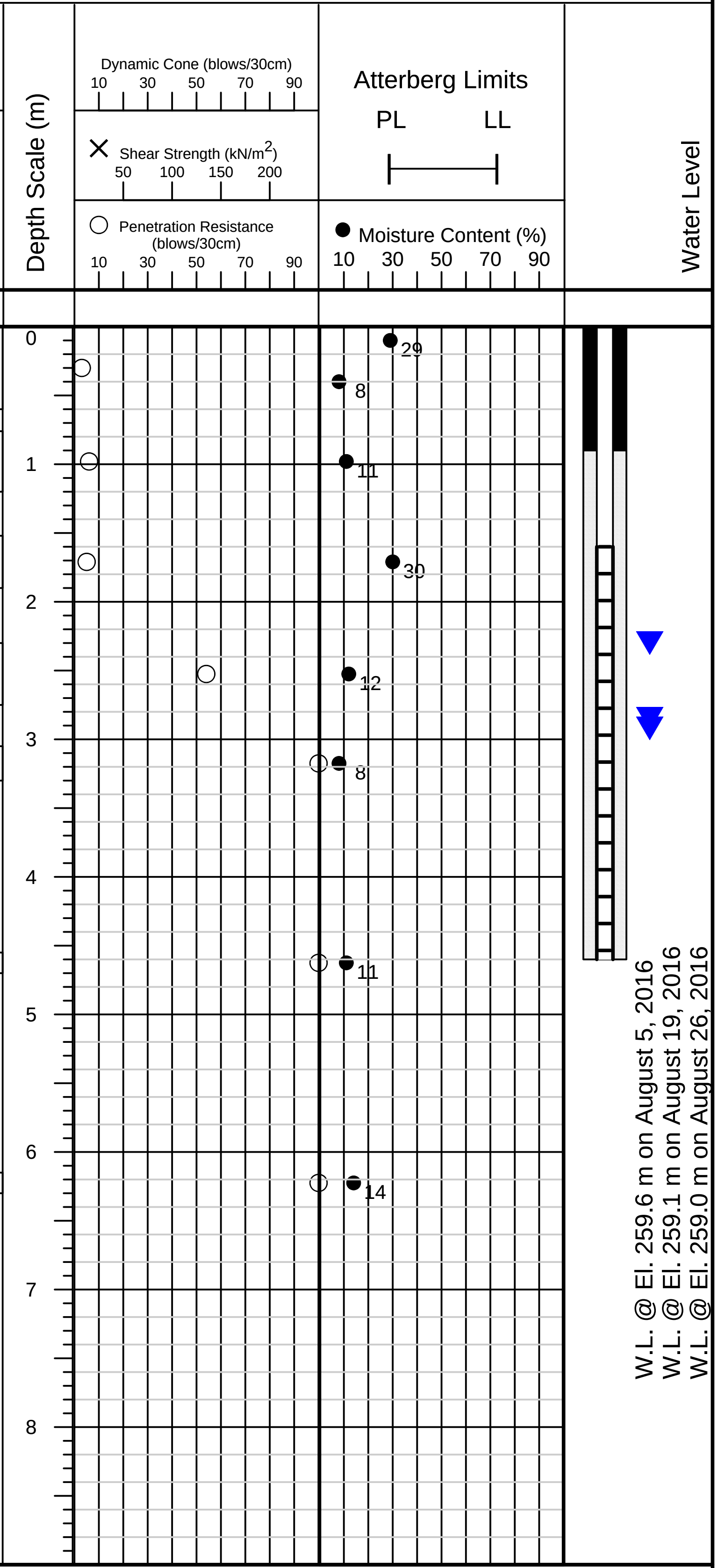
Project Description: Proposed Residential Development

Job Location: 3879 Town Line, City of Orillia

Method of Boring: Flight-Auger

Drilling Date: July 19, 2016

Elev. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
261.9	Ground Surface			
0.0	20 cm TOPSOIL Brown, very loose to loose SAND fine grained above 0.7 m, fine to coarse grained below 0.7 m	1A 1B	DO	3
		2	DO	6
260.6 1.3	weathered Brown, loose to very dense SILTY SAND, Till a trace to some clay some gravel occ. sand and silt seams and layers, cobbles and boulders occ. sand pockets	3	DO	5
		4	DO	54
		5	DO	100
258.2 3.7	brown grey Very dense SANDY SILT, Till a trace of clay and gravel occ. cobbles and boulders	6	DO	100
		7	DO	100
255.6 6.3	End of Borehole Installed 50 mm dia. monitoring well to 4.6 m (3.0 m screen). Sand backfill from 0.9 m to 4.6 m. Bentonite seal from 0 to 0.9 m. Provided with steel monument casing.			



W.L. @ El. 259.6 m on August 5, 2016
W.L. @ El. 259.1 m on August 19, 2016
W.L. @ El. 259.0 m on August 26, 2016

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FIGURES 5 to 6

GRAIN SIZE DISTRIBUTION GRAPHS

REFERENCE NO. 1606-W168

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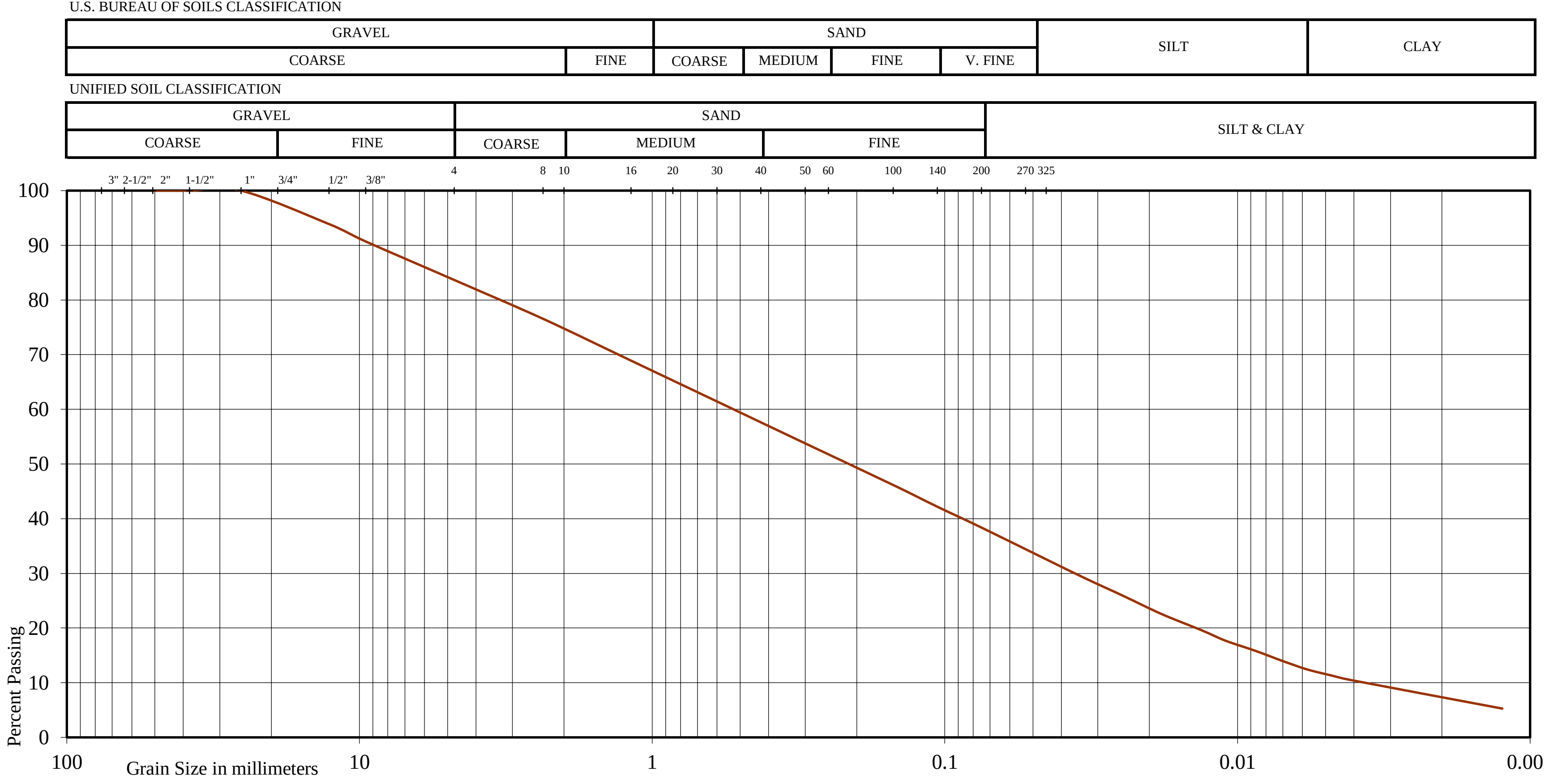
GRAIN SIZE DISTRIBUTION

Reference No: 1606-W168



Project: Proposed Residential Development

Location: 3879 Town Line, City of Orillia

Borehole No: 2

Sample No: 4

Depth (m): 2.5

Elevation (m): 268.05

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

Classification of Sample [& Group Symbol]: SILTY SAND TILL, some gravel, a trace of clay

Figure 5

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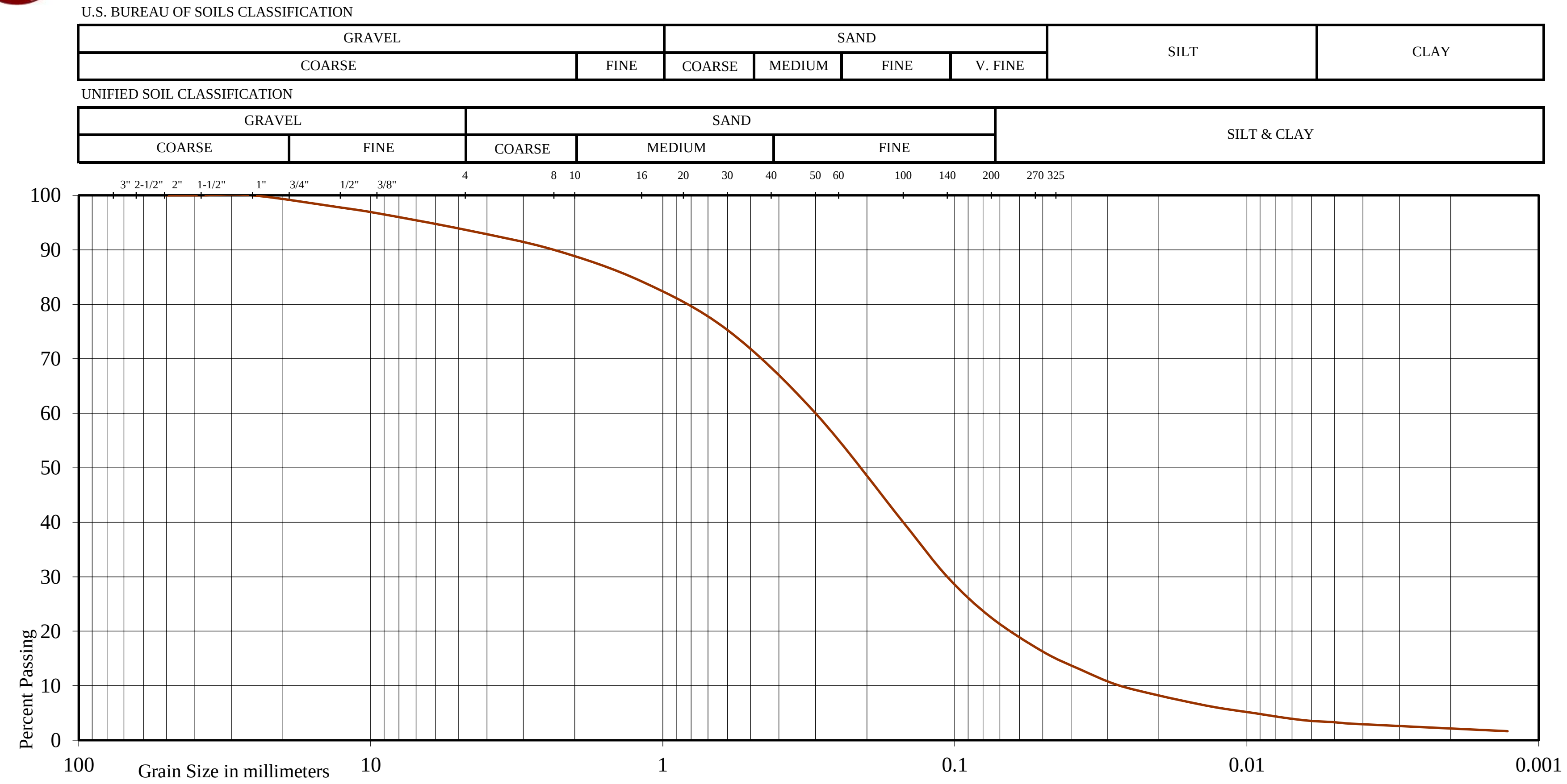
GRAIN SIZE DISTRIBUTION

Reference No: 1606-W068



Project: Proposed Residential Development

Location: 3879 Town Line

Borehole No: 4

Sample No: 5

Depth (m): 3.2

Elevation (m): 258.71

Estimated Permeability (m./sec.) = 10^{-5}

Classification of Sample [& Group Symbol]: FINE TO MEDIUM SAND, some silt to silty, traces of clay and gravel

Figure: 6

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DRAWINGS 1 to 9

REFERENCE NO. 1606-W168

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

C:\GIS2016\Jobs\1606-W168

N

🟥 Approximate Boundary of Subject Site

🟦 Water Body

Watercourse

Piped

Culvert

Flow Direction

Expressway/Freeway

Major Road

Local Road

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Title: Site Location Plan

Project:

Hydrogeological Study
Proposed Residential Development
3879 Town Line
City of Orillia

Reference No. 1606-W168

Date: December 1, 2017

Scale:

0 50 100 200 300 400
Metres

Drawing No. 1

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

C:\GIS2016\Jobs\1606-W168

N

🟥 Approximate Boundary of Subject Site
🟦 Water Body
➤ Watercourse
⊕ Borehole and Monitoring Well Location
▬ Expressway/Freeway
▬ Major Road
— Local Road

Soil Engineers Ltd.

Title: Borehole and Monitoring Well Location Plan

Project:

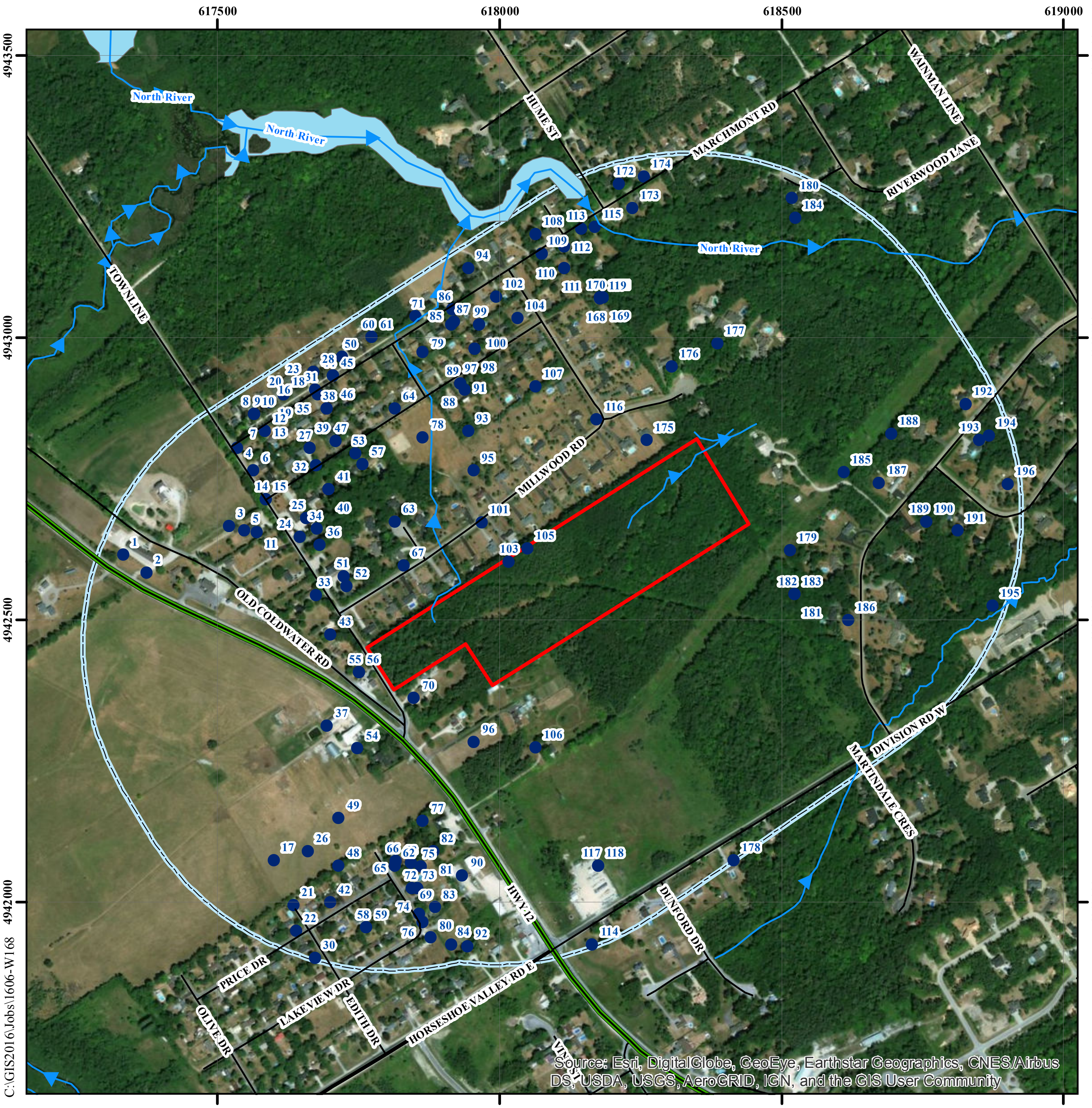
Hydrogeological Study
Proposed Residential Development
3879 Town Line
City of Orillia

Reference No. 1606-W168

Date: December 1, 2017

Scale:
0 35 70 140 210 280 350
Metres

Drawing No. 2



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

C:\GIS2016\Jobs\1606-W168

▭ Approximate 500 metres from Subject Site Boundary

🟥 Approximate Boundary of Subject Site

● 1 Well Locations from MOECC Well Records

▭ Water Body

→ Watercourse

━ Expressway/Freeway

━ Major Road

— Local Road

Soil Engineers Ltd.

Title: MOECC Well Location Plan

Project:

Hydrogeological Study
Proposed Residential Development
3879 Town Line
City of Orillia

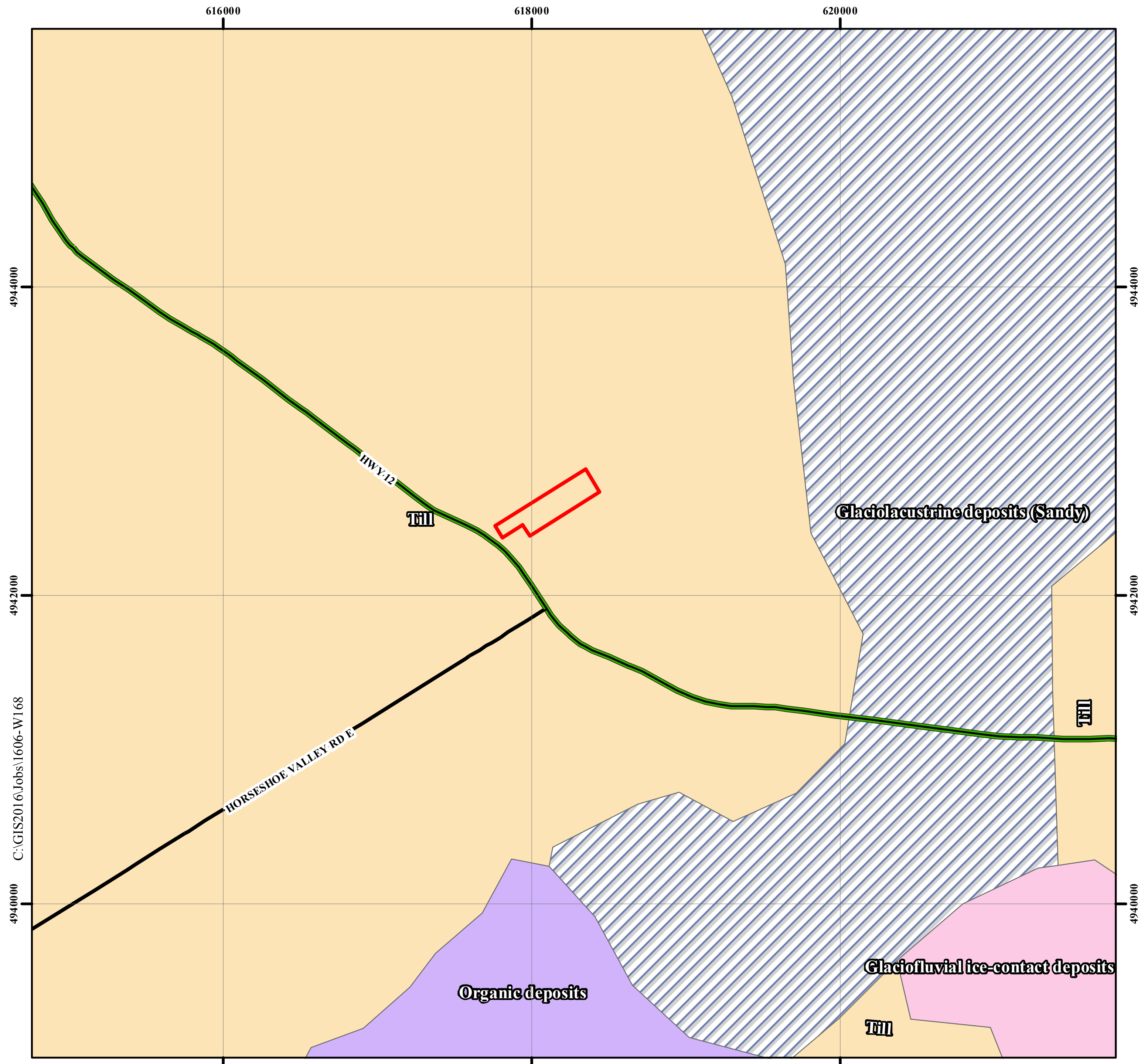
Reference No. 1606-W168

Date: December 1, 2017

Scale:
0 40 80 160 240 320 400
Metres

Drawing No. 3

Source: Water Body, 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



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

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

Source: Wetland, 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

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

N

▭	Approximate Boundary of Subject Site
🟧	Till Material: undifferentiated, predominantly sandy silt to silt matrix, commonly rich in clasts, often high in total matrix carbonate content
▨	Glaciolacustrine deposits (Sandy) Material: sand, gravelly sand and gravel, nearshore and beach deposits
▩	Glaciofluvial ice-contact deposits Material: gravel and sand, minor till, includes esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits
🟪	Organic deposits material: peat, muck and marl
═	Expressway/Freeway
━	Major Road

Soil Engineers Ltd.

Title: Quaternary and Surface
Geology Map

Project:

Hydrogeological Study
Proposed Residential Development
3879 Town Line
City of Orillia

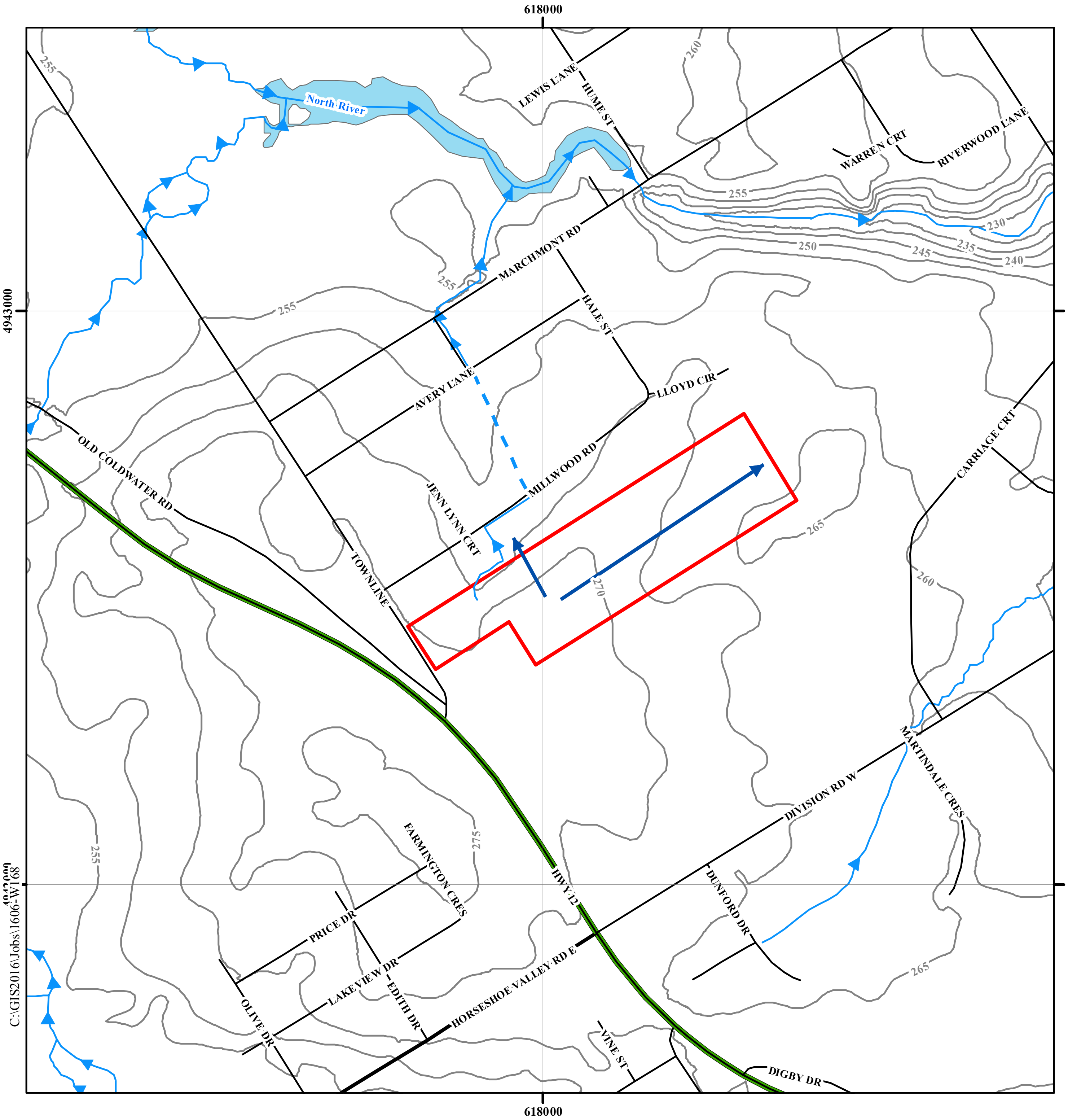
Reference No. 1606-W168

Date: December 1, 2017

Scale:

0 180 360 720 1,080 1,440 1,800
Metres

Drawing No. 4



C:\GIS2016\Jobs\1606-W168

Soil Engineers Ltd.

Title: Topographic Map

Project:

Hydrogeological Study
Proposed Residential Development
3879 Town Line
City of Orillia

Reference No. 1606-W168

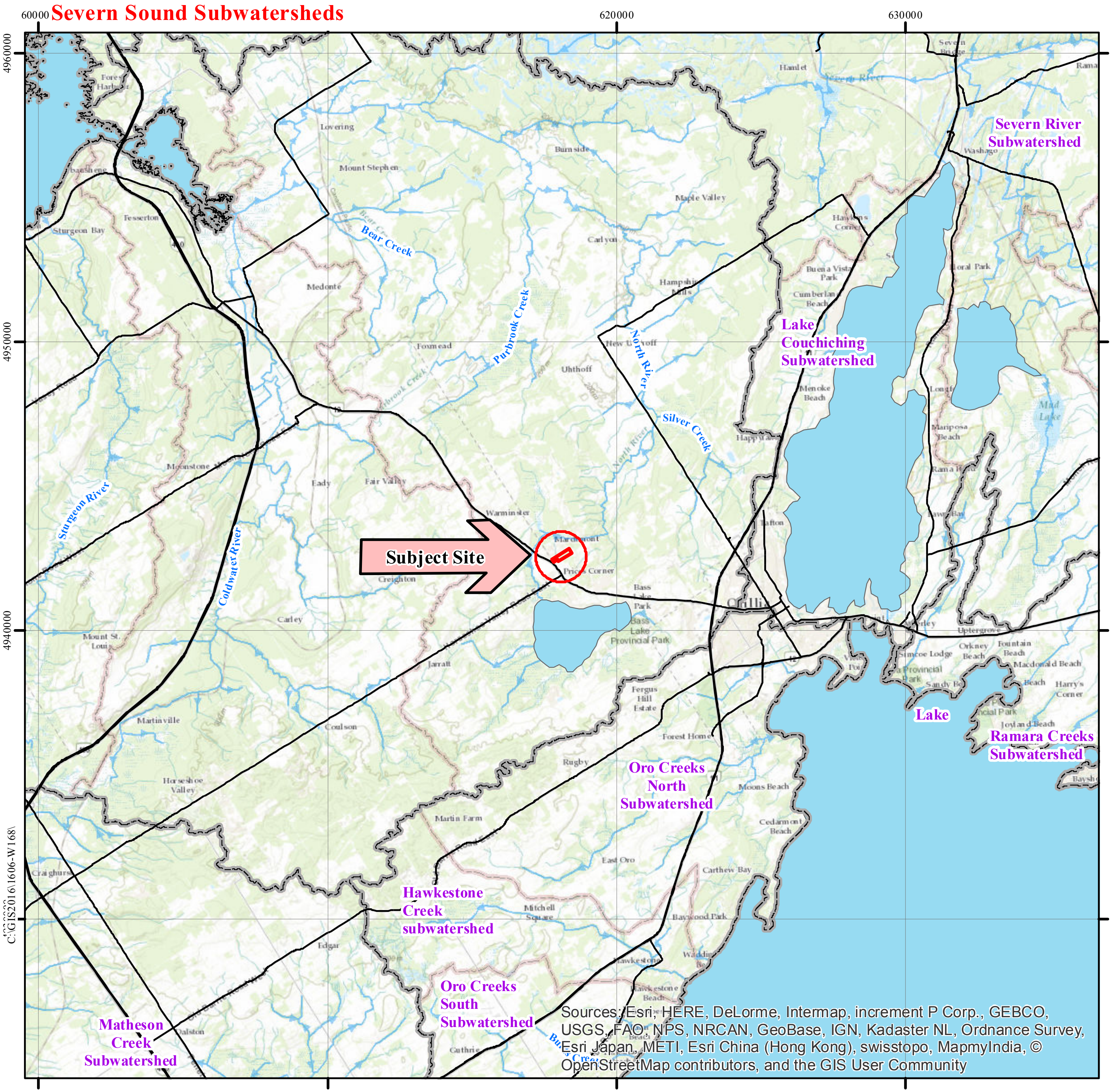
Date: December 1, 2017

Drawing No. 5

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

Source: Water Body, 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, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Soil Engineers Ltd.

Title: Watershed and Subwatershed Map

Project:

Hydrogeological Study
Proposed Residential Development
3879 Town Line
City of Orillia

Reference No. 1606-W168

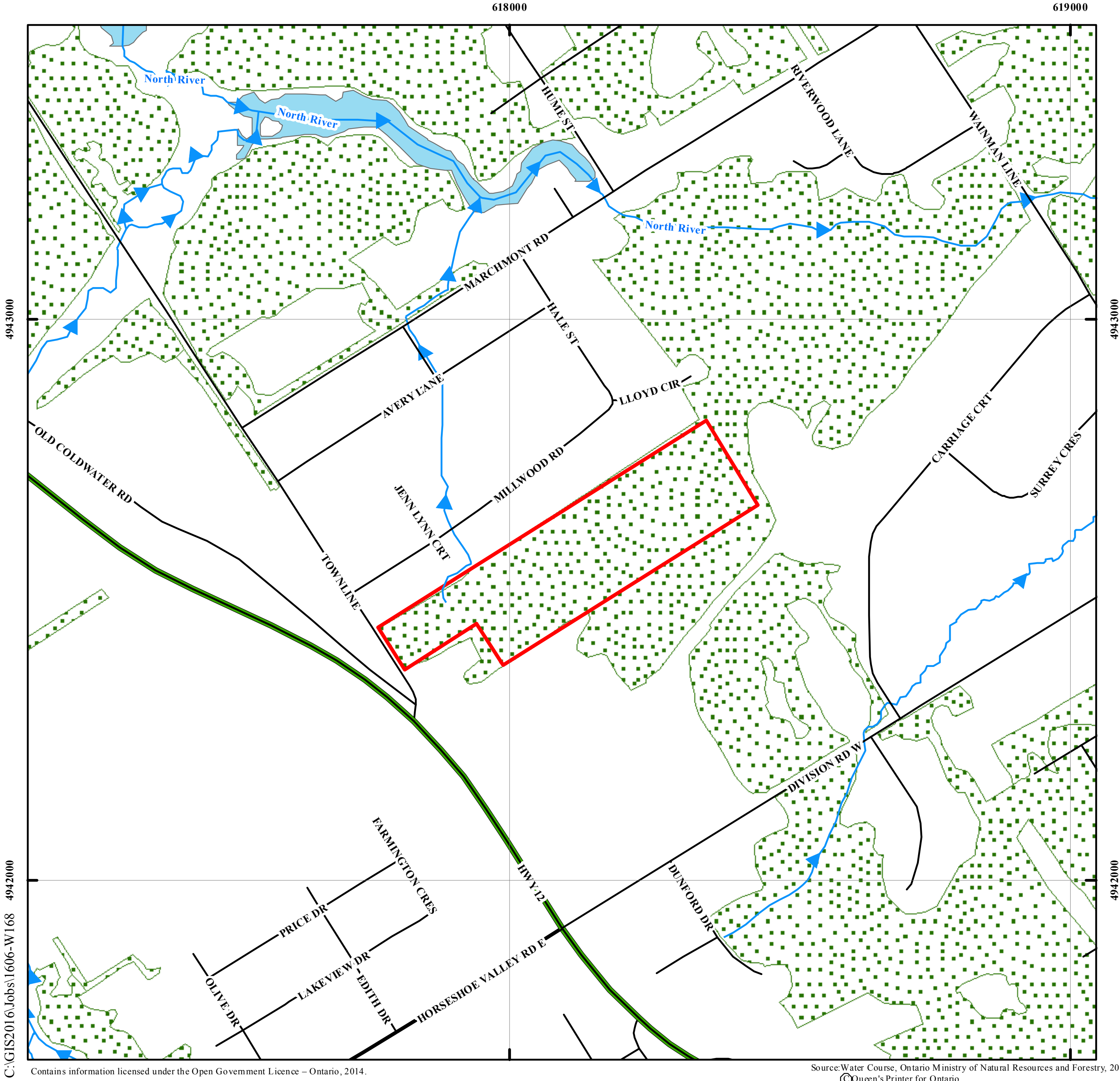
Date: December 1, 2017

Scale:

0 5,000 10,000 20,000 30,000 40,000 50,000
Metres

Drawing No. 6

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

▨ Wooded Area

🟦 Water Body

→ Watercourse

━ Major Road

— Local Road

Soil Engineers Ltd.

Title: Natural Features and Protection Area Plan

Project:

Hydrogeological Study
Proposed Residential Development
3879 Town Line
City of Orillia

Reference No. 1606-W168

Date: December 1, 2017

Scale:

0 50 100 200 300 400 500
Metres

Drawing No. 7

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

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

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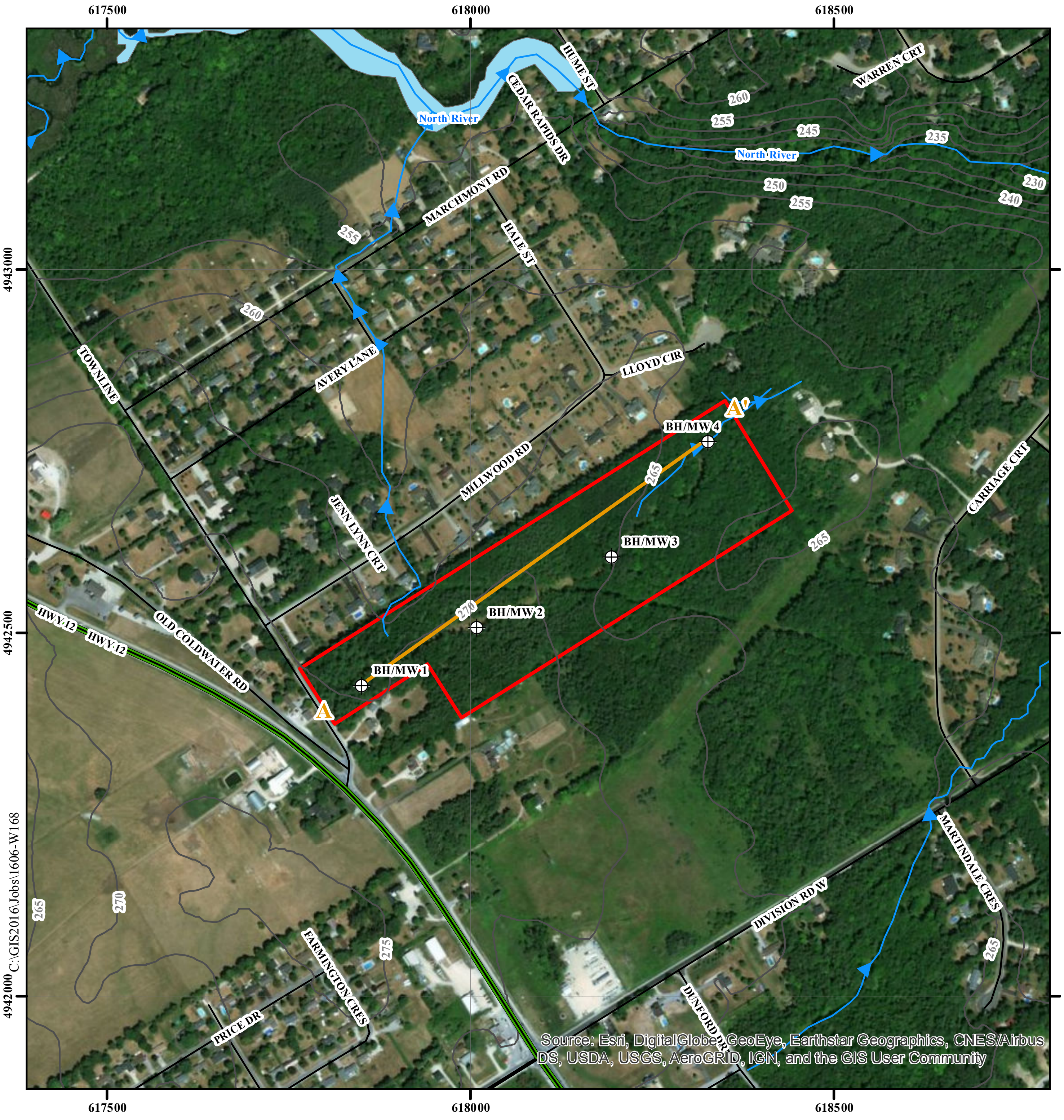
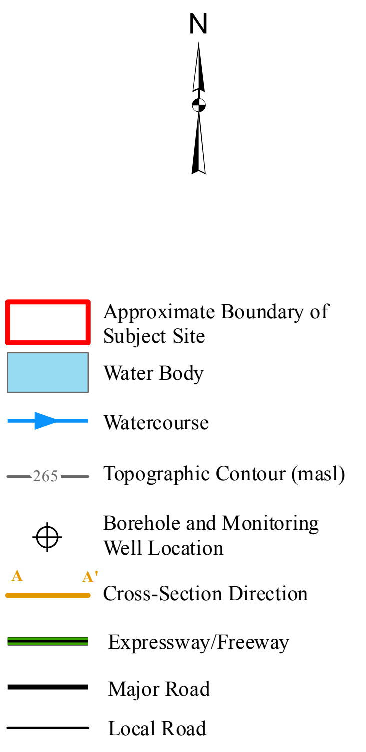
Includes information: Provincial Park, Conservation Reserve, Area of Natural and Scientific Interest, Niagara Escarpment Pretection Area, Oak Ridges Moraine Conservation and Wilderness Areas

* OWES: Ontario Wetland Evaluatuion System





Soil Engineers Ltd.

Title: Cross-Section Key Plan

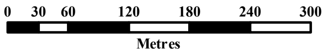
Project:

Hydrogeological Study
Proposed Residential Development
3879 Town Line
City of Orillia

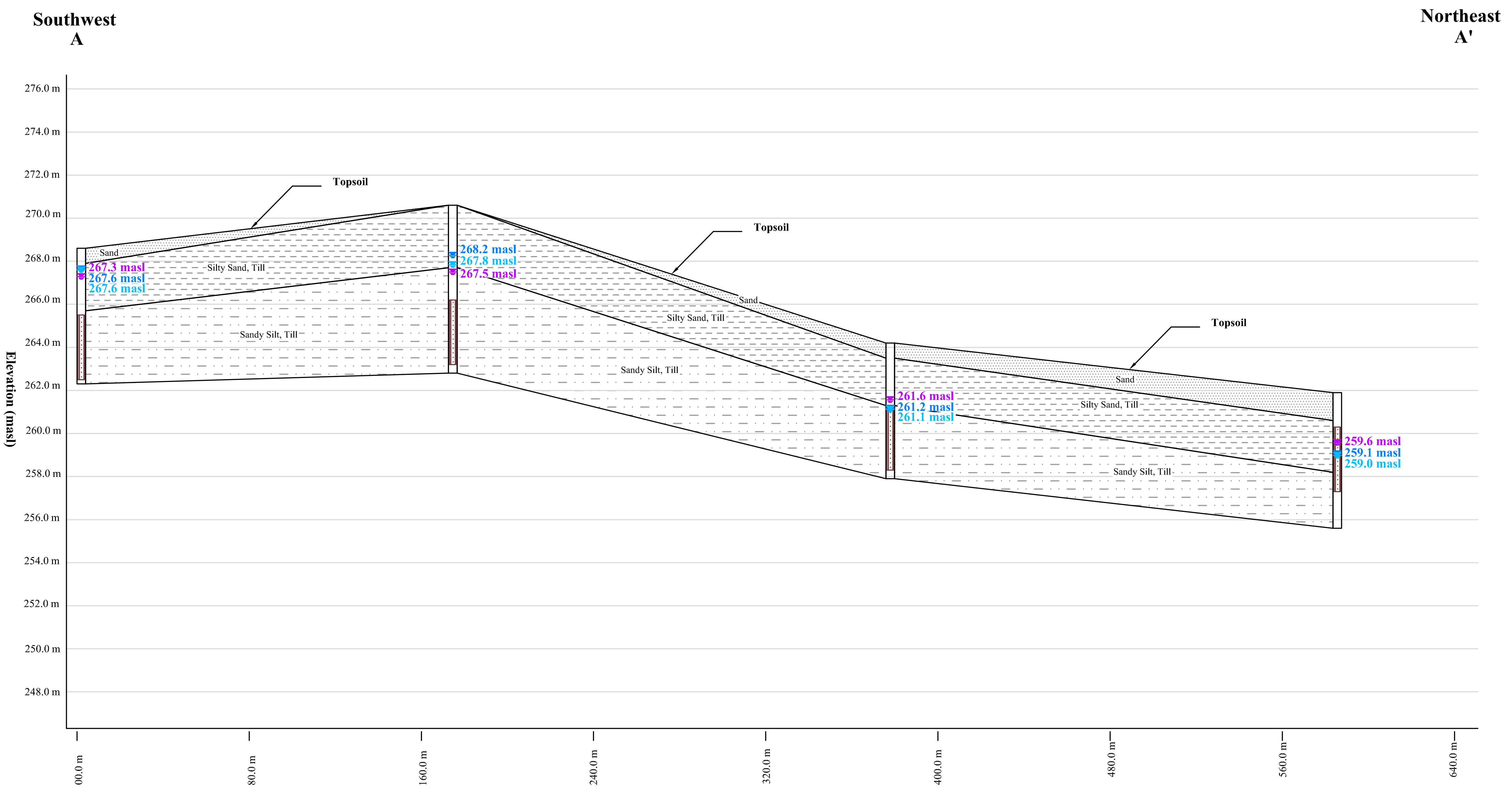
Reference No. 1606-W168

Date: December 1, 2017

Scale:



Drawing No. 8-1



Section A-A'

▨ **Sand**

▨ **Sandy Silt, Till**

▨ **Silty Sand, Till**

▯ **3.0 m Screen**

▼ **Water Table on August 5, 2016**

▼ **Water Table on August 19, 2016**

▼ **Water Table on August 29, 2016**

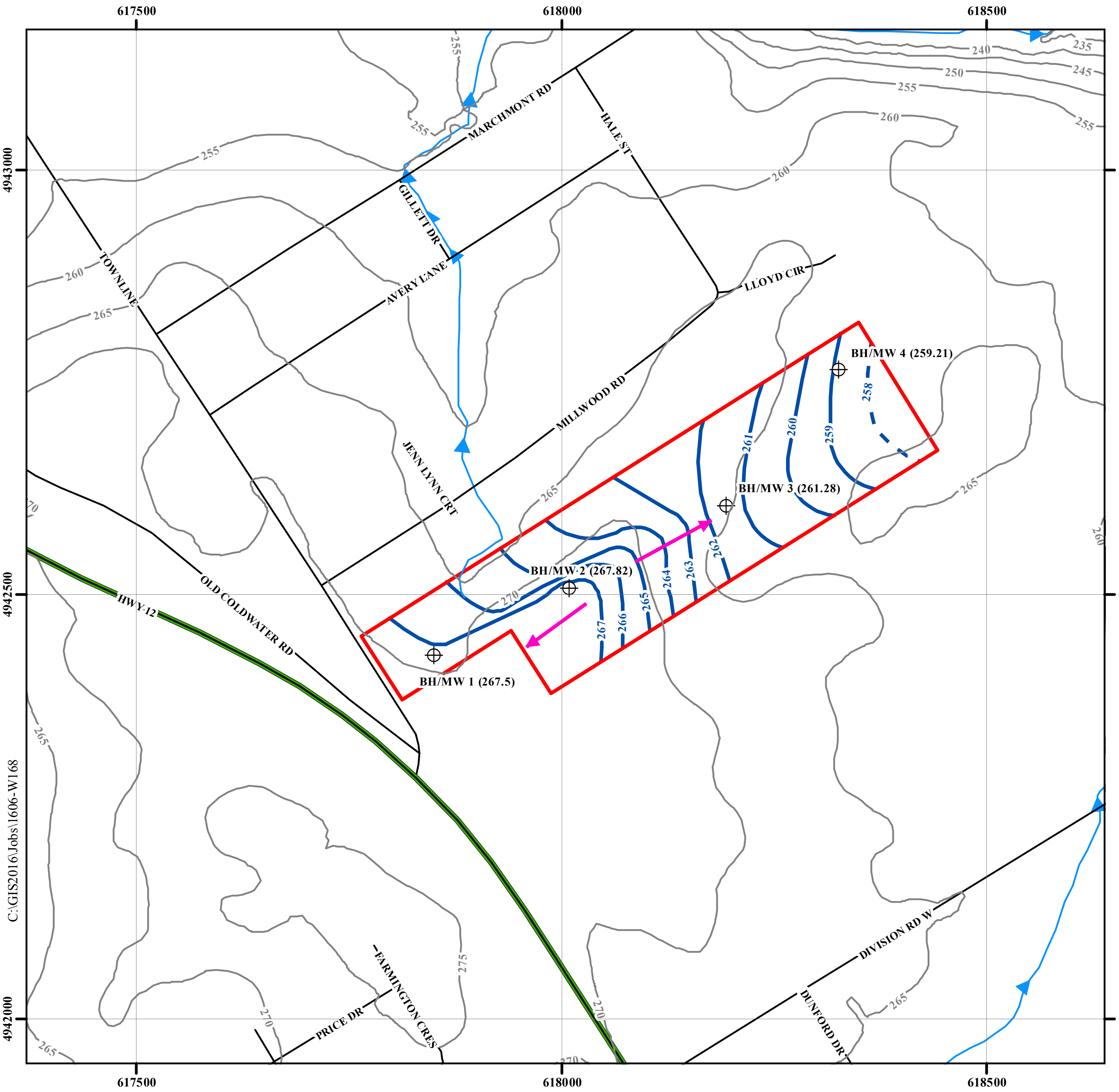
C: Hydrog./Projects/1606-W168/Cross-section

Soil Engineers Ltd.
CONSULTING SOIL, FOUNDATION & ENVIRONMENTAL ENGINEERS

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

Project: Hydrogeological Study
Proposed Residential Development
3879 Town Line, City of Orillia

Reference No:	Date:	Scale: V	Scale: H	Drawing No.
1606-W168	December, 2017	1:200	1:2000	8-2



N

🟥	Approximate Boundary of Subject Sites
→	Watercourse
→	Interpreted Shallow Groundwater Flow Direction
—	Interpreted Shallow Groundwater Level Elevation (masl)
- -	Inferred Shallow Groundwater Level Elevation (masl)
—265—	Topographic Contour (masl)
261.28	Average Shallow Groundwater Level Elevation (masl)
⊕	Borehole and Monitoring Well Location
🟩	Expressway/Freeway
—	Local Road

Soil Engineers Ltd.

Title: Shallow Groundwater
Flow Pattern Plan

Project:

Hydrogeological Study
Proposed Residential Development
3879 Town Line
City of Orillia

Reference No. 1606-W168

Date: December 1, 2017

Scale:

0 25 50 100 150 200 250
Metres

Drawing No. 9

Source: Contour Map, York Region
©York Maps, Open Data

Soil Engineers Ltd.
CONSULTING ENGINEERS
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FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (416) 754-8516	FAX: (705) 684-8522	FAX: (905) 725-1315	FAX: (905) 542-2769

APPENDIX ‘A’

MOECC WATER WELL RECORDS SUMMARY

REFERENCE NO. 1606-W168

Ontario Water Well Records

WELL ID	MOECC 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	5713939	Rotary (Convent.)	85.65	Water Supply	Livestock	54.86	35.05	-	-
2	5708316	Boring	16.76	Water Supply	Domestic	15.24	10.67	-	-
3	5726027	Cable Tool	21.03	Water Supply	Public	21.03	4.88	-	-
4	5707435	Cable Tool	56.39	Water Supply	Domestic	55.78	28.96	55.17	56.39
5	5725060	Cable Tool	17.07	Water Supply	Public	17.07	2.44	14.94	16.15
6	5706811	Boring	11.28	Water Supply	Domestic	7.62	3.66	-	-
7	5738682	Rotary (Air)	27.4	Water Supply	Domestic	26	15.27	26	27.4
8	5738681	Rotary (Air)	70.1	Water Supply	Domestic	18	25.02	-	-
9	5738681	Rotary (Air)	70.1	Water Supply	Domestic	31	25.02	-	-
10	5738681	Rotary (Air)	70.1	Water Supply	Domestic	70	25.02	-	-
11	5739088	Rotary (Air)	54.25	Water Supply	Domestic	54.25	21.34	53.04	54.25
12	5707168	Boring	9.45	Water Supply	Domestic	4.57	2.44	-	-
13	5707168	Boring	9.45	Water Supply	Domestic	9.45	2.44	-	-
14	5723948	Cable Tool	17.07	Water Supply	Domestic	13.72	8.84	-	-
15	5723948	Cable Tool	17.07	Water Supply	Domestic	16.76	8.84	-	-
16	7177619	Air Percussion	70.1	Water Supply	Domestic	70.1	25.66	-	-
17	5711562	Boring	6.4	Water Supply	Domestic	1.22	0.61	-	-
18	7207090	Rotary (Convent.)	30.48	Water Supply	Domestic	29.87	13.41	-	-
19	7207090	Rotary (Convent.)	30.48	Water Supply	Domestic	29.87	13.41	-	-
20	7207090	Rotary (Convent.)	30.48	Water Supply	Domestic	29.87	13.41	-	-
21	5709109	Boring	6.1	Water Supply	Domestic	3.05	3.05	-	-
22	5711561	Boring	5.49	Water Supply	Domestic	1.83	3.66	-	-
23	7154184	Air Percussion	30.48	Water Supply	Domestic	30.48	12.8	29.26	30.48
24	5725968	Cable Tool	49.99	Water Supply	Public	49.99	29.57	48.77	49.99
25	5738542	Rotary (Convent.)	41.4	Water Supply	Domestic	37	29.1	36.7	37.9
26	5710669	Cable Tool	45.11	Water Supply	Domestic	44.5	22.86	43.59	44.81
27	5713270	Cable Tool	27.74	Water Supply	Domestic	27.43	10.97	-	-
28	7197113	Air Percussion	27.74	Water Supply	Domestic	25.91	1.22	26.21	27.13
29	7197113	Air Percussion	27.74	Water Supply	Domestic	25.91	1.22	26.21	27.13
30	5710460	Boring	6.1	Water Supply	Domestic	5.49	4.27	-	-
31	5708801	Boring	13.72	Water Supply	Domestic	10.67	9.75	-	-
32	5713682	Cable Tool	28.04	Water Supply	Domestic	27.74	11.58	-	-
33	5726817	Cable Tool	47.85	Water Supply	Domestic	47.85	28.96	46.63	47.85
34	5726021	Cable Tool	48.77	Water Supply	Domestic	48.77	25.91	47.55	48.77
35	5709630	Cable Tool	24.38	Water Supply	Domestic	22.56	10.67	22.56	24.38
36	5708865	Boring	12.19	Water Supply	Domestic	9.75	7.62	-	-
37	5701874	Cable Tool	54.86	Water Supply	Livestock	54.86	21.34	52.43	54.86
38	5707167	Boring	11.28	Water Supply	Domestic	8.25	5.79	-	-
39	5707167	Boring	11.28	Water Supply	Domestic	10.67	5.79	-	-
40	5722144	Boring	13.72	Water Supply	Domestic	5.79	5.18	-	-
41	5722144	Boring	13.72	Water Supply	Domestic	11.58	5.18	-	-
42	5712603	Cable Tool	19.81	Water Supply	Domestic	16.15	3.05	17.68	19.81
43	5729835	Rotary (Air)	46.33	Water Supply	Domestic	44.2	18.29	45.11	46.33
44	7207091	Air Percussion	26.82	Water Supply	Domestic	25.3	11.28	24.99	25.91
45	7207091	Air Percussion	26.82	Water Supply	Domestic	25.3	11.28	24.99	25.91
46	7207091	Air Percussion	26.82	Water Supply	Domestic	25.3	11.28	24.99	25.91
47	5738541	Rotary (Convent.)	49.09	Water Supply	Domestic	42.5	24.61	42.43	45.46
48	5709042	Boring	6.86	Water Supply	Domestic	6.1	3.35	-	-
49	5711563	Boring	6.4	Water Supply	Domestic	2.13	4.27	-	-
50	7154183	Air Percussion	24.38	Water Supply	Domestic	24.38	10.97	23.16	24.38

Ontario Water Well Records

WELL ID	MOECC 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				
51	5738972	Other Method	12.2	Abandoned-Other	Not Used	-	5	-	-
52	5738971	Other Method	10.67	Abandoned-Other	Not Used	-	2	-	-
53	5708575	Cable Tool	26.82	Water Supply	Domestic	25.91	12.19	25.6	26.82
54	5731185	Cable Tool	56.69	Water Supply	Domestic	54.25	32	54.25	56.69
55	5728286	Rotary (Air)	48.46	Water Supply	Domestic	47.55	13.72	47.55	48.46
56	5730086	Rotary (Air)	7.62	Abandoned-Quality	-	-	-	-	-
57	5722381	Cable Tool	43.28	Water Supply	Domestic	43.28	22.86	42.06	43.28
58	5707678	Boring	7.32	Water Supply	Domestic	4.57	2.74	-	-
59	5707678	Boring	7.32	Water Supply	Domestic	7.32	2.74	-	-
60	7228774	Air Percussion	34.44	Water Supply	Domestic	-	15.85	32.92	34.14
61	7228774	Air Percussion	34.44	Water Supply	Domestic	-	15.85	32.92	34.14
62	5708300	Boring	8.23	Water Supply	Domestic	5.49	5.49	-	-
63	5714058	Cable Tool	30.78	Water Supply	Domestic	30.78	21.36	-	-
64	5716241	Cable Tool	34.14	Water Supply	Domestic	33.53	19.81	33.22	34.14
65	5709641	Cable Tool	24.99	Water Supply	Domestic	10.67	5.49	9.14	24.99
66	5709641	Cable Tool	24.99	Water Supply	Domestic	24.38	5.49	9.14	24.99
67	5737305	Air Percussion	42.67	Water Supply	Domestic	42.67	13.72	-	-
68	5711059	Boring	7.62	Water Supply	Domestic	6.1	4.57	-	-
69	5709108	Boring	8.53	Water Supply	Domestic	6.1	6.1	-	-
70	5728753	Cable Tool	52.73	Water Supply	Domestic	52.73	33.53	-	-
71	7245713	Air Percussion	28.04	Water Supply	Domestic	28.04	8.99	26.82	28.04
72	5712980	Cable Tool	55.78	Water Supply	Domestic	45.72	27.43	53.34	54.86
73	5712980	Cable Tool	55.78	Water Supply	Domestic	53.95	27.43	53.34	54.86
74	5739400	Cable Tool	25.91	Water Supply	Domestic	21.34	8.53	20.73	22.86
75	5741421	Cable Tool	74.68	Water Supply	Domestic	73.76	35.05	73.76	74.68
76	5713147	Cable Tool	63.7	Water Supply	Domestic	63.7	25.91	-	-
77	5706890	Boring	8.38	Water Supply	Domestic	7.62	3.05	-	-
78	5713684	Cable Tool	31.7	Water Supply	Domestic	31.39	19.51	-	-
79	5714134	Cable Tool	24.34	Water Supply	Domestic	23.77	14.94	-	-
80	5740918	Rotary (Air)	61.9	Water Supply	Domestic	60	22	60	61.5
81	5723747	Cable Tool	38.4	Water Supply	Domestic	36.88	18.9	37.19	38.4
82	5723748	Cable Tool	35.66	Water Supply	Domestic	35.66	18.9	34.44	35.66
83	5711056	Boring	12.8	Water Supply	Domestic	12.19	10.97	-	-
84	5713731	Cable Tool	78.03	Water Supply	Domestic	78.03	64.01	-	-
85	5716343	Cable Tool	28.96	Water Supply	Domestic	28.96	17.68	-	-
86	7251844	Air Percussion	28.96	Water Supply	Domestic	28.96	8.29	27.74	28.96
87	5725917	Cable Tool	28.35	Water Supply	Domestic	28.35	13.72	-	-
88	7157595	Rotary (Convent.)	30.5	Water Supply	Domestic	28	18.72	28.7	29.9
89	7157595	Rotary (Convent.)	30.5	Water Supply	Domestic	28	18.72	28.7	29.9
90	5736341	Rotary (Convent.)	60.96	Water Supply	Domestic	56.08	32.31	56.39	57.61
91	7157597	Other Method	20	Abandoned-Supply	Domestic	-	-	-	-
92	5740025	Rotary (Convent.)	64.01	Water Supply	Domestic	6.1	29.26	62.79	64.04
93	5713683	Cable Tool	30.48	Water Supply	Domestic	30.48	18.59	-	-
94	5707199	Cable Tool	36.58	Water Supply	Domestic	36.58	16.76	35.36	36.58
95	5736177	Cable Tool	43.89	Water Supply	Domestic	43.89	21.64	42.67	43.89
96	5713685	Cable Tool	39.93	Water Supply	Domestic	39.62	15.85	-	-
97	5720250	Cable Tool	28.65	Water Supply	Domestic	27.43	115.24	27.74	28.65
98	5720250	Cable Tool	28.65	Water Supply	Domestic	28.65	115.24	27.74	28.65
99	5707198	Cable Tool	38.71	Water Supply	Domestic	38.1	18.29	37.49	38.71
100	5717377	Cable Tool	27.74	Water Supply	Domestic	27.74	17.69	-	-

Ontario Water Well Records

WELL ID	MOECC 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				
101	5736114	Air Percussion	39.62	Water Supply	Domestic	39.62	24.38	38.1	39.32
102	7251843	Air Percussion	30.18	Water Supply	Domestic	30.18	9.08	28.96	30.18
103	5736116	Air Percussion	48.77	Water Supply	Domestic	48.77	26.82	-	-
104	5725198	Cable Tool	32	Water Supply	Domestic	32	19.81	30.78	32
105	5736113	Air Percussion	47.24	Water Supply	Domestic	47.24	25.91	46.02	47.24
106	5717264	Cable Tool	58.22	Water Supply	Domestic	57.91	31.09	-	-
107	5713066	Cable Tool	29.57	Water Supply	Domestic	29.26	19.81	-	-
108	5702718	Cable Tool	30.78	Water Supply	Domestic	29.87	20.12	29.87	30.78
109	5702715	Cable Tool	31.09	Water Supply	Domestic	29.87	19.81	30.18	31.09
110	5702716	Boring	12.19	Water Supply	Domestic	12.19	11.28	-	-
111	5715630	Cable Tool	30.78	Water Supply	Domestic	30.48	21.34	29.87	30.78
112	7189415	Air Percussion	35.97	Water Supply	Domestic	35.97	14.48	34.75	35.97
113	5702714	Cable Tool	28.04	Water Supply	Domestic	28.04	19.81	-	-
114	5717890	Cable Tool	49.68	Water Supply	Domestic	-	18.29	-	-
115	5724792	Cable Tool	28.04	Water Supply	Public	28.04	20.42	-	-
116	5736115	Air Percussion	35.97	Water Supply	Domestic	35.97	22.86	34.75	35.97
117	5707671	Boring	7.32	Water Supply	Domestic	4.57	2.74	-	-
118	5707671	Boring	7.32	Water Supply	Domestic	7.32	2.74	-	-
119	5738157	Air Percussion	39.62	Water Supply	Domestic	39.62	16.76	-	-
120	5738609	Cable Tool	28.35	Water Supply	Domestic	28.35	13.72	-	-
121	5736863	Air Percussion	30.48	Water Supply	Domestic	29.87	9.14	-	-
122	5736394	Air Percussion	33.53	Water Supply	Domestic	32	12.19	-	-
123	5735650	Air Percussion	38.1	Water Supply	Domestic	38.1	15.24	-	-
124	5738487	Air Percussion	36.88	Water Supply	Domestic	35.66	24.38	-	-
125	5720862	Cable Tool	24.69	Water Supply	Domestic	24.69	17.07	-	-
126	5733779	Rotary (Convent.)	53.95	Water Supply	Domestic	53.95	24.38	52.73	53.95
127	5720807	Cable Tool	28.35	Water Supply	Domestic	28.35	16.46	27.43	28.35
128	5720742	Cable Tool	24.99	Water Supply	Domestic	24.99	16.15	-	-
129	5725524	Cable Tool	54.86	Water Supply	Domestic	54.86	39.62	-	-
130	5721085	Cable Tool	26.82	Water Supply	Domestic	26.83	15.85	25.6	26.82
131	5722146	Boring	9.75	Water Supply	Domestic	3.05	2.44	-	-
132	5723772	Cable Tool	30.78	Water Supply	Domestic	30.78	13.72	29.57	30.78
133	5726023	Cable Tool	31.39	Water Supply	Domestic	31.39	19.81	-	-
134	5723335	Cable Tool	27.74	Water Supply	Domestic	27.74	13.72	-	-
135	5723336	Cable Tool	25.6	Water Supply	Domestic	25.6	13.41	-	-
136	5723773	Cable Tool	30.48	Water Supply	Domestic	30.48	18.9	29.26	30.48
137	5725401	Cable Tool	28.35	Water Supply	Domestic	28.35	16.77	-	-
138	5720562	Cable Tool	43.28	Water Supply	Domestic	43.28	22.86	42.06	43.28
139	5734221	Air Percussion	39.93	Water Supply	Domestic	39.93	19.81	-	-
140	5732759	Cable Tool	47.24	Water Supply	Domestic	47.24	19.81	-	-
141	5732955	Cable Tool	34.44	Water Supply	Domestic	34.44	21.34	33.22	34.44
142	5733019	Cable Tool	45.42	Water Supply	Domestic	45.42	22.86	-	-
143	5733515	Rotary (Convent.)	51.82	Water Supply	Domestic	51.82	22.86	50.6	51.82
144	5733436	Air Percussion	37.19	Water Supply	Domestic	37.19	21.34	35.97	37.19
145	5733437	Cable Tool	51.51	Water Supply	Domestic	51.51	27.43	49.68	50.9
146	5733520	Rotary (Convent.)	48.16	Water Supply	Domestic	48.16	24.99	46.33	47.55
147	5733780	Cable Tool	32.92	Water Supply	Domestic	32.92	21.34	31.39	32.61
148	5732571	Cable Tool	37.49	Water Supply	Domestic	37.49	22.86	36.27	37.49
149	5734219	Air Percussion	46.33	Water Supply	Domestic	46.33	16.76	45.11	46.33
150	5734222	Air Percussion	42.06	Water Supply	Domestic	42.06	18.29	40.84	42.06

Ontario Water Well Records

WELL ID	MOECC 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				
151	5734331	Air Percussion	47.85	Water Supply	Domestic	47.85	15.24	45.72	46.94
152	5734332	Air Percussion	42.37	Water Supply	Domestic	42.37	18.29	41.15	42.37
153	5734539	Air Percussion	37.49	Water Supply	Domestic	37.49	13.72	36.27	37.49
154	5734660	Air Percussion	18.9	Water Supply	Domestic	18.9	3.05	17.68	18.9
155	5735065	Air Percussion	49.68	Water Supply	Domestic	49.68	22.86	-	-
156	5735221	Air Percussion	43.28	Water Supply	Domestic	43.28	21.34	42.06	43.28
157	5735222	Air Percussion	44.2	Water Supply	Domestic	44.2	24.34	42.98	44.2
158	5733512	Air Percussion	36.27	Water Supply	Domestic	36.27	21.34	34.75	35.97
159	5733781	Cable Tool	50.6	Water Supply	Domestic	50.6	25.3	49.38	50.6
160	5730902	Cable Tool	53.04	Water Supply	Domestic	53.04	23.46	-	-
161	5732553	Cable Tool	42.06	Water Supply	Domestic	42.06	17.68	-	-
162	5734220	Air Percussion	45.11	Water Supply	Domestic	45.11	15.24	43.28	44.5
163	5728748	Cable Tool	29.26	Water Supply	Domestic	29.26	17.68	28.35	29.26
164	5730901	Cable Tool	37.8	Water Supply	Domestic	36.88	21.97	36.88	37.8
165	5730903	Cable Tool	29.87	Water Supply	Domestic	28.04	20.55	28.04	29.87
166	5733273	Cable Tool	45.72	Water Supply	Domestic	45.72	25.91	44.5	45.72
167	5731704	Cable Tool	24.38	Water Supply	Domestic	24.38	14.63	23.16	24.38
168	5727398	Cable Tool	28.65	Water Supply	Domestic	28.65	13.72	-	-
169	5732302	Cable Tool	43.59	Water Supply	Domestic	43.59	25.91	42.37	43.59
170	5732303	Cable Tool	35.97	Water Supply	Domestic	35.97	21.95	34.75	35.97
171	5727688	Cable Tool	31.39	Water Supply	Domestic	31.39	29.87	-	-
172	5740919	Rotary (Air)	36	Water Supply	Domestic	36	18.2	34.5	36
173	5733235	Cable Tool	51.82	Water Supply	Domestic	50.29	22.56	-	-
174	5741392	Rotary (Air)	39	Water Supply	Domestic	33	22	37.5	39
175	5740308	Rotary (Convent.)	42.7	Water Supply	Domestic	41	28.68	41.5	42.7
176	5739251	Cable Tool	39.62	Water Supply	Domestic	38.7	22	38.7	39.62
177	5737614	Air Percussion	57.91	Water Supply	Domestic	57.91	15.24	-	-
178	5717426	Cable Tool	53.64	Water Supply	Domestic	52.64	30.48	-	-
179	5715086	Rotary (Convent.)	32.61	Water Supply	Domestic	30.18	18.29	30.18	31.09
180	7148422	Cable Tool	48.77	Water Supply	Domestic	48.16	20.73	47.55	48.77
181	5724762	Cable Tool	36.88	Water Supply	Domestic	36.88	19.81	-	-
182	5721601	Cable Tool	27.13	Water Supply	Domestic	27.13	14.94	-	-
183	5720468	Cable Tool	26.21	Water Supply	Domestic	26.21	12.19	-	-
184	5735905	Air Percussion	46.33	Water Supply	Domestic	46.33	24.34	45.11	46.33
185	5725197	Rotary (Convent.)	60.96	Water Supply	Domestic	60.96	27.43	-	-
186	7053923	Rotary (Convent.)	86	Water Supply	Domestic	86	31	-	-
187	5737617	Cable Tool	58.52	Water Supply	Domestic	58.52	52.43	-	-
188	5722379	Boring	9.75	Water Supply	Domestic	2.44	2.44	-	-
189	5722147	Boring	12.19	Water Supply	Domestic	5.49	2.44	-	-
190	5722147	Boring	12.19	Water Supply	Domestic	12.19	2.44	-	-
191	5721435	Boring	9.14	Water Supply	Domestic	3.66	0.91	-	-
192	5729625	Cable Tool	50.9	Water Supply	Domestic	50.9	23.16	-	-
193	5721436	Boring	9.14	Water Supply	Domestic	6.71	2.44	-	-
194	5739183	Cable Tool	52.5	Water Supply	Domestic	52	21.1	-	-
195	5702713	Cable Tool	35.05	Water Supply	Public	27.43	21.34	27.74	28.96
196	5721524	Cable Tool	47.24	Water Supply	Domestic	47.24	35.05	-	-

*MOECC WWID: Ministry of Environment and Climate Change Water Well Records Identification

**metres below ground surface

Soil Engineers Ltd.
CONSULTING ENGINEERS
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BARRIE	MISSISSAUGA	OSHAWA	NEWMARKET	GRAVENHURST	PETERBOROUGH	HAMILTON
TEL: (705) 721-7863	TEL: (905) 542-7605	TEL: (905) 440-2040	TEL: (905) 853-0647	TEL: (705) 684-4242	TEL: (905) 440-2040	TEL: (905) 777-7956
FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (416) 754-8516	FAX: (705) 684-8522	FAX: (905) 725-1315	FAX: (905) 542-2769

APPENDIX ‘B’

RESULTS OF SINGLE WELL RESPONSE TESTS

REFERENCE NO. 1606-W168

Falling Head Test (Slug Test)

Test Date:		19-Aug-16	
Piezometer/Well No.:		BH/MW 1	
Ground level:		268.59	m
Screen top level:		265.49	m
Screen bottom level:		262.49	m
Test El. (at midpoint of screen):		263.99	m
Test depth (at midpoint of screen):		4.6	m
Screen length	L=	3.00	m
Diameter of undisturbed portion (	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.511	m
Initial water depth		0.95	m
Aquifer material:		**Sandy Silt, 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)

$$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.00087553$$

K= **3.0E-05** cm/s

3.0E-07 m/s

Falling Head Test (Slug Test)

Test Date:		19-Aug-16	
Piezometer/Well No.:		BH/MW 2	
Ground level:		270.55	m
Screen top level:		266.15	m
Screen bottom level:		263.15	m
Test El. (at midpoint of screen):		264.65	m
Test depth (at midpoint of screen):		5.9	m
Screen length	L=	3.00	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.509	m
Initial water depth		2.32	m
Aquifer material:		**Sandy Silt, Till**	

Shape factor

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

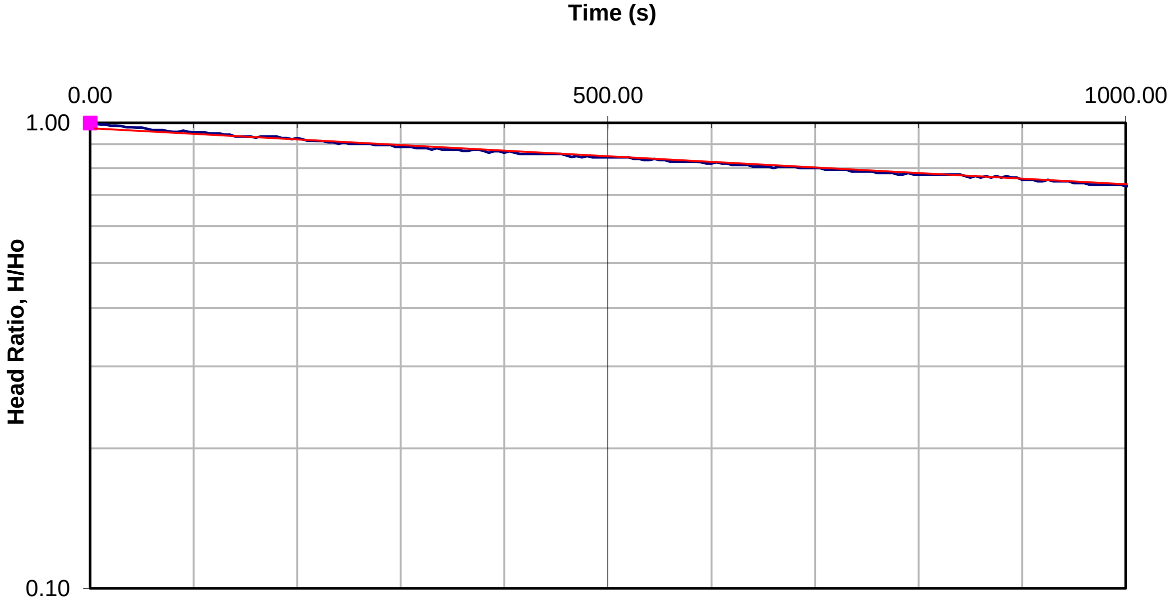
Permeability

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

(Bouwer and Rice Method)

$$\frac{\ln (H1/H2)}{(t2 - t1)} = 0.00025958$$

K= **8.9E-06** cm/s
8.9E-08 m/s



Falling Head Test (Slug Test)

Test Date:		19-Aug-16	
Piezometer/Well No.:		BH/MW 3	
Ground level:		264.19	m
Screen top level:		261.29	m
Screen bottom level:		258.29	m
Test El. (at midpoint of screen):		259.79	m
Test depth (at midpoint of screen):		4.4	m
Screen length	L=	3.00	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.595	m
Initial water depth		3.03	m
Aquifer material:		**Silty Sand Till and Sandy Silt Till**	

Shape factor

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

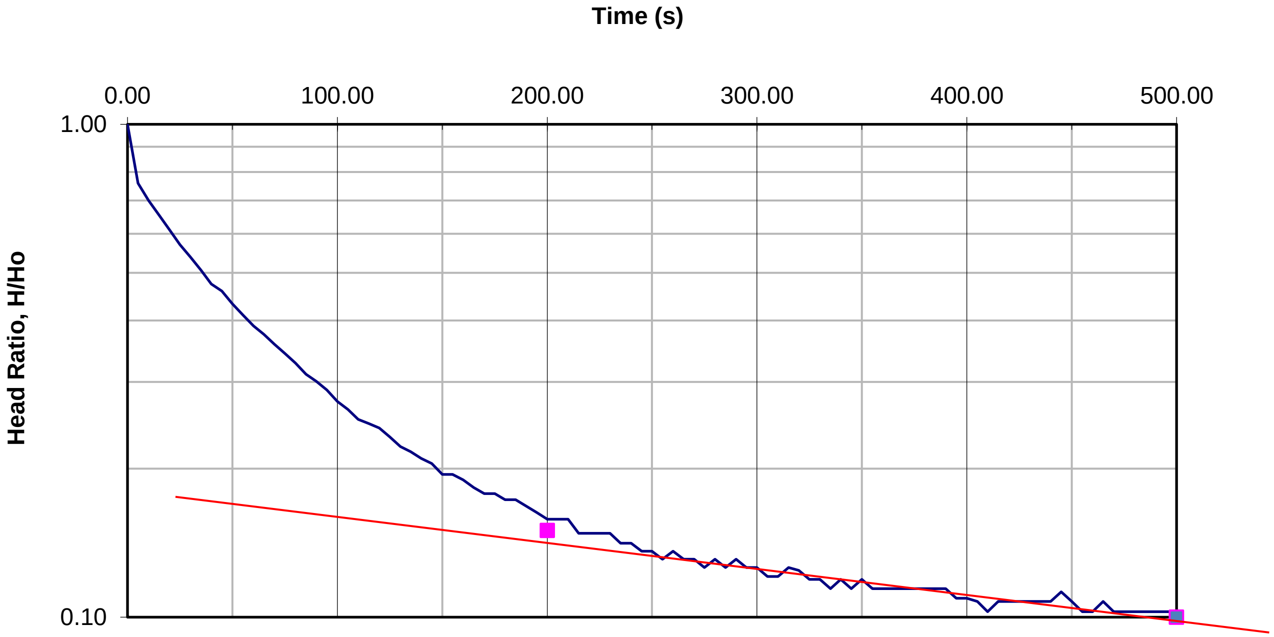
Permeability

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

(Bouwer and Rice Method)

$$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.00135155$$

K= **4.7E-05** cm/s
4.7E-07 m/s



Falling Head Test (Slug Test)

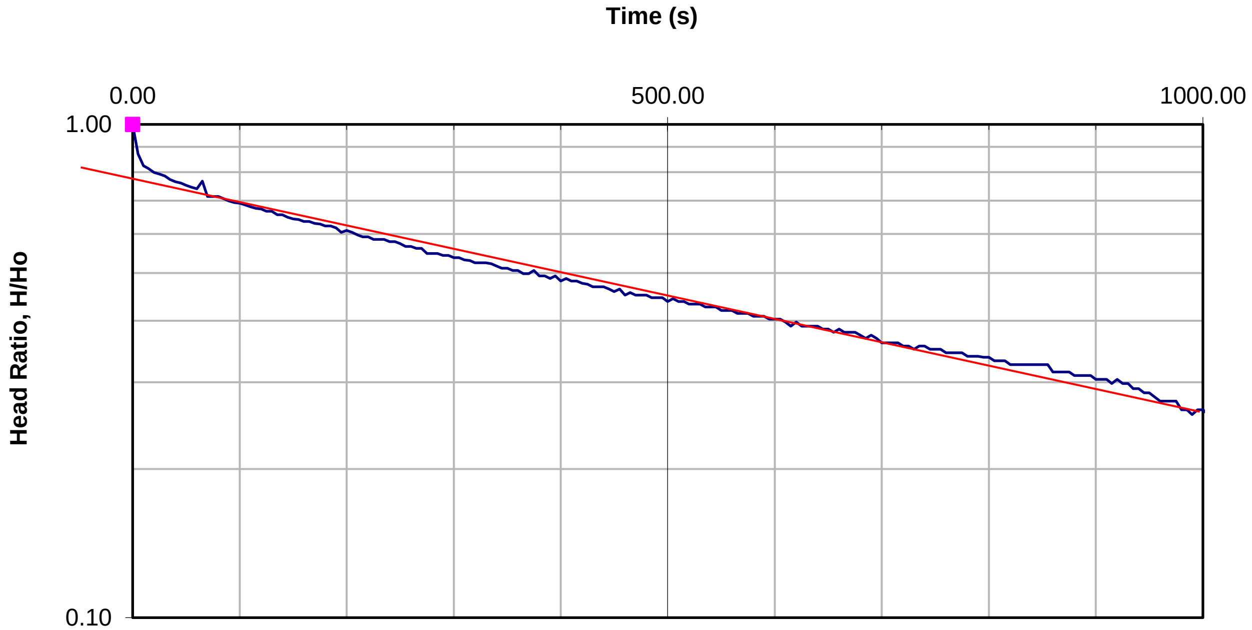
Test Date:		19-Aug-16	
Piezometer/Well No.:		BH/MW 4	
Ground level:		261.91	m
Screen top level:		260.31	m
Screen bottom level:		257.31	m
Test El. (at midpoint of screen):		258.81	m
Test depth (at midpoint of screen):		3.1	m
Screen length	L=	3.00	m
Diameter of undisturbed portion c	2R=	0.22	m
Standpipe diameter	2r=	0.05	m
Initial unbalanced head	Ho=	-0.546	m
Initial water depth		2.85	m
Aquifer material:		**Silty Sand Till and Sandy Silt 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)

$$\frac{\ln(H1/H2)}{(t2 - t1)} = 0.00165269$$

K= **5.7E-05** cm/s
5.7E-07 m/s



APPENDIX ‘C’

NITRATE IMPACT ASSESSMENT

REFERENCE NO. 1606-W168

STANDARD TERTIARY

Soil Engineers Ltd.

Subject Site Information				
Total Site Area	8.74 ha	87,410.00	m^2	
Proposed Lots	19			
Lot Types	Conventional Residential			
(1 lot reserved for SWM pond)				recharge (full site area) 87,410.00 m^2
Calculation of Infiltration Rate				
Annual Water Surplus after interception		402.87	mm/yr	Net Area available for recharge infiltration
Weighted infiltration to soil		261.87	mm/yr	MOECC infiltration factor (total of factors)
				0.65 *Slope* rolling land (0.2)
Nitrate going into the system				total of MOE *cover* Wooded Lot (0.2)
				infiltr factors *soil* Silty sand till/Sand (0.25)
Concentration of nitrate in precipitation		0.1	mg/L	Source: G.K.Rutherford
Net Area of subject site		87,410.00	sq. m	considers diversion of roof runoff to recharge groundwater
Infiltration of soil		0.2618655	m/yr	
Annual Infiltration to site (volume)		22,889.66	m^3/yr	
volume of recharge to soil/groundwater table		**22,889,663.36**	L/yr	
Nitrate exiting leaching bed system				
Concentration of nitrate in septic bed effluent		20	mg/L	Assumed standard tertiary treatment loading
Area of septic bed for each lot		257.24	m^2	Based on average leaching bed sizes
Assumed loading rate of sewage system		7,628.50	m^3/yr	1,100 L/day (average daily loading per residential dwelling)
assuming 15 conventional residential lots		**7,628,500.00**	L/yr	
Background nitrate in groundwater excluded	3 mg/L			
Calculated Concentration at Property Boundary based on standard tertiary sewage systems		**5.07**	mg/L	**<10 mg/L** (Maximum Permitted Concentration of Nitrate at Property Boundary, based on ODWS)
results assume no dilution resulting from groundwater underflow				NO UNDERFLOW DILUTION
Alernate calculation after considering background nitrate in groundwater (@3.00 mg/L)		**8.07**	mg/L	
				<10 mg/L (Maximum Permitted Concentration of Nitrate at Property Boundary, based on ODWS) NO UNDERFLOW DILUTION

*Source: G.K. Rutherford, A Preliminary Study of the Composition of Precipitation in Southern Ontario, Department of Geography, Queen's University, Kingston, Ontario, Canada. Received April 14, 1967.

CONVENTIONAL SYSTEM

Soil Engineers Ltd.

Subject Site Information

Total Site Area	8.74 ha	87,410.00	m^2
Proposed Lots	19		
Lot Types	Conventional Residential		
(1 lot reserved for proposed SWM pond)			

Net Area for recharge (full site area)	87,410.00	m^2

Calculation of Infiltration Rate

Annual Water Surplus after interception	402.87	mm/yr
Weighted infiltration to soil	261.87	mm/yr

MOECC infiltration factor (total of factors)

0.65	*Slope*	Rolling land (0.2)
total of MOE	*cover*	Wooded Lot (0.2)
infiltr factors	*soil*	Silty sand till/Sand (0.25)

Source: G.K.Rutherford

considers diversion of roof runoff to recharge groundwater

Nitrate going into the system

Concentration of nitrate in precipitation	0.1	mg/L
Net Area of subject site	87,410.00	sq. m
Infiltration of soil	0.2618655	m/yr
Annual Infiltration to site (volume)	22,889.66	m^3/yr
volume of recharge to soil/groundwater table	**22,889,663.36**	L/yr

Nitrate exiting leaching bed system

Concentration of nitrate in septic bed effluent	40	mg/L	Assumed conventional system loading
Area of septic bed for each lot	257.24	m^2	Based on average leaching bed sizes
Assumed loading rate of sewage system	7,628.50	m^3/yr	1,100 L/day (average daily loading per residential dwelling)
assuming 15 conventional residential lots	**7,628,500.00**	L/yr	

Background nitrate in groundwater excluded 3 mg/L

Calculated Concentration at Property Boundary based on conventional sewage systems	**10.07**	mg/L	**>10 mg/L** (Maximum Permitted Concentration of Nitrate at Property Boundary, based on ODWS)

results assume no dilution resulting from groundwater underflow

NO UNDERFLOW DILUTION

Alernate calculation considering the inclusion of background nitrate in groundwater (@3.00 mg/L)	**13.07**	mg/L

>10 mg/L (Maximum Permitted Concentration of Nitrate at Property Boundary, based on ODWS)
NO UNDERFLOW DILUTION

*Source: G.K. Rutherford, A Preliminary Study of the Composition of Precipitation in Southern Ontario, Department of Geography, Queen's University, Kingston, Ontario, Canada. Received April 14, 1967.

STANDARD TERTIARY

Soil Engineers Ltd.

Subject Site Information						
Total Site Area	8.74 ha	87,410.00	m^2			
Proposed Lots	30					
Lot Types	Conventional Residential					
(1 lot reserved for SWM pond)				recharge (full site area)	87,410.00	m^2
Calculation of Infiltration Rate						
Annual Water Surplus after interception		402.87	mm/yr	Net Area available for recharge infiltration		
Weighted infiltration to soil		261.87	mm/yr	MOECC infiltration factor (total of factors)		
				0.65	*Slope*	rolling land (0.2)
Nitrate going into the system				total of MOE	*cover*	Wooded Lot (0.2)
				infiltr factors	*soil*	
Concentration of nitrate in precipitation		0.1	mg/L	Source: G.K.Rutherford		Silty sand till/Sand (0.25)
Net Area of subject site		87,410.00	sq. m	considers diversion of roof runoff to recharge groundwater		
Infiltration of soil		0.2618655	m/yr			
Annual Infiltration to site (volume)		22,889.66	m^3/yr			
volume of recharge to soil/groundwater table		**22,889,663.36**	L/yr			
Nitrate exiting leaching bed system						
Concentration of nitrate in septic bed effluent		20	mg/L	Assumed standard tertiary treatment loading		
Area of septic bed for each lot		257.24	m^2	Based on average leaching bed sizes		
Assumed loading rate of sewage system		12,045.00	m^3/yr	1,100 L/day (average daily loading per residential dwelling)		
assuming 15 conventional residential lots		**12,045,000.00**	L/yr			
Background nitrate in groundwater excluded	3 mg/L					
Calculated Concentration at Property Boundary based on standard tertiary sewage systems		**6.96**	mg/L	**<10 mg/L** (Maximum Permitted Concentration of Nitrate at Property Boundary, based on ODWS)		
results assume no dilution resulting from groundwater underflow				NO UNDERFLOW DILUTION		
Alernate calculation after considering background nitrate in groundwater (@3.00 mg/L)		**9.96**	mg/L			
				<10 mg/L (Maximum Permitted Concentration of Nitrate at Property Boundary, based on ODWS) NO UNDERFLOW DILUTION		

*Source: G.K. Rutherford, A Preliminary Study of the Composition of Precipitation in Southern Ontario, Department of Geography, Queen's University, Kingston, Ontario, Canada. Received April 14, 1967.

APPENDIX ‘D’

WATER QUALITY CERTIFICATE OF ANALYSIS

REFERENCE NO. 1606-W168

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: SOIL ENGINEERS LIMITED
100 NUGGET AVENUE
TORONTO, ON M1S3A7
(416) 754-8515

ATTENTION TO: Gavin O'Brien

PROJECT: 1606-W168

AGAT WORK ORDER: 16T131833

WATER ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Sep 06, 2016

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

Certificate of Analysis

AGAT WORK ORDER: 16T131833
PROJECT: 1606-W168

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: SOIL ENGINEERS LIMITED
SAMPLING SITE:

ATTENTION TO: Gavin O'Brien
SAMPLED BY:

Inorganic Chemistry (Water)

DATE RECEIVED: 2016-08-29

DATE REPORTED: 2016-09-06

			SAMPLE DESCRIPTION:	BH/MW 3		BH/MW 1		BH/MW 2
			SAMPLE TYPE:	Water		Water		Water
			DATE SAMPLED:	8/26/2016		8/26/2016		8/26/2016
Parameter	Unit	G / S	RDL	7811718	RDL	7811720	RDL	7811723
pH	pH Units		NA	8.22	NA	8.03	NA	7.97
Nitrate as N	mg/L		0.05	<0.05	0.5	3.0	0.05	<0.05
Nitrite as N	mg/L		0.05	<0.05	0.5	<0.5	0.05	<0.05
Ammonia as N	mg/L		0.02	<0.02	0.02	<0.02	0.02	<0.02
Total Phosphorus	mg/L		0.05	1.84	0.05	3.21	0.05	0.92
Total Kjeldahl Nitrogen	mg/L		0.10	<0.10	0.10	0.21	0.10	0.12

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

7811720 Elevated RDL indicates the degree of sample dilution prior to the analysis for Anions in order to keep analytes within the calibration range of the instrument and to reduce matrix interference.

Certified By: Amanjot Bhela

Quality Assurance

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 1606-W168
SAMPLING SITE:

AGAT WORK ORDER: 16T131833
ATTENTION TO: Gavin O'Brien
SAMPLED BY:

Water Analysis

RPT Date: Sep 06, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Inorganic Chemistry (Water)															
pH	7806888		7.61	7.69	1.0%	NA	101%	90%	110%	NA			NA		
Nitrate as N	7812051		<0.25	<0.25	NA	< 0.05	98%	90%	110%	105%	90%	110%	110%	80%	120%
Nitrite as N	7812051		<0.25	<0.25	NA	< 0.05	NA	90%	110%	97%	90%	110%	103%	80%	120%
Ammonia as N	7810703		0.12	0.12	0.0%	< 0.02	95%	90%	110%	104%	90%	110%	111%	80%	120%
Total Phosphorus	7812000		<0.05	<0.05	NA	< 0.05	100%	80%	120%	101%	90%	110%	98%	70%	130%
Total Kjeldahl Nitrogen	7806904		0.40	0.37	NA	< 0.10	107%	80%	120%	103%	80%	120%	98%	70%	130%

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: SOIL ENGINEERS LIMITED

AGAT WORK ORDER: 16T131833

PROJECT: 1606-W168

ATTENTION TO: Gavin O'Brien

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
pH	INOR-93-6000	SM 4500-H+ B	PC TITRATE
Nitrate as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-93-6059	QuikChem 10-107-06-1-J & SM 4500 NH3-F	LACHAT FIA
Total Phosphorus	INOR-93-6057	QuikChem 10-115-01-3-A & SM 4500-P I	LACHAT FIA
Total Kjeldahl Nitrogen	INOR-93-6048	QuikChem 10-107-06-2-I & SM 4500-Norg D	LACHAT FIA

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water intended for human consumption)

Laboratory Use Only

Work Order #: 16T131833

Cooler Quantity: ~~[illegible]~~ 3 small

Arrival Temperatures: 4.3 | 4.5 | 4.1
3.7 | 3.4 | 5.2

Custody Seal Intact: ☐ Yes ☐ No ☑ N/A

Notes:

Report Information:

Company: Soil Engineers Ltd
Contact: Gavin O'Brien
Address: 100 Nugget Ave
Toronto, ON M1S 3A7
Phone: 416-754-8515 Fax: 416-754-8516
Reports to be sent to:
1. Email: gavin@soilengineersltd.com
2. Email: vivian.yu@soilengineersltd.com

Regulatory Requirements:

☑ No Regulatory Requirement

(Please check all applicable boxes)

☐ Regulation 153/04
Table ____ *Indicate One*
☐ Ind/Com
☐ Res/Park
☐ Agriculture
Soil Texture *(Check One)*
☐ Coarse
☐ Fine

☐ Sewer Use
☐ Sanitary
☐ Storm
Region ____ *Indicate One*

☐ Regulation 558
☐ CCME
☐ Prov. Water Quality Objectives (PWQO)
☐ Other
____ *Indicate One*

Is this submission for a **Record of Site Condition?** ☐ Yes ☑ No

Report Guideline on *Certificate of Analysis* ☐ Yes ☑ No

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT **(Rush Surcharges Apply)**

☐ 3 Business Days ☐ 2 Business Days ☐ 1 Business Day

OR Date Required (Rush Surcharges May Apply): ____

Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*

Project Information:

Project: 1606-W168
Site Location: 3879 Town Line, Orillia
Sampled By: Vivian
AGAT Quote #: ____ PO: ____
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☑ No ☐

Company:
Contact:
Address:
Email:

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Please Circle) Y / N	Metals and Inorganics	Metal Scan	Hydride Forming Metals	Client Custom Metals	(Check Applicable) ORPs: ☐ B-HWS ☐ Cl⁻ ☐ CN⁻ ☐ Cr^{6+} ☐ EC ☐ FOC ☐ NO_3/NO_2 ☐ Total N ☐ Hg ☐ pH ☐ SAR	Nutrients: ☑ TP ☑ NH_3 ☑ TKN ☑ NO_3 ☑ NO_2 ☐ NO_3/NO_2	Volatiles: ☐ VOC ☐ BTEX ☐ THM	CCME Fractions 1 to 4	ABNs	PAHs	Chlorophenols	PCBs	Organochlorine Pesticides	TCLP Metals/Inorganics	Sewer Use	pH					
BH/MW 3	8/26/2016	9:30	3	GW	TP/NH3 field filtered							✓										✓					
BH/MW 1	8/26/2016	11:00	3	GW	TP/NH3 field filtered							✓										✓					
BH/MW 2	8/26/2016	1:00	3	GW	TP/NH3 field filtered							✓										✓					

Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time
Vivian Yu	8/29/2016	9:00		2016/8/29	12:05

Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time
	2016/8/29	1:57		16/8/29	1:37

Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time

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Nº: T 026353