Solmar (Niagara 2) Inc.

HYDROGEOLOGICAL INVESTIGATION

200 John Street and 588 Charlotte Street, Niagara-on-the-Lake, Ontario

Project No. 2018-0419

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Attention: Mr. Correia

Hydrogeological Investigation Report
Proposed Development at 200 John Street and 588 Charlott Street,
Niagara-on-the-Lake, ON

Cole Engineering Group Ltd. (COLE) is pleased to submit the enclosed hydrogeological investigation report for the site located at 200 John Street and 588 Charlotte Street, Niagara-on-the-Lake, ON. This investigation includes a review of the hydrogeological information collected from the site, characterization of the geological and hydrogeological setting, assessment of potential impacts due to the proposed development, and proposed mitigation measures.

Should you have any questions or comments, please do not hesitate to contact the undersigned.

Best Regards,
COLE ENGINEERING GROUP LTD.

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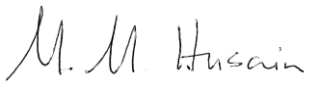

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Issues and Revisions Registry

Identification	Date	Description of issued and/or revision
Draft Report	27 November 2018	For internal review
Draft Report	30 November 2018	For client review
Final Report	4 October 2019	For client review
Final Report (minor site plan updates)	30 June 2020	For client review

Statement of Conditions

This Report has been prepared at the request of, and for the exclusive use of, Solmar (Niagara 2) Inc., and its affiliates (the "Intended User"). No one other than the Intended User has the right to use and rely on the Work without first obtaining the written authorization of Cole Engineering Group Ltd. and Solmar (Niagara 2) Inc. Cole Engineering Group Ltd. expressly excludes liability to any party except the Intended User for any use of, and/or reliance upon, the work.

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Executive Summary

Cole Engineering Group Ltd. ("COLE") was retained by Solmar (Niagara 2) Inc. to undertake a hydrogeological investigation in support of the proposed residential development 220 John Street and 588 Charlotte Street, Niagara-on-the-Lake, ON (the "Site").

The Site is situated in the Iroquois Plain physiographic region, and falls under the jurisdiction of the Niagara Peninsula Conservation Authority ("NPCA"). Regional mapping indicates that the Site is not located within Wellhead Protection Area ("WHPA") or Significant Recharge Area ("SGRA"). However, the Site is located within a highly vulnerable aquifer ("HVA").

At a regional scale, groundwater flows to the north towards Lake Ontario. Four (4) monitoring events were completed from September 27, 2018 to August 21, 2019 to assess groundwater levels at the Site. Groundwater elevations were generally higher in the southern portion of the Site and at a lower elevation in the northern portion of the Site. Shallow groundwater flow appears to augment the direction of regional groundwater flow and surface topography and flows in a northeasterly direction towards Lake Ontario.

Single-well hydraulic tests were conducted in three (3) on-site monitoring wells to determine the in-situ hydraulic conductivity (K) of the screened overburden materials. The in-situ K values were estimated to range from 1.1×10^{-6} m/s to 2.5×10^{-8} m/s.

Two (2) groundwater samples were collected from two (2) on-site monitoring wells. The results were compared against the Provincial Water Quality Objectives ("PWQO"). Based on the laboratory analysis, the results met the applicable criteria with the exception of minor exceedances of total cobalt and total uranium.

A small tributary has been mapped across the northern portion of the Site. No stream flow was observed at the monitoring station during the four (4) monitoring events. A mini-piezometer nest station was installed to assess potential interaction between the groundwater system and on-site watercourse. The downward vertical hydraulic gradient estimates obtained at mini-piezometer nest indicates that that the stream is not groundwater fed.

Potential impacts to the groundwater system associated with the proposed development include reduction in infiltration, lowering of the groundwater levels in the overburden, and the potential introduction of preferential pathways for contaminants. Based on the results of a preliminary water balance analysis for the Site, an infiltration reduction of 12,075 m^3/year is anticipated as a result of the proposed development without any mitigation.

Low Impact Development ("LID") measures (e.g., underground infiltration trenches, grassed or dry swales, and green roofs) may be proposed and designed at the detailed design stage to address the infiltration deficit and match pre-development infiltration. The use of collars or other methods to restrict preferential movement of groundwater along the subsurface infrastructure corridors are recommended to preserve the existing groundwater flow regime. Furthermore, road salt application at the proposed development should be managed to minimize sodium and/or chloride loading to the shallow groundwater system.

1 Introduction

1.1 Project Background

Cole Engineering Group Ltd. ("COLE") was retained by Solmar (Niagara 2) Inc. to undertake a hydrogeological investigation in support of the proposed residential development at 220 John and 588 Charlotte Street, Niagara-on-the-Lake, ON (the "Site"). The Site is located within an agricultural setting and is bounded by vineyards to the east with residential subdivisions that extend from the southwest along the Promenade Road to the northwest along the Charlotte Street and John Street intersection. The Site is irregular in shape with an approximate area of 12.34 hectares (ha) and consists primarily of vacant land. The location of the Site is shown on **Figure 1**.

The proposed development consists of residential semi-detached and single-detached homes. Collectively, 191 units will be constructed as part of the final development and will utilize much of the available land that is currently present. A proposed conceptual site plan is shown in **Appendix A.**

1.2 Objectives

This hydrogeological investigation was conducted to:

- Characterize the existing geological and hydrogeological setting;
- Identify groundwater-related regulations applicable to the Site development;
- Assess potential groundwater-surface interactions;
- Review groundwater quality results for the Site and compare to Provincial Water Quality Objectives ("PWQO");
- Assess the potential impacts to the natural environment and other groundwater users as a result of the development; and
- Provide recommendations on management measures to mitigate potential impacts.

2 Applicable Regulation and Agencies

Environmental regulations and policies that may be relevant for this hydrogeological investigation are briefly discussed below.

Niagara Peninsula Conservation Authority ("NPCA") Policies and Regulations (O.Reg. 155/06)

Under Section 28 of the *Conservation Authorities Act*, the local conservation authorities are mandated to protect the health and integrity of the regional greenspace system and to maintain or improve the hydrological and ecological functions performed by valley and stream corridors. The NPCA, through its regulatory mandate, is responsible for issuing permits under *Ontario Regulation (O.Reg.) 155/06, Development, Interference with Wetlands and Alterations to Shorelines and Watercourses* for development proposal or Site alteration work within the regulated areas.

Based on mapping by the NPCA, the small portion of the Site is located within a NPCA regulated area (regulated floodplains). As such, a permit under *O.Reg. 155/06* will be required for the proposed development.

Town of Niagara-on-the-Lake Official Plan (2017)

The Official Plan of the Town of Niagara-on-the-Lake contains a vision and sets up policies that deal with legislative and administrative concerns, policies to guide physical growth and policies to express a wide of social, economic and environmental concerns. Based on Schedule J, any proposed development or site alternation within or adjacent to any natural heritage feature, the regulated area of the NPCA, and the official Plan of the Town Niagara-on-the-Lake shall provide an inventory and assessment of ecological features to determine areas to be protected.

Permit to Taker Water ("PTTW"), Section 34 of the Ontario Water Resource Act (1990)

For construction dewatering, water takings of more than 50,000 L/day but less than 400,000 L/day may be registered on the Environmental Activity and Sector Registry ("EASR"), while water takings of more than 400,000 L/day require a PTTW issued by the Ministry of Environment, Conservation and Parks ("MECP"). If it is identified that an EASR or PTTW is required for the Site, then an updated hydrogeological report would need to be submitted in support of the application. The updated report would include assessment of any potential impacts associated with the construction dewatering and establish a monitoring plan and set of mitigation measures to address the potential impacts.

The Clean Water Act, 2006

The MECP mandates the protection of existing and future sources of drinking water under the Clean Water Act, 2006 ("CWA"). Initiatives under the CWA include the delineation of Wellhead Protection Areas ("WHPAs"), significant groundwater recharge areas ("SGRAs") and Highly Vulnerable Aquifers ("HVAs") as well as the assessment of drinking water quality and quantity threats within Source Protection Regions. Source Protection Plans are developed under the CWA and include the restriction and prohibition of certain types of activities and land uses within WHPAs.

Based on a review of the Source Water Protection Report mapping produced by the NPCA, the Site is not located within a WHPA or a SGRA. Therefore, the CWA is not applicable.

3 Regional Geological and Hydrogeological Understanding

3.1 Topography and Physiography

The Site lies within the Niagara River Watershed, which is under the jurisdiction of the NPCA. The regional topography is generally flat with slight undulations. The Niagara River is located approximately 1 km east of the Site boundary and flows north to Lake Ontario. Additionally, a creek traverses across the northern section of the Site and is located approximately 100 m southwest of John Street East. Within the Site, the ground surface is generally flat with an average elevation of approximately 93 m above sea level ("masl"). A map of the local topography surrounding the Site is shown on **Figure 2.**

The Site is situated within the physiographic region known as the Iroquois Plain. In this region, the area is described as a having stratified clay, sand and silt glaciolacustrine deposits which are underlain by silt to silt clay till deposits (Chapman and Putnam, 1984). A physiography map of the Site and surrounding area is shown on **Figure 3**.

3.2 Regional Geology and Hydrogeology

The current understanding of the geological and hydrogeological conditions was based on work by the Ontario Geological Survey ("OGS") and information available from the NPCA.

In general, overburden thickness is interpreted to range from approximately 5 m to 10 m. The regional surficial geology within and around the Site is characterized by glaciolacustrine deposits that have been reworked sand, silts and clay. Surficial mapping indicates that the Site is underlain by coarse-textured glaciolacustrine deposits. In addition, surrounding the Site are clayey silt glacial till deposits. **Figure 4** illustrates the regional surficial geology underlying the Site.

The bedrock underlying the Site consists of the Queenston Formation. The Queenston Formation consists primarily of shale, with minor amounts of limestone, dolostone, and siltstone (OGS, 2005). The bedrock surface in the area is expected to be at approximately 80-85 masl. A bedrock geology map is presented as **Figure 5.**

Based on the abundance of fine-grained glaciolacustrine deposits, fine-grained till, and shale bedrock, widespread transmissive aquifers are not anticipated. The fine-grained units may act as a semi-confining layer.

4 Local Geology and Hydrogeology

The current understanding of the local geological and hydrogeological environment at the Site is based on the geotechnical investigation conducted by Soil Engineers Ltd. ("Soil Engineers") and the hydrogeological investigation conducted by COLE.

4.1 Geotechnical Investigation

In August 2018, Soil Engineers conducted a geotechnical investigation at the Site (Soil Engineers, 2018). As part of this investigation, nine (9) boreholes were drilled to depths ranging between 5.4 m below ground surface ("mbgs") and 9.3 mbgs. The boreholes were identified as BH 1 through BH 9 and are illustrated on **Figure 6**. Based on the borehole logs, the primary composition of the overburden material at the Site consist of silty clay, sandy silt till to silty clay till, with some silt and silty sand. Earth fill material was encountered at BH8, which consisted of sandy silt, with rock fragments and brick debris. The fill thickness at BH8 was 1.4 m. The overall thickness of the overburden ranged from 5.4 m to 9.1 m. The corresponding borehole logs are included in **Appendix B**.

4.2 Groundwater Conditions

To support the hydrogeological investigation, the four (4) boreholes (three (3) shallow and one (1) deep) were completed as 50 mm groundwater monitoring wells to a maximum depth of approximately 9.65 mbgs. Three (3) shallow monitoring wells (MW1-S, MW2, and MW7) were screened to depths ranging from 3.1 mbgs to 6.1 mbgs and one (1) deep monitoring well (MW1-D) was screened to depths ranging from 6.1 mbgs to 9.1 mbgs The monitoring wells were used to measure groundwater levels, collect samples for groundwater quality analyses, and estimate hydraulic conductivity of the screened units. A map illustrating the location of the boreholes and monitoring wells is provided as **Figure 6.**

4.2.1 Groundwater Levels

Each monitoring well was developed prior to measuring the water level by removing a minimum of three (3) well volumes of water to clear any silt or drilling debris from the sandpack and well casing. Four (4) monitoring events were conducted from September 27, 2018 to August 21, 2019 to assess groundwater levels at the Site. Monitoring data are presented in **Table 4.1**.

Table 4.1 Water Level Measurements

Well ID	Ground Elevation (masl)	Depth to bottom (mbgs)	27 Sep 18		16 Nov 18		29 March 19		21 Aug 19	
			mbgs	masl	mbgs	masl	mbgs	masl	mbgs	masl
MW1-S	91.50	6.2	2.14	89.36	1.78	89.72	1.27	**90.23**	1.40	90.10
MW1-D	91.50	9.3	2.24	89.26	1.86	89.64	1.33	90.17	1.45	90.05
MW2	91.10	6.3	4.12	**86.98**	3.76	87.34	2.46	88.64	3.06	88.04
MW7	90.50	6.6	2.57	87.93	2.55	87.95	1.81	88.69	2.03	88.47

Notes:
mbgs meters below ground surface
masl meters above sea level

A review of the groundwater level measurements indicates that the groundwater level ranges from 90.23 masl (1.27 mbgs) to 86.98 masl (4.12 mbgs). The highest observed groundwater level (90.23 masl) was measured at MW1-S on March 29, 2019 and the lowest observed water level (86.98 masl) was measured at MW2 on September 27, 2018.

Based on our conceptual understanding of the local hydrogeology, monitoring wells are considered to be screened within the unconfined overburden and the water levels recorded from the monitoring wells are interpreted to be representative of the shallow groundwater table.

4.2.2 Groundwater Flow

At a regional scale, groundwater is expected to flow north or northeast towards Lake Ontario and / or the Niagara River (Waterloo Hydrogeologic, 2005). Based on the groundwater levels collected during the four (4) monitoring events, shallow groundwater flows in a northeast direction and is consistent with the direction of the regional groundwater flow.

The vertical hydraulic gradient was also estimated at a monitoring well nest (MW1D/MW1S). **Table 4.2** below summarizes the calculated vertical hydraulic gradient at the well nest for the water level monitoring events conducted from September 27, 2018 to August 21, 2019.

Table 4.2 Estimated Vertical Hydraulic Gradient at onsite Monitoring Wells

Well Nest	Vertical Hydraulic Gradient (m/m)			
	27-Sep-18	16-Nov-18	29-March-19	21-Aug-19
MW1D/MW1S	0.04	0.03	0.02	0.02

Notes:

Well Nest	Vertical Hydraulic Gradient (m/m)			
	27-Sep-18	16-Nov-18	29-March-19	21-Aug-19

Negative values indicate an upward gradient; positive values indicate a downward gradient.

Based on the available water level measurement collected between September 27, 2018 and August 21, 2019, the vertical hydraulic gradient at the MW1D/MW1S well nest was determined to be neutral to downward.

4.2.3 Hydraulic Conductivity

Single-well hydraulic tests were conducted by COLE on September 27 and 28, 2018 in three (3) monitoring wells. These tests were carried out to estimate the in-situ hydraulic conductivity (K) of the screened overburden materials.

During each hydraulic test, a known volume of water was displaced from the well by either inserting a slug or removing water. The recovery was measured either manually or using a data logger until a minimum of 80% recovery was achieved. Hydraulic conductivity estimates were obtained using the Hvorslev method (1951). Estimated K values are presented in **Table 4.3**. Details of the Hvorslev method and a summary of Hvorslev calculations are presented in **Appendix C.**

Table 4.3 Estimated Hydraulic Conductivity

Well ID	Well Diameter (m)	Screen Length (m)	Screen Unit	K (m/s)
MW1-D	0.05	3	Sandy Silt Till/Shale	1.1×10^{-6}
MW2	0.05	3	Sandy Silt Till	2.5×10^{-8}
MW7	0.05	3	Sandy Silt Till	5.4×10^{-8}

The in-situ K values estimated using the Hvorslev method range from 1.1×10^{-6} m/s to 2.5×10^{-8} m/s. Overall, the estimated hydraulic conductivities are within the range for the types of materials (sandy silt till) in which the shallow monitoring wells were screened (Freeze and Cherry, 1979).

4.2.4 Groundwater Quality

COLE collected two (2) groundwater samples on September 28, 2018 from two (2) on-site monitoring wells (MW1-D and MW2). The collected samples were sent to Maxxam Analytics for analyses of metal and inorganic criteria. Analytical results were compared to Provincial Water Quality Objectives ("PWQO"). Results are summarized in **Table 4.4** below. The laboratory analytical results and Certificate of Analysis are included in **Appendix D**.

Table 4.4 Groundwater Quality Results

Parameter	Units	PWQO Guidelines	MW1-D	MW2
Inorganics				
Total Ammonia	mg/L	20	0.051	0.25

Table 4.4 Groundwater Quality Results

Parameter	Units	PWQO Guidelines	MW1-D	MW2
Dissolved Oxygen	mg/L	-	8.67	8.51
pH	pH	6.5-8.5	8.21	8.18
Phenols-4AAP	mg/L	1.0	ND	ND
Total Phosphorus	mg/L	30	24	12
Sulphide	mg/L	-	0.20	0.037
WAD Cyanide (Free)	µg/L	2	ND	660
Alkalinity (Total as $CaCO_3$)	Mg/L	-	310	ND
Metals				
Dissolved (0.2u) Aluminum (Al)	ug/L	75	5	ND
Chromium (VI)	ug/L	1	ND	ND
Mercury (Hg)	ug/L	0.2	ND	ND
Total Antimony (Sb)	ug/L	20	ND	ND
Total Arsenic (As)	ug/L	100	8.4	1.1
Total Beryllium (Be)	ug/L	1100	ND	ND
Total Boron (B)	ug/L	200	230	88
Total Cadmium (Cd)	ug/L	0.5	ND	ND
Total Chromium (Cr)	ug/L	-	ND	ND
Total Cobalt (Co)	ug/L	0.9	ND	**1.4**
Total Copper (Cu)	ug/L	5	ND	3.8
Total Lead (Pb)	ug/L	5	ND	ND
Total Molybdenum (Mo)	ug/L	40	13	13
Total Nickel (Ni)	ug/L	25	1.2	9.2
Total Selenium (Se)	ug/L	100	ND	ND
Total Silver (Ag)	ug/L	0.1	ND	ND
Total Thallium (Tl)	ug/L	0.3	ND	ND
Total Tungsten (W)	ug/L	30	ND	1.0
Total Uranium (U)	ug/L	5	2.4	**7.7**
Total Vanadium (V)	ug/L	6	1.1	0.77
Total Zinc (Zn)	ug/L	30	ND	7.7
Total Zirconium (Zr)	ug/L	4	ND	ND

Based on laboratory analyses, the results for the groundwater sample collected from BH2 on September 27, 2018 exceeded the PWQO for total cobalt and total uranium. All other parameters met the criteria.

5 Groundwater – Surface Water Interactions

5.1 Streamflow

No stream flow was observed at the monitoring station during the four (4) monitoring events. Based on this observation, this water course is interpreted to not be a perennially flowing feature.

5.2 Stream Bank Mini-Piezometers

One (1) stream bank mini-piezometer nest was installed by COLE adjacent to the mapped on-site watercourse to assess potential groundwater – surface water interactions. The locations of the surface water monitoring stations are illustrated on **Figure 10**.

Each mini-piezometer consists of a 1.9 cm diameter galvanized steel pipe with a 0.3 m screened drivepoint. The piezometers were driven manually into the stream bank using a slide hammer. The shallow piezometers (denoted by "S" after the piezometer ID) were driven to depths ranging from 1.5 mbgs to 2.2 mbgs. The deep piezometers (denoted by "D" after the piezometer ID) were driven to depths ranging from 2.0 mbgs to 3.4 mbgs. Details of the surface water monitoring station is presented in **Table 5.1.**

Table 5.1 Surface Water Monitoring Station Details

Monitoring Station ID	Piezometer ID	Ground Elevation at Piezometer (masl)	Piezometer Depth to bottom of the screen (mbgs)	Piezometer Top of Riser above Grade (m)	Piezometer Diameter (m)	Piezometer Screen Length (m)
PZ-1	PZ-1D	88.5	2.23	0.43	0.02	0.30
	PZ-1S	88.5	0.55	0.85	0.02	0.3

Notes:
masl = metre above sea level
mbgs = metre below ground surface

Water levels at the mini-piezometers were measured manually from September 27, 2018 to August 21, 2019 through four (4) monitoring events. The piezometer water level monitoring data are presented in **Table 5.2.** Vertical hydraulic gradients were also estimated at each piezometer nest to assess potential groundwater-surface water interactions, as shown in **Table 5.3.**

Table 5.2 Piezometer Water Level Measurements

Well ID	Ground Elevation (masl)	Depth to bottom (mbgs)	27 Sep 18		16 Nov 18		29 March 19		21 Aug 19	
			mbgs	masl	mbgs	masl	mbgs	masl	mbgs	masl
PZ-1D	88.5	2.23	1.71	86.79	1.06	87.44	0.38	88.13	0.4	88.10
PZ-1S	88.5	0.55	dry	dry	0.55	87.95	0.11	88.39	0.46	88.04

Table 5.3 Estimated Vertical Hydraulic Gradients at Mini-Piezometers

Well Nest	Vertical Hydraulic Gradient (m/m)			
	27-Sep-18	16-Nov-18	29-March-19	21-Aug-19
MW1D/MW1S	-	0.51	0.27	-0.06

Notes:

Negative values indicate an upward gradient; positive values indicate a downward gradient.

'-' indicates that the vertical hydraulic gradient could not be estimated due to one or both piezometers being dry

A downward hydraulic gradient was estimated for the PZ-1 monitoring station on November 16, 2018 and March 29, 2019. Despite the estimated upward vertical hydraulic gradients on August 21, 2019, it was noted that no flow was observed at this location. Therefore, any groundwater contribution to the tributary at this location is believed to be minimal.

5.3 Groundwater – Surface Water Summary

Based on the observation of no flow in the water course during the Site visits and the downward vertical gradients, the water course is interpreted not to be perennial nor receive groundwater discharge.

6 Water Balance Analysis

As part of the hydrogeological investigation, a water balance analysis was completed to compare pre-development and post-development recharge conditions to evaluate predicted changes in recharge and runoff volumes due to the proposed development.

6.1 Water Balance Analysis Methodology

A site scale water balance analysis was completed following the Thornthwaite and Mather water balance method outlined in *Chapter 3 of the Ministry of Environment's ("MOE"s) Stormwater Management Planning and Design Manual* (MOE, 2003). The water balance method estimates evapotranspiration, infiltration, and runoff volumes based on soil types, vegetation cover, topography, and precipitation.

The St. Catharines/ Niagara District Airport station (ID# 6137287) is the closest meteorological station to the Site. Therefore, the climate normal data from this station between 1981 and 2010 were obtained from Environment Canada and used in the water balance analysis.

The monthly mean temperature and monthly precipitation data were used in the Thornthwaite and Mather Equation to estimate the monthly potential evapotranspiration. The estimated monthly potential evapotranspiration was adjusted using a daylight correction value to account for varying length of daylight throughout the year.

The precipitation surplus (amount of water available to infiltrate or runoff) was estimated by calculating the difference of the yearly precipitation and potential evapotranspiration. Infiltration was estimated by multiplying a set of infiltration factors (dependent on the topography, soil type and land cover) to the estimated precipitation surplus.

Impervious percentages for the pre-development and post-development scenarios were estimated by measuring the total impervious areas across the Site and are summarized in **Table 6.1**. The estimations of

pre-development pervious area and the post-development impervious areas were based on the Existing Site Condition plan provided by SGL (SGL Planning & Design Inc., June 2020).

The infiltration factor for each area was selected from Table 3.1 in the MOE's Stormwater Management Planning and Design Manual (MOE, 2003) based on various factors (topography, soil type and land cover) and is summarized in **Table 6.1**. Based on the geotechnical investigation by Soil Engineers Ltd. (Soil Engineers, 2018), the primary composition of the overburden material at the Site consist of silty clay, sandy silt till to silty clay till, with some silt and silty sand.

An infiltration factor reflective of medium combinations of clay and loam was assumed in estimating the infiltration rates for the Site.

Table 6.1 Summary of Infiltration Factors

Area	Area (m^2)	Impervious Percentage	Measured Slope (m/m)	Infiltration Factor (Topography)	Infiltration Factor (Soil)	Infiltration Factor (Cover)
Pre-Development	123,400	2%	0.01	0.2	0.2	0.2
Post-Development	123,400	64%	0.01	0.2	0.2	0.2

6.2 Water Balance Analysis Results

Based on the water balance analysis for the pre-development conditions, infiltration comprises a small portion (16%) of total precipitation, runoff comprises 12% of total precipitation, and evapotranspiration comprises the majority (72%) of total precipitation. A low infiltration rate is expected at the Site due to the low permeability soils (silty clay to silty sand) encountered during this investigation. The estimated overall infiltration rate for the pre-development scenario is approximately 141 mm/year (17,457 m^3/year).

The post-development water balance showed an increase in runoff and reduction in evapotranspiration and infiltration in the absence of mitigation measures due to the increased impervious areas. The post-development infiltration is reduced to approximately 6% of total precipitation, compared to 16% in the pre-development scenario. Runoff is increased to approximately 55% of total precipitation while evapotranspiration is decreased to approximately 39% of total precipitation. Based on the water balance analysis, the estimated infiltration in the post-development scenario is approximately 52 mm/year or 6,420 m^3/year before any mitigation measures are applied.

The difference between pre-development and post-development infiltration is approximately 89 mm/year (11,036 m^3/year). Details of the water balance analysis are presented in **Appendix E**.

7 Potential Receptors

7.1 Local Groundwater Users

A MECP well records search conducted around the Site identified 45 wells within a 1 km radius. Based on the MECP well records, the majority of wells (42%) were classified as monitoring and test hole wells. Seven (7) supply wells were identified within 1 km of the Site of which two (2) were used for livestock. The search results are summarized in **Table 7.1**. The locations of nearby MECP well records are illustrated on **Figure 7**.

Table 7.1 Summary of Private Well Uses within 1 km of the Site

Well Use	Number of Wells	Percent of Wells
Monitoring/Test Hole	19	42
Unknown/Other	15	33
Observation	3	7
Abandoned	1	2
Water Supply	7	16
Total	**45**	**100%**

A search of permitted water takers around the Site was conducted in November 2018 through the MECP digital data request process. The search return one (1) active groundwater taker within 850 m northeast of the Site. The permitted water taker was identified to be the Shaw Festival Theatre located on 10 Queen's Parade.

7.2 Environmental Features

There are no natural features on the Site aside from a small wooded area. The Niagara River is located approximately 1 km east of the Site boundary and flows north to Lake Ontario. Additionally, a creek traverses across the northern section of the Site and is located approximately 100 m southwest of John Street East. A search of the Natural Heritage Information Centre returned no significant environmental features within the Site's boundary (Ministry of Natural Resources and Forestry ("MNRF"), 2017). The natural features located within a 1 km buffer of the Site are illustrated on **Figure 8**.

8 Potential Impacts and Proposed Mitigation

8.1 Identification and Mitigation of Potential Impacts

8.1.1 Potential Impacts to the Groundwater System

The proposed development will increase the impermeable cover and, as a result, reduce the amount of infiltration to the underlying aquifer units while increasing surface water run-off. The results of the water balance analysis indicated the post-development infiltration is reduced to approximately 6% of the total precipitation, compared to 16% in the pre-development scenario. As a result, long-term impacts to the regional groundwater system may result from the reduced amount of groundwater infiltration to the aquifers. However, this impact is expected to be small at a watershed scale since the Site is not located within a SGRA under the CWA.

The introduction of overburden material with different hydraulic properties or alterations to the local topography during construction can affect the existing groundwater system. Installation of Site services could also potentially introduce preferential pathways for contaminants to the groundwater and alter the natural groundwater levels and pathways. Moreover, local groundwater quality may be affected by the future application of road salt along the roadways.

8.1.2 Potential Impacts to Natural Areas

As mentioned in **Section 7.2**, there is a surface water feature that traverses across the northern portion of the Site. Since this feature is interpreted not be perennial nor receive groundwater discharge, the expected reduction in infiltration should not impact this feature.

The increase in runoff due to increased impervious areas may result in greater stream flows into on-site and nearby watercourses, potentially leading to channel erosion and an increase in sediment loading into downstream surface water features. As such, the downstream water quantity and quality of the surface water features could potentially be affected by the proposed development without appropriate mitigation measures.

8.1.3 Potential Impacts to Other Groundwater Users

The areas around the Site are relatively developed and serviced with municipal water. Groundwater users are not expected in the area and potential impacts to nearby groundwater users are unlikely.

8.1.4 Potential Impacts related to Dewatering Activities

According to Section 34 of the Ontario Water Resources Act ("OWRA"), any groundwater taking greater than 400,000 L/day will require a Category 3 Permit to Take Water from the MECP. If the groundwater taking is less than 400,000 L/day but more than 50,000 L/day, the construction related taking can be filed under EASR online registry instead. A detailed review of site conditions and proposed infrastructure design will need to be undertaken to assess the need for dewatering during construction once site plans are prepared.

Should dewatering be required during construction, erosion control and settlement or filtration measures may be needed to remove entrained sediment from construction dewatering discharge prior to it being discharged to the natural environment in order to meet the PWQO.

8.1.5 Mitigation of Impacts

On a regional scale, most aquifer recharge occurs in areas where coarse-grained units are found at shallow depth. The Site is not expected to contribute a significant amount of infiltration on a watershed scale due to the generally low permeability of the overburden materials on-site. Various Best Management Practices ("BMP"s) (e.g., underground infiltration trenches, grassed or dry swales, green roofs) could be incorporated into the proposed development that would promote infiltration and decrease runoff. They may address the infiltration deficit and help preserve the existing groundwater flow regime, including maintaining groundwater contributions to nearby groundwater-dependent features. The use of collars or other methods to restrict the preferential movement of groundwater along the subsurface infrastructure corridors should also be considered.

9 Summary

A summary of the hydrogeological investigation is provided below:

- The Site is located within the Iroquois Plain physiographic region, which consist of fine-grained (silt and clay) glaciolacustrine deposits.
- Based on the borehole logs, surficial lithology comprised of topsoil or fill underlain predominantly fine-grained soil (silty clay, sandy silt till to silty clay till, with some silt and silty sand). Bedrock was

encountered at BH1, BH2, and BH3 and was confirmed to be part of the Queenston (shale) Formation.

- Single-well rising-head and falling-head tests were conducted in on-site monitoring wells to determine the in-situ hydraulic conductivity of the screened overburden materials. The in-situ K values were estimated to range from 1.1×10^{-6} m/s to 2.5×10^{-8} m/s.
- Groundwater levels at the monitoring wells were measured from September 28, 2018 to August 21, 2019 through four (4) monitoring events. The water levels from both monitoring events ranged between 4.12 mbgs and 1.27 mbgs.
- Two (2) groundwater samples were collected from two (2) on-site monitoring wells (MW1-D and MW2) on September 28, 2018. Based on laboratory analyses, the results for groundwater samples met all criteria for the PWQO guidelines with the exception of total cobalt and total uranium where elevated concentrations were noted for MW2.
- The potential long-term impacts to the groundwater system associated with the development include: reduction in infiltration; lowering of the groundwater levels in the overburden; and the introduction of preferential pathways for contaminants. Implementation of BMPs to promote infiltration and the use of collars or other methods to restrict preferential movement of groundwater along the subsurface infrastructure corridors are recommended to preserve the existing groundwater flow regime.

10 References

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Freeze, A. & Cherry, J. (1979). *Groundwater*. New Jersey: Prentice-Hall Inc.

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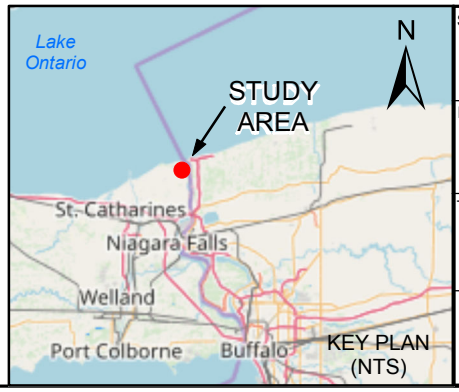
Soil Engineers Ltd. 2018. A geotechnical investigation for proposed residential development. 1807-S136.

Figures

LEGEND

- Site Boundary
- Road
- Watercourse
- Waterbody



SCALE 1:30,000

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PROJECT

Hydrogeological Investigation
200 John Street
Niagara-on-the-Lake, ON

TITLE

SITE LOCATION MAP

COLE	DATE: 06/25/2018		PROJECT: 2018-0419
	GIS	C.C. 06/25/2018	REV. 0.0
	DESIGN		FIGURE 1
	CHECK	A.H. 06/25/2018	

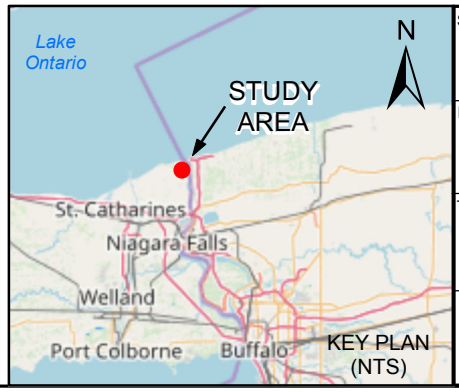
REFERENCE

LEGEND

- Site Boundary
- Arterial Road
- Watercourse
- Waterbody

Elevation (masl)

- 75
- 80
- 85
- 90
- 95



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PROJECT

Hydrogeological Investigation
200 John Street
Niagara-on-the-Lake, ON

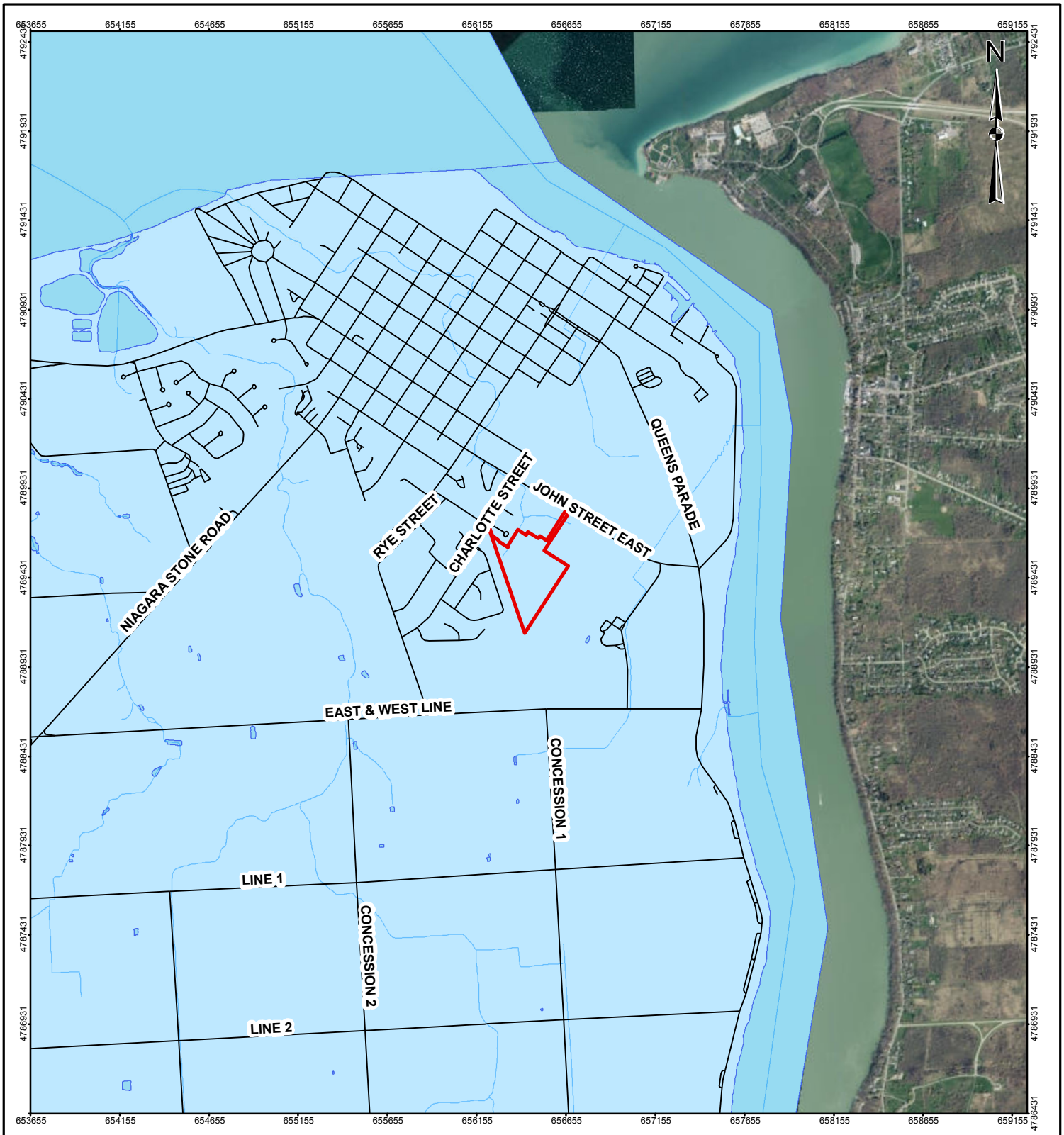
TITLE

TOPOGRAPHY

COLE

DATE: 06/25/2018			PROJECT: 2018-0419
GIS	C.C.	06/25/2018	REV. 0.0
DESIGN			**FIGURE 2**
CHECK	A.H.	06/25/2018	

REFERENCE

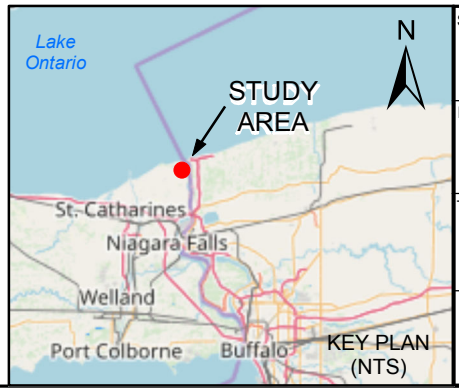


LEGEND

- Site Boundary
- Arterial Road
- Watercourse
- Waterbody

Region

- Iroquois Plain



SCALE 1:30,000

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PROJECT

Hydrogeological Investigation
200 John Street
Niagara-on-the-Lake, ON

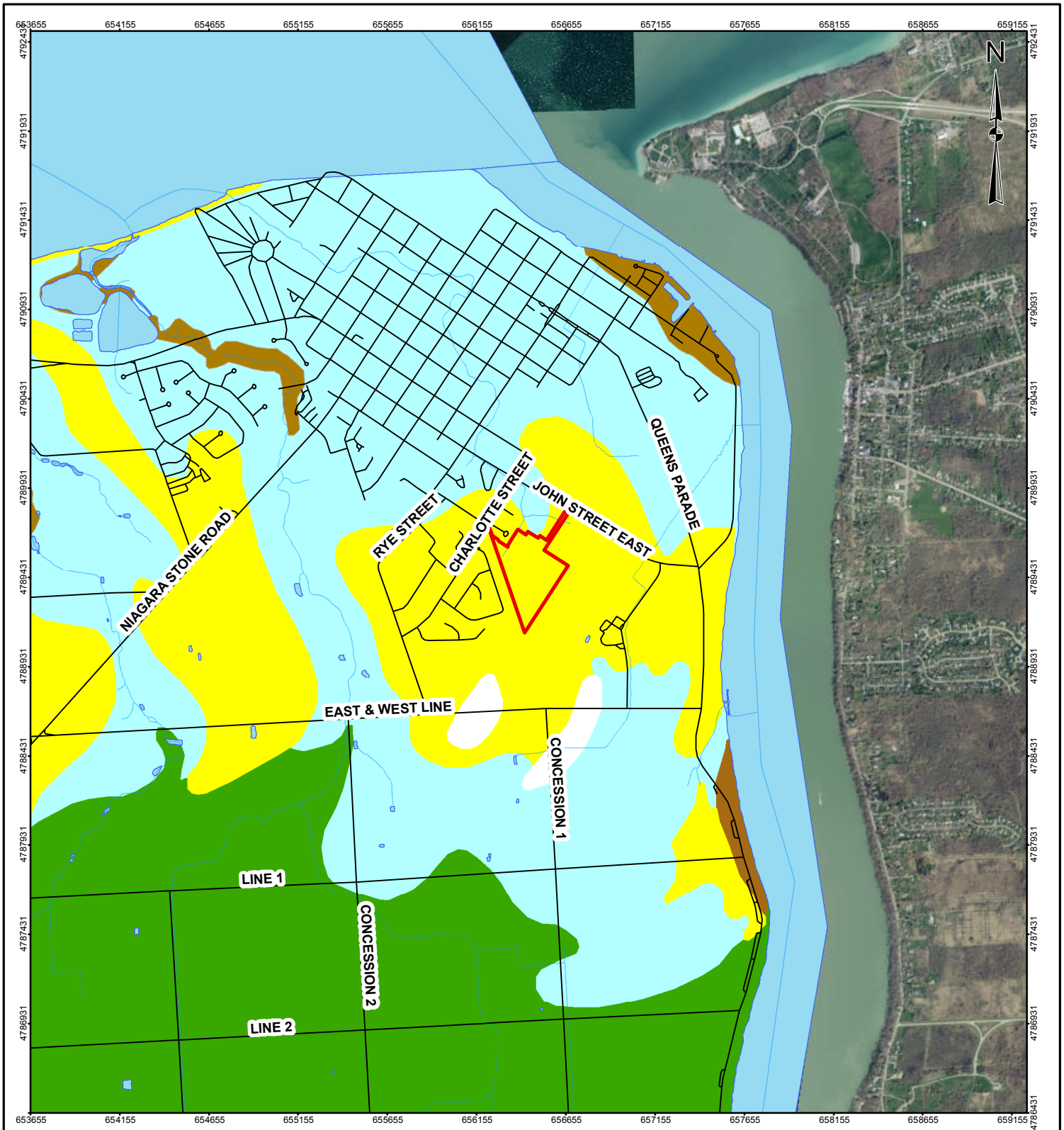
TITLE

PHYSIOGRAPHY

COLE

DATE: 06/25/2018			PROJECT: 2018-0419
GIS	C.C.	06/25/2018	REV. 0.0
DESIGN			FIGURE 3
CHECK	A.H.	06/25/2018	

REFERENCE

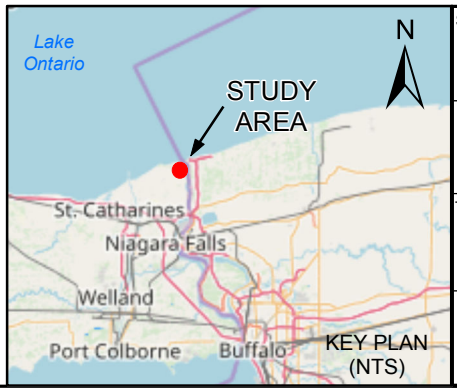


LEGEND

- Site Boundary
- Arterial Road
- Watercourse
- Waterbody

Surficial Geology

- Older alluvium deposits
- Modern alluvium deposits
- Till
- Fine-textured glaciolacustrine deposits (silt and clay, minor sand and gravel)
- Coarse-textured glaciolacustrine deposits (sand, gravel, minor silt and clay)



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PROJECT

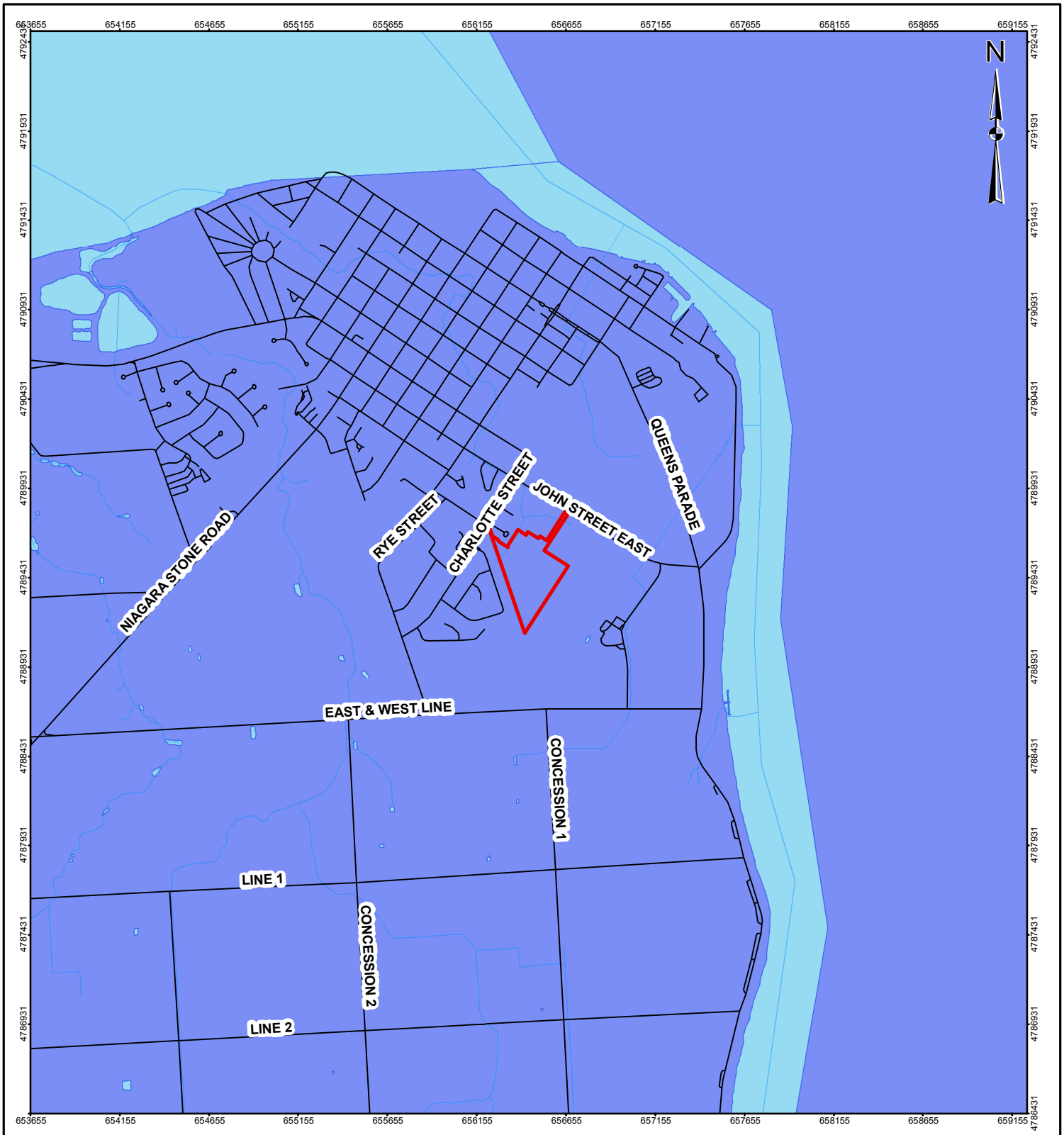
Hydrogeological Investigation
200 John Street
Niagara-on-the-Lake, ON

TITLE

SURFICIAL GEOLOGY

COLE

DATE: 06/25/2018			PROJECT: 2018-0419
GIS	C.C.	06/25/2018	REV. 0.0
DESIGN			FIGURE 4
CHECK	A.H.	06/25/2018	

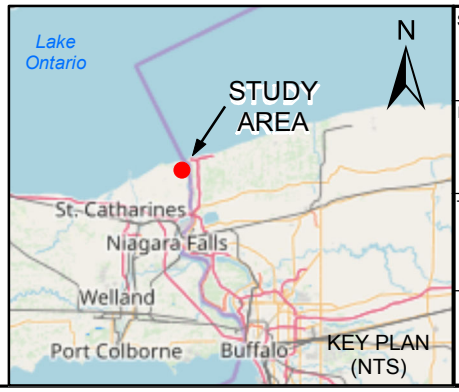


LEGEND

- Site Boundary
- Arterial Road
- Watercourse
- Waterbody

Bedrock Geology

- Queenston Fm.



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PROJECT

Hydrogeological Investigation
200 John Street
Niagara-on-the-Lake, ON

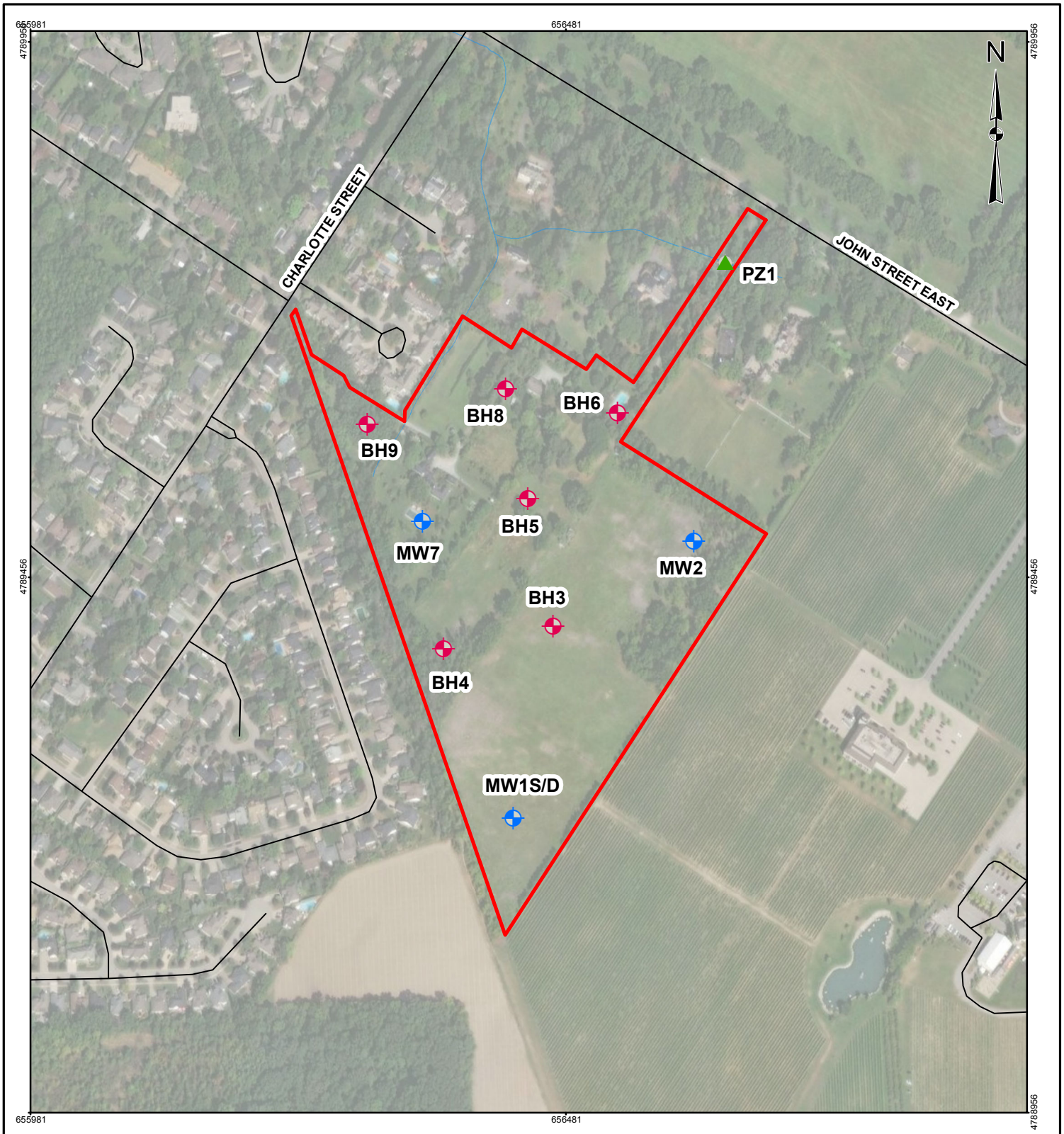
TITLE

BEDROCK GEOLOGY

COLE

DATE: 06/25/2018			PROJECT: 2018-0419
GIS	C.C.	06/25/2018	REV. 0.0
DESIGN			FIGURE 5
CHECK	A.H.	06/25/2018	

REFERENCE

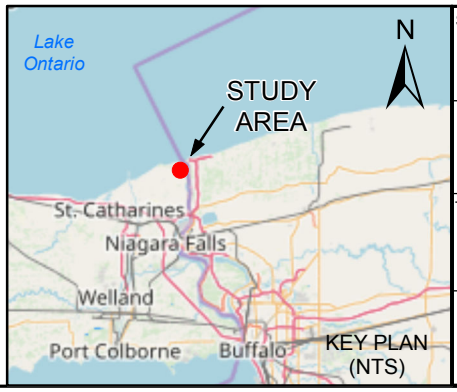


LEGEND

- Site Boundary
- Road
- Watercourse
- Monitoring Well
- Borehole
- Piezometer Station

REFERENCE

Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Produced by Cole Engineering Group Ltd. under licence from the Ontario



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PROJECT

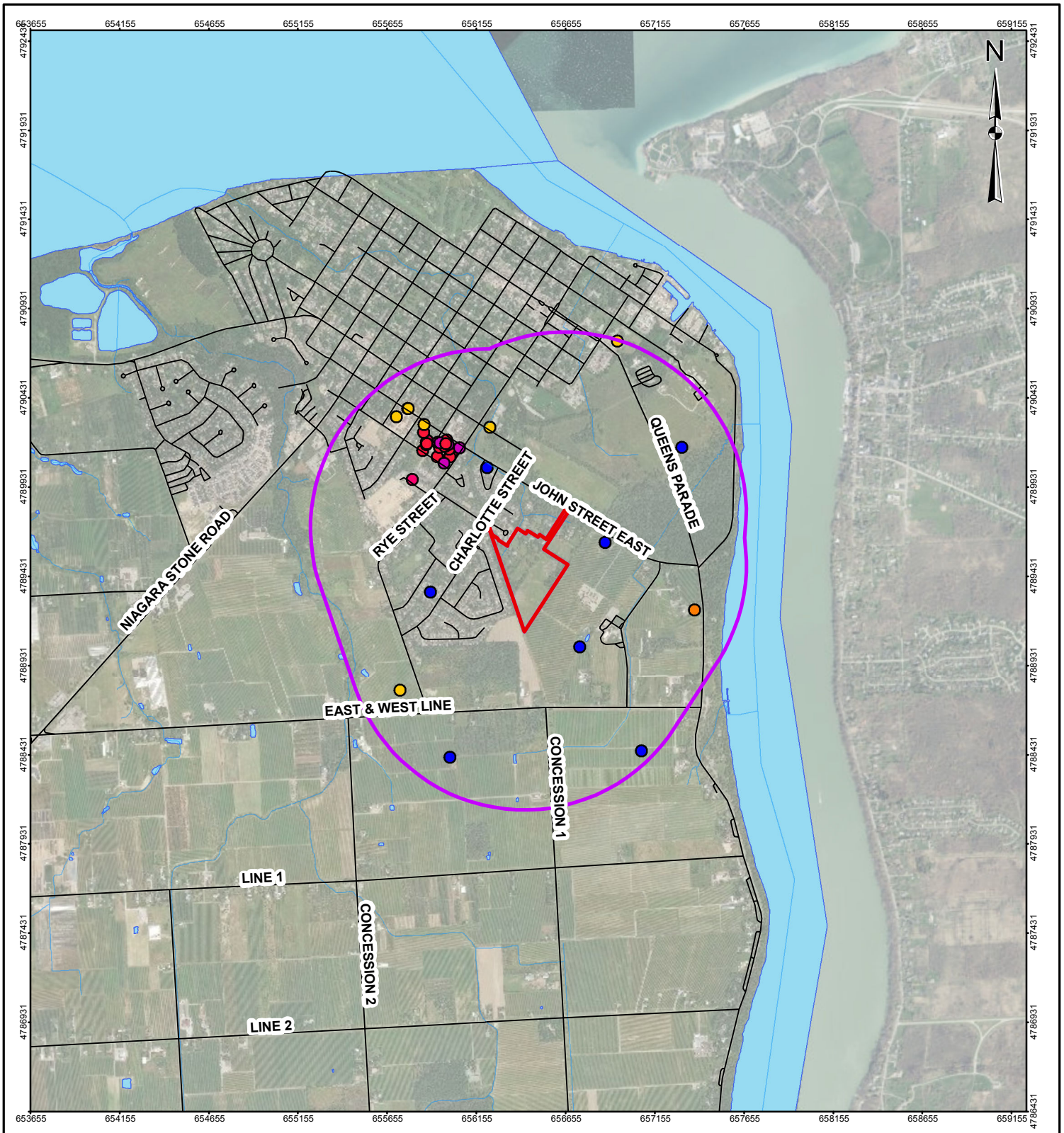
Hydrogeological Investigation
200 John Street
Niagara-on-the-Lake, ON

TITLE

MONITORING WELL AND BOREHOLE LOCATION

COLE

DATE: 11/28/2018			PROJECT: 2018-0419
GIS	A.H.	06/25/2018	REV. 0.0
DESIGN			FIGURE 6
CHECK	S.D.	06/25/2018	

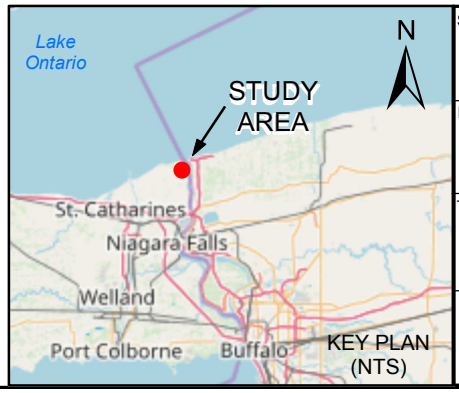


LEGEND

- Site Boundary
- 1 km Buffer
- Road
- Watercourse
- Waterbody

Well Records

- Unknown
- Abandoned-Other
- Monitoring and Test Hole
- Observation Wells
- Test Hole
- Water Supply



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PROJECT

Hydrogeological Investigation
200 John Street
Niagara-on-the-Lake, ON

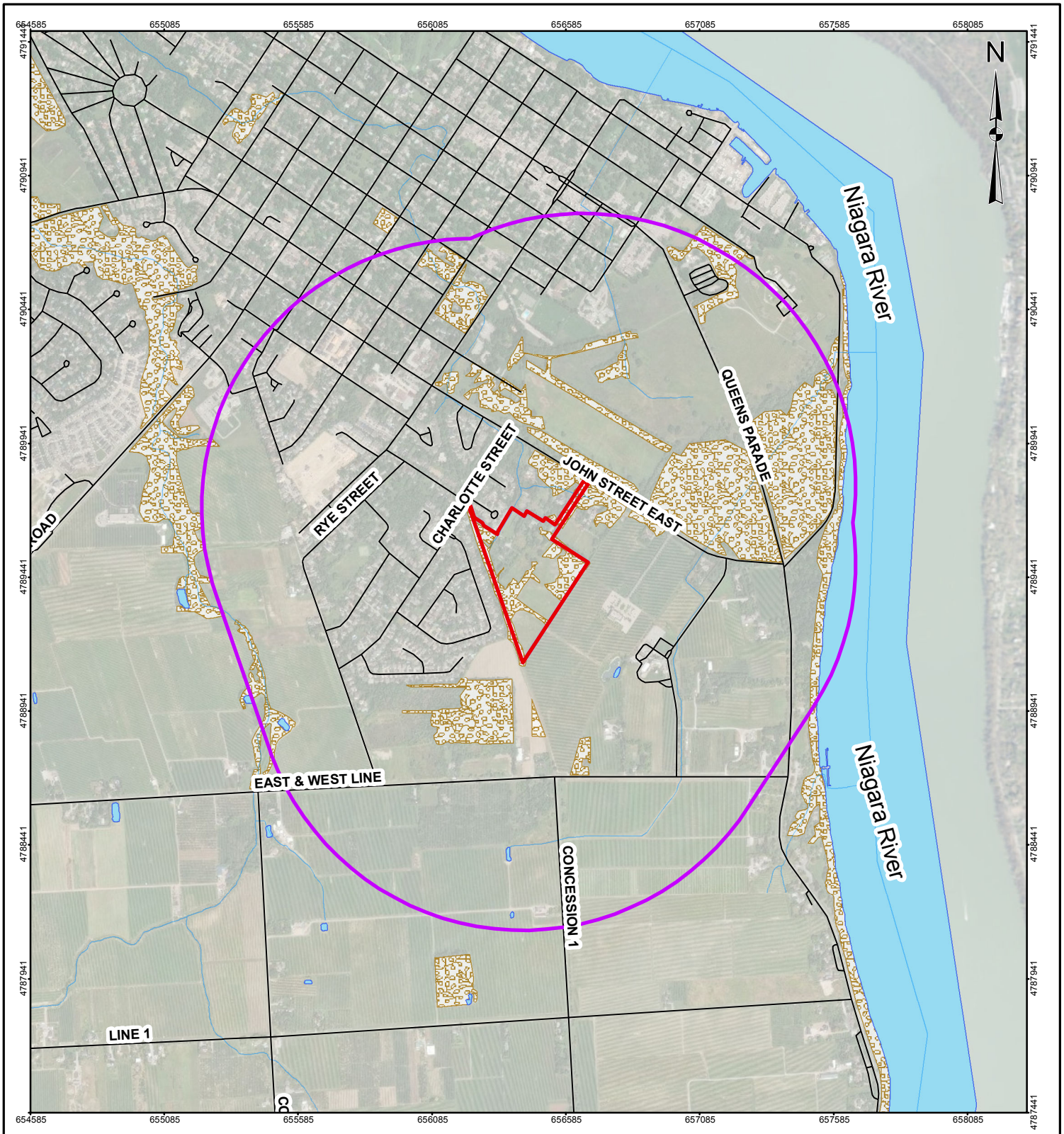
TITLE

MECP WELL RECORDS

COLE

DATE: 06/25/2018			PROJECT: 2018-0419
GIS	C.C.	06/25/2018	REV. 0.0
DESIGN			FIGURE 7
CHECK	A.H.	06/25/2018	

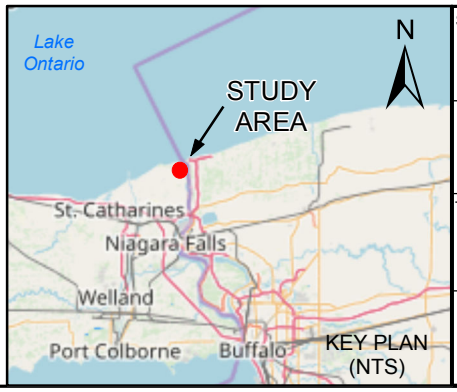
REFERENCE



LEGEND

- Site Boundary
- 1 km Buffer
- Road
- Wetland
- Watercourse
- Waterbody
- Wooded Area

REFERENCE



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PROJECT

Hydrogeological Investigation
200 John Street
Niagara-on-the-Lake, ON

TITLE

ENVIRONMENTAL FEATURES

COLE

DATE: 06/25/2018			PROJECT: 2018-0419
GIS	C.C.	06/25/2018	REV. 0.0
DESIGN			FIGURE 8
CHECK	A.H.	06/25/2018	

Appendix A

Conceptual Site Plan

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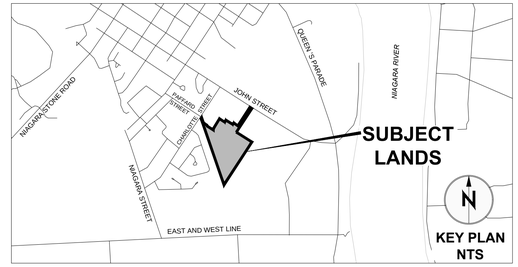


SOLMAR® DEVELOPMENT CORP

DRAFT PLAN OF SUBDIVISION
SOLMAR
FILE #

LOTS 145 and 156
REGISTRAR'S COMPILED PLAN 692 and LOT 14
PLAN M-11
TOWN OF NIAGARA-ON-THE-LAKE
REGIONAL MUNICIPALITY OF NIAGARA

OWNERS CERTIFICATE

I HEREBY AUTHORIZE SGL PLANNING & DESIGN INC. TO SUBMIT THIS PLAN FOR APPROVAL.

SIGNED _____ DATE: _____
Solmar (Niagara 2) Inc.

SURVEYORS CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED AS SHOWN ON THIS PLAN AND THEIR RELATIONSHIP TO ADJACENT LANDS ARE CORRECTLY AND ACCURATELY SHOWN.

SIGNED _____ DATE: _____
SHAN GOONEWARDENA, O.L.S.
R-PE SURVEYING LTD

ADDITIONAL INFORMATION

(UNDER SECTION 51(17) OF THE PLANNING ACT) INFORMATION REQUIRED BY CLAUSES A,B,C,D,E,F,G,J & L ARE SHOWN ON THE DRAFT AND KEY PLANS.

H) MUNICIPAL AND PIPED WATER TO BE PROVIDED
I) SILTY CLAY, SILTY CLAY TILL, SANDY SILT, SANDY SILT TILL
K) SANITARY AND STORM SEWERS TO BE PROVIDED

LAND USE SCHEDULE

LAND USE	LOT / BLOCK #	AREA (ha)	AREA (ac)	UNITS
RESIDENTIAL SEMI DETACHED HOMES	2-34	1.54	3.81	66
RESIDENTIAL SINGLE DETACHED HOMES	1,35-158	4.03	9.96	125
PARK	159 - 160	0.89	2.20	
NATURAL HERITAGE	161	0.17	0.42	
GREENBELT PLAN AREA & EASEMENT	162	3.63	8.97	
STREAM & BUFFER	163	0.12	0.30	
HOTEL	164-165	0.07	0.17	
ROAD & OPEN SPACE	166	0.47	1.16	
WALKWAY	167	0.01	0.02	
ROAD R.O.W.		1.41	3.48	
TOTAL	**167**	**12.34**	**30.49**	**191**

SGL Planning & Design Inc.
416-923-6630 sglplanning.ca

SCALE 1: 1,000
(24x36)
July 7, 2020

Appendix B

Geotechnical Borehole Logs

JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 14. 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
91.5	Ground Surface							
0.0	**18 cm TOPSOIL**	1	DO	6	0		15	
	Brown, firm, weathered **SILTY CLAY**							
90.8 / 0.7	Brown, compact to very dense	2	DO	28	1		12	
		3	DO	65	2		12	
	SANDY SILT	4	DO	50/13			11	
		5	DO	50/8	3		12	
87.5 / 4.0	Brown to reddish-brown, very dense				4			
		6	DO	69	5		9	
	SANDY SILT TILL occ. wet sand and silt seams and layers, cobbles and boulders	7	DO	80	6		12	
83.7		8	DO	50/10	7		9	
7.8	Reddish-brown **SHALE BEDROCK** (weathered)				8			
82.2		9	DO	50/8	9		6	
9.3	**END OF BOREHOLE** Installed 50 mm Ø monitoring wells to 6.1 m and 9.1 m (nest wells) provided with a steel protective casing				10			
					11			
					12			

W.L. @ El. 85.7 m on completion

Soil Engineers Ltd.

JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

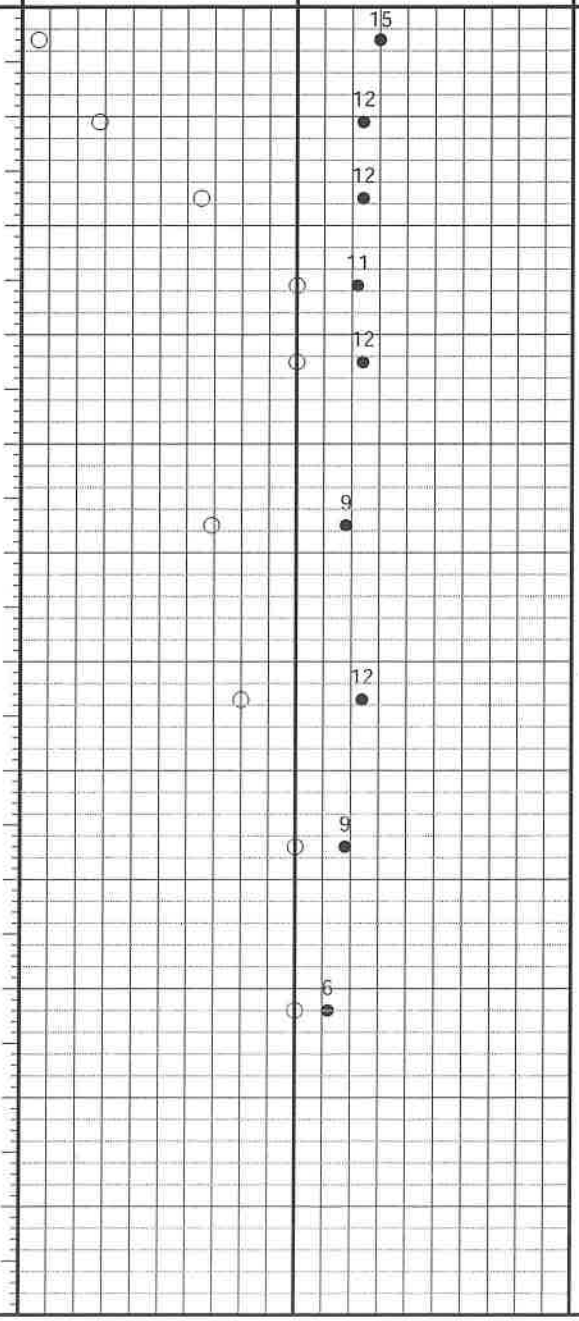
DRILLING DATE: August 14. 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)
91.5	Ground Surface				
0.0	**18 cm TOPSOIL**	1	DO	6	0
90.8	Brown, firm, weathered **SILTY CLAY**				
0.7	Brown, compact to very dense	2	DO	28	1
		3	DO	65	2
	SANDY SILT	4	DO	50/13	
		5	DO	50/8	3
87.5					
4.0	Brown to reddish-brown, very dense				4
		6	DO	69	5
	SANDY SILT TILL occ. wet sand and silt seams and layers, cobbles and boulders	7	DO	80	6
83.7		8	DO	50/10	7
7.8	Reddish-brown **SHALE BEDROCK** (weathered)				8
82.2		9	DO	50/8	9
9.3	**END OF BOREHOLE** Installed 50 mm Ø monitoring wells to 6.1 m and 9.1 m (nest wells) provided with a steel protective casing				10
					11
					12

Dynamic Cone (blows/30 cm) 10 30 50 70 90
Shear Strength (kN/m²) 50 100 150 200
Penetration Resistance (blows/30 cm) 10 30 50 70 90

Atterberg Limits PL LL

Moisture Content (%) 10 20 30 40



WATER LEVEL

W.L. @ El. 85.7 m on completion

JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 14. 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
91.1	Ground Surface							
0.0	**20 cm TOPSOIL**				0			
	Brown, firm, weathered	1	DO	6			15	
90.4	**SILTY CLAY**							
0.7	Brown, hard	2	DO	37	1		12	
	SILTY CLAY TILL							
	occ. wet sand and silt seams and layers, cobbles and boulders	3	DO	42			13	
		4	DO	45	2		13	
88.2								
2.9	Reddish-brown, very dense	5	DO	50/13	3		7	
	SANDY SILT TILL							
	occ. wet sand and silt seams and layers, cobbles and boulders	6	DO	50/15	4		7	
85.3					5			
5.8	Reddish-brown							
	SHALE BEDROCK (weathered)	7	DO	50/8	6		10	
84.8								
6.3	**END OF BOREHOLE**				7			
	Installed 50 mm Ø monitoring well to 6.1 m provided with a steel protective casing				8			

Cave-In @ El. 86.5 m on completion

W.L. @ El. 86.8 m on completion

Soil Engineers Ltd.

JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

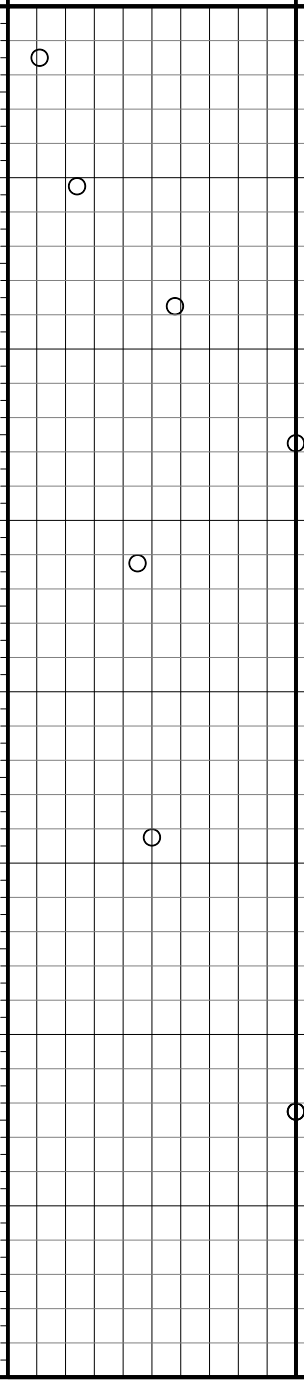
PROJECT DESCRIPTION: Proposed Residential Development

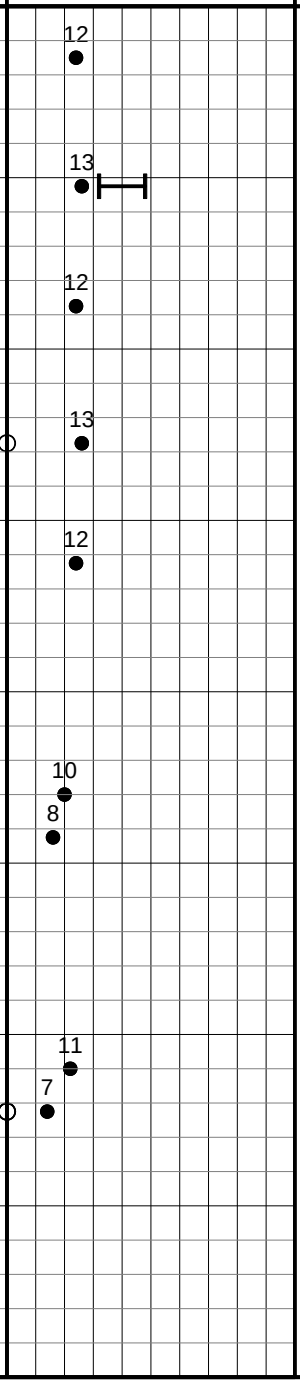
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 14. 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)
91.0	Ground Surface				
0.0	**23 cm TOPSOIL**				0
	Brown, stiff, weathered	1	DO	11	
90.3	**SILTY CLAY**				
0.7	Brown, very stiff				
	SILTY CLAY TILL	2	DO	24	1
89.6					
1.4	Brown to reddish-brown, dense to very dense				
		3	DO	58	2
		4	DO	50/13	
					3
	SANDY SILT TILL	5	DO	45	
	occ. wet sand and silt seams and layers, cobbles and boulders				4
		6A	DO		
		6B	DO	50	5
84.7		7A	DO		
6.3	Reddish-brown				6
84.4	**SHALE BEDROCK**	7B	DO	50/13	
6.6	**END OF BOREHOLE**				7
					8





WATER LEVEL: Dry on completion

Soil Engineers Ltd.

JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 16. 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
90.6	Ground Surface							
0.0	**15 cm TOPSOIL**				0			
	Brown, firm, weathered	1	DO	6			16	
	SILTY CLAY	2	DO	7	1		17	
89.2								
1.4	Brown, compact to dense	3	DO	19			14	
	SANDY SILT	4	DO	37	2		20	
87.7								
2.9	Grey, stiff	5	DO	16	3		16	
	SILTY CLAY							
86.6								
4.0	Reddish-brown, dense to very dense	6	DO	35	4		11	
	SANDY SILT TILL				5			
					6			
84.3		7	DO	50/10			10	
6.3	**END OF BOREHOLE**				7			
					8			

W.L. @ El. 87.6 m on completion
Cave-in @ El. 85.4 m on completion

Soil Engineers Ltd.

JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 16. 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
90.4	Ground Surface							
0.0	**10 cm TOPSOIL**				0			Dry on completion
	Brown, stiff to very stiff	1	DO	12			12	
	weathered							
	SILTY CLAY	2	DO	21	1		17	
89.0								
1.4	Brown, very dense							
	SANDY SILT	3	DO	50/13			11	
88.3					2			
2.1	Brown, hard							
	SILTY CLAY	4	DO	50/13			10	
	brown / grey							
	occ. wet sand and silt seams and layers	5	DO	50/13	3		10	
86.4								
4.0	Reddish-brown, very dense				4			
		6	DO	50/13			11	
	SANDY SILT TILL				5			
	occ. wet sand and silt seams and layers, cobbles and boulders							
		7	DO	50/13	6		8	
83.8								
6.6	**END OF BOREHOLE**				7			
					8			

Soil Engineers Ltd.

JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 15. 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
90.4	Ground Surface							
0.0	**8 cm TOPSOIL**							
	Brown, compact to dense	1	DO	16				
	SANDY SILT	2	DO	50				
89.0								
1.4	Brown, very dense	3	DO	62				
		4	DO	50/10				
	SANDY SILT TILL	5	DO	50/13				
	occ. wet sand and silt seams and layers, cobbles and boulders	6	DO	50/10				
		7	DO	70				
83.8								
6.6	**END OF BOREHOLE**							

Dry on completion

JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 14. 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
90.5	Ground Surface							
0.0	**15 cm TOPSOIL**				0			
0.1	Brown, compact, weathered **SANDY SILT**	1	DO	11			8	
89.8								
0.7	Compact to very dense	2	DO	17	1		11	
		3	DO	54	2		12	
	SANDY SILT TILL occ. wet sand and silt seams and layers, cobbles and boulders	4	DO	50/15			9	Dry on completion
		5	DO	50/13	3		9	
	brown / grey	6	DO	50/13	4		8	
		7	DO	66	5		11	
83.9					6			
6.6	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 6.1 m provided with a steel protective casing				7			
					8			

Soil Engineers Ltd.

JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 8

FIGURE NO.: 8

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 15. 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
90.3	Ground Surface							
0.0	**15 cm TOPSOIL**	1	DO	18	0		8	Dry on completion
	Brown **EARTH FILL** sandy silt with rock fragments and brick debris	2	DO	30	1		10	
88.9 1.4	Brown to reddish-brown, very dense	3	DO	50/15	2		9	
	SANDY SILT TILL occ. wet sand and silt seams and layers, cobbles and boulders	4	DO	50/13	3		8	
		5	DO	50/15	4		8	
		6	AS	50/15	5		11	
84.9 5.4	**END OF BOREHOLE** **Refusal to augering** **Inferred bedrock or boulders**				6 7 8			

Soil Engineers Ltd.

JOB NO.: 1807-S136

LOG OF BOREHOLE NO.: 9

FIGURE NO.: 9

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 200 John Street and 588 Charlotte Street
Town of Niagara-on-the-Lake

DRILLING DATE: August 16. 2018

El. (m) / Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Dynamic Cone (blows/30 cm) 10 30 50 70 90 / Shear Strength (kN/m²) 50 100 150 200 / Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL / Moisture Content (%) 10 20 30 40	WATER LEVEL
90.1	Ground Surface							
0.0	**18 cm TOPSOIL**	1	DO	9	0		11	
	Brown, loose to dense weathered							
	SANDY SILT	2	DO	21	1		15	
		3	DO	32			15	
88.0					2			
2.1	Brown, dense **SANDY SILT TILL**	4	DO	36			27	
87.2					3			
2.9	Grey, hard **SILTY CLAY TILL** occ. wet sand and silt seams and layer, cobbles and boulders	5	DO	73			10	
		6	DO	37	4		11	
84.3					5			
5.8	Reddish-brown, very dense **SANDY SILT TILL**	7	DO	50/13	6		9	
83.5					7			
6.6	**END OF BOREHOLE**				8			

W.L. @ El. 88.0 m on completion

Soil Engineers Ltd.

Appendix C

Hydraulic Conductivity Calculations

200 John Street and 588 Charlott Street

In-Situ Hydraulic Conductivity Analyses - MW1D (Falling Head Test)

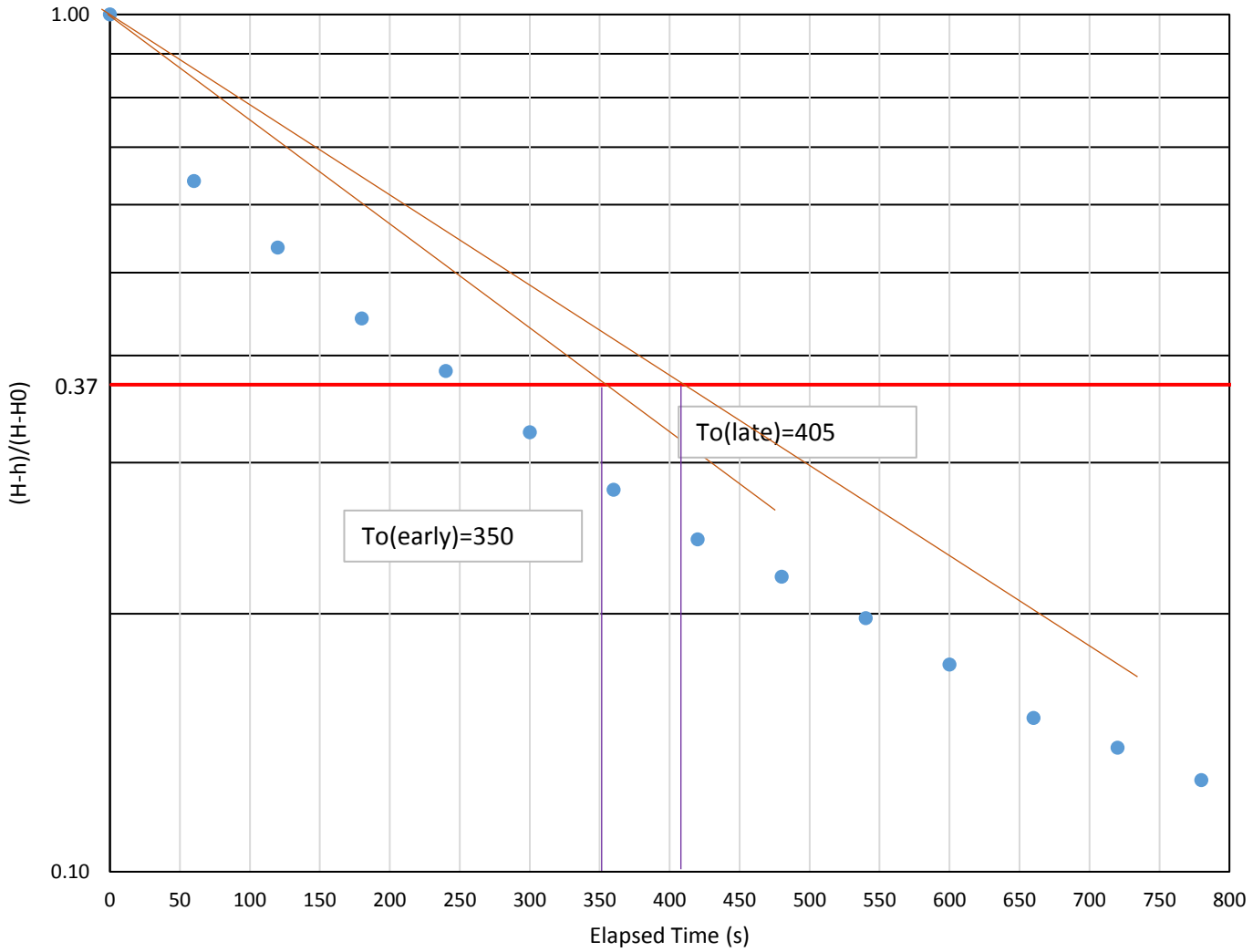
Date: 6-Nov-18

Conducted By:	JM	
Well Depth:		mbtor
Screened Unit:	Silty Clay	
Initial Water Level:	16.53	mbtor
Available Drawdown (H):		m
Head at Time = 0 (Ho):	5.6	m
Screen Length (L):	3	m
Borehole Radius (R):	0.0775	m
Monitoring Well Radius (r):	0.025	m
Stick Up		m

To(early):	350	s
K(early):	1.09E-06	m/s
To(late):	405	s
K(late):	9.40E-07	m/s
K(average)	1.0E-06	m/s
Recovery:	94.2%	%

Elapsed Time (s)	Water Level (mtor)	H-h	H-Ho	(H-h)/(H-Ho)
0	16.788	0.258	0.258	1.000
60	16.695	0.165	0.258	0.640
120	16.668	0.138	0.258	0.535
180	16.644	0.114	0.258	0.442
240	16.629	0.099	0.258	0.384
300	16.614	0.084	0.258	0.326
360	16.602	0.072	0.258	0.279
420	16.593	0.063	0.258	0.244
480	16.587	0.057	0.258	0.221
540	16.581	0.051	0.258	0.198
600	16.575	0.045	0.258	0.174
660	16.569	0.039	0.258	0.151
720	16.566	0.036	0.258	0.140
780	16.563	0.033	0.258	0.128
840	16.56	0.030	0.258	0.116
900	16.557	0.027	0.258	0.105
960	16.557	0.027	0.258	0.105
1020	16.554	0.024	0.258	0.093
1080	16.551	0.021	0.258	0.081
1140	16.551	0.021	0.258	0.081
1200	16.548	0.018	0.258	0.070
1260	16.548	0.018	0.258	0.070
1320	16.545	0.015	0.258	0.058
1380	16.545	0.015	0.258	0.058
1440	16.416	-0.114	0.258	-0.442
1500	16.314	-0.216	0.258	-0.837
1560	16.359	-0.171	0.258	-0.663
1620	16.389	-0.141	0.258	-0.547
1680	16.416	-0.114	0.258	-0.442
1740	16.434	-0.096	0.258	-0.372
1800	16.449	-0.081	0.258	-0.314
1860	16.461	-0.069	0.258	-0.267
1920	16.473	-0.057	0.258	-0.221
1980	16.479	-0.051	0.258	-0.198
2040	16.488	-0.042	0.258	-0.163
2100	16.494	-0.036	0.258	-0.140

In-Situ Hydraulic Conductivity Analyses - MW1D (Falling Head)



200 John Street and 588 Charlott Street

In-Situ Hydraulic Conductivity Analyses - MW1D (Rising Head Test)

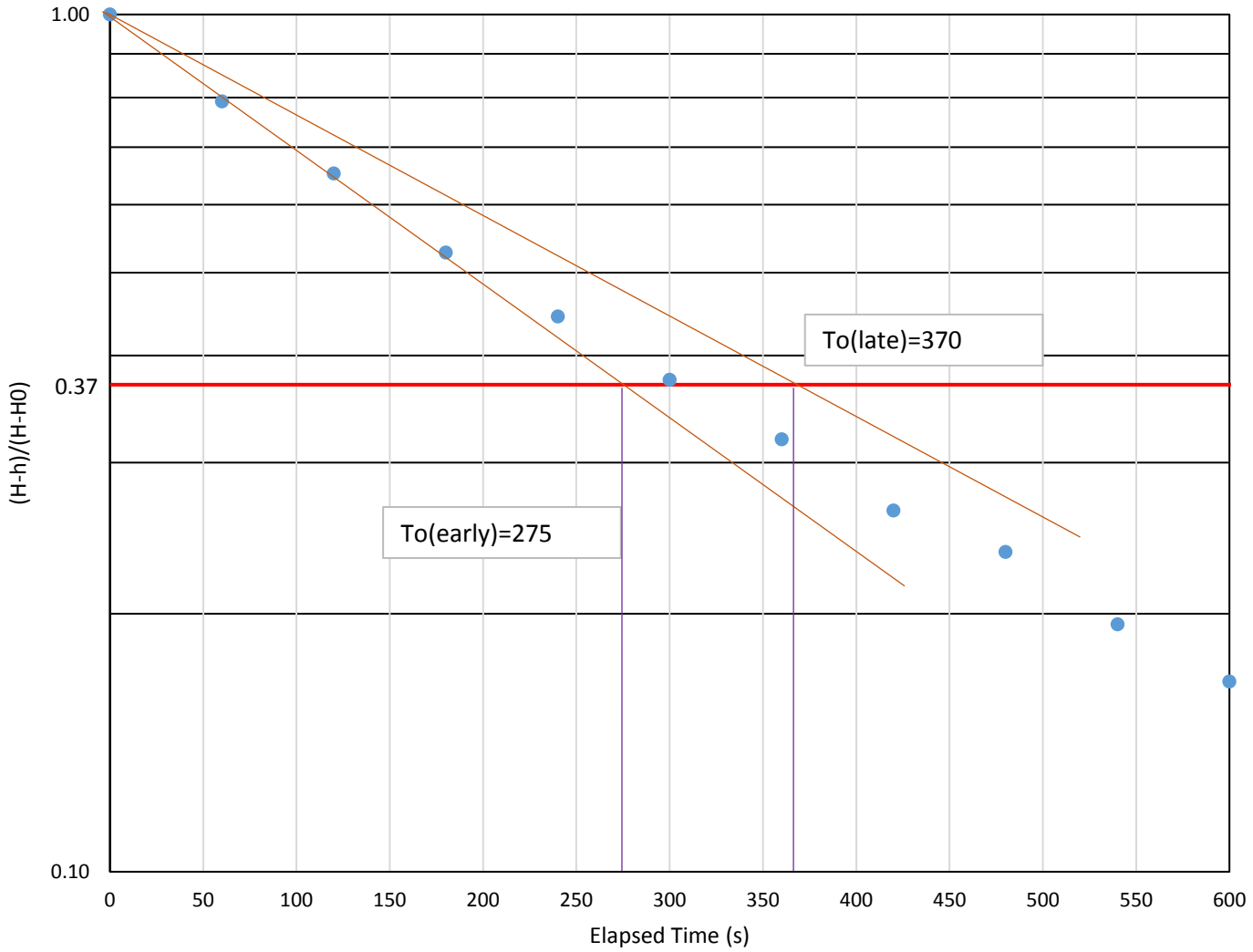
Date: 23-Aug-18

Conducted By:	JM	
Well Depth:		mbtor
Screened Unit:	Silty Clay	
Initial Water Level:	16.53	mbtor
Available Drawdown (H):		m
Head at Time = 0 (Ho):	5.6	m
Screen Length (L):	3	m
Borehole Radius (R):	0.0775	m
Monitoring Well Radius (r):	0.025	m
Stick Up		m

To(early):	275	s
K(early):	1.38E-06	m/s
To(late):	370	s
K(late):	1.03E-06	m/s
K(average)	1.2E-06	m/s
Recovery:	100.0%	%

Elapsed Time (s)	Water Level (mtor)	H-h	H-Ho	(H-h)/(H-Ho)
0	16.314	-0.216	-0.216	1.000
60	16.359	-0.171	-0.216	0.792
120	16.389	-0.141	-0.216	0.653
180	16.416	-0.114	-0.216	0.528
240	16.434	-0.096	-0.216	0.444
300	16.449	-0.081	-0.216	0.375
360	16.461	-0.069	-0.216	0.319
420	16.473	-0.057	-0.216	0.264
480	16.479	-0.051	-0.216	0.236
540	16.488	-0.042	-0.216	0.194
600	16.494	-0.036	-0.216	0.167
660	16.494	-0.036	-0.216	0.167
720	16.5	-0.030	-0.216	0.139
780	16.503	-0.027	-0.216	0.125
840	16.506	-0.024	-0.216	0.111
900	16.509	-0.021	-0.216	0.097
960	16.515	-0.015	-0.216	0.069
1020	16.512	-0.018	-0.216	0.083
1080	16.515	-0.015	-0.216	0.069
1140	16.515	-0.015	-0.216	0.069
1200	16.518	-0.012	-0.216	0.056
1260	16.518	-0.012	-0.216	0.056
1320	16.518	-0.012	-0.216	0.056
1380	16.518	-0.012	-0.216	0.056
1440	16.521	-0.009	-0.216	0.042
1500	16.521	-0.009	-0.216	0.042
1560	16.521	-0.009	-0.216	0.042
1620	16.524	-0.006	-0.216	0.028
1680	16.524	-0.006	-0.216	0.028
1740	16.524	-0.006	-0.216	0.028
1800	16.527	-0.003	-0.216	0.014
1860	16.527	-0.003	-0.216	0.014
1920	16.527	-0.003	-0.216	0.014
1980	16.527	-0.003	-0.216	0.014
2040	16.527	-0.003	-0.216	0.014
2100	16.53	0.000	-0.216	0.000

In-Situ Hydraulic Conductivity Analyses - MW1D (Rising Head)



200 John Street and 588 Charlott Street

In-Situ Hydraulic Conductivity Analyses - MW2 (Rising Head Test)

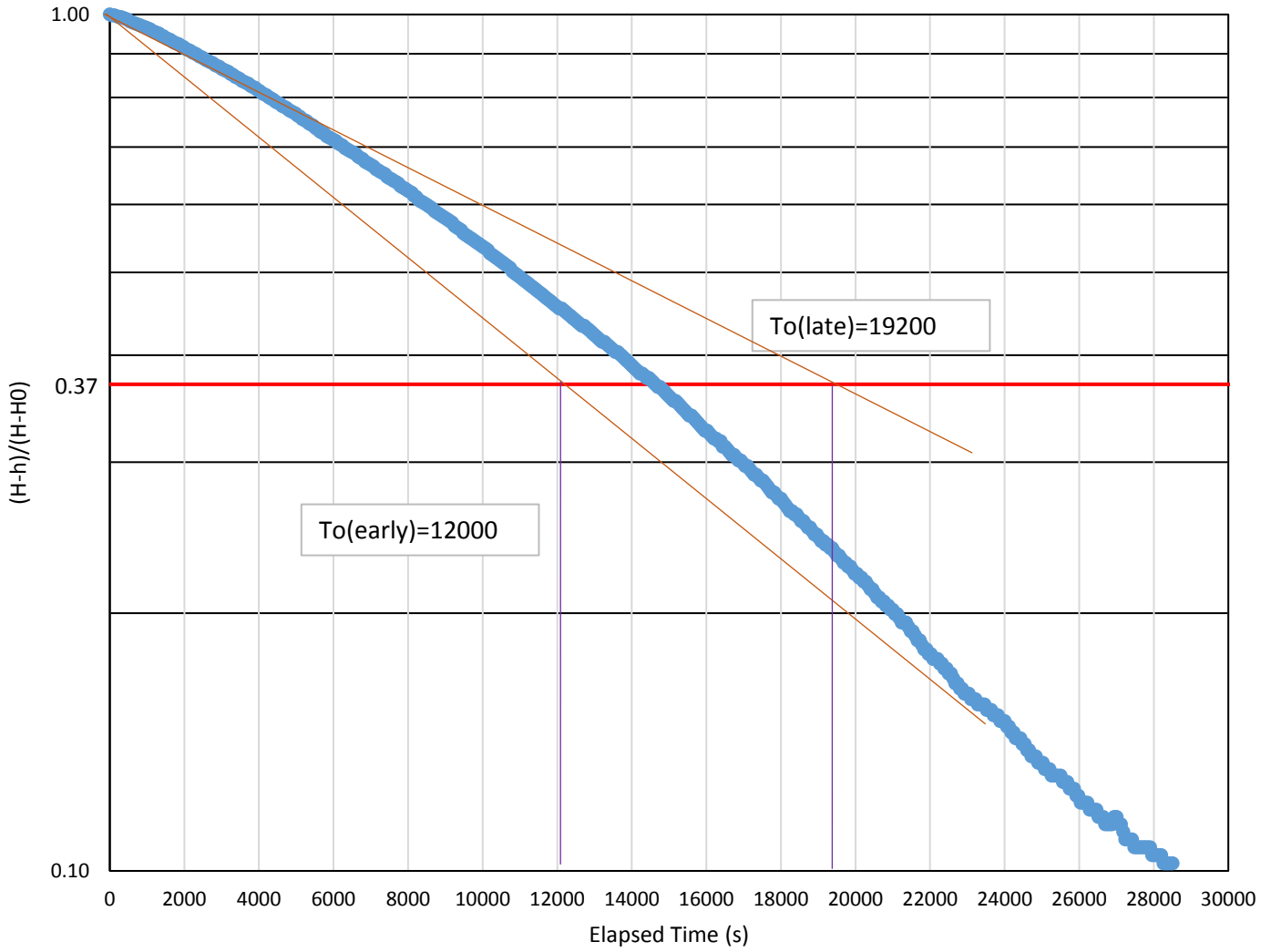
Date:

Conducted By:	JM	
Well Depth:		mbtor
Screened Unit:		
Initial Water Level:	11.943	mbtor
Available Drawdown (H):		m
Head at Time = 0 (Ho):	5.6	m
Screen Length (L):	3	m
Borehole Radius (R):	0.0775	m
Monitoring Well Radius (r):	0.025	m
Stick Up		m

To(early):	12000	s
K(early):	3.17E-08	m/s
To(late):	19200	s
K(late):	1.98E-08	m/s
K(average)	2.5E-08	m/s
Recovery:	99.8%	%

Elapsed Time (s)	Water Level (mtor)	H-h	H-Ho	(H-h)/(H-Ho)
0	10.62	-1.323	-1.323	1.000
60	10.623	-1.320	-1.323	0.998
120	10.623	-1.320	-1.323	0.998
180	10.626	-1.317	-1.323	0.995
240	10.629	-1.314	-1.323	0.993
300	10.629	-1.314	-1.323	0.993
360	10.632	-1.311	-1.323	0.991
420	10.635	-1.308	-1.323	0.989
480	10.638	-1.305	-1.323	0.986
540	10.644	-1.299	-1.323	0.982
600	10.647	-1.296	-1.323	0.980
660	10.65	-1.293	-1.323	0.977
720	10.653	-1.290	-1.323	0.975
780	10.656	-1.287	-1.323	0.973
840	10.659	-1.284	-1.323	0.971
900	10.662	-1.281	-1.323	0.968
960	10.665	-1.278	-1.323	0.966
1020	10.668	-1.275	-1.323	0.964
1080	10.671	-1.272	-1.323	0.961
1140	10.677	-1.266	-1.323	0.957
1200	10.68	-1.263	-1.323	0.955
1260	10.683	-1.260	-1.323	0.952
1320	10.686	-1.257	-1.323	0.950
1380	10.692	-1.251	-1.323	0.946
1440	10.695	-1.248	-1.323	0.943
1500	10.701	-1.242	-1.323	0.939
1560	10.704	-1.239	-1.323	0.937
1620	10.707	-1.236	-1.323	0.934
1680	10.713	-1.230	-1.323	0.930
1740	10.716	-1.227	-1.323	0.927
1800	10.719	-1.224	-1.323	0.925
1860	10.722	-1.221	-1.323	0.923
1920	10.728	-1.215	-1.323	0.918
1980	10.731	-1.212	-1.323	0.916
2040	10.737	-1.206	-1.323	0.912
2100	10.74	-1.203	-1.323	0.909

In-Situ Hydraulic Conductivity Analyses - MW2 (Rising Head)



200 John Street and 588 Charlott Street

In-Situ Hydraulic Conductivity Analyses - MW7 (Falling Head Test)

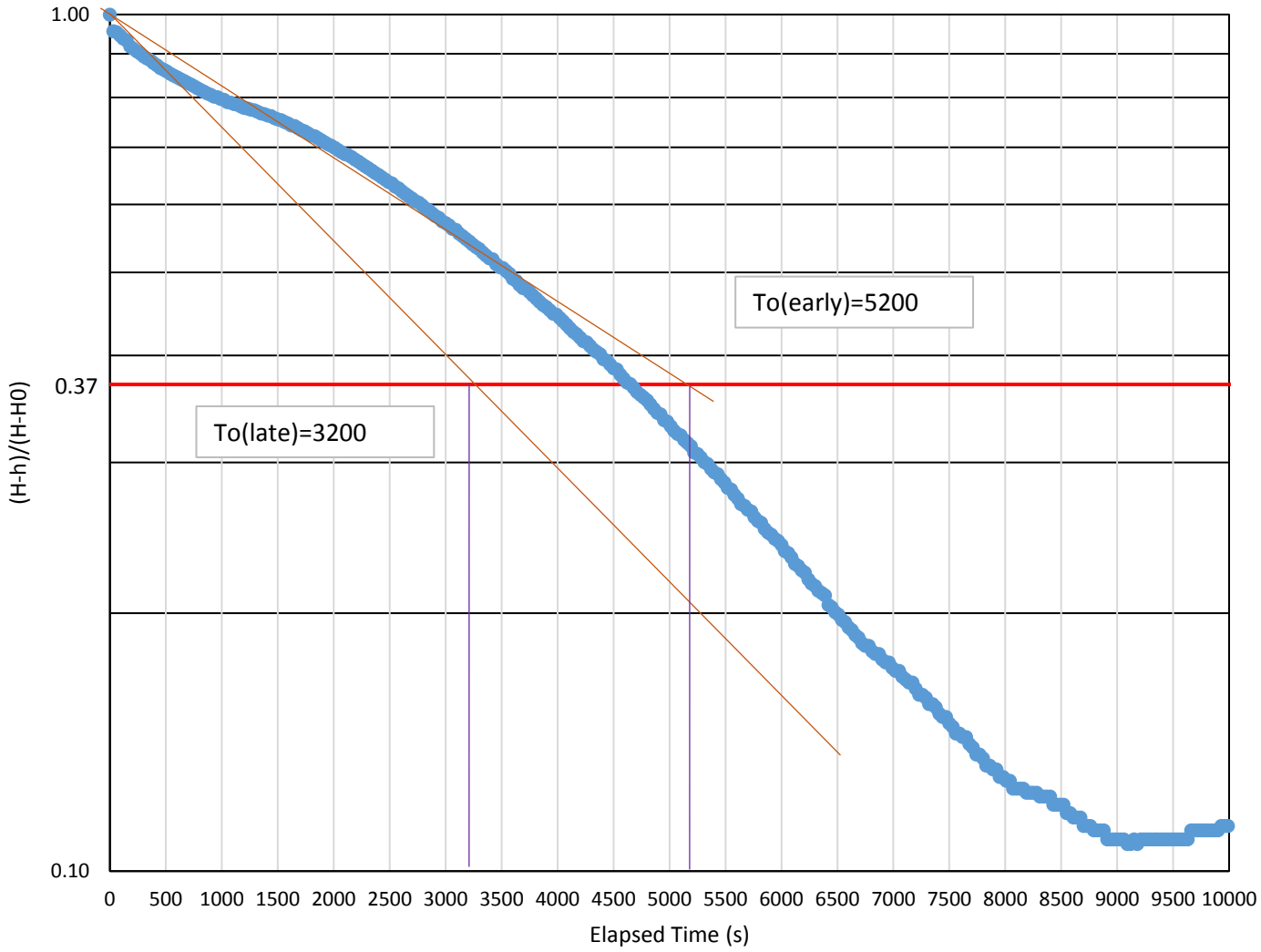
Date: 23-Aug-18

Conducted By:	AH	
Well Depth:		mbtor
Screened Unit:		
Initial Water Level:	13.266	mbtor
Available Drawdown (H):		m
Head at Time = 0 (Ho):	5.6	m
Screen Length (L):	3	m
Borehole Radius (R):	0.0775	m
Monitoring Well Radius (r):	0.019	m
Stick Up		m

To(early):	5200	s
K(early):	4.23E-08	m/s
To(late):	3200	s
K(late):	6.87E-08	m/s
K(average)	5.4E-08	m/s
Recovery:	99.1%	%

Elapsed Time (s)	Water Level (mtor)	H-h	H-Ho	(H-h)/(H-Ho)
0	14.019	0.753	0.753	1.000
30	13.986	0.720	0.753	0.956
60	13.984	0.718	0.753	0.954
90	13.978	0.712	0.753	0.946
120	13.972	0.706	0.753	0.938
150	13.968	0.702	0.753	0.932
180	13.957	0.691	0.753	0.918
210	13.953	0.687	0.753	0.912
240	13.948	0.682	0.753	0.906
270	13.944	0.678	0.753	0.900
300	13.939	0.673	0.753	0.894
330	13.935	0.669	0.753	0.888
360	13.932	0.666	0.753	0.884
390	13.927	0.661	0.753	0.878
420	13.923	0.657	0.753	0.873
450	13.918	0.652	0.753	0.866
480	13.915	0.649	0.753	0.862
510	13.912	0.646	0.753	0.858
540	13.908	0.642	0.753	0.853
570	13.905	0.639	0.753	0.849
600	13.902	0.636	0.753	0.845
630	13.899	0.633	0.753	0.841
660	13.896	0.630	0.753	0.837
690	13.893	0.627	0.753	0.833
720	13.89	0.624	0.753	0.829
750	13.887	0.621	0.753	0.825
780	13.884	0.618	0.753	0.821
810	13.881	0.615	0.753	0.817
840	13.878	0.612	0.753	0.813
870	13.875	0.609	0.753	0.809
900	13.873	0.607	0.753	0.806
930	13.87	0.604	0.753	0.802
960	13.869	0.603	0.753	0.801
990	13.866	0.600	0.753	0.797
1020	13.865	0.599	0.753	0.795
1050	13.861	0.595	0.753	0.790

In-Situ Hydraulic Conductivity Analyses - MW7 (Falling Head)



Appendix D

Water Quality Analysis Results

Maxxam
A Bureau Veritas Group Company

Your Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Your C.O.C. #: 682753-01-01

Attention: Alireza Hejazi

Cole Engineering Group Ltd
70 Valleywood Dr
Markham, ON
CANADA L3R 4T5

Report Date: 2018/10/09
Report #: R5433158
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8P6421
Received: 2018/09/28, 18:21

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Dissolved Aluminum (0.2 u, clay free)	1	N/A	2018/10/02	CAM SOP-00447	EPA 6020B m
Alkalinity	1	N/A	2018/10/04	CAM SOP-00448	SM 23 2320 B m
Chromium (VI) in Water	1	N/A	2018/10/04	CAM SOP-00436	EPA 7199 m
Free (WAD) Cyanide	1	N/A	2018/10/01	CAM SOP-00457	OMOE E3015 m
Dissolved Oxygen	1	2018/09/29	2018/09/29	CAM SOP-00427	SM 23 4500 O G m
Hardness (calculated as CaCO3)	1	N/A	2018/10/03	CAM SOP 00102/00408/00447	SM 2340 B
Mercury	1	2018/10/04	2018/10/04	CAM SOP-00453	EPA 7470A m
Total Metals Analysis by ICPMS	1	N/A	2018/10/02	CAM SOP-00447	EPA 6020B m
Total Ammonia-N	1	N/A	2018/10/05	CAM SOP-00441	EPA GS I-2522-90 m
pH	1	N/A	2018/10/04	CAM SOP-00413	SM 4500H+ B m
Phenols (4AAP)	1	N/A	2018/10/03	CAM SOP-00444	OMOE E3179 m
Field pH (1)	1	N/A	2018/09/28		Field pH Meter
Sulphide	1	N/A	2018/10/03	CAM SOP-00455	SM 23 4500-S G m
Field Temperature (1)	1	N/A	2018/09/28		Field Thermometer
Total Phosphorus (Colourimetric)	1	2018/10/02	2018/10/03	CAM SOP-00407	SM 23 4500 P B H m
Turbidity	1	N/A	2018/10/01	CAM SOP-00417	SM 23 2130 B m
Un-ionized Ammonia	1	2018/09/29	2018/10/05	PWQO	PWQO

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their

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Your Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Your C.O.C. #: 682753-01-01

Attention: Alireza Hejazi

Cole Engineering Group Ltd
70 Valleywood Dr
Markham, ON
CANADA L3R 4T5

Report Date: 2018/10/09
Report #: R5433158
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8P6421
Received: 2018/09/28, 18:21
agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This is a field test, therefore, the results relate to items that were not analysed at Maxxam Analytics Inc.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Jolanta Goralczyk, Project Manager
Email: JGoralczyk@maxxam.ca
Phone# (905)817-5751
==========
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Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

PWQO METALS AND INORGANICS (WATER)

Maxxam ID		HWT008		
Sampling Date		2018/09/28 13:15		
COC Number		682753-01-01		
	UNITS	MW-1D	RDL	QC Batch
Calculated Parameters				
Hardness (CaCO3)	mg/L	310	1.0	5758768
Total Un-ionized Ammonia	mg/L	0.051	0.005	5758770
Field Measurements				
Field Temperature	Celcius	14.34	N/A	ONSITE
Field pH	pH	8.54		ONSITE
Inorganics				
Total Ammonia-N	mg/L	0.51	0.050	5760560
Dissolved Oxygen	mg/L	8.67		5759321
pH	pH	8.21		5760592
Phenols-4AAP	mg/L	ND	0.0010	5764253
Total Phosphorus	mg/L	24	0.4	5761988
Sulphide	mg/L	0.20	0.020	5764591
Turbidity	NTU	230	0.1	5757542
WAD Cyanide (Free)	ug/L	ND	1	5760081
Alkalinity (Total as CaCO3)	mg/L	310	1.0	5760576
Metals				
Dissolved (0.2u) Aluminum (Al)	ug/L	5	5	5760804
Chromium (VI)	ug/L	ND	0.50	5767547
Mercury (Hg)	ug/L	ND	0.1	5766584
Total Antimony (Sb)	ug/L	ND	0.50	5760479
Total Arsenic (As)	ug/L	8.4	1.0	5760479
Total Beryllium (Be)	ug/L	ND	0.50	5760479
Total Boron (B)	ug/L	230	10	5760479
Total Cadmium (Cd)	ug/L	ND	0.10	5760479
Total Chromium (Cr)	ug/L	ND	5.0	5760479
Total Cobalt (Co)	ug/L	ND	0.50	5760479
Total Copper (Cu)	ug/L	ND	1.0	5760479
Total Iron (Fe)	ug/L	ND	100	5760479

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

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PWQO METALS AND INORGANICS (WATER)

Maxxam ID		HWT008		
Sampling Date		2018/09/28 13:15		
COC Number		682753-01-01		
	UNITS	MW-1D	RDL	QC Batch
Total Lead (Pb)	ug/L	ND	0.50	5760479
Total Molybdenum (Mo)	ug/L	13	0.50	5760479
Total Nickel (Ni)	ug/L	1.2	1.0	5760479
Total Selenium (Se)	ug/L	ND	2.0	5760479
Total Silver (Ag)	ug/L	ND	0.10	5760479
Total Thallium (Tl)	ug/L	ND	0.050	5760479
Total Tungsten (W)	ug/L	ND	1.0	5760479
Total Uranium (U)	ug/L	2.4	0.10	5760479
Total Vanadium (V)	ug/L	1.1	0.50	5760479
Total Zinc (Zn)	ug/L	ND	5.0	5760479
Total Zirconium (Zr)	ug/L	ND	1.0	5760479

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

TEST SUMMARY

Maxxam ID: HWT008
Sample ID: MW-1D
Matrix: Water

Collected: 2018/09/28
Shipped:
Received: 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	5760804	N/A	2018/10/02	Prempal Bhatti
Alkalinity	AT	5760576	N/A	2018/10/04	Surinder Rai
Chromium (VI) in Water	IC	5767547	N/A	2018/10/04	Lang Le
Free (WAD) Cyanide	SKAL/CN	5760081	N/A	2018/10/01	Louise Harding
Dissolved Oxygen	DO	5759321	2018/09/29	2018/09/29	Hinal Shah
Hardness (calculated as CaCO3)		5758768	N/A	2018/10/03	Automated Statchk
Mercury	CV/AA	5766584	2018/10/04	2018/10/04	Ron Morrison
Total Metals Analysis by ICPMS	ICP/MS	5760479	N/A	2018/10/02	Arefa Dabhad
Total Ammonia-N	LACH/NH4	5760560	N/A	2018/10/05	Anastassia Hamanov
pH	AT	5760592	N/A	2018/10/04	Surinder Rai
Phenols (4AAP)	TECH/PHEN	5764253	N/A	2018/10/03	Bramdeo Motiram
Field pH	PH	ONSITE	N/A	2018/09/28	Adriana Smith
Sulphide	ISE/S	5764591	N/A	2018/10/03	Gnana Thomas
Field pH	PH	ONSITE	N/A	2018/09/28	Adriana Smith
Total Phosphorus (Colourimetric)	LACH/P	5761988	2018/10/02	2018/10/03	Amanpreet Sappal
Turbidity	AT	5757542	N/A	2018/10/01	Neil Dassanayake
Un-ionized Ammonia	CALC/NH3	5758770	2018/10/05	2018/10/05	Automated Statchk

Maxxam ID: HWT008 Dup
Sample ID: MW-1D
Matrix: Water

Collected: 2018/09/28
Shipped:
Received: 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Oxygen	DO	5759321	2018/09/29	2018/09/29	Hinal Shah
Total Metals Analysis by ICPMS	ICP/MS	5760479	N/A	2018/10/02	Arefa Dabhad

Maxxam ID: HWT094
Sample ID: MW-2
Matrix: Water

Collected: 2018/09/28
Shipped:
Received: 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	5760804	N/A	2018/10/02	Prempal Bhatti
Alkalinity	AT	5759984	N/A	2018/10/04	Surinder Rai
Chromium (VI) in Water	IC	5767547	N/A	2018/10/04	Lang Le
Free (WAD) Cyanide	SKAL/CN	5760081	N/A	2018/10/01	Louise Harding
Dissolved Oxygen	DO	5759321	2018/09/29	2018/09/29	Hinal Shah
Hardness (calculated as CaCO3)		5758768	N/A	2018/10/03	Automated Statchk
Mercury	CV/AA	5766584	2018/10/04	2018/10/04	Ron Morrison
Total Metals Analysis by ICPMS	ICP/MS	5760479	N/A	2018/10/02	Arefa Dabhad
Total Ammonia-N	LACH/NH4	5760560	N/A	2018/10/05	Anastassia Hamanov
pH	AT	5759987	N/A	2018/10/04	Surinder Rai
Phenols (4AAP)	TECH/PHEN	5762010	N/A	2018/10/02	Bramdeo Motiram
Field pH	PH	ONSITE	N/A	2018/09/28	Adriana Smith
Sulphide	ISE/S	5764591	N/A	2018/10/03	Gnana Thomas

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

TEST SUMMARY

Maxxam ID: HWT094
Sample ID: MW-2
Matrix: Water

Collected: 2018/09/28
Shipped:
Received: 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Field pH	PH	ONSITE	N/A	2018/09/28	Adriana Smith
Total Phosphorus (Colourimetric)	LACH/P	5761988	2018/10/02	2018/10/03	Amanpreet Sappal
Turbidity	AT	5757542	N/A	2018/10/01	Neil Dassanayake
Un-ionized Ammonia	CALC/NH3	5758770	2018/10/05	2018/10/05	Automated Statchk

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Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	18.3°C

Results relate only to the items tested.

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

QUALITY ASSURANCE REPORT

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5757542	Turbidity	2018/10/01			101	85 - 115	ND, RDL=0.1	NTU	4.5	20		
5759984	Alkalinity (Total as CaCO3)	2018/10/04			96	85 - 115	ND, RDL=1.0	mg/L	0.64	20		
5759987	pH	2018/10/04			101	98 - 103			0.24	N/A		
5760081	WAD Cyanide (Free)	2018/10/01	94	80 - 120	101	80 - 120	ND,RDL=1	ug/L	NC	20		
5760479	Total Antimony (Sb)	2018/10/02	100	80 - 120	98	80 - 120	ND, RDL=0.50	ug/L	2.8	20		
5760479	Total Arsenic (As)	2018/10/02	96	80 - 120	98	80 - 120	ND, RDL=1.0	ug/L	1.5	20		
5760479	Total Beryllium (Be)	2018/10/02	93	80 - 120	97	80 - 120	ND, RDL=0.50	ug/L	NC	20		
5760479	Total Boron (B)	2018/10/02	89	80 - 120	96	80 - 120	ND, RDL=10	ug/L	1.4	20		
5760479	Total Cadmium (Cd)	2018/10/02	99	80 - 120	99	80 - 120	ND, RDL=0.10	ug/L	NC	20		
5760479	Total Chromium (Cr)	2018/10/02	87	80 - 120	90	80 - 120	ND, RDL=5.0	ug/L	NC	20		
5760479	Total Cobalt (Co)	2018/10/02	94	80 - 120	97	80 - 120	ND, RDL=0.50	ug/L	NC	20		
5760479	Total Copper (Cu)	2018/10/02	94	80 - 120	95	80 - 120	ND, RDL=1.0	ug/L	NC	20		
5760479	Total Iron (Fe)	2018/10/02	95	80 - 120	97	80 - 120	ND, RDL=100	ug/L	NC	20		
5760479	Total Lead (Pb)	2018/10/02	95	80 - 120	95	80 - 120	ND, RDL=0.50	ug/L	NC	20		
5760479	Total Molybdenum (Mo)	2018/10/02	100	80 - 120	101	80 - 120	ND, RDL=0.50	ug/L	2.8	20		
5760479	Total Nickel (Ni)	2018/10/02	87	80 - 120	92	80 - 120	ND, RDL=1.0	ug/L	9.8	20		
5760479	Total Selenium (Se)	2018/10/02	98	80 - 120	101	80 - 120	ND, RDL=2.0	ug/L	NC	20		
5760479	Total Silver (Ag)	2018/10/02	92	80 - 120	91	80 - 120	ND, RDL=0.10	ug/L	NC	20		
5760479	Total Thallium (Tl)	2018/10/02	92	80 - 120	92	80 - 120	ND, RDL=0.050	ug/L	NC	20		
5760479	Total Tungsten (W)	2018/10/02	98	80 - 120	96	80 - 120	ND, RDL=1.0	ug/L	NC	20		
5760479	Total Uranium (U)	2018/10/02	97	80 - 120	94	80 - 120	ND, RDL=0.10	ug/L	2.0	20		
5760479	Total Vanadium (V)	2018/10/02	89	80 - 120	92	80 - 120	ND, RDL=0.50	ug/L	3.7	20		
5760479	Total Zinc (Zn)	2018/10/02	96	80 - 120	101	80 - 120	ND, RDL=5.0	ug/L	NC	20		
5760479	Total Zirconium (Zr)	2018/10/02	94	80 - 120	94	80 - 120	ND, RDL=1.0	ug/L	NC	20		
5760560	Total Ammonia-N	2018/10/05	104	75 - 125	101	80 - 120	ND, RDL=0.050	mg/L	8.6	20		
5760576	Alkalinity (Total as CaCO3)	2018/10/04			95	85 - 115	ND, RDL=1.0	mg/L	2.0	20		
5760592	pH	2018/10/04			101	98 - 103			0.51	N/A		
5760804	Dissolved (0.2u) Aluminum (Al)	2018/10/02	104	80 - 120	103	80 - 120	ND,RDL=5	ug/L	2.5	20		

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

QUALITY ASSURANCE REPORT(CONT'D)

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5761988	Total Phosphorus	2018/10/03	103	80 - 120	90	80 - 120	ND, RDL=0.004	mg/L	4.1	20	82	80 - 120
5762010	Phenols-4AAP	2018/10/02	100	80 - 120	100	80 - 120	ND, RDL=0.0010	mg/L	6.2	20		
5764253	Phenols-4AAP	2018/10/03	99	80 - 120	100	80 - 120	ND, RDL=0.0010	mg/L	NC	20		
5764591	Sulphide	2018/10/03	91	80 - 120	91	80 - 120	ND, RDL=0.020	mg/L	NC	20		
5766584	Mercury (Hg)	2018/10/04	96	75 - 125	102	80 - 120	ND, RDL=0.1	ug/L	NC	20		
5767547	Chromium (VI)	2018/10/04	102	80 - 120	104	80 - 120	ND, RDL=0.50	ug/L	0.60	20		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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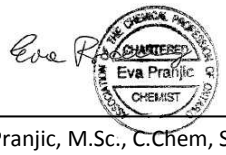
Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

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Your Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Your C.O.C. #: 682753-01-01

Attention: Alireza Hejazi

Cole Engineering Group Ltd
70 Valleywood Dr
Markham, ON
CANADA L3R 4T5

Report Date: 2018/10/09
Report #: R5433158
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8P6421
Received: 2018/09/28, 18:21

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Dissolved Aluminum (0.2 u, clay free)	1	N/A	2018/10/02	CAM SOP-00447	EPA 6020B m
Alkalinity	1	N/A	2018/10/04	CAM SOP-00448	SM 23 2320 B m
Chromium (VI) in Water	1	N/A	2018/10/04	CAM SOP-00436	EPA 7199 m
Free (WAD) Cyanide	1	N/A	2018/10/01	CAM SOP-00457	OMOE E3015 m
Dissolved Oxygen	1	2018/09/29	2018/09/29	CAM SOP-00427	SM 23 4500 O G m
Hardness (calculated as CaCO3)	1	N/A	2018/10/03	CAM SOP 00102/00408/00447	SM 2340 B
Mercury	1	2018/10/04	2018/10/04	CAM SOP-00453	EPA 7470A m
Total Metals Analysis by ICPMS	1	N/A	2018/10/02	CAM SOP-00447	EPA 6020B m
Total Ammonia-N	1	N/A	2018/10/05	CAM SOP-00441	EPA GS I-2522-90 m
pH	1	N/A	2018/10/04	CAM SOP-00413	SM 4500H+ B m
Phenols (4AAP)	1	N/A	2018/10/03	CAM SOP-00444	OMOE E3179 m
Field pH (1)	1	N/A	2018/09/28		Field pH Meter
Sulphide	1	N/A	2018/10/03	CAM SOP-00455	SM 23 4500-S G m
Field Temperature (1)	1	N/A	2018/09/28		Field Thermometer
Total Phosphorus (Colourimetric)	1	2018/10/02	2018/10/03	CAM SOP-00407	SM 23 4500 P B H m
Turbidity	1	N/A	2018/10/01	CAM SOP-00417	SM 23 2130 B m
Un-ionized Ammonia	1	2018/09/29	2018/10/05	PWQO	PWQO

Remarks:

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Your Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Your C.O.C. #: 682753-01-01

Attention: Alireza Hejazi

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Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
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Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This is a field test, therefore, the results relate to items that were not analysed at Maxxam Analytics Inc.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Jolanta Goralczyk, Project Manager
Email: JGoralczyk@maxxam.ca
Phone# (905)817-5751
==========
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Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

PWQO METALS AND INORGANICS (WATER)

Maxxam ID		HWT008		
Sampling Date		2018/09/28 13:15		
COC Number		682753-01-01		
	UNITS	**MW-1D Lab-Dup**	**RDL**	**QC Batch**
Inorganics				
Dissolved Oxygen	mg/L	8.66		5759321
Metals				
Total Antimony (Sb)	ug/L	0.51	0.50	5760479
Total Arsenic (As)	ug/L	8.6	1.0	5760479
Total Beryllium (Be)	ug/L	ND	0.50	5760479
Total Boron (B)	ug/L	230	10	5760479
Total Cadmium (Cd)	ug/L	ND	0.10	5760479
Total Chromium (Cr)	ug/L	ND	5.0	5760479
Total Cobalt (Co)	ug/L	ND	0.50	5760479
Total Copper (Cu)	ug/L	ND	1.0	5760479
Total Iron (Fe)	ug/L	ND	100	5760479

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
ND = Not detected

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

PWQO METALS AND INORGANICS (WATER)

Maxxam ID		HWT008		
Sampling Date		2018/09/28 13:15		
COC Number		682753-01-01		
	UNITS	**MW-1D Lab-Dup**	**RDL**	**QC Batch**
Total Lead (Pb)	ug/L	ND	0.50	5760479
Total Molybdenum (Mo)	ug/L	13	0.50	5760479
Total Nickel (Ni)	ug/L	1.0	1.0	5760479
Total Selenium (Se)	ug/L	ND	2.0	5760479
Total Silver (Ag)	ug/L	ND	0.10	5760479
Total Thallium (Tl)	ug/L	ND	0.050	5760479
Total Tungsten (W)	ug/L	ND	1.0	5760479
Total Uranium (U)	ug/L	2.5	0.10	5760479
Total Vanadium (V)	ug/L	1.1	0.50	5760479
Total Zinc (Zn)	ug/L	ND	5.0	5760479
Total Zirconium (Zr)	ug/L	ND	1.0	5760479

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
ND = Not detected

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

TEST SUMMARY

Maxxam ID: HWT008
Sample ID: MW-1D
Matrix: Water

Collected: 2018/09/28
Shipped:
Received: 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	5760804	N/A	2018/10/02	Prempal Bhatti
Alkalinity	AT	5760576	N/A	2018/10/04	Surinder Rai
Chromium (VI) in Water	IC	5767547	N/A	2018/10/04	Lang Le
Free (WAD) Cyanide	SKAL/CN	5760081	N/A	2018/10/01	Louise Harding
Dissolved Oxygen	DO	5759321	2018/09/29	2018/09/29	Hinal Shah
Hardness (calculated as CaCO3)		5758768	N/A	2018/10/03	Automated Statchk
Mercury	CV/AA	5766584	2018/10/04	2018/10/04	Ron Morrison
Total Metals Analysis by ICPMS	ICP/MS	5760479	N/A	2018/10/02	Arefa Dabhad
Total Ammonia-N	LACH/NH4	5760560	N/A	2018/10/05	Anastassia Hamanov
pH	AT	5760592	N/A	2018/10/04	Surinder Rai
Phenols (4AAP)	TECH/PHEN	5764253	N/A	2018/10/03	Bramdeo Motiram
Field pH	PH	ONSITE	N/A	2018/09/28	Adriana Smith
Sulphide	ISE/S	5764591	N/A	2018/10/03	Gnana Thomas
Field pH	PH	ONSITE	N/A	2018/09/28	Adriana Smith
Total Phosphorus (Colourimetric)	LACH/P	5761988	2018/10/02	2018/10/03	Amanpreet Sappal
Turbidity	AT	5757542	N/A	2018/10/01	Neil Dassanayake
Un-ionized Ammonia	CALC/NH3	5758770	2018/10/05	2018/10/05	Automated Statchk

Maxxam ID: HWT008 Dup
Sample ID: MW-1D
Matrix: Water

Collected: 2018/09/28
Shipped:
Received: 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Oxygen	DO	5759321	2018/09/29	2018/09/29	Hinal Shah
Total Metals Analysis by ICPMS	ICP/MS	5760479	N/A	2018/10/02	Arefa Dabhad

Maxxam ID: HWT094
Sample ID: MW-2
Matrix: Water

Collected: 2018/09/28
Shipped:
Received: 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	5760804	N/A	2018/10/02	Prempal Bhatti
Alkalinity	AT	5759984	N/A	2018/10/04	Surinder Rai
Chromium (VI) in Water	IC	5767547	N/A	2018/10/04	Lang Le
Free (WAD) Cyanide	SKAL/CN	5760081	N/A	2018/10/01	Louise Harding
Dissolved Oxygen	DO	5759321	2018/09/29	2018/09/29	Hinal Shah
Hardness (calculated as CaCO3)		5758768	N/A	2018/10/03	Automated Statchk
Mercury	CV/AA	5766584	2018/10/04	2018/10/04	Ron Morrison
Total Metals Analysis by ICPMS	ICP/MS	5760479	N/A	2018/10/02	Arefa Dabhad
Total Ammonia-N	LACH/NH4	5760560	N/A	2018/10/05	Anastassia Hamanov
pH	AT	5759987	N/A	2018/10/04	Surinder Rai
Phenols (4AAP)	TECH/PHEN	5762010	N/A	2018/10/02	Bramdeo Motiram
Field pH	PH	ONSITE	N/A	2018/09/28	Adriana Smith
Sulphide	ISE/S	5764591	N/A	2018/10/03	Gnana Thomas

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

TEST SUMMARY

Maxxam ID: HWT094
Sample ID: MW-2
Matrix: Water

Collected: 2018/09/28
Shipped:
Received: 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Field pH	PH	ONSITE	N/A	2018/09/28	Adriana Smith
Total Phosphorus (Colourimetric)	LACH/P	5761988	2018/10/02	2018/10/03	Amanpreet Sappal
Turbidity	AT	5757542	N/A	2018/10/01	Neil Dassanayake
Un-ionized Ammonia	CALC/NH3	5758770	2018/10/05	2018/10/05	Automated Statchk

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	18.3°C

Results relate only to the items tested.

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

QUALITY ASSURANCE REPORT

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5757542	Turbidity	2018/10/01			101	85 - 115	ND, RDL=0.1	NTU	4.5	20		
5759984	Alkalinity (Total as CaCO3)	2018/10/04			96	85 - 115	ND, RDL=1.0	mg/L	0.64	20		
5759987	pH	2018/10/04			101	98 - 103			0.24	N/A		
5760081	WAD Cyanide (Free)	2018/10/01	94	80 - 120	101	80 - 120	ND,RDL=1	ug/L	NC	20		
5760479	Total Antimony (Sb)	2018/10/02	100	80 - 120	98	80 - 120	ND, RDL=0.50	ug/L	2.8	20		
5760479	Total Arsenic (As)	2018/10/02	96	80 - 120	98	80 - 120	ND, RDL=1.0	ug/L	1.5	20		
5760479	Total Beryllium (Be)	2018/10/02	93	80 - 120	97	80 - 120	ND, RDL=0.50	ug/L	NC	20		
5760479	Total Boron (B)	2018/10/02	89	80 - 120	96	80 - 120	ND, RDL=10	ug/L	1.4	20		
5760479	Total Cadmium (Cd)	2018/10/02	99	80 - 120	99	80 - 120	ND, RDL=0.10	ug/L	NC	20		
5760479	Total Chromium (Cr)	2018/10/02	87	80 - 120	90	80 - 120	ND, RDL=5.0	ug/L	NC	20		
5760479	Total Cobalt (Co)	2018/10/02	94	80 - 120	97	80 - 120	ND, RDL=0.50	ug/L	NC	20		
5760479	Total Copper (Cu)	2018/10/02	94	80 - 120	95	80 - 120	ND, RDL=1.0	ug/L	NC	20		
5760479	Total Iron (Fe)	2018/10/02	95	80 - 120	97	80 - 120	ND, RDL=100	ug/L	NC	20		
5760479	Total Lead (Pb)	2018/10/02	95	80 - 120	95	80 - 120	ND, RDL=0.50	ug/L	NC	20		
5760479	Total Molybdenum (Mo)	2018/10/02	100	80 - 120	101	80 - 120	ND, RDL=0.50	ug/L	2.8	20		
5760479	Total Nickel (Ni)	2018/10/02	87	80 - 120	92	80 - 120	ND, RDL=1.0	ug/L	9.8	20		
5760479	Total Selenium (Se)	2018/10/02	98	80 - 120	101	80 - 120	ND, RDL=2.0	ug/L	NC	20		
5760479	Total Silver (Ag)	2018/10/02	92	80 - 120	91	80 - 120	ND, RDL=0.10	ug/L	NC	20		
5760479	Total Thallium (Tl)	2018/10/02	92	80 - 120	92	80 - 120	ND, RDL=0.050	ug/L	NC	20		
5760479	Total Tungsten (W)	2018/10/02	98	80 - 120	96	80 - 120	ND, RDL=1.0	ug/L	NC	20		
5760479	Total Uranium (U)	2018/10/02	97	80 - 120	94	80 - 120	ND, RDL=0.10	ug/L	2.0	20		
5760479	Total Vanadium (V)	2018/10/02	89	80 - 120	92	80 - 120	ND, RDL=0.50	ug/L	3.7	20		
5760479	Total Zinc (Zn)	2018/10/02	96	80 - 120	101	80 - 120	ND, RDL=5.0	ug/L	NC	20		
5760479	Total Zirconium (Zr)	2018/10/02	94	80 - 120	94	80 - 120	ND, RDL=1.0	ug/L	NC	20		
5760560	Total Ammonia-N	2018/10/05	104	75 - 125	101	80 - 120	ND, RDL=0.050	mg/L	8.6	20		
5760576	Alkalinity (Total as CaCO3)	2018/10/04			95	85 - 115	ND, RDL=1.0	mg/L	2.0	20		
5760592	pH	2018/10/04			101	98 - 103			0.51	N/A		
5760804	Dissolved (0.2u) Aluminum (Al)	2018/10/02	104	80 - 120	103	80 - 120	ND,RDL=5	ug/L	2.5	20		

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

QUALITY ASSURANCE REPORT(CONT'D)

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5761988	Total Phosphorus	2018/10/03	103	80 - 120	90	80 - 120	ND, RDL=0.004	mg/L	4.1	20	82	80 - 120
5762010	Phenols-4AAP	2018/10/02	100	80 - 120	100	80 - 120	ND, RDL=0.0010	mg/L	6.2	20		
5764253	Phenols-4AAP	2018/10/03	99	80 - 120	100	80 - 120	ND, RDL=0.0010	mg/L	NC	20		
5764591	Sulphide	2018/10/03	91	80 - 120	91	80 - 120	ND, RDL=0.020	mg/L	NC	20		
5766584	Mercury (Hg)	2018/10/04	96	75 - 125	102	80 - 120	ND, RDL=0.1	ug/L	NC	20		
5767547	Chromium (VI)	2018/10/04	102	80 - 120	104	80 - 120	ND, RDL=0.50	ug/L	0.60	20		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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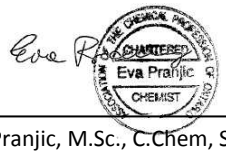
Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

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Maxxam
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Your Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Your C.O.C. #: 682753-01-01

Attention: Alireza Hejazi

Cole Engineering Group Ltd
70 Valleywood Dr
Markham, ON
CANADA L3R 4T5

Report Date: 2018/10/09
Report #: R5433158
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8P6421
Received: 2018/09/28, 18:21

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Dissolved Aluminum (0.2 u, clay free)	1	N/A	2018/10/02	CAM SOP-00447	EPA 6020B m
Alkalinity	1	N/A	2018/10/04	CAM SOP-00448	SM 23 2320 B m
Chromium (VI) in Water	1	N/A	2018/10/04	CAM SOP-00436	EPA 7199 m
Free (WAD) Cyanide	1	N/A	2018/10/01	CAM SOP-00457	OMOE E3015 m
Dissolved Oxygen	1	2018/09/29	2018/09/29	CAM SOP-00427	SM 23 4500 O G m
Hardness (calculated as CaCO3)	1	N/A	2018/10/03	CAM SOP 00102/00408/00447	SM 2340 B
Mercury	1	2018/10/04	2018/10/04	CAM SOP-00453	EPA 7470A m
Total Metals Analysis by ICPMS	1	N/A	2018/10/02	CAM SOP-00447	EPA 6020B m
Total Ammonia-N	1	N/A	2018/10/05	CAM SOP-00441	EPA GS I-2522-90 m
pH	1	N/A	2018/10/04	CAM SOP-00413	SM 4500H+ B m
Phenols (4AAP)	1	N/A	2018/10/02	CAM SOP-00444	OMOE E3179 m
Field pH (1)	1	N/A	2018/09/28		Field pH Meter
Sulphide	1	N/A	2018/10/03	CAM SOP-00455	SM 23 4500-S G m
Field Temperature (1)	1	N/A	2018/09/28		Field Thermometer
Total Phosphorus (Colourimetric)	1	2018/10/02	2018/10/03	CAM SOP-00407	SM 23 4500 P B H m
Turbidity	1	N/A	2018/10/01	CAM SOP-00417	SM 23 2130 B m
Un-ionized Ammonia	1	2018/09/29	2018/10/05	PWQO	PWQO

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their

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Your Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Your C.O.C. #: 682753-01-01

Attention: Alireza Hejazi

Cole Engineering Group Ltd
70 Valleywood Dr
Markham, ON
CANADA L3R 4T5

Report Date: 2018/10/09
Report #: R5433158
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8P6421
Received: 2018/09/28, 18:21
agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
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Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This is a field test, therefore, the results relate to items that were not analysed at Maxxam Analytics Inc.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Jolanta Goralczyk, Project Manager
Email: JGoralczyk@maxxam.ca
Phone# (905)817-5751
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Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

PWQO METALS AND INORGANICS (WATER)

Maxxam ID		HWT094		
Sampling Date		2018/09/28 13:30		
COC Number		682753-01-01		
	UNITS	MW-2	RDL	QC Batch
Calculated Parameters				
Hardness (CaCO3)	mg/L	380	1.0	5758768
Total Un-ionized Ammonia	mg/L	0.012	0.0024	5758770
Field Measurements				
Field Temperature	Celcius	15.35	N/A	ONSITE
Field pH	pH	8.16		ONSITE
Inorganics				
Total Ammonia-N	mg/L	0.25	0.050	5760560
Dissolved Oxygen	mg/L	8.51		5759321
pH	pH	8.18		5759987
Phenols-4AAP	mg/L	ND	0.0010	5762010
Total Phosphorus	mg/L	12	0.4	5761988
Sulphide	mg/L	0.037	0.020	5764591
Turbidity	NTU	660	0.1	5757542
WAD Cyanide (Free)	ug/L	ND	1	5760081
Alkalinity (Total as CaCO3)	mg/L	280	1.0	5759984
Metals				
Dissolved (0.2u) Aluminum (Al)	ug/L	ND	5	5760804
Chromium (VI)	ug/L	ND	0.50	5767547
Mercury (Hg)	ug/L	ND	0.1	5766584
Total Antimony (Sb)	ug/L	ND	0.50	5760479
Total Arsenic (As)	ug/L	1.1	1.0	5760479
Total Beryllium (Be)	ug/L	ND	0.50	5760479
Total Boron (B)	ug/L	88	10	5760479
Total Cadmium (Cd)	ug/L	ND	0.10	5760479
Total Chromium (Cr)	ug/L	ND	5.0	5760479
Total Cobalt (Co)	ug/L	1.4	0.50	5760479
Total Copper (Cu)	ug/L	3.8	1.0	5760479
Total Iron (Fe)	ug/L	330	100	5760479

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected
N/A = Not Applicable

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

PWQO METALS AND INORGANICS (WATER)

Maxxam ID		HWT094		
Sampling Date		2018/09/28 13:30		
COC Number		682753-01-01		
	UNITS	MW-2	RDL	QC Batch
Total Lead (Pb)	ug/L	ND	0.50	5760479
Total Molybdenum (Mo)	ug/L	13	0.50	5760479
Total Nickel (Ni)	ug/L	9.2	1.0	5760479
Total Selenium (Se)	ug/L	ND	2.0	5760479
Total Silver (Ag)	ug/L	ND	0.10	5760479
Total Thallium (Tl)	ug/L	ND	0.050	5760479
Total Tungsten (W)	ug/L	1.0	1.0	5760479
Total Uranium (U)	ug/L	7.7	0.10	5760479
Total Vanadium (V)	ug/L	0.77	0.50	5760479
Total Zinc (Zn)	ug/L	7.7	5.0	5760479
Total Zirconium (Zr)	ug/L	ND	1.0	5760479

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

TEST SUMMARY

Maxxam ID: HWT008
Sample ID: MW-1D
Matrix: Water

Collected: 2018/09/28
Shipped:
Received: 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	5760804	N/A	2018/10/02	Prempal Bhatti
Alkalinity	AT	5760576	N/A	2018/10/04	Surinder Rai
Chromium (VI) in Water	IC	5767547	N/A	2018/10/04	Lang Le
Free (WAD) Cyanide	SKAL/CN	5760081	N/A	2018/10/01	Louise Harding
Dissolved Oxygen	DO	5759321	2018/09/29	2018/09/29	Hinal Shah
Hardness (calculated as CaCO3)		5758768	N/A	2018/10/03	Automated Statchk
Mercury	CV/AA	5766584	2018/10/04	2018/10/04	Ron Morrison
Total Metals Analysis by ICPMS	ICP/MS	5760479	N/A	2018/10/02	Arefa Dabhad
Total Ammonia-N	LACH/NH4	5760560	N/A	2018/10/05	Anastassia Hamanov
pH	AT	5760592	N/A	2018/10/04	Surinder Rai
Phenols (4AAP)	TECH/PHEN	5764253	N/A	2018/10/03	Bramdeo Motiram
Field pH	PH	ONSITE	N/A	2018/09/28	Adriana Smith
Sulphide	ISE/S	5764591	N/A	2018/10/03	Gnana Thomas
Field pH	PH	ONSITE	N/A	2018/09/28	Adriana Smith
Total Phosphorus (Colourimetric)	LACH/P	5761988	2018/10/02	2018/10/03	Amanpreet Sappal
Turbidity	AT	5757542	N/A	2018/10/01	Neil Dassanayake
Un-ionized Ammonia	CALC/NH3	5758770	2018/10/05	2018/10/05	Automated Statchk

Maxxam ID: HWT008 Dup
Sample ID: MW-1D
Matrix: Water

Collected: 2018/09/28
Shipped:
Received: 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Oxygen	DO	5759321	2018/09/29	2018/09/29	Hinal Shah
Total Metals Analysis by ICPMS	ICP/MS	5760479	N/A	2018/10/02	Arefa Dabhad

Maxxam ID: HWT094
Sample ID: MW-2
Matrix: Water

Collected: 2018/09/28
Shipped:
Received: 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	5760804	N/A	2018/10/02	Prempal Bhatti
Alkalinity	AT	5759984	N/A	2018/10/04	Surinder Rai
Chromium (VI) in Water	IC	5767547	N/A	2018/10/04	Lang Le
Free (WAD) Cyanide	SKAL/CN	5760081	N/A	2018/10/01	Louise Harding
Dissolved Oxygen	DO	5759321	2018/09/29	2018/09/29	Hinal Shah
Hardness (calculated as CaCO3)		5758768	N/A	2018/10/03	Automated Statchk
Mercury	CV/AA	5766584	2018/10/04	2018/10/04	Ron Morrison
Total Metals Analysis by ICPMS	ICP/MS	5760479	N/A	2018/10/02	Arefa Dabhad
Total Ammonia-N	LACH/NH4	5760560	N/A	2018/10/05	Anastassia Hamanov
pH	AT	5759987	N/A	2018/10/04	Surinder Rai
Phenols (4AAP)	TECH/PHEN	5762010	N/A	2018/10/02	Bramdeo Motiram
Field pH	PH	ONSITE	N/A	2018/09/28	Adriana Smith
Sulphide	ISE/S	5764591	N/A	2018/10/03	Gnana Thomas

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

TEST SUMMARY

Maxxam ID: HWT094
Sample ID: MW-2
Matrix: Water

Collected: 2018/09/28
Shipped:
Received: 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Field pH	PH	ONSITE	N/A	2018/09/28	Adriana Smith
Total Phosphorus (Colourimetric)	LACH/P	5761988	2018/10/02	2018/10/03	Amanpreet Sappal
Turbidity	AT	5757542	N/A	2018/10/01	Neil Dassanayake
Un-ionized Ammonia	CALC/NH3	5758770	2018/10/05	2018/10/05	Automated Statchk

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	18.3°C

Results relate only to the items tested.

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

QUALITY ASSURANCE REPORT

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5757542	Turbidity	2018/10/01			101	85 - 115	ND, RDL=0.1	NTU	4.5	20		
5759984	Alkalinity (Total as CaCO3)	2018/10/04			96	85 - 115	ND, RDL=1.0	mg/L	0.64	20		
5759987	pH	2018/10/04			101	98 - 103			0.24	N/A		
5760081	WAD Cyanide (Free)	2018/10/01	94	80 - 120	101	80 - 120	ND,RDL=1	ug/L	NC	20		
5760479	Total Antimony (Sb)	2018/10/02	100	80 - 120	98	80 - 120	ND, RDL=0.50	ug/L	2.8	20		
5760479	Total Arsenic (As)	2018/10/02	96	80 - 120	98	80 - 120	ND, RDL=1.0	ug/L	1.5	20		
5760479	Total Beryllium (Be)	2018/10/02	93	80 - 120	97	80 - 120	ND, RDL=0.50	ug/L	NC	20		
5760479	Total Boron (B)	2018/10/02	89	80 - 120	96	80 - 120	ND, RDL=10	ug/L	1.4	20		
5760479	Total Cadmium (Cd)	2018/10/02	99	80 - 120	99	80 - 120	ND, RDL=0.10	ug/L	NC	20		
5760479	Total Chromium (Cr)	2018/10/02	87	80 - 120	90	80 - 120	ND, RDL=5.0	ug/L	NC	20		
5760479	Total Cobalt (Co)	2018/10/02	94	80 - 120	97	80 - 120	ND, RDL=0.50	ug/L	NC	20		
5760479	Total Copper (Cu)	2018/10/02	94	80 - 120	95	80 - 120	ND, RDL=1.0	ug/L	NC	20		
5760479	Total Iron (Fe)	2018/10/02	95	80 - 120	97	80 - 120	ND, RDL=100	ug/L	NC	20		
5760479	Total Lead (Pb)	2018/10/02	95	80 - 120	95	80 - 120	ND, RDL=0.50	ug/L	NC	20		
5760479	Total Molybdenum (Mo)	2018/10/02	100	80 - 120	101	80 - 120	ND, RDL=0.50	ug/L	2.8	20		
5760479	Total Nickel (Ni)	2018/10/02	87	80 - 120	92	80 - 120	ND, RDL=1.0	ug/L	9.8	20		
5760479	Total Selenium (Se)	2018/10/02	98	80 - 120	101	80 - 120	ND, RDL=2.0	ug/L	NC	20		
5760479	Total Silver (Ag)	2018/10/02	92	80 - 120	91	80 - 120	ND, RDL=0.10	ug/L	NC	20		
5760479	Total Thallium (Tl)	2018/10/02	92	80 - 120	92	80 - 120	ND, RDL=0.050	ug/L	NC	20		
5760479	Total Tungsten (W)	2018/10/02	98	80 - 120	96	80 - 120	ND, RDL=1.0	ug/L	NC	20		
5760479	Total Uranium (U)	2018/10/02	97	80 - 120	94	80 - 120	ND, RDL=0.10	ug/L	2.0	20		
5760479	Total Vanadium (V)	2018/10/02	89	80 - 120	92	80 - 120	ND, RDL=0.50	ug/L	3.7	20		
5760479	Total Zinc (Zn)	2018/10/02	96	80 - 120	101	80 - 120	ND, RDL=5.0	ug/L	NC	20		
5760479	Total Zirconium (Zr)	2018/10/02	94	80 - 120	94	80 - 120	ND, RDL=1.0	ug/L	NC	20		
5760560	Total Ammonia-N	2018/10/05	104	75 - 125	101	80 - 120	ND, RDL=0.050	mg/L	8.6	20		
5760576	Alkalinity (Total as CaCO3)	2018/10/04			95	85 - 115	ND, RDL=1.0	mg/L	2.0	20		
5760592	pH	2018/10/04			101	98 - 103			0.51	N/A		
5760804	Dissolved (0.2u) Aluminum (Al)	2018/10/02	104	80 - 120	103	80 - 120	ND,RDL=5	ug/L	2.5	20		

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Maxxam Job #: B8P6421
Report Date: 2018/10/09

QUALITY ASSURANCE REPORT(CONT'D)

Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
5761988	Total Phosphorus	2018/10/03	103	80 - 120	90	80 - 120	ND, RDL=0.004	mg/L	4.1	20	82	80 - 120
5762010	Phenols-4AAP	2018/10/02	100	80 - 120	100	80 - 120	ND, RDL=0.0010	mg/L	6.2	20		
5764253	Phenols-4AAP	2018/10/03	99	80 - 120	100	80 - 120	ND, RDL=0.0010	mg/L	NC	20		
5764591	Sulphide	2018/10/03	91	80 - 120	91	80 - 120	ND, RDL=0.020	mg/L	NC	20		
5766584	Mercury (Hg)	2018/10/04	96	75 - 125	102	80 - 120	ND, RDL=0.1	ug/L	NC	20		
5767547	Chromium (VI)	2018/10/04	102	80 - 120	104	80 - 120	ND, RDL=0.50	ug/L	0.60	20		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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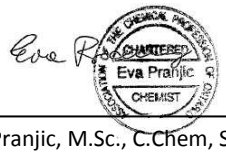
Cole Engineering Group Ltd
Client Project #: 2018-0419
Site Location: NIAGARA ON THE LAKE
Sampler Initials: JM

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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CHAIN OF CUSTODY RECORD

Page of

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#24008 Cole Engineering Group Ltd	Company Name:	COLE ENGINEERING	Quotation #:	B02064	Maxxam Job #:	Bottle Order #: 682753
Attention:	Accounts Payable	Attention:	Alireza Hejazi	P.O. #:			
Address:	70 Valleywood Dr Markham ON L3R 4T5	Address:	70 VALLEYWOOD DRIVE, MARKHAM, ON L3R 4T5	Project:	2018-0419	COC #: C#682753-01-01	Project Manager: Jolanta Goralczyk
Tel:	(416) 987-6161 Fax: (905) 940-2064	Tel:	(416) 987-6161 Ext: 243 Fax:	Project Name:	NIAGRA ON THE LAKE		
Email:	accountspayable@coleengineering.ca	Email:	AHejazi@coleengineering.ca	Site #:			
				Sampled By:	JAMES MAGEE		

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)	Other Regulations	Special Instructions
☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___	☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ___ ☑ PWQO ☐ Other ___	

Include Criteria on Certificate of Analysis (Y/N)? ___

Field Filtered (please circle): Metals / Hg / Cr VI

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required:

Please provide advance notice for rush projects

Regular (Standard) TAT: ☑
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ___ Time Required: ___ ☐
Rush Confirmation Number: ___ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	PWQO Metals and Inorganics	# of Bottles	Comments
1	19602	MW-1D	Sep28/2018	1:15pm	GW	X	9	Cr(6+) was not filtered.
2	19602	MW-2	Sep28/2018	1:30pm	GW	X	9	
3								
4								
5								
6								
7								
8								
9								
10								

28-Sep-18 18:21
Jolanta Goralczyk
B8P6421
CA2 ENV-710

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
James Magee	18/09/28	6:23pm	[illegible]	2018/09/28	18:21	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Receipt	Custody Seal	Yes	No
	19/18/18	Present	☑	
		Intact	☑	

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

White: Maxxam Yellow: Client

Appendix E

Water Balance Analysis

CLIMATIC WATER BUDGET: CLIMATE NORMAL 1981-2010 (ST CATHARINES A, Climate ID: 6137287)
Potential Evapotranspiration

Month	Mean Temperature (°C)	Heat Index	Potential Evapotranspiration (mm)	Daylight Correction Value	Adusted PET (mm)	Total Precipitation (mm)	Surplus (mm)	Deficit (mm)
January	-3.8	0.0	0.0	0.81	0.0	65.20	65.2	0.0
February	-2.9	0.0	0.0	0.81	0.0	54.90	54.9	0.0
March	1.1	0.1	3.4	1.03	3.5	61.70	58.2	0.0
April	7.4	1.8	30.8	1.12	34.5	77.00	42.5	0.0
May	13.7	4.6	62.9	1.27	79.8	76.80	0.0	3.0
June	19	7.5	92.0	1.29	118.2	85.90	0.0	32.3
July	21.9	9.4	108.4	1.30	141.2	77.80	0.0	63.4
August	20.8	8.7	102.1	1.20	122.8	70.30	0.0	52.5
September	16.6	6.2	78.6	1.05	82.3	90.60	8.3	0.0
October	10.4	3.0	45.7	0.95	43.3	67.00	23.7	0.0
November	4.6	0.9	17.7	0.81	14.3	81.60	67.3	0.0
December	-0.9	0.0	0.0	0.77	0.0	71.50	71.5	0.0
TOTALS		**42.1**			**639.8**	**880.30**	**391.7**	**151.2**
				TOTAL WATER SURPLUS		**240.5**	mm	

Latitude 43.2

Estimates of potential evaporation (mm) [edit]

Thornthwaite equation (1948) [edit]

$$PET = 16\left(\frac{L}{12}\right)\left(\frac{N}{30}\right)\left(\frac{10T_a}{I}\right)^{\alpha}$$

Where

PET is the estimated potential evapotranspiration (mm/month)

T_a is the average daily temperature (degrees Celsius; if this is negative, use 0) of the month being calculated

N is the number of days in the month being calculated

L is the average day length (hours) of the month being calculated

$$\alpha = (6.75 \times 10^{-7})I^3 - (7.71 \times 10^{-5})I^2 + (1.792 \times 10^{-2})I + 0.49239$$

$I = \sum_{i=1}^{12}\left(\frac{T_{ai}}{5}\right)^{1.514}$ is a heat index which depends on the 12 monthly mean temperatures T_{ai}.[1]

Somewhat modified forms of this equation appear in later publications (1955 and 1957) by Thornthwaite and Mather. [2]

Daylight Correction Factors for Potential Evapotranspiration

Latitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	1.04	0.94	1.04	1.01	1.04	1.01	1.04	1.04	1.01	1.04	1.01	1.04
10 N	1.00	0.91	1.03	1.03	1.08	1.06	1.08	1.07	1.02	1.02	0.98	0.99
20 N	0.95	0.90	1.03	1.05	1.13	1.11	1.14	1.11	1.02	1.00	0.93	0.94
30 N	0.90	0.87	1.03	1.08	1.18	1.17	1.20	1.14	1.03	0.98	0.89	0.88
40 N	0.84	0.83	1.03	1.11	1.24	1.25	1.27	1.18	1.04	0.96	0.83	0.81
>50 N	0.74	0.78	1.02	1.15	1.33	1.36	1.37	1.25	1.06	0.92	0.76	0.70
10 S	1.08	0.97	1.05	0.99	1.01	0.96	1.00	1.01	1.00	1.06	1.05	1.10
20 S	1.14	1.00	1.05	0.97	0.96	0.91	0.95	0.99	1.00	1.08	1.09	1.15
30 S	1.20	1.03	1.06	0.95	0.92	0.85	0.90	0.96	1.00	1.12	1.14	1.21
40 S	1.27	1.06	1.07	0.93	0.86	0.78	0.84	0.92	1.00	1.15	1.20	1.29
>50 S	1.37	1.12	1.08	0.89	0.77	0.67	0.74	0.88	0.99	1.19	1.29	1.41

Assume L=12, 12 hours of day length; N=30, 30 days in the month

WATER BUDGET - PRE-DEVELOPMENT
WATER BALANCE / WATER BUDGET ASSESSMENT

Catchment Designation	Site		
			Totals
Area (m²)	123400		123400
Pervious Area (m²)	120994		120994
Impervious Area (m²)	2406		2406
Infiltration Factors			
Topography Infiltration Factor	0.2		0.1
Soil Infiltration Factor	0.2		0.2
Land Cover Infiltration Factor	0.2		0.1
MOE Infiltration Factor	0.6		0.4
Run-Off Coefficient	0.4		0.6
Runoff from Impervious Surfaces*	0.8		0.8
Inputs (per Unit Area)			
Precipitation (mm/yr)	880		880
Run-On (mm/yr)	0		0
Other Inputs (mm/yr)	0		0
Total Inputs (mm/yr)	**880**		**880**
Outputs (per Unit Area)			
Precipitation Surplus (mm/yr)	250		250
Net Surplus (mm/yr)	250		250
Evapotranspiration (mm/yr)	631		631
Infiltration (mm/yr)	141		141
Rooftop Infiltration (mm/yr)**	0		0
Total Infiltration (mm/yr)	141		141
Runoff Pervious Areas	94		94
Runoff Impervious Areas	14		14
Total Runoff (mm/yr)	108		108
Total Outputs (mm/yr)	**880**		**880**
Difference (Inputs - Outputs)	0		0
Inputs (Volumes)			
Precipitation (m³/yr)	108629		108629
Run-On (m³/yr)	0		0
Other Inputs (m³/yr)	0		0
Total Inputs (m³/yr)	**108629**		**108629**
Outputs (Volumes)			
Precipitation Surplus (m³/yr)	30789		30789
Net Surplus (m³/yr)	30789		30789
Evapotranspiration (m³/yr)	77840		77840
Infiltration (m³/yr)	17457		17457
Rooftop Infiltration (m³/yr)	0		0
Total Infiltration (m³/yr)	17457		17457
Runoff Pervious Areas	11638		11638
Runoff Impervious Areas	1694		1694
Total Runoff (m³/yr)	13332		13332
Total Outputs (m³/yr)	**108629**		**108629**
Difference (Inputs - Outputs)	0		0

Table 3.1: Hydrologic Cycle Component Values

	Water Holding Capacity mm	Hydrologic Soil Group	Precipitation mm	Evapo-transpiration mm	Runoff mm	Infiltration* mm
Urban Lawns/Shallow Rooted Crops (spinach, beans, beets, carrots)						
Fine Sand	50	A	940	515	149	276
Fine Sandy Loam	75	B	940	525	187	228
Silt Loam	125	C	940	536	222	182
Clay Loam	100	CD	940	531	245	164
Clay	75	D	940	525	270	145
Moderately Rooted Crops (corn and cereal grains)						
Fine Sand	75	A	940	525	125	291
Fine Sandy Loam	150	B	940	539	160	241
Silt Loam	200	C	940	543	199	199
Clay Loam	200	CD	940	543	218	179
Clay	150	D	940	539	241	160
Pasture and Shrubs						
Fine Sand	100	A	940	531	102	307
Fine Sandy Loam	150	B	940	539	140	261
Silt Loam	250	C	940	546	177	217
Clay Loam	250	CD	940	546	197	197
Clay	200	D	940	543	218	179
Mature Forests						
Fine Sand	250	A	940	546	79	315
Fine Sandy Loam	300	B	940	548	118	274
Silt Loam	400	C	940	550	156	234
Clay Loam	400	CD	940	550	176	215
Clay	350	D	940	549	196	196

Notes: Hydrologic Soil Group A represents soils with low runoff potential and Soil Group D represents soils with high runoff potential. The evapotranspiration values are for mature vegetation. Streamflow is composed of baseflow and runoff.

** This is the total infiltration of which some discharges back to the stream as base flow. The infiltration factor is determined by summing a factor for topography, soils and cover.*

Topography	Flat Land, average slope < 0.6 m/km	0.3
	Rolling Land, average slope 2.8 m to 3.8 m/km	0.2
	Hilly Land, average slope 28 m to 47 m/km	0.1
Soils	Tight impervious clay	0.1
	Medium combinations of clay and loam	0.2
	Open Sandy loam	0.4
Cover	Cultivated Land	0.1
	Woodland	0.2

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*Evaporation from impervious areas was assumed to be: 20% of precipitation

WATER BUDGET, POST-DEVELOPMENT
WATER BALANCE / WATER BUDGET ASSESSMENT

Catchment Designation	Site		Total
Area (m²)	123400		123400
Pervious Area (m²)	44500		44500
Impervious Area (m²)	78900		78900
New Rooftop Area (m²)	0		0
Infiltration Factors			
Topography Infiltration Factor	0.2		0.1
Soil Infiltration Factor	0.2		0.2
Land Cover Infiltration Factor	0.2		0.1
MOE Infiltration Factor	0.6		0.4
Run-Off Coefficient	0.4		0.6
Runoff from Impervious Surfaces*	0.8		0.8
Inputs (per Unit Area)			
Precipitation (mm/yr)	880		880
Run-On (mm/yr)	0		0
Other Inputs (mm/yr)	0		0
Total Inputs (mm/yr)	**880**		**880**
Outputs (per Unit Area)			
Precipitation Surplus (mm/yr)	537		537
Net Surplus (mm/yr)	537		537
Evapotranspiration (mm/yr)	343		343
Infiltration (mm/yr)	52		52
Rooftop Infiltration (mm/yr)	0		0
Total Infiltration (mm/yr)	52		52
Runoff Pervious Areas	35		35
Runoff Impervious Areas	450		450
Total Runoff (mm/yr)	485		485
Total Outputs (mm/yr)	**880**		**880**
Difference (Inputs - Outputs)	0		0
Inputs (Volumes)			
Precipitation (m³/yr)	108629		108629
Run-On (m³/yr)	0		0
Other Inputs (m³/yr)	0		0
Total Inputs (m³/yr)	**108629**		**108629**
Outputs (Volumes)			
Precipitation Surplus (m³/yr)	66265		66265
Net Surplus (m³/yr)	66265		66265
Evapotranspiration (m³/yr)	42364		42364
Infiltration (m³/yr)	6420		6420
Rooftop Infiltration (m³/yr)	0		0
Total Infiltration (m³/yr)	6420		6420
Runoff Pervious Areas	4280		4280
Runoff Impervious Areas	55565		55565
Total Runoff (m³/yr)	59845		59845
Total Outputs (m³/yr)	**108629**		**108629**
Difference (Inputs - Outputs)	0		0

*Evaporation from impervious areas was ass of precipitation 20% of precipitation

Table 3.1: Hydrologic Cycle Component Values

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	Open Sandy loam	0.4
Cover	Cultivated Land	0.1
	Woodland	0.2

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WATER BUDGET SUMMARY
WATER BALANCE / WATER BUDGET ASSESSMENT

Characteristic	Site		
	Pre-Development	Post-Development	Change (Pre- to Post-)
Inputs (Volumes)			
Precipitation (m^3/yr)	108629	108629	0.0%
Run-On (m^3/yr)	0	0	0.0%
Other Inputs (m^3/yr)	0	0	0.0%
Total Inputs (m^3/yr)	**108629**	**108629**	**0.0%**
Outputs (Volumes)			
Precipitation Surplus (m^3/yr)	30789	66265	115.2%
Net Surplus (m^3/yr)	30789	66265	115.2%
Evapotranspiration (m^3/yr)	77840	42364	-45.6%
Infiltration (m^3/yr)	17457	6420	-63.2%
Rooftop Infiltration (m^3/yr)	0	0	0.0%
Total Infiltration (m^3/yr)	17457	6420	-63.2%
Runoff Pervious Areas	11638	4280	-63.2%
Runoff Impervious Areas	1694	55565	3179.3%
Total Runoff (m^3/yr)	13332	59845	348.9%
Total Outputs (m^3/yr)	**108629**	**108629**	**0.0%**