CORAL SOPHIA HOUSING INC.

HYDROGEOLOGICAL STUDY

113-117 BAYFIELD STREET, BARRIE

MARCH 03, 2021

HYDROGEOLOGICAL STUDY

113-117 BAYFIELD STREET, BARRIE

CORAL SOPHIA HOUSING INC.

PROJECT NO.: 191-04694-00

DATE: MARCH 03, 2021

WSP
UNIT 2
126 DON HILLOCK DRIVE
AURORA, ON, CANADA L4G 0G9

T: +1 905 750-3080
F: +1 905 727-0463
WSP.COM

March 03, 2021

CORAL SOPHIA HOUSING INC.
c/o DMS Property Management Ltd.
4810 Dufferin Street, Suite E
Toronto, ON
M3H 5S8

Attention: Mr. Nick Savino

Dear Mr. Savino:

Subject: Hydrogeological Study
113-117 Bayfield Street, Barrie, Ontario

WSP Canada Inc. (WSP) is pleased to submit the attached report to document the Hydrogeological Study prepared in support of the development application for Coral Sophia Inc. for 113-117 Bayfield Street (Site) in the City of Barrie, Ontario. The Hydrogeological Study included three components:

1. Hydrogeological Assessment
2. Water Balance Study
3. Dewatering Assessment

The report provides an assessment of the existing hydrogeological conditions beneath the Site as well as water budgets for existing and future conditions to illustrate the likely changes in water balance that would be expected due to the proposed development. The report includes a preliminary assessment of anticipated dewatering requirements for the proposed development design based on observed conditions.

Thank you for the opportunity to carry out this study on your behalf. We trust that this information is sufficient for your current needs. If you have any questions or require further information, please contact us.

Yours truly,

Lloyd Lemon, M.Sc., P.Geo.
Senior Project Geoscientist

VB/dlw

WSP ref.: 191-04694-00
H:\Data\Proj\19\191-04694-00 Bayfield Barrie\Wp\191-04694-00 Hydrogeological Study_Rev_2021-03-03_Final.docx

UNIT 2
126 DON HILLOCK DRIVE
AURORA, ON, CANADA L4G 0G9

T: +1 905 750-3080
F: +1 905 727-0463
wsp.com

EXECUTIVE SUMMARY

WSP Canada Inc. (WSP) was retained by Coral Sophia Housing Inc. (Coral Sophia) to prepare a Hydrogeological Study in support of a proposed development at 113-117 Bayfield Street and 6, 8, 12 Sophia Street East (together referred to as 113-117 Bayfield Street), in the City of Barrie, Ontario (Site). The work is to be carried out in order to support development planning concepts for the site and possible dewatering requirements. The proposed development encompasses one eight (8) storey building comprising 108 residential units and aboveground parking that encompasses most of the total Site area of 0.37 hectares (0.92 acres). The Hydrogeological Study included three components:

1. Hydrogeological Assessment.
2. Water Balance Study.
3. Dewatering Assessment.

The proposed development area straddles the boundary of the Simcoe Uplands and Simcoe Lowlands physiographic region as defined by Chapman and Putnam (1984).

The Site is located within the Lake Simcoe Watershed. Regional drainage is directed to the south toward Lake Simcoe.

The observed stratigraphic profile beneath the site consists of:

- A layer of topsoil up to 0.4 m thick.
- A layer of fill up to a typical depth of 2.2 mbgs and to a maximum depth of 3 mbgs. The fill varies in texture from silty clay to clayey silt to sandy silt to silty sand.
- An upper layer of till to depths between 3 mbgs and 7 m bgs. This till varies in texture from sandy silt to silty sand.
- A lower layer of till to the bottom of the investigated depth (9.8 m bgs). This till varies in texture from sandy clayey silt to silty clayey sand.

The observed depth to groundwater varied between 0.73 and 3.44 m below ground on May 15, 2019. Groundwater elevations measured in May 2019 varied from a high of 235.85 in the northeastern area of the site (MW19-06) to a low of 232.25 in the south of the Site (MW19-05). Groundwater flow is observed to be directed in a southerly direction.

Continuous groundwater elevation monitoring from April through September 2019 demonstrates that the seasonal high groundwater elevation occurred in May. The seasonal high value of 235.85 has been used as a basis for the proposed building design. The floor level is established 0.5 m above the seasonally high water table.

Single well response tests were conducted to estimate hydraulic conductivity in the newly installed monitoring wells (MW19-02, MW19-05, and MW19-06), as well as in the well from previous investigations (BH2). The hydraulic conductivity is estimated to be between 2.7 $x10^{-8}$ m/s to 2.1 $x10^{-6}$ m/s. This range is considered to reflect the observed saturated materials below the water table.

Representative groundwater samples were collected from BH2, MW19-02, and MW19-06 on May 2, 2019 and tested for general water quality parameters, dissolved metals, total phosphorus, total organic carbon, reactive silica, and nutrients. The results of these tests indicated that the concentrations of dissolved Copper (Cu) in BH2, MW19-02 and MW19-06, of dissolved Cobalt (Co) in BH2, and MW19-06, and of dissolved Uranium (U) in MW19-02 are greater than the Provincial Water Quality Objectives (PWQO).

The water quality samples from MW19-05 were submitted to determine concentrations of parameters to assess suitability for discharge to the City of Barrie sewers and included: pH, Total Suspended Solids (TSS), Chloride, Fluoride, Total Kjeldahl Nitrogen (TKN), Hardness, Total Phosphorus, Sulphate, Sulphide. Total Cyanide, Chemical Oxygen Demand (COD), Total Metals, Aggregate Organics, Volatile Organic Compounds (VOC), Polycyclic

Aromatic Hydrocarbons (PAH), and Semi-Volatile Organics. The reported concentration of Total Suspended Solids (TSS) in MW19-05 of 300,000 mg/L is greater than the Bylaw 2012-172 objectives for sanitary and storm sewers. The reported concentrations of Total Phosphorus, Total Barium, Total Manganese, and Chemical Oxygen Demand were also greater than the Bylaw 2012-172 objectives for sanitary sewers.

The results of the water quality testing indicate that treatment will be required to reduce TSS and metals concentrations for discharge to the City of Barrie Sewers.

The Climate-Based Water Budget indicates that average annual precipitation over the past 30 years is 932.9 mm/year. The available moisture surplus at the Site is 383.4 mm/year based on the type of soil and vegetation cover. The moisture surplus will reflect the infiltration and runoff based on the soil properties, slopes, and vegetation within individual catchments.

The pre-development water budget was assumed to reflect the condition with the former buildings and parking lots in place. the Site consists of one (1) drainage catchment that drains to City of Barrie storm sewers. There is one (1) off-site catchment that drains on-site from the north.

The Pre-Development Water Budget reflects infiltration for the Site of approximately 144 m^3/yr and runoff from the Site of approximately 2,875 m^3/yr. The Pre-Development infiltration and runoff reflect the urban nature of the pre-development condition.

The Post-Development Water Budget reflects changes in land use to include increased areas of impervious surfaces (i.e. roads, buildings etc.). Under Post-Development conditions, runoff from the Site will drain to City of Barrie storm sewers.

The Post-Development Water Budget predicts a total on-site infiltration of 209 m^3/yr. The Post-Development Water Budget reflects an infiltration surplus of 65 m^3/yr (45% increase from pre-development).

The Post-Development Water Budget, for the development predicts an annual runoff on the order of 2,907 m^3/yr. This reflects an increase of 32 m^3/yr or 1% from pre-development. The potential capacity of the City of Barrie storm sewers to receive these flows has not been evaluated as part of this study.

The Site lies within the WHPA and WHPA Q1/Q2 for the City of Barrie wells, IPZ-3 for water supplies that draw from Lake Simcoe, and an issue contributing area (ICA) for sodium and chloride. The policies that are in place to govern development at this site will promote recharge and minimize use of sodium and chloride as part of winter road maintenance.

The Site is mapped as a Highly Vulnerable Aquifer (HVA). The observed fine-grained soils beneath the property are not consistent with the mapping as a highly vulnerable aquifer.

The Site partially lies in an area mapped as a Significant Groundwater Recharge Area (SGRA). The observed fine-grained soils are not consistent with the mapping as a SGRA.

The proposed structure will occupy the majority of the available lands and the base of the floor elevation has been established to be 0.5 m above the high groundwater elevation. The high groundwater elevation is approximately 235.85 mASL. The foundation footings are currently proposed to be founded at the top of the native soil, which ranges between 233.2 and 233.9 mASL. As a conservative assumption, the elevation of the underside of the footing will be placed at 233 mASL . It is anticipated that the footings will be submerged during seasonal high groundwater elevations.

Conservative estimates of the requirements for construction dewatering to install the building foundations indicate that the dewatering volumes will be up to 136,800 L/day. This volume is greater than the threshold to register on the EASR but is less that the requirement to obtain a PTTW for construction dewatering purposes. WSP is currently conducting an updated Phase One and Phase Two Environmental Site Assessment (ESA) at the Site. If the findings and recommendations of the Phase One and Phase Two ESA support the removal of excess soil to address potential contamination concerns at the Site, there may be a potential that the additional volumes of water would need to be removed during these remediation activities. It is recommended that the dewatering estimates be revisited if the Phase Two ESA identifies a requirement to remove soils to a depth greater than required for the construction of the building foundation footings. An Excess Soil Management Plan may be required in the event that fill material cannot be re-used on-site.

Direct precipitation into the open excavation may contribute up to 120,000 L/day of water for a 30 mm storm event over a period of one day. This volume can be managed within the EASR.

An agreement with the City of Barrie will be required for discharge of construction dewatering water to municipal infrastructure.

The seasonal high groundwater elevations are anticipated to be above the proposed footings. As such, the design of the building foundation system is recommended to consider that the footings may be submerged for part of the year.

A discharge plan will be required in support of the proposed construction dewatering. This will require confirmation that the City of Barrie sewage infrastructure has capacity to handle proposed quantity and quality of discharge. Treatment will be required to remove TSS and metals to achieve the water quality limits as per City of Barrie By-law 2012-172.

A Monitoring Program will be required in support of the proposed construction. The anticipated components of the monitoring program include:

- Maintaining records of daily discharge volumes.
- Monitoring water quality to ensure compliance with City of Barrie Bylaw 2012-172.
- Performing a settlement analysis and, if necessary monitoring, to minimize potential for settling related to the proposed development.
- Mitigating potential effects from dewatering by reducing dewatering volumes (if possible), providing additional treatment, or re-evaluating proposed design/construction.
- Maintaining an adaptive management approach to review and update the dewatering and monitoring program in response to observed conditions.

SIGNATURES

PREPARED BY

Valyn Bernard, P.Eng.
Project Engineer

March 3, 2021
Date

APPROVED BY

Lloyd Lemon, M.Sc., P.Geo.
Senior Project Geoscientist

March 3, 2021
Date

WSP Canada Inc ("WSP") prepared this report solely for the use of the intended recipient. CORAL SOPHIA HOUSING INC., in accordance with the professional services agreement between the parties. In the event a contract has not been executed, the parties agree that the WSP General Terms for Consultant shall govern their business relationship which was provided to you prior to the preparation of this report.

The report is intended to be used in its entirety. No excerpts may be taken to be representative of the findings in the assessment.

The conclusions presented in this report are based on work performed by trained, professional and technical staff, in accordance with their reasonable interpretation of current and accepted engineering and scientific practices at the time the work was performed.

The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation, using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by WSP and other engineering/scientific practitioners working under similar conditions, and subject to the same time, financial and physical constraints applicable to this project.

WSP disclaims any obligation to update this report if, after the date of this report, any conditions appear to differ significantly from those presented in this report; however, WSP reserves the right to amend or supplement this report based on additional information, documentation or evidence.

WSP makes no other representations whatsoever concerning the legal significance of its findings.

The intended recipient is solely responsible for the disclosure of any information contained in this report. If a third party makes use of, relies on, or makes decisions in accordance with this report, said third party is solely responsible for such use, reliance or decisions. WSP does not accept responsibility for damages,

if any, suffered by any third party as a result of decisions made or actions taken by said third party based on this report.

WSP has provided services to the intended recipient in accordance with the professional services agreement between the parties and in a manner consistent with that degree of care, skill and diligence normally provided by members of the same profession performing the same or comparable services in respect of projects of a similar nature in similar circumstances. It is understood and agreed by WSP and the recipient of this report that WSP provides no warranty, express or implied, of any kind. Without limiting the generality of the foregoing, it is agreed and understood by WSP and the recipient of this report that WSP makes no representation or warranty whatsoever as to the sufficiency of its scope of work for the purpose sought by the recipient of this report.

In preparing this report, WSP has relied in good faith on information provided by others, as noted in the report. WSP has reasonably assumed that the information provided is correct and WSP is not responsible for the accuracy or completeness of such information.

Benchmark and elevations used in this report are primarily to establish relative elevation differences between the specific testing and/or sampling locations and should not be used for other purposes, such as grading, excavating, construction, planning, development, etc.

WSP disclaims any responsibility for consequential financial effects on transactions or property values, or requirements for follow-up actions /or costs.]

Design recommendations given in this report are applicable only to the project and areas as described in the text and then only if constructed in accordance with the details stated in this report. The comments made in this report on potential construction issues and possible methods are intended only for the guidance of the designer. The number of testing and/or sampling locations may not be sufficient to determine all the factors that may affect construction methods and costs. We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.]

Overall conditions can only be extrapolated to an undefined limited area around these testing and sampling locations. The conditions that WSP interprets to exist between testing and sampling points may differ from those that actually exist. The accuracy of any extrapolation and interpretation beyond the sampling locations will depend on natural conditions, the history of Site development and changes through construction and other activities. In addition, analysis has been carried out for the identified chemical and physical parameters only, and it should not be inferred that other chemical species or physical conditions are not present. WSP cannot warrant against undiscovered environmental liabilities or adverse impacts off-Site.]

The original of this digital file will be kept by WSP for a period of not less than 10 years. As the digital file transmitted to the intended recipient is no longer under the control of WSP, its integrity cannot be assured. As such, WSP does not guarantee any modifications made to this digital file subsequent to its transmission to the intended recipient.]

This limitations statement is considered an integral part of this report.

TABLE OF CONTENTS

TABLES (APPENDED)

TABLES (IN-TEXT)

FIGURES (APPENDED)

APPENDICES

1 INTRODUCTION

WSP Canada Inc. (WSP) was retained by Coral Sophia Housing Inc. (Coral Sophia) to prepare a Hydrogeological Study in support of a proposed development at 113-117 Bayfield Street and 6, 8, 12 Sophia Street East (together referred to as 113-117 Bayfield Street), in the City of Barrie, Ontario (Site). The work is to be carried out to support development planning concepts for the site.

This report documents the work performed to provide an understanding of the hydrogeological conditions at the Site, to prepare a water balance analysis, and to provide a preliminary assessment of dewatering requirements for Site design and construction.

1.1 PROJECT BACKGROUND & REQUIREMENTS

The proposed development encompasses one eight (8) storey building comprising 108 residential units, and aboveground parking that encompasses most of the total Site area of 0.37 hectares (0.92 acres). The Site location is shown on **Figure 1** and the Site boundaries are illustrated on **Figure 2**.

Previous work performed at the Site includes:

- Phase Two Environmental Site Assessment - 113-117 Bayfield Street, Barrie, Ontario (S2S Environmental Inc., October 2016).
- Assessment of Dewatering Requirements - 113-117 Bayfield Street, Barrie, Ontario (WSP, November 2016).
- Geotechnical Investigation - 113-117 Bayfield Street, Barrie, Ontario (WSP, May 2019).

The Assessment of Dewatering Requirements report (WSP, 2016) recommended drilling additional boreholes to better characterise the distribution of soils, assess the seasonal variation of groundwater levels, and to confirm the absence of deeper pressurized aquifers.

A Preliminary Site Plan (March 2018) was provided to WSP by Skelton Brumwell & Associates Inc. (SBA) Engineering Planning Environmental Consultants as input in preparing the scope of work for the current studies by WSP. The current studies by WSP include concurrent work to provide a Geotechnical Investigation (WSP, 2019). The scope of field work for the Geotechnical Investigation and Hydrogeological Study were developed together to ensure consistency and minimize duplication of effort. The scope of the Hydrogeological Study included re-evaluation of potential dewatering requirements for the proposed construction and maintenance of the structure, and determines whether this dewatering would require obtaining a Permit to Take Water (PTTW) from the Ministry of the Environment, Conservation and Parks (MECP) or whether the dewatering activity can be registered on the Environmental Activity and Sector Registry (EASR).

1.2 OBJECTIVES AND SCOPE

WSP has prepared the scope of work for the Hydrogeological Study to address the requirements and current expectations of the Lake Simcoe Region Conservation Authority (LSRCA) for hydrogeological assessments and the City of Barrie Terms of Reference for Hydrogeological Study dated January 2019. In addition, the LSRCA has provided "Hydrogeological Assessments - Conservation Authority Guidelines to Support Development Applications" (2013) to define the expected goals of the LSRCA to ensure that a comprehensive evaluation of natural recharge and discharge features within and adjacent to the development area is undertaken. The goal for work completed under these guidelines is to minimize the potential for development to change the form and function of the groundwater-surface water systems. The Guideline document describes the basic expectation for the hydrogeological studies to characterize the existing conditions in terms of:

1 Water table elevation and seasonal fluctuations;
2 Groundwater flow direction(s);
3 Recharge/discharge rates and volumes on an appropriate time scale (daily to annual depending on proximal environmental features);
4 Soils and stratigraphic data;
5 Water quality information;
6 Description of the receiving water bodies; and
7 Preparation of a Pre-Development and Post-Development Water Budget to identify potential changes in recharge and run-off and to identify mitigation measures that will minimize adverse effects from these changes.

Pre-consultation with LSRCA pre-consultation was undertaken for the property in the context of the Provincial Policy Statement (PPS), the Lake Simcoe Protection Plan (LSPP), the Ontario Regulation 179/06 under the Conservation Authorities Act, as well as the Natural Heritages of the City of Barrie Official Plan. Ms. Lisa- Beth Bulford of the LSRCA determined in an April 28, 2017 letter the necessity of a Hydrogeological Assessment addressing the designated policy 6.40 of the LSPP. Policy 6.40 of the LSPP addresses the requirement to demonstrate that the quality and quantity of groundwater within significant groundwater recharge areas will be protected, improved, or restored.

The Hydrogeological Study has been designed to:

- Review historical information and integrate findings.
- Identify the inventory of groundwater users within 500 m of the property.
- Characterize the shallow groundwater flow system in terms of soil characteristics, ability to conduct water, and role in the regional groundwater flow system.
- Identify and define the lateral extent and thickness of aquifer and aquitard units within the upper five (5) to 10 m of soil.
- Identify the presence and depth of a shallow water table.
- Determine groundwater flow directions and patterns.
- Identify potential watershed divides that control groundwater flow.
- Identify potential for vertical components of groundwater flow in the upper three (3) to 10 m of the soil profile.
- Characterize the relative permeability (hydraulic conductivity) of aquifer units within the upper five (5) to 10 m.
- Provide continuous groundwater elevation monitoring over a 12-month period on one onsite well through the use of an electronic datalogger, and one barologger for compensation.
- Measure groundwater elevations manually in all the wells on a monthly frequency between April and June 2019, and every three (3) months thereafter to capture seasonal variability.
- Characterize the water quality of the shallow and deep groundwater units. One (1) groundwater sample from within the building footprint of the will be unfiltered and compared with the City of Barrie sewer use bylaw. Samples from other wells will be filtered and tested from general chemistry (metals, nutrient, and inorganics).
- Characterize the relationships between on-site groundwater flow systems and adjacent surface water bodies.
- Provide updated estimates for preliminary dewatering volumes to determine whether a PTTW will be required or whether construction dewatering can be registered on the EASR.
- Identify footprints of potential structures that may extend below the water table. Provide area and estimated depth below the water table.
- Assess potential for long-term drainage from structures constructed below the ground surface, including basements and foundations.
- Summarize the results of the dewatering assessment, including preparation of a dewatering discharge plan and monitoring program that will be sufficient to support a PTTW application or filing of the EASR.
- Create an annual water budget for the existing conditions at the property for use as a baseline.
- Confirm the water balance infiltration target with the City of Barrie.
- Determine a future annual water budget for the proposed development scenario.

- Identify significant changes to the water balance or to the form and function of the groundwater or surface water systems that might result from future plans and provide recommendations for mitigative measures to address these changes.
- Consider and integrate findings from the Phase 2 Environmental Site Assessment, the Assessment of Dewatering Requirements (WSP, 2016) and the Geotechnical Investigation (WSP, 2019) reports.
- Prepare a project report.

WSP has also been contracted to conduct a Phase One and Phase Two Environmental Site Assessment (ESA) at the Site. The findings and recommendations of the Phase One and Phase Two ESA will be issued under separate cover

1.3 ANALYSIS AND DOCUMENTATION

The following published information and mapping was reviewed and considered in our analysis of the Site:

- Hydrogeological Assessments - Conservation Authority Guidelines to Support Development Applications, April 2013.
- Assessment Report, South Georgian Bay Lake Simcoe Source Protection Region, Part 1 (Lake Simcoe, May 2015 update). Approved Lakes Simcoe and Couchiching Source Protection Plan.
- MECP Water Well Information System (MECP WWIS).
- Other sources of information as listed in **Section 11.0**.

2 REGIONAL SETTING

2.1 PHYSIOGRAPHY

The regional physiography for the Site area is shown in **Figure 3**. The proposed development area straddles the boundary of the Simcoe Uplands and Simcoe Lowlands physiographic regions as defined by Chapman and Putnam (1984) as represented in the OGS Earth application accessible through the Ministry of Northern Development and Mines Web Page (http://www.geologyontario.mndm.gov.on.ca). The northern part of the Site is mapped within the Simcoe Uplands and the southern part of the Site is mapped within the Simcoe Lowlands.

The Simcoe Uplands consist of a drumlinized rolling till plain. The Simcoe Lowlands consists of a sand plain.

2.2 TOPOGRAPHY AND DRAINAGE

Regional topography is illustrated on **Figure 4**. The Site is located within the Lake Simcoe Watershed. Regional drainage is directed to the south toward Lake Simcoe.

The local topography of the Site slopes to the south. Runoff from the Site exits across the southern boundary and flows to the storm sewer system.

2.3 REGIONAL GEOLOGY

The near surface soils are the top unit in a layered sequence of glacial and interglacial sediments that comprise the stratigraphic profile overlying bedrock beneath the Lake Simcoe region. The distribution of surficial soil types in and around the Site are shown on **Figure 5**. The surficial soils at the Site are mapped as fine-grained sandy deposits related to the late stages of development of Lake Simcoe. These deposits are underlain by silty to sandy till.

The Geological Survey of Canada, under the direction of Dr. David Sharpe, published detailed three-dimensional mapping of stratigraphic profiles in the regional areas to the south of the site. Work is ongoing to extend this basic stratigraphic framework into Simcoe County. The stratigraphic profile beneath Oak Ridges Moraine area typically include equivalents to the following layers, from youngest to oldest:

1. Recent deposits.
2. Newmarket Till.
3. Thorncliffe Formation.
4. Sunnybrook Drift.
5. Scarborough Formation.
6. Don Formation.
7. York Till.
8. Bedrock.

The Newmarket Till represents a regionally extensive stratum that is associated with the most recent period of glaciation. This till is typically dense to very hard and sandy to silty in texture with relatively low gravel content. The Newmarket Till is mapped at ground surface to the north of the Site.

The stratigraphic layers between the Newmarket Till and the underlying bedrock are commonly grouped as the Lower Sediments. The Lower Sediments are considered to have been formed by similar cycles of earlier glacial advances and retreats and associated meltwater events that resulted in the deposition of the Newmarket Till and Oak Ridges Moraine sediments. Five (5) stratigraphic layers that constitute the Lower Sediments are described below, although not all are interpreted to occur below the study area.

- The Thorncliffe Formation is a complex of stratified glaciofluvial and glaciolacustrine deposits. The texture of the Thorncliffe Formation is highly variable and is best described as fine-grained, with interbedded coarse-grained material capable of yielding notable amounts of water.
- The Sunnybrook Drift is a fine-grained material deposited in glacial and proglacial lacustrine depositional environments (diamicton). The advance of the ice sheet blocked the main drainage from the regional basin, which caused water levels to rise and form a deep lacustrine environment with deposits including varved clays.
- The Scarborough Formation is a coarsening upward sequence of sediment that ranges from clay/silt rhythmites (fine-grained) to channelized cross-bedded sands (coarse-grained). The coarser fractions of this delta are a potential source of groundwater.
- The Don Formation is only rarely preserved within southern Ontario and consists of alternating beds of fossiliferous sand and mud.
- The York Till was deposited immediately overlying the bedrock by the preceding Illinoian glaciation. This till occurs only sporadically within the study area and is believed to be preserved in lows upon the bedrock surface. The till is dark grey with a sandy silt matrix and includes clusters of the underlying shale.

The bedrock beneath the study area is mapped as the fossiliferous limestone/shale of the Verulam Formation (Armstrong and Dodge, 2007) as illustrated on **Figure 6**. The depth to bedrock is estimated to be between 115 to 120 metres below ground surface, based on bedrock topography mapping (Gao et al., 2006). The depth to bedrock decreases in a southerly direction toward Lake Simcoe. A map of overburden thickness is provided in **Figure 7**.

2.4 REGIONAL HYDROGEOLOGY

The movement of groundwater through the subsurface is controlled by the hydraulic gradients and the relative distribution of coarse and fine-grained sediments. In general, water will move laterally through coarse-grained sediments (sands and gravels) and vertically through fine-grained sediments (silts and clays). As such, the geologic units are typically grouped into hydrostratigraphic units that reflect the capacity of the geologic units to transmit water. Hydrostratigraphic units are considered to be either aquifers (with good capacity to transmit water) or aquitards (which typically impede transmission of water). Ultimately the distribution and interconnection of aquifers and aquitards are responsible for observed groundwater movement.

Earthfx Inc. (2006) grouped the regional stratigraphic profile into a seven-layer hydrostratigraphic profile as follows:

1) Recent Deposits.
2) Newmarket Aquitard.
3) Thorncliffe Aquifer Complex.
4) Sunnybrook Aquitard.
5) Scarborough Aquifer Complex.
6) Bedrock.

In this area, the Recent Deposits typically reflect a thin local aquifer comprised of sandy sediments. The shallow water table will typically be observed within this layer.

The Newmarket Aquitard consists of the Newmarket Till and low permeability deposits that are known to infill the erosional channels. The Newmarket Aquitard is considered to be a leaky confining layer that provides protection from contamination to aquifers within the underlying hydrostratigraphic units. The Newmarket Aquitard may be present at ground surface beneath the Site.

The Thorncliffe Aquifer Complex consists of fine to coarse-grained sediments of the Thorncliffe Formation. Local sand and gravel deposits within the Thorncliffe Aquifer Complex provide high yield wells. Groundwater in this layer is typically under pressure and in areas to the south of Aurora, the groundwater is under artesian pressure which can result in flowing wells.

The Sunnybrook Aquitard separates the Thorncliffe and Scarborough Aquifer Complexes. This aquitard demonstrates low permeability, provides some resistance to vertical groundwater movement, and protects the underlying aquifer from potential contaminant movement.

The Scarborough Aquifer Complex consists of fine to coarse-grained sediments associated with the Scarborough Formation. In general, these sediments tend to be coarse-grained and thicker where they fill topographic lows and valleys in the underlying bedrock surface. Groundwater within the Scarborough Aquifer Complex is typically under pressure, but only local artesian conditions occur. Locally, the Scarborough Aquifer Complex produces high well yields suitable for municipal or commercial wells. Due to its depth and presence of shallower aquifers, the Scarborough Aquifer Complex is not exploited extensively for private water supplies.

2.4.1 REGIONAL GROUNDWATER MOVEMENT

In general terms, precipitation infiltrates vertically into the surficial sand/gravel soil units. Groundwater will primarily move downward to the water table within the upper aquifer or aquitard unit. Groundwater will then tend to flow up or down through the aquitard units and laterally within the aquifers. Groundwater flow patterns can be influenced by established watercourses where there is potential for groundwater discharge to supply baseflow into the watercourses. The rate of groundwater discharge is controlled by the relative permeability of the recent deposits at the base of the streams. Discharge as baseflow is typically low through fine-grained base soils and higher where the streams have eroded down into coarser aquifers.

The horizontal groundwater movement through the subsurface aquifers tends to reflect the ground surface topography and the presence of stream channels.

3 WORK PERFORMED

The work program for the Hydrogeological Study included the following activities:

1. Coordinating field work.
2. Describing the natural Site conditions: surface features, surface topography, soil types and stratigraphy.
3. Identifying current users of groundwater within 500 m of the subject property through the review of the MECP WWIS.
4. Obtaining utility clearances for subsurface investigations.
5. Inspecting the Site to locate monitoring wells from the Phase II ESA (WSP, 2016). Only one (1) of the monitoring wells (BH2) was located and found to be in suitable condition for use in the Hydrogeological Study.
6. Advancing six (6) boreholes, with three (3) completed as a monitoring wells, to depths of approximately 9.8 (BH19-01), 9.8 (MW19-02), 5.2 (BH19-03),5.2 (BH19-04),9.8 (MW19-05) and 6.7 (MW19-06) meters below ground surface (mbgs).
7. Constructing monitoring wells in three boreholes: BH/MW19-02; BH/MW19/05 and BH/MW19-06.
8. Measuring static water depths following well construction, before well development and before groundwater sample collection.
9. Measure water levels manually in all wells on a monthly basis for the first three months, then every three months afterward in conjunction with datalogger downloads to capture seasonal variability.
10. Provide continuous groundwater elevation monitoring of onsite monitoring well BH2 through the use of an electronic datalogger and one barologger for compensation over the period of one year, with the data from loggers downloaded quarterly.
11. Developing newly installed monitoring wells to a condition suitable for collection of a representative groundwater sample.
12. Conducting a single-well response test on four accessible (4) groundwater monitors to determine the relative horizontal hydraulic conductivity adjacent to the well screen.
13. Collecting a representative sample of groundwater for testing of general groundwater quality from monitoring wells BH2, MW19-02, and MW19-06.
14. Collecting a representative sample of groundwater for testing against Barrie Sewer Bylaw from monitoring well MW19-05.
15. Analyzing the data gathered to document geological and hydrogeological conditions;
16. Preparing an annual climatic water budget and Site-specific water balance for Pre- and Post-Development conditions; and
17. Estimating preliminary dewatering volumes based on the proposed development plans and observed water levels and hydraulic conductivity estimates.
18. Review and revise water balance and dewatering estimates to reflect redesign of the Site with a structure constructed above the water table and with footings founded on native soil.

3.1 BACKGROUND REVIEW OF GEOLOGICAL CONDITIONS

The geologic conditions beneath the proposed development were reviewed using published map sources, records from work on adjacent properties, and the WWIS database as maintained by the MECP.

Water well records within a 500-metre radius of the Site were reviewed to obtain information on existing wells and to provide information on the geology of the area. A summary of the well record search is provided in Table A-1, **Appendix A** and water well record locations are plotted on **Figure 8**.

3.2 BOREHOLE DRILLING

Ontario One Call was consulted to identify where existing public utilities entered the Site boundaries prior to initiating on-site activities. In addition, given that the Site is a private property, WSP retained the services of a private utility locator to clear the specific borehole and test pit locations from potential interference with private utilities.

The borehole drilling and monitoring well installation was carried out between April 24 and April 25, 2019. Drilling and excavation services were provided by Orbit Garant Drilling Services Inc of Sharon, Ontario. A CME 750 Rubber Tire ATV-mounted auger drill was used for borehole drilling and monitoring well installation. A WSP technician was on-site to supervise the drilling, and monitor installation.

The borehole locations are shown on **Figure 9**. Records of the observed stratigraphy in the boreholes and grain size analysis are provided in **Appendix B**.

3.2.1 DRILLING METHODS

Boreholes were drilled and sampled using a continuous flight hollow-stem auger method using approximately 108 mm inside diameter hollow stem augers (~200 mm borehole). Standard penetration tests were performed at select intervals in accordance with procedures (ASTM D1586) to provide a record of soil density and to enable collection of soil samples. The augers were advanced to the target depth and subsequently removed after installation of the monitoring well.

3.2.2 SOIL SAMPLES

Soil samples were retrieved from the boreholes at approximately 0.75 m intervals using a split-spoon sampling device. The split-spoon was advanced using a pneumatic hammer and the number of blows required to advance the spoon was recorded to provide an estimate of in situ soil density (standard penetration tests or SPT). All samples were examined in the split-spoon to observe stratigraphic changes and to document the length of sample recovery. Samples were then placed in plastic bags for future review and storage. Each sample bag was labeled to describe borehole identification, date drilled, depth interval, and sample number. The soil samples were examined and described in the field and a preliminary log of the borehole was prepared. The soil samples were subsequently reviewed in more detail by senior geoscientists from WSP. The observed soil stratigraphy is provided on the borehole records in **Appendix B**.

3.2.3 LABORATORY TESTING OF SOIL SAMPLES

Soil samples from the boreholes were selected to determine the particle size distribution (ASTM D422) at the WSP laboratory. Samples were selected to reflect the geological strata observed and to characterize the materials adjacent to the monitoring intervals.

Moisture content analysis (ASTM D2216) was performed on all soil samples collected from the three (3) borehole locations (MW19-02, MW19-05, and MW19-06). The results of the moisture content analysis are presented in the Geotechnical Report (WSP,2019), which has been submitted under separate cover.

Laboratory results are presented in **Appendix B** and are summarized on the borehole records.

3.2.4 SURVEYING

The locations and approximate ground elevations of monitoring wells and elevations of the ground and measuring point elevations at the monitoring wells used in this study were determined using an optical level and rod. The locations of monitoring wells were determined by WSP relative to the known elevation of catch basin Jw100A 05, the second catch basin from corner of Bayfield Street and Sophia Street.

3.3 MONITORING WELL INSTALLATION

The positions of the monitoring well screens in MW19-02, MW19-05, and MW19-06 were selected based on the observed soil profile and were targeted to correspond with identified sandy or wet and more permeable layers of the soil within the upper 10 m of ground surface. This target depth considered observations from past investigations in the area (WSP, 2016).

The monitoring wells were constructed upon reaching the target depth in the boreholes. The wells were constructed in individual boreholes using 52 mm (2 inch) inside nominal diameter (ID), schedule 40, environmental grade PVC riser pipes and well screens. The well screens are factory slotted with No. 10 slot size, and are 3.05 m (10 feet) long. The wells were constructed to leave the PVC riser pipe between 0.95 and 1.06 m above ground surface.

The borehole annulus around the well screens was filled with No. 2 silica sand to approximately 0.6 m above the top of the well screen to provide a filter pack. A low-permeability seal was placed above the filter pack using bentonite pellets. A 1.5 m long, lockable, steel, protective casing was placed over the PVC riser pipe.

The monitoring well installations were prepared to O. Reg. 903 standards and a well tag was submitted to the MECP by the licensed driller for each individual well. The monitoring well construction details are summarized in **Table 1** and on the borehole records provided in **Appendix B**. Well construction details for other wells installed at the site as part of previous investigations are also summarized in **Table 1**.

3.4 GROUNDWATER LEVEL MEASUREMENTS

Observations during the drilling of the boreholes confirmed that the water table is approximately 1.3 – 9.1 mbgs beneath the Site. The well screen intervals were placed at depth in stratigraphic positions that were considered to have potential to yield water. \

The depth to groundwater was measured in the on-site monitoring wells on April 25, 2019, May 2, 2019, May 15, 2019 and June 25, 2019. Static groundwater elevations were estimated by subtracting the measured water depth from the determined reference elevation at each monitoring well. A summary of groundwater elevations measured as part of the monthly monitoring program is provided in **Table 2**. A site plan showing the groundwater elevations measured on May 15, 2019 is presented as **Figure 10**.

A pressure transducer/datalogger and a corresponding Barologger was installed at BH2 on April 5, 2019. The groundwater monitoring program will continue after this submission, with regular manual measurements and continued recording of groundwater elevation change using a datalogger for up to one year (April 2020). WSP shall prepare a technical memorandum to summarize the groundwater elevation data obtained at the end of this monitoring period. A hydrograph showing the groundwater elevations in BH2 from April 5, 2019 to September 19, 2019 is presented as **Figure 11**.

3.5 WELL DEVELOPMENT

The monitoring wells were developed after installation to remove silt and sediment. The purpose of development is to ensure that representative formation water is obtained for water quality analysis and that the observed recovery during response tests reflects the permeability of the formation.

The volume of water in the well casing was estimated based on the static groundwater level measurement. A dedicated Waterra™ Inertial pump was installed in the monitoring well and used to remove water from the well. Standing water was observed within the four monitoring wells BH2, MW19-02, MW19-05 and MW19-06.

3.6 SINGLE WELL HYDRAULIC RESPONSE TESTS

A single well hydraulic response test was performed to estimate the hydraulic conductivity of the aquifer materials adjacent to the well screens in BH2, MW19-02, MW19-05 and MW19-06.

For this program, the single well hydraulic response test consisted of monitoring the recovery of the water level after a short pumping/bailing interval. The recovery data obtained from these response tests was adequate to estimate the *in situ* hydraulic conductivity of the saturated intervals adjacent to the monitoring well screen.

The hydraulic conductivity was estimated from the data using the methods of Hvorslev (1957).

The hydraulic response tests for the on-site wells were performed on May 2, 2019. The results of the Single Well Response Test Analysis are summarized in **Table 3**. Detailed results are provided in **Appendix C**.

3.7 WATER QUALITY SAMPLING

3.7.1 GROUNDWATER

Representative samples of groundwater were collected from monitoring wells BH2, MW19-02, MW19-05 and MW19-06 on May 2, 2019. Samples were collected via the dedicated Waterra™ inertial pump placed in the monitoring well. Field measurements of temperature, electrical conductivity, and pH were recorded at the time of sample collection. The water samples were collected in sample bottles prepared and provided by ALS Environmental (ALS) located in Waterloo, Ontario.

The water quality results for MW19-02, MW19-05, and MW19-06 were reviewed with respect to the Provincial Water Quality Objectives (PWQO). The objective of the PWQO is to establish concentrations for specific parameters that is considered satisfactory for aquatic life and recreation. The water quality results for MW19-05 were reviewed and compared to the objectives established in the City of Barrie Sewer Use By-law 2012-172.

Samples for BH2, MW19-02, and MW19-06 were tested for general chemistry and these samples were filtered in the field using disposable 45-micron filters to determine concentrations of dissolved metals and simulate simple treatment for particulates. The water quality samples for BH2, MW19-02, and MW19-06 were submitted to determine concentrations of:

- General water quality parameters (major cations, major anions, pH).
- Dissolved Metals.
- Total Phosphorous concentrations.
- Total Organic Carbon.
- Reactive silica.
- Nutrients.

The water quality samples for MW19-05 were submitted as part of a sewer use package to determine concentrations of parameters to assess suitability for discharge to the City of Barrie sewers and included: pH, Total Suspended Solids (TSS), Chloride, Fluoride, Total Kjeldahl Nitrogen (TKN), Hardness, Total Phosphorus, Sulphate, Sulphide. Total Cyanide, Chemical Oxygen Demand (COD), Total Metals, Aggregate Organics, Volatile Organic Compounds (VOC), Polycyclic Aromatic Hydrocarbons (PAH), Semi-Volatile Organics.

The results of the groundwater quality analysis are summarized in **Table 4** and the Certificates of Analysis completed by ALS are provided in **Appendix D**.

3.8 WATER BUDGET ANALYSIS

A Water Budget provides an accounting of the water inputs and water outputs within a defined area. In this case, the area of the proposed development is used to estimate the water budgets in the existing condition (Pre-Development) and in the future condition (Post-Development).

The basic assumption of a water budget analysis is that there is a balance between water inputs and outputs, unless there is a clear understanding that water is being removed from storage within the system. The water budget is typically represented in a simple form as:

Water In = Water Out

P + EI = ET + IR + RO + EO

Where:

P	=	Precipitation
EI	=	External Inputs (including run-on, irrigation, and vertical/lateral transfers)
ET	=	Evapotranspiration
IR	=	Infiltration Recharge
RO	=	Runoff
EO	=	External Outputs (including water taking, and vertical/lateral transfers)

In more complex scenarios, lateral inputs through groundwater and surface water, movement between subsurface aquifer layers, and removal from storage can also be considered.

The objectives of the Water Budget Analysis are to:

a) quantify the water budget equation for the existing conditions;
b) quantify the water budget equation for proposed future conditions; and
c) illustrate that there is either no significant change (i.e. a water balance) between the existing or future conditions, or that mitigation methods can be employed to minimize the estimated change.

The Water Budget Analysis was completed in three main steps:

Step 1) Analysis of Climatic Data;

Step 2) Pre-Development Water Budget; and

Step 3) Post-Development Water Budget (not including mitigation).

The water budget analysis has been completed using methods outlined in "Hydrogeological Technical Information Requirements for Land Development Applications" (MECP, 1995).

3.8.1 ANALYSIS OF CLIMATE DATA

Climate data available from on-line resources maintained by the Meteorological Service of Canada (Environmental Canada) were obtained and analyzed to determine the appropriate values for annual average precipitation and evapotranspiration. The surplus left over after subtraction of the evapotranspiration from the average precipitation is considered to represent the quantity of water available for infiltration and runoff under existing conditions.

Climate data was obtained for the Barrie WPCC Climate Station for the period from 1981 until 2010. These data are provided in Table E-1, **Appendix E**. Mean monthly temperatures were calculated by averaging mean monthly minimum and maximum temperatures. Temperature data were derived from the 30-year (1981-2010) climate data summaries.

The Thornthwaite-Mather method was used to estimate potential and actual evapotranspiration on a monthly basis. The Thornthwaite-Mather method is based on an empirical relationship between potential evapotranspiration and mean air temperature. The method also takes into account the water holding capacity for the soil to compute the actual evapotranspiration and the resulting moisture surplus that is available for infiltration and runoff.

The water holding capacity of the soil depends on two different factors – the soil type and structure, and the type of vegetation growing on the surface. Different types of soil hold different amounts of moisture storage capacity, while different species of vegetation will send roots into the soil to different depths and therefore retain varying amounts of moisture. The water holding capacity for each soil type/vegetation type combination found on the Site was determined from the Environmental Design Criteria of the Storm Water Management Planning and Design Manual published by the Ontario Ministry of the Environment, Conservation and Parks ("MECP") in 2003.

The monthly estimates were used to calculate an annual average for precipitation, potential evapotranspiration, actual evapotranspiration, and available moisture surplus for each combination of soil and vegetation type found on-site. The moisture surplus represents the quantity of water available for infiltration and runoff on an annual average basis. Tables that document the details of the Thornthwaite-Mather analysis for the combinations of soil type and land use are provided in **Appendix E.**

3.8.2 PRE-DEVELOPMENT WATER BUDGET

The Pre-Development Water Budget was estimated using the approach recommended in Table 2 of the "Hydrogeological Technical Information Requirements for Land Development Applications" (MECP, 1995). The steps taken to estimate the Pre-Development Water Budget included:

1) Identify sensitive features and to observe existing topography, soil types, and other controls on infiltration and runoff.
2) Delineating drainage catchments and sub-catchments based on observed drainage outlets and physical characteristics as described below.
3) Estimating the quantities of infiltration and runoff for each of the sub-catchment areas and preparing summary estimates for catchments related to identified drainage outlets and for the proposed development area.

The drainage catchments and sub-catchments were defined by considering the following factors:

- Existing elevations;
- Existing property boundaries;
- Post-development features and property boundaries;
- Natural topographical features;
- Slope ratio;
- Land cover, and
- Land use.

The sub-catchments defined for the Pre-Development Water Budget also considered the proposed development areas and future drainage considerations for the proposed development. This was incorporated into the analysis to be able to demonstrate changes in drainage to the identified outlets and infiltration beneath the development area. The defined sub-catchments for the Pre-Development Water Budget are shown on **Figure 12** and in calculations provided in Table F-1, **Appendix F**.

The Infiltration Factor for each Pre-Development sub-catchment was estimated by adding the sub-factors for topography, soil type, and land cover as recommended in the MECP methodology. A geographic information system (GIS) was used to evaluate the topography, soil type and land use for each of the Pre-Development, Current Condition, and Post-Development scenarios and to generate a set of sub-catchments that can be used in analysis of each scenario. **Section 5** provides a characterization of the Site in terms of the topography, soil type, and land use as input into the water budget analysis. The calculated infiltration factor for each catchment was reviewed and updated

manually, as a confirmation that they reflect actual conditions. Assumptions applied to the Pre-Development water budget scenario are described in **Section 5.2**.

The volume of Pre-Development Infiltration was estimated as the product of [sub-catchment area] x [moisture surplus] x [Infiltration factor]. The Pre-Development Runoff was estimated by subtracting the volume of infiltration from the total volume of moisture surplus for each sub-catchment. A detailed table to document the calculations of the Pre-development Water Budget is provided in **Appendix F**.

3.8.3 POST-DEVELOPMENT WATER BUDGET

The Post-Development Water Budget was estimated using a similar approach as outlined for the Pre-Development case. The proposed development plan and future drainage plan were used to establish new drainage sub-catchments that relate to the outlets identified in the Pre-Development case. Within each drainage sub-catchment, the area of pervious soils and impervious development (roads, driveways, amenities, and roofs) were estimated based on the preliminary post-development storm drainage area plan as provided by SBA.

For the pervious areas, the quantity of infiltration was calculated using the [pervious area] x [precipitation surplus] x [Infiltration Factor]. The Infiltration Factors were reviewed to correspond to the Post-Development conditions. The runoff for the pervious areas was estimated by subtracting the volume of infiltration from the total volume of precipitation surplus for the pervious area in each sub-catchment.

The volume of runoff from the impervious surfaces was estimated using the area of impervious surfaces and the volume of precipitation. A factor of 10% was considered to represent some evaporation in the course of runoff. This value is consistent with assumptions made on adjacent lands.

Estimates of the annual volumes associated with dewatering to maintain dry foundations has been factored into the Post-Development Water Budget.

The Post-Development Water Budget was compared to the Pre-Development Water Budget to evaluate the effects of the proposed development. The Post-Development Water Budget does not consider additional mitigation measures to address an infiltration deficit. At this time, the findings of the water balance analysis are intended to provide direction regarding options to maintain pre-development recharge.

The defined sub-catchments for the Post-Development Water Budget are shown on **Figure 13** and in calculations are provided in Table G-1, **Appendix G**.

3.9 DEWATERING ESTIMATES

The proposed development provides for 108 residential and commercial units in an eight (8) storey building. The building is proposed to be constructed with a floor elevation at 0.5 m above the observed seasonally high water table. The potential requirements for dewatering associated with construction (short-term) or long-term conditions are assessed in **Section 7** of this report.

4 OBSERVATIONS

The information obtained during previous site studies was reviewed and analyzed to characterize the soil profile and the groundwater system at the Site.

4.1 SOIL PROFILE

The stratigraphy observed in boreholes drilled beneath the Site is generally characterized as follows:

- Thin layer of asphalt and fill up to 0.3 m thick.
- Topsoil in MW19-05 up to 0.1 m thick.
- Fill (varying in texture from silty clay to clayey silt to sandy silt to silty sand) to a relatively uniform depth of 2.2 m bgs (3 m in BH19-1).
- Till (varying in texture from sandy silt to silty sand) to depths between 3 and 7.5 m bgs.
- Till (varying in texture from sandy clayey silt to silty clayey sand) to the bottom of investigated depth.

The upper 2 to 3 m of the soil profile has been disturbed. As such, the observed materials in the upper layers do not match the mapped surficial geology.

The layer below the Fill was not specifically identified in the borehole logs as being till at BH 19-04 and BH19-05, and BH19-06, however the observed density is consistent with the density of the till described in other boreholes. Visible evidence of laminations or layering typically associated with sediments were not observed.

The subsurface stratigraphy observed during the borehole investigation is consistent with the regional profile described in **Section 2**.

The observed soil materials are fine-grained and, while locally may have capacity to provide some water, are not considered to be aquifers in the context of the regional soil profile.

Table A-1 in **Appendix A** provides a list of water well records. Borehole logs are provided in **Appendix B**.

4.2 GROUNDWATER ELEVATIONS

Upon development of the wells, the water level within each monitoring well was observed and recorded. Observed depths to groundwater and calculated groundwater elevations are presented in **Table 2**.

The observed groundwater levels and elevations ranged from 0.73 m bgl to 3.87 m bgl, and 235.85 m above sea level (ASL) to 232.20 m ASL, respectively. Groundwater levels are typically at their highest level during the spring months (March -May) as the spring melt causes higher elevations than the those experienced throughout the rest of the year. As such, WSP has assumed that the seasonally high groundwater level and elevation is reflected by the levels observed during the May 2019 monitoring events. The seasonal high groundwater level at each

Figure 10 presents a map illustrating Groundwater Elevations and the interpreted groundwater flow direction for groundwater elevation measurements on May 15, 2019. The apparent groundwater flow direction is inferred to be in a southerly direction. This inferred groundwater flow direction is consistent with the topography observed at the Site and the observed surface water drainage patterns. The perturbations in the contoured groundwater elevations may reflect influence of subsurface utilities or local areas where previous excavations have been filled with granular material.

Review of the measured groundwater elevations at MW19-06 identified that there is potential that the high groundwater elevations may reflect ponding of water within previously excavated materials that are now filled with granular materials. Groundwater elevations are considered likely to be higher in the northeastern corner of the property based on the observed groundwater elevation contours. The seasonal high groundwater elevation is

assumed to be 235.85 m based on the observed high level at MW19-06 and projected groundwater elevations from **Figure 10**.

4.3 WATER USE

The area surrounding the Site contains residential and commercial buildings and is municipally serviced for water and sanitary sewers. The buildings shown on the aerial photographs used as a base in the figures have been removed to prepare for development. The proposed development will be municipally serviced for water and sanitary sewage.

A discussion of wells in the area surrounding the Site is provided below.

4.3.1 MECP WATER WELL SEARCH

A list of MECP water well records within 500 m of the Site is provided in **Appendix A**. **Appendix A** also includes a summary of the information presented in the water well records. **Figure 8** illustrates the locations of wells located within 500 m of the Site property as per the MECP WWIS. The well record database includes 31 water well records within a 500-metre radius of the Site. Of the well records, one (1) is a water supply well for cooling and air conditioning purposes, 25 are for monitoring, test hole and observation well purposes, four (4) are for unknown purposes, and one (1) is abandoned.

The one (1) listed water supply well provides an estimated yield of 10 GPM. The water supply well appears to draw water from a coarse sand layer approximately 39 m below grade.

Well Records 7277585 and 7277585 are shown as being on the Site property. These wells are shown to be bored to depths of 7.62 m and are noted to have been constructed in 2016. These wells are considered to reflect monitoring wells that have been constructed as part of previous investigations on the Site.

WSP understands that the search area is now municipally serviced for water supply. This is reflected by the small number of domestic supply wells observed. It is likely that some of the identified water supply wells have also been removed from active use, but are not documented in the MECP WWIS. It is also possible that other water supply wells were used historically and are not documented in the MECP database.

It is possible that the MECP WWIS database includes other wells that are incorrectly located and there may be some wells for which well records are not on file at the MECP.

4.4 SINGLE WELL HYDRAULIC RESPONSE TESTS

The hydraulic response to pumping of most wells showed a change in slope during the test. This is interpreted to reflect the change in recovery rate at the transition from to filling the borehole annulus within the sand pack to filling only the 50 mm diameter annulus of the monitoring well. Hydraulic conductivity was estimated for the individual segments within a test by adjusting the dimensions used in the calculation, and used to provide an estimate of the hydraulic conductivity range for each well.

The results of the single well hydraulic response tests indicate that the hydraulic conductivity of the materials surrounding the well screens of the on-site monitoring wells range from 2.7 $x10^{-8}$ m/s to 2.1 $x10^{-6}$ m/s. The geometric mean value for all tests is 3 x 10^{-7} m/s. The results of testing reported in the previous investigation (WSP, 2016) were included in this characterization. The hydraulic conductivity estimates are summarized in **Table 3**, and below:

- BH1: 1.6 – 1.9 $x10^{-6}$ m/s (geometric mean: 1.8 $x10^{-6}$ m/s)
- BH2: 1.9 – 5.7 $x10^{-7}$ m/s (geometric mean: 3.2 $x10^{-7}$ m/s)
- MW19-02: 3.7 – 4.5 $x10^{-8}$ m/s (geometric mean: 4.1 $x10^{-8}$ m/s)
- MW19-05: 2.7 x 10^{-8} – 2.6 $x10^{-7}$ m/s (geometric mean: 9.9 $x10^{-8}$ m/s)
- MW19-06: 2.2 x 10^{-7} – 2.1 $x10^{-6}$ m/s (geometric mean: 6.7 $x10^{-7}$ m/s)

The materials surrounding the well screens of monitoring wells BH2, MW19-02, MW19-05, and MW19-06 include sandy silt, silty sand till, silty clayey sand till and sandy clayey silt till, respectively. The range of hydraulic conductivity values is consistent with the observed materials.

The single well hydraulic response test calculations are provided in **Appendix C**.

4.5 WATER QUALITY

The results of groundwater quality testing at the four (4) on-site monitoring wells are summarized in **Table 4**. The water quality analysis reports as provided by ALS are presented in **Appendix D**. The ALS Laboratory Report refers to BH2 as MW1.

The following parameters were measured in concentrations that are greater than the limits for the City of Barrie Bylaw 2012-172:

- Total Suspended Solids (TSS) at MW19-05 (300,000 mg/L) [Greater than limit for both storm and sanitary]
- Chloride at BH2 (1,500 mg/L) [Greater than limit for sanitary]
- Total Phosphorus at MW19-05 (47.9 mg/L) [Greater than limit for sanitary]
- Total Manganese at MW19-05 (10.8 mg/L) [Greater than limit for sanitary]
- Chemical Oxygen Demand (COD) [Greater than limit for sanitary]

The values for turbidity and total dissolved solids at BH2, MW19-2, and MW19-6 were also elevated.

The following parameters were measured in concentrations that are greater than the PWQO:

- Dissolved Cobalt at BH2, and MW19-6
- Dissolved Copper at BH2, MW19-2, and MW19-6
- Dissolved Uranium at MW19-2

The following total parameter concentrations were measured at MW19-05 and are greater than the PWQO value (for dissolved constituents):

- Total Phosphorus
- Total Aluminum
- Total Cadmium

The tests for the following parameters required detection limits to be increased to be greater than applicable standards:

- Dissolved Aluminum at BH2 and MW19-6 (> PWQO)
- Dissolved Phosphorus at BH2, MW19-2, and MW19-6 (> PWQO)
- Dissolved Silver at BH2 and MW19-6 (> PWQO)
- Total Arsenic at MW19-05 [Greater than PWQO (for dissolved)]
- Total Cobalt at MW19-05 [Greater than PWQO (for dissolved)]
- Total Copper at MW19-05 [Greater than PWQO (for dissolved) and City of Barrie Storm Sewer]
- Total Iron at MW19-05 [Greater than PWQO (for dissolved)]
- Total Lead at MW19-05 [Greater than PWQO (for dissolved)]
- Total Nickel at MW19-05 [Greater than PWQO (for dissolved)]
- Total Silver at MW19-05 [Greater than PWQO (for dissolved)]
- Total Vanadium at MW19-05 [Greater than PWQO (for dissolved)]
- Total Zinc at MW19-05 [Greater than PWQO (for dissolved)]
- Anthracene at MW19-05 [Greater than PWQO]

- Benzo(a)anthracene [Greater than PWQO]
- Benzo(g,h,i)perylene [Greater than PWQO]
- Benzo(k)fluoranthene [Greater than PWQO]
- Chrysene [Greater than PWQO]
- Dibenzo(ah)anthracene [Greater than PWQO]
- Fluoranthene [Greater than PWQO]
- Phenanthrene [Greater than PWQO]
- Hexachlorobenzene [Greater than PWQO]

5 WATER BUDGET ANALYSIS

The Water Budget Analysis is presented in the following sections. **Section 5.1** describes the analysis of historical climate data to estimate annual average precipitation and potential evapotranspiration. **Section 5.2** describes the Pre-Development Water Budget. **Section 5.3** Describes the Post-Development Water Budget.

5.1 CLIMATE-BASED WATER BUDGET

The climate-based water budget calculations are included in Tables E-1 to E-2 (**Appendix E**) and are summarized in **Table 5**. The average annual precipitation for the thirty year normal data between 1981 and 2010 is about 932.9 mm/m^2/year (mm/year). The annual potential evapotranspiration is calculated in Table E-1 at 582.9 mm/year. This equates to a potential water surplus of 455 mm/year and a soil moisture deficit of 105.5 mm/year. Thus the net annual water surplus based on potential evapotranspiration is 350 mm/year.

The calculations were expanded to include the water holding capacity of the soil as presented in Table E-2. This will produce a total moisture surplus based on the calculated actual evapotranspiration. One (1) combination of soil type and vegetation type were identified on the Site property for the Pre-Development scenario. In post-development, the proposed development will not result in infiltration to the underlying groundwater flow system. The majority of the surficial soil at the site is considered to be silty sand loam. The land use classifications and the corresponding water holding capacities are:

— Silty Sand Loam, Urban Lawn (125 mm/year).

Consideration of these factors produces a net annual moisture surplus of 383.4 mm/year as summarized in **Table 5**. The soils with higher water holding capacity effectively increase the water removed as evapotranspiration.

The calculated moisture surplus occurs during the winter, spring and fall months, and a water deficit occurs during the summer months. Much of the water surplus in the winter accumulates as snow. Snowmelt during the spring results in the runoff or infiltration of precipitation that is effectively equivalent to the winter and spring water surplus.

5.2 PRE-DEVELOPMENT WATER BUDGET

The Pre-Development Water Budget was developed based on topographic information provided by Ontario Base Mapping. The LSRCA was consulted for advice on the approach to the pre-development water budget scenario as the structures have now been removed from the Site in preparation for the proposed development. Based on this consultation, WSP has prepared the Pre-Development Water Budget based on the site conditions presented in **Figure 2**. To this end, the change in infiltration due to development will reflect the change relative to the historical condition and not the current, interim condition.

5.2.1 PRE-DEVELOPMENT CATCHMENTS

Figure 12 illustrates the delineation of drainage catchments and sub-catchments for the Site prior to the proposed development. The Site is represented by one (1) (on site) catchment area that is considered to receive runon from an adjacent property, identified as one (1) offsite catchment. Catchments are typically divided based on drainage divides due to topography and/or outlet location.

The catchment areas have been further subdivided based on similar slopes, soils, and vegetation/land use. The drainage sub-catchments also include consideration of post-development drainage boundaries so that changes to drainage areas can be evaluated for the post-development conditions. The outlets for drainage of the identified Pre-Development catchments are as follows:

On-Site Catchments:

- **Pre-Development On-Site Catchment A:** Drains off-site through the southern property boundary via overland flow (to the storm sewer system) or on-site catch basins that direct runoff to storm sewer.

Off-Site Catchments:

- **Pre-Development Off-Site Catchment B:** Drains on-site across the northern property boundary via overland flow and is subsequently drained with other runoff from the Site.

Table F-1 (**Appendix F**) provides a summary of the data attributes used to estimate the infiltration factor for each pre-development catchment and sub-catchment. The infiltration factor determined the proportion of the annual water surplus that would infiltrate or runoff within each sub-catchment.

5.2.2 PRE-DEVELOPMENT ANALYSIS

Properties associated with area, slope, soil type, and land cover were analyzed and assigned to each Pre-Development sub-catchment. The values assigned to each Pre-Development sub-catchment are provided in Table F-1. These values were used to estimate an Infiltration Factor. The Infiltration Factors were reviewed to confirm that they are appropriate and adjusted if necessary. Existing paved areas were assumed to be impervious and to generate runoff equivalent to the precipitation volume minus a 10% evaporative loss. Gravel areas were assumed to have a surplus equivalent to that of urban lawn areas.

Table F-1 includes the overall analysis of the total Site's infiltration and runoff. Table F-1 also documents the calculation of volumes associated with input and output parameters for the Pre-Development conditions. These volumes are also expressed in terms of the number of mm of water within each sub-catchment area.

A summary of the Pre-Development water budget calculations is provided in **Table 6**. These values will be used to assess the changes that proposed development will create relative to the pre-development conditions.

5.2.3 PRE-DEVELOPMENT INFILTRATION

The estimated total infiltration for the Site is 144 m^3/yr or an equivalent of 39 mm/year (mm/m^2/yr). The calculated infiltration represents approximately 4% of the annual precipitation (933 mm/yr) and 5% of the estimated annual precipitation surplus (756.1 mm/yr). The pre-development infiltration reflects the previously developed condition on the property.

5.2.4 PRE-DEVELOPMENT RUNOFF

The total runoff for the Site is 2,875 m^3/yr or an equivalent of 771 mm/year. The calculated runoff represents approximately 83% of the annual precipitation (933 mm/yr) and 102% of the estimated annual precipitation surplus (756.1 mm/yr). This runoff is greater than the estimated precipitation surplus value due to the inputs from off-site catchments (Catchment B). The pre-development runoff reflects the previously developed condition on the property.

5.3 WATER BUDGET– POST-DEVELOPMENT CONDITIONS

Figure 13 illustrates the delineation of drainage catchments and sub-catchments for the Site based on the proposed concept plan. The Post-Development scenario introduces a proposed eight (8) storey high residential structure with above grade parking. The proposed Site Grading plan The proposed structure is planned to occupy much of the

property. As such, there will be minimal opportunity to enhance infiltration associated with the proposed development. Some infiltration may continue to the proposed naturalized area along the northern property boundary (East side). The structures are proposed to be constructed above grade and to require minimal dewatering. Dewatering estimates are provided in **Section 7**. The effects of potential dewatering on long-term water balance are incorporated into the discussion in **Section 5.3.7**.

5.3.1 POST-DEVELOPMENT CATCHMENTS

Under post-development conditions, the Site is subdivided into three (3) on-site catchments. Sub-catchment delineations in Pre-Development conditions were maintained for the Post-Development analysis.

Under Post-Development conditions, runoff from the areas of the residential units will drain to storm sewer catch basins.

The outlets for each Catchment are summarized below:

On-Site Catchments:

- **Post-Development On-Site Catchment PA:** Drains to the on-site storm sewer catch basins via overland flow.
- **Post-Development On-Site Catchment PB:** Drains off-site to the western, southern, and eastern boundaries via overland flow (to be captured in off-site storm sewer catch basins).
- **Post-Development On-Site Catchment PC:** Drains to the on-site storm sewer catch basins via overland flow.

Off-Site Catchments:

- **Post-Development On-Site Catchment PD:** Drains on-site to Catchment PC across the northern property boundary via overland flow. Runoff from Catchment PD will be directed to the storm sewer catch basin within Catchment PC.

Runoff from the developed areas in on-site catchment areas will be affected by the creation of buildings and driveway areas.

5.3.2 POST-DEVELOPMENT ANALYSIS

Properties associated with area, slope, soil type, and land cover were analyzed and assigned to each Post-Development sub-catchment. The values assigned to each Post-Development sub-catchment are provided in Table G-1 (**Appendix G**). These values were used to estimate an Infiltration Factor. The Infiltration Factors were reviewed to confirm that they are appropriate and adjusted if necessary. In this case, infiltration will not occur through most of the Site.

Table G-1 includes the overall analysis of the total Study Area's infiltration and runoff. Table G-1 also documents the calculation of volumes associated with input and output parameters for the Post-Development condition. These volumes are also expressed in terms of the number of mm of water within each sub-catchment area. The volumes are summed by catchment and for the total property area.

Assumptions incorporated into the water budget for the Post-Development scenario included:

1) Impervious surfaces (roads, driveways and buildings) are assumed to have a 10% evaporative loss.
2) Runoff is assumed to be conveyed directly to the outlets and not infiltrated.
3) Runoff from external sub-catchments is released to the closest on-site sub-catchment, unless otherwise stated.

A summary of the Post-Development water budget calculations is provided in **Table 6**.

5.3.3 POST-DEVELOPMENT INFILTRATION

In the post-development condition, the estimated total infiltration for the Site is 209 m^3/yr or an equivalent of 56 mm/yr (mm/m^2/yr). The net infiltration reflects approximately 6% of the precipitation (933 mm/yr) or 7% of the calculated total surplus (756.1 mm/yr).

5.3.4 POST-DEVELOPMENT RUNOFF

The total runoff generated by the proposed development area is 2,907 m^3/yr or 779 mm/year. The total calculated Post-Development runoff represents approximately 84% of the annual precipitation (933 mm/yr).

5.3.5 IMPACT OF LONG-TERM DEWATERING ON WATER BALANCE

Section 7.4 provides an estimate of the conservative (maximum) rate that may be required for dewatering to maintain dry foundations as part of the proposed development. The estimated rate of dewatering is up to 17,700 L/day but this rate is only expected on peak occasions and the actual rate would be much lower.

Dewatering of foundation drains at this site would require a collection system and mechanical systems to store and deliver collected water to the municipal storm sewer system. Removal of water from foundation drains would also effectively reduce the balance of recharge from Pre-Development to Post-Development. As municipal guidelines for this development require efforts to minimize continuous foundation drainage, the building foundations will be constructed to be submerged such that no active foundation drainage will be required.

Additional discussion on the implications of the long-term dewatering are provided in **Section 7.4.**

5.3.6 COMPARISON WITH PRE-DEVELOPMENT

Table 6 provides a comparison of the water budget estimates for the Pre-Development and Post-Development cases without any proposed mitigation measures considered. The total on-site infiltration is increased by approximately 56 m^3/yr, or 45%, due to the introduction of pervious surfaces along the northeastern property boundary.

The proposed development results in a predicted increase in runoff on the order of 1%. The runoff from the Site in Post-Development would be increased by 32 m^3/yr, or less than 1%.

5.3.7 DISCUSSION

Table 6 illustrates that the proposed development would result in an increase in infiltration and a minor increase in runoff relative to pre-development conditions.

These calculations estimate that all runoff from impervious surfaces will be collected and directed to stormwater systems. There is potential that some of the rooftop areas could be designed to make use of these water inputs, for example as green roofs, and that these features could further reduce the net runoff.

Overall, the proposed development will result in a slight net increase in infiltration and runoff relative to pre-development conditions.

5.4 WATER QUALITY

The water budget analysis must also consider potential changes to water quality that could be experienced in relation to the proposed development. The following sections describe the typical contaminants associated with the current and future land uses.

5.4.1 EXISTING CONDITIONS

The Site has been used for commercial and residential purposes and includes large areas of pavement, buildings, and concrete. Runoff is currently directed to the City of Barrie storm sewer system. These areas have likely been a potential source of contamination to groundwater infiltration or surface water runoff by winter road de-icing agents. Any pervious areas used for winter snow storage may also become potential sources of contamination from winter road de-icing agents.

The driveway and roadway areas may also be a potential sources of petroleum hydrocarbons. These are typically contained in vehicles. The release of these substances will typically be the result of accidents or leaks from vehicles. These potential releases could result in impairment of water quality by infiltrating into the groundwater. The risk of an accident occurring at the Site is low considering the only traffic will be the residents who occupy the buildings.

In pervious areas, soil-enrichment agents (i.e. fertilizers) and/or herbicides may also be a source of contamination.

5.4.2 FUTURE CONDITIONS

The proposed Post-Development condition is similar to the Pre-Development condition, with a change in the way that water is redirected to the City of Barrie Storm Sewer system. An assessment of the capacity of the City of Barrie Storm Sewer system is recommended to confirm that there is sufficient capacity to handle additional flows.

The most effective method of reducing potential impacts from salt or other winter road de-icing agents is to minimize the mass/volume of material applied through the use of Best Management Practices (BMPs). BMPs recommend storing snow on impervious surfaces. Application of soil-enrichment agents (i.e. fertilizers) and/or herbicides should be minimized in order to reduce potential contamination.

6 POLICY AREAS

6.1 WELLHEAD PROTECTION AREA

Figure 14 illustrates that the Site is within the following wellhead protection areas (WHPA) for the City of Barrie:

- WHPA D, with a vulnerability score of 2.
- Intake Protection Zone (IPZ) IPZ-3 (for surface water drainage to Lake Simcoe).
- Issues Contributing Area for municipal water supply wells for sodium and chloride.
- WHPA-Q1 and WHPA Q-2 (Low Stress) for water quantity threats.

Based on this mapping, policies of the Source Protection Plan for the South Georgian Bay Lake Simcoe Source Protection Region will apply. The policies that will be most relevant will pertain to maintaining recharge to groundwater systems and to managing activities to minimize the use of sodium and chloride at the Site.

6.2 HIGHLY VULNERABLE AQUIFERS

The Source Protection Plan for the Lakes Simcoe and Couchiching Source Protection Area contains policies that apply to Highly Vulnerable Aquifers. **Figure 15** presents the mapping of Highly Vulnerable Aquifers (HVA) from the Assessment Report for the Lakes Simcoe and Couchiching Source Protection Area. HVA are considered susceptible to contamination of groundwater from activities on the surface or shallow subsurface. The Site is mapped as a Highly Vulnerable Aquifer with a Vulnerability Score of 6.

The observed soil condition beneath the property are not consistent with the mapping of as a highly vulnerable aquifer. The HVA have been delineated based on regional information and conditions on the ground can vary such that the delineated vulnerability score does not reflect observed conditions. The drilling program does not clearly identify an aquifer formation within the upper 9.8 m of the soil profile.

6.3 SIGNIFICANT GROUNDWATER RECHARGE AREAS

Policies 6.36 DP through 6.40 DP of the Lake Simcoe Protection Plan address Significant Groundwater Recharge Areas (SGRA).

The Assessment Report for the Lakes Simcoe and Couchiching Source Protection Area contains mapping of Significant Groundwater Recharge Areas (SGRA). SGRA are regional areas that receive more than the average recharge. A portion of the Site is mapped within a delineated as a SGRA (High), as shown on **Figure 16**.

Similarly, to the discussion of Highly Vulnerable Aquifers, the observed soil materials in the upper 9.8 m of the observed soil profile is predominantly fine grained and are not consistent with materials that would promote recharge.

7 DEWATERING ASSESSMENT

The potential requirements for dewatering in association with construction of the proposed eight (8) storey residential structure, and for long-term drainage from foundation drains is assessed below. The potential requirements for permitting associated with dewatering activities are as follows:

- Takings of less than 50,000 L/day at any one time do not require a permit;
- Takings of greater than 50,000 L/day but less than 400,000 L/day at any one time for construction dewatering requires registration with the Environmental Activity and Sector Registry (EASR);
- Takings of greater than 400,000 L/day at any one time for construction dewatering will require a Category 3 Permit to Take Water (PTTW); and
- Takings of greater than 50,000 L/day at any one time for long-term foundation dewatering will require a Category 3 PTTW.

WSP has prepared a preliminary assessment of the dewatering requirements and the associated impacts associated with construction and long-term drainage. This assessment provides an update to the previous work (WSP, 2016).

7.1 DEWATERING EQUATIONS AND ASSUMPTIONS

Given the subsurface conditions encountered beneath the Site, equations are used to account for excavations under unconfined groundwater conditions. For the purposes of these calculations, long narrow trench equations are assumed to be more appropriate to estimate flows for the foundation excavation, since the length to width ratio of the excavation is greater than 1.5. The Darcy equation was used to estimate flow across the bottom of the excavation.

LONG NARROW TRENCH EQUATION – UNCONFINED CONDITIONS

Dewatering volumes were estimated using the following equation from Powers (1992) for a drainage trench of finite length with a length to width ratio of greater than 1.5 for an unconfined system:

$$Q = \frac{xK(H^2 - h^2)}{In\frac{R_o}{r_s}} + 2\left[\frac{xK(H^2 - h^2)}{2L}\right]$$

where Q is discharge (m^3/s), x is the trench sidewall length (m), K is hydraulic conductivity (m/s), H is initial water level (m), h is the required drawdown (m), R_0 is the equivalent radius of influence (m), and r_s is the equivalent well radius (m). For the purposes of these calculations, r_s is the approximate distance to the centre of the trench from a theoretical dewatering well. The first term of the equation represents radial flow to the ends of the trench, while the second term represents flow across the trench walls. For more details, please refer to Powers (1992). Using the equation for a long, narrow system provides a more conservative estimate for dewatering rates when compared with using the equation for a drainage trench from a line source.

DARCY'S LAW

Dewatering volumes for the calculation of seepage across the base of the excavation was estimated using the empirical Darcy's Law equation as described in Powers (1992):

$$Q = K_V A i$$

where Q is discharge (m^3/s), K_V is vertical hydraulic conductivity (m/s), A is cross-sectional area (m^2), and i is the hydraulic gradient.

EQUIVALENT RADIUS OF INFLUENCE (R_O)

The equivalent radius of influence R_0 is assumed to be equivalent to the zone of influence (ZOI). R_0 was estimated using the empirical Sichart equation as described in Powers (1992):

$$R_0 = 3000(H-h)\sqrt{K}$$

where R_0 is the equivalent radius of influence or ZOI (meters), H is the initial water level (meters), h is the required drawdown (meters), and K is hydraulic conductivity (meters/second).

EQUIVALENT WELL RADIUS (RS)

The equivalent well radius r_s is estimated in different ways depending on the type of system that is being evaluated. For a circular shaft, r_s is simply the radius of the shaft. For a rectangular shaft, r_s can be assumed to act as a circular system of the same enclosed area:

$$r_s = \sqrt{\frac{ab}{\pi}}$$

For a trench, r_s is the approximate distance to the centre of the trench from a theoretical dewatering well. For more details, please refer to Powers (1992).

7.2 ASSUMPTIONS

A number of assumptions were incorporated based on the site-specific data collected in site investigations and information about the proposed development. The assumptions related to construction dewatering are as follows:

- No measures are to be put in place to restrict flows into the excavations (e.g., sheet piling, caissons) to provide more conservative (overestimate) dewatering rates;
- The aquifer is uniform, continuous and of infinite extent;
- Anticipated dewatering rates were estimated using the geomean of hydraulic conductivity estimated from field testing (3.0×10^{-7} m/sec)
- Conservative dewatering rates were estimated using the highest hydraulic conductivity estimated from field testing (2.1×10^{-6} m/sec);
- For the purposes of estimating flux across the base of the excavation, vertical hydraulic conductivity was used in the calculation using the Darcy equation. The vertical hydraulic conductivity is assumed to be an order of magnitude lower than the horizontal hydraulic conductivity (3.0×10^{-8} m/sec for the anticipated dewatering rate, 2.1×10^{-7} m/sec for the conservative dewatering rate);
- The vertical hydraulic gradient was assumed to be 0.1 m/m;
- Groundwater elevations are conservatively assumed to be uniform at 0.7 m bgs, or 235.85 mASL, which is slightly higher than the measurement from MW19-6 in May 2019.
- WSP has assumed that the seasonally high groundwater level and elevation is equivalent to the levels observed during the May 2019 monitoring events.
- The proposed development is to be constructed with the bottom of the floor at 0.5 m above the high water level (236.35 mASL). The footings (and associated drainage) will be founded at the top of the native soil, which ranges between 233.2 and 233.9 mASL. As a conservative assumption, the elevation of the underside of the footing will be placed at 233 mASL. The footings may be below the water table on occasion, particularly in the northeast corner of the Site.
- The proposed dimensions of the open excavation are assumed to be approximately 80 m x 50 m, based on the preliminary Site plan.

- As a conservative estimate for construction dewatering, a drawdown of 1 m below the base of the footing level is proposed, for a total drawdown of 3.85 m for the perimeter of the footings.
- As a conservative estimate for potential long-term drainage, a drawdown to the base of the excavation is proposed, for a potential total drawdown of 2.84 m for foundation drains associated with the footings. Part A of **Table 7** shows that this estimate for drawdown is reasonable, given the planned finished floor elevations.
- Measures are in place to prevent precipitation runoff or other surface runoff from entering the excavation.

The primary factors that will control the rate of seepage into the excavation or foundations are the hydraulic conductivity and the depth that the water table will be lowered. The assumptions above are considered to be conservative and are likely to overestimate the actual values of water that will need to be removed to maintain dry conditions, particularly if work is carried out during a dry season. In addition, based on the observed groundwater flow pattern, groundwater influx to the foundation drains may only be expected in the northeast corner of the Site.

This assessment does not represent an engineering design of a dewatering operation, but a preliminary hydrogeological analysis for assessment of dewatering volumes. The actual design of the dewatering operation will be the responsibility of the contractor.

7.3 CONSTRUCTION DEWATERING CALCULATIONS

The calculations of the estimated volumes of water that could enter the excavations during construction are shown in Part B of **Table 7**. These calculations show a dewatering rate that is anticipated as well as the calculation of the conservative (maximum) rate. Dewatering calculations are provided in **Appendix I**.

The total volume that would potentially need to be dewatered to maintain dry conditions to construct foundations at the same time is estimated to be up to 136,800 L/day. For this scenario, the zone of hydraulic influence from individual blocks is estimated to be up to 17 m. Direct precipitation into the open excavation may contribute up to 120,000 L/day of water for a 30 mm storm event over a period of one day. Given the nature of the site, it is likely that hydraulic influence would extend off-site. The values above are conservative. It is more likely that volumes will be on the order of 23,800 L/day during seasons with high groundwater elevations.

7.4 LONG-TERM DRAINAGE

The foundations for the proposed structure have potential to be below the water table during seasonally high groundwater elevations, particularly in the northeast corner of the Site. Foundation drainage systems would be required to maintain dry foundations. It is possible that there may be reduced or no flow in dry seasons. The calculations of the estimated potential volume of water that could enter the foundation drains for the building block is shown in Part C of **Table 7**. These calculations show a seepage rate that is anticipated as well as the conservative (maximum) rate. Dewatering calculations for the long-tern drainage scenario are provided in **Appendix I**.

The total volume that would potentially need to be drained to maintain all foundations dry at the same time would be up to 17,700 L/day. The zone of hydraulic influence under this circumstance would be 12 m. It is likely that hydraulic influence would extend off-site. The anticipated rate of drainage will be substantially less when the seasonal water table is low.

Municipal guidelines for this development require effort to minimize continuous foundation drainage from the proposed building. As such, the building foundations are recommended to be constructed so that they can be submerged such that no active foundation drainage is required.

7.5 DEWATERING SUMMARY

The calculations of potential volumes of water that may require removal during construction or during long term use of the proposed structure is summarized in **Table 7**.

The dewatering estimates indicate that the volumes of water to be removed during construction dewatering and may long term drainage will be less than 50,000 L/day. The estimated dewatering rates for construction may be up to 136,800 L/day. These rates are conservative estimates and would reflect a worst-case condition when dewatering the entire foundation excavation in groundwater conditions. The proposed construction at the Site is recommended to be registered on the EASR. Registration on the EASR and a PTTW is not estimated to be required for the long-term drainage. WSP is currently conducting an updated Phase One and Phase Two Environmental Site Assessment (ESA) at the Site. If the findings and recommendations of the Phase One and Phase Two ESA support the removal of excess soil to address potential contamination concerns at the Site, there may be a potential that the additional volumes of water would need to be removed during these remediation activities. It is recommended that the dewatering estimates be revisited if the Phase Two ESA identifies a requirement to remove soils to a depth greater than required for the construction of the building foundation footings. An Excess Soil Management Plan may be required in the event that fill material cannot be re-used on-site.

Precipitation may contribute up to 120,000 L/day of water entering the excavation, in addition to the volumes estimated above. Appropriate measures are to be implemented in the event of precipitation during construction to keep excavations dry and stable. This additional volume can be managed within the EASR.

Discharge from the construction dewatering is recommended to be directed to the City of Barrie storm sewers, following treatment to reduce TSS. Agreements with the City of Barrie will be required to direct construction dewatering volumes to the municipal storm sewers.

The foundations of the proposed structure will be below the water table during seasonally high groundwater events. The floor elevation is planned to be above the seasonally high water table. The water table will likely be lower than the footings at the southeast side of the building during dry seasons. In order to comply with municipal guidelines to minimize discharge to the storm sewer system, construction of the foundations and footings so that they can be submerged (potentially seasonally) is recommended to be incorporated into the building design.

Details of proposed engineering structures, such as elevator shafts have not been finalized at this time. This assessment considers that the elevator shafts will be within the proposed depth of fill removal and that the elevator shafts will be constructed to be water proof and will not require long term drainage. The dewatering requirements to construct an elevator shaft are not anticipated to be sufficient to require a PTTW. This can be verified when details of proposed structures are finalized.

This assessment does not represent an engineering design of a dewatering operation, but provides a preliminary hydrogeological analysis for assessment of potential dewatering volumes to be generated during construction or under permanent drainage conditions. The actual design of the dewatering operation or the permanent foundation drains will be the responsibility of the contractor or the building design team.

8 DISCHARGE PLAN

A discharge plan will be required in support of either construction dewatering or long-term drainage. The following sections provide an outline for a discharge plan that will address the quantity and quality of discharge water.

8.1 QUANTITY

The currently proposed design for the Site indicates that dewatering will be required during construction and for long-term drainage. The volumes of discharge during construction are estimated to require registration on the EASR. Registration on the EASR or a PTTW is not estimated to be required for the long-term drainage.

The first step in the Discharge Plan will be to confirm that capacity is available in local infrastructure to receive predicted flow rates. Infrastructure options for disposal of the discharge are 1) the adjacent sanitary sewer, or 2) the storm sewer. Discharging to the natural environment is not considered a practical option based on the current design and the urbanized character of the Site and surroundings. Ultimately discharge will be released to Lake Simcoe, after treatment via the chosen receptor.

The process of evaluating infrastructure capacity would require additional inputs from the City of Barrie, MECP, LSRCA, and possibly also the Department of Fisheries and Oceans (DFO) and Ministry of Natural Resources and Forestry (MNRF) prior to proceeding. Requirements for water quality treatment will also need to be considered as part of the capacity assessment.

Discharge to any sewer will require a permit from the City of Barrie. The option to discharge to the sanitary sewer may require less treatment of the discharge prior to release to the sewer. Construction dewatering is anticipated to occur only for a limited time, hence the capacity assessment is more critical for long-term drainage. Should the sanitary sewer not be able to accept the expected volumes from the site, then other alternatives would need to be considered, including treatment and discharge to the storm sewer (see next section), waterproofing / tanking the structure or raising the base of foundation structures above the water table.

8.2 QUALITY

Groundwater quality sampling results indicate high concentrations of TSS and presence of elevated concentrations of dissolved metals in groundwater. The initial assessment does not reflect changes to water quality that may occur over time during dewatering. Treatment of the groundwater is required prior to discharge, although treatment requirements are different for the sanitary sewer as compared to the storm sewer or the natural environment.

8.2.1 SANITARY SEWER

If the sanitary sewer is demonstrated to have capacity to receive the estimated discharge, the pumped water will need to be tested prior to discharge to ensure that it continues to meet the quality requirements laid out in the City of Barrie Bylaw 2012-172. At a minimum, discharge water quality is to be tested regularly for TSS and metals. The limit for discharge of TSS to the Sanitary Sewer in the City of Barrie is 350 mg/L. Test results from the on-site monitoring wells indicate that treatment will be required to reduce TSS before discharge to the sanitary sewer. In the event that discharge concentrations are greater than the established standards, additional treatment measures shall be implemented to ensure compliance.

If the storm sewer is demonstrated to have capacity to receive the estimated discharge, the pumped water will need to be tested prior to discharge to ensure that it continues to meet the quality requirements laid out in the City of Barrie Bylaw 2012-172. At a minimum, discharge water quality is to be tested regularly for TSS and metals. The limit for discharge of TSS to the Storm Sewer in the City of Barrie is 15 mg/L. Test results from the on-site

monitoring wells indicate that treatment will be required to reduce TSS before discharge to the storm sewer. In the event that discharge concentrations are greater than the established standards, additional treatment measures shall be implemented to ensure compliance.

Given the proximity of the Site to Lake Simcoe, it is expected that the requirements for discharge to the storm sewer will be similar to those for discharge to the natural environment.

9 MONITORING PROGRAM

A monitoring program will be required to in support of the both construction dewatering or long-term discharge from foundation drains. The anticipated components of the monitoring program are:

- Quantify dewatering volumes.
- Assess groundwater quality.
- Conduct settlement analysis.
- Provide mitigation and adaptive management.

Monitoring of groundwater elevations are not considered to be required in the groundwater monitoring program due to the low rates of discharge and the plans for excavation of the underground parking structure to near the limits of the Site. Monitoring of environmental conditions are not considered necessary as the discharge is to be directed to a sewage system, pending approval.

These monitoring program components are discussed in the following sections. A detailed monitoring program will be required as part of sewer discharge agreements with the City of Barrie.

9.1 DEWATERING DISCHARGE

Total dewatering volumes are to be recorded on a daily basis during dewatering and during long-term drainage, regardless of whether volumes exceed 50,000 L/day or not. This shall be done through the use of properly calibrated flow meter(s). The values shall be recorded and available for inspection by MECP on request.

9.2 GROUNDWATER QUALITY

A groundwater sample shall be taken prior to discharge and tested against the appropriate criteria as discussed in the discharge section to confirm that the treatment systems are functioning properly and to determine whether additional treatment measures are required. In the event that concentrations are greater than the established standards, additional treatment measures must be implemented and new samples shall be taken and tested prior to directing discharge to the receptor. Sampling will be conducted prior to construction based on the appropriate regulatory requirements and will include parameters of concern that have been identified during previous sampling (TSS, metals). At a minimum, samples shall be taken weekly during construction to ensure that parameter concentrations remain within regulatory guidelines.

Discharge is to be checked at least five times throughout the day during construction for clarity prior to discharge and recorded in a log book that is to be kept on site. Field testing of dewatering volumes is to be completed (after treatment) on a daily basis for conductivity, pH, temperature and turbidity to assess changes over time.

A separate water quality monitoring program will be required for long-term discharge to the sanitary sewer from foundation drains, if applicable.

Table 8 Dewatering Discharge Monitoring Program

	BASELINE	DURING CONSTRUCTION DEWATERING	POST-CONSTRUCTION
Water Quality (Applicable Regulations)	Once prior to discharge for TSS, Metals	Weekly for parameters of concern	None
		Visual checks five times per day	
Dewatering Volumes	N/A	Daily	N/A

9.3 SETTLEMENT ANALYSIS

The Zone of Influence (ZOI) is predicted to extend marginally beyond the Site boundary and potentially beneath areas where adjacent structures and infrastructure are located. A settlement analysis by a qualified geotechnical engineer is recommended to assess potential for settlement of existing structures as a result of proposed dewatering. A settlement monitoring program for adjacent buildings and infrastructure will be recommended based on the settlement analysis.

9.4 MITIGATION

Although no impacts are expected to occur to nearby receptors, proposed mitigation based on the identification of impacts will include:

- Reduce dewatering volumes, if possible.
- Implement additional treatment measures.
- Re-evaluate the construction approach, including but not limited to use of groundwater cutoffs or waterproofing the structure.

9.5 ADAPTIVE MANAGEMENT

The intent of the monitoring plan is to conduct a comprehensive program that will continually assess the effects of dewatering on nearby receptors. Minor adjustments to the monitoring and mitigation strategies may be required over time. The analysis of qualitative and quantitative data from the monitoring program will be used to adaptively adjust monitoring variables, frequency of sampling, mitigation operational rules and mitigation.

10 CONCLUSIONS

1. The proposed development area straddles the boundary of the Simcoe Uplands and Simcoe Lowlands physiographic region as defined by Chapman and Putnam (1984).
2. The Site is located within the Lake Simcoe Watershed. Regional drainage is directed to the south toward Lake Simcoe.
3. The observed stratigraphic profile beneath the site consists of:
   a. A layer of topsoil up to 0.4 m thick.
   b. A layer of fill up to a typical depth of 2.2 mbgs and to a maximum depth of 3 mbgs. The fill varies in texture from silty clay to clayey silt to sandy silt to silty sand.
   c. An upper layer of till to depths between 3 mbgs and 7 m bgs. This till varies in texture from sandy silt to silty sand.
   d. A lower layer of till to the bottom of the investigated depth (9.8 m bgs). This till varies in texture from sandy clayey silt to silty clayey sand.
4. The observed depth to groundwater varied between 0.73 and 3.44 m below ground on May 15, 2019. Groundwater elevations measured in May 2019 varied from a high of 235.85 in the northeastern area of the site (MW19-06) to a low of 232.25 in the south of the Site (MW19-05). Groundwater flow is observed to be directed in a southerly direction.
5. Continuous groundwater elevation monitoring from April through September 2019 demonstrates that the seasonal high groundwater elevation occurred in May. The seasonal high value of 235.85 has been used as a basis for the proposed building design. The floor level is established 0.5 m above the seasonally high water table.
6. Single well response tests were conducted to estimate hydraulic conductivity in the newly installed monitoring wells (MW19-02, MW19-05, and MW19-06), as well as in the well from previous investigations (BH2). The hydraulic conductivity is estimated to be between 2.7 $x10^{-8}$ m/s to 2.1 $x10^{-6}$ m/s. This range is considered to reflect the observed saturated materials below the water table.
7. Representative groundwater samples were collected from BH2, MW19-02, and MW19-06 on May 2, 2019 and tested for general water quality parameters, dissolved metals, total phosphorus, total organic carbon, reactive silica, and nutrients. The results of these tests indicated that the concentrations of dissolved Copper (Cu) in BH2, MW19-02 and MW19-06, of dissolved Cobalt (Co) in BH2, and MW19-06, and of dissolved Uranium (U) in MW19-02 are greater than the Provincial Water Quality Objectives (PWQO).
8. The water quality samples from MW19-05 were submitted to determine concentrations of parameters to assess suitability for discharge to the City of Barrie sewers and included: pH, Total Suspended Solids (TSS), Chloride, Fluoride, Total Kjeldahl Nitrogen (TKN), Hardness, Total Phosphorus, Sulphate, Sulphide. Total Cyanide, Chemical Oxygen Demand (COD), Total Metals, Aggregate Organics, Volatile Organic Compounds (VOC), Polycyclic Aromatic Hydrocarbons (PAH), and Semi-Volatile Organics. The reported concentration of Total Suspended Solids (TSS) in MW19-05 of 300,000 mg/L is greater than the Bylaw 2012-172 objectives for sanitary and storm sewers. The reported concentrations of Total Phosphorus, Total Barium, Total Manganese, and Chemical Oxygen Demand were also greater than the Bylaw 2012-172 objectives for sanitary sewers.
9. The results of the water quality testing indicate that treatment will be required to reduce TSS and metals concentrations for discharge to the City of Barrie Sewers.
10. The Climate-Based Water Budget indicates that average annual precipitation over the past 30 years is 932.9 mm/year. The available moisture surplus at the Site is 383.4 mm/year based on the type of soil and vegetation cover. The moisture surplus will reflect the infiltration and runoff based on the soil properties, slopes, and vegetation within individual catchments.

11 The pre-development water budget was assumed to reflect the condition with the former buildings and parking lots in place. the Site consists of one (1) drainage catchment that drains to City of Barrie storm sewers. There is one (1) off-site catchment that drains on-site from the north.

12 The Pre-Development Water Budget reflects infiltration for the Site of approximately 144 m^3/yr and runoff from the Site of approximately 2,875 m^3/yr. The Pre-Development infiltration and runoff reflect the urban nature of the pre-development condition.

13 The Post-Development Water Budget reflects changes in land use to include increased areas of impervious surfaces (i.e. roads, buildings etc.). Under Post-Development conditions, runoff from the Site will drain to City of Barrie storm sewers.

14 The Post-Development Water Budget, including existing plans for infiltration of stormwater, predicts a total on-site infiltration of 209 m^3/yr. The Post-Development Water Budget reflects an infiltration surplus of 65 m^3/yr (45% increase from pre-development).

15 The Post-Development Water Budget, for the development predicts an annual runoff on the order of 2,907 m^3/yr. This reflects an increase of 32 m^3/yr or 1% from pre-development. The potential capacity of the City of Barrie storm sewers to receive these flows has not been evaluated as part of this study.

16 The Site lies within the WHPA and WHPA Q1/Q2 for the City of Barrie wells, IPZ-3 for water supplies that draw from Lake Simcoe, and an issue contributing area (ICA) for sodium and chloride. The policies that are in place to govern development at this site will promote recharge and minimize use of sodium and chloride as part of winter road maintenance.

17 The Site is mapped as a Highly Vulnerable Aquifer (HVA). The observed fine-grained soils beneath the property are not consistent with the mapping as a highly vulnerable aquifer.

18 The Site partially lies in an area mapped as a Significant Groundwater Recharge Area (SGRA). The observed fine-grained soils are not consistent with the mapping as a SGRA.

19 The proposed structure will occupy the majority of the available lands and the base of the floor elevation has been established to be 0.5 m above the high groundwater elevation. The high groundwater elevation is approximately 285.5 mASL. The foundation footings are currently proposed to be founded at the top of the native soil, which ranges between 233.2 and 233.9 mASL. As a conservative assumption, the elevation of the underside of the footing will be placed at 233 mASL. It is anticipated that the footings will be submerged during seasonal high groundwater elevations.

20 Conservative estimates of the requirements for construction dewatering to install the building foundations indicate that the dewatering volumes will be up to 136,800 L/day. This volume is greater than the threshold to register on the EASR but is less that the requirement to obtain a PTTW for construction dewatering purposes. WSP is currently conducting an updated Phase One and Phase Two Environmental Site Assessment (ESA) at the Site. If the findings and recommendations of the Phase One and Phase Two ESA support the removal of excess soil to address potential contamination concerns at the Site, there may be a potential that the additional volumes of water would need to be removed during these remediation activities. It is recommended that the dewatering estimates be revisited if the Phase Two ESA identifies a requirement to remove soils to a depth greater than required for the construction of the building foundation footings. An Excess Soil Management Plan may be required in the event that fill material cannot be re-used on-site.

21 Direct precipitation into the open excavation may contribute up to 120,000 L/day of water for a 30 mm storm event over a period of one day. This volume can be managed within the EASR.

22 An agreement with the City of Barrie will be required for discharge of construction dewatering water to municipal infrastructure.

23 The seasonal high groundwater elevations are anticipated to be above the proposed footings. As such, the design of the building foundation system is recommended to consider that the footings may be submerged for part of the year.

24 Details of proposed engineering structures, such as elevator shafts, have not been finalized at this time. This assessment considers that the elevator shafts will be within the proposed depth of fill removal and will be constructed to be water proof.

25 A discharge plan will be required in support of the proposed construction. This will require confirmation that the City of Barrie sewage infrastructure has capacity to handle proposed quantity and quality of discharge. Treatment will be required to remove TSS and metals to achieve the water quality limits as per City of Barrie By-law 2012-172.

26 A Monitoring Program will be required in support of the proposed construction dewatering and long-term foundation drainage system. The anticipated components of the monitoring program include:

- Maintaining records of daily discharge volumes.
- Monitoring water quality to ensure compliance with City of Barrie Bylaw 2012-172.
- Performing a settlement analysis and, if necessary monitoring, to minimize potential for settling related to the proposed development.
- Mitigating potential effects from dewatering by reducing dewatering volumes (if possible), providing additional treatment, or re-evaluating proposed design/construction.
- Maintaining an adaptive management approach to review and update the dewatering and monitoring program in response to observed conditions.

11 REFERENCES

- Armstrong, D.K., and Dodge, J.E.P., 2007. Paleozoic Geology of Southern Ontario - Project Summary and Technical Document, Ontario Geological Survey, Miscellaneous Release – Data 219.
- Chapman, L.J. and D.F. Putnam, 1984. The Physiography of Southern Ontario. Ontario Geological Survey, Third Edition. 270 pp. Accompanied by Map P.2715, Scale 1: 600,000.
- Federal Highway Administration Research and Technology, 1997. User Guidelines for Waste and Byproduct Materials in Pavement Construction. Publication Number FWHA-RD-97-148.
- Gao, C., Shirota, J., Kelly, R.I., Brunton, F.R., and van Haaften, S., 2006. Bedrock Topography and overburden thickness mapping, southern Ontario, Ontario Geological Survey, Miscellaneous Release – Data 207.
- Hvlorslev, M.J., 1951. Time Lag and Soil Permeability in Ground-Water Observations. Bulletin No. 36. Waterways Experiment Station, U.S. Army Corps of Engineers, Vicksburg, Mississsippi.
- Kassenaar, J.D.C. and Wexler, E.J., 2006. Groundwater Modelling of the Oak Ridges Moraine Area. CAMC-YPDT Technical Report #01-06.
- Ontario Geological Survey, 2011. 1:250,000 Scale Bedrock Geology of Ontario, Ontario Geological Survey Miscellaneous Release – Data 126- Revision 1.
- Ontario Ministry of the Environment and Energy. 1995. Hydrological Technical Information Requirements for Land Development Applications.
- Ontario Ministry of the Environment, Design Guidelines for Sewage Works, 2008.
- Russell, H.A.J., Sharpe, D.R., and Logan, C. 2005: Structural Model of the Greater Toronto and Oak Ridges Moraine Areas, Southern Ontario: Halton Till; Geological Survey of Canada, Open File 5064, scale 1:250,000.
- Russell, H.A.J., Sharpe, D.R., and Logan, C. 2005: Structural Model of the Greater Toronto and Oak Ridges Moraine Areas, Southern Ontario: ORM Sediment; Geological Survey of Canada, Open File 5065, scale 1:250,000.
- S2S Environmental Inc., 2016. Phase Two Environmental Site Assessment - 113-117 Bayfield Street, Barrie, Ontario.
- Sharpe, D.R., Russell, H.A.J., and Logan, C. 2005. Structural Model of the Greater Toronto and Oak Ridges Moraine Areas, Southern Ontario: Newmarket Till, Geological Survey of Canada, Open File 5066, scale 1:250,000.
- Sharpe, D.R., Russell, H.A.J., and Logan, C. 2005: Structural Model of the Greater Toronto and Oak Ridges Moraine Areas, Southern Ontario: Lower Sediment, Geological Survey of Canada, Open File 5067, scale 1:250,000.
- WSP, 2016. Assessment of Dewatering Requirements - 113-117 Bayfield Street, Barrie, Ontario.
- WSP, 2019. Geotechnical Investigation – 113-117 Bayfield Street, Barrie, Ontario.

TABLES

TABLE 1
MONITORING WELL CONSTRUCTION DETAILS
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

Monitor Designation	Co-ordinates		Diameters		Depth	Elevations									
					Total	Top of Pipe	Ground	Bottom of Borehole	Bottom of Monitor	Screen		Sand Pack		Bentonite Seals	
	Northing	Easting	Borehole	Monitor						Bottom of	Top of	Bottom of	Top of	Bottom of	Top of
	m	m	mm	mm	m bgs	m ASL	m ASL	m ASL	m ASL	m ASL	m ASL	m ASL	m ASL	m ASL	m ASL
MW19-02	4916293	604146	203	51	9.14	236.95	236.06	226.31	226.92	226.92	229.96	226.92	230.88	230.88	235.45
MW19-05	4916295	604189	203	51	9.14	236.48	235.69	225.94	226.55	226.55	229.59	225.94	229.90	229.90	234.47
MW19-06	4916327	604180	203	51	6.10	237.48	236.58	228.87	230.48	230.48	233.54	228.87	233.58	233.58	234.97
BH2			203	51	7.50	235.73	235.90	228.30	228.40	228.40	232.97	228.30	233.12	233.12	235.52

Notes:

1) "m agl" indicates metres above ground level.
2) "m bgs" indicates metres below ground surface
3) "m" indicates metres
4) "m ASL" indicates metres above sea level.

TABLE 2
OBSERVED GROUNDWATER ELEVATIONS
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

Monitor Designation	Elevation of T.O.P. m ASL	Ground Elevation m ASL	PVC Casing Stick-up m	Measurement Date	Depth to Water m bmp	Depth to Water m bgl	Groundwater Elevation m ASL
MW19-02	236.95	236.06	0.88	25-Apr-19	4.75	3.87	232.20
				2-May-19	2.49	1.61	234.46
				15-May-19	2.12	1.24	**234.83**
				25-Jun-19	2.38	1.50	234.57
				13-Sep-19	2.84	1.96	234.11
MW19-05	236.48	235.69	0.79	24-Apr-19	2.65	1.86	**233.83**
				2-May-19	4.21	3.42	232.27
				15-May-19	4.23	3.44	232.25
				25-Jun-19	4.46	3.67	232.02
				13-Sep-19	5.03	4.24	231.45
MW19-06	237.48	236.58	0.90	25-Apr-19	2.26	1.36	235.22
				2-May-19	1.63	0.73	**235.85**
				15-May-19	1.72	0.82	235.76
				25-Jun-19	2.29	1.39	235.19
				13-Sep-19	3.71	2.81	233.77
BH1	-	-	-	6-Oct-16	-	2.50	-
BH2	235.73	235.90	-0.17	6-Oct-16	2.53	2.70	233.20
				5-Apr-19	1.60	1.77	234.13
				2-May-19	1.35	1.52	**234.38**
				15-May-19	1.42	1.59	234.31
				25-Jun-19	1.69	1.86	234.04
				13-Sep-19	2.16	2.33	233.57

Notes:
1) "m ASL" indicates metres above sea level.
2) "m" indicates metres.
3) "m bmp" indicates metres below measurement point, which is the top of pipe (referred to as T.O.P.)
4) "m bgl" indicates metres below ground level.
5) Measurements taken on April 24-25th are not considered to be static but water levels upon completion of drilling

Table 3
SUMMARY OF HYDRAULIC CONDUCTIVITY TEST VALUES
HYDROGEOLOGICAL STUDY
113-117 Bayfield Street, Barrie, ON

Test Interval	Test Date	Material Adjacent to the Screen	Method of Analysis	Test Type	Static Water Depth (BTOP)	Estimated Hydraulic Conductivity		
					m	m/sec	cm/sec	m/day
BH1								
BH1 (Test 1)	1-Nov-16	Sand and Silt/ Silt	Bouwer & Rice, Aqtesolv	RISING HEAD	unknown	1.9E-06	1.9E-04	1.63E-01
BH1 (Test 2)	1-Nov-16	Sand and Silt/ Silt	Bouwer & Rice, Aqtesolv	RISING HEAD	unknown	1.9E-06	1.9E-04	1.63E-01
BH1 (Test 3)	1-Nov-16	Sand and Silt/ Silt	Bouwer & Rice, Aqtesolv	RISING HEAD	unknown	1.6E-06	1.6E-04	1.37E-01
Geometric Mean						**1.8E-06**	**1.8E-04**	**1.5E-01**
Maximum						**1.9E-06**	**1.9E-04**	**1.6E-01**
Minimum						**1.6E-06**	**1.6E-04**	**1.4E-01**
BH2								
BH2 (Test 1)	1-Nov-16	Sand and Silt/ Silt	Bouwer & Rice, Aqtesolv	RISING HEAD	unknown	4.0E-07	4.0E-05	3.46E-02
BH2 (Test 2)	1-Nov-16	Sand and Silt/ Silt	Bouwer & Rice, Aqtesolv	RISING HEAD	unknown	4.0E-07	4.0E-05	3.46E-02
BH2 (Test 3)	1-Nov-16	Sand and Silt/ Silt	Bouwer & Rice, Aqtesolv	RISING HEAD	unknown	5.7E-07	5.7E-05	4.89E-02
Early Time	2-May-19	Sand and Silt, Sandy Silt	Hvorslev, Analytical Method	RISING HEAD	1.52	1.9E-07	1.9E-05	1.65E-02
Late Time	2-May-19	Sand and Silt, Sandy Silt	Hvorslev, Analytical Method	RISING HEAD	1.52	1.9E-07	1.9E-05	1.63E-02
Geometric Mean					**1.52**	**3.2E-07**	**3.2E-05**	**2.8E-02**
Maximum					**1.52**	**5.7E-07**	**5.7E-05**	**4.9E-02**
Minimum					**1.52**	**1.9E-07**	**1.9E-05**	**1.6E-02**
MW19-02								
Early Time	2-May-19	Silty Sand Till and Sandy Clayey Silt Till	Hvorslev, Analytical Method	RISING HEAD	2.49	3.7E-08	3.7E-06	3.21E-03
Late Time	2-May-19	Silty Sand Till and Sandy Clayey Silt Till	Hvorslev, Analytical Method	RISING HEAD	2.49	4.5E-08	4.5E-06	3.86E-03
Geometric Mean					**2.49**	**4.1E-08**	**4.1E-06**	**3.5E-03**
Maximum					**2.49**	**4.5E-08**	**4.5E-06**	**3.9E-03**
Minimum					**2.49**	**3.7E-08**	**3.7E-06**	**3.2E-03**
M19-05								
Early Time	2-May-19	Silty Clayey Sand Till	Hvorslev, Analytical Method	RISING HEAD	4.21	2.6E-07	2.6E-05	2.22E-02
Mid Time	2-May-19	Silty Clayey Sand Till	Hvorslev, Analytical Method	RISING HEAD	4.21	2.7E-08	2.7E-06	2.34E-03
Late Time	2-May-19	Silty Clayey Sand Till	Hvorslev, Analytical Method	RISING HEAD	4.21	1.4E-07	1.4E-05	1.21E-02
Geometric Mean					**4.21**	**9.9E-08**	**9.9E-06**	**8.6E-03**
Maximum					**4.21**	**2.6E-07**	**2.6E-05**	**2.2E-02**
Minimum					**4.21**	**2.7E-08**	**2.7E-06**	**2.3E-03**
MW19-06								
Early Time	2-May-19	Sandy Silt, Sandy Clayey Silt Till	Hvorslev, Analytical Method	RISING HEAD	1.63	2.1E-06	2.1E-04	1.78E-01
Late Time	2-May-19	Sand and Silt/ Silt	Hvorslev, Analytical Method	RISING HEAD	1.63	2.2E-07	2.2E-05	1.89E-02
Geometric Mean					**1.63**	**6.7E-07**	**6.7E-05**	**5.8E-02**
Maximum					**1.63**	**2.1E-06**	**2.1E-04**	**1.8E-01**
Minimum					**1.63**	**2.2E-07**	**2.2E-05**	**1.9E-02**
All Monitors								
Geometric Mean					**2.42**	**3.0E-07**	**3.0E-05**	**2.6E-02**
Maximum					**4.21**	**2.1E-06**	**2.1E-04**	**1.8E-01**
Minimum					**1.52**	**2.7E-08**	**2.7E-06**	**2.3E-03**

TABLE 4
WATER QUALITY RESULTS - GROUNDWATER
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

NOTES:
1) Barrie Storm = Barrie Storm Sewer Use Bylaw 2012-172
2) Barrie Sanitary = Barrie Sanitary Sewer Use Bylaw 2012-172
3) PWQO = Provincial Water Quality Objectives for Use Under Part XV.1 of the Environmental Protection Act (July, 1994).
3) Yellow shading indicates parameter reportable detection limit exceeds Barrie Storm.
4) Orange shading indicates parameter reportable detection limit exceeds Barrie Sanitary.
5) Red shading indicates parameter reportable detection limit exceeds PWQO.
6)Blue shading indicates the Detection Limit for the result exceeds the Guideline Limit.

Parameters	**UNIT**	**Barrie Storm (1)**	**Barrie Sanitary (2)**	**PWQO (3)**	**BH2**	**MW19-02**	**MW19-05**	**MW19-06**
Sample Date					02-May-19	02-May-19	02-May-19	02-May-19
Field Parameters								
Colour, Apparent	CU				294	323		173
Conductivity	umhos/cm				4770	1850		2820
pH	pH units	6.0-9.5	6.0-9.5	6.5 - 8.5	6.71	7.36	7.41	6.86
Total Suspended Solids	mg/L	15	350				300,000	
Total Dissolved Solids	mg/L				3380	1140		1940
Turbidity	NTU				>4000	>4000		>4000
Calculated Parameters								
Alkalinity, Bicarbonate (as CaCO3)	mg/L				1210	1260		1860
Alkalinity, Carbonate (as CaCO3)	mg/L				<50	<50		<50
Alkalinity, Hydroxide (as CaCO3)	mg/L				<50	<50		<50
Alkalinity, Total (as CaCO3)	mg/L				1210	1260		1860
Ammonia, Total (as N)	mg/L				0.490	0.058		0.276
Bromide (Br)	mg/L				<1.0	<0.50		<0.50
Chloride (Cl)	mg/L		1500		1520	379	130	718
Computed Conductivity	uS/cm				4520	2110		3130
Conductivity % Difference	%				-5	13		11
Fluoride (F)	mg/L		10		<0.20	<0.10	0.03	<0.10
Hardness (as CaCO3)	mg/L				1760.000	492.000		949.000
Ion Balance	%				80	59		57
Langelier Index	-				1	1		1
Nitrate and Nitrite as N	mg/L				1.99	4.79		3.934
Nitrate (as N)	mg/L				1.99	4.74		3.8
Nitrite (as N)	mg/L				<0.10	0.05		0.134

TABLE 4
WATER QUALITY RESULTS - GROUNDWATER
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

NOTES:
1) Barrie Storm = Barrie Storm Sewer Use Bylaw 2012-172
2) Barrie Sanitary = Barrie Sanitary Sewer Use Bylaw 2012-172
3) PWQO = Provincial Water Quality Objectives for Use Under Part XV.1 of the Environmental Protection Act (July, 1994).
3) Yellow shading indicates parameter reportable detection limit exceeds Barrie Storm.
4) Orange shading indicates parameter reportable detection limit exceeds Barrie Sanitary.
5) Red shading indicates parameter reportable detection limit exceeds PWQO.
6)Blue shading indicates the Detection Limit for the result exceeds the Guideline Limit.

Parameters	UNIT	Barrie Storm (1)	Barrie Sanitary (2)	PWQO (3)	BH2	MW19-02	MW19-05	MW19-06
Sample Date					02-May-19	02-May-19	02-May-19	02-May-19
Total Kjeldahl Nitrogen	mg/L		100				4.5	
Saturation pH	pH				5.88	6.33		5.87
Orthophosphate-Dissolved (as P)	mg/L				<0.0030	<0.0030		<0.0030
Phosphorus, Total	mg/L			0.03			47.9	
TDS (Calculated)	mg/L				3310	1630		2500
Sulfate (SO4)	mg/L		1500		41.6	67.6	44.1	45.8
Sulphide (as S)	mg/L						0.06	
Sulphide (as H2S)	mg/L		1				0.06	
Anion Sum	me/L				63.7	33.1		52
Cation Sum	me/L				51.1	19.7		29.5
Cation - Anion Balance	%				-11	-25		-28
Cyanides								
Total Cyanide	mg/L		1.2				<0.0020	
Organic / Inorganic Carbon (Water)								
Dissolved Organic Carbon	mg/L				4.88	2.26		3.08
Inorganics								
Silica	mg/L				20.1	15.6		15.7
Total Metals								
Total Aluminum (Al)	mg/L		50				0.66	
Total Antimony (Sb)	mg/L		5				<0.010	
Total Arsenic (As)	mg/L		1				<0.010	
Total Barium (Ba)	mg/L		5				7.01	
Total Beryllium (Be)	mg/L							
Total Bismuth (Bi)	mg/L		5				<0.0050	

TABLE 4
WATER QUALITY RESULTS - GROUNDWATER
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

NOTES:
1) Barrie Storm = Barrie Storm Sewer Use Bylaw 2012-172
2) Barrie Sanitary = Barrie Sanitary Sewer Use Bylaw 2012-172
3) PWQO = Provincial Water Quality Objectives for Use Under Part XV.1 of the Environmental Protection Act (July, 1994).
3) Yellow shading indicates parameter reportable detection limit exceeds Barrie Storm.
4) Orange shading indicates parameter reportable detection limit exceeds Barrie Sanitary.
5) Red shading indicates parameter reportable detection limit exceeds PWQO.
6)Blue shading indicates the Detection Limit for the result exceeds the Guideline Limit.

Parameters	UNIT	Barrie Storm (1)	Barrie Sanitary (2)	PWQO (3)	BH2	MW19-02	MW19-05	MW19-06
Sample Date					02-May-19	02-May-19	02-May-19	02-May-19
Total Boron (B)	mg/L							
Total Cadmium (Cd)	mg/L	0.001	0.7				0.0009	
Total Calcium (Ca)	mg/L							
Total Cesium (Cs)	mg/L							
Total Chromium (Cr)	mg/L	0.08	2				<0.050	
Total Cobalt (Co)	mg/L		5				<0.010	
Total Copper (Cu)	mg/L	0.01	2				<0.10	
Total Iron (Fe)	mg/L		50				<1.0	
Total Lead (Pb)	mg/L	0.05	0.7				<0.0050	
Total Magnesium (Mg)	mg/L		0.01					
Total Manganese (Mn)	mg/L		5				10.8	
Total Mercury (Hg)	mg/L		0.01				0.00004	
Total Molybdenum (Mo)	mg/L		5				0.0097	
Total Nickel (Ni)	mg/L	0.05	2				<0.050	
Total Phosphorous (P)	mg/L							
Total Potassium (K)	mg/L							
Total Rubidium (Rb)								
Total Selenium (Se)	mg/L		1				<0.0050	
Total Silicon (Si)	mg/L		0.4					
Total Silver (Ag)	mg/L						<0.0050	
Total Sodium (Na)	mg/L							
Total Strontium (Sr)	mg/L							
Total Sulfur (S)								
Total Tellurium (Te)								

TABLE 4
WATER QUALITY RESULTS - GROUNDWATER
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

NOTES:
1) Barrie Storm = Barrie Storm Sewer Use Bylaw 2012-172
2) Barrie Sanitary = Barrie Sanitary Sewer Use Bylaw 2012-172
3) PWQO = Provincial Water Quality Objectives for Use Under Part XV.1 of the Environmental Protection Act (July, 1994).
3) Yellow shading indicates parameter reportable detection limit exceeds Barrie Storm.
4) Orange shading indicates parameter reportable detection limit exceeds Barrie Sanitary.
5) Red shading indicates parameter reportable detection limit exceeds PWQO.
6)Blue shading indicates the Detection Limit for the result exceeds the Guideline Limit.

Parameters	UNIT	Barrie Storm (1)	Barrie Sanitary (2)	PWQO (3)	BH2	MW19-02	MW19-05	MW19-06
Sample Date					02-May-19	02-May-19	02-May-19	02-May-19
Total Thallium (Tl)	mg/L							
Total Thorium (Th)								
Total Tin (Sn)			5				<0.010	
Total Titanium (Ti)	mg/L						<0.030	
Total Tungsten (W)								
Total Uranium (U)								
Total Vanadium (V)	mg/L		5				<0.050	
Total Zinc (Zn)	mg/L	0.04	2				<0.30	
Total Zirconium (Zr)								
Dissolved Metals (Water)								
Aluminum (Al)-Dissolved	mg/L		0.075	0.075	<0.050	<0.0050		<0.050
Antimony (Sb)-Dissolved	mg/L			0.02	<0.0010	0.00		<0.0010
Arsenic (As)-Dissolved	mg/L			0.005	<0.0010	0.00036		<0.0010
Barium (Ba)-Dissolved	mg/L				0.807	0.231		0.253
Beryllium (Be)-Dissolved	mg/L			0.011	<0.0010	<0.00010		<0.0010
Bismuth (Bi)-Dissolved	mg/L				<0.00050	<0.000050		<0.00050
Boron (B)-Dissolved	mg/L			0.2	<0.10	0.05		<0.10
Cadmium (Cd)-Dissolved	mg/L			0.0001	<0.000050	<0.000010		<0.000050
Calcium (Ca)-Dissolved	mg/L				563	142		326
Chromium (Cr)-Dissolved	mg/L				<0.0050	<0.00050		<0.0050
Cobalt (Co)-Dissolved	mg/L			0.0009	0.0017	0.0005		0.0012
Copper (Cu)-Dissolved	mg/L			0.001	0.006	0.002		0.004
Iron (Fe)-Dissolved	mg/L			0.3	<0.10	<0.010		<0.10

TABLE 4
WATER QUALITY RESULTS - GROUNDWATER
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

NOTES:
1) Barrie Storm = Barrie Storm Sewer Use Bylaw 2012-172
2) Barrie Sanitary = Barrie Sanitary Sewer Use Bylaw 2012-172
3) PWQO = Provincial Water Quality Objectives for Use Under Part XV.1 of the Environmental Protection Act (July, 1994).
3) Yellow shading indicates parameter reportable detection limit exceeds Barrie Storm.
4) Orange shading indicates parameter reportable detection limit exceeds Barrie Sanitary.
5) Red shading indicates parameter reportable detection limit exceeds PWQO.
6)Blue shading indicates the Detection Limit for the result exceeds the Guideline Limit.

Parameters	UNIT	Barrie Storm (1)	Barrie Sanitary (2)	PWQO (3)	BH2	MW19-02	MW19-05	MW19-06
Sample Date					02-May-19	02-May-19	02-May-19	02-May-19
Lead (Pb)-Dissolved	mg/L			0.001	<0.00050	0.000061		<0.00050
Magnesium (Mg)-Dissolved	mg/L				86	33.7		32.7
Manganese (Mn)-Dissolved	mg/L				0.748	0.0485		0.485
Molybdenum (Mo)-Dissolved	mg/L			0.04	<0.00050	0.00		0.00
Nickel (Ni)-Dissolved	mg/L			0.025	<0.0050	0.00229		<0.0050
Phosphorus (P)-Dissolved	mg/L			0.01	<0.50	<0.050		<0.50
Potassium (K)-Dissolved	mg/L				4.79	7.08		3.34
Selenium (Se)-Dissolved	mg/L			0.1	0.0	0.0		<0.00050
Silicon (Si)-Dissolved	mg/L				9.38	7.3		7.32
Silver (Ag)-Dissolved	mg/L			0.0001	<0.00050	<0.000050		<0.00050
Sodium (Na)-Dissolved	mg/L				362	223		240
Strontium (Sr)-Dissolved	mg/L				1.41	0.426		0.837
Sulfur (S)-Dissolved	mg/L				14	23.8		15.1
Thallium (Tl)-Dissolved	mg/L			0.0003	<0.00010	0.000018		<0.00010
Tin (Sn)-Dissolved	mg/L				<0.0010	<0.00010		<0.0010
Titanium (Ti)-Dissolved	mg/L				<0.0030	<0.00030		<0.0030
Tungsten (W)-Dissolved	mg/L			0.03	<0.0010	0.00		<0.0010
Uranium (U)-Dissolved	mg/L			0.005	0.002	0.008		0.002
Vanadium (V)-Dissolved	mg/L			0.006	<0.0050	0.00114		<0.0050
Zinc (Zn)-Dissolved	mg/L			0.02	<0.010	0.0021		<0.010
Zirconium (Zr)-Dissolved	mg/L			0.004	<0.0030	<0.00030		<0.0030
Aggregate Organics (Water)								
BOD	mg/L	15	300				<3.0	

TABLE 4
WATER QUALITY RESULTS - GROUNDWATER
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

NOTES:
1) Barrie Storm = Barrie Storm Sewer Use Bylaw 2012-172
2) Barrie Sanitary = Barrie Sanitary Sewer Use Bylaw 2012-172
3) PWQO = Provincial Water Quality Objectives for Use Under Part XV.1 of the Environmental Protection Act (July, 1994).
3) Yellow shading indicates parameter reportable detection limit exceeds Barrie Storm.
4) Orange shading indicates parameter reportable detection limit exceeds Barrie Sanitary.
5) Red shading indicates parameter reportable detection limit exceeds PWQO.
6)Blue shading indicates the Detection Limit for the result exceeds the Guideline Limit.

Parameters	**UNIT**	**Barrie Storm (1)**	**Barrie Sanitary (2)**	**PWQO (3)**	**BH2**	**MW19-02**	**MW19-05**	**MW19-06**
Sample Date					02-May-19	02-May-19	02-May-19	02-May-19
COD	mg/L		600				790	
Oil and Grease, Total	mg/L						<5.0	
Animal/Veg Oil & Grease	mg/L		150				<5.0	
Mineral Oil and Grease	mg/L		15				<2.5	
Phenols (4AAP)	mg/L		0.1				<0.0010	
Volatile Organic Compounds (Wa								
Acetone	ug/L						<20	
Benzene	ug/L		10				<0.50	
Bromodichloromethane	ug/L						<1.0	
Bromoform	ug/L						<1.0	
Bromomethane	ug/L						<0.50	
Carbon Disulfide	ug/L						<1.0	
Carbon tetrachloride	ug/L						<0.50	
Chlorobenzene	ug/L						<0.50	
Dibromochloromethane	ug/L						<1.0	
Chloroethane	ug/L						<1.0	
Chloroform	ug/L						<1.0	
Chloromethane	ug/L						<1.0	
1,2-Dibromoethane	ug/L						<0.20	
1,2-Dichlorobenzene	ug/L		50				<0.50	
1,3-Dichlorobenzene	ug/L						<0.50	
1,4-Dichlorobenzene	ug/L		80				<0.50	
Dichlorodifluoromethane	ug/L						<1.0	

TABLE 4
WATER QUALITY RESULTS - GROUNDWATER
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

NOTES:
1) Barrie Storm = Barrie Storm Sewer Use Bylaw 2012-172
2) Barrie Sanitary = Barrie Sanitary Sewer Use Bylaw 2012-172
3) PWQO = Provincial Water Quality Objectives for Use Under Part XV.1 of the Environmental Protection Act (July, 1994).
3) Yellow shading indicates parameter reportable detection limit exceeds Barrie Storm.
4) Orange shading indicates parameter reportable detection limit exceeds Barrie Sanitary.
5) Red shading indicates parameter reportable detection limit exceeds PWQO.
6)Blue shading indicates the Detection Limit for the result exceeds the Guideline Limit.

Parameters	UNIT	Barrie Storm (1)	Barrie Sanitary (2)	PWQO (3)	BH2	MW19-02	MW19-05	MW19-06
Sample Date					02-May-19	02-May-19	02-May-19	02-May-19
1,1-Dichloroethane	ug/L						<0.50	
1,2-Dichloroethane	ug/L						<0.50	
1,1-Dichloroethylene	ug/L						<0.50	
cis-1,2-Dichloroethylene	ug/L						<0.50	
trans-1,2-Dichloroethylene	ug/L						<0.50	
Dichloromethane	ug/L		90				<2.0	
1,2-Dichloropropane	ug/L						<0.50	
cis-1,3-Dichloropropene	ug/L						<0.50	
trans-1,3-Dichloropropene	ug/L						<0.50	
Ethylbenzene	ug/L		60				<0.50	
n-Hexane	ug/L						<0.50	
2-Hexanone	ug/L						<20	
Methyl Ethyl Ketone	ug/L						<20	
Methyl Isobutyl Ketone	ug/L						<20	
MTBE	ug/L						<0.50	
Styrene	ug/L						<0.50	
1,1,1,2-Tetrachloroethane	ug/L						<0.50	
1,1,2,2-Tetrachloroethane	ug/L		60				<0.50	
Tetrachloroethylene	ug/L		60				<0.50	
Toluene	ug/L		20				<0.50	
1,1,1-Trichloroethane	ug/L						<0.50	
1,1,2-Trichloroethane	ug/L						<0.50	
Trichloroethylene	ug/L		50				<0.50	
Trichlorofluoromethane	ug/L						<1.0	

TABLE 4
WATER QUALITY RESULTS - GROUNDWATER
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

NOTES:
1) Barrie Storm = Barrie Storm Sewer Use Bylaw 2012-172
2) Barrie Sanitary = Barrie Sanitary Sewer Use Bylaw 2012-172
3) PWQO = Provincial Water Quality Objectives for Use Under Part XV.1 of the Environmental Protection Act (July, 1994).
3) Yellow shading indicates parameter reportable detection limit exceeds Barrie Storm.
4) Orange shading indicates parameter reportable detection limit exceeds Barrie Sanitary.
5) Red shading indicates parameter reportable detection limit exceeds PWQO.
6)Blue shading indicates the Detection Limit for the result exceeds the Guideline Limit.

Parameters	**UNIT**	**Barrie Storm (1)**	**Barrie Sanitary (2)**	**PWQO (3)**	**BH2**	**MW19-02**	**MW19-05**	**MW19-06**
Sample Date					02-May-19	02-May-19	02-May-19	02-May-19
Vinyl chloride	ug/L						<0.50	
o-Xylene	ug/L						<0.50	
m+p-Xylenes	ug/L						<1.0	
Xylenes (Total)	ug/L		300				<1.1	
4-Bromofluorobenzene	%						99.8	
1,4-Difluorobenzene	%						101.5	
Polycyclic Aromatic Hydrocarbor								
Acenaphthene	ug/L						<0.020	
Acenaphthylene	ug/L						<0.020	
Anthracene	ug/L						<0.030	
Benzo(a)anthracene	ug/L						<0.030	
Benzo(a)pyrene	ug/L						<0.015	
Benzo(b)fluoranthene	ug/L						<0.030	
Benzo(g,h,i)perylene	ug/L						<0.030	
Benzo(k)fluoranthene	ug/L						<0.030	
Chrysene	ug/L						<0.080	
Dibenzo(ah)anthracene	ug/L						<0.030	
Fluoranthene	ug/L						<0.060	
Fluorene	ug/L						<0.020	
Indeno(1,2,3-cd)pyrene	ug/L						<0.030	
1-Methylnaphthalene	ug/L						<0.020	
2-Methylnaphthalene	ug/L						<0.020	
Naphthalene	ug/L						<0.050	

TABLE 4
WATER QUALITY RESULTS - GROUNDWATER
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

NOTES:
1) Barrie Storm = Barrie Storm Sewer Use Bylaw 2012-172
2) Barrie Sanitary = Barrie Sanitary Sewer Use Bylaw 2012-172
3) PWQO = Provincial Water Quality Objectives for Use Under Part XV.1 of the Environmental Protection Act (July, 1994).
3) Yellow shading indicates parameter reportable detection limit exceeds Barrie Storm.
4) Orange shading indicates parameter reportable detection limit exceeds Barrie Sanitary.
5) Red shading indicates parameter reportable detection limit exceeds PWQO.
6)Blue shading indicates the Detection Limit for the result exceeds the Guideline Limit.

Parameters	**UNIT**	**Barrie Storm (1)**	**Barrie Sanitary (2)**	**PWQO (3)**	**BH2**	**MW19-02**	**MW19-05**	**MW19-06**
Sample Date					02-May-19	02-May-19	02-May-19	02-May-19
Phenanthrene	ug/L						<0.050	
Pyrene	ug/L						<0.050	
2-Fluorobiphenyl	%						93.5	
d14-Terphenyl	%						58.8	
Total PAHs	ug/L		5				0.22	
Semi-Volatile Organics (Water)								
Hexachlorobenzene	ug/L		0.1				<0.040	
2-Fluorobiphenyl	%						67.2	
p-Terphenyl d14	%						45.3	

TABLE 5
CLIMATE BASED WATER BUDGET SUMMARY
HYDROGEOLOGICAL INVESTIGATION
113-117 BAYFIELD STREET, BAYFIELD

Year of Climate Data Used	Total Adjusted Potential Evapotranspiration	Total Water Surplus	Total Precipitation	Soil Type	Land Use	Water Holding Capacity	Total Actual Evapotranspiration	Total Moisture Surplus used for Water Balance
	mm/yr	mm/yr	mm/yr			mm/yr	mm/yr	mm/yr
CLIMATE NORMAL 1981-2010	582.9	350.0	932.9	Silty Sand Loam	Lawns	125	549.5	383.4

NOTES:
1) Water Holding Capacity obtained from Environmental Design Criteria of the SWM Planning and Design Manual published by the MOE in 2003.

TABLE 6 WATER BALANCE SUMMARY
HYDROGEOLOGICAL INVESTIGATION
113-117 BAYFIELD STREET, BAYFIELD

Characteristics		Pre-development		Post-development (No Recharge mitigation)		Change	
		Volume (m^3/yr)	mm/yr	Volume (m^3/yr)	mm/yr	Volume (m^3/yr)	%
Input	Precipitation	3,479	933	3,479	933	0	0%
	Runon	199	53	199	53	0	0.0%
	Total In	**3,678**	**986**	**3,678**	**986**	**0**	**0.00%**
Output	Total Infiltration	144	39	209	56	65	**45%**
	Total Run-off	2,875	771	2,907	779	32	1.1%
	Evapotranspiration	659	177	563	151	-96	-14.6%
	Total Out	**3,678**	**986**	**3,678**	**986**	**0**	**0.00%**

TABLE 7
DEWATERING ESTIMATES SUMMARY
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

Part A - Estimation of Drawdown

Block	Finished 1st Floor Elevation	Assumed Base of Excavation	Assumed High Groundwater Elevation		Drawdown for Construction Dewatering	Drawdown for Long-Term Dewatering
	mASL	mASL	mASL	mBGS	mBGS	mBGS
			235.85	0.7		
Main Floor	236.35	235.85			0	0
Main Floor Footings	**233.00**	233.00			**3.85**	2.85
Minimum	233.00	233.00				
Maximum					3.85	2.85

Part B - Construction Dewatering

Block	Anticipated Rate (L/D)		Conservative Rate (L/D)		Precipitation Contribution (L/D)
	Calculated Value	Maximum ZOI (m)	Calculated Value	Maximum ZOI (m)	
Main Floor Footings	22,763	6	129,542	17	120,000
Floor Seepage	1,037		7,258		
Total	23800		136800		120000
Rounded Total	**23,800**	**6**	**136,800**	**17**	**120,000**

Part C - Long-Term Dewatering

Block	Anticipated Rate (L/D)		Conservative Rate (L/D)		Precipitation Contribution (L/D)
	Calculated Value	Maximum ZOI (m)	Calculated Value	Maximum ZOI (m)	
Underground Garage	13,785	5	17,680	12	120,000
Total	13785		17680		120000
Rounded Total	**13,800**	**5**	**17,700**	**12**	**120,000**

FIGURES

126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

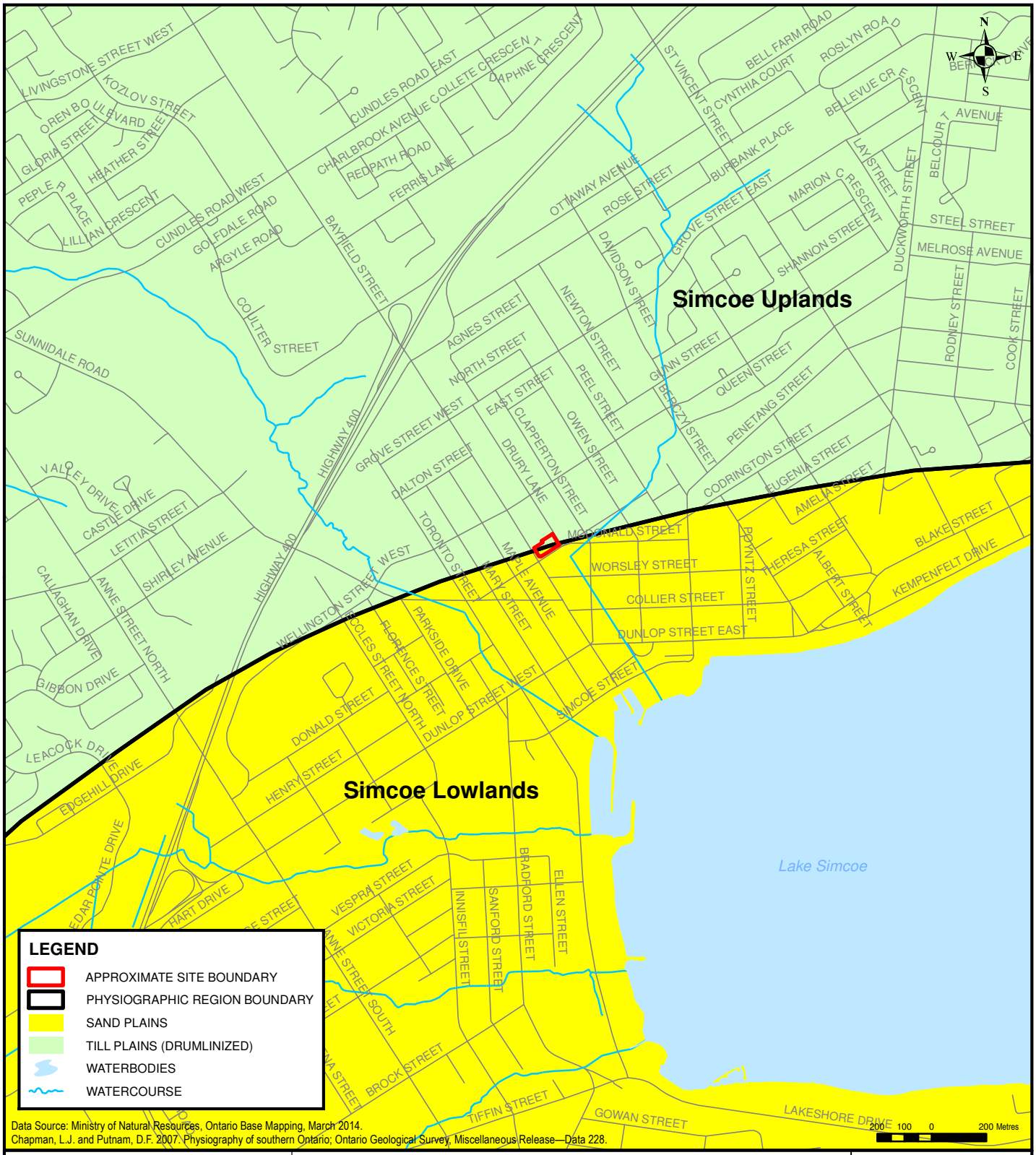
PROJECT: HYDROGEOLOGICAL STUDY 113-117 BAYFIELD STREET BARRIE, ONTARIO	SCALE: 1:20,000
	DRAWN BY: TP / CHECKED BY: LL
TITLE: SITE LOCATION MAP	PROJECT NO: 191-04694-00 200
	DATE: MARCH 2021
CLIENT: CORAL SOPHIA HOUSING INC.	FIGURE NO: 1 / REV.: -

Document Path: T:\191-04694-00\MXD\191-04694-00 200 Figure 1 Location Map.mxd

wsp
126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

PROJECT:	HYDROGEOLOGICAL STUDY 113-117 BAYFIELD STREET BARRIE, ONTARIO
TITLE:	EXISTING CONDITIONS
CLIENT:	CORAL SOPHIA HOUSING INC.
SCALE:	1:600
DRAWN BY:	TP
CHECKED BY:	LL
PROJECT NO:	191-04694-00 200
DATE:	MARCH 2021
FIGURE NO:	2
REV.:	-

Document Path: T:\191-04694-00\MXD\191-04694-00 200 Figure 2 Existing Conditions.mxd



126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

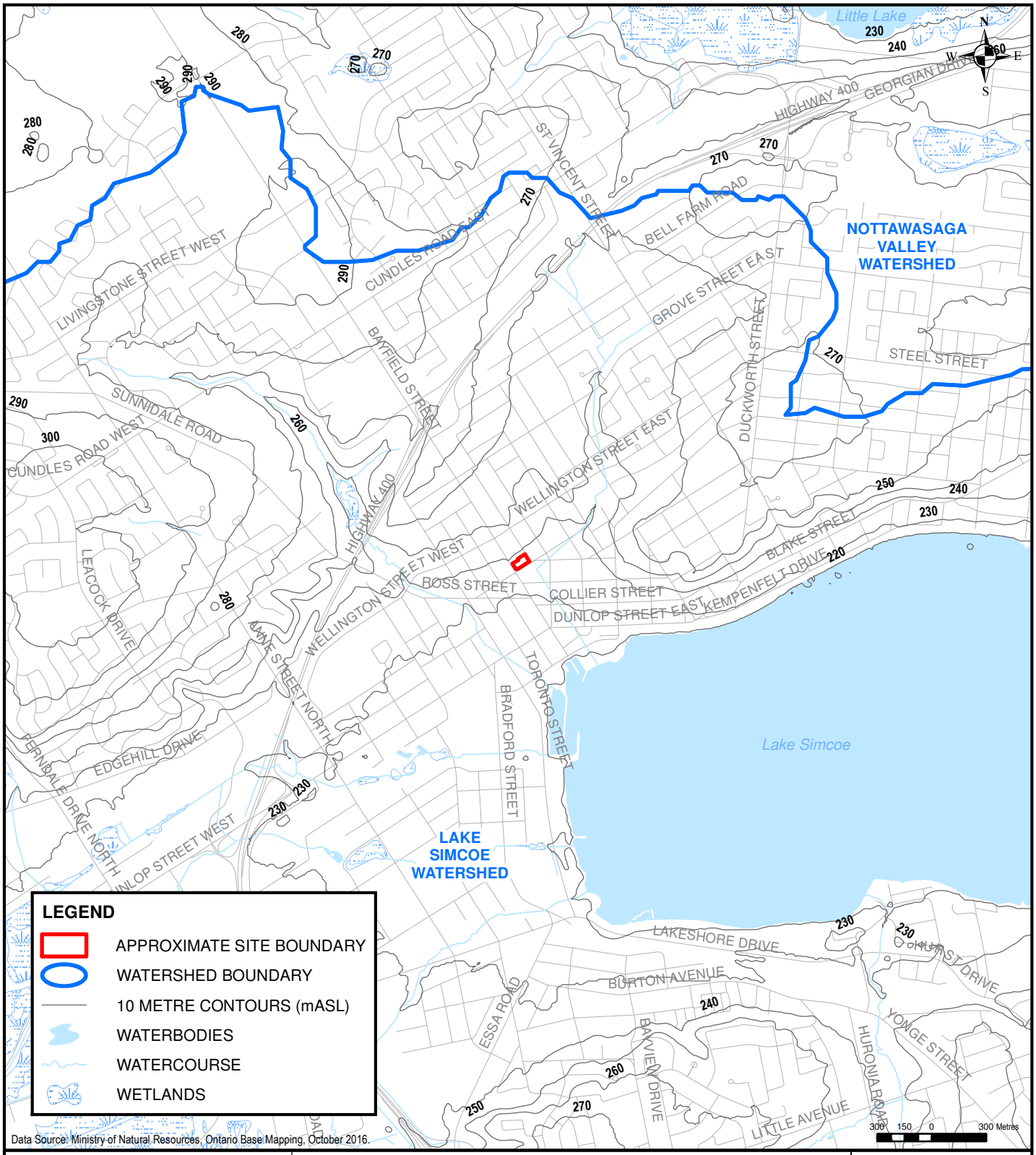
PROJECT:
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

TITLE:
REGIONAL PHYSIOGRAPHY

CLIENT:
CORAL SOPHIA HOUSING INC.

SCALE: 1:20,000
DRAWN BY: TP
CHECKED BY: LL
PROJECT NO: 191-04694-00 200
DATE: MARCH 2021
FIGURE NO: 3
REV.: -

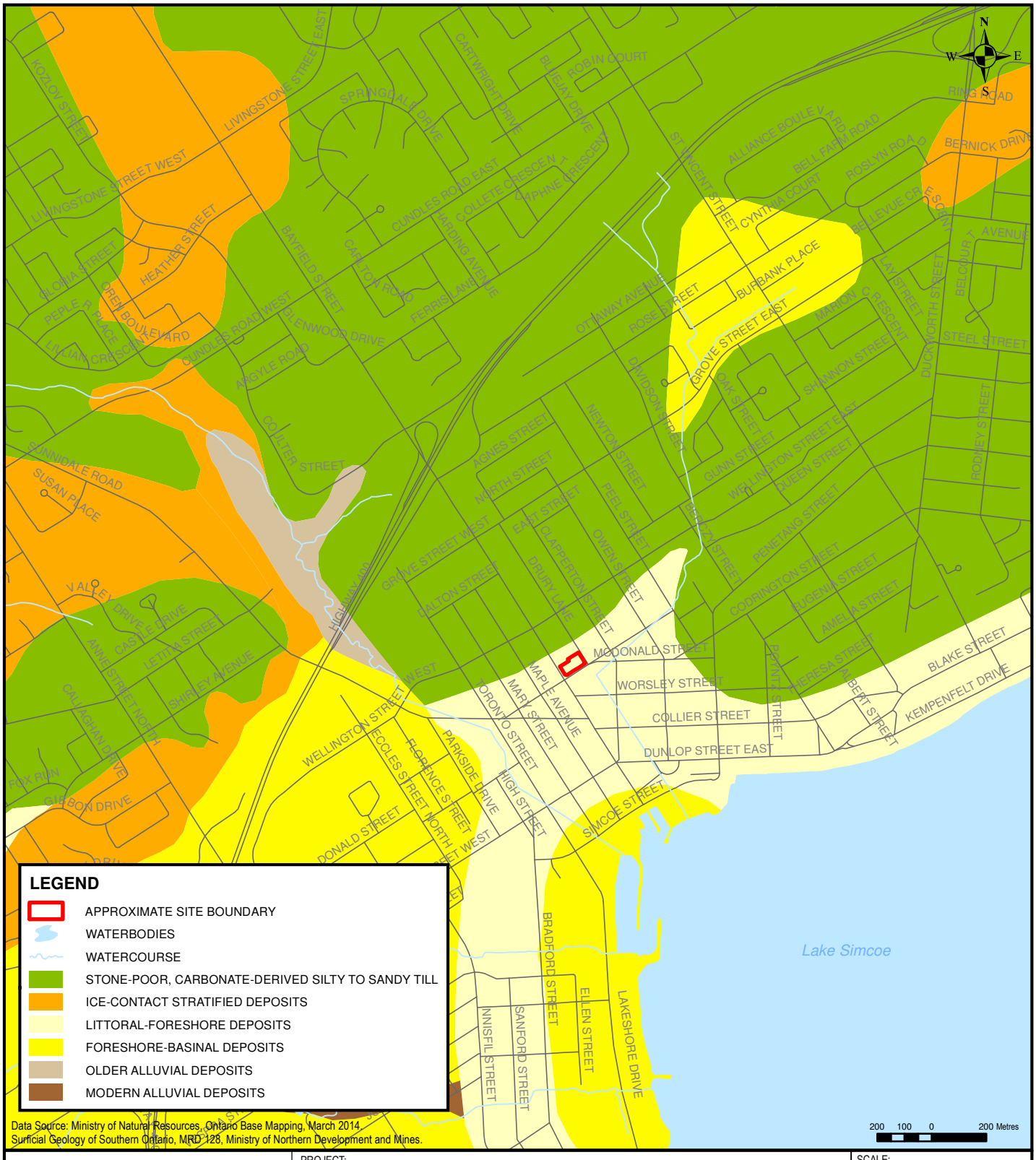
Document Path: T:\191-04694-00\MXD\191-04694-00 200 Figure 3 Physiography.mxd



126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

PROJECT: HYDROGEOLOGICAL STUDY 113-117 BAYFIELD STREET BARRIE, ONTARIO	SCALE: 1:30,000
	DRAWN BY: TP / CHECKED BY: LL
TITLE: REGIONAL TOPOGRAPHY AND DRAINAGE	PROJECT NO: 191-04694-00 200
	DATE: MARCH 2021
CLIENT: CORAL SOPHIA HOUSING INC.	FIGURE NO: 4 / REV.: -

Document Path: T:\191-04694-00\MXD\191-04694-00 200 Figure 4 Drainage.mxd



Data Source: Ministry of Natural Resources, Ontario Base Mapping, March 2014.
Surficial Geology of Southern Ontario, MRD 128, Ministry of Northern Development and Mines.

126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

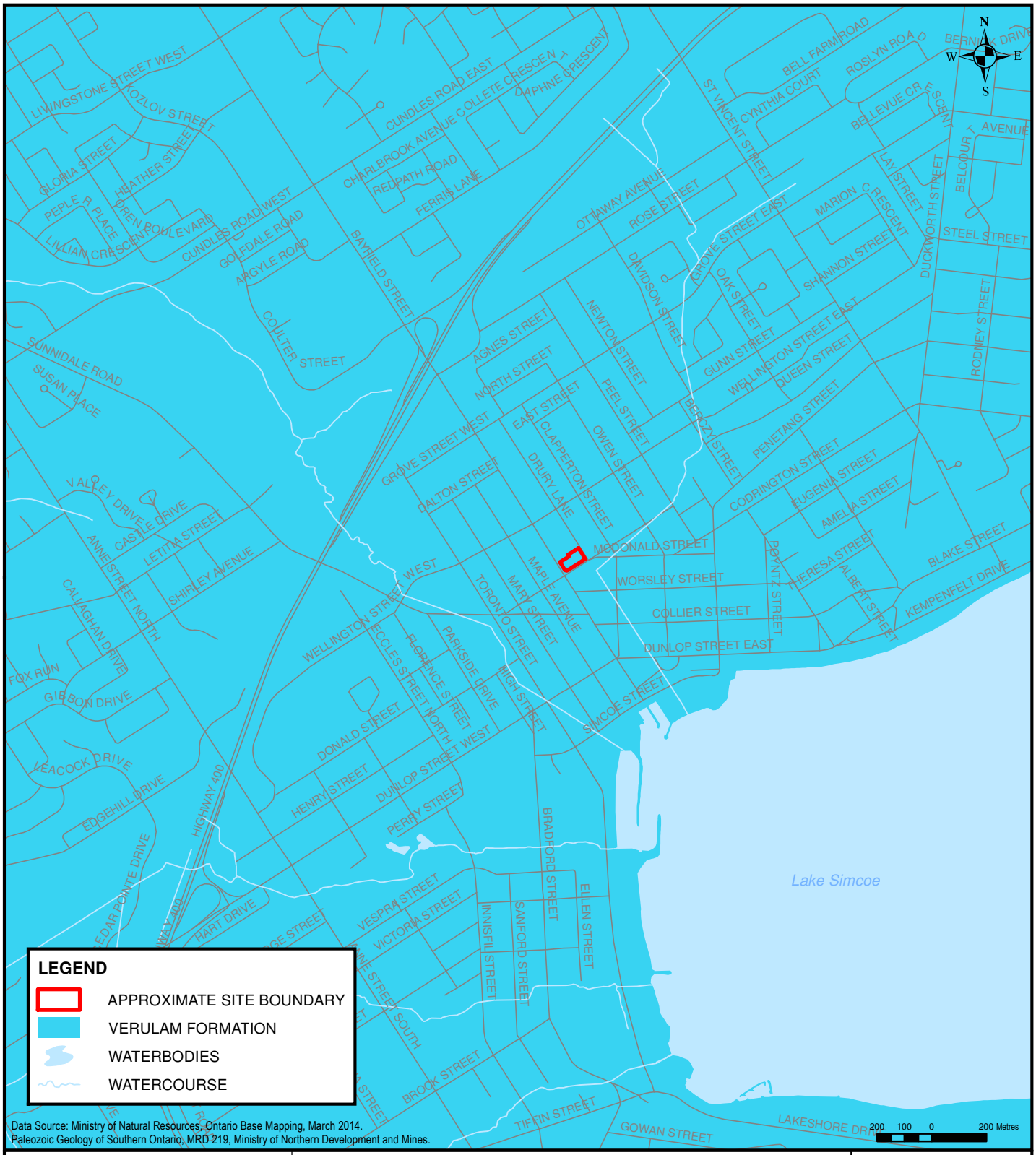
PROJECT:
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

TITLE:
SURFICIAL GEOLOGY

CLIENT:
CORAL SOPHIA HOUSING INC.

SCALE: 1:20,000
DRAWN BY: TP
CHECKED BY: LL
PROJECT NO: 191-04694-00 200
DATE: MARCH 2021
FIGURE NO: 5
REV.: -

Document Path: T:\191-04694-00\MXD\191-04694-00 200 Figure 5 Surficial Geology.mxd



126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

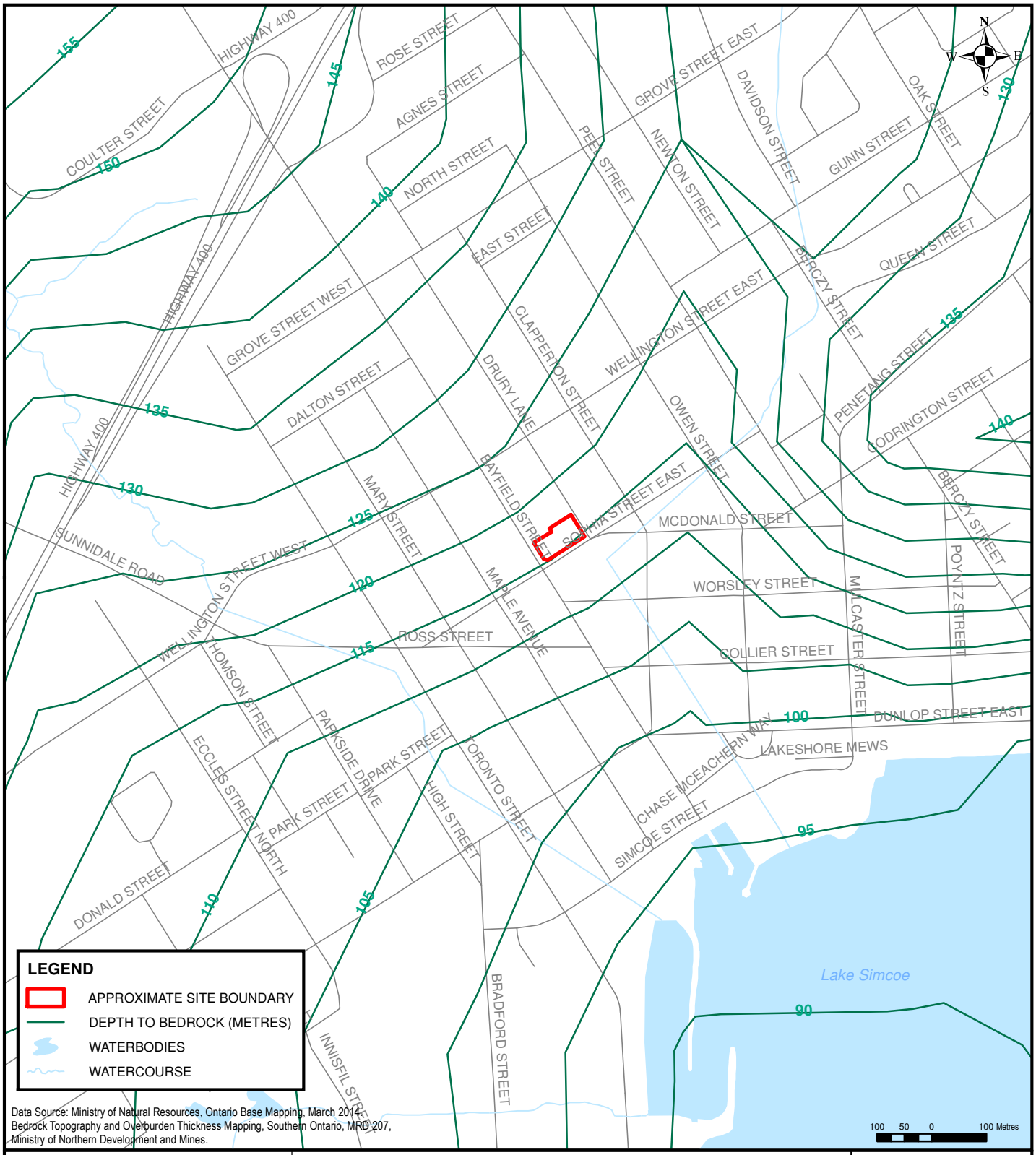
PROJECT:
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

TITLE:
BEDROCK GEOLOGY

CLIENT:
CORAL SOPHIA HOUSING INC.

SCALE:	1:20,000
DRAWN BY:	TP
CHECKED BY:	LL
PROJECT NO:	191-04694-00 200
DATE:	MARCH 2021
FIGURE NO:	6
REV.:	-

Document Path: T:\191-04694-00\MXD\191-04694-00 200 Figure 6 Bedrock Geology.mxd

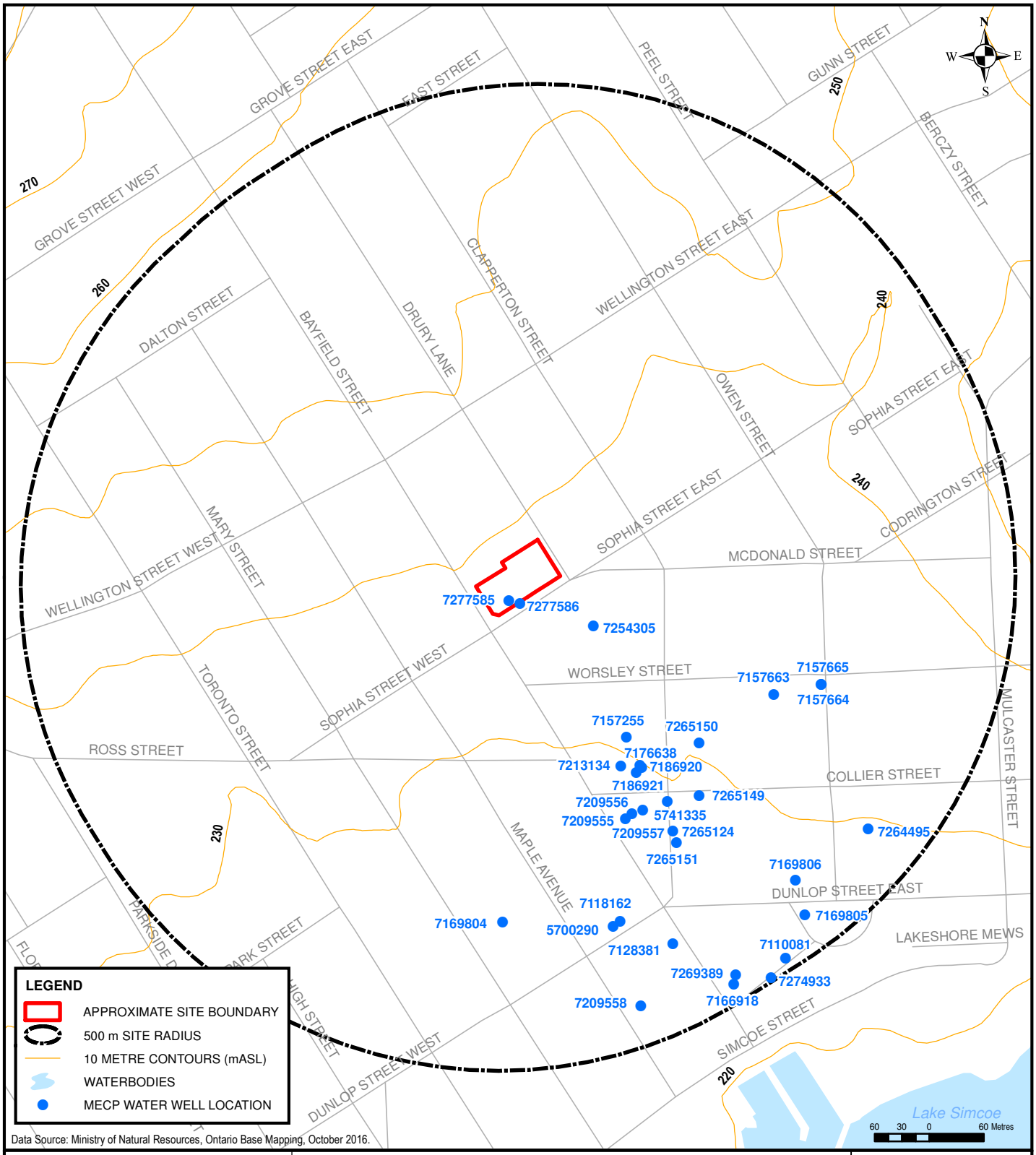


Data Source: Ministry of Natural Resources, Ontario Base Mapping, March 2014.
Bedrock Topography and Overburden Thickness Mapping, Southern Ontario, MRD 207, Ministry of Northern Development and Mines.

126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

PROJECT: HYDROGEOLOGICAL STUDY 113-117 BAYFIELD STREET BARRIE, ONTARIO	SCALE: 1:10,000
	DRAWN BY: TP / CHECKED BY: LL
TITLE: OVERBURDEN THICKNESS	PROJECT NO: 191-04694-00 200
	DATE: MARCH 2021
CLIENT: CORAL SOPHIA HOUSING INC.	FIGURE NO: 7 / REV.: -

Document Path: T:\191-04694-00\MXD\191-04694-00 200 Figure 7 Overburden Thickness.mxd



Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2016.

126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

PROJECT:
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

TITLE:
MECP WATER WELLS

CLIENT:
CORAL SOPHIA HOUSING INC.

SCALE:	1:6,000
DRAWN BY:	TP
CHECKED BY:	LL
PROJECT NO:	191-04694-00 200
DATE:	MARCH 2021
FIGURE NO:	8
REV.:	-

Document Path: T:\191-04694-00\MXD\191-04694-00 200 Figure 8 MECP Wells.mxd

wsp

126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

LEGEND

- APPROXIMATE SITE BOUNDARY
- BOREHOLE LOCATION
- MONITORING WELL LOCATION

N
W E
S

10 5 0 10 Metres

Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2016.

CLIENT:

CORAL SOPHIA HOUSING INC.

PROJECT:

HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

PROJECT NO:	DATE:
191-04694-00	MARCH 2021

DESIGNED BY: -

DRAWN BY: T.P.

CHECKED BY: LL

FIGURE NO:	SCALE:
9	1:400

TITLE:

BOREHOLE LOCATIONS

DISCIPLINE:

ENVIRONMENT

ISSUE:	REV.:
	-

Document Path: T:\191-04694-00\MXD\191-04694-00 200 Figure 9 BH Locations.mxd

wsp

126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

LEGEND

- APPROXIMATE SITE BOUNDARY
- BOREHOLE LOCATION
- MONITORING WELL LOCATION
- 234.83 GROUNDWATER ELEVATION (MAY 15, 2019)
- GROUNDWATER CONTOURS (mASL)
- INFERRED GROUNDWATER FLOW DIRECTION

N W E S

10 5 0 10 Metres

Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2016.

CLIENT:

CORAL SOPHIA HOUSING INC.

PROJECT:

HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

PROJECT NO:	DATE:
191-04694-00	MAY 2020

DESIGNED BY: -

DRAWN BY: T.P.

CHECKED BY: LL

FIGURE NO:	SCALE:
10	1:400

TITLE:

GROUNDWATER ELEVATIONS

DISCIPLINE:

ENVIRONMENT

ISSUE:	REV.:
	-

Document Path: T:\191-04694-00\MXD\191-04694-00 200 Figure 10 GW Elevations.mxd

wsp

126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

LEGEND

- APPROXIMATE SITE BOUNDARY
- BOREHOLE LOCATION
- MONITORING WELL LOCATION
- 234.83 GROUNDWATER ELEVATION
- GROUNDWATER CONTOURS (mASL)
- INFERRED GROUNDWATER FLOW DIRECTION

N
W E
S

10 5 0 10 Metres

Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2016.

CLIENT:

CORAL SOPHIA HOUSING INC.

PROJECT:

HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

PROJECT NO:	DATE:
191-04694-00	MARCH 2021

DESIGNED BY: -

DRAWN BY: T.P.

CHECKED BY: LL

FIGURE NO:	SCALE:
10	1:400

TITLE:

GROUNDWATER ELEVATIONS

DISCIPLINE:

ENVIRONMENT

ISSUE:	REV.:
	-

Document Path: C:\aProjects\191-04964-00\MXD\191-04694-00 200 Figure 10 GW ElevationsV2.mxd

wsp

126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

LEGEND

- APPROXIMATE SITE BOUNDARY
- CATCHBASIN
- PRE DEVELOPMENT CATCHMENTS
- BUILDINGS
- CONCRETE
- LAWNS
- PAVEMENT
- PRE DEVELOPMENT FLOW DIRECTION

N W E S

10 0 0 10 Metres

Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2016.

CLIENT:

CORAL SOPHIA HOUSING INC.

PROJECT:

HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

PROJECT NO:	DATE:
191-04694-00 200	MARCH 2021

DESIGNED BY: -

DRAWN BY: T.P.

CHECKED BY: LL

FIGURE NO:	SCALE:
12	1:400

TITLE:

PRE DEVELOPMENT
SITE CATCHMENT AREAS

DISCIPLINE: ENVIRONMENT

ISSUE:	REV.:
-	-

Document Path: C:\aProjects\191-04964-00\MXD\191-04694-00 200 Figure 11 Pre Development Catchments.mxd

wsp

126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

LEGEND

- POST DEVELOPMENT CATCHMENTS
- BUILDINGS
- CONCRETE
- LAWNS
- PAVEMENT
- APPROXIMATE SITE BOUNDARY
- POST DEVELOPMENT FLOW DIRECTION
- CATCHBASIN

N W E S

10 5 0 10 Metres

Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2016.

CLIENT:
CORAL SOPHIA HOUSING INC.

PROJECT:
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

PROJECT NO:	DATE:
191-04694-00 200	MARCH 2021

DESIGNED BY: -

DRAWN BY: T.P.

CHECKED BY: LL

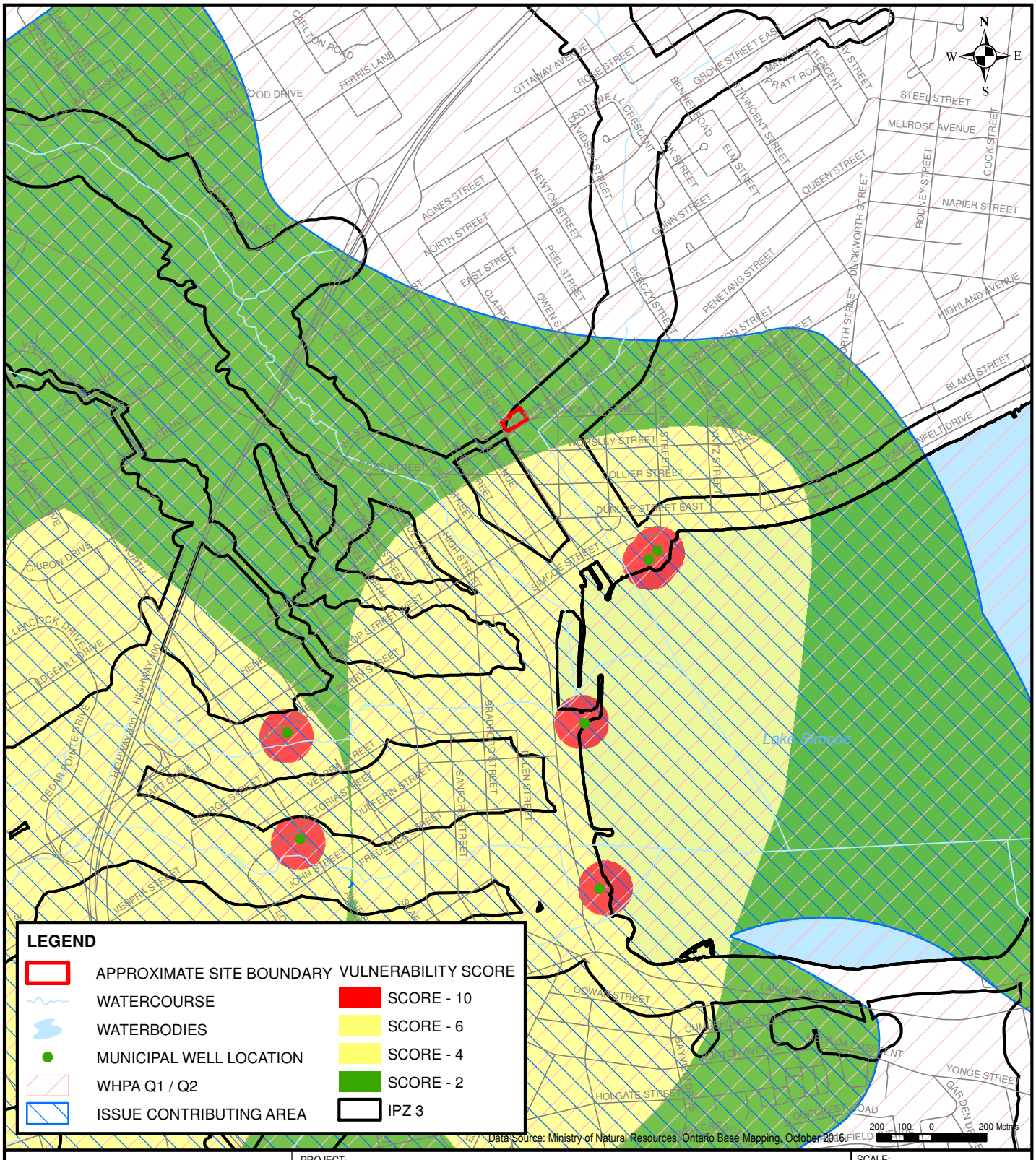
FIGURE NO:	SCALE:
13	1:400

TITLE:
POST DEVELOPMENT
SITE CATCHMENT AREAS

DISCIPLINE:
ENVIRONMENT

ISSUE:	REV.:
-	-

Document Path: C:\aProjects\191-04964-00\MXD\191-04694-00 200 Figure 12 Post Development Catchments.mxd



126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

PROJECT:
HYDROGEOLOGICAL STUDY
113-117 BAYFIELD STREET
BARRIE, ONTARIO

TITLE:
WELLHEAD PROTECTION AREAS

CLIENT:
CORAL SOPHIA HOUSING INC.

SCALE: 1:20,000

DRAWN BY: TP

CHECKED BY: LL

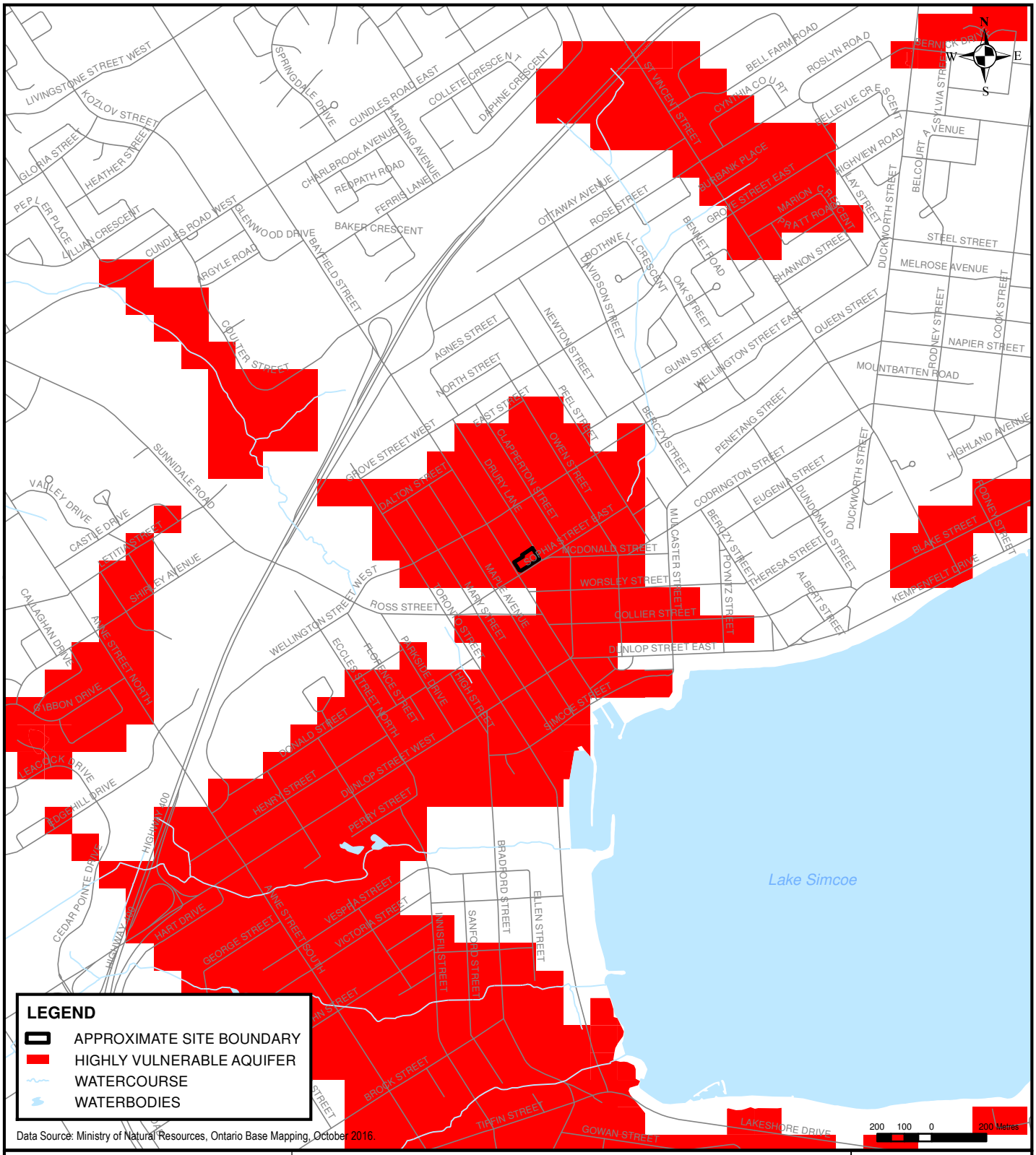
PROJECT NO: 191-04694-00 200

DATE: MARCH 2021

FIGURE NO: 14

REV.: -

Document Path: T:\191-04694-00\MXD\191-04694-00 200 Figure 13 WHPA.mxd



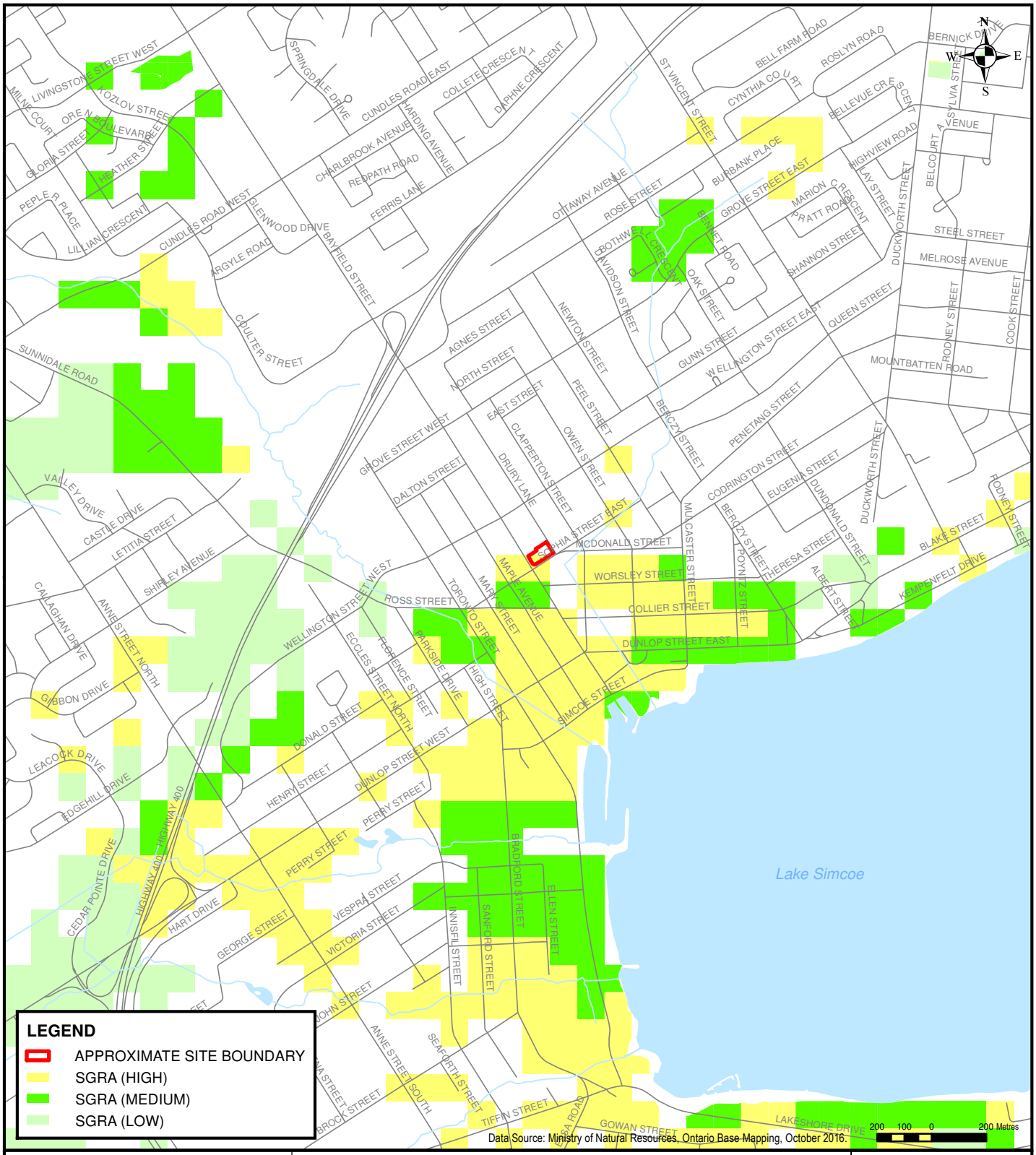
Data Source: Ministry of Natural Resources, Ontario Base Mapping, October 2016.

wsp

126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

PROJECT: HYDROGEOLOGICAL STUDY 113-117 BAYFIELD STREET BARRIE, ONTARIO	SCALE: 1:20,000
	DRAWN BY: TP / CHECKED BY: LL
TITLE: HIGHLY VULNERABLE AQUIFERS	PROJECT NO: 191-04694-00 200
	DATE: MARCH 2021
CLIENT: CORAL SOPHIA HOUSING INC.	FIGURE NO: 15 / REV.: -

Document Path: T:\191-04694-00\MXD\191-04694-00 200 Figure 14 HVA.mxd



126 DON HILLOCK DRIVE, UNIT 2
AURORA, ONTARIO CANADA L4G 0G9
TEL.: 905-750-3080 | FAX: 905-727-0463 | WWW.WSP.COM

PROJECT: HYDROGEOLOGICAL STUDY 113-117 BAYFIELD STREET BARRIE, ONTARIO	SCALE: 1:20,000
	DRAWN BY: TP / CHECKED BY: LL
TITLE: SIGNIFICANT GROUNDWATER RECHARGE AREAS	PROJECT NO: 191-04694-00 200
	DATE: MARCH 2021
CLIENT: CORAL SOPHIA HOUSING INC.	FIGURE NO: 16 / REV.: -

APPENDIX

A MECP WATER WELL RECORDS

TABLE A-1 MECP WATER WELL RECORDS
HYDROGEOLOGICAL STUDY
113-117 Bayfield Street, Barrie, ON

Well ID	X	Y	Elevation (m)	Well Depth (m)	Construction Method	Water Level (m)	Water Yield	Units of Measurement	Water Use	Water Status	Formation Depth (m)	Material Colour	Material 1	Material 2	Material 3
5700290	604270.4	4915921	225.70	39.6	Cable Tool	39.6	10	GPM	Cooling And A/C	Water Supply	5.49		CLAY	BOULDERS	
											7.92		BOULDERS	CLAY	
											35.97		GRAVEL	CLAY	
											39.62		COARSE SAND		
5741335	604330	4916058	229.30	13.1	Boring	11.5				Observation Wells	0.15	BLACK			
											1.50	BROWN	SAND	GRAVEL	
											6.10	BROWN	SAND	SILT	GRAVEL
											11.60	GREY	SILT	CLAY	GRAVEL
											13.10	GREY	SAND	SILT	GRAVEL
7110081	604460	4915886	223.01	5.3	Boring				Monitoring	Observation Wells	3.81	BROWN	SAND	GRAVEL	
											5.33	BROWN	SAND	SILT	WATER-BEARING
7118162	604278	4915927	225.79	7.6	Rotary (Convent.)				Other	Observation Wells	7.62	BROWN	SAND	CLAY	HARD
7128381	604336	4915902	225.00	8.0	Rotary (Convent.)				Other		3.00	BROWN	FILL		PACKED
											8.00	BROWN	SAND		DENSE
7157255	604285	4916129	230.57	12.8	Boring	10.7			Monitoring	Test Hole	7.60	BROWN	SAND	GRAVEL	LOOSE
											9.80	BROWN	SAND	SILT	SOFT
											12.80	GREY	SAND	SILT	SOFT
7157663	604447	4916176	233.50	7.0	DIRECT PUSH				Monitoring and Test Hole	Monitoring and Test Hole	2.44	BROWN	FILL	ROCK	SAND
											4.88	BROWN	SAND	ROCK	
											5.49	BROWN	GRAVEL		DENSE
											7.01	GREY	SAND		SOFT
7157664	604499	4916187	233.81	8.8	DIRECT PUSH				Monitoring and Test Hole	Monitoring and Test Hole	1.22	BROWN	TOPSOIL		LOOSE
											4.88	BROWN	SAND	ROCK	SOFT
											6.10	BROWN	SAND		
											8.84	BROWN	SAND	ROCK	DENSE
7157665	604499	4916187	233.81	8.5	DIRECT PUSH				Monitoring and Test Hole	Monitoring and Test Hole	1.52	BROWN	TOPSOIL	ROCK	LOOSE
											4.88	BROWN	SAND		SOFT
											6.10	BROWN	SAND	ROCK	
											8.53	BROWN	SAND		DENSE
7166918	604403	4915858	223.15	6.1	Rotary (Convent.)				Test Hole	Test Hole	1.52	BROWN	FILL		
											6.10	BROWN	SAND		WATER-BEARING
7169804	604149	4915926	226.49		Direct Push				Monitoring						
7169805	604481	4915934	224.55		Direct Push				Monitoring						
7169806	604471	4915972	225.73		Direct Push				Monitoring						
7176638	604296	4916090	229.62												
7186920	604302	4916096	229.87	12.8	Boring	11.0			Monitoring	Observation Wells	2.40	BROWN	SAND	GRAVEL	LOOSE
											5.10	BROWN	SAND	GRAVEL	STONES
											6.30	BROWN	SAND	SAND	DENSE
											12.80	GREY	SILT	SAND	SOFT
7186921	604300	4916098	229.89		Boring				Monitoring	Abandoned-Supply					
7209555	604284	4916039	228.25	7.6	Direct Push				Monitoring and Test Hole	Monitoring and Test Hole	0.15	BLACK			
											5.18	BROWN	SAND	SILT	LOOSE
											7.62	GREY	SILT	SAND	LOOSE
7209556	604291	4916045	228.43	7.6	Direct Push				Monitoring and Test Hole	Monitoring and Test Hole	0.15	BLACK			
											5.18	BROWN	SAND	SILT	LOOSE
											7.62	GREY	SILT	SAND	LOOSE

TABLE A-1 MECP WATER WELL RECORDS
HYDROGEOLOGICAL STUDY
113-117 Bayfield Street, Barrie, ON

Well ID	X	Y	Elevation (m)	Well Depth (m)	Construction Method	Water Level (m)	Water Yield	Units of Measurement	Water Use	Water Status	Formation Depth (m)	Material Colour	Material 1	Material 2	Material 3
7209557	604303	4916049	228.65	7.6	Direct Push				Monitoring and Test Hole	Monitoring and Test Hole	0.15	BLACK			
											5.18	BROWN	SAND	SILT	LOOSE
											7.62	GREY	SILT	SAND	LOOSE
7209558	604301	4915834	223.25	7.6	Direct Push				Monitoring and Test Hole	Monitoring and Test Hole	0.08	BLACK			
											0.61	BROWN	FILL		
											5.18	BROWN	SAND		
											7.62	GREY	SILT	SAND	
7213134	604279	4916097	229.55	10.7	Rotary (Convent.)	6.1			Monitoring	Observation Wells	3.05	BROWN	GRAVEL	SAND	LOOSE
											10.67	GREY	SILT	SAND	DENSE
7254305	604249	4916251	233.45	15.2	Boring				Monitoring	Observation Wells	1.22	BROWN	SAND	GRAVEL	LOOSE
											8.53	BROWN	SAND	SILT	LOOSE
											15.24	BROWN	SAND	SILT	LOOSE
7264495	604551	4916028	229.20	10.7	Rotary (Convent.)	6.1			Monitoring	Observation Wells	3.05	BROWN	FILL		LOOSE
											10.67	BROWN	SAND		LOOSE
7265124	604336	4916026	228.40	12.2	Boring				Monitoring	Observation Wells	4.50		SAND	GRAVEL	FILL
											12.20		SILT	SAND	
7265149	604365	4916065	229.62	12.2	Boring				Monitoring	Observation Wells	4.50		SAND	GRAVEL	FILL
											12.20		SILT	SAND	
7265150	604365	4916123	231.14	12.2	Boring				Monitoring	Observation Wells	4.50		SAND	GRAVEL	FILL
											12.20		SILT	SAND	
7265151	604340	4916013	228.04	10.7	Boring				Monitoring	Observation Wells	4.50		SAND	GRAVEL	FILL
											10.70		SILT	SAND	
7269389	604405	4915868	223.36												
7274933	604444	4915865	222.77												
7277585	604156	4916279	236.54	7.6	Boring	3.0			Test Hole	Test Hole	7.62		SAND	SILT	
7277586	604168	4916276	236.26		Boring				Test Hole	Test Hole	7.62		SAND	SILT	

APPENDIX

B

GEOTECHNICAL BOREHOLE LOGS AND PARTICLE SIZE DISTRIBUTION CURVES

LOG OF BOREHOLE BH19-01

PROJECT: 113 - 117 Bayfield Street

CLIENT: Coral Sophia Housing Inc.

PROJECT LOCATION: 113 - 117 Bayfield Street, Barrie, ON

DATUM: Relative

BH LOCATION: N 4916268 E 604145

Method: Hollow Stem Auger

Diameter: 203 mm

Date: Apr-25-2019

REF. NO.: 191-04694-00

ENCL NO.: 1

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
236.2	Ground Surface							
0.0 / 236.0	**TOPSOIL:** trace gravel, black, moist							
0.2	**SAND to SILTY SAND FILL:** trace gravel, black and brown, moist, very loose to compact		1	SS	21		236	
			2	SS	4		235	9 68 (23)
			3	SS	3			
233.2			4	SS	10		234	
3.0	**SILTY SAND TILL to SANDY SILT TILL:** trace gravel, some clay, brown to gray, moist, dense to very dense		5	SS	49		233	
			6	SS	95		232	
230.3							231	
5.9	**SANDY CLAYEY SILT TILL:** trace gravel, gray, moist, hard		7	SS	91		230	
			8	SS	74		229	
			9	SS	114		228	
226.5							227	
9.8	**END OF BOREHOLE** Notes: 1) Water level 9.1mbgs upon completion							

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%) 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE MW19-02

PROJECT: 113 - 117 Bayfield Street

CLIENT: Coral Sophia Housing Inc.

PROJECT LOCATION: 113 - 117 Bayfield Street, Barrie, ON

DATUM: Relative

BH LOCATION: N 4916293 E 604146

Method: Hollow Stem Auger

Diameter: 203 mm

Date: Apr-24-2019

REF. NO.: 191-04694-00

ENCL NO.: 2

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	BLOWS "N" 0.3 m	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
236.1	Ground Surface					
236.0	**ASPHALT**- 13 cm				236	
0.1	**SAND to SANDY SILT FILL:** trace to some gravel, brown, moist to wet, loose	1	SS	10	Cement	
		2	SS	9	235	
		3	SS	10	W. L. 234.8 m May 15, 2019 W. L. 234.0 m Jun 25, 2019 Feb 05, 2019	
233.9					234	
2.2	**SILTY SAND TILL:** trace to some gravel, brown and gray, moist to wet, compact to very dense	4	SS	18	Holeplug	
		5	SS	36	233	
					W. L. 232.2 m Apr 24, 2019	
		6	SS	59	231	
		7	SS	64	230	2 49 35 14
					229 Sand	
228.6					Screen	
7.5	**SANDY CLAYEY SILT TILL:** gray, moist, hard	8	SS	75	228	
		9	SS	38	227	
226.3						
9.8	**END OF BOREHOLE**					

Notes:
1) 50mm dia. monitoring well installed upon completion, screened 6.1 to 9.1 mbgs.
2) Water Level Readings:
Shallow well

Date	W. L. Depth (mBGL)
April 24, 2019	3.9
May 2, 2019	1.6
May 15, 2019	1.2
June 25, 2019	1.5
Sept 13, 2019	2.0

SOIL PROFILE | SAMPLES | GROUND WATER CONDITIONS | STRATA PLOT

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) (10 20 30)

POCKET PEN. (Cu) (kPa) | NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

LOG OF BOREHOLE BH19-03

PROJECT: 113 - 117 Bayfield Street

CLIENT: Coral Sophia Housing Inc.

PROJECT LOCATION: 113 - 117 Bayfield Street, Barrie, ON

DATUM: Relative

BH LOCATION: N 4916282 E 604168

Method: Hollow Stem Auger

Diameter: 203 mm

Date: Apr-25-2019

REF. NO.: 191-04694-00

ENCL NO.: 3

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
235.8	Ground Surface											
235.7 0.0	**ASPHALT** - 10 cm											
0.1	**SAND to SILTY SAND FILL:** trace gravel, trace clay, dark brown, moist, compact to loose		1	SS	24							
			2	SS	5		235					
233.6			3	SS	5		234					1 54 33 12
2.2	**SILTY SAND TILL:** brown, moist, compact		4	SS	24							
			5	SS	31		233					
231.5							232					
4.3	**SANDY CLAYEY SILT TILL:** gray, moist, hard		6	SS	41		231					
230.6												
5.2	**END OF BOREHOLE** Notes: 1) Water level 3.3mbgs upon completion											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

LOG OF BOREHOLE BH19-04

PROJECT: 113 - 117 Bayfield Street

CLIENT: Coral Sophia Housing Inc.

PROJECT LOCATION: 113 - 117 Bayfield Street, Barrie, ON

DATUM: Relative

BH LOCATION: N 4916307 E 604168

Method: Hollow Stem Auger

Diameter: 203 mm

Date: Apr-24-2019

REF. NO.: 191-04694-00

ENCL NO.: 4

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
235.9	Ground Surface											
0.0	**SILTY SAND FILL:** trace gravel, brown, moist, loose		1	SS	9				○			
235.2												
0.7	**SILTY CLAY FILL:** trace gravel, brown, moist, firm		2	SS	7		235		○			
1												
234.4												
1.5	**SANDY SILT FILL:** trace gravel, some clay to clayey, brown, moist, loose		3	SS	6		234		○			4 27 47 22
2												
233.7												
2.2	**SANDY SILT to SILTY SAND:** trace to some clay, brown, moist, dense		4	SS	36				○			
232.9							233					
3.0	**SANDY CLAYEY SILT TILL:** brown to gray, moist, hard		5	SS	31				○			
4							232					
5			6	SS	24		231		○			
230.7												
5.2	**END OF BOREHOLE** Notes: 1) Water level 4.3mbgs upon completion											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

LOG OF BOREHOLE MW19-05

PROJECT: 113 - 117 Bayfield Street
CLIENT: Coral Sophia Housing Inc.
PROJECT LOCATION: 113 - 117 Bayfield Street, Barrie, ON
DATUM: Relative
BH LOCATION: N 4916295 E 604189

Method: Hollow Stem Auger
Diameter: 203 mm
Date: Apr-24-2019

REF. NO.: 191-04694-00
ENCL NO.: 5

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
235.7	Ground Surface											
~~235.6~~ 0.1	**TOPSOIL:** black, moist		1	SS	12		Cement					
	SAND to SANDY SILT FILL: trace gravel, trace to some clay, compact to loose		2	SS	3		235					
233.5			3	SS	4	▽	234 W. L. 233.8 m Apr 24, 2019					
2.2	**SANDY SILT:** brown, moist, dense		4	SS	32		233 Holeplug					
232.7												
3.0	**SILTY CLAYEY SAND TILL:** trace to some gravel, brown to gray, moist, very dense		5	SS	80	▽ ▽	W. L. 232.3 m May 15, 2019 Jun 25, 2019					
			6	SS	78		231					1 51 24 24
			7	SS	81		230					
							229 Sand Screen					
			8	SS	78		227					
225.9			9	SS	50/ 280mm		226					
9.8	**END OF BOREHOLE**											

Notes:
1) 50mm dia. monitoring well installed upon completion, screened 6.1 to 9.1 mbgs.
2) Water Level Readings:
Shallow well

Date	W. L. Depth (mBGL)
April 24, 2019	1.9
May 2, 2019	3.4
May 15, 2019	3.4
June 25, 2019	3.7
Sept 13, 2019	4.2

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

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

LOG OF BOREHOLE MW19-06

PROJECT: 113 - 117 Bayfield Street
CLIENT: Coral Sophia Housing Inc.
PROJECT LOCATION: 113 - 117 Bayfield Street, Barrie, ON
DATUM: Relative
BH LOCATION: N 4916327 E 604180

Method: Hollow Stem Auger
Diameter: 203 mm
Date: Apr-25-2019

REF. NO.: 191-04694-00
ENCL NO.: 6

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
236.6	Ground Surface											
236.5	**ASPHALT**- 5 cm											
0.1	**SAND to SANDY SILT FILL:** trace gravel, tace clay, gray, moist, compact		1	SS	28		Cement					
							236					
			2	SS	15		W. L. 235.9 m W. L. 235.8 m May 15, 2019					
1 235.1							Holeplug W. L. 235.2 m Apr 25, 2019					
1.5	**CLAYEY SILT FILL:** some sand, brown, moist, firm		3	SS	7							
2 234.4												
2.2	**SANDY SILT:** brown, moist, compact		4	SS	27		234					
3			5	SS	31		233					
4 232.4												
4.2	**SANDY CLAYEY SILT TILL:** brown to gray, moist, hard						Sand Screen					
			6	SS	42							0 19 63 18
5							231					
6			7	SS	37							
229.9							230					
6.7	**END OF BOREHOLE**											

Notes:
1) 50mm dia. monitoring well installed upon completion, screened 3.1 to 6.1 mbgs.
2) Water Level Readings:
Shallow well

Date	W. L. Depth (mBGL)
April 25, 2019	1.4
May 2, 2019	0.7
May 15, 2019	0.8
June 25, 2019	1.4
Sept 13, 2019	2.8

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

APPENDIX

C IN-SITU HYDRAULIC TEST RESULTS

HYDRAULIC CONDUCTIVITY DETERMINATION
SINGLE WELL RESPONSE TESTS

Project Name:	113-117 Bayfield	**Project Number:**	191-04694-00
Test Date:	02-May-19	**Borehole Number:**	**BH2 (In screen)**
Field Personnel:	Kayla Allen	**Analysis By:**	Kay Harvey

Well Diameter (2r):	0.10	m	**Screen (Sand Pack) Length (L):**	5.98	m
Borehole Diameter (2R):	0.2	m	**Static Water Depth (H):**	1.52	m

HYDRAULIC CONDUCTIVITY:

$K = [(r^2)*\ln(L/R)]/(2*L*To)$

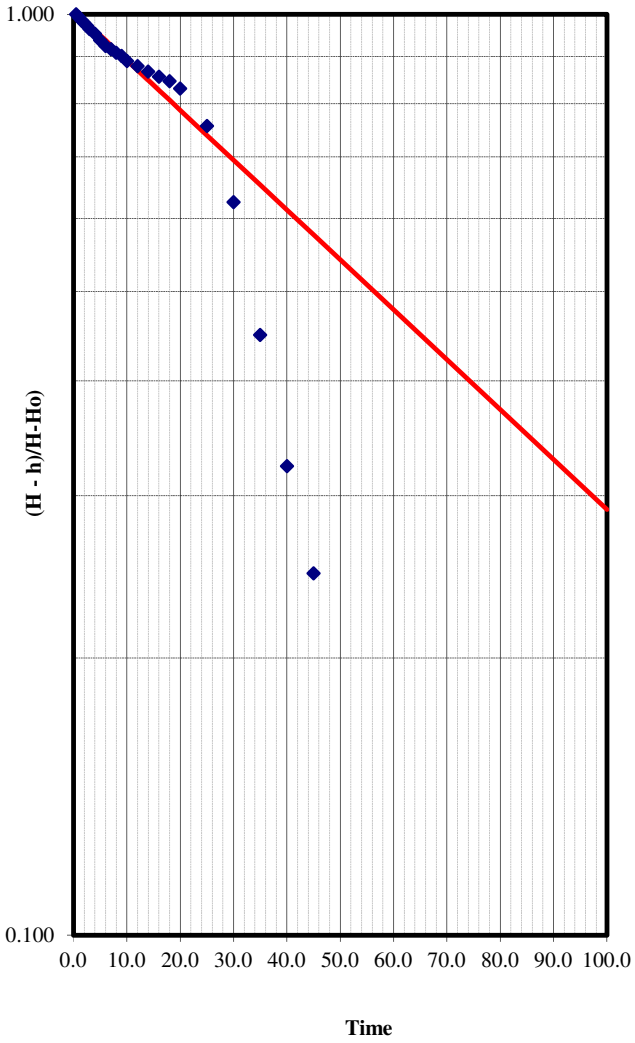
K = **1.9E-07** **m/sec** **1.9E-05** **cm/sec** **1.6E-02** **m/day**

RISING HEAD

TIME LAG (To): 80.5 min

Time (min)	Measured Water Depth (m)	H-h (m)	(H-h)/ (H-Ho)
0.5	4.15	-2.63	1.000
1.0	4.13	-2.61	0.992
1.5	4.11	-2.59	0.985
2.0	4.10	-2.575	0.979
2.5	4.08	-2.555	0.971
3.0	4.06	-2.535	0.964
4.0	4.03	-2.505	0.952
5.0	3.99	-2.465	0.937
6.0	3.95	-2.43	0.924
7.0	3.93	-2.41	0.916
8.0	3.91	-2.39	0.909
9.0	3.89	-2.37	0.901
10.0	3.86	-2.34	0.890
12.0	3.83	-2.31	0.878
14.0	3.80	-2.28	0.867
16.0	3.77	-2.25	0.856
18.0	3.75	-2.225	0.846
20.0	3.71	-2.185	0.831
25.0	3.51	-1.99	0.757
30.0	3.17	-1.645	0.625
35.0	2.70	-1.18	0.449
40.0	2.37	-0.85	0.323
45.0	2.17	-0.65	0.247
100.0	1.63	-0.11	0.042

NORMALIZED RECOVERY CURVE



HYDRAULIC CONDUCTIVITY DETERMINATION
SINGLE WELL RESPONSE TESTS

Project Name:	113-117 Bayfield	**Project Number:**	191-04694-00
Test Date:	02-May-19	**Borehole Number:**	**BH2 (Out of Screen)**
Field Personnel:	Kayla Allen	**Analysis By:**	Kay Harvey

Well Diameter (2r):	0.05	m	**Screen (Sand Pack) Length (L):**	4.5	m
Borehole Diameter (2R):	0.2	m	**Static Water Depth (H):**	1.52	m

HYDRAULIC CONDUCTIVITY:

$$K = [(r^2)*\ln(L/R)]/(2*L*To)$$

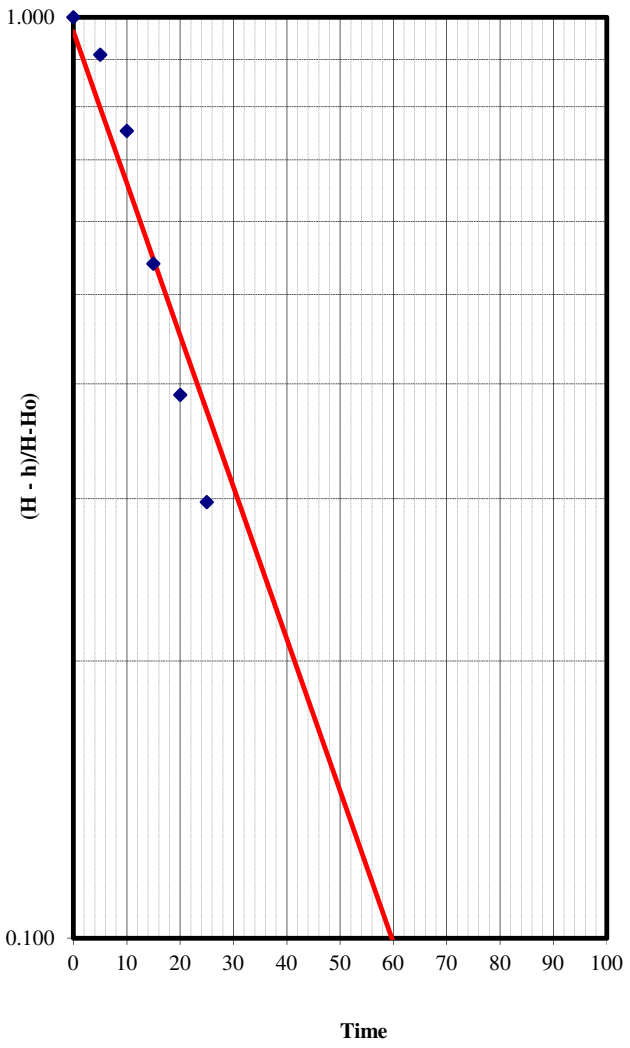
K = **1.9E-07** **m/sec** **1.9E-05** **cm/sec** **1.6E-02** **m/day**

RISING HEAD

TIME LAG (To): 25.2 min

Time (min)	Measured Water Depth (m)	H-h (m)	(H-h)/ (H-Ho)
0	3.71	-2.185	1.000
5	3.51	-1.99	0.911
10	3.17	-1.645	0.753
15	2.70	-1.18	0.540
20	2.37	-0.85	0.389
25	2.17	-0.65	0.297
80	1.63	-0.11	0.050

NORMALIZED RECOVERY CURVE



HYDRAULIC CONDUCTIVITY DETERMINATION
SINGLE WELL RESPONSE TESTS

Project Name:	113-117 Bayfield	**Project Number:**	191-04694-00
Test Date:	02-May-19	**Borehole Number:**	**MW19-02 (In screen)**
Field Personnel:	Kayla Allen	**Analysis By:**	Kay Harvey

Well Diameter (2r):	0.10	m	**Screen (Sand Pack) Length (L):**	7.31	m
Borehole Diameter (2R):	0.2	m	**Static Water Depth (H):**	2.49	m

HYDRAULIC CONDUCTIVITY:

$K = [(r^2)*\ln(L/R)]/(2*L*To)$

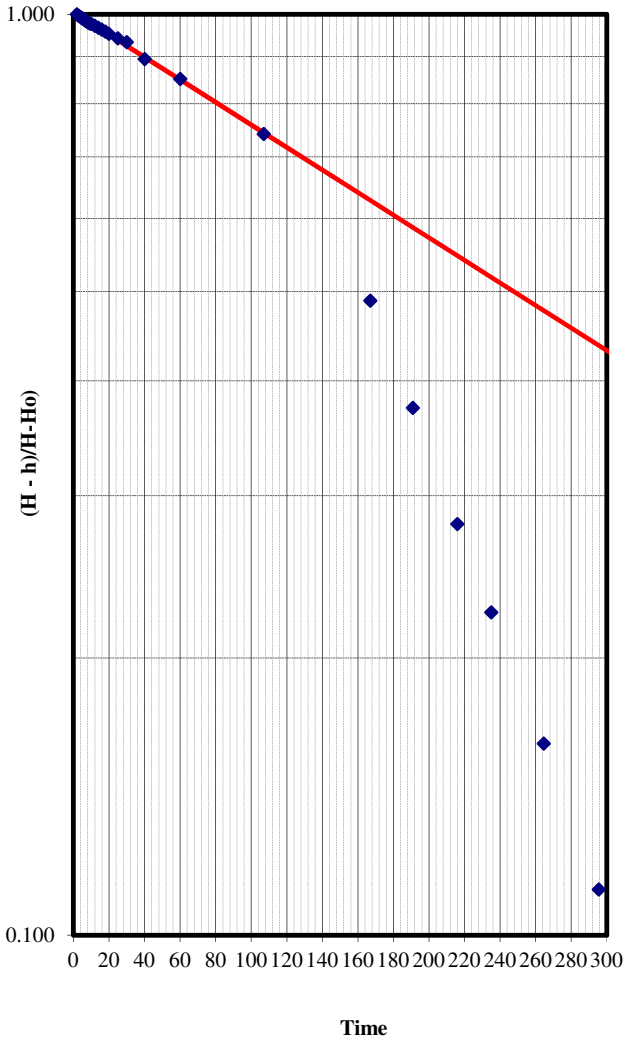
K = **3.7E-08** **m/sec** **3.7E-06** **cm/sec** **3.2E-03** **m/day**

RISING HEAD

TIME LAG (To): 354.6 min

Time (min)	Measured Water Depth (m)	H-h (m)	(H-h)/ (H-Ho)
2	9.18	-6.69	1.000
3	9.155	-6.665	0.996
4	9.135	-6.645	0.993
5	9.11	-6.62	0.990
6	9.09	-6.6	0.987
7	9.07	-6.58	0.984
8	9.05	-6.56	0.981
9	9.035	-6.545	0.978
10	9.02	-6.53	0.976
12	8.99	-6.5	0.972
14	8.96	-6.47	0.967
16	8.93	-6.44	0.963
18	8.9	-6.41	0.958
20	8.86	-6.37	0.952
25	8.79	-6.3	0.942
30	8.73	-6.24	0.933
40	8.47	-5.98	0.894
60	8.18	-5.69	0.851
107	7.45	-4.96	0.741
167	5.76	-3.27	0.489
191	4.99	-2.5	0.374
216	4.36	-1.87	0.280
235	3.99	-1.5	0.224
264.5	3.57	-1.08	0.161
295.5	3.24	-0.75	0.112
303.5	3.16	-0.67	0.100

NORMALIZED RECOVERY CURVE



HYDRAULIC CONDUCTIVITY DETERMINATION
SINGLE WELL RESPONSE TESTS

Project Name:	113-117 Bayfield	**Project Number:**	191-04694-00
Test Date:	02-May-19	**Borehole Number:**	**MW19-02 (Out of Screen)**
Field Personnel:	Kayla Allen	**Analysis By:**	Kay Harvey

Well Diameter (2r):	0.05	m	**Screen (Sand Pack) Length (L):**	4.5	m
Borehole Diameter (2R):	0.2	m	**Static Water Depth (H):**	2.49	m

HYDRAULIC CONDUCTIVITY:

$K = [(r^2)*\ln(L/R)]/(2*L*To)$

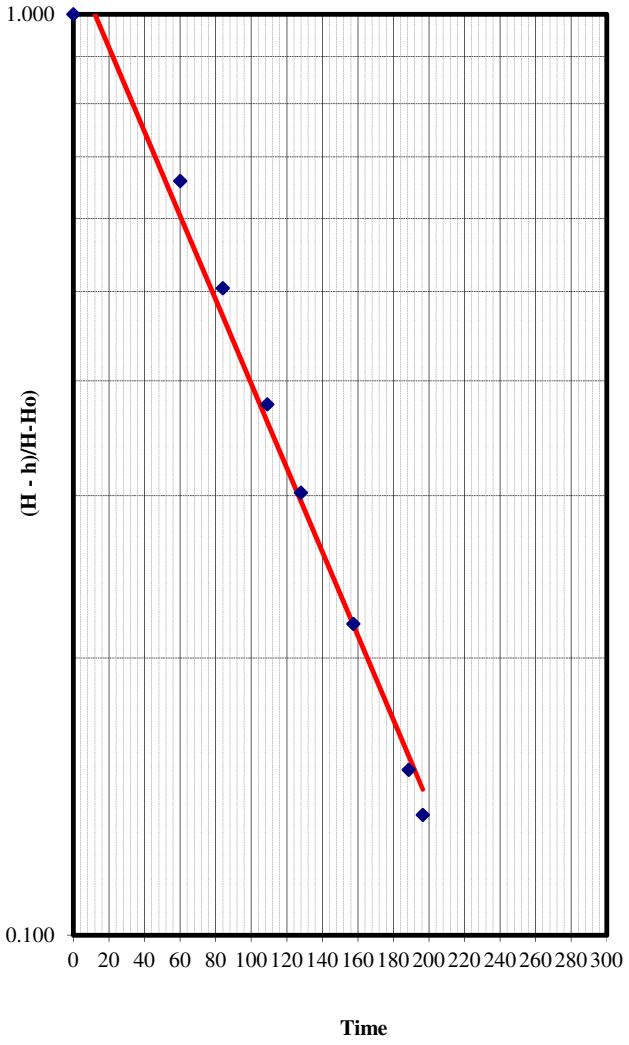
K = **4.5E-08** **m/sec** **4.5E-06** **cm/sec** **3.9E-03** **m/day**

RISING HEAD

TIME LAG (To): 106.7 min

Time (min)	Measured Water Depth (m)	H-h (m)	(H-h)/ (H-Ho)
0	7.45	-4.96	1.000
60	5.76	-3.27	0.659
84	4.99	-2.5	0.504
109	4.36	-1.87	0.377
128	3.99	-1.5	0.302
157.5	3.57	-1.08	0.218
188.5	3.24	-0.75	0.151
196.5	3.16	-0.67	0.135

NORMALIZED RECOVERY CURVE



HYDRAULIC CONDUCTIVITY DETERMINATION
SINGLE WELL RESPONSE TESTS

Project Name:	113-117 Bayfield	**Project Number:**	191-04694-00
Test Date:	02-May-19	**Borehole Number:**	**MW19-05 (manual, in screen)**
Field Personnel:	Kayla Allen	**Analysis By:**	Kay Harvey

Well Diameter (2r):	0.10	m	**Screen (Sand Pack) Length (L):**	5.59	m
Borehole Diameter (2R):	0.2	m	**Static Water Depth (H):**	4.21	m

HYDRAULIC CONDUCTIVITY:

$K = [(r^2)*\ln(L/R)]/(2*L*To)$

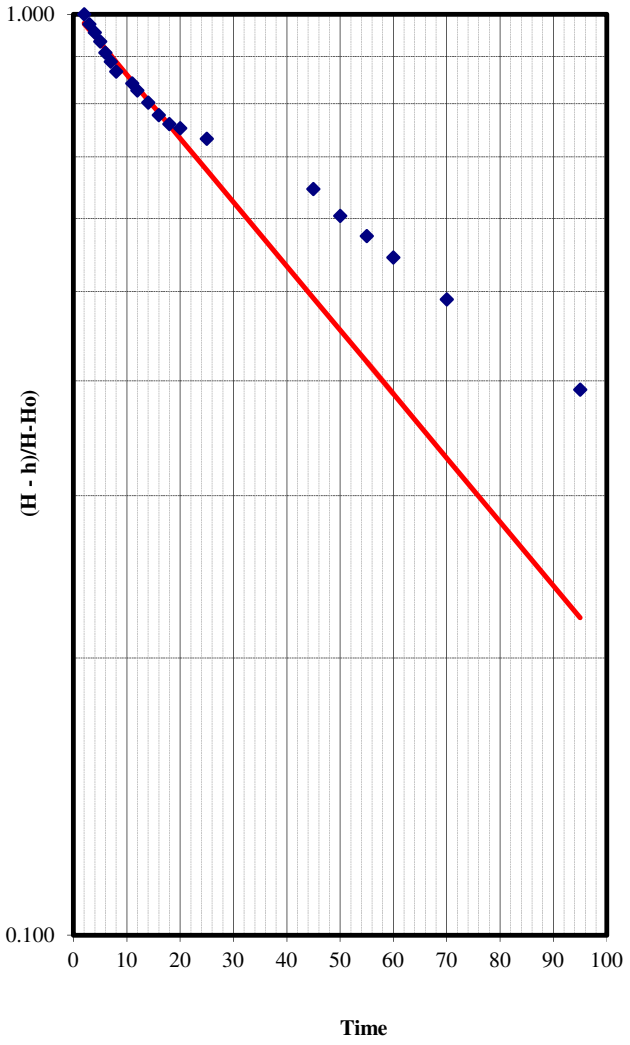
K = **2.6E-07** **m/sec** **2.6E-05** **cm/sec** **2.2E-02** **m/day**

RISING HEAD

TIME LAG (To): 62.8 min

Time (min)	Measured Water Depth (m)	H-h (m)	(H-h)/ (H-Ho)
2	8.25	-4.04	1.000
3.00	8.15	-3.94	0.975
4	8.07	-3.86	0.955
5	7.985	-3.775	0.934
6	7.88	-3.67	0.908
7	7.8	-3.59	0.889
8	7.71	-3.5	0.866
11	7.61	-3.4	0.842
12	7.55	-3.34	0.827
14	7.45	-3.24	0.802
16	7.35	-3.14	0.777
18	7.28	-3.07	0.760
20	7.25	-3.04	0.752
25	7.17	-2.96	0.733
45	6.82	-2.61	0.646
50	6.65	-2.44	0.604
55	6.53	-2.32	0.574
60	6.41	-2.2	0.545
70	6.19	-1.98	0.490
95	5.79	-1.58	0.391

NORMALIZED RECOVERY CURVE



HYDRAULIC CONDUCTIVITY DETERMINATION
SINGLE WELL RESPONSE TESTS

Project Name:	113-117 Bayfield	**Project Number:**	191-04694-00
Test Date:	02-May-19	**Borehole Number:**	**MW19-05 (DL,out of screen)**
Field Personnel:	Kayla Allen	**Analysis By:**	Kay Harvey

Well Diameter (2r):	0.05	m	**Screen (Sand Pack) Length (L):**	3.05	m
Borehole Diameter (2R):	0.2	m	**Static Water Depth (H):**	4.21	m

HYDRAULIC CONDUCTIVITY:

$K = [(r^2)*\ln(L/R)]/(2*L*To)$

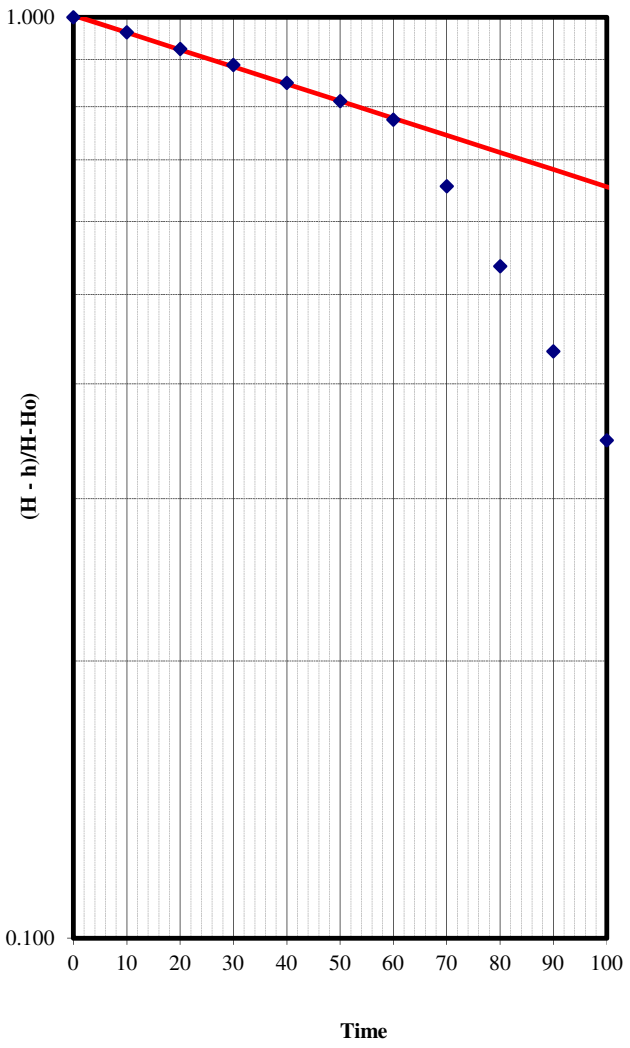
K = **2.7E-08** **m/sec** **2.7E-06** **cm/sec** **2.3E-03** **m/day**

RISING HEAD

TIME LAG (To): 233.4 min

Time (min)	Measured Water Depth (m)	H-h (m)	(H-h)/ (H-Ho)
0	7.87	-3.662	1.000
10	7.74	-3.528	0.963
20	7.59	-3.384	0.924
30	7.46	-3.25	0.887
40	7.32	-3.108	0.849
50	7.18	-2.97	0.811
60	7.04	-2.834	0.774
70	6.61	-2.401	0.656
80	6.18	-1.965	0.537
90	5.80	-1.588	0.434
100	5.48	-1.272	0.347
110	5.15	-0.942	0.257
120	4.88	-0.67	0.183

NORMALIZED RECOVERY CURVE



HYDRAULIC CONDUCTIVITY DETERMINATION
SINGLE WELL RESPONSE TESTS

Project Name:	113-117 Bayfield	**Project Number:**	191-04694-00
Test Date:	02-May-19	**Borehole Number:**	**MW19-05 (DL,out of screen)**
Field Personnel:	Kayla Allen	**Analysis By:**	Kay Harvey

Well Diameter (2r):	0.05	m	**Screen (Sand Pack) Length (L):**	3.05	m
Borehole Diameter (2R):	0.2	m	**Static Water Depth (H):**	4.21	m

HYDRAULIC CONDUCTIVITY:

$K = [(r^2)*\ln(L/R)]/(2*L*To)$

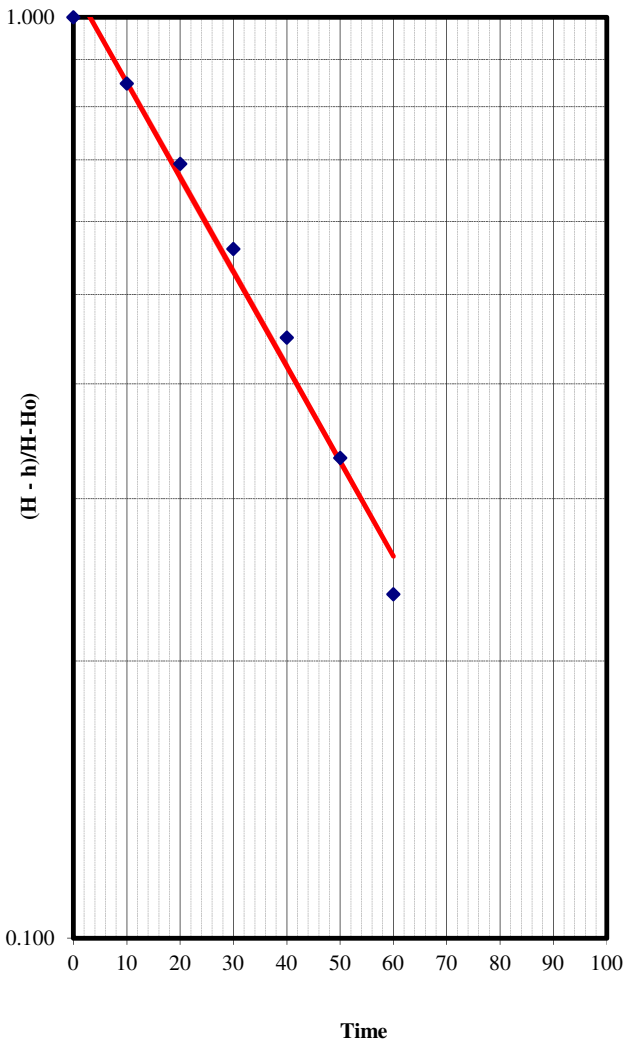
K = **1.4E-07** **m/sec** **1.4E-05** **cm/sec** **1.2E-02** **m/day**

RISING HEAD

TIME LAG (To): 45.1 min

Time (min)	Measured Water Depth (m)	H-h (m)	(H-h)/ (H-Ho)
0	7.04	-2.834	1.000
10	6.61	-2.401	0.847
20	6.18	-1.965	0.693
30	5.80	-1.588	0.560
40	5.48	-1.272	0.449
50	5.15	-0.942	0.332
60	4.88	-0.67	0.236

NORMALIZED RECOVERY CURVE



HYDRAULIC CONDUCTIVITY DETERMINATION
SINGLE WELL RESPONSE TESTS

Project Name:	113-117 Bayfield	**Project Number:**	191-04694-00
Test Date:	02-May-19	**Borehole Number:**	**MW19-06 (In screen)**
Field Personnel:	Kayla Allen	**Analysis By:**	Kay Harvey

Well Diameter (2r):	0.10	m	**Screen (Sand Pack) Length (L):**	5.07	m
Borehole Diameter (2R):	0.2	m	**Static Water Depth (H):**	1.63	m

HYDRAULIC CONDUCTIVITY:

$K = [(r^2)*\ln(L/R)]/(2*L*To)$

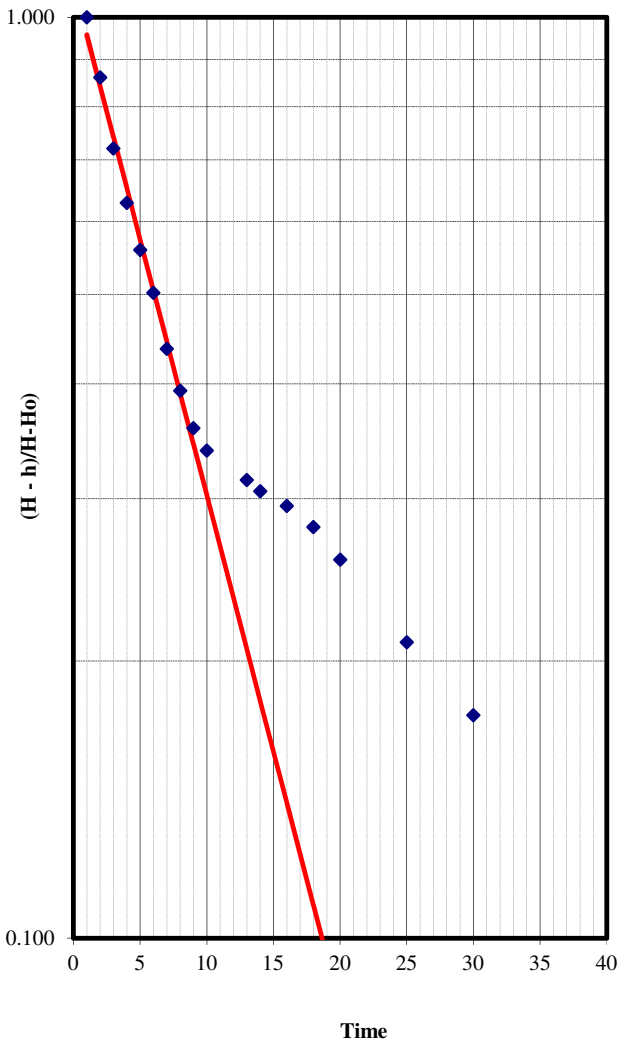
K = **2.1E-06** **m/sec** **2.1E-04** **cm/sec** **1.8E-01** **m/day**

RISING HEAD

TIME LAG (To): 8.4 min

Time (min)	Measured Water Depth (m)	H-h (m)	(H-h)/ (H-Ho)
1	3.92	-2.29	1.000
2	3.6	-1.97	0.860
3	3.28	-1.65	0.721
4	3.07	-1.44	0.629
5	2.91	-1.28	0.559
6	2.78	-1.15	0.502
7	2.63	-1	0.437
8	2.53	-0.9	0.393
9	2.45	-0.82	0.358
10	2.405	-0.775	0.338
13	2.35	-0.72	0.314
14	2.33	-0.7	0.306
16	2.305	-0.675	0.295
18	2.27	-0.64	0.279
20	2.22	-0.59	0.258
25	2.11	-0.48	0.210
30	2.03	-0.4	0.175
40	1.84	-0.21	0.092

NORMALIZED RECOVERY CURVE



HYDRAULIC CONDUCTIVITY DETERMINATION
SINGLE WELL RESPONSE TESTS

Project Name:	113-117 Bayfield	**Project Number:**	191-04694-00
Test Date:	02-May-19	**Borehole Number:**	**MW19-06 (Out of Screen)**
Field Personnel:	Kayla Allen	**Analysis By:**	Kay Harvey

Well Diameter (2r):	0.05	m	**Screen (Sand Pack) Length (L):**	4.5	m
Borehole Diameter (2R):	0.2	m	**Static Water Depth (H):**	1.63	m

HYDRAULIC CONDUCTIVITY:

$K = [(r^2)*\ln(L/R)]/(2*L*To)$

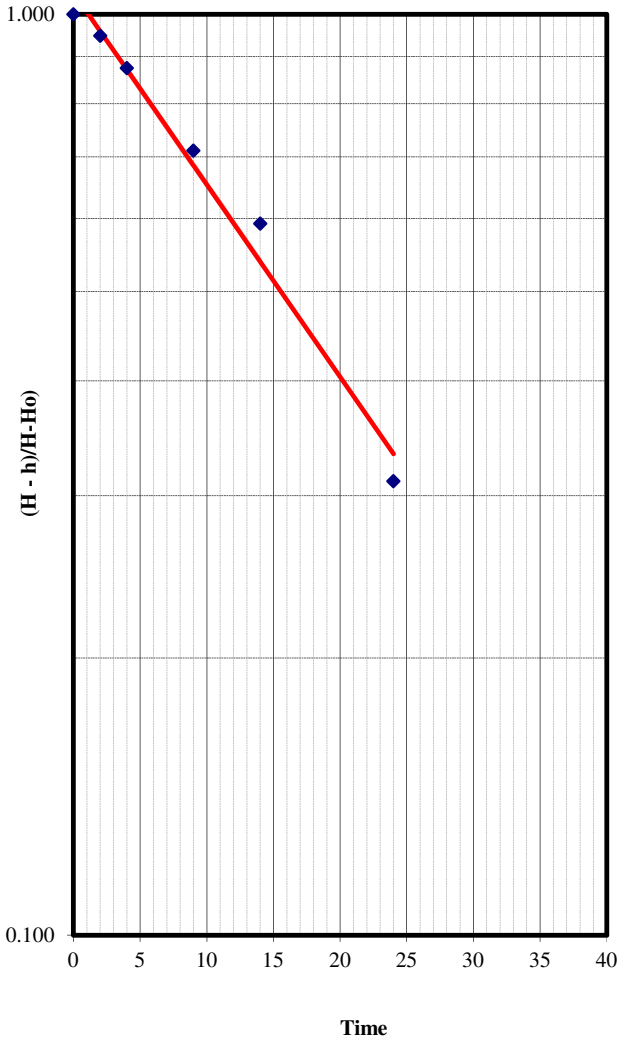
K = **2.2E-07** **m/sec** **2.2E-05** **cm/sec** **1.9E-02** **m/day**

RISING HEAD

TIME LAG (To): 21.8 min

Time (min)	Measured Water Depth (m)	H-h (m)	(H-h)/ (H-Ho)
0	2.305	-0.675	1.000
2	2.27	-0.64	0.948
4	2.22	-0.59	0.874
9	2.11	-0.48	0.711
14	2.03	-0.4	0.593
24	1.84	-0.21	0.311

NORMALIZED RECOVERY CURVE



APPENDIX

D LABORATORY CERTIFICATES

[redacted]

ANALYTICAL GUIDELINE REPORT

191-04694-00

Sample Details Grouping	Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2	#3
L2267557-1	MW1								
Sampled By:	CLIENT on 02-MAY-19								
Matrix:	WATER								
Physical Tests									
	Colour, Apparent	294	DLHC	4.0	CU	04-MAY-19			
	Conductivity	4770		3.0	umhos/cm	04-MAY-19			
	pH	6.71		0.10	pH units	04-MAY-19	6.5-8.5	6.0-9.5	6.0-9.5
	Total Dissolved Solids	3380	DLDS	20	mg/L	08-MAY-19			
	Turbidity	>4000		0.10	NTU	04-MAY-19			
Anions and Nutrients									
	Alkalinity, Bicarbonate (as CaCO3)	1210	DLM	50	mg/L	04-MAY-19			
	Alkalinity, Carbonate (as CaCO3)	<50	DLM	50	mg/L	04-MAY-19			
	Alkalinity, Hydroxide (as CaCO3)	<50	DLM	50	mg/L	04-MAY-19			
	Alkalinity, Total (as CaCO3)	1210	DLM	50	mg/L	04-MAY-19			
	Ammonia, Total (as N)	0.490		0.010	mg/L	08-MAY-19			
	Bromide (Br)	<1.0	DLDS	1.0	mg/L	07-MAY-19			
	Chloride (Cl)	1520	DLDS	5.0	mg/L	07-MAY-19			*1500
	Computed Conductivity	4520			uS/cm	10-MAY-19			
	Conductivity % Difference	-5			%	10-MAY-19			
	Fluoride (F)	<0.20	DLDS	0.20	mg/L	07-MAY-19			10
	Hardness (as CaCO3)	1760			mg/L	10-MAY-19			
	Ion Balance	80			%	10-MAY-19			
	Langelier Index	1			No Unit	10-MAY-19			
	Nitrate and Nitrite as N	1.99		0.22	mg/L	08-MAY-19			
	Nitrate (as N)	1.99	DLDS	0.20	mg/L	07-MAY-19			
	Nitrite (as N)	<0.10	DLDS	0.10	mg/L	07-MAY-19			
	Saturation pH	5.88			pH	10-MAY-19			
	Orthophosphate-Dissolved (as P)	<0.0030		0.0030	mg/L	08-MAY-19			
	TDS (Calculated)	3310			mg/L	10-MAY-19			
	Sulfate (SO4)	41.6	DLDS	3.0	mg/L	07-MAY-19			1500
	Anion Sum	63.7			me/L	10-MAY-19			
	Cation Sum	51.1			me/L	10-MAY-19			
	Cation - Anion Balance	-11			%	10-MAY-19			
Organic / Inorganic Carbon									
	Dissolved Carbon Filtration Location	LAB			No Unit	06-MAY-19			
	Dissolved Organic Carbon	4.88		0.50	mg/L	08-MAY-19			
Inorganic Parameters									
	Silica	20.1		1.1	mg/L	07-MAY-19			
Dissolved Metals									
	Dissolved Metals Filtration Location	FIELD			No Unit	06-MAY-19			
	Aluminum (Al)-Dissolved	<0.050	DLHC	0.050	mg/L	06-MAY-19	**0.015		50
	Antimony (Sb)-Dissolved	<0.0010	DLHC	0.0010	mg/L	06-MAY-19	0.02		5
	Arsenic (As)-Dissolved	<0.0010	DLHC	0.0010	mg/L	06-MAY-19	0.005		1
	Barium (Ba)-Dissolved	0.807	DLHC	0.0010	mg/L	06-MAY-19			5
	Beryllium (Be)-Dissolved	<0.0010	DLHC	0.0010	mg/L	06-MAY-19	0.011		
	Bismuth (Bi)-Dissolved	<0.00050	DLHC	0.00050	mg/L	06-MAY-19			5
	Boron (B)-Dissolved	<0.10	DLHC	0.10	mg/L	06-MAY-19	0.2		
	Cadmium (Cd)-Dissolved	<0.000050	DLHC	0.000050	mg/L	06-MAY-19	0.0001	0.001	0.7
	Calcium (Ca)-Dissolved	563	DLHC	0.50	mg/L	06-MAY-19			
	Chromium (Cr)-Dissolved	<0.0050	DLHC	0.0050	mg/L	06-MAY-19		0.08	2
	Cobalt (Co)-Dissolved	0.0017	DLHC	0.0010	mg/L	06-MAY-19			

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.

* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario PWQO (JULY 1994) + Barrie Sanitary Sewer Use By-Law (2012-172) = [Suite] - ON-PWQO+SAN+STORM-BARRIE

#1: Ontario PWQO

#2: Barrie Storm Sewer

#3: Barrie Sanitary Sewer

[redacted]

ANALYTICAL GUIDELINE REPORT

191-04694-00

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2	#3
L2267557-1 MW1								
Sampled By: CLIENT on 02-MAY-19								
Matrix: WATER								
Dissolved Metals								
Copper (Cu)-Dissolved	0.0058	DLHC	0.0020	mg/L	06-MAY-19	*0.0009		5.0
Iron (Fe)-Dissolved	<0.10	DLHC	0.10	mg/L	06-MAY-19	*0.001	0.01	2.0
Lead (Pb)-Dissolved	<0.00050	DLHC	0.00050	mg/L	06-MAY-19	0.3		50
Magnesium (Mg)-Dissolved	86.0	DLHC	0.050	mg/L	06-MAY-19	0.001	0.05	0.7
Manganese (Mn)-Dissolved	0.748	DLHC	0.0050	mg/L	06-MAY-19			5
Molybdenum (Mo)-Dissolved	<0.00050	DLHC	0.00050	mg/L	06-MAY-19	0.04		5
Nickel (Ni)-Dissolved	<0.0050	DLHC	0.0050	mg/L	06-MAY-19	0.025	0.05	2
Phosphorus (P)-Dissolved	<0.50	DLHC	0.50	mg/L	06-MAY-19	**0.01		10
Potassium (K)-Dissolved	4.79	DLHC	0.50	mg/L	06-MAY-19			
Selenium (Se)-Dissolved	0.00093	DLHC	0.00050	mg/L	06-MAY-19	0.1		1.0
Silicon (Si)-Dissolved	9.38	DLHC	0.50	mg/L	06-MAY-19			
Silver (Ag)-Dissolved	<0.00050	DLHC	0.00050	mg/L	06-MAY-19	**0.0001		0.4
Sodium (Na)-Dissolved	362	DLHC	0.50	mg/L	06-MAY-19			
Strontium (Sr)-Dissolved	1.41	DLHC	0.010	mg/L	06-MAY-19			
Sulfur (S)-Dissolved	14.0	DLHC	5.0	mg/L	06-MAY-19			
Thallium (Tl)-Dissolved	<0.00010	DLHC	0.00010	mg/L	06-MAY-19	0.0003		
Tin (Sn)-Dissolved	<0.0010	DLHC	0.0010	mg/L	06-MAY-19			5
Titanium (Ti)-Dissolved	<0.0030	DLHC	0.0030	mg/L	06-MAY-19			
Tungsten (W)-Dissolved	<0.0010	DLHC	0.0010	mg/L	06-MAY-19	0.03		
Uranium (U)-Dissolved	0.00150	DLHC	0.00010	mg/L	06-MAY-19	0.005		
Vanadium (V)-Dissolved	<0.0050	DLHC	0.0050	mg/L	06-MAY-19	0.006		5.0
Zinc (Zn)-Dissolved	<0.010	DLHC	0.010	mg/L	06-MAY-19	0.02	0.04	2.0
Zirconium (Zr)-Dissolved	<0.0030	DLHC	0.0030	mg/L	06-MAY-19	0.004		
L2267557-2 MW19-2								
Sampled By: CLIENT on 02-MAY-19 @ 12:00								
Matrix: WATER								
Physical Tests								
Colour, Apparent	323	DLHC	4.0	CU	04-MAY-19			
Conductivity	1850		3.0	umhos/cm	04-MAY-19			
pH	7.36		0.10	pH units	04-MAY-19	6.5-8.5	6.0-9.5	6.0-9.5
Total Dissolved Solids	1140	DLDS	20	mg/L	08-MAY-19			
Turbidity	>4000		0.10	NTU	04-MAY-19			
Anions and Nutrients								
Alkalinity, Bicarbonate (as CaCO3)	1260	DLM	50	mg/L	04-MAY-19			
Alkalinity, Carbonate (as CaCO3)	<50	DLM	50	mg/L	04-MAY-19			
Alkalinity, Hydroxide (as CaCO3)	<50	DLM	50	mg/L	04-MAY-19			
Alkalinity, Total (as CaCO3)	1260	DLM	50	mg/L	04-MAY-19			
Ammonia, Total (as N)	0.058		0.010	mg/L	08-MAY-19			
Bromide (Br)	<0.50	DLDS	0.50	mg/L	07-MAY-19			
Chloride (Cl)	379	DLDS	2.5	mg/L	07-MAY-19			1500
Computed Conductivity	2110			uS/cm	09-MAY-19			
Conductivity % Difference	13			%	09-MAY-19			
Fluoride (F)	<0.10	DLDS	0.10	mg/L	07-MAY-19			10
Hardness (as CaCO3)	492			mg/L	09-MAY-19			

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario PWQO (JULY 1994) + Barrie Sanitary Sewer Use By-Law (2012-172) = [Suite] - ON-PWQO+SAN+STORM-BARRIE

#1: Ontario PWQO

#2: Barrie Storm Sewer

#3: Barrie Sanitary Sewer

ANALYTICAL GUIDELINE REPORT

191-04694-00

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2	#3	
L2267557-2 MW19-2									
Sampled By: CLIENT on 02-MAY-19 @ 12:00									
Matrix: WATER									
Anions and Nutrients									
Ion Balance	59			%	09-MAY-19				
Langelier Index	1			No Unit	09-MAY-19				
Nitrate and Nitrite as N	4.79		0.11	mg/L	08-MAY-19				
Nitrate (as N)	4.74	DLDS	0.10	mg/L	07-MAY-19				
Nitrite (as N)	0.050	DLDS	0.050	mg/L	07-MAY-19				
Saturation pH	6.33			pH	09-MAY-19				
Orthophosphate-Dissolved (as P)	<0.0030		0.0030	mg/L	08-MAY-19				
TDS (Calculated)	1630			mg/L	09-MAY-19				
Sulfate (SO4)	67.6	DLDS	1.5	mg/L	07-MAY-19			1500	
Anion Sum	33.1			me/L	09-MAY-19				
Cation Sum	19.7			me/L	09-MAY-19				
Cation - Anion Balance	-25			%	09-MAY-19				
Organic / Inorganic Carbon									
Dissolved Carbon Filtration Location	LAB			No Unit	06-MAY-19				
Dissolved Organic Carbon	2.26		0.50	mg/L	08-MAY-19				
Inorganic Parameters									
Silica	15.6		0.11	mg/L	07-MAY-19				
Dissolved Metals									
Dissolved Metals Filtration Location	FIELD			No Unit	06-MAY-19				
Aluminum (Al)-Dissolved	<0.0050		0.0050	mg/L	07-MAY-19	0.015		50	
Antimony (Sb)-Dissolved	0.00018		0.00010	mg/L	07-MAY-19	0.02		5	
Arsenic (As)-Dissolved	0.00036		0.00010	mg/L	07-MAY-19	0.005		1	
Barium (Ba)-Dissolved	0.231		0.00010	mg/L	07-MAY-19			5	
Beryllium (Be)-Dissolved	<0.00010		0.00010	mg/L	07-MAY-19	0.011			
Bismuth (Bi)-Dissolved	<0.000050		0.000050	mg/L	07-MAY-19			5	
Boron (B)-Dissolved	0.050		0.010	mg/L	07-MAY-19	0.2			
Cadmium (Cd)-Dissolved	<0.000010		0.000010	mg/L	07-MAY-19	0.0001	0.001	0.7	
Calcium (Ca)-Dissolved	142		0.050	mg/L	07-MAY-19				
Chromium (Cr)-Dissolved	<0.00050		0.00050	mg/L	07-MAY-19		0.08	2	
Cobalt (Co)-Dissolved	0.00054		0.00010	mg/L	07-MAY-19	0.0009		5.0	
Copper (Cu)-Dissolved	0.00170		0.00020	mg/L	07-MAY-19	*0.001	0.01	2.0	
Iron (Fe)-Dissolved	<0.010		0.010	mg/L	07-MAY-19	0.3		50	
Lead (Pb)-Dissolved	0.000061		0.000050	mg/L	07-MAY-19	0.001	0.05	0.7	
Magnesium (Mg)-Dissolved	33.7		0.050	mg/L	07-MAY-19				
Manganese (Mn)-Dissolved	0.0485		0.00050	mg/L	07-MAY-19			5	
Molybdenum (Mo)-Dissolved	0.00360		0.000050	mg/L	07-MAY-19	0.04		5	
Nickel (Ni)-Dissolved	0.00229		0.00050	mg/L	07-MAY-19	0.025	0.05	2	
Phosphorus (P)-Dissolved	<0.050		0.050	mg/L	07-MAY-19	**0.01		10	
Potassium (K)-Dissolved	7.08		0.050	mg/L	07-MAY-19				
Selenium (Se)-Dissolved	0.00273		0.000050	mg/L	07-MAY-19	0.1		1.0	
Silicon (Si)-Dissolved	7.30		0.050	mg/L	07-MAY-19				
Silver (Ag)-Dissolved	<0.000050		0.000050	mg/L	07-MAY-19	0.0001		0.4	
Sodium (Na)-Dissolved	223	DLHC	0.50	mg/L	06-MAY-19				
Strontium (Sr)-Dissolved	0.426		0.0010	mg/L	07-MAY-19				
Sulfur (S)-Dissolved	23.8		5.0	mg/L	07-MAY-19				
Thallium (Tl)-Dissolved	0.000018		0.000010	mg/L	07-MAY-19	0.0003			

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario PWQO (JULY 1994) + Barrie Sanitary Sewer Use By-Law (2012-172) = [Suite] - ON-PWQO+SAN+STORM-BARRIE

#1: Ontario PWQO

#2: Barrie Storm Sewer

#3: Barrie Sanitary Sewer

ANALYTICAL GUIDELINE REPORT

191-04694-00

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2	#3
L2267557-2 MW19-2								
Sampled By: CLIENT on 02-MAY-19 @ 12:00								
Matrix: WATER								
Dissolved Metals								
Tin (Sn)-Dissolved	<0.00010		0.00010	mg/L	07-MAY-19			5
Titanium (Ti)-Dissolved	<0.00030		0.00030	mg/L	07-MAY-19			
Tungsten (W)-Dissolved	0.00014		0.00010	mg/L	07-MAY-19	0.03		
Uranium (U)-Dissolved	0.00753		0.000010	mg/L	07-MAY-19	*0.005		
Vanadium (V)-Dissolved	0.00114		0.00050	mg/L	07-MAY-19	0.006		5.0
Zinc (Zn)-Dissolved	0.0021		0.0010	mg/L	07-MAY-19	0.02	0.04	2.0
Zirconium (Zr)-Dissolved	<0.00030		0.00030	mg/L	07-MAY-19	0.004		
L2267557-3 MW19-5								
Sampled By: CLIENT on 02-MAY-19 @ 12:00								
Matrix: WATER						#1	#2	#3
Physical Tests								
pH	7.41		0.10	pH units	04-MAY-19	6.5-8.5	6.0-9.5	6.0-9.5
Total Suspended Solids	300000	DLHC	100	mg/L	08-MAY-19		*15	*350
Anions and Nutrients								
Chloride (Cl)	130		0.50	mg/L	06-MAY-19			1500
Fluoride (F)	0.030		0.020	mg/L	06-MAY-19			10
Total Kjeldahl Nitrogen	4.5	DLM	1.5	mg/L	09-MAY-19			100
Phosphorus, Total	47.9	DLM	0.15	mg/L	09-MAY-19	*0.01		*10
Sulfate (SO4)	44.1		0.30	mg/L	06-MAY-19			1500
Sulphide (as S)	0.056		0.018	mg/L	08-MAY-19			
Sulphide (as H2S)	0.060		0.019	mg/L	08-MAY-19			1
Cyanides								
Cyanide, Total	<0.0020		0.0020	mg/L	07-MAY-19			1.2
Total Metals								
Aluminum (Al)-Total	0.66	DLHC	0.50	mg/L	06-MAY-19	*0.015		50
Antimony (Sb)-Total	<0.010	DLHC	0.010	mg/L	06-MAY-19	0.02		5
Arsenic (As)-Total	<0.010	DLHC	0.010	mg/L	06-MAY-19	**0.005		1
Barium (Ba)-Total	7.01	DLHC	0.010	mg/L	06-MAY-19			*5
Bismuth (Bi)-Total	<0.0050	DLHC	0.0050	mg/L	06-MAY-19			5
Cadmium (Cd)-Total	0.00090	DLHC	0.00050	mg/L	06-MAY-19	*0.0001	0.001	0.7
Chromium (Cr)-Total	<0.050	DLHC	0.050	mg/L	06-MAY-19		0.08	2
Cobalt (Co)-Total	<0.010	DLHC	0.010	mg/L	06-MAY-19	**0.0009		5.0
Copper (Cu)-Total	<0.10	DLHC	0.10	mg/L	06-MAY-19	**0.001	**0.01	2.0
Iron (Fe)-Total	<1.0	DLHC	1.0	mg/L	06-MAY-19	**0.3		50
Lead (Pb)-Total	<0.0050	DLHC	0.0050	mg/L	06-MAY-19	**0.001	0.05	0.7
Manganese (Mn)-Total	10.8	DLHC	0.050	mg/L	06-MAY-19			*5
Mercury (Hg)-Total	0.000040		0.000010	mg/L	06-MAY-19	0.0002		0.01
Molybdenum (Mo)-Total	0.0097	DLHC	0.0050	mg/L	06-MAY-19	0.04		5
Nickel (Ni)-Total	<0.050	DLHC	0.050	mg/L	06-MAY-19	**0.025	0.05	2
Selenium (Se)-Total	<0.0050	DLHC	0.0050	mg/L	06-MAY-19	0.1		1.0
Silver (Ag)-Total	<0.0050	DLHC	0.0050	mg/L	06-MAY-19	**0.0001		0.4
Tin (Sn)-Total	<0.010	DLHC	0.010	mg/L	06-MAY-19			5
Titanium (Ti)-Total	<0.030	DLHC	0.030	mg/L	06-MAY-19			
Vanadium (V)-Total	<0.050	DLHC	0.050	mg/L	06-MAY-19	**0.006		5.0

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario PWQO (JULY 1994) + Barrie Sanitary Sewer Use By-Law (2012-172) = [Suite] - ON-PWQO+SAN+STORM-BARRIE

#1: Ontario PWQO

#2: Barrie Storm Sewer

#3: Barrie Sanitary Sewer

ANALYTICAL GUIDELINE REPORT

191-04694-00

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2	#3
L2267557-3 MW19-5								
Sampled By: CLIENT on 02-MAY-19 @ 12:00								
Matrix: WATER								
Total Metals								
Zinc (Zn)-Total	<0.30	DLHC	0.30	mg/L	06-MAY-19	**0.02	**0.04	2.0
Aggregate Organics								
BOD	<3.0	BODL	3.0	mg/L	09-MAY-19		15	300
COD	790	DLM	200	mg/L	09-MAY-19			*600
Oil and Grease, Total	<5.0		5.0	mg/L	08-MAY-19			
Animal/Veg Oil & Grease	<5.0		5.0	mg/L	08-MAY-19			150
Mineral Oil and Grease	<2.5		2.5	mg/L	08-MAY-19			15
Phenols (4AAP)	<0.0010		0.0010	mg/L	06-MAY-19	0.001		0.1
Volatile Organic Compounds								
Acetone	<20	OWP	20	ug/L	08-MAY-19			
Benzene	<0.50	OWP	0.50	ug/L	08-MAY-19	100		10
Bromodichloromethane	<1.0	OWP	1.0	ug/L	08-MAY-19	200		
Bromoform	<1.0	OWP	1.0	ug/L	08-MAY-19	60		
Bromomethane	<0.50	OWP	0.50	ug/L	08-MAY-19			
Carbon Disulfide	<1.0	OWP	1.0	ug/L	08-MAY-19			
Carbon tetrachloride	<0.50	OWP	0.50	ug/L	08-MAY-19			
Chlorobenzene	<0.50	OWP	0.50	ug/L	08-MAY-19	15		
Dibromochloromethane	<1.0	OWP	1.0	ug/L	08-MAY-19	40		
Chloroethane	<1.0	OWP	1.0	ug/L	08-MAY-19			
Chloroform	<1.0	OWP	1.0	ug/L	08-MAY-19			
Chloromethane	<1.0	OWP	1.0	ug/L	08-MAY-19	700		
1,2-Dibromoethane	<0.20	OWP	0.20	ug/L	08-MAY-19	5		
1,2-Dichlorobenzene	<0.50	OWP	0.50	ug/L	08-MAY-19	2.5		50
1,3-Dichlorobenzene	<0.50	OWP	0.50	ug/L	08-MAY-19	2.5		
1,4-Dichlorobenzene	<0.50	OWP	0.50	ug/L	08-MAY-19	4		80
Dichlorodifluoromethane	<1.0	OWP	1.0	ug/L	08-MAY-19			
1,1-Dichloroethane	<0.50	OWP	0.50	ug/L	08-MAY-19	200		
1,2-Dichloroethane	<0.50	OWP	0.50	ug/L	08-MAY-19	100		
1,1-Dichloroethylene	<0.50	OWP	0.50	ug/L	08-MAY-19	40		
cis-1,2-Dichloroethylene	<0.50	OWP	0.50	ug/L	08-MAY-19			
trans-1,2-Dichloroethylene	<0.50	OWP	0.50	ug/L	08-MAY-19			
Dichloromethane	<2.0	OWP	2.0	ug/L	08-MAY-19	100		90
1,2-Dichloropropane	<0.50	OWP	0.50	ug/L	08-MAY-19	0.7		
cis-1,3-Dichloropropene	<0.50	OWP	0.50	ug/L	08-MAY-19			
trans-1,3-Dichloropropene	<0.50	OWP	0.50	ug/L	08-MAY-19	7		
Ethylbenzene	<0.50	OWP	0.50	ug/L	08-MAY-19	8		60
n-Hexane	<0.50	OWP	0.50	ug/L	08-MAY-19			
2-Hexanone	<20	OWP	20	ug/L	08-MAY-19			
Methyl Ethyl Ketone	<20	OWP	20	ug/L	08-MAY-19	400		
Methyl Isobutyl Ketone	<20	OWP	20	ug/L	08-MAY-19			
MTBE	<0.50	OWP	0.50	ug/L	08-MAY-19			
Styrene	<0.50	OWP	0.50	ug/L	08-MAY-19	4		
1,1,1,2-Tetrachloroethane	<0.50	OWP	0.50	ug/L	08-MAY-19	20.0		
1,1,2,2-Tetrachloroethane	<0.50	OWP	0.50	ug/L	08-MAY-19	70		60
Tetrachloroethylene	<0.50	OWP	0.50	ug/L	08-MAY-19	50		60
Toluene	<0.50	OWP	0.50	ug/L	08-MAY-19	0.8		20

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario PWQO (JULY 1994) + Barrie Sanitary Sewer Use By-Law (2012-172) = [Suite] - ON-PWQO+SAN+STORM-BARRIE

#1: Ontario PWQO

#2: Barrie Storm Sewer

#3: Barrie Sanitary Sewer

ANALYTICAL GUIDELINE REPORT

191-04694-00

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2	#3	
L2267557-3 MW19-5									
Sampled By: CLIENT on 02-MAY-19 @ 12:00									
Matrix: WATER									
Volatile Organic Compounds									
1,1,1-Trichloroethane	<0.50	OWP	0.50	ug/L	08-MAY-19	10			
1,1,2-Trichloroethane	<0.50	OWP	0.50	ug/L	08-MAY-19	800			
Trichloroethylene	<0.50	OWP	0.50	ug/L	08-MAY-19	20		50	
Trichlorofluoromethane	<1.0	OWP	1.0	ug/L	08-MAY-19				
Vinyl chloride	<0.50	OWP	0.50	ug/L	08-MAY-19	600			
o-Xylene	<0.50	OWP	0.50	ug/L	08-MAY-19	40			
m+p-Xylenes	<1.0	OWP	1.0	ug/L	08-MAY-19	2			
Xylenes (Total)	<1.1		1.1	ug/L	08-MAY-19			300	
Surrogate: 4-Bromofluorobenzene	99.8		70-130	%	08-MAY-19				
Surrogate: 1,4-Difluorobenzene	101.5		70-130	%	08-MAY-19				
Polycyclic Aromatic Hydrocarbons									
Acenaphthene	<0.020	HSED	0.020	ug/L	10-MAY-19				
Acenaphthylene	<0.020	HSED	0.020	ug/L	10-MAY-19				
Anthracene	<0.030	HSED	0.030	ug/L	10-MAY-19	**0.0008			
Benzo(a)anthracene	<0.030	HSED	0.030	ug/L	10-MAY-19	**0.0004			
Benzo(a)pyrene	<0.015	HSED	0.015	ug/L	10-MAY-19				
Benzo(b)fluoranthene	<0.030	HSED	0.030	ug/L	10-MAY-19				
Benzo(g,h,i)perylene	<0.030	HSED	0.030	ug/L	10-MAY-19	**0.00002			
Benzo(k)fluoranthene	<0.030	HSED	0.030	ug/L	10-MAY-19	**0.0002			
Chrysene	<0.080	RRR	0.080	ug/L	10-MAY-19	**0.0001			
Dibenzo(ah)anthracene	<0.030	HSED	0.030	ug/L	10-MAY-19	**0.002			
Fluoranthene	<0.060	RRR	0.060	ug/L	10-MAY-19	**0.008			
Fluorene	<0.020	HSED	0.020	ug/L	10-MAY-19	0.2			
Indeno(1,2,3-cd)pyrene	<0.030	HSED	0.030	ug/L	10-MAY-19				
1-Methylnaphthalene	<0.020	HSED	0.020	ug/L	10-MAY-19	2			
2-Methylnaphthalene	<0.020	HSED	0.020	ug/L	10-MAY-19	2			
Naphthalene	<0.050	HSED	0.050	ug/L	10-MAY-19	7			
Phenanthrene	<0.050	RRR	0.050	ug/L	10-MAY-19	**0.03			
Pyrene	<0.050	RRR	0.050	ug/L	10-MAY-19				
Surrogate: 2-Fluorobiphenyl	93.5		50-140	%	10-MAY-19				
Surrogate: d14-Terphenyl	58.8	RRR	60-140	%	10-MAY-19				
Total PAHs	0.22		0.12	ug/L	10-MAY-19			5 5	
Total PAHs	0.252		0.095	ug/L	03-MAY-19			5 5	
Semi-Volatile Organics									
Hexachlorobenzene	<0.040	HSED	0.040	ug/L	10-MAY-19	**0.0065		0.1	
Surrogate: 2-Fluorobiphenyl	67.2		40-130	%	10-MAY-19				
Surrogate: p-Terphenyl d14	45.3		40-130	%	10-MAY-19				
L2267557-4 MW19-6									
Sampled By: CLIENT on 02-MAY-19									
Matrix: WATER						#1	#2	#3	
Physical Tests									
Colour, Apparent	173		2.0	CU	04-MAY-19				
Conductivity	2820		3.0	umhos/cm	04-MAY-19				

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario PWQO (JULY 1994) + Barrie Sanitary Sewer Use By-Law (2012-172) = [Suite] - ON-PWQO+SAN+STORM-BARRIE

#1: Ontario PWQO

#2: Barrie Storm Sewer

#3: Barrie Sanitary Sewer

ANALYTICAL GUIDELINE REPORT

191-04694-00

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2	#3
L2267557-4 MW19-6								
Sampled By: CLIENT on 02-MAY-19								
Matrix: WATER								
Physical Tests								
pH	6.86		0.10	pH units	04-MAY-19	6.5-8.5	6.0-9.5	6.0-9.5
Total Dissolved Solids	1940	DLDS	20	mg/L	08-MAY-19			
Turbidity	>4000		0.10	NTU	04-MAY-19			
Anions and Nutrients								
Alkalinity, Bicarbonate (as CaCO3)	1860	DLM	50	mg/L	04-MAY-19			
Alkalinity, Carbonate (as CaCO3)	<50	DLM	50	mg/L	04-MAY-19			
Alkalinity, Hydroxide (as CaCO3)	<50	DLM	50	mg/L	04-MAY-19			
Alkalinity, Total (as CaCO3)	1860	DLM	50	mg/L	04-MAY-19			
Ammonia, Total (as N)	0.276	DLHC	0.050	mg/L	09-MAY-19			
Bromide (Br)	<0.50	DLDS	0.50	mg/L	07-MAY-19			
Chloride (Cl)	718	DLDS	2.5	mg/L	07-MAY-19			1500
Computed Conductivity	3130			uS/cm	09-MAY-19			
Conductivity % Difference	11			%	09-MAY-19			
Fluoride (F)	<0.10	DLDS	0.10	mg/L	07-MAY-19			10
Hardness (as CaCO3)	949			mg/L	09-MAY-19			
Ion Balance	57			%	09-MAY-19			
Langelier Index	1			No Unit	09-MAY-19			
Nitrate and Nitrite as N	3.934		0.11	mg/L	08-MAY-19			
Nitrate (as N)	3.80	DLDS	0.10	mg/L	07-MAY-19			
Nitrite (as N)	0.134	DLDS	0.050	mg/L	07-MAY-19			
Saturation pH	5.87			pH	09-MAY-19			
Orthophosphate-Dissolved (as P)	<0.0030		0.0030	mg/L	08-MAY-19			
TDS (Calculated)	2500			mg/L	09-MAY-19			
Sulfate (SO4)	45.8	DLDS	1.5	mg/L	07-MAY-19			1500
Anion Sum	52.0			me/L	09-MAY-19			
Cation Sum	29.5			me/L	09-MAY-19			
Cation - Anion Balance	-28			%	09-MAY-19			
Organic / Inorganic Carbon								
Dissolved Carbon Filtration Location	LAB			No Unit	06-MAY-19			
Dissolved Organic Carbon	3.08		0.50	mg/L	08-MAY-19			
Inorganic Parameters								
Silica	15.7		1.1	mg/L	07-MAY-19			
Dissolved Metals								
Dissolved Metals Filtration Location	FIELD			No Unit	06-MAY-19			
Aluminum (Al)-Dissolved	<0.050	DLHC	0.050	mg/L	06-MAY-19	**0.015		50
Antimony (Sb)-Dissolved	<0.0010	DLHC	0.0010	mg/L	06-MAY-19	0.02		5
Arsenic (As)-Dissolved	<0.0010	DLHC	0.0010	mg/L	06-MAY-19	0.005		1
Barium (Ba)-Dissolved	0.253	DLHC	0.0010	mg/L	06-MAY-19			5
Beryllium (Be)-Dissolved	<0.0010	DLHC	0.0010	mg/L	06-MAY-19	0.011		
Bismuth (Bi)-Dissolved	<0.00050	DLHC	0.00050	mg/L	06-MAY-19			5
Boron (B)-Dissolved	<0.10	DLHC	0.10	mg/L	06-MAY-19	0.2		
Cadmium (Cd)-Dissolved	<0.000050	DLHC	0.000050	mg/L	06-MAY-19	0.0001	0.001	0.7
Calcium (Ca)-Dissolved	326	DLHC	0.50	mg/L	06-MAY-19			
Chromium (Cr)-Dissolved	<0.0050	DLHC	0.0050	mg/L	06-MAY-19		0.08	2
Cobalt (Co)-Dissolved	0.0012	DLHC	0.0010	mg/L	06-MAY-19	*0.0009		5.0
Copper (Cu)-Dissolved	0.0041	DLHC	0.0020	mg/L	06-MAY-19	*0.001	0.01	2.0

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario PWQO (JULY 1994) + Barrie Sanitary Sewer Use By-Law (2012-172) = [Suite] - ON-PWQO+SAN+STORM-BARRIE

#1: Ontario PWQO

#2: Barrie Storm Sewer

#3: Barrie Sanitary Sewer

ANALYTICAL GUIDELINE REPORT

191-04694-00

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	#2	#3	
L2267557-4 MW19-6 Sampled By: CLIENT on 02-MAY-19 Matrix: WATER									
Dissolved Metals									
Iron (Fe)-Dissolved	<0.10	DLHC	0.10	mg/L	06-MAY-19	0.3		50	
Lead (Pb)-Dissolved	<0.00050	DLHC	0.00050	mg/L	06-MAY-19	0.001	0.05	0.7	
Magnesium (Mg)-Dissolved	32.7	DLHC	0.050	mg/L	06-MAY-19				
Manganese (Mn)-Dissolved	0.485	DLHC	0.0050	mg/L	06-MAY-19			5	
Molybdenum (Mo)-Dissolved	0.00103	DLHC	0.00050	mg/L	06-MAY-19	0.04		5	
Nickel (Ni)-Dissolved	<0.0050	DLHC	0.0050	mg/L	06-MAY-19	0.025	0.05	2	
Phosphorus (P)-Dissolved	<0.50	DLHC	0.50	mg/L	06-MAY-19	**0.01		10	
Potassium (K)-Dissolved	3.34	DLHC	0.50	mg/L	06-MAY-19				
Selenium (Se)-Dissolved	<0.00050	DLHC	0.00050	mg/L	06-MAY-19	0.1		1.0	
Silicon (Si)-Dissolved	7.32	DLHC	0.50	mg/L	06-MAY-19				
Silver (Ag)-Dissolved	<0.00050	DLHC	0.00050	mg/L	06-MAY-19	**0.0001		0.4	
Sodium (Na)-Dissolved	240	DLHC	0.50	mg/L	06-MAY-19				
Strontium (Sr)-Dissolved	0.837	DLHC	0.010	mg/L	06-MAY-19				
Sulfur (S)-Dissolved	15.1	DLHC	5.0	mg/L	06-MAY-19				
Thallium (Tl)-Dissolved	<0.00010	DLHC	0.00010	mg/L	06-MAY-19	0.0003			
Tin (Sn)-Dissolved	<0.0010	DLHC	0.0010	mg/L	06-MAY-19			5	
Titanium (Ti)-Dissolved	<0.0030	DLHC	0.0030	mg/L	06-MAY-19				
Tungsten (W)-Dissolved	<0.0010	DLHC	0.0010	mg/L	06-MAY-19	0.03			
Uranium (U)-Dissolved	0.00160	DLHC	0.00010	mg/L	06-MAY-19	0.005			
Vanadium (V)-Dissolved	<0.0050	DLHC	0.0050	mg/L	06-MAY-19	0.006		5.0	
Zinc (Zn)-Dissolved	<0.010	DLHC	0.010	mg/L	06-MAY-19	0.02	0.04	2.0	
Zirconium (Zr)-Dissolved	<0.0030	DLHC	0.0030	mg/L	06-MAY-19	0.004			

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Ontario PWQO (JULY 1994) + Barrie Sanitary Sewer Use By-Law (2012-172) = [Suite] - ON-PWQO+SAN+STORM-BARRIE

#1: Ontario PWQO

#2: Barrie Storm Sewer

#3: Barrie Sanitary Sewer

Reference Information

Sample Parameter Qualifier key listed:

Qualifier	Description
HSED	High sediment content in submitted water sample. Analysis could only proceed using aqueous fraction after decanting. Results may be biased low and may be inappropriate for regulatory or compliance purposes.
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
BODL	Limit of Reporting for BOD was increased to account for the largest volume of sample tested.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
OWP	Organic water sample contained visible sediment (must be included as part of analysis). Measured concentrations of organic substances in water can be biased high due to presence of sediment.
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
RRR	Refer to Report Remarks for issues regarding this analysis

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference***
ALK-AUTO-WT	Water	Automated Speciated Alkalinity	EPA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ALK-SPECIATED-WT	Water	pH Measurement for Spec. Alk	APHA 4500 H-Electrode
Water samples are analyzed directly by a calibrated pH meter.			
BOD-WT	Water	BOD	APHA 5210 B
This analysis is carried out using procedures adapted from APHA Method 5210B - "Biochemical Oxygen Demand (BOD)". All forms of biochemical oxygen demand (BOD) are determined by diluting and incubating a sample for a specified time period, and measuring the oxygen depletion using a dissolved oxygen meter. Dissolved BOD (SOLUBLE) is determined by filtering the sample through a glass fibre filter prior to dilution. Carbonaceous BOD (CBOD) is determined by adding a nitrification inhibitor to the diluted sample prior to incubation.			
BR-IC-N-WT	Water	Bromide in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-IC-N-WT	Water	Chloride by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection. Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).			
CN-TOT-WT	Water	Cyanide, Total	ISO 14403-2
Total cyanide is determined by the combination of UV digestion and distillation. Cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex. When using this method, high levels of thiocyanate in samples can cause false positives at ~1-2% of the thiocyanate concentration. For samples with detectable cyanide analyzed by this method, ALS recommends analysis for thiocyanate to check for this potential interference			
COD-T-WT	Water	Chemical Oxygen Demand	APHA 5220 D
This analysis is carried out using procedures adapted from APHA Method 5220 "Chemical Oxygen Demand (COD)". Chemical oxygen demand is determined using the closed reflux colourimetric method.			
COLOUR-APPARENT-WT	Water	Colour	APHA 2120
Apparent Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method after sample decanting. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.			
DOC-WT	Water	Dissolved Organic Carbon	APHA 5310B
Sample is filtered through a 0.45um filter, then injected into a heated reaction chamber which is packed with an oxidative catalyst. The water is vaporized and the organic carbon is oxidized to carbon dioxide. The carbon dioxide is transported in a carrier gas and is measured by a non-dispersive infrared detector.			
EC-WT	Water	Conductivity	APHA 2510 B
Water samples can be measured directly by immersing the conductivity cell into the sample.			
ETL-N2N3-WT	Water	Calculate from NO2 + NO3	APHA 4110 B
ETL-SILICA-CALC-WT	Water	Calculate from SI-TOT-WT	EPA 200.8
F-IC-N-WT	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HEXACHLOROBENZENE-WT	Water	Hexachlorobenzene in water	SW846 8270
HG-T-CVAA-WT	Water	Total Mercury in Water by CVAAS	EPA 1631E (mod)
Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS.			

Reference Information

IONBALANCE-OP03-WT	Water	Detailed Ion Balance Calculation	APHA 1030E, 2330B, 2510A
MET-D-CCMS-WT	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

MET-T-CCMS-WT	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

NH3-F-WT	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-IC-WT	Water	Nitrite in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-IC-WT	Water	Nitrate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

OGG-SPEC-CALC-WT	Water	Speciated Oil and Grease A/V Calc	CALCULATION

Sample is extracted with hexane, sample speciation into mineral and animal/vegetable fractions is achieved via silica gel separation and is then determined gravimetrically.

OGG-SPEC-WT	Water	Speciated Oil and Grease-Gravimetric	APHA 5520 B

The procedure involves an extraction of the entire water sample with hexane. Sample speciation into mineral and animal/vegetable fractions is achieved via silica gel separation and is then determined gravimetrically.

P-T-COL-WT	Water	Total P in Water by Colour	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is deteremined colourimetrically after persulphate digestion of the sample.

PAH-511-WT	Water	PAH-O. Reg 153/04 (July 2011)	SW846 3510/8270

Aqueous samples, fortified with surrogates, are extracted using liquid/liquid extraction technique. The sample extracts are concentrated and then analyzed using GC/MS. Results for benzo(b) fluoranthene may include contributions from benzo(j)fluoranthene, if also present in the sample.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

PAH-SUM-CALC-WT	Water	TOTAL PAH's	CALCULATION

Total PAH represents the sum of all PAH analytes reported for a given sample. Note that regulatory agencies and criteria differ in their definitions of Total PAH in terms of the individual PAH analytes to be included.

PH-WT	Water	pH	APHA 4500 H-Electrode

Water samples are analyzed directly by a calibrated pH meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011). Holdtime for samples under this regulation is 28 days

PHENOLS-4AAP-WT	Water	Phenol (4AAP)	EPA 9066

An automated method is used to distill the sample. The distillate is then buffered to pH 9.4 which reacts with 4AAP and potassium ferricyanide to form a red complex which is measured colorimetrically.

PO4-DO-COL-WT	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

Reference Information

S2-T>H2S-CALC-WT	Water	Total Sulphide Calculated as H2S	Calculation

This calculation converts Total Sulphide as (S2-) and reports it as Total Sulphide as (H2S). Total Sulphide as (S2-) is determined using procedures adapted from APHA 4500-S2 "Sulphide".

SO4-IC-N-WT	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SOLIDS-TDS-WT	Water	Total Dissolved Solids	APHA 2540C

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

SOLIDS-TSS-WT	Water	Suspended solids	APHA 2540 D-Gravimetric

A well-mixed sample is filtered through a weighed standard glass fibre filter and the residue retained is dried in an oven at 104–1°C for a minimum of four hours or until a constant weight is achieved.

SULPHIDE-WT	Water	Sulphide (as S)	APHA 4500S2D

This analysis is carried out using procedures adapted from APHA Method 4500-S2-D "Methylene Blue Method". Sulphide is determined colourmetrically.

TKN-WT	Water	Total Kjeldahl Nitrogen	APHA 4500-Norg D

This analysis is carried out using procedures adapted from APHA Method 4500-Norg "Nitrogen (Organic)". Total Kjeldahl Nitrogen is determined by sample digestion at 380 Celsius with analysis using an automated colorimetric method.

TURBIDITY-WT	Water	Turbidity	APHA 2130 B

Sample result is based on a comparison of the intensity of the light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. Sample readings are obtained from a Nephelometer.

VOC-ROU-HS-WT	Water	Volatile Organic Compounds	SW846 8260

Aqueous samples are analyzed by headspace-GC/MS.

XYLENES-SUM-CALC-WT	Water	Sum of Xylene Isomer Concentrations	CALCULATION

Total xylenes represents the sum of o-xylene and m&p-xylene.

*** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Chain of Custody numbers:

17-623778

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location	Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA		

Reference Information

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information. Guideline limits are not adjusted for the hardness, pH or temperature of the sample (the most conservative values are used). Measurement uncertainty is not applied to test results prior to comparison with specified criteria values.

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-AUTO-WT	**Water**							
Batch R4623949								
WG3041627-6 LCS								
Alkalinity, Total (as CaCO3)			100.2		%		85-115	04-MAY-19
WG3041627-5 MB								
Alkalinity, Total (as CaCO3)			<10		mg/L		10	04-MAY-19
Alkalinity, Bicarbonate (as CaCO3)			<10		mg/L		10	04-MAY-19
Alkalinity, Carbonate (as CaCO3)			<10		mg/L		10	04-MAY-19
Alkalinity, Hydroxide (as CaCO3)			<10		mg/L		10	04-MAY-19
ALK-SPECIATED-WT	**Water**							
Batch R4623949								
WG3041627-8 DUP		**WG3041627-7**						
pH		7.54	7.54	J	pH units	0.00	0.2	04-MAY-19
WG3041627-6 LCS								
pH			7.01		pH units		6.9-7.1	04-MAY-19
BOD-WT	**Water**							
Batch R4629117								
WG3041854-6 DUP		**L2267199-1**						
BOD		<2.0	<2.0	RPD-NA	mg/L	N/A	20	09-MAY-19
WG3041854-7 LCS								
BOD			91.4		%		85-115	09-MAY-19
WG3041854-5 MB								
BOD			<2.0		mg/L		2	09-MAY-19
BR-IC-N-WT	**Water**							
Batch R4628221								
WG3043259-9 DUP		**L2267836-2**						
Bromide (Br)		0.11	0.11		mg/L	1.6	20	07-MAY-19
WG3043259-7 LCS								
Bromide (Br)			104.4		%		85-115	07-MAY-19
WG3043259-6 MB								
Bromide (Br)			<0.10		mg/L		0.1	07-MAY-19
WG3043259-10 MS		**L2267836-2**						
Bromide (Br)			100.9		%		75-125	07-MAY-19
CL-IC-N-WT	**Water**							
Batch R4625685								
WG3042630-20 DUP		**WG3042630-18**						
Chloride (Cl)		110	110		mg/L	0.7	20	06-MAY-19
WG3042630-17 LCS								
Chloride (Cl)			100.3		%		90-110	06-MAY-19

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-IC-N-WT	**Water**							
Batch R4625685								
WG3042630-16 MB								
Chloride (Cl)			<0.50		mg/L		0.5	06-MAY-19
WG3042630-19 MS		**WG3042630-18**						
Chloride (Cl)			N/A	MS-B	%		-	06-MAY-19
Batch R4628221								
WG3043259-9 DUP		**L2267836-2**						
Chloride (Cl)		73.8	73.7		mg/L	0.1	20	07-MAY-19
WG3043259-7 LCS								
Chloride (Cl)			101.5		%		90-110	07-MAY-19
WG3043259-6 MB								
Chloride (Cl)			<0.50		mg/L		0.5	07-MAY-19
WG3043259-10 MS		**L2267836-2**						
Chloride (Cl)			104.4		%		75-125	07-MAY-19
CN-TOT-WT	**Water**							
Batch R4628902								
WG3043257-3 DUP		**L2267242-3**						
Cyanide, Total		<0.0020	<0.0020	RPD-NA	mg/L	N/A	20	07-MAY-19
WG3043257-2 LCS								
Cyanide, Total			87.7		%		80-120	07-MAY-19
WG3043257-1 MB								
Cyanide, Total			<0.0020		mg/L		0.002	07-MAY-19
WG3043257-4 MS		**L2267242-3**						
Cyanide, Total			88.2		%		70-130	07-MAY-19
COD-T-WT	**Water**							
Batch R4630342								
WG3045180-3 DUP		**L2267065-1**						
COD		41	42		mg/L	2.2	20	09-MAY-19
WG3045180-2 LCS								
COD			99.6		%		85-115	09-MAY-19
WG3045180-1 MB								
COD			<10		mg/L		10	09-MAY-19
WG3045180-4 MS		**L2267065-1**						
COD			103.4		%		75-125	09-MAY-19
COLOUR-APPARENT-WT	**Water**							

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
COLOUR-APPARENT-WT	**Water**							
Batch R4622813								
WG3041709-3 DUP		**L2267466-1**						
Colour, Apparent		3.3	3.4		CU	2.8	20	04-MAY-19
WG3041709-2 LCS								
Colour, Apparent			99.8		%		85-115	04-MAY-19
WG3041709-1 MB								
Colour, Apparent			<2.0		CU		2	04-MAY-19
DOC-WT	**Water**							
Batch R4629369								
WG3042753-3 DUP		**L2266968-3**						
Dissolved Organic Carbon		5.24	5.78		mg/L	9.8	25	08-MAY-19
WG3042753-2 LCS								
Dissolved Organic Carbon			95.9		%		70-130	08-MAY-19
WG3042753-1 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	08-MAY-19
WG3042753-4 MS		**L2266968-3**						
Dissolved Organic Carbon			105.0		%		70-130	08-MAY-19
EC-WT	**Water**							
Batch R4623949								
WG3041627-8 DUP		**WG3041627-7**						
Conductivity		1890	1870		umhos/cm	1.4	10	04-MAY-19
WG3041627-6 LCS								
Conductivity			95.7		%		90-110	04-MAY-19
WG3041627-5 MB								
Conductivity			<3.0		umhos/cm		3	04-MAY-19
F-IC-N-WT	**Water**							
Batch R4625685								
WG3042630-20 DUP		**WG3042630-18**						
Fluoride (F)		0.101	0.100		mg/L	1.3	20	06-MAY-19
WG3042630-17 LCS								
Fluoride (F)			99.8		%		90-110	06-MAY-19
WG3042630-16 MB								
Fluoride (F)			<0.020		mg/L		0.02	06-MAY-19
WG3042630-19 MS		**WG3042630-18**						
Fluoride (F)			99.1		%		75-125	06-MAY-19

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F-IC-N-WT	**Water**							
Batch R4628221								
WG3043259-9 DUP		**L2267836-2**						
Fluoride (F)		0.110	0.111		mg/L	0.7	20	07-MAY-19
WG3043259-7 LCS								
Fluoride (F)			101.9		%		90-110	07-MAY-19
WG3043259-6 MB								
Fluoride (F)			<0.020		mg/L		0.02	07-MAY-19
WG3043259-10 MS		**L2267836-2**						
Fluoride (F)			96.9		%		75-125	07-MAY-19
HEXACHLOROBENZENE-W	**Water**							
Batch R4630498								
WG3043988-2 LCS								
Hexachlorobenzene			79.5		%		40-130	09-MAY-19
WG3043988-1 MB								
Hexachlorobenzene			<0.040		ug/L		0.04	10-MAY-19
Surrogate: 2-Fluorobiphenyl			82.9		%		40-130	10-MAY-19
Surrogate: p-Terphenyl d14			80.0		%		40-130	10-MAY-19
HG-T-CVAA-WT	**Water**							
Batch R4624326								
WG3042307-4 DUP		**WG3042307-3**						
Mercury (Hg)-Total		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	06-MAY-19
WG3042307-2 LCS								
Mercury (Hg)-Total			108.0		%		80-120	06-MAY-19
WG3042307-1 MB								
Mercury (Hg)-Total			<0.000010		mg/L		0.00001	06-MAY-19
WG3042307-6 MS		**WG3042307-5**						
Mercury (Hg)-Total			111.9		%		70-130	06-MAY-19
MET-D-CCMS-WT	**Water**							
Batch R4625286								
WG3042106-4 DUP		**WG3042106-3**						
Aluminum (Al)-Dissolved		<0.050	<0.050	RPD-NA	mg/L	N/A	20	06-MAY-19
Antimony (Sb)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	06-MAY-19
Arsenic (As)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	06-MAY-19
Barium (Ba)-Dissolved		0.0492	0.0483		mg/L	1.8	20	06-MAY-19
Beryllium (Be)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	06-MAY-19
Bismuth (Bi)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	06-MAY-19
Boron (B)-Dissolved		0.15	0.15		mg/L	1.9	20	06-MAY-19

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R4625286								
WG3042106-4 DUP		**WG3042106-3**						
Cadmium (Cd)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	06-MAY-19
Calcium (Ca)-Dissolved		148	147		mg/L	0.6	20	06-MAY-19
Chromium (Cr)-Dissolved		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	06-MAY-19
Cobalt (Co)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	06-MAY-19
Copper (Cu)-Dissolved		<0.0020	<0.0020	RPD-NA	mg/L	N/A	20	06-MAY-19
Iron (Fe)-Dissolved		<0.10	<0.10	RPD-NA	mg/L	N/A	20	06-MAY-19
Lead (Pb)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	06-MAY-19
Magnesium (Mg)-Dissolved		265	264		mg/L	0.4	20	06-MAY-19
Manganese (Mn)-Dissolved		0.104	0.102		mg/L	2.1	20	06-MAY-19
Molybdenum (Mo)-Dissolved		0.00411	0.00397		mg/L	3.5	20	06-MAY-19
Nickel (Ni)-Dissolved		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	06-MAY-19
Phosphorus (P)-Dissolved		<0.50	<0.50	RPD-NA	mg/L	N/A	20	06-MAY-19
Potassium (K)-Dissolved		3.64	3.62		mg/L	0.8	20	06-MAY-19
Selenium (Se)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	06-MAY-19
Silicon (Si)-Dissolved		7.62	7.58		mg/L	0.5	20	06-MAY-19
Silver (Ag)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	06-MAY-19
Sodium (Na)-Dissolved		121	120		mg/L	1.1	20	06-MAY-19
Strontium (Sr)-Dissolved		2.48	2.38		mg/L	4.1	20	06-MAY-19
Sulfur (S)-Dissolved		377	380		mg/L	0.8	20	06-MAY-19
Thallium (Tl)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	06-MAY-19
Tin (Sn)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	06-MAY-19
Titanium (Ti)-Dissolved		<0.0030	<0.0030	RPD-NA	mg/L	N/A	20	06-MAY-19
Tungsten (W)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	06-MAY-19
Uranium (U)-Dissolved		0.0165	0.0164		mg/L	0.6	20	06-MAY-19
Vanadium (V)-Dissolved		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	06-MAY-19
Zinc (Zn)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	06-MAY-19
Zirconium (Zr)-Dissolved		<0.0030	<0.0030	RPD-NA	mg/L	N/A	20	06-MAY-19
WG3042106-2 LCS								
Aluminum (Al)-Dissolved			109.6		%		80-120	06-MAY-19
Antimony (Sb)-Dissolved			99.9		%		80-120	06-MAY-19
Arsenic (As)-Dissolved			100.9		%		80-120	06-MAY-19
Barium (Ba)-Dissolved			102.1		%		80-120	06-MAY-19
Beryllium (Be)-Dissolved			98.9		%		80-120	06-MAY-19

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R4625286								
WG3042106-2 LCS								
Bismuth (Bi)-Dissolved			100.6		%		80-120	06-MAY-19
Boron (B)-Dissolved			98.7		%		80-120	06-MAY-19
Cadmium (Cd)-Dissolved			104.0		%		80-120	06-MAY-19
Calcium (Ca)-Dissolved			103.0		%		80-120	06-MAY-19
Chromium (Cr)-Dissolved			103.0		%		80-120	06-MAY-19
Cobalt (Co)-Dissolved			95.7		%		80-120	06-MAY-19
Copper (Cu)-Dissolved			99.2		%		80-120	06-MAY-19
Iron (Fe)-Dissolved			97.0		%		80-120	06-MAY-19
Lead (Pb)-Dissolved			105.2		%		80-120	06-MAY-19
Magnesium (Mg)-Dissolved			107.6		%		80-120	06-MAY-19
Manganese (Mn)-Dissolved			104.1		%		80-120	06-MAY-19
Molybdenum (Mo)-Dissolved			104.9		%		80-120	06-MAY-19
Nickel (Ni)-Dissolved			100.1		%		80-120	06-MAY-19
Phosphorus (P)-Dissolved			110.7		%		80-120	06-MAY-19
Potassium (K)-Dissolved			111.2		%		80-120	06-MAY-19
Selenium (Se)-Dissolved			97.9		%		80-120	06-MAY-19
Silicon (Si)-Dissolved			106.7		%		60-140	06-MAY-19
Silver (Ag)-Dissolved			98.8		%		80-120	06-MAY-19
Sodium (Na)-Dissolved			103.0		%		80-120	06-MAY-19
Strontium (Sr)-Dissolved			101.1		%		80-120	06-MAY-19
Sulfur (S)-Dissolved			109.6		%		80-120	06-MAY-19
Thallium (Tl)-Dissolved			103.1		%		80-120	06-MAY-19
Tin (Sn)-Dissolved			102.2		%		80-120	06-MAY-19
Titanium (Ti)-Dissolved			101.4		%		80-120	06-MAY-19
Tungsten (W)-Dissolved			99.4		%		80-120	06-MAY-19
Uranium (U)-Dissolved			96.9		%		80-120	06-MAY-19
Vanadium (V)-Dissolved			105.3		%		80-120	06-MAY-19
Zinc (Zn)-Dissolved			100.7		%		80-120	06-MAY-19
Zirconium (Zr)-Dissolved			96.5		%		80-120	06-MAY-19
WG3042106-1 MB								
Aluminum (Al)-Dissolved			<0.0050		mg/L		0.005	06-MAY-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	06-MAY-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	06-MAY-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	06-MAY-19

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R4625286								
WG3042106-1 MB								
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	06-MAY-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	06-MAY-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	06-MAY-19
Cadmium (Cd)-Dissolved			<0.000005(		mg/L		0.000005	06-MAY-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	06-MAY-19
Chromium (Cr)-Dissolved			<0.00050		mg/L		0.0005	06-MAY-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	06-MAY-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	06-MAY-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	06-MAY-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	06-MAY-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	06-MAY-19
Manganese (Mn)-Dissolved			<0.00050		mg/L		0.0005	06-MAY-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	06-MAY-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	06-MAY-19
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	06-MAY-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	06-MAY-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	06-MAY-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	06-MAY-19
Silver (Ag)-Dissolved			<0.000050		mg/L		0.00005	06-MAY-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	06-MAY-19
Strontium (Sr)-Dissolved			<0.0010		mg/L		0.001	06-MAY-19
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	06-MAY-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	06-MAY-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	06-MAY-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	06-MAY-19
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	06-MAY-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	06-MAY-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	06-MAY-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	06-MAY-19
Zirconium (Zr)-Dissolved			<0.00030		mg/L		0.0003	06-MAY-19
WG3042106-5 MS		**WG3042106-6**						
Aluminum (Al)-Dissolved			90.0		%		70-130	06-MAY-19
Antimony (Sb)-Dissolved			93.7		%		70-130	06-MAY-19
Arsenic (As)-Dissolved			93.8		%		70-130	06-MAY-19

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9

Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R4625286								
WG3042106-5 MS		**WG3042106-6**						
Barium (Ba)-Dissolved			N/A	MS-B	%		-	06-MAY-19
Beryllium (Be)-Dissolved			94.4		%		70-130	06-MAY-19
Bismuth (Bi)-Dissolved			88.7		%		70-130	06-MAY-19
Boron (B)-Dissolved			N/A	MS-B	%		-	06-MAY-19
Cadmium (Cd)-Dissolved			93.4		%		70-130	06-MAY-19
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	06-MAY-19
Chromium (Cr)-Dissolved			92.3		%		70-130	06-MAY-19
Cobalt (Co)-Dissolved			84.1		%		70-130	06-MAY-19
Copper (Cu)-Dissolved			85.9		%		70-130	06-MAY-19
Iron (Fe)-Dissolved			N/A	MS-B	%		-	06-MAY-19
Lead (Pb)-Dissolved			90.9		%		70-130	06-MAY-19
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	06-MAY-19
Manganese (Mn)-Dissolved			N/A	MS-B	%		-	06-MAY-19
Molybdenum (Mo)-Dissolved			N/A	MS-B	%		-	06-MAY-19
Nickel (Ni)-Dissolved			79.9		%		70-130	06-MAY-19
Phosphorus (P)-Dissolved			98.3		%		70-130	06-MAY-19
Selenium (Se)-Dissolved			87.6		%		70-130	06-MAY-19
Silicon (Si)-Dissolved			N/A	MS-B	%		-	06-MAY-19
Silver (Ag)-Dissolved			74.7		%		70-130	06-MAY-19
Sodium (Na)-Dissolved			N/A	MS-B	%		-	06-MAY-19
Strontium (Sr)-Dissolved			N/A	MS-B	%		-	06-MAY-19
Sulfur (S)-Dissolved			N/A	MS-B	%		-	06-MAY-19
Thallium (Tl)-Dissolved			92.8		%		70-130	06-MAY-19
Tin (Sn)-Dissolved			97.2		%		70-130	06-MAY-19
Titanium (Ti)-Dissolved			91.9		%		70-130	06-MAY-19
Tungsten (W)-Dissolved			N/A	MS-B	%		-	06-MAY-19
Uranium (U)-Dissolved			N/A	MS-B	%		-	06-MAY-19
Vanadium (V)-Dissolved			95.3		%		70-130	06-MAY-19
Zinc (Zn)-Dissolved			88.1		%		70-130	06-MAY-19
Zirconium (Zr)-Dissolved			85.3		%		70-130	06-MAY-19
MET-T-CCMS-WT	**Water**							

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9

Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R4624148								
WG3042090-4 DUP		**WG3042090-3**						
Aluminum (Al)-Total		<0.050	<0.050	RPD-NA	mg/L	N/A	20	06-MAY-19
Antimony (Sb)-Total		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	06-MAY-19
Arsenic (As)-Total		0.0037	0.0038		mg/L	2.1	20	06-MAY-19
Barium (Ba)-Total		0.0106	0.0109		mg/L	2.7	20	06-MAY-19
Bismuth (Bi)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	06-MAY-19
Cadmium (Cd)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	06-MAY-19
Chromium (Cr)-Total		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	06-MAY-19
Cobalt (Co)-Total		0.0019	0.0019		mg/L	0.4	20	06-MAY-19
Copper (Cu)-Total		<0.010	<0.010	RPD-NA	mg/L	N/A	20	06-MAY-19
Iron (Fe)-Total		<0.10	<0.10	RPD-NA	mg/L	N/A	20	06-MAY-19
Lead (Pb)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	06-MAY-19
Manganese (Mn)-Total		0.0832	0.0834		mg/L	0.3	20	06-MAY-19
Molybdenum (Mo)-Total		0.00120	0.00115		mg/L	3.8	20	06-MAY-19
Nickel (Ni)-Total		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	06-MAY-19
Selenium (Se)-Total		0.00060	0.00072		mg/L	19	20	06-MAY-19
Silver (Ag)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	06-MAY-19
Tin (Sn)-Total		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	06-MAY-19
Titanium (Ti)-Total		<0.0030	<0.0030	RPD-NA	mg/L	N/A	20	06-MAY-19
Vanadium (V)-Total		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	06-MAY-19
Zinc (Zn)-Total		<0.030	<0.030	RPD-NA	mg/L	N/A	20	06-MAY-19
WG3042090-2 LCS								
Aluminum (Al)-Total			103.7		%		80-120	06-MAY-19
Antimony (Sb)-Total			104.9		%		80-120	06-MAY-19
Arsenic (As)-Total			102.2		%		80-120	06-MAY-19
Barium (Ba)-Total			97.2		%		80-120	06-MAY-19
Bismuth (Bi)-Total			99.6		%		80-120	06-MAY-19
Cadmium (Cd)-Total			98.7		%		80-120	06-MAY-19
Chromium (Cr)-Total			102.4		%		80-120	06-MAY-19
Cobalt (Co)-Total			99.9		%		80-120	06-MAY-19
Copper (Cu)-Total			101.2		%		80-120	06-MAY-19
Iron (Fe)-Total			96.7		%		80-120	06-MAY-19
Lead (Pb)-Total			103.9		%		80-120	06-MAY-19
Manganese (Mn)-Total			103.6		%		80-120	06-MAY-19

Quality Control Report

Workorder: L2267557 Report Date: 21-MAY-19

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R4624148								
WG3042090-2 LCS								
Molybdenum (Mo)-Total			96.4		%		80-120	06-MAY-19
Nickel (Ni)-Total			100.2		%		80-120	06-MAY-19
Selenium (Se)-Total			101.7		%		80-120	06-MAY-19
Silver (Ag)-Total			98.7		%		80-120	06-MAY-19
Tin (Sn)-Total			101.0		%		80-120	06-MAY-19
Titanium (Ti)-Total			99.4		%		80-120	06-MAY-19
Vanadium (V)-Total			103.7		%		80-120	06-MAY-19
Zinc (Zn)-Total			100.8		%		80-120	06-MAY-19
WG3042090-1 MB								
Aluminum (Al)-Total			<0.0050		mg/L		0.005	06-MAY-19
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	06-MAY-19
Arsenic (As)-Total			<0.00010		mg/L		0.0001	06-MAY-19
Barium (Ba)-Total			<0.00010		mg/L		0.0001	06-MAY-19
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	06-MAY-19
Cadmium (Cd)-Total			<0.000005(		mg/L		0.000005	06-MAY-19
Chromium (Cr)-Total			<0.00050		mg/L		0.0005	06-MAY-19
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	06-MAY-19
Copper (Cu)-Total			<0.0010		mg/L		0.001	06-MAY-19
Iron (Fe)-Total			<0.010		mg/L		0.01	06-MAY-19
Lead (Pb)-Total			<0.000050		mg/L		0.00005	06-MAY-19
Manganese (Mn)-Total			<0.00050		mg/L		0.0005	06-MAY-19
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	06-MAY-19
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	06-MAY-19
Selenium (Se)-Total			<0.000050		mg/L		0.00005	06-MAY-19
Silver (Ag)-Total			<0.000050		mg/L		0.00005	06-MAY-19
Tin (Sn)-Total			<0.00010		mg/L		0.0001	06-MAY-19
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	06-MAY-19
Vanadium (V)-Total			<0.00050		mg/L		0.0005	06-MAY-19
Zinc (Zn)-Total			<0.0030		mg/L		0.003	06-MAY-19
WG3042090-5 MS		**WG3042090-6**						
Aluminum (Al)-Total			107.8		%		70-130	06-MAY-19
Antimony (Sb)-Total			100.3		%		70-130	06-MAY-19
Arsenic (As)-Total			101.7		%		70-130	06-MAY-19
Barium (Ba)-Total			N/A	MS-B	%		-	06-MAY-19

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R4624148								
WG3042090-5 MS		**WG3042090-6**						
Bismuth (Bi)-Total			86.8		%		70-130	06-MAY-19
Cadmium (Cd)-Total			99.4		%		70-130	06-MAY-19
Chromium (Cr)-Total			102.7		%		70-130	06-MAY-19
Cobalt (Co)-Total			93.1		%		70-130	06-MAY-19
Copper (Cu)-Total			93.2		%		70-130	06-MAY-19
Iron (Fe)-Total			99.5		%		70-130	06-MAY-19
Lead (Pb)-Total			86.5		%		70-130	06-MAY-19
Manganese (Mn)-Total			N/A	MS-B	%		-	06-MAY-19
Molybdenum (Mo)-Total			102.3		%		70-130	06-MAY-19
Nickel (Ni)-Total			94.0		%		70-130	06-MAY-19
Selenium (Se)-Total			97.8		%		70-130	06-MAY-19
Silver (Ag)-Total			91.1		%		70-130	06-MAY-19
Tin (Sn)-Total			96.2		%		70-130	06-MAY-19
Titanium (Ti)-Total			101.7		%		70-130	06-MAY-19
Vanadium (V)-Total			106.6		%		70-130	06-MAY-19
Zinc (Zn)-Total			91.5		%		70-130	06-MAY-19
NH3-F-WT	**Water**							
Batch R4629164								
WG3044170-8 DUP		**L2269034-1**						
Ammonia, Total (as N)		0.778	0.784		mg/L	0.7	20	08-MAY-19
WG3044170-6 LCS								
Ammonia, Total (as N)			100.3		%		85-115	08-MAY-19
WG3044170-5 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	08-MAY-19
WG3044170-7 MS		**L2269034-1**						
Ammonia, Total (as N)			N/A	MS-B	%		-	08-MAY-19
Batch R4629261								
WG3045264-3 DUP		**L2266968-12**						
Ammonia, Total (as N)		0.293	0.293		mg/L	0.1	20	09-MAY-19
WG3045264-2 LCS								
Ammonia, Total (as N)			96.8		%		85-115	09-MAY-19
WG3045264-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	09-MAY-19
WG3045264-4 MS		**L2266968-12**						
Ammonia, Total (as N)			N/A	MS-B	%		-	09-MAY-19

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-IC-WT	**Water**							
Batch R4628221								
WG3043259-9 DUP		**L2267836-2**						
Nitrite (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	20	07-MAY-19
WG3043259-7 LCS								
Nitrite (as N)			102.3		%		90-110	07-MAY-19
WG3043259-6 MB								
Nitrite (as N)			<0.010		mg/L		0.01	07-MAY-19
WG3043259-10 MS		**L2267836-2**						
Nitrite (as N)			104.6		%		75-125	07-MAY-19
NO3-IC-WT	**Water**							
Batch R4628221								
WG3043259-9 DUP		**L2267836-2**						
Nitrate (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	07-MAY-19
WG3043259-7 LCS								
Nitrate (as N)			100.7		%		90-110	07-MAY-19
WG3043259-6 MB								
Nitrate (as N)			<0.020		mg/L		0.02	07-MAY-19
WG3043259-10 MS		**L2267836-2**						
Nitrate (as N)			99.6		%		75-125	07-MAY-19
OGG-SPEC-WT	**Water**							
Batch R4628661								
WG3044063-2 LCS								
Oil and Grease, Total			92.1		%		70-130	08-MAY-19
Mineral Oil and Grease			78.1		%		70-130	08-MAY-19
WG3044063-1 MB								
Oil and Grease, Total			<5.0		mg/L		5	08-MAY-19
Mineral Oil and Grease			<2.5		mg/L		2.5	08-MAY-19
P-T-COL-WT	**Water**							
Batch R4629354								
WG3044577-3 DUP		**L2267551-5**						
Phosphorus, Total		0.0118	0.0109		mg/L	7.2	20	09-MAY-19
WG3044577-2 LCS								
Phosphorus, Total			104.0		%		80-120	09-MAY-19
WG3044577-1 MB								
Phosphorus, Total			<0.0030		mg/L		0.003	09-MAY-19
WG3044577-4 MS		**L2267551-5**						
Phosphorus, Total			92.5		%		70-130	09-MAY-19
PAH-511-WT	**Water**							

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-511-WT	**Water**							
Batch R4630334								
WG3043988-2 LCS								
1-Methylnaphthalene			97.5		%		50-140	10-MAY-19
2-Methylnaphthalene			95.5		%		50-140	10-MAY-19
Acenaphthene			98.6		%		50-140	10-MAY-19
Acenaphthylene			94.2		%		50-140	10-MAY-19
Anthracene			82.0		%		50-140	10-MAY-19
Benzo(a)anthracene			85.0		%		50-140	10-MAY-19
Benzo(a)pyrene			87.7		%		50-140	10-MAY-19
Benzo(b)fluoranthene			77.0		%		50-140	10-MAY-19
Benzo(g,h,i)perylene			85.9		%		50-140	10-MAY-19
Benzo(k)fluoranthene			105.9		%		50-140	10-MAY-19
Chrysene			98.0		%		50-140	10-MAY-19
Dibenzo(ah)anthracene			82.8		%		50-140	10-MAY-19
Fluoranthene			92.8		%		50-140	10-MAY-19
Fluorene			98.7		%		50-140	10-MAY-19
Indeno(1,2,3-cd)pyrene			81.0		%		50-140	10-MAY-19
Naphthalene			92.5		%		50-140	10-MAY-19
Phenanthrene			96.7		%		50-140	10-MAY-19
Pyrene			93.4		%		50-140	10-MAY-19
WG3043988-1 MB								
1-Methylnaphthalene			<0.020		ug/L		0.02	10-MAY-19
2-Methylnaphthalene			<0.020		ug/L		0.02	10-MAY-19
Acenaphthene			<0.020		ug/L		0.02	10-MAY-19
Acenaphthylene			<0.020		ug/L		0.02	10-MAY-19
Anthracene			<0.020		ug/L		0.02	10-MAY-19
Benzo(a)anthracene			<0.020		ug/L		0.02	10-MAY-19
Benzo(a)pyrene			<0.010		ug/L		0.01	10-MAY-19
Benzo(b)fluoranthene			<0.020		ug/L		0.02	10-MAY-19
Benzo(g,h,i)perylene			<0.020		ug/L		0.02	10-MAY-19
Benzo(k)fluoranthene			<0.020		ug/L		0.02	10-MAY-19
Chrysene			<0.020		ug/L		0.02	10-MAY-19
Dibenzo(ah)anthracene			<0.020		ug/L		0.02	10-MAY-19
Fluoranthene			<0.020		ug/L		0.02	10-MAY-19
Fluorene			<0.020		ug/L		0.02	10-MAY-19
Indeno(1,2,3-cd)pyrene			<0.020		ug/L		0.02	10-MAY-19

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-511-WT	**Water**							
Batch R4630334								
WG3043988-1 MB								
Naphthalene			<0.050		ug/L		0.05	10-MAY-19
Phenanthrene			<0.020		ug/L		0.02	10-MAY-19
Pyrene			<0.020		ug/L		0.02	10-MAY-19
Surrogate: 2-Fluorobiphenyl			96.0		%		50-140	10-MAY-19
Surrogate: d14-Terphenyl			81.2		%		60-140	10-MAY-19
PH-WT	**Water**							
Batch R4623949								
WG3041627-8 DUP		**WG3041627-7**						
pH		7.54	7.54	J	pH units	0.00	0.2	04-MAY-19
WG3041627-6 LCS								
pH			7.01		pH units		6.9-7.1	04-MAY-19
PHENOLS-4AAP-WT	**Water**							
Batch R4624049								
WG3042322-3 DUP		**L2266311-1**						
Phenols (4AAP)		0.0058	0.0056		mg/L	3.1	20	06-MAY-19
WG3042322-2 LCS								
Phenols (4AAP)			96.5		%		85-115	06-MAY-19
WG3042322-1 MB								
Phenols (4AAP)			<0.0010		mg/L		0.001	06-MAY-19
WG3042322-4 MS		**L2266311-1**						
Phenols (4AAP)			91.9		%		75-125	06-MAY-19
PO4-DO-COL-WT	**Water**							
Batch R4628467								
WG3044254-7 DUP		**L2268001-1**						
Orthophosphate-Dissolved (as P)		<0.0030	<0.0030	RPD-NA	mg/L	N/A	20	08-MAY-19
WG3044254-6 LCS								
Orthophosphate-Dissolved (as P)			116.2		%		80-120	08-MAY-19
WG3044254-5 MB								
Orthophosphate-Dissolved (as P)			<0.0030		mg/L		0.003	08-MAY-19
WG3044254-8 MS		**L2268001-1**						
Orthophosphate-Dissolved (as P)			103.3		%		70-130	08-MAY-19
SO4-IC-N-WT	**Water**							
Batch R4625685								
WG3042630-20 DUP		**WG3042630-18**						
Sulfate (SO4)		41.4	41.1		mg/L	0.8	20	06-MAY-19
WG3042630-17 LCS								

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-WT	**Water**							
Batch R4625685								
WG3042630-17 LCS								
Sulfate (SO4)			101.2		%		90-110	06-MAY-19
WG3042630-16 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	06-MAY-19
WG3042630-19 MS		**WG3042630-18**						
Sulfate (SO4)			102.0		%		75-125	06-MAY-19
Batch R4628221								
WG3043259-9 DUP		**L2267836-2**						
Sulfate (SO4)		22.4	22.4		mg/L	0.3	20	07-MAY-19
WG3043259-7 LCS								
Sulfate (SO4)			102.0		%		90-110	07-MAY-19
WG3043259-6 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	07-MAY-19
WG3043259-10 MS		**L2267836-2**						
Sulfate (SO4)			107.1		%		75-125	07-MAY-19
SOLIDS-TDS-WT	**Water**							
Batch R4629371								
WG3044613-3 DUP		**L2266649-1**						
Total Dissolved Solids		2120	2120		mg/L	0.0	20	08-MAY-19
WG3044613-2 LCS								
Total Dissolved Solids			101.1		%		85-115	08-MAY-19
WG3044613-1 MB								
Total Dissolved Solids			<10		mg/L		10	08-MAY-19
SOLIDS-TSS-WT	**Water**							
Batch R4628130								
WG3043590-3 DUP		**L2267557-3**						
Total Suspended Solids		300000	312000		mg/L	3.7	20	08-MAY-19
WG3043590-2 LCS								
Total Suspended Solids			100.3		%		85-115	08-MAY-19
WG3043590-1 MB								
Total Suspended Solids			<2.0		mg/L		2	08-MAY-19
SULPHIDE-WT	**Water**							
Batch R4628512								
WG3044031-3 DUP		**WG3044031-5**						
Sulphide (as S)		0.069	0.067		mg/L	2.9	20	08-MAY-19
WG3044031-2 LCS								
Sulphide (as S)			92.2		%		75-125	08-MAY-19

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9

Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SULPHIDE-WT	**Water**							
Batch R4628512								
WG3044031-9 LCS								
Sulphide (as S)			92.2		%		75-125	08-MAY-19
WG3044031-1 MB								
Sulphide (as S)			<0.018		mg/L		0.018	08-MAY-19
WG3044031-8 MB								
Sulphide (as S)			<0.018		mg/L		0.018	08-MAY-19
WG3044031-4 MS		**WG3044031-5**						
Sulphide (as S)			100.0		%		65-135	08-MAY-19
TKN-WT	**Water**							
Batch R4629335								
WG3044054-3 DUP		**L2267705-1**						
Total Kjeldahl Nitrogen		94.1	96.5		mg/L	2.5	20	09-MAY-19
WG3044054-2 LCS								
Total Kjeldahl Nitrogen			98.2		%		75-125	09-MAY-19
WG3044054-1 MB								
Total Kjeldahl Nitrogen			<0.15		mg/L		0.15	09-MAY-19
WG3044054-4 MS		**L2267705-1**						
Total Kjeldahl Nitrogen			N/A	MS-B	%		-	09-MAY-19
TURBIDITY-WT	**Water**							
Batch R4622746								
WG3041620-3 DUP		**L2267466-1**						
Turbidity		0.36	0.38		NTU	3.3	15	04-MAY-19
WG3041620-2 LCS								
Turbidity			102.0		%		85-115	04-MAY-19
WG3041620-1 MB								
Turbidity			<0.10		NTU		0.1	04-MAY-19
VOC-ROU-HS-WT	**Water**							
Batch R4628193								
WG3043835-4 DUP		**WG3043835-3**						
1,1,1,2-Tetrachloroethane		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
1,1,2,2-Tetrachloroethane		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
1,1,1-Trichloroethane		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
1,1,2-Trichloroethane		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
1,2-Dibromoethane		<0.20	<0.20	RPD-NA	ug/L	N/A	30	08-MAY-19
1,1-Dichloroethane		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
1,1-Dichloroethylene		0.92	0.86		ug/L	6.7	30	08-MAY-19

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-ROU-HS-WT	**Water**							
Batch R4628193								
WG3043835-4 DUP		**WG3043835-3**						
1,2-Dichlorobenzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
1,2-Dichloroethane		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
1,2-Dichloropropane		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
1,3-Dichlorobenzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
1,4-Dichlorobenzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
2-Hexanone		<20	<20	RPD-NA	ug/L	N/A	30	08-MAY-19
Acetone		<20	<20	RPD-NA	ug/L	N/A	30	08-MAY-19
Benzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
Bromodichloromethane		<1.0	<1.0	RPD-NA	ug/L	N/A	30	08-MAY-19
Bromoform		<1.0	<1.0	RPD-NA	ug/L	N/A	30	08-MAY-19
Bromomethane		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
Carbon Disulfide		<1.0	<1.0	RPD-NA	ug/L	N/A	30	08-MAY-19
Carbon tetrachloride		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
Chlorobenzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
Chloroethane		<1.0	<1.0	RPD-NA	ug/L	N/A	30	08-MAY-19
Chloroform		<1.0	<1.0	RPD-NA	ug/L	N/A	30	08-MAY-19
Chloromethane		<1.0	<1.0	RPD-NA	ug/L	N/A	30	08-MAY-19
cis-1,2-Dichloroethylene		2.28	2.34		ug/L	2.6	30	08-MAY-19
cis-1,3-Dichloropropene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
Dibromochloromethane		<1.0	<1.0	RPD-NA	ug/L	N/A	30	08-MAY-19
Dichlorodifluoromethane		<1.0	<1.0	RPD-NA	ug/L	N/A	30	08-MAY-19
Dichloromethane		<2.0	<2.0	RPD-NA	ug/L	N/A	30	08-MAY-19
Ethylbenzene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
m+p-Xylenes		<1.0	<1.0	RPD-NA	ug/L	N/A	30	08-MAY-19
Methyl Ethyl Ketone		<20	<20	RPD-NA	ug/L	N/A	30	08-MAY-19
Methyl Isobutyl Ketone		<20	<20	RPD-NA	ug/L	N/A	30	08-MAY-19
n-Hexane		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
MTBE		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
o-Xylene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
Styrene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
Tetrachloroethylene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
Toluene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
trans-1,2-Dichloroethylene		<0.50	<0.50		ug/L			08-MAY-19

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9

Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-ROU-HS-WT	**Water**							
Batch R4628193								
WG3043835-4 DUP		**WG3043835-3**						
trans-1,2-Dichloroethylene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
trans-1,3-Dichloropropene		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
Trichloroethylene		150	147		ug/L	2.2	30	08-MAY-19
Trichlorofluoromethane		<1.0	<1.0	RPD-NA	ug/L	N/A	30	08-MAY-19
Vinyl chloride		<0.50	<0.50	RPD-NA	ug/L	N/A	30	08-MAY-19
WG3043835-1 LCS								
1,1,1,2-Tetrachloroethane			107.5		%		70-130	08-MAY-19
1,1,2,2-Tetrachloroethane			112.1		%		70-130	08-MAY-19
1,1,1-Trichloroethane			109.2		%		70-130	08-MAY-19
1,1,2-Trichloroethane			111.5		%		70-130	08-MAY-19
1,2-Dibromoethane			113.2		%		70-130	08-MAY-19
1,1-Dichloroethane			113.7		%		70-130	08-MAY-19
1,1-Dichloroethylene			113.0		%		70-130	08-MAY-19
1,2-Dichlorobenzene			108.5		%		70-130	08-MAY-19
1,2-Dichloroethane			109.0		%		70-130	08-MAY-19
1,2-Dichloropropane			112.8		%		70-130	08-MAY-19
1,3-Dichlorobenzene			108.6		%		70-130	08-MAY-19
1,4-Dichlorobenzene			109.2		%		70-130	08-MAY-19
2-Hexanone			95.6		%		60-140	08-MAY-19
Acetone			107.6		%		60-140	08-MAY-19
Benzene			113.0		%		70-130	08-MAY-19
Bromodichloromethane			110.8		%		70-130	08-MAY-19
Bromoform			107.2		%		70-130	08-MAY-19
Bromomethane			130.9		%		60-140	08-MAY-19
Carbon Disulfide			129.4		%		70-130	08-MAY-19
Carbon tetrachloride			107.8		%		70-130	08-MAY-19
Chlorobenzene			109.5		%		70-130	08-MAY-19
Chloroethane			115.3		%		70-130	08-MAY-19
Chloroform			114.1		%		70-130	08-MAY-19
Chloromethane			137.0		%		60-140	08-MAY-19
cis-1,2-Dichloroethylene			109.2		%		70-130	08-MAY-19
cis-1,3-Dichloropropene			114.4		%		70-130	08-MAY-19
Dibromochloromethane			109.7		%		70-130	08-MAY-19

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9

Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-ROU-HS-WT	**Water**							
Batch R4628193								
WG3043835-1 LCS								
Dichlorodifluoromethane			145.5	MES	%		50-140	08-MAY-19
Dichloromethane			116.9		%		70-130	08-MAY-19
Ethylbenzene			106.3		%		70-130	08-MAY-19
m+p-Xylenes			108.2		%		70-130	08-MAY-19
Methyl Ethyl Ketone			102.4		%		60-140	08-MAY-19
Methyl Isobutyl Ketone			97.5		%		50-150	08-MAY-19
n-Hexane			118.6		%		70-130	08-MAY-19
MTBE			111.0		%		70-130	08-MAY-19
o-Xylene			105.0		%		70-130	08-MAY-19
Styrene			107.6		%		70-130	08-MAY-19
Tetrachloroethylene			106.3		%		70-130	08-MAY-19
Toluene			109.0		%		70-130	08-MAY-19
trans-1,2-Dichloroethylene			112.8		%		70-130	08-MAY-19
trans-1,3-Dichloropropene			115.1		%		70-130	08-MAY-19
Trichloroethylene			110.3		%		70-130	08-MAY-19
Trichlorofluoromethane			121.6		%		60-140	08-MAY-19
Vinyl chloride			103.3		%		60-140	08-MAY-19
WG3043835-2 MB								
1,1,1,2-Tetrachloroethane			<0.50		ug/L		0.5	08-MAY-19
1,1,2,2-Tetrachloroethane			<0.50		ug/L		0.5	08-MAY-19
1,1,1-Trichloroethane			<0.50		ug/L		0.5	08-MAY-19
1,1,2-Trichloroethane			<0.50		ug/L		0.5	08-MAY-19
1,2-Dibromoethane			<0.20		ug/L		0.2	08-MAY-19
1,1-Dichloroethane			<0.50		ug/L		0.5	08-MAY-19
1,1-Dichloroethylene			<0.50		ug/L		0.5	08-MAY-19
1,2-Dichlorobenzene			<0.50		ug/L		0.5	08-MAY-19
1,2-Dichloroethane			<0.50		ug/L		0.5	08-MAY-19
1,2-Dichloropropane			<0.50		ug/L		0.5	08-MAY-19
1,3-Dichlorobenzene			<0.50		ug/L		0.5	08-MAY-19
1,4-Dichlorobenzene			<0.50		ug/L		0.5	08-MAY-19
2-Hexanone			<20		ug/L		20	08-MAY-19
Acetone			<20		ug/L		20	08-MAY-19
Benzene			<0.50		ug/L		0.5	08-MAY-19
Bromodichloromethane			<1.0		ug/L		1	08-MAY-19

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9

Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-ROU-HS-WT	**Water**							
Batch R4628193								
WG3043835-2 MB								
Bromoform			<1.0		ug/L		1	08-MAY-19
Bromomethane			<0.50		ug/L		0.5	08-MAY-19
Carbon Disulfide			<1.0		ug/L		1	08-MAY-19
Carbon tetrachloride			<0.50		ug/L		0.5	08-MAY-19
Chlorobenzene			<0.50		ug/L		0.5	08-MAY-19
Chloroethane			<1.0		ug/L		1	08-MAY-19
Chloroform			<1.0		ug/L		1	08-MAY-19
Chloromethane			<1.0		ug/L		1	08-MAY-19
cis-1,2-Dichloroethylene			<0.50		ug/L		0.5	08-MAY-19
cis-1,3-Dichloropropene			<0.50		ug/L		0.5	08-MAY-19
Dibromochloromethane			<1.0		ug/L		1	08-MAY-19
Dichlorodifluoromethane			<1.0		ug/L		1	08-MAY-19
Dichloromethane			<2.0		ug/L		2	08-MAY-19
Ethylbenzene			<0.50		ug/L		0.5	08-MAY-19
m+p-Xylenes			<1.0		ug/L		1	08-MAY-19
Methyl Ethyl Ketone			<20		ug/L		20	08-MAY-19
Methyl Isobutyl Ketone			<20		ug/L		20	08-MAY-19
n-Hexane			<0.50		ug/L		0.5	08-MAY-19
MTBE			<0.50		ug/L		0.5	08-MAY-19
o-Xylene			<0.50		ug/L		0.5	08-MAY-19
Styrene			<0.50		ug/L		0.5	08-MAY-19
Tetrachloroethylene			<0.50		ug/L		0.5	08-MAY-19
Toluene			<0.50		ug/L		0.5	08-MAY-19
trans-1,2-Dichloroethylene			<0.50		ug/L		0.5	08-MAY-19
trans-1,3-Dichloropropene			<0.50		ug/L		0.5	08-MAY-19
Trichloroethylene			<0.50		ug/L		0.5	08-MAY-19
Trichlorofluoromethane			<1.0		ug/L		1	08-MAY-19
Vinyl chloride			<0.50		ug/L		0.5	08-MAY-19
Surrogate: 1,4-Difluorobenzene			101.3		%		70-130	08-MAY-19
Surrogate: 4-Bromofluorobenzene			103.6		%		70-130	08-MAY-19
WG3043835-5 MS		**WG3043835-3**						
1,1,1,2-Tetrachloroethane			110.2		%		50-150	08-MAY-19
1,1,2,2-Tetrachloroethane			156.7	RRQC	%		50-150	08-MAY-19
1,1,1-Trichloroethane			102.8		%		50-150	08-MAY-19

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-ROU-HS-WT	**Water**							
Batch R4628193								
WG3043835-5 MS		**WG3043835-3**						
1,1,2-Trichloroethane			124.3		%		50-150	08-MAY-19
1,2-Dibromoethane			127.5		%		50-150	08-MAY-19
1,1-Dichloroethane			112.4		%		50-150	08-MAY-19
1,1-Dichloroethylene			102.3		%		50-150	08-MAY-19
1,2-Dichlorobenzene			109.0		%		50-150	08-MAY-19
1,2-Dichloroethane			121.8		%		50-150	08-MAY-19
1,2-Dichloropropane			119.0		%		50-150	08-MAY-19
1,3-Dichlorobenzene			103.8		%		50-150	08-MAY-19
1,4-Dichlorobenzene			105.3		%		50-150	08-MAY-19
2-Hexanone			126.6		%		50-150	08-MAY-19
Acetone			130.1		%		50-150	08-MAY-19
Benzene			112.5		%		50-150	08-MAY-19
Bromodichloromethane			118.6		%		50-150	08-MAY-19
Bromoform			125.0		%		50-150	08-MAY-19
Bromomethane			121.6		%		50-150	08-MAY-19
Carbon Disulfide			116.1		%		50-150	08-MAY-19
Carbon tetrachloride			99.7		%		50-150	08-MAY-19
Chlorobenzene			109.9		%		50-150	08-MAY-19
Chloroethane			106.2		%		50-150	08-MAY-19
Chloroform			117.9		%		50-150	08-MAY-19
Chloromethane			122.9		%		50-150	08-MAY-19
cis-1,2-Dichloroethylene			112.8		%		50-150	08-MAY-19
cis-1,3-Dichloropropene			122.0		%		50-150	08-MAY-19
Dibromochloromethane			120.2		%		50-150	08-MAY-19
Dichlorodifluoromethane			113.1		%		50-150	08-MAY-19
Dichloromethane			121.1		%		50-150	08-MAY-19
Ethylbenzene			100.7		%		50-150	08-MAY-19
m+p-Xylenes			102.6		%		50-150	08-MAY-19
Methyl Ethyl Ketone			123.4		%		50-150	08-MAY-19
Methyl Isobutyl Ketone			128.1		%		50-150	08-MAY-19
n-Hexane			102.1		%		50-150	08-MAY-19
MTBE			110.6		%		50-150	08-MAY-19
o-Xylene			102.5		%		50-150	08-MAY-19

COMMENTS: Matrix Spike recovery was above ALS DQO. Non-detect sample results are considered reliable. Other results, if reported,

Quality Control Report

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-ROU-HS-WT	**Water**							
Batch R4628193								
WG3043835-5 MS		**WG3043835-3**						
Styrene			109.4		%		50-150	08-MAY-19
Tetrachloroethylene			96.5		%		50-150	08-MAY-19
Toluene			104.4		%		50-150	08-MAY-19
trans-1,2-Dichloroethylene			106.8		%		50-150	08-MAY-19
trans-1,3-Dichloropropene			122.2		%		50-150	08-MAY-19
Trichloroethylene			N/A	MS-B	%		-	08-MAY-19
Trichlorofluoromethane			106.1		%		50-150	08-MAY-19
Vinyl chloride			89.5		%		50-150	08-MAY-19

COMMENTS: Matrix Spike recovery was above ALS DQO. Non-detect sample results are considered reliable. Other results, if reported, have been qualified.

Quality Control Report

Workorder: L2267557 Report Date: 21-MAY-19

Client: WSP Canada Inc. (Aurora)
126 Hillock Drive Unit 2
Aurora ON L4G 0G9
Contact: Kay Harvey

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.
RRQC	Refer to report remarks for information regarding this QC result.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ANALYTICAL REPORT

Report Date: May 21, 2019

Mary-Lynn Pike
ALS Laboratory Group-Waterloo
60 Northland Rd. Unit 1
Waterloo, ON N2V 2B8
CANADA

Phone: (519) 886-6910

E-mail: mary-lynn.pike@ALSGlobal.com

Workorder: **34-1913234**
Project ID: L2267557
Purchase Order: L2267557
Project Manager Jessica Helland

Client Sample ID	Lab ID	Collect Date	Receive Date	Sampling Site
MW19-5	1913234001	05/02/19	05/07/19	

ANALYTICAL REPORT

Workorder: 34-1913234
Client: ALS Environmental (Mississauga)
Project Manager: Jessica Helland

Analytical Results

Sample ID: **MW19-5** | Sampling Site: NA | Collected: 05/02/2019
Lab ID: 1913234001 | Media: 40 mL Amber Glass VOA | Received: 05/07/2019
Matrix: Water | Sampling Parameter: NA

Analysis Method - SW 6020

Preparation:	EPA 3010, SW 6020 Water Prep	**Weight/Volume**	**Analysis:**	SW 6020A, Water	**Instrument ID:** ICPM02
Batch:	EMS/5450 (HBN: 238990)	**Initial:** 25 mL	**Batch:**	EMS/5454 (HBN: 239401)	**Percent Solid:** NA
Prepared:	05/13/2019	**Final:** 50 mL	**Analyzed:**	05/16/2019 11:11	**Report Basis:** Wet

Analyte	Result (ug/L)	MDL (ug/L)	RL (ug/L)	Dilution	Qual
Gold	ND	20	50	5	U
Platinum	ND	6.0	20	5	U
Rhodium	ND	6.0	20	5	U

Comments

Workorder: 1913234

Sample was received at pH 7.

SW 6020: The pH of the field sample was adjusted prior to preparation by adding HCl to the sample to bring the pH to approximately 2. The samples were prepared using aqua regia so they were diluted 5x prior to analysis to reduce the acid concentration and preserve instrument integrity.

Quality Control: SW 6020 - (HBN: 239401)

EPA 6020, Water: Rhodium post digestion spike recovery is flagged at 76.0%. Possible matrix issue.

Report Authorization (/S/ is an electronic signature that complies with 21 CFR Part 11)

Method	Analyst	Peer Review
SW 6020	/S/ Kristie F. Bitner 05/16/2019 14:53	/S/ Penny A. Foote 05/21/2019 14:15

Laboratory Contact Information

ALS Environmental
960 W Levoy Drive
Salt Lake City, Utah 84123

Phone: (801) 266-7700
Email: alslt.lab@ALSGlobal.com
Web: www.alsslc.com

ANALYTICAL REPORT

Workorder: 34-1913234
Client: ALS Environmental (Mississauga)
Project Manager: Jessica Helland

General Lab Comments

The results provided in this report relate only to the items tested.
Samples were received in acceptable condition unless otherwise noted.
Samples have not been blank corrected unless otherwise noted.
This test report shall not be reproduced, except in full, without written approval of ALS.

ALS provides professional analytical services for all samples submitted. ALS is not in a position to interpret the data and assumes no responsibility for the quality of the samples submitted.

All quality control samples processed with the samples in this report yielded acceptable results unless otherwise noted.

ALS is accredited for specific fields of testing (scopes) in the following testing sectors. The quality system implemented at ALS conforms to accreditation requirements and is applied to all analytical testing performed by ALS. The following table lists testing sector, accreditation body, accreditation number and website. Please contact these accrediting bodies or your ALS project manager for the current scope of accreditation that applies to your analytical testing.

Testing Sector	Accreditation Body (Standard)	Certificate Number	Website
Environmental	PJLA (DoD ELAP)	L17-506	http://www.pjlabs.com
	PJLA (ISO 17025)	L17-507-R1	http://www.pjlabs.com
	Utah (TNI)	UT00953	http://lams.nelac-institute.org/search
	Nevada (TNI)	UT00953201-1	https://ndep.nv.gov/water/lab-certification
	Iowa (TNI)	IA# 376	http://www.shl.uiowa.edu/labcert/idnr/
	Kansas	E-10416	http://www.kdheks.gov/envlab/disclaimer.html
	Oklahoma (TNI)	IJ# 9980	http://www.deq.state.ok.us/CSDnew/labcert.htm
	Texas (TNI)	T104704456-18-9	https://www.tceq.texas.gov/assets/public/compliance/compliance_support/qa/txnelap_lab_list.pdf
Industrial Hygiene	AIHA (ISO 17025 & AIHA IHLAP)	101574	http://www.aihaaccreditedlabs.org
	DOECAP-AP	L18-606	http://www.pjlabs.com
	Washington	C596	https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Laboratory-Accreditation
Dietary Supplements	PJLA (ISO 17025)	L17-507-R1	http://www.pjlabs.com

Result Symbol Definitions

MDL = Method Detection Limit, a statistical estimate of method/media/instrument sensitivity.
RL = Reporting Limit, a verified value of method/media/instrument sensitivity.
CRDL = Contract Required Detection Limit
Reg. Limit = Regulatory Limit.
ND = Not Detected, testing result not detected above the MDL or RL.
< Means this testing result is less than the numerical value.
** No result could be reported, see sample comments for details.

Qualifier Symbol Definitions

U = Qualifier indicates that the analyte was not detected above the MDL.
J = Qualifier Indicates that the analyte value is between the MDL and the RL. It is also used to indicate an estimated value for tentatively identified compounds in mass spectrometry where a 1:1 response is assumed.
B = Qualifier indicates that the analyte was detected in the blank.
E = Qualifier indicates that the analyte result exceeds calibration range.
P = Qualifier indicates that the RPD between the two columns is greater than 40%.

Quality Control Sample
Batch Report

Analysis Information

Workorder: 1913234

Limits:	Historical/Performance	**Preparation:**	EPA 3010, SW 6020 Water Prep	**Analysis:**	SW 6020
Basis:	ALS Laboratory Group	**Batch:**	EMS/5450 (HBN: 238990)	**Batch:**	EMS/5454 (HBN: 239401)
		Prepared By:	Kristie F. Bitner	**Analyzed By:**	Kristie F. Bitner

Blank

MB: 652617
Analyzed: 05/16/2019 10:55
Units: ug/L

Analyte	Result	MDL	RL
Gold	ND	10	25.0
Platinum	ND	3	10.0
Rhodium	ND	3	10.0

Laboratory Control Sample - Laboratory Control Sample Duplicate

LCS: 652618
Analyzed: 05/16/2019 11:03
Dilution: 5
Units: ug/L

LCSD: 652619
Analyzed: 05/16/2019 11:06
Dilution: 5
Units: ug/L

Analyte	Result	Target	% Rec	QC Limits		Result	% Rec	RPD	QC Limits	
Platinum	381	400	95.3	85.5	111.8	385	96.1	0.918	0.0	20.0
Gold	382	400	95.6	62.2	119.9	388	97.1	1.59	0.0	20.0
Rhodium	368	400	92.0	80.0	120.0	370	92.5	0.508	0.0	20.0

Comments

EPA 6020, Water: Rhodium post digestion spike recovery is flagged at 76.0%. Possible matrix issue.

QC Report Authorization (/S/ is an electronic signature that complies with 21 CFR Part 11)

Analyst	Peer Review
/S/ Kristie F. Bitner	/S/ Penny A. Foote
05/16/2019 14:53	05/21/2019 14:15

Symbols and Definitions

- * - Analyte above reporting limit or outside of control limits
- ▲ - Sample result is greater than 4 times the spike added
- ◓ - Sample and Matrix Duplicate less than 5 times the reporting limit
- ● - Result is above the calibration range
- # - The Matrix Spike, Matrix Spike duplicate or Matrix Duplicate is reported for your information only. The sample matrix may be inappropriate for the method selected.

RPD - Relative % Difference (Spike / Spike Duplicate)
ND - Not Detected (U - Qualifier also flags analyte as not detected)
NA - Not Applicable
QC results are not adjusted for moisture correction, where applicable

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2267557-COFC

COC Number: 17 - 623778

Page of

Report To	Contact and company name below will appear on the final report
Company:	WSP
Contact:	Kay Harvey
Phone:	905 750 3050
Company address below will appear on the final report	
Street:	126 Don Hillock Dr
City/Province:	Aurora, ON
Postal Code:	L4G 0G9

Report Format / Distribution	
Select Report Format:	[X] PDF [X] EXCEL | | EDD (DIGITAL)
Quality Control (QC) Report with Report	[ ] YES [ ] NO
[ ] Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	[X] EMAIL | | MAIL [ ] FAX
Email 1 or Fax	Kay.harvey@wsp.com
Email 2	
Email 3	

Invoice To		
	Same as Report To	[X] YES [ ] NO
	Copy of Invoice with Report	[ ] YES [ ] NO
Company:		
Contact:		

Invoice Distribution	
Select Invoice Distribution:	[X] EMAIL [ ] MAIL [ ] FAX
Email 1 or Fax	Kay.harvey@wsp.com
Email 2	

Project Information	
ALS Account # / Quote #:	
Job #:	191-04694-00
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)	
AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only): L2267557

ALS Contact: Sampler:

Select Service Level below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R]: [X] Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] [ ] | 3 day [P3-25%] [ ] | 2 day [P2-50%] [ ]

EMERGENCY: 1 Business day [E-100%] [ ] | Same Day, Weekend or Statutory holiday [E2-200% (Laboratory opening fees may apply)] [ ]

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	General Chem	City of Barrie Sewer	SAMPLES ON HOLD	Sample is hazardous (please provide further details)	NUMBER OF CONTAINERS
	MW1	02/05/19	AM	GW	X				5
	MW19-2	↓	PM	↓	X				
	MW19-5		PM			X			
	MW19-6		AM		X				5

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? [ ] YES [X] NO	Metals filtered in Gen Chem samples.
Are samples for human consumption/ use? | | YES [X] NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	[ ]	SIF Observations	Yes [ ]	No	[ ]
Ice Packs [ ]	Ice Cubes [X]	Custody seal intact	Yes [ ]	No	[ ]
Cooling Initiated	[ ]				

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C
	6.1°C 7.2°C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
Kay Harvey	May 2/19	5pm					03/May/2019	17:30

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JULY 2017 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

SIF

APPENDIX

E CLIMATE BASED WATER BUDGET

TABLE E-1
CLIMATIC WATER BUDGET: CLIMATE NORMAL 1981-2010 (BARRIE WPCC CLIMATE STATION)
HYDROGEOLOGICAL INVESTIGATION
113-117 BAYFIELD STREET, BAYFIELD

	Thornthwaite (1948)							
Month	**Mean Temperature (^{o}C)**	**Heat Index**	**Potential Evapo-transpiration (mm)**	**Daylight Correction Value**	**Adjusted Potential Evapo-transpiration (mm)**	**Total Precipitation (mm)**	**Surplus (mm)**	**Deficit (mm)**
January	-7.7	0.0	0.0	0.7839	0.00	82.5	82.5	0.0
February	-6.6	0.0	0.0	0.8786	0.00	61.8	61.8	0.0
March	-2.1	0.0	0.0	0.9871	0.00	58.1	58.1	0.0
April	5.6	1.2	25.5	1.1200	28.51	62.2	33.7	0.0
May	12.3	3.9	59.2	1.2194	72.22	82.4	10.2	0.0
June	17.9	6.9	88.6	1.2800	113.41	84.8	0.0	28.6
July	20.8	8.7	104.1	1.2484	129.95	77.2	0.0	52.8
August	19.7	8.0	98.2	1.1613	114.04	89.9	0.0	24.1
September	15.3	5.4	74.9	1.0400	77.86	94	16.1	0.0
October	8.7	2.3	40.8	0.9194	37.55	77.5	40.0	0.0
November	2.7	0.4	11.6	0.8100	9.42	88.9	79.5	0.0
December	-3.5	0.0	0.0	0.7355	0.00	73.6	73.6	0.0
TOTALS		**36.8**			**582.9**	**932.9**	**455.4**	**105.5**

TOTAL WATER SURPLUS **350.0** **mm**

NOTES:

1) Water budget adjusted for latitude (to nearest degree) and daylight as per Table 6 - Thonthwaite and Mather(1957).

2) (°C) - Represents calculated mean of daily temperatures for the month.

3) Precipitation and Temperature data from the Barrie WPCC Climate Station located at latitude 44°22'33.012" N, longitude 79°41'23.010" W, elevation 221.0 m.

4) Total Water Surplus (Thornthwaite, 1948) is calculated as total precipitation minus adjusted potential evapotranspiration.

5) Total Moisture Surplus (Thornthwaite and Mather, 1957) is calculated as total precipitation minus actual evapotranspiration.

2020-05-01 11:29 AM

TABLE E-2
CLIMATIC WATER BUDGET: CLIMATE NORMAL 1981-2010 (BARRIE WPCC CLIMATE STATION)
SILTY SAND LOAM, LAWNS (125 mm HOLDING CAPACITY)
HYDROGEOLOGICAL INVESTIGATION
113-117 BAYFIELD STREET, BAYFIELD

	Thornthwaite (1948)									Thornthwaite and Mather (1957)					
Month	Mean Temperature (°C)	Heat Index	Potential Evapo-transpiration (mm)	Daylight Correction Value	Adjusted Potential Evapo-transpiration (mm)	Total Precipitation (mm)	Surplus (mm)	Deficit (mm)	TP - PET (mm)	Accumulated Potential Water Loss (mm)	Soil Moisture (mm)	Change in Soil Moisture (mm) (delta S)	Actual Evapo-transpiration (mm)	Moisture Deficit (mm)	Unadjusted Moisture Surplus (mm)
January	-7.7	0.0	0.0	0.7839	0.00	82.5	82.5	0.0	82.5	0.0	125.0	0.0	0.0	0.0	82.5
February	-6.6	0.0	0.0	0.8786	0.00	61.8	61.8	0.0	61.8	0.0	125.0	0.0	0.0	0.0	61.8
March	-2.1	0.0	0.0	0.9871	0.00	58.1	58.1	0.0	58.1	0.0	125.0	0.0	0.0	0.0	58.1
April	5.6	1.2	25.5	1.1200	28.51	62.2	33.7	0.0	33.7	0.0	125.0	0.0	28.5	0.0	33.7
May	12.3	3.9	59.2	1.2194	72.22	82.4	10.2	0.0	10.2	0.0	125.0	0.0	72.2	0.0	10.2
June	17.9	6.9	88.6	1.2800	113.41	84.8	0.0	28.6	-28.6	-28.6	99.0	-26.0	110.8	2.6	0.0
July	20.8	8.7	104.1	1.2484	129.95	77.2	0.0	52.8	-52.8	-81.4	64.0	-35.0	112.2	17.8	0.0
August	19.7	8.0	98.2	1.1613	114.04	89.9	0.0	24.1	-24.1	-105.5	53.0	-11.0	100.9	13.1	0.0
September	15.3	5.4	74.9	1.0400	77.86	94.0	16.1	0.0	16.1	0.0	69.1	16.1	77.9	0.0	0.0
October	8.7	2.3	40.8	0.9194	37.55	77.5	40.0	0.0	40.0	0.0	109.1	40.0	37.5	0.0	0.0
November	2.7	0.4	11.6	0.8100	9.42	88.9	79.5	0.0	79.5	0.0	125.0	15.9	9.4	0.0	63.6
December	-3.5	0.0	0.0	0.7355	0.00	73.6	73.6	0.0	73.6	0.0	125.0	0.0	0.0	0.0	73.6
TOTALS		**36.8**			**582.9**	**932.9**	**455.4**	**105.5**	**350.0**	**-105.5**	**1269.2**	**0.0**	**549.5**	**33.5**	**383.4**

TOTAL WATER SURPLUS **350.0** **mm**

TOTAL MOISTURE SURPLUS **383.4** **mm**

NOTES:

1) Water budget adjusted for latitude (to nearest degree) and daylight as per Table 6 - Thonthwaite and Mather(1957).

2) (°C) - Represents calculated mean of daily temperatures for the month.

3) Precipitation and Temperature data from the Barrie WPCC Climate Station located at latitude 44°22'33.012" N, longitude 79°41'23.010" W, elevation 221.0 m.

4) Total Water Surplus (Thornthwaite, 1948) is calculated as total precipitation minus adjusted potential evapotranspiration.

5) Total Moisture Surplus (Thornthwaite and Mather, 1957) is calculated as total precipitation minus actual evapotranspiration.

APPENDIX

F

WATER BUDGET CALCULATIONS – PRE-DEVELOPMENT

TABLE F-1 PRE-DEVELOPMENT WATER BUDGET (BY CATCHMENT)
HYDROGEOLOGICAL INVESTIGATION
113-117 BAYFIELD STREET, BAYFIELD

Subcatchment Designation	Outlet	Area	MOE TABLE 2 Components					MOE Infiltration Factor	Adjusted MOE Infiltration Factor	Precipitation	Precipitation Total	Precipitation Surplus	Evapotranspiration	Runon		Net Surplus		Infiltration		Runoff*		Total Infiltration + Runoff
		(m^2)	Cover		Soil		Topography			(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(m^3/a)
Cat A-10	Storm sewers	9.7	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	9.1	839.6	0.9	0	0	839.6	8.2	0.0	0.0	839.6	8.2	8.2
Cat A-14	Storm sewers	1154.6	Pavement	0	Silty Sand	0.25	0.25	0.5	0	932.9	1077.2	839.6	107.7	0	0	839.6	969.4	0.0	0.0	839.6	969.4	969.4
Cat A-2	Storm sewers	25.8	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	24.1	839.6	2.4	0	0	839.6	21.7	0.0	0.0	839.6	21.7	21.7
Cat A-24	Storm sewers	161.7	Building	0	Silty Sand	0.25	0.25	0.5	0	932.9	150.9	839.6	15.1	0	0	839.6	135.8	0.0	0.0	839.6	135.8	135.8
Cat A-25	Storm sewers	121.1	Building	0	Silty Sand	0.25	0.25	0.5	0	932.9	113.0	839.6	11.3	0	0	839.6	101.7	0.0	0.0	839.6	101.7	101.7
Cat A-28	Storm sewers	314.3	Building	0	Silty Sand	0.25	0.25	0.5	0	932.9	293.2	839.6	29.3	0	0	839.6	263.9	0.0	0.0	839.6	263.9	263.9
Cat A-29	Storm sewers	174.0	Building	0	Silty Sand	0.25	0.25	0.5	0	932.9	162.4	839.6	16.2	0	0	839.6	146.1	0.0	0.0	839.6	146.1	146.1
Cat A-30	Storm sewers	128.9	Building	0	Silty Sand	0.25	0.25	0.5	0	932.9	120.2	839.6	12.0	0	0	839.6	108.2	0.0	0.0	839.6	108.2	108.2
Cat A-40	Storm sewers	155.4	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	145.0	383.4	85.4	0	0	383.4	59.6	210.9	32.8	172.6	26.8	59.6
Cat A-47	Storm sewers	159.2	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	148.5	383.4	87.5	0	0	383.4	61.1	210.9	33.6	172.6	27.5	61.1
Cat A-52	Storm sewers	3.4	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	3.2	383.4	1.9	0	0	383.4	1.3	210.9	0.7	172.6	0.6	1.3
Cat A-59	Storm sewers	140.5	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	131.1	839.6	13.1	0	0	839.6	117.9	0.0	0.0	839.6	117.9	117.9
Cat A-6	Storm sewers	36.6	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	34.2	839.6	3.4	0	0	839.6	30.8	0.0	0.0	839.6	30.8	30.8
Cat A-60	Storm sewers	3.7	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	3.5	839.6	0.3	0	0	839.6	3.1	0.0	0.0	839.6	3.1	3.1
Cat A-61	Storm sewers	22.4	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	20.9	383.4	12.3	0	0	383.4	8.6	210.9	4.7	172.6	3.9	8.6
Cat A-62	Storm sewers	13.1	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	12.2	383.4	7.2	0	0	383.4	5.0	210.9	2.8	172.6	2.3	5.0
Cat A-63	Storm sewers	16.1	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	15.0	383.4	8.8	0	0	383.4	6.2	210.9	3.4	172.6	2.8	6.2
Cat A-8	Storm sewers	3.4	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	3.1	839.6	0.3	0	0	839.6	2.8	0.0	0.0	839.6	2.8	2.8
Cat A-11	Storm sewers	9.2	Pavement	0	Silty Sand	0.25	0.25	0.5	0	932.9	8.6	839.6	0.9	0	0	839.6	7.7	0.0	0.0	839.6	7.7	7.7
Cat A-12	Storm sewers	74.2	Pavement	0	Silty Sand	0.25	0.25	0.5	0	932.9	69.2	839.6	6.9	0	0	839.6	62.3	0.0	0.0	839.6	62.3	62.3
Cat A-13	Storm sewers	9.9	Pavement	0	Silty Sand	0.25	0.25	0.5	0	932.9	9.3	839.6	0.9	0	0	839.6	8.3	0.0	0.0	839.6	8.3	8.3
Cat A-17	Storm sewers	1.9	Pavement	0	Silty Sand	0.25	0.25	0.5	0	932.9	1.7	839.6	0.2	0	0	839.6	1.6	0.0	0.0	839.6	1.6	1.6
Cat A-18	Storm sewers	1.9	Pavement	0	Silty Sand	0.25	0.25	0.5	0	932.9	1.8	839.6	0.2	0	0	839.6	1.6	0.0	0.0	839.6	1.6	1.6
Cat A-19	Storm sewers	2.0	Pavement	0	Silty Sand	0.25	0.25	0.5	0	932.9	1.9	839.6	0.2	0	0	839.6	1.7	0.0	0.0	839.6	1.7	1.7
Cat A-20	Storm sewers	11.8	Pavement	0	Silty Sand	0.25	0.25	0.5	0	932.9	11.0	839.6	1.1	0	0	839.6	9.9	0.0	0.0	839.6	9.9	9.9
Cat A-21	Storm sewers	5.1	Pavement	0	Silty Sand	0.25	0.25	0.5	0	932.9	4.7	839.6	0.5	0	0	839.6	4.3	0.0	0.0	839.6	4.3	4.3
Cat A-23	Storm sewers	18.2	Pavement	0	Silty Sand	0.25	0.25	0.5	0	932.9	16.9	839.6	1.7	0	0	839.6	15.3	0.0	0.0	839.6	15.3	15.3
Cat A-26	Storm sewers	6.1	Building	0	Silty Sand	0.25	0.25	0.5	0	932.9	5.7	839.6	0.6	0	0	839.6	5.1	0.0	0.0	839.6	5.1	5.1
Cat A-3	Storm sewers	28.0	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	26.1	839.6	2.6	0	0	839.6	23.5	0.0	0.0	839.6	23.5	23.5
Cat A-31	Storm sewers	17.9	Building	0	Silty Sand	0.25	0.25	0.5	0	932.9	16.7	839.6	1.7	0	0	839.6	15.0	0.0	0.0	839.6	15.0	15.0
Cat A-33	Storm sewers	65.1	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	60.7	839.6	6.1	0	0	839.6	54.7	0.0	0.0	839.6	54.7	54.7
Cat A-34	Storm sewers	8.8	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	8.2	839.6	0.8	0	0	839.6	7.4	0.0	0.0	839.6	7.4	7.4
Cat A-36	Storm sewers	2.3	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	2.1	383.4	1.3	0	0	383.4	0.9	210.9	0.5	172.6	0.4	0.9
Cat A-37	Storm sewers	104.8	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	97.8	383.4	57.6	0	0	383.4	40.2	210.9	22.1	172.6	18.1	40.2
Cat A-38	Storm sewers	12.6	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	11.7	383.4	6.9	0	0	383.4	4.8	210.9	2.7	172.6	2.2	4.8
Cat A-39	Storm sewers	5.0	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	4.6	383.4	2.7	0	0	383.4	1.9	210.9	1.0	172.6	0.9	1.9
Cat A-4	Storm sewers	9.3	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	8.7	839.6	0.9	0	0	839.6	7.8	0.0	0.0	839.6	7.8	7.8
Cat A-41	Storm sewers	4.2	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	3.9	383.4	2.3	0	0	383.4	1.6	210.9	0.9	172.6	0.7	1.6
Cat A-42	Storm sewers	5.8	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	5.4	383.4	3.2	0	0	383.4	2.2	210.9	1.2	172.6	1.0	2.2
Cat A-43	Storm sewers	0.3	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	0.3	383.4	0.1	0	0	383.4	0.1	210.9	0.1	172.6	0.0	0.1
Cat A-44	Storm sewers	13.9	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	13.0	383.4	7.7	0	0	383.4	5.3	210.9	2.9	172.6	2.4	5.3
Cat A-45	Storm sewers	14.0	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	13.0	383.4	7.7	0	0	383.4	5.4	210.9	2.9	172.6	2.4	5.4
Cat A-46	Storm sewers	28.1	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	26.2	383.4	15.5	0	0	383.4	10.8	210.9	5.9	172.6	4.9	10.8
Cat A-48	Storm sewers	2.0	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	1.9	383.4	1.1	0	0	383.4	0.8	210.9	0.4	172.6	0.4	0.8

TABLE F-1 PRE-DEVELOPMENT WATER BUDGET (BY CATCHMENT)
HYDROGEOLOGICAL INVESTIGATION
113-117 BAYFIELD STREET, BAYFIELD

Subcatchment Designation	Outlet	Area	MOE TABLE 2 Components					MOE Infiltration Factor	Adjusted MOE Infiltration Factor	Precipitation	Precipitation Total	Precipitation Surplus	Evapotranspiration	Runon		Net Surplus		Infiltration		Runoff*		Total Infiltration + Runoff
		(m^2)	Cover		Soil		Topography			(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(m^3/a)
Cat A-49	Storm sewers	5.5	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	5.1	383.4	3.0	0	0	383.4	2.1	210.9	1.2	172.6	0.9	2.1
Cat A-5	Storm sewers	10.3	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	9.6	839.6	1.0	0	0	839.6	8.7	0.0	0.0	839.6	8.7	8.7
Cat A-50	Storm sewers	5.4	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	5.0	383.4	2.9	0	0	383.4	2.1	210.9	1.1	172.6	0.9	2.1
Cat A-51	Storm sewers	22.9	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	21.4	383.4	12.6	0	0	383.4	8.8	210.9	4.8	172.6	3.9	8.8
Cat A-53	Storm sewers	84.6	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	78.9	383.4	46.5	0	0	383.4	32.4	210.9	17.8	172.6	14.6	32.4
Cat A-54	Storm sewers	1.5	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	1.4	383.4	0.8	0	0	383.4	0.6	210.9	0.3	172.6	0.3	0.6
Cat A-55	Storm sewers	2.0	Building	0	Silty Sand	0.25	0.25	0.5	0	932.9	1.9	839.6	0.2	0	0	839.6	1.7	0.0	0.0	839.6	1.7	1.7
Cat A-56	Storm sewers	1.9	Building	0	Silty Sand	0.25	0.25	0.5	0	932.9	1.7	839.6	0.2	0	0	839.6	1.6	0.0	0.0	839.6	1.6	1.6
Cat A-57	Storm sewers	24.3	Building	0	Silty Sand	0.25	0.25	0.5	0	932.9	22.7	839.6	2.3	0	0	839.6	20.4	0.0	0.0	839.6	20.4	20.4
Cat A-58	Storm sewers	30.2	Building	0	Silty Sand	0.25	0.25	0.5	0	932.9	28.2	839.6	2.8	0	0	839.6	25.4	0.0	0.0	839.6	25.4	25.4
Cat A-7	Storm sewers	1.1	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	1.0	839.6	0.1	0	0	839.6	0.9	0.0	0.0	839.6	0.9	0.9
Cat A-9	Storm sewers	2.4	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	2.2	839.6	0.2	0	0	839.6	2.0	0.0	0.0	839.6	2.0	2.0
Cat A-15	Storm sewers	58.6	Pavement	0	Silty Sand	0.25	0.25	0.5	0	932.9	54.7	839.6	5.5	0	0	839.6	49.2	0.0	0.0	839.6	49.2	49.2
Cat A-16	Storm sewers	136.2	Pavement	0	Silty Sand	0.25	0.25	0.5	0	932.9	127.1	839.6	12.7	0	0	839.6	114.4	0.0	0.0	839.6	114.4	114.4
Cat A-22	Storm sewers	216.9	Pavement	0	Silty Sand	0.25	0.25	0.5	0	932.9	202.3	839.6	20.2	917	199	1756.5	381.0	0.0	0.0	1756.5	381.0	381.0
Cat A-27	Storm sewers	6.2	Building	0	Silty Sand	0.25	0.25	0.5	0	932.9	5.8	839.6	0.6	0	0	839.6	5.2	0.0	0.0	839.6	5.2	5.2
Cat A-35	Storm sewers	13.5	Concrete	0	Silty Sand	0.25	0.25	0.5	0	932.9	12.6	839.6	1.3	0	0	839.6	11.3	0.0	0.0	839.6	11.3	11.3
Pre-Development Catchment A Total	**Storm sewers**	**3,729.7**								**932.9**	**3,479**	**756.1**	**659.3**	**917**	**199**	**809.5**	**3,019**	**39**	**144**	**771**	**2,875**	**3,019**
SITE TOTAL		**3,730**								**932.9**	**3,479**	**756.1**	**659**	**53**	**199**	**809.5**	**3,019**	**39**	**144**	**771**	**2,875**	**3,019**

EXTERNAL AREAS (Run-on Estimates)

Cat B-1	SE (Via Catchment A)	773.8	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	932.9	721.9	383.4	425.2	0	0	383.4	296.7	210.9	163.2	172.6	133.5	296.7
Cat B-32	SE (Via Catchment A)	77.8	Building	0	Silty Sand	0.25	0.25	0.50	0	932.9	72.6	839.6	7.3	0	0	839.6	65.4	0.0	0.0	839.6	65.4	65.4
Pre-Development Catchment B Total	**SE (Via Catchment A)**	**852**								**932.9**	**794**	**425.1**	**432**	**0**	**0**	**425**	**362**	**192**	**163**	**234**	**199**	**362**

APPENDIX

G WATER BUDGET CALCULATIONS – POST DEVELOPMENT

TABLE G-1 POST-DEVELOPMENT WATER BUDGET (BY CATCHMENT)
HYDROGEOLOGICAL INVESTIGATION
113-117 BAYFIELD STREET, BAYFIELD

ANNUAL PRECIPITATION	EVAPORATION AND EVAPOTRANSPIRATION FACTORS			
	Impervious Areas		Waterbody	
mm	%	mm	%	mm
933	10%	93	69%	646

On-Site Subcatchment Designation	Outlet	Total Area (m^2)	MOE TABLE 2 Components					MOE Infiltration Factor	Adjusted MOE Infiltration Factor	Inputs					Outputs								
										Precipitation			Run-on	Total Inputs	Evapotranspiration			Infiltration	Runoff				Total Outputs	
			Cover		Soil		Topography			Annual Average	Surplus (Pervious)	Surplus (Impervious)			Pervious	Impervious	Total Evapotranspiration	Total Infiltration	Pervious	Total Impervious		Total Runoff			
										(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)
Cat PA-10	Building to Storm Sewer	9.7	Building	0	Silty Sand	0.25	0.25	0.5	0	9	0	8	0	9	0	1	1	0	0	840	8	840	8	933	9
Cat PA-14	Building to Storm Sewer	1154.6	Building	0	Silty Sand	0.25	0.25	0.5	0	1,077	0	969	0	1,077	0	108	108	0	0	840	969	840	969	933	1,077
Cat PA-2	Building to Storm Sewer	25.8	Building	0	Silty Sand	0.25	0.25	0.5	0	24	0	22	0	24	0	2	2	0	0	840	22	840	22	933	24
Cat PA-24	Building to Storm Sewer	161.7	Building	0	Silty Sand	0.25	0.25	0.5	0	151	0	136	0	151	0	15	15	0	0	840	136	840	136	933	151
Cat PA-25	Building to Storm Sewer	121.1	Building	0	Silty Sand	0.25	0.25	0.5	0	113	0	102	0	113	0	11	11	0	0	840	102	840	102	933	113
Cat PA-28	Building to Storm Sewer	314.3	Building	0	Silty Sand	0.25	0.25	0.5	0	293	0	264	0	293	0	29	29	0	0	840	264	840	264	933	293
Cat PA-29	Building to Storm Sewer	174.0	Building	0	Silty Sand	0.25	0.25	0.5	0	162	0	146	0	162	0	16	16	0	0	840	146	840	146	933	162
Cat PA-30	Building to Storm Sewer	128.9	Building	0	Silty Sand	0.25	0.25	0.5	0	120	0	108	0	120	0	12	12	0	0	840	108	840	108	933	120
Cat PA-40	Building to Storm Sewer	155.4	Building	0	Silty Sand	0.25	0.25	0.5	0	145	0	130	0	145	0	14	14	0	0	840	130	840	130	933	145
Cat PA-47	Building to Storm Sewer	159.2	Building	0	Silty Sand	0.25	0.25	0.5	0	149	0	134	0	149	0	15	15	0	0	840	134	840	134	933	149
Cat PA-52	Building to Storm Sewer	3.4	Building	0	Silty Sand	0.25	0.25	0.5	0	3	0	3	0	3	0	0	0	0	0	840	3	840	3	933	3
Cat PA-59	Building to Storm Sewer	140.5	Building	0	Silty Sand	0.25	0.25	0.5	0	131	0	118	0	131	0	13	13	0	0	840	118	840	118	933	131
Cat PA-6	Building to Storm Sewer	36.6	Building	0	Silty Sand	0.25	0.25	0.5	0	34	0	31	0	34	0	3	3	0	0	840	31	840	31	933	34
Cat PA-60	Building to Storm Sewer	3.7	Building	0	Silty Sand	0.25	0.25	0.5	0	3	0	3	0	3	0	0	0	0	0	840	3	840	3	933	3
Cat PA-61	Building to Storm Sewer	22.4	Building	0	Silty Sand	0.25	0.25	0.5	0	21	0	19	0	21	0	2	2	0	0	840	19	840	19	933	21
Cat PA-62	Building to Storm Sewer	13.1	Building	0	Silty Sand	0.25	0.25	0.5	0	12	0	11	0	12	0	1	1	0	0	840	11	840	11	933	12
Cat PA-63	Building to Storm Sewer	16.1	Building	0	Silty Sand	0.25	0.25	0.5	0	15	0	13	0	15	0	1	1	0	0	840	13	840	13	933	15
Cat PA-8	Building to Storm Sewer	3.4	Building	0	Silty Sand	0.25	0.25	0.5	0	3	0	3	0	3	0	0	0	0	0	840	3	840	3	933	3
Post-Development Catchment PA Total	**Building to Storm Sewer**	**2,644**								**2,467**		**2,220**	**0**	**2,467**	**0**	**247**	**247**	**0**	**0**	**840**	**2,220**	**840**	**2,220**	**933**	**2,467**
Cat PB-11	Overland to Storm Sewer	9.2	Concrete	0	Silty Sand	0.25	0.25	0.5	0	9	0	8	0	9	0	1	1	0	0	840	8	840	8	933	9
Cat PB-12	Overland to Storm Sewer	74.2	Concrete	0	Silty Sand	0.25	0.25	0.5	0	69	0	62	0	69	0	7	7	0	0	840	62	840	62	933	69
Cat PB-13	Overland to Storm Sewer	9.9	Pavement	0	Silty Sand	0.25	0.25	0.5	0	9	0	8	0	9	0	1	1	0	0	840	8	840	8	933	9
Cat PB-17	Overland to Storm Sewer	1.9	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	2	1	0	0	2	1	0	1	0	0	0	0	173	0	933	2
Cat PB-18	Overland to Storm Sewer	1.9	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	2	1	0	0	2	1	0	1	0	0	0	0	173	0	933	2
Cat PB-19	Overland to Storm Sewer	2.0	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	2	1	0	0	2	1	0	1	0	0	0	0	173	0	933	2
Cat PB-20	Overland to Storm Sewer	11.8	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	11	5	0	0	11	6	0	6	2	2	0	0	173	2	933	11
Cat PB-21	Overland to Storm Sewer	5.1	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	5	2	0	0	5	3	0	3	1	1	0	0	173	1	933	5
Cat PB-23	Overland to Storm Sewer	18.2	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	17	7	0	0	17	10	0	10	4	3	0	0	173	3	933	17
Cat PB-26	Overland to Storm Sewer	6.1	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	6	2	0	0	6	3	0	3	1	1	0	0	173	1	933	6
Cat PB-3	Overland to Storm Sewer	28.0	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	26	11	0	0	26	15	0	15	6	5	0	0	173	5	933	26
Cat PB-31	Overland to Storm Sewer	17.9	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	17	7	0	0	17	10	0	10	4	3	0	0	173	3	933	17
Cat PB-33	Overland to Storm Sewer	65.1	Concrete	0	Silty Sand	0.25	0.25	0.5	0	61	0	55	0	61	0	6	6	0	0	840	55	840	55	933	61
Cat PB-34	Overland to Storm Sewer	8.8	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	8	3	0	0	8	5	0	5	2	2	0	0	173	2	933	8
Cat PB-36	Overland to Storm Sewer	2.3	Pavement	0	Silty Sand	0.25	0.25	0.5	0	2	0	2	0	2	0	0	0	0	0	840	2	840	2	933	2
Cat PB-37	Overland to Storm Sewer	104.8	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	98	40	0	0	98	58	0	58	22	18	0	0	173	18	933	98
Cat PB-38	Overland to Storm Sewer	12.6	Concrete	0	Silty Sand	0.25	0.25	0.5	0	12	0	11	0	12	0	1	1	0	0	840	11	840	11	933	12
Cat PB-39	Overland to Storm Sewer	5.0	Concrete	0	Silty Sand	0.25	0.25	0.5	0	5	0	4	0	5	0	0	0	0	0	840	4	840	4	933	5
Cat PB-4	Overland to Storm Sewer	9.3	Concrete	0	Silty Sand	0.25	0.25	0.5	0	9	0	8	0	9	0	1	1	0	0	840	8	840	8	933	9
Cat PB-41	Overland to Storm Sewer	4.2	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	4	2	0	0	4	2	0	2	1	1	0	0	173	1	933	4
Cat PB-42	Overland to Storm Sewer	5.8	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	5	2	0	0	5	3	0	3	1	1	0	0	173	1	933	5
Cat PB-43	Overland to Storm Sewer	0.3	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	0	0	0	0	0	0	0	0	0	0	0	0	173	0	933	0
Cat PB-44	Overland to Storm Sewer	13.9	Concrete	0	Silty Sand	0.25	0.25	0.5	0	13	0	12	0	13	0	1	1	0	0	840	12	840	12	933	13
Cat PB-45	Overland to Storm Sewer	14.0	Concrete	0	Silty Sand	0.25	0.25	0.5	0	13	0	12	0	13	0	1	1	0	0	840	12	840	12	933	13
Cat PB-46	Overland to Storm Sewer	28.1	Concrete	0	Silty Sand	0.25	0.25	0.5	0	26	0	24	0	26	0	3	3	0	0	840	24	840	24	933	26
Cat PB-48	Overland to Storm Sewer	2.0	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	2	1	0	0	2	1	0	1	0	0	0	0	173	0	933	2
Cat PB-49	Overland to Storm Sewer	5.5	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	5	2	0	0	5	3	0	3	1	1	0	0	173	1	933	5
Cat PB-5	Overland to Storm Sewer	10.3	Concrete	0	Silty Sand	0.25	0.25	0.5	0	10	0	9	0	10	0	1	1	0	0	840	9	840	9	933	10
Cat PB-50	Overland to Storm Sewer	5.4	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	5	2	0	0	5	3	0	3	1	1	0	0	173	1	933	5
Cat PB-51	Overland to Storm Sewer	22.9	Concrete	0	Silty Sand	0.25	0.25	0.5	0	21	0	19	0	21	0	2	2	0	0	840	19	840	19	933	21
Cat PB-53	Overland to Storm Sewer	84.6	Concrete	0	Silty Sand	0.25	0.25	0.5	0	79	0	71	0	79	0	8	8	0	0	840	71	840	71	933	79
Cat PB-54	Overland to Storm Sewer	1.5	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	1	1	0	0	1	1	0	1	0	0	0	0	173	0	933	1
Cat PB-55	Overland to Storm Sewer	2.0	Concrete	0	Silty Sand	0.25	0.25	0.5	0	2	0	2	0	2	0	0	0	0	0	840	2	840	2	933	2
Cat PB-56	Overland to Storm Sewer	1.9	Concrete	0	Silty Sand	0.25	0.25	0.5	0	2	0	2	0	2	0	0	0	0	0	840	2	840	2	933	2
Cat PB-57	Overland to Storm Sewer	24.3	Concrete	0	Silty Sand	0.25	0.25	0.5	0	23	0	20	0	23	0	2	2	0	0	840	20	840	20	933	23
Cat PB-58	Overland to Storm Sewer	30.2	Concrete	0	Silty Sand	0.25	0.25	0.5	0	28	0	25	0	28	0	3	3	0	0	840	25	840	25	933	28
Cat PB-7	Overland to Storm Sewer	1.1	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	1	0	0	0	1	1	0	1	0	0	0	0	173	0	933	1
Cat PB-9	Overland to Storm Sewer	2.4	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	2	1	0	0	2	1	0	1	0	0	0	0	173	0	933	2

TABLE G-1 POST-DEVELOPMENT WATER BUDGET (BY CATCHMENT)
HYDROGEOLOGICAL INVESTIGATION
113-117 BAYFIELD STREET, BAYFIELD

ANNUAL PRECIPITATION	EVAPORATION AND EVAPOTRANSPIRATION FACTORS			
	Impervious Areas		Waterbody	
mm	%	mm	%	mm
933	10%	93	69%	646

On-Site Subcatchment Designation	Outlet	Total Area (m^2)	MOE TABLE 2 Components					MOE Infiltration Factor	Adjusted MOE Infiltration Factor	Inputs					Outputs									
										Precipitation			Run-on	Total Inputs	Evapotranspiration			Infiltration	Runoff					Total Outputs
			Cover		Soil		Topography			Annual Average	Surplus (Pervious)	Surplus (Impervious)			Pervious	Impervious	Total Evapotranspiration	Total Infiltration	Pervious	Total Impervious		Total Runoff		
										(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)	(mm/yr)	(m^3/yr)
Post-Development Catchment PB Total	**Overland to Storm Sewer**	**654**								**610**		**353**	**0**	**610**	**129**	**39**	**168**	**49**	**40**	**539**	**353**	**601**	**393**	**933**	**610**
Cat PC-15	Internal Storm Drain	58.6	Concrete	0	Silty Sand	0.25	0.25	0.5	0	55	0	49	0	55	0	5	5	0	0	840	49	840	49	933	55
Cat PC-16	Internal Storm Drain	136.2	Pavement	0	Silty Sand	0.25	0.25	0.5	0	127	0	114	0	127	0	13	13	0	0	840	114	840	114	933	127
Cat PC-22	Internal Storm Drain	216.9	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	202	83	0	199	401	119	0	119	155	127	0	0	585	127	1,850	401
Cat PC-27	Internal Storm Drain	6.2	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	6	2	0	0	6	3	0	3	1	1	0	0	173	1	933	6
Cat PC-35	Internal Storm Drain	13.5	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	13	5	0	0	13	7	0	7	3	2	0	0	173	2	933	13
Post-Development Catchment PC Total	**Internal Storm Drain**	**431**								**402**	**91**	**164**	**199**	**601**	**130**	**18**	**148**	**159**	**130**	**379**	**164**	**681**	**294**	**1,394**	**601**
Total Site		**3,730**								**3,479**	**91**	**2,736**	**199**	**3,678**	**259**	**304**	**563**	**209**	**171**	**734**	**2,736**	**779**	**2,907**	**986**	**3,678**
External Areas																									
Cat PD-1	SE (Via Catchment C)	773.8	Lawns	0.05	Silty Sand	0.25	0.25	0.55	0.55	722	297	0	0	722	425	0	425	163	134	0	0	173	134	933	722
Cat PD-32	SE (Via Catchment C)	77.8	Building	0	Silty Sand	0.25	0.25	0.5	0	73	0	65	0	73	0	7	7	0	0	840	65	840	65	933	73
Post-Development Catchment PDTotal	**SE (Via Catchment C)**	**852**								**794**	**297**	**65**	**0**	**794**	**425**	**7**	**432**	**163**	**134**	**77**	**65**	**234**	**199**	**933**	**794**

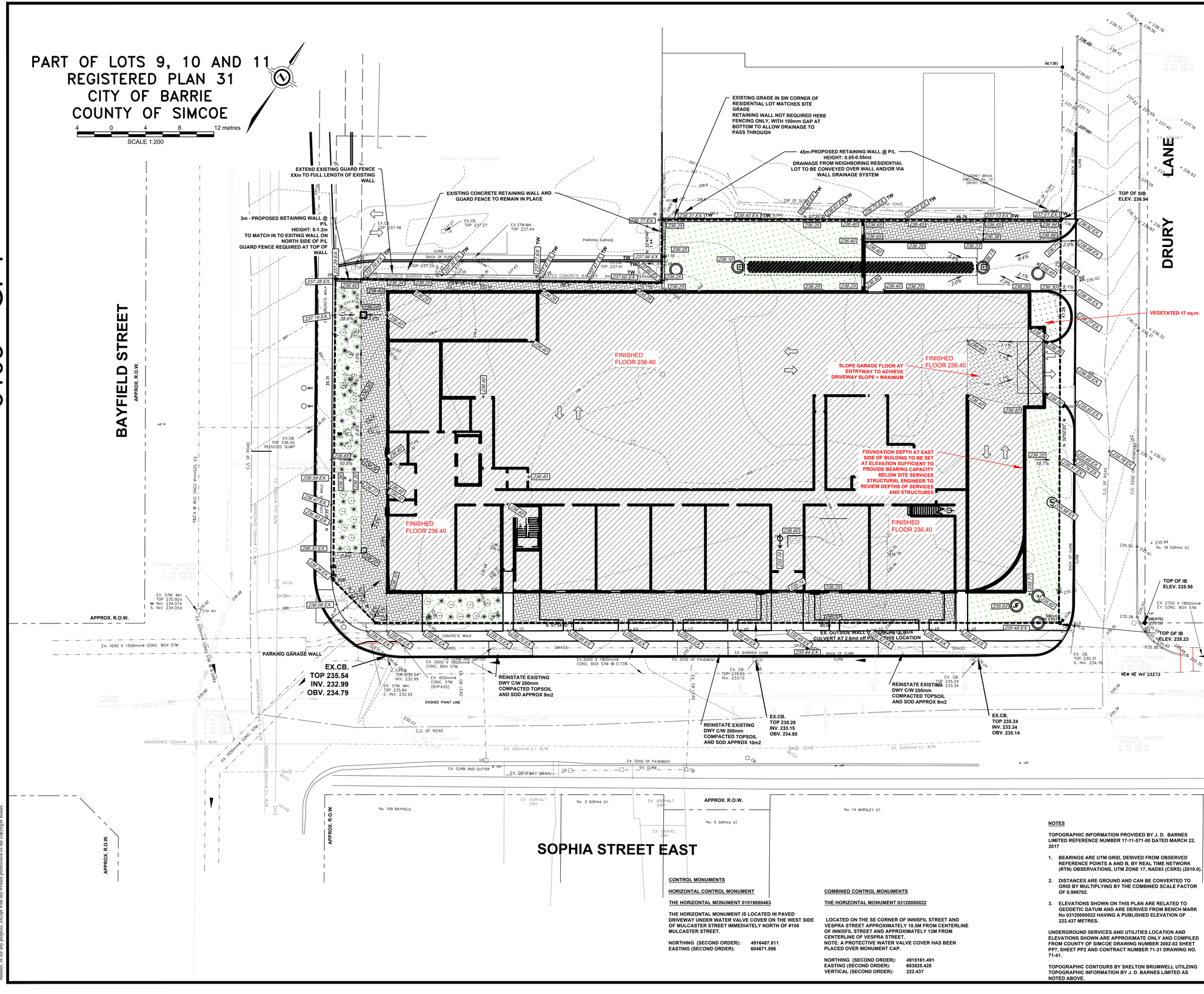
APPENDIX

H ENGINEERING DRAWINGS

3103 – GP1

PART OF LOTS 9, 10 AND 11
REGISTERED PLAN 31
CITY OF BARRIE
COUNTY OF SIMCOE

4 0 4 8 12 metres
SCALE 1:200



KEY MAP
N.T.S.

LEGEND

- DEVELOPMENT BOUNDARY
- EXISTING LIMIT OF R.O.W.
- IB — FOUND IRON BAR
- SB — FOUND SQUARE IRON BARS
- × 263.20 — EXISTING ELEVATIONS
- CB — EXISTING CATCH BASIN
- STM MH — EXISTING STORM MANHOLE
- STM — EXISTING STORM SEWER
- SAN MH — EXISTING SANITARY MANHOLE
- SAN — EXISTING SANITARY SEWER
- SAN — EXISTING SANITARY SERVICE
- HYD — EXISTING FIRE HYDRANT PER TOPO SURVEY
- WV — EXISTING WATER VALVE PER TOPO SURVEY
- EXISTING CURB STOP PER TOPO SURVEY
- EXISTING WATERMAIN
- E.M.H. — EXISTINGELECTRICAL MANHOLE
- LS — EXISTING LIGHT STANDARD
- HP — EXISTING HYDRO POLE
- OH — EXISTING OVERHEAD HYDRO
- PED — EXISTING BELL PEDESTAL
- SIGN — EXISTING SIGN
- 1M — EXISTING 1.00 m CONTOUR
- 0.5M — EXISTING 0.50 m CONTOUR
- MW — EXISTING MONITOURING WELL
- × 263.80 / 236.16 — PROP. SPOT ELEVATION
- × 263.80 TC — PROP. TOP OF CURB SPOT ELEVATION
- × 263.80 TW — PROP. TOP OF WALL SPOT ELEVATION
- × 263.80 BW — PROP. BOTTOM OF WALL SPOT ELEVATION
- 18.7% — PROPOSED GRADE
- PROPOSED TREES AND/OR SHRUBS
- PROPOSED VEGETATED SURFACE
- PROPOSED PERMEABLE PAVING WITH UNDERDRAIN

SCHEDULE OF REVISIONS

NO.	DATE	DESCRIPTION	CHECKED
1.	MARCH 20, 2020	ISSUED FOR PRE-CONSULTATION	BWB
2.	APRIL 2020	SUBMISSION FOR REZONING	BWB

LICENSED PROFESSIONAL ENGINEER
April 15, 2020
B. W. BOLIVAR
100013673
PROVINCE OF ONTARIO

CORAL SOPHIA HOUSING
117 BAYFIELD ST.
BARRIE, ONTARIO
COUNTY OF SIMCOE

SITE GRADING PLAN

CONTROL MONUMENTS

HORIZONTAL CONTROL MONUMENT

THE HORIZONTAL MONUMENT 01019860463

THE HORIZONTAL MONUMENT IS LOCATED IN PAVED DRIVEWAY UNDER WATER VALVE COVER ON THE WEST SIDE OF MULCASTER STREET IMMEDIATELY NORTH OF #108 MULCASTER STREET.

NORTHING (SECOND ORDER): 4916487.811
EASTING (SECOND ORDER): 604671.596

COMBINED CONTROL MONUMENTS

THE HORIZONTAL MONUMENT 03120080022

LOCATED ON THE SE CORNER OF INNISFIL STREET AND VESPRA STREET APPROXIMATELY 18.5M FROM CENTERLINE OF INNISFIL STREET AND APPROXIMATELY 13M FROM CENTERLINE OF VESPRA STREET.
NOTE: A PROTECTIVE WATER VALVE COVER HAS BEEN PLACED OVER MONUMENT CAP.

NORTHING (SECOND ORDER): 4915161.491
EASTING (SECOND ORDER): 603825.428
VERTICAL (SECOND ORDER): 222.437

NOTES

TOPOGRAPHIC INFORMATION PROVIDED BY J. D. BARNES LIMITED REFERENCE NUMBER 17-11-071-00 DATED MARCH 22, 2017

1. **BEARINGS ARE UTM GRID, DERIVED FROM OBSERVED REFERENCE POINTS A AND B, BY REAL TIME NETWORK (RTN) OBSERVATIONS, UTM ZONE 17, NAD83 (CSRS) (2010.0).**
2. **DISTANCES ARE GROUND AND CAN BE CONVERTED TO GRID BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.999702.**
3. **ELEVATIONS SHOWN ON THIS PLAN ARE RELATED TO GEODETIC DATUM AND ARE DERIVED FROM BENCH MARK No 03120080022 HAVING A PUBLISHED ELEVATION OF 222.437 METRES.**

UNDERGROUND SERVICES AND UTILITIES LOCATION AND ELEVATIONS SHOWN ARE APPROXIMATE ONLY AND COMPILED FROM COUNTY OF SIMCOE DRAWING NUMBER 2002-02 SHEET PP7, SHEET PP2 AND CONTRACT NUMBER 71-31 DRAWING NO. 71-41.

TOPOGRAPHIC CONTOURS BY SKELTON BRUMWELL UTILIZING TOPOGRAPHIC INFORMATION BY J. D. BARNES LIMITED AS NOTED ABOVE.

PROJECT NO. 17-3103	DRWG NO. 3103-GP1
DATE APRIL 2020	SCALE: 1:200 HOR.
DRAWN: BDD/BWB	CHECKED: APPROVED:

SBA Skelton Brumwell & Associates Inc.
ENGINEERING PLANNING ENVIRONMENTAL CONSULTANTS
93 BELL FARM ROAD, SUITE 107
BARRIE, ONTARIO L4M 5G1
www.skeltonbrumwell.ca
TELEPHONE (705) 726-1141
FAX (705) 726-0331
TOLL FREE (877) 726-1141

APPENDIX

I DEWATERING CALCULATIONS

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Site Bayfield Site - Parking Garage - Low K

Input Parameters

Initial Elevation of Water Table (m)	H	3.85	m
Final Elevation of Water Table (m)	h	0	m
Hydraulic Conductivity (m/s)	K	3.00E-07	m/s
Hydraulic Conductivity (m/d)	K	2.59E-02	m/d
Aquifer Thickness (m)	B	5.30	
Linear Trench Size (m)	a	80	m
Linear Trench Size (m)	b	50	m
Length of Dewatering - Trench Length (m)	X	80	m
Width of Dewatering (m)	L	2.00	m

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m)

Ro = 3 (H - h) x sqrt (K) (eq. 6.14, p. 104)

Corrected Ro	Ro	42	m
	Ro	6	m

Equivalent Radius of Well (m)

Rs = sqrt ((a x b)/ pi) (eq. 6.10, p. 102)

Rs	35.68	m

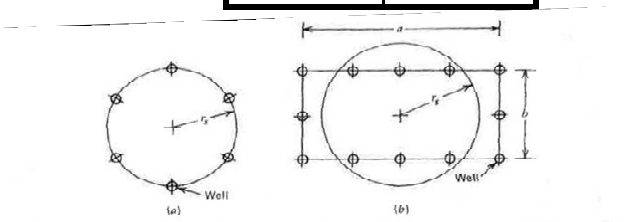


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b < 1.5)

Shaft Calculation (m3/day)

Q = (pi x K x (H^2 - h^2)) / ln (Ro / Rs) (Eq. 6.3, p. 99)

Q	7.4	m3/day
Q	7395	L/day

Long Narrow System - Trench (a/b > 1.5)

Trench Calculation (m3/day)

Q = (pi x K x (H^2 - h^2)) / ln (Ro / Rs) + 2 x (X x K x (H^2 - h^2)) / 2 x L

Q	22.8	m3/day
Q	22763	L/day

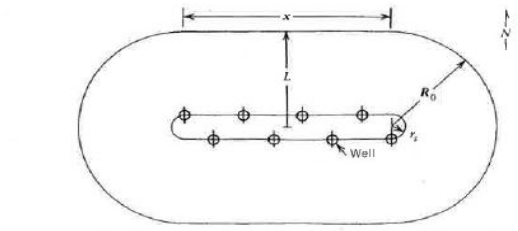
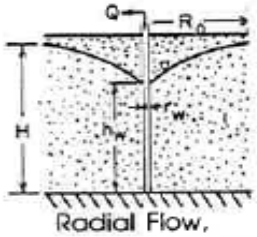
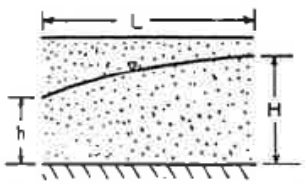


Figure 6.8 Approximate analysis of long narrow systems.



Radial Flow, Water Table Aquifer



Water Table Flow From a Line Source to a Drainage Trench

Construction Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Site Bayfield Site - Parking Garage - High K

Input Parameters

Initial Elevation of Water Table (m)	H	3.85	m
Final Elevation of Water Table (m)	h	0	m
Hydraulic Conductivity (m/s)	K	2.10E-06	m/s
Hydraulic Conductivity (m/d)	K	1.81E-01	m/d
Aquifer Thickness (m)	B	5.30	
Linear Trench Size (m)	a	80	m
Linear Trench Size (m)	b	50	m
Length of Dewatering - Trench Length (m)	X	80	m
Width of Dewatering (m)	L	2.00	m

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m)

Ro = 3 (H - h) x sqrt (K) (eq. 6.14, p. 104)

Corrected Ro	Ro	52	m
	Ro	17	m

Equivalent Radius of Well (m)

Rs = sqrt ((a x b)/ pi) (eq. 6.10, p. 102)

Rs	35.68	m

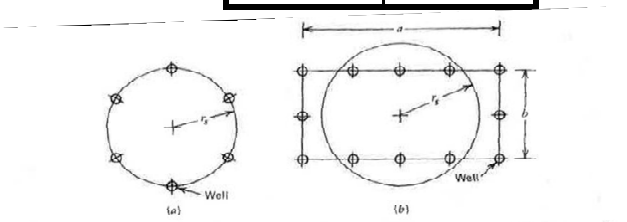


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b < 1.5)

Shaft Calculation (m3/day)

Q = (pi x K x (H^2 - h^2)) / ln (Ro / Rs) (Eq. 6.3, p. 99)

Q	22	m3/day
Q	21967	L/day

Long Narrow System - Trench (a/b > 1.5)

Trench Calculation (m3/day)

Q = (pi x K x (H^2 - h^2)) / ln (Ro / Rs) + 2 x (X x K x (H^2 - h^2)) / 2 x L

Q	130	m3/day
Q	129542	L/day

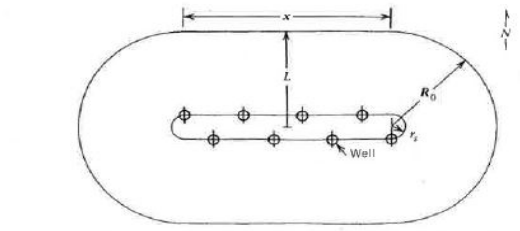
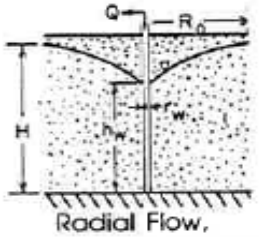
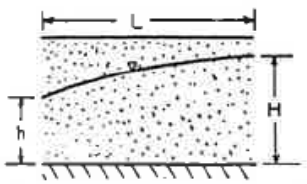


Figure 6.8 Approximate analysis of long narrow systems.



Radial Flow, Water Table Aquifer



Water Table Flow From a Line Source to a Drainage Trench

Long-term Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Site Bayfield Site - Parking Garage - Low K

Input Parameters

Initial Elevation of Water Table (m)	H	2.85	m
Final Elevation of Water Table (m)	h	0	m
Hydraulic Conductivity (m/s)	K	3.00E-07	m/s
Hydraulic Conductivity (m/d)	K	2.59E-02	m/d
Aquifer Thickness (m)	B	5.30	
Linear Trench Size (m)	a	80	m
Linear Trench Size (m)	b	50	m
Length of Dewatering - Trench Length (m)	X	80	m
Width of Dewatering (m)	L	2.00	m

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m)

Ro = 3 (H - h) x sqrt (K) (eq. 6.14, p. 104)

Corrected Ro	Ro	40	m
	Ro	5	m

Equivalent Radius of Well (m)

Rs = sqrt ((a x b)/ pi) (eq. 6.10, p. 102)

Rs	35.68	m

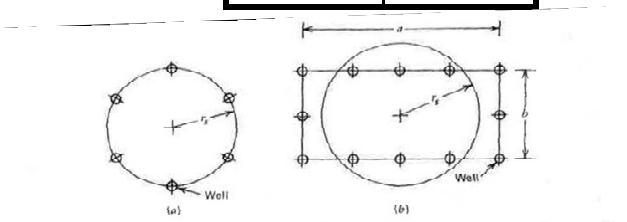


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b < 1.5)

Shaft Calculation (m3/day)

Q = (pi x K x (H^2 - h^2)) / ln (Ro / Rs) (Eq. 6.3, p. 99)

Q	5	m3/day
Q	5364	L/day

Long Narrow System - Trench (a/b > 1.5)

Trench Calculation (m3/day)

Q = (pi x K x (H^2 - h^2)) / ln (Ro / Rs) + 2 x (X x K x (H^2 - h^2)) / 2 x L

Q	14	m3/day
Q	13785	L/day

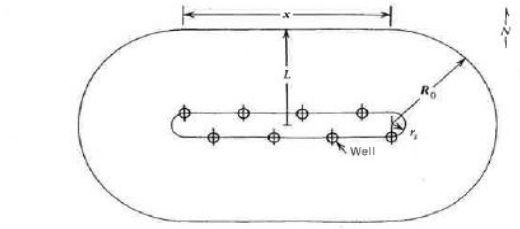
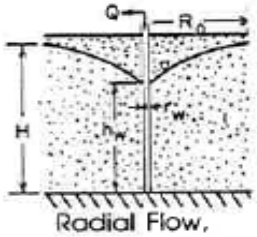
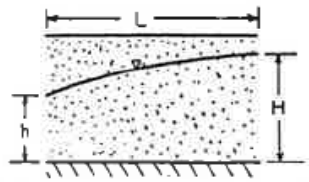


Figure 6.8 Approximate analysis of long narrow systems.



Radial Flow, Water Table Aquifer



Water Table Flow From a Line Source to a Drainage Trench

Long-term Dewatering Worksheet - Unconfined Conditions

from Powers, 1992

Site Bayfield Site - Parking Garage - High K

Input Parameters

Initial Elevation of Water Table (m)	H	2.85	m
Final Elevation of Water Table (m)	h	0	m
Hydraulic Conductivity (m/s)	K	2.10E-06	m/s
Hydraulic Conductivity (m/d)	K	1.81E-01	m/d
Aquifer Thickness (m)	B	5.30	
Linear Trench Size (m)	a	80	m
Linear Trench Size (m)	b	50	m
Length of Dewatering - Trench Length (m)	X	35	m
Width of Dewatering (m)	L	24.04	m

L = Ro / 2 (eq. 6.15, p. 105)

ZOI - Radius of Influence (m)

Ro = 3 (H - h) x sqrt (K) (eq. 6.14, p. 104)

Corrected Ro	Ro	48	m
	Ro	12	m

Equivalent Radius of Well (m)

Rs = sqrt ((a x b)/ pi) (eq. 6.10, p. 102)

Rs	35.68	m

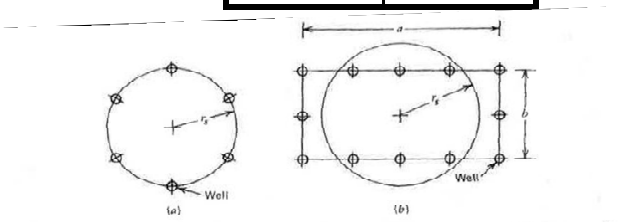


Figure 6.7 Approximation of equivalent radius r_s. (a) Circular systems. (b) Rectangular systems.

Flow Calculations - Q

Radial Flow to a Shaft (a/b < 1.5)

Shaft Calculation (m3/day)

Q = (pi x K x (H^2 - h^2)) / ln (Ro / Rs) (Eq. 6.3, p. 99)

Q	16	m3/day
Q	15534	L/day

Long Narrow System - Trench (a/b > 1.5)

Trench Calculation (m3/day)

Q = (pi x K x (H^2 - h^2)) / ln (Ro / Rs) + 2 x (X x K x (H^2 - h^2)) / 2 x L

Q	18	m3/day
Q	17680	L/day

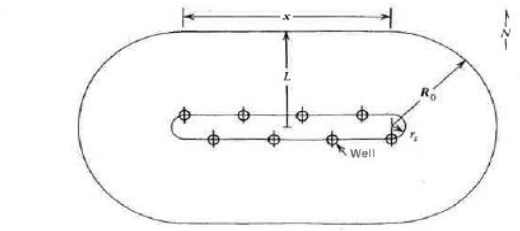
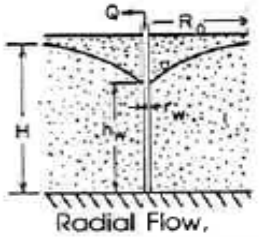
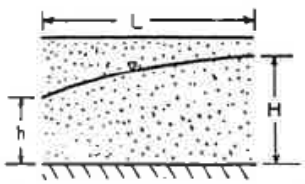


Figure 6.8 Approximate analysis of long narrow systems.



Radial Flow, Water Table Aquifer



Water Table Flow From a Line Source to a Drainage Trench