

**TOWN OF CALEDON
PLANNING
RECEIVED**

July 29, 2020

NITRATE IMPACT ASSESSMENT

Proposed Sub-Division Development

17791 Mount Hope Road

Part of Lot 28, Concession 8

Town of Caledon, Ontario

Prepared for:

Mr. Joe Triumbari

Palgrave Development Inc

3 Manswood Crescent

Brampton, ON L6P 0A3

Prepared By:

SIRATI & PARTNERS CONSULTANTS LIMITED

Project: SP18-334-00

November 25, 2019



12700 Keele Street

King City, Ontario L7B 1H5

Tel: 905.833.1582

Fax: 905.833.5360

www.sirati.ca

TABLE OF CONTENTS

1.0	INTRODUCTION AND BACKGROUND	1
1.1	Previous Investigations	1
2.0	LAND USE	1
3.0	SITE DEVELOPMENT PLAN	2
4.0	PHYSICAL SETTING	2
4.1	Topography and Drainage	2
4.2	Physiography	3
4.3	Overburden Geology	3
4.4	Bedrock Geology	3
5.0	REGIONAL HYDROGEOLOGY	4
5.1	Private Water Wells	4
5.2	Palgrave Municipal Water Supply Wells	4
6.0	SOIL AND GROUNDWATER CONDITIONS	5
6.1	Soil Stratigraphy	5
6.2	Groundwater Conditions	6
7.0	GROUNDWATER QUALITY AND BACKGROUND NITRATE CONCENTRATION	6
7.1	General Water Quality	6
7.2	Nitrate Concentrations	7
8.0	WATER BALANCE ANALYSIS	8
8.1	Site Level Water Balance	8
8.2	Climate Data	8
8.3	Infiltration and Runoff	10
9.0	ASSESSMENT OF POTENTIAL NITRATE IMPACTS	10
9.1	Background Nitrate Concentration	11
9.2	Nitrate Loading Analysis – On-Site Impact Assessment	11
9.3	Nitrate Dilution – Application of Reasonable Use Policy	12
9.4	Potential Nitrate Impacts	13
10.0	CONCLUSIONS AND RECOMMENDATIONS	15
	SELECTED BIBLIOGRAPHY	17
	LIMITATIONS AND USE OF THE REPORT	18

FIGURES

Figure 1-1 – Site Location Plan

Figure 1-2 – Land Use Designation Map

Figure 4-1 – Topographic Map

Figure 4-1a – Innisfil Creek Sub-watershed Map

Figure 4-2 – Physiography Map

Figure 4-3 – Surficial Geology Map

Figure 4-4 – Bedrock Geology Map

Figure 5-1 – MECP Water Well Location Map

Figure 6-1 – Borehole/Monitoring Well Location Plan

Figure 6-2 – Cross Section Profile A-A'

Figure 6-3 – Groundwater Elevations and Inferred Groundwater Flow Direction

Figure 8-1 – Mean Annual Temperature at the Site

Figure 8-2 – Mean Annual Precipitation at the Site

Figure 8-3 – Monthly Average Temperature and Precipitation at the Site

APPENDICES

Appendix A – Site Development Plan

Appendix B – Borehole Logs

Appendix C – Laboratory Certificates of Analysis

Appendix D – Water Balance -Thornthwaite

1.0 INTRODUCTION AND BACKGROUND

Sirati & Partners (SIRATI) was retained by Palgrave Development Inc. (the Client) to conduct a Nitrate Impact Assessment study at a property located at 17791 Mount Hope Road, described as Part of Lot 28, Concession 8, Mount Hope Road, Town of Caledon, Ontario (the Site). The approximate site location is presented on Figure 1-1.

The Site is located in the Town of Caledon, within the Regional Municipality of Peel or Region of Peel (Peel Region). It is understood that a residential subdivision development has been proposed at the Site.

Based on Town of Caledon Official Plan, the Site is located in a zoning area identified as rural area on Oak Ridges Moraine (A2-ORM). This study was performed in conformance with the Town of Caledon Official Plan Secondary Plan Policies Section 7.1.8.3.

Section 7.1.8.3 indicated that an applicant for an estate residential plan of subdivisions will be required to undertake any studies deemed necessary to assess the termination probability of contaminants on wells in nearby properties by septic system leachate or other sources of contaminants likely to be caused by the proposed development. Accordingly, an assessment of nitrate loadings from the on-site septic systems is being carried out.

1.1 Previous Investigations

In support of the development, geotechnical and hydrogeological investigations were carried out previously at the Site.

As part of geotechnical investigation, ten (10) boreholes were drilled and five (5) monitoring wells were completed at the Site. During the hydrogeological investigation, additional monitoring wells were completed at three (3) locations. A hydrogeological study was completed using the data obtained from the geotechnical investigation and the data obtained from the additional monitoring wells. A report entitled “Hydrogeological Investigation, Proposed Sub-Division Development, 17791 Mount Hope Road, Part of Lot 28, Concession 8, Town of Caledon, Region of Peel, Ontario” dated November 22, 2019 was prepared by SIRATI.

It should be noted that the existing monitoring wells were used for groundwater sampling for this nitrate impact assessment. In addition, the data or information obtained in the previous investigations was used and incorporated into this report.

2.0 LAND USE

The Site consists of a cultivated or undeveloped parcel of land, currently with no structures developed on the property, and is bounded by Mount Hope Road further with residential houses to the southwest, by a

vegetated wood lot and a residential property to the northwest, and by woodlots further with residential houses to the southeast and northeast.

As shown on Figure 1-2, the Site is located in an area designated as Palgrave Estate Residential Community land use area within Oak Ridges Moraine Conservation Plan area (a component of Countryside Area), where residential development is permitted.

It is understood that a residential subdivision development has been proposed at the Site.

3.0 SITE DEVELOPMENT PLAN

The Site is located on the northeast side of Mount Hope Road, in the Town of Caledon, and consists of a parcel of land with an area of approximately 41 hectares (102 acres).

A residential subdivision development consisting of twenty-nine (29) single homes has been proposed to be built on part of the property with a total development area of about 29.8 hectares (73.6 acres). A recent site development grading plan dated October 2019 provided by the Client is presented in Appendix A.

It is understood that the source of potable water for the proposed development will be supplied through the Palgrave municipal supply wells, and the new development will be serviced by private septic systems.

4.0 PHYSICAL SETTING

4.1 Topography and Drainage

As shown in Figure 4-1, the topography of the Site ranges in elevation generally between 290 mASL and 310 mASL. An unnamed creek crossing from the northwest to the southeast divides the property in two (2) parts, which drains the surface runoffs from the Site.

The Site is almost entirely located within the Nottawasaga Valley Watershed under the jurisdiction of Nottawasaga Valley Conservation Authority (NVCA).

The Nottawasaga Valley Watershed has nine (9) subwatersheds. The Innisfil Creek subwatershed (Figure 4-1a) is one of the nine (9) subwatersheds, and consists of four (4) main creek systems, namely Innisfil Creek, Bailey Creek, Beeton Creek and Penville Creek that drain the southeast portion of the Nottawasaga River watershed. The Site falls within the Beeton Creek system.

Beeton Creek arises on the Oak Ridges Moraine south of Tottenham. Flowing north, the creek enters a reservoir at the Tottenham Conservation Area and then continues downstream. An east branch, originating east of Tottenham, flows westward through agricultural lands and enters Beeton Creek north of Tottenham. Beeton Creek continues to flow northward through an agricultural landscape, skirting the west side of Beeton before joining Bailey Creek and then entering Innisfil Creek.

As shown in Figure 4-1, the unnamed tributary flows southeasterly and joins into a main tributary of Beeton Creek, which flows northwards and joins into Innisfil Creek.

4.2 Physiography

The Nottawasaga Valley Watershed is located within five (5) main regional-scale physiographic regions (Figure 4-2) as defined by Chapman and Putnam (1984). These regions include;

- Horseshoe Moraines,
- Oak Ridges Moraine,
- Peterborough Drumlin Field,
- Schomberg Clay Plains, and
- Simcoe Lowlands.

The Subject Property lies within the physiographic region termed as Oak Ridges Moraine. The Oak Ridges Moraine is comprised of rolling sandy hills, hummocky topography and closed depressions that form the source of the headwaters to major stream that drain off the moraine. The moraine within the subwatershed consists primarily of surficial sand and gravel deposits. The physiographic region provides headwater sources to Beeton Creek and Baily Creek in the southern portion of the watershed.

The Oak Ridges Moraine is an extensive interlobate moraine that extends from the Caledon area, eastward across the northern limits of the Greater Toronto area.

4.3 Overburden Geology

Surficial geology refers to those unconsolidated geologic materials overlying consolidated bedrock. As shown in Figure 4-3, the Subject Property is located in an area covered with ice-contact stratified deposits, which generally consist of gravel and sand deposits, with minor till, and also contain esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits.

The Paleozoic bedrock topography appears to strongly influence the overlying Quaternary sediment thickness and distribution. The thicker Quaternary sediments occur in bedrock topographical lows (i.e. within bedrock valleys and beneath the ORM). The overburden thickness within the Oak Ridges Moraine (ORM) ranges from approximately 56 m to 240 m.

4.4 Bedrock Geology

Bedrock geology of the NVCA watershed is defined as the Paleozoic sedimentary rocks deposited during the Upper Ordovician geological period.

The bedrock consists of shale, limestone, dolostone, and dolomitic siltstone, which were deposited in shallow seas about 450 million years ago. These beds, named as Georgian Bay Formation are approximately 250 m thick and dip to the southeast at about 5 m/km. Following long periods of additional sedimentation and erosion, the ancient Laurentian River and its tributaries cut several deep, poorly-defined bedrock valleys trending northwest-southeast across the area. As depicted in Figure 4-4, the study area is underlain by the Georgian Bay Formation and have an important influence on drift thickness and groundwater distribution in the study area.

5.0 REGIONAL HYDROGEOLOGY

Water well records on file with the Ministry of the Environment, Conservation and Parks (MECP) serve as a database for assessment of the regional hydrogeological conditions. The water well locations were provided from the MECP interactive water well record database, and the recorded water wells located within a 500 m radius are shown on Figure 5-1.

5.1 Private Water Wells

As shown in Figure 5-1, a total of thirty (30) water wells have been found within a 500 m radius around the property. One (1) record for an abandoned well is found on Site.

Based on the well records, bedrock was encountered at three (3) wells (#4906507, #4906507 and #4906507) at the depth of 74.1 ~ 74.4 mbgs, indicating presence of thick overburden sediment at and/or near the Site. In addition, layers of sand and/gravel were recorded, where the well screens were installed. The recorded water levels ranged from approximately 14 mbgs to 26 mbgs. Therefore, multiple aquifers may be present in the overburden deposits.

5.2 Palgrave Municipal Water Supply Wells

The Palgrave community is being serviced by Palgrave municipal supply wells #2, #3 and #4. The Site is situated within a wellhead protection zone, which is associated with the municipal supply well Palgrave Well#3.

Palgrave Well#3 is located about 220 m southeast of the Site, on the northeast side of Mount Hope Road, in Caledon, Ontario. Geologically, Palgrave Well#3 is located near the edge of a local bedrock valley and is overlain by about 80 m thick overburden of Oak Ridges Moraine Aquifer Complex (ORMAC) stratified sediments. This sequence consists (from surface downward) of about four metres of sand and gravel, about 35 m of silt and clay with minor sand, about 25 m of gravelly sand and silty sand, a silt and clay unit about five metres thick, and finally, about 10 m of gravelly sand where the well is screened (Earthfx , May 2007).

Based on MECP water well record, Palgrave Well#3 was found to have a well ID of 4906859, and was drilled to the depth of approximately 82.3 mbgs into (sandy) clay, and screened between 71.3 mbgs and 80.5 mbgs in (gravelly) sand. The static water level was recorded to be 15.1 mbgs.

Based on the above findings, it can be inferred that layers in a significant thickness of unconsolidated overburden are present in the site area, and multiple sandy soils can serve as the aquifer for water supply. However, it is more common that the deeper aquifer is selected for the water supply aquifer, probably because of having a thicker and better protection from the potential contamination.

6.0 SOIL AND GROUNDWATER CONDITIONS

The soil and groundwater conditions were at the Site were interpreted based on the data obtained from the previous geotechnical and hydrogeological investigations. All the boreholes and monitoring wells completed as part of the geotechnical and hydrogeological investigations are shown on Figure 6-1.

The details of Borehole Logs are presented in Appendix A. In addition, one (1) cross section (as shown on Figure 6-2) was constructed to illustrate the horizontal and vertical extents of the soil and groundwater conditions.

6.1 Soil Stratigraphy

The soil stratigraphy of the Site as revealed in the boreholes generally consisted of topsoil and fill materials (reworked soil), underlain by native soils predominantly comprised of cohesionless soils, locally with cohesive soils. No bedrock was encountered at the maximum explored depth of 18.3 mbgs. A summary of the encountered soils is made as follows.

Topsoil: A 300 mm to 450 mm thick surficial layer of topsoil was found at all borehole locations except BH4, BH19-1/1A, BH19-2 and BH19-3/3A. The thickness of the topsoil in each borehole is shown in the respective borehole logs. It should be noted that the thickness of the topsoil observed at the borehole locations may not be representative for the entire site and should not be relied on to calculate the amount of topsoil that need to be stripped from the Site.

Fill Material/Possible Fill: Below the topsoil, where present, a zone of earth fill/disturbed native material was encountered in all boreholes. The fill layer was found extending to depths varying between 0.2 m (BH19-1/1A) and 3 m (BH6) below the existing ground surface. The fill material mainly consisted of silty sand, sandy silt and sand, with trace to some topsoil inclusion at some borehole locations. The composition of the weathered/disturbed sand was generally similar to that of the underlying undisturbed native soils.

Cohesionless Layers: Cohesionless layers of silt, sandy silt, silty sand, sand, gravelly sand, and sand and gravel were encountered in all borehole locations. The native cohesionless layers were encountered at

different depths ranging from 0.2 m to 3.0 m below the existing ground surface and extended to the termination depth at all borehole locations.

Cohesive Layer: A thin cohesive layer of clayey silt was observed locally in BH5, extending from 1.5 m to 2.3 m depth.

The surficial geology is fairly consistent across the Site, as indicated in the borehole logs. Sand and gravel are predominant across the site indicating highly pervious nature of the soils.

All the boreholes and monitoring wells installed as part of the geotechnical and hydrogeological investigations are shown in Figure 6-1.

The details of the soil stratigraphy are presented in Borehole Logs in Appendix A. In addition, one (1) cross section (as shown on Figure 6-2) was constructed to illustrate the horizontal and vertical extents of the soil and groundwater conditions.

6.2 Groundwater Conditions

As part of geotechnical investigation, five (5) monitoring wells identified as BH/MW1, MW/BH3, MW/BH6, MW/BH9 & MW/BH10B) were installed at the Site. However, these monitoring wells were found to be dry wells. For further hydrogeological investigation, additional three (3) deeper monitoring wells (BH19-1A, BH19-2 and BH19-3A) were installed for groundwater monitoring, sampling and testing.

The groundwater levels measured in the three (3) monitoring wells ranged from 6.3 mbgs at BH/MW19-2 to 14.8 mbgs at BH/MW19-1A, and elevations ranged from 283.8 mASL at BH/MW19-3A to 291.6 mASL at BH/MW19-3A. Based on the most recent water level data dated October 21, 2019, the groundwater elevation contours were established. As shown on Figure 6-3, the inferred groundwater flow appeared to be generally in a northerly direction.

7.0 GROUNDWATER QUALITY AND BACKGROUND NITRATE CONCENTRATION

7.1 General Water Quality

To assess the general water quality, groundwater samples were collected on October 8, 2019 from monitoring well BH/MW19-2 and on October 18, 2019 from monitoring wells BH/MW19-1A and BH/MW19-3A. The samples were submitted to AGAT laboratory for analysis of the parameters as per Water Quality Assessment package provided by AGAT. The analytical results are provided in the Laboratory Certificate of Analysis in Appendix B.

The results were compared with Ontario Drinking Water Quality Standards (ODWQS)-Aesthetic Objectives and Operational Guidelines, and indicated that exceedances or elevated concentrations for aluminum, iron, manganese, total hardness, turbidity and nitrate were found in the tested groundwater samples.

Table 7:1 Guideline Violation of Groundwater Samples Compared to ODWQS-AO&OG

Sample ID	Parameter	Guideline	Guideline Value (mg/L)	Measured Concentration (mg/L)
BH19-1A	Manganese	ODWQS	0.05	2.23
BH19-1A	Total Hardness (as CaCO ₃)	ODWQS	80-100	330
BH19-1A	Turbidity	ODWQS	5 NTU	24900
BH19-1A	Nitrate as N	ODWQS	10	21.5
BH19-2	Manganese	ODWQS	0.05	1.29
BH19-2	Total Hardness (as CaCO ₃)	ODWQS	80-100	367
BH19-2	Turbidity	ODWQS	5 NTU	6890
BH19-2	Nitrate as N	ODWQS	10	29.2
BH19-3A	Aluminum	ODWQS	0.1	4.36
BH19-3A	Iron	ODWQS	0.3	3.12
BH19-3A	Manganese	ODWQS	0.05	3.11
BH19-3A	Total Hardness (as CaCO ₃)	ODWQS	80-100	378
BH19-3A	Turbidity	ODWQS	5 NTU	7300
BH19-3A	Nitrate as N	ODWQS	10	27.0

Based on the results above, exceedances or elevated concentrations for manganese, total hardness, nitrate and turbidity were found in all the tested groundwater samples. In addition, nitrate was found exceeding the ODWQS limit of 10 mg/L in groundwater at all locations.

It should be noted that the groundwater samples analyzed were in unfiltered state and shall contain a certain amount of sediments and/or particulates, which caused high value of turbidity. The exceedances or elevated concentrations may have resulted from the sediments and/or particulates in the water samples.

7.2 Nitrate Concentrations

As part of water quality assessment, nitrate was analyzed in three (3) groundwater samples taken from BH/MW19-1A, BH/MW19-2 and BH/MW19-3A. The results are presented in Table 7-2 below.

7-2: Nitrate Concentration in Groundwater from On-Site Wells.

Monitoring Well	Nitrate as N (mg/L)	ODWQS Standard (mg/L)
BH/MW19-1A	21.5	10
BH/MW19-2	29.3	10
BH/MW19-3A	27.0	10

Based on the results of chemical analysis, nitrate concentrations in the analyzed groundwater samples were found to be raised, which are above the ODWQS standards, indicating elevated background nitrate concentrations.

8.0 WATER BALANCE ANALYSIS

8.1 Site Level Water Balance

Based on the Thornthwaite and Mather methodology (1957), the water balance is an accounting of water in the hydrologic cycle. Precipitation (P) falls as rain and snow. It can run off towards lakes and streams (R), infiltrate to the groundwater table (I), or evaporate from ground or evapotranspire by vegetation (ET). When long-term average values of P, R, I, and ET are used, there is minimal or no net change to groundwater storage (ΔS).

The annual water budget can be expressed as:

$$P = ET + R + I + \Delta S$$

Where:

P = Precipitation (mm/year)

ET = Evapotranspiration (mm/year)

R = Run-off (mm/year)

I = Infiltration (mm/year)

ΔS = Change in groundwater storage (taken as zero) (mm/year)

8.2 Climate Data

Monthly average temperature and precipitation data were obtained from Environment Canada, for Orangeville WPCP station (climate identifier: 6155790) as the nearest station located at about 8 km distance from the Property. Data was available between the years 1962 to 2006. Temporal variations of temperature and rainfall are shown in Figures 8-1 and 8-2. Long-term average annual rainfall at the study area is 901

mm. Actual evapotranspiration was estimated to be about 482 mm/annum using the USGS Thornthwaite Monthly Water Balance software utilizing average monthly temperature and precipitation (Appendix C).

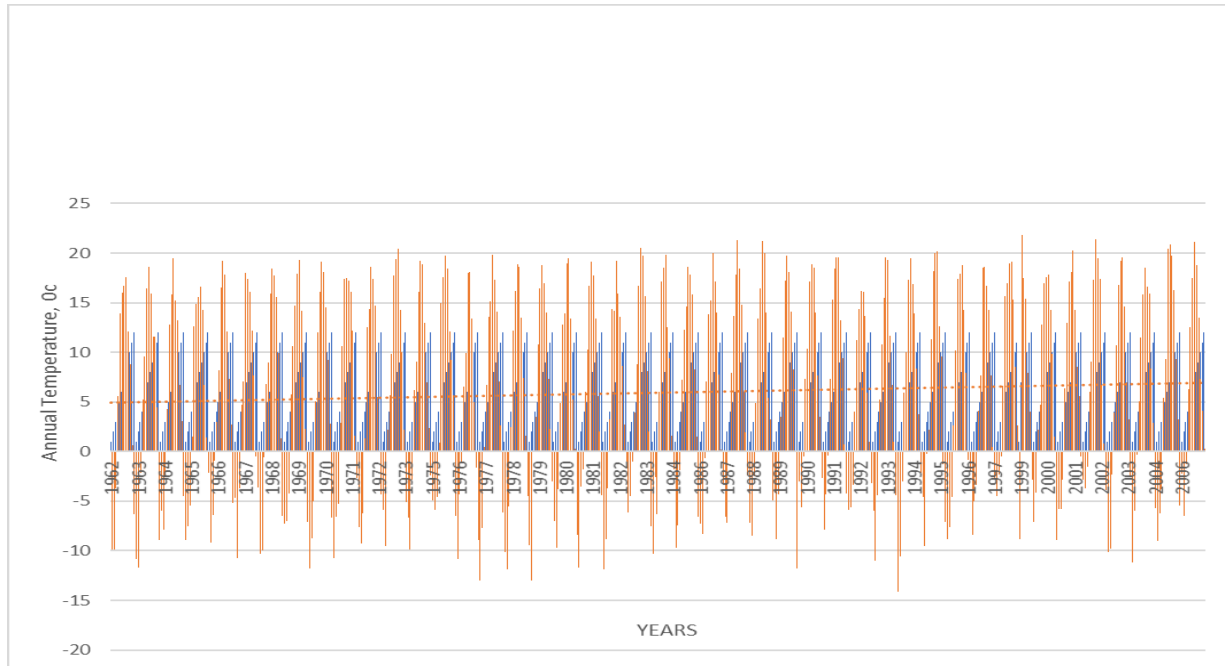


Figure 8-1 Mean Annual Temperature at the Site

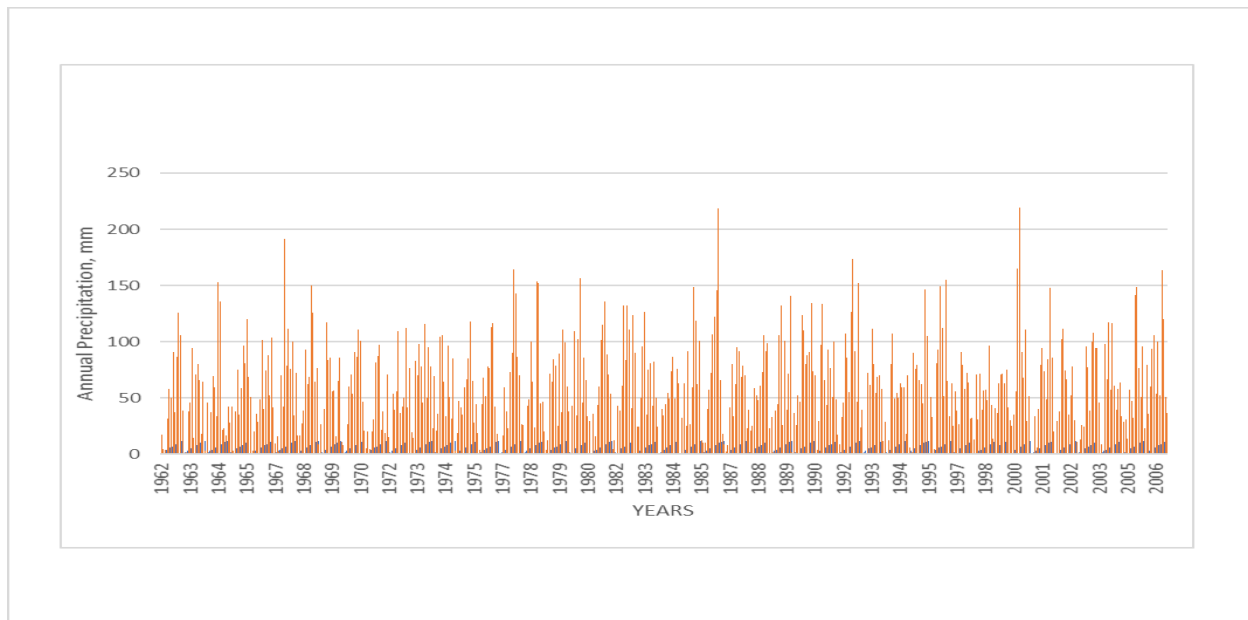


Figure 8-2 Mean Annual Precipitation at the Site

Average monthly variations of both temperature and precipitation were calculated for the period from 1962 to 2006 and is presented below in Figure 8-3. The highest temperature was recorded in the month of July, while the highest rainfall was in the month of August.

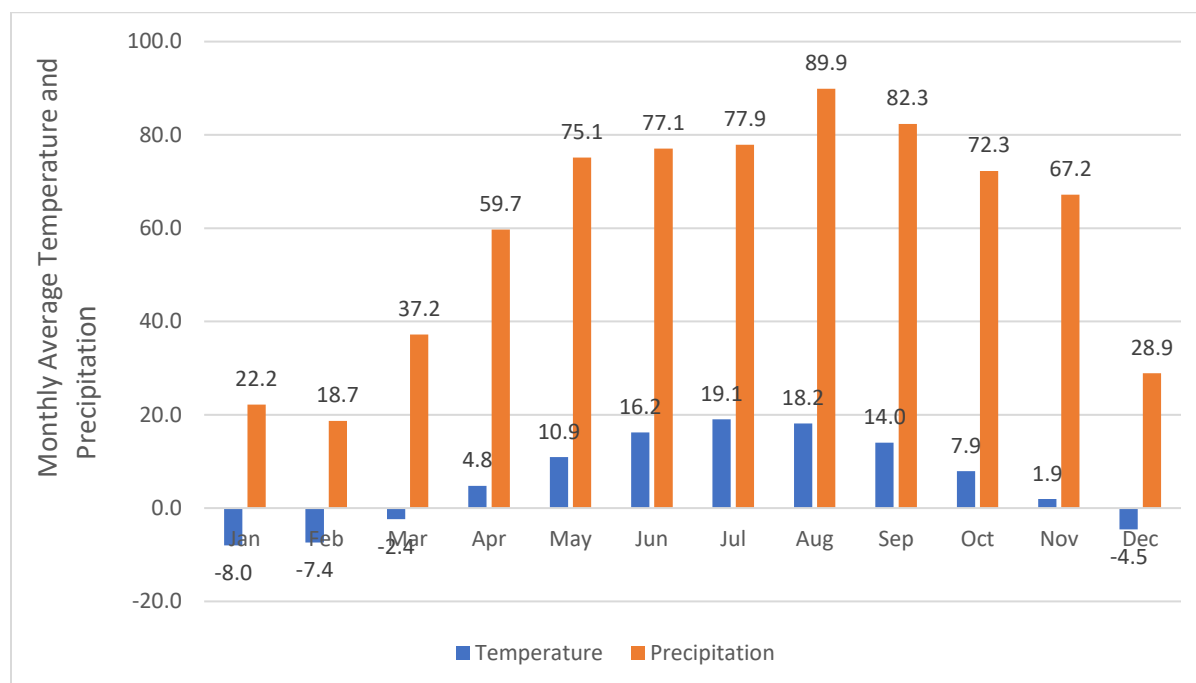


Figure 8-3 Average Monthly Temperature at the Site

8.3 Infiltration and Runoff

Actual evapotranspiration was estimated to be about 482 mm/annum using the USGS Thornthwaite Monthly Water Balance software (Appendix D) utilizing average monthly temperature and precipitation results of Environment Canada, Orangeville weather station.

As mentioned above, given the actual evapotranspiration at 482 mm/annum and the average annual precipitation of 901 mm/annum, there is a net water surplus of 419 (=901 - 482) mm/annum occurring at the Site, which can either infiltrate into subsurface or go as run-off.

As a very conservative estimate of precipitation infiltration at the Site, a value of 419 mm/year (say 0.4 m/year) could be utilized for nitrate dilution calculations.

9.0 ASSESSMENT OF POTENTIAL NITRATE IMPACTS

In compliance with Town of Caledon Official Plan, potential nitrate impacts which are associated with the proposed development were assessed. Since, the size of each lot in the proposed development is less than a hectare, it is necessary to characterize and assess the nature of impact of nitrate on the natural environment.

The impacts on local groundwater regime and down gradient property boundary are dependent upon the hydrogeology of the area, the background concentration of nitrate in the groundwater and contaminant concentration contained within the effluent.

9.1 Background Nitrate Concentration

As discussed in Section 7, nitrate was analyzed in groundwater samples taken from three (3) monitoring wells BH/MW19-1A, BH/MW19-2 and BH/MW19-3A, which are located in the development area. The analyzed nitrate concentrations (Nitrate as nitrogen) ranged from 21.5 mg/L to 29.3 mg/L, which are above the ODWQS Standard of 10 mg/L for nitrate as nitrogen.

It is known that the Site has been used to grow agricultural crops for farming purpose. Nitrogen is a very important nutrient element in agriculture, which occurs in soils in several forms. Application of nitrogen fertilizers may have occurred for the farming purpose, which provides the extra sources of nitrogen to the soil and groundwater.

In most soils, ammonium is rapidly converted to nitrate via nitrite by a process called nitrification, where ammonium is oxidized to nitrite and then to nitrate by the action of aerobic bacteria. Nitrate is very soluble and unless intercepted and taken up by plant roots, it may leach down in the soil along with the irrigation water or rain water or it may be carried away by runoff.

Based on the site condition, the background nitrate concentrations at the Site may have been elevated or raised due to the farming activities.

It would be anticipated that after the residential development, no further farming activities will take place at the Site, and therefore, the nitrate concentration in soil and groundwater at the Site will be minimized or reduced.

On the other hand, the Site is at the downgradient of the residential houses located in the southwest and southeast of the Site. These rural residential houses may have been using private septic systems, which would result in elevated nitrate concentration in local groundwater. Therefore, given the locations at the property boundary, the elevated nitrate concentrations found in BH/MW19-1A and BH/MW19-2 may also likely be caused due to the operations of the septic systems on the upgradient residential properties.

9.2 Nitrate Loading Analysis – On-Site Impact Assessment

It should be noted that where municipal water and wastewater services are not available, all the proposed developments need to be self-sustaining on private individual water wells and private individual sewage disposal systems. As noted previously in the report, the source of the potable drinking water supply for the proposed residential development will be from the Palgrave municipal water supply wells.

The nitrate loading analysis presented here is as per the methodology and procedures indicated in the Technical Guideline D-5 (Ministry of Environment, 1996) and the Ontario Building Code (Ministry of Municipal Affairs and Housing, 2011, as amended) for development proposals involving private on-site sewage servicing.

Site Information:

Number of Proposed lots (P)	29
Daily Effluent Flow /Lot (F)	1,000 L/day
Development Area (A)	29.8 ha (298,000 m ²)
Infiltration Rate (Ir) (From water balance)	0.40 m/year
Nitrate Loading /Dwelling (N)	40 g/day
Impervious Surface (S)	2 ha or ~7% (from Hydrogeological report)

Calculations:

Step 1: Calculation of On-site Recharge (R)

$$\begin{aligned} &= A \times (1-S) \times Ir + P \times F \\ &= 298,000 \text{ m}^2 \times (1-0.07) \times (0.40 \text{ m/year}) + (29 \times 1,000 \text{ L/day}) \\ &= 110,856 \text{ m}^3/\text{year} + 29,000 \text{ L/day} \\ &= 303,715 \text{ L/day} + 29,000 \text{ L/day} \\ &= 332,715 \text{ L/day} \end{aligned}$$

Step 2: Calculation of Nitrate Loading (L)

$$\begin{aligned} &= N \times P \\ &= 40 \text{ g/day} \times 29 \\ &= 1,160,000 \text{ mg/day} \end{aligned}$$

Step 3: Resultant Nitrate Concentration in Development Area

$$\begin{aligned} &= L / R \\ &= 1,160,000 \text{ mg/day} / 332,715 \text{ L/day} \\ &= 3.5 \text{ mg/L} \end{aligned}$$

Based on the above calculations, a total load of 1,160,000 mg/day of nitrate will be added on the proposed development lots, which will result in an added concentration of 3.5 mg/L for nitrate in groundwater in the development area.

9.3 Nitrate Dilution – Application of Reasonable Use Policy

Reasonable Use Policy (RUP) is used to assess the off-site nitrate impact at the property boundary of the Site with the proposed development, based on RUP Guideline B-7 (MOE, 1996). Since, the background nitrate concentrations are already well above the ODWQS guideline value of 10 mg/L, it is not recommended to perform RUP calculation. Off-site impact is however, estimated as below.

It is known that the Site has a total area of 40 hectares, out of which 29.8 hectares is the development area. Therefore, there is an additional infiltration water from the undeveloped area at the Site, which can be used for the purpose of nitrate dilution.

The additional recharge will be:

$$(40-29.8) \times 10,000 \text{ m}^2 \times 0.4 \text{ (m/year)} = 40800 \text{ m}^3/\text{year} \text{ or } 111,781 \text{ L/day.}$$

The resultant nitrate concentration at the Site Boundary will be:

$$1,160,000 \text{ mg/day} / (332,715 + 111,781) \text{ L/day} = 2.6 \text{ mg/L.}$$

It should be noted that the background nitrate concentrations tested in groundwater in the development area are well above the ODWQS guideline value of 10 mg/L, which may have been caused by the farming activities occurring in this area. However, the area with no proposed development is occupied mainly by woodlots, where no fertilizers would be applied and the background nitrate concentration should be much lower.

With the proposed residential development, the farming activities will not take place and no fertilizers will be used for farming purpose at the Site. As a result, no more nitrogen will be added to the Site and nitrate concentrations will therefore be minimized with time.

9.4 Potential Nitrate Impacts

Nitrate is highly mobile in groundwater. In addition, natural attenuation via denitrification and other processes is limited and slow to occur. As a result, nitrate can persist in groundwater for a time frame of years to decades.

Based on the analysis of nitrate dilution, an extra 2.6 mg/L of nitrate will be added to the local groundwater at the site property boundary. Since the background nitrate concentrations are elevated across the development area, it is necessary to assess the potential nitrate impacts with regards to natural environments as well as use of groundwater in water wells.

9.4.1 Surface Water

Based on the data review, an unnamed creek was noted in the middle of the Site crossing from the northwest to the southeast. However, no water or creek channel was observed in the area of the unnamed creek, and therefore, the unnamed creek should be an ephemeral stream.

Based on the soil and groundwater conditions observed during the investigations, it would be expected that the Site is situated in a recharge area rather than a discharge area of the groundwater flow regime. The observations of dry creek/stream and relatively deep groundwater levels indicate that there should be no groundwater discharge to the surface water.

Therefore, the added nitrate concentration due to the proposed development would not affect the local surface water.

9.4.2 On Site Water Wells

Based on the MECP water well records, no water supply wells are located on Site. It is also known that the source of the potable drinking water supply for the proposed residential development will be from the Palgrave municipal water supply wells. Therefore, no water wells will be anticipated at the Site or in the development area of the Site, and therefore should be no impact due to the proposed development.

9.4.3 Off Site Water Wells

Based on the MECP water well records, a number of water supply wells are located near the Site. It is known that the Site and its vicinity is situated in Oak Ridges Moraine area, in which the Oak Ridges Moraine Aquifer Complex (ORMAC) is present.

As revealed at Palgrave Well#3, the ORMAC sequence consists of about 80 m thick stratified sediments, and consists (from surface downward) of about four (4) metres of sand and gravel, about 35 m of silt and clay with minor sand, about 25 m of gravelly sand and silty sand, a silt and clay unit about 5 m thick, and finally, about 10 m of gravelly sand where the well is screened (Earthfx , May 2007).

The details of water well records also indicated that multiple aquifers are present in the overburden deposits. However, most of the water wells were constructed screening below 40 mbgs or in deep aquifers, probably because of having a thicker and better protection from the potential contamination. The recorded water levels ranged from approximately 14 mbgs to 26 mbgs.

Considering the interfered depth of development and the presence of clayey deposits above the potential aquifers, the potential impact generally on the shallow groundwater due to the added nitrate concentration would not occur on the deep aquifers which are preferably selected for water supply. Therefore, no impact would be anticipated on the off-site water supply wells.

9.4.4 Development Area Hydrogeologically Isolated.

- The Oak Ridges Moraine Aquifer Complex (ORMAC) stratified sediments consists of about 80 m thick overburden. This sequence consists (from surface downward) of about 35 m of silt and clay with minor sand, about 25 m of gravelly sand and silty sand, a silt and clay unit about five metres thick, and finally, about 10 m of gravelly sand where the productive water supply wells are screened (Earthfx, May 2007). The highly productive aquifer is overlain by thick silt and clayey silt layer, effectively isolating the aquifer from the surface contamination.

- The MECP well records in the area have indicated that the sand and gravelly sand overburden is followed by alternate layers of thick silt and clay layer which marks as a lower hydraulic or physical boundary of the groundwater receiving the sewage effluent.

Based on the above findings, it can be inferred that multiple sandy soils, separated by relatively highly impermeable silty clay to clayey silt layers, can serve as the aquifer for water supply. It is more common that the deeper aquifer is selected for the water supply, probably because of having a thicker and better protection from the potential contamination.

Therefore, it would be safe to say that the local water supply aquifer is hydrogeologically isolated from the naturally elevated nitrate concentrations across the Site. Also, the nitrate levels will decline after the development, within a reasonable time frame, as the application of fertilizers for agricultural purposes will completely be eliminated with the development of the Subject Property for residential purposes.

10.0 CONCLUSIONS AND RECOMMENDATIONS

This report was prepared by SIRATI in support of a proposed residential subdivision development at 17791 Mount Hope Road, Town of Caledon, Ontario.

Based on the information obtained from previous investigations and the results of nitrate impact assessment conducted at the Site, the following findings or conclusions can be presented:

- The soil stratigraphy of the Site generally consisted of topsoil and fill materials (reworked soil), underlain by native soils predominantly comprised of cohesionless soils, locally with cohesive soils. No bedrock was encountered at the maximum explored depth of 18.3 mbgs.
- Groundwater levels monitored in three (3) monitoring wells (BH/MW19-1A, BH/MW19-2 and BH/MW19-3A) ranged from 6.3 mbgs and 14.8 mbgs, with the highest groundwater level measured in BH/MW19-2 located in the south corner of the Site. Groundwater flow was inferred to be generally in the northerly direction.
- Groundwater quality assessment indicated that groundwater samples may not meet the Ontario Drinking Water Quality Standards (ODWQS) due to the elevated concentrations of aluminum, iron, manganese, total hardness and turbidity and nitrate.
- The background nitrate concentrations were found to exceed the ODWQS standard of 10 mg/L for nitrate. The elevated background nitrate concentrations may have resulted from the farming activities occurring at the development area and/or from the operations of private septic systems on the upgradient properties, which might be minimized after the residential development when no farming activities will take place.
- A water balance analysis indicated that there is a net water surplus of 419 mm/annum (or about 0.4 m/year) occurring at the Site, which can either infiltrate into subsurface or go as run-off.

- On-site nitrate loading calculation have resulted that, a total load of 1,160,000 mg/day of nitrate will be added on the proposed development lots, which will result in an added concentration of 3.5 mg/L for nitrate in groundwater in the development area.
- Based on the nitration dilution assessment, an extra 2.6 mg/L of nitrate will be added to the local groundwater at the site property boundary.
- The local water supply aquifer is hydrogeologically isolated from the naturally elevated nitrate concentrations across the Site.
- The nitrate concentration levels will decline after the development, within a reasonable time frame, as the application of fertilizers for agricultural purposes will completely be eliminated with the development of the Subject Property for residential purposes.
- Given the site features and the site-specific soil and groundwater conditions, the impact on the local surface water and/or groundwater or use of the water wells due to the proposed development will be minor or negligible.

SELECTED BIBLIOGRAPHY

Johnson, M.D., Armstrong, D.K., Sanford, B.V., Telford, P.G. and Rutka, M.A., 1992. Paleozoic and Mesozoic geology of Ontario; *in* Geology of Ontario, Ontario Geological Survey, Special Volume 4, Part 2, p.907-1008.

Ministry of Natural Resources, Ontario Geologic Survey, 1984, The Physiography of Southern Ontario, Third Edition, L. J. Chapman and D. F. Putnam

MMAH, 1997. Ontario Building Code, Part 8 – Sewage Systems. Ont. Reg. 403/97 made under the Building Code Act, 1992. As amended from time to time.

Ministry of the Environment, 1982. Manual of Policy, Procedures and Guidelines for Onsite Sewage Systems. Queen's Printer for Ontario, ISBN 0-7743-7303.

Ministry of the Environment, 1996. Procedure D-5-4 – Technical Guideline for Individual On-Site Sewage Systems: Water Quality Impact Assessment.

Ministry of the Environment, 1997. Ontario Building Code. Sewage System Design Flows. Table 8.2.1.3.A. Residential Occupancy

Ministry of the Environment, 2008. Design Guideline for Sewage Works. PIBS6879

Ontario Geological Survey 1991. Bedrock geology of Ontario, southern sheet; Ontario Geological Survey, Map 2544, scale 1: 1 000 000.

Thornthwaite, C.W., and Mather, J.R., 1957 Instructions and tables for computing potential evapotranspiration and the water balance. Climatology, vol. X, #3.

Freeze, R. A. and Cherry, J. A., 1979, Groundwater, Prentice-Hall, Englewood Cliffs, New Jersey

LIMITATIONS AND USE OF THE REPORT

This report was produced for the sole use of Palgrave Development Inc. (the Client) for the property located at 17791 Mount Hope Road, Town of Caledon, Ontario and may not be relied upon by any other person or entity without the written authorization of Sirati & Partners Consultants Limited (SIRATI). The conclusions presented in this report are professional opinions based on the historical and current records search, visual observations and limited information provided by persons knowledgeable about past and current activities on this site. As such, SIRATI cannot be held responsible for environmental conditions at the Property that was not apparent from the available information. No investigation method can completely eliminate the possibility of obtaining partially imprecise or incomplete information; it can only reduce the possibility to an acceptable level.

Professional judgement was exercised in gathering and analyzing data and formulation of recommendations using current industry guidelines and standards. Similar to all professional persons rendering advice, SIRATI cannot act as absolute insurer of the conclusion we have reached. No additional warranty or representation, expressed or implied, is included or intended in this report other than stated herein the report.

The assessment should not be considered a comprehensive audit that eliminates all risks of encountering environmental problems. The information presented herein this report is primarily based on information collected during the hydrogeological study based on the condition of the Property at the time of site inspection/drilling followed by a review of historical data, as appended to this report.

In assessing the environmental setting of the Property, SIRATI has solely relied upon information supplied by others in good faith and has therefore assumed that the information supplied is factual and accurate. We accept no responsibility for any inaccurate information, misrepresentation or for any deficiency of the information supplied by any third party.

The scope of services performed in the execution of this investigation may not be appropriate to satisfy third parties. SIRATI accepts no responsibility for damages if any, suffered by any third party as a result of decisions made or action taken based on this report. Any use, copying or distribution of the report in whole or in part is not permitted without the express written permission of SIRATI and use of findings, conclusions and recommendations represented in this report, is at the sole risk of third parties.

In the event that during future work new information regarding the environmental condition of the Property is encountered, or in the event that the outstanding responses from the regulatory agencies indicate outstanding issues on file with respect to the Property, SIRATI should be notified in order that we may re-evaluate the findings of this assessment and provide amendments, as required.

Should you have any questions regarding the information presented or limitation set in this report, please do not hesitate to contact our office.

Yours truly,

Sirati and Partners Consultants Limited



Sudhakar Kurli, M.Sc., P. Geo.
Hydrogeologist/Project Manager



Bujing Guan, M. A.Sc., P. Geo.
Senior Hydrogeologist/Environmental Specialist

FIGURES



North:



Legend:

Property Boundary

Project Title:
Nitrate Impact Assessment

Site Location:
17791 Mount Hope Road, Caledon, ON

Figure Title:
Site Location Plan

Scale:
As Shown

Project Number:
SP18-334-00

Date:
November 2019

Figure Number:
1-1



North:



Legend:



Subject Site

Legend	
	Oak Ridges Moraine Conservation Plan Area • Boundary of Oak Ridges Moraine Conservation Plan Area Ontario Regulation 149/02 • Boundary of Oak Ridges Moraine Area Ontario Regulation 01/02
	Natural Core Area
	Natural Linkage Area
	Countryside Area
	Rural Settlement (a component of Countryside Area)
	Palgrave Estates Residential Community (a component of Countryside Area)
	Settlement Area
	Upper and Single-Tier Municipal Boundaries
	Lower-Tier Municipal Boundaries
	Road or Highway
	First Nations
	Niagara Escarpment Plan Boundary

Project Title:

Nitrate Impact Assessment

Site Location:

17791 Mount Hope Road, Caledon, ON

Figure Title:

Land Use Designation Map
Oak Ridges Moraine Conservation Plan

Scale:

As Shown

Project Number:

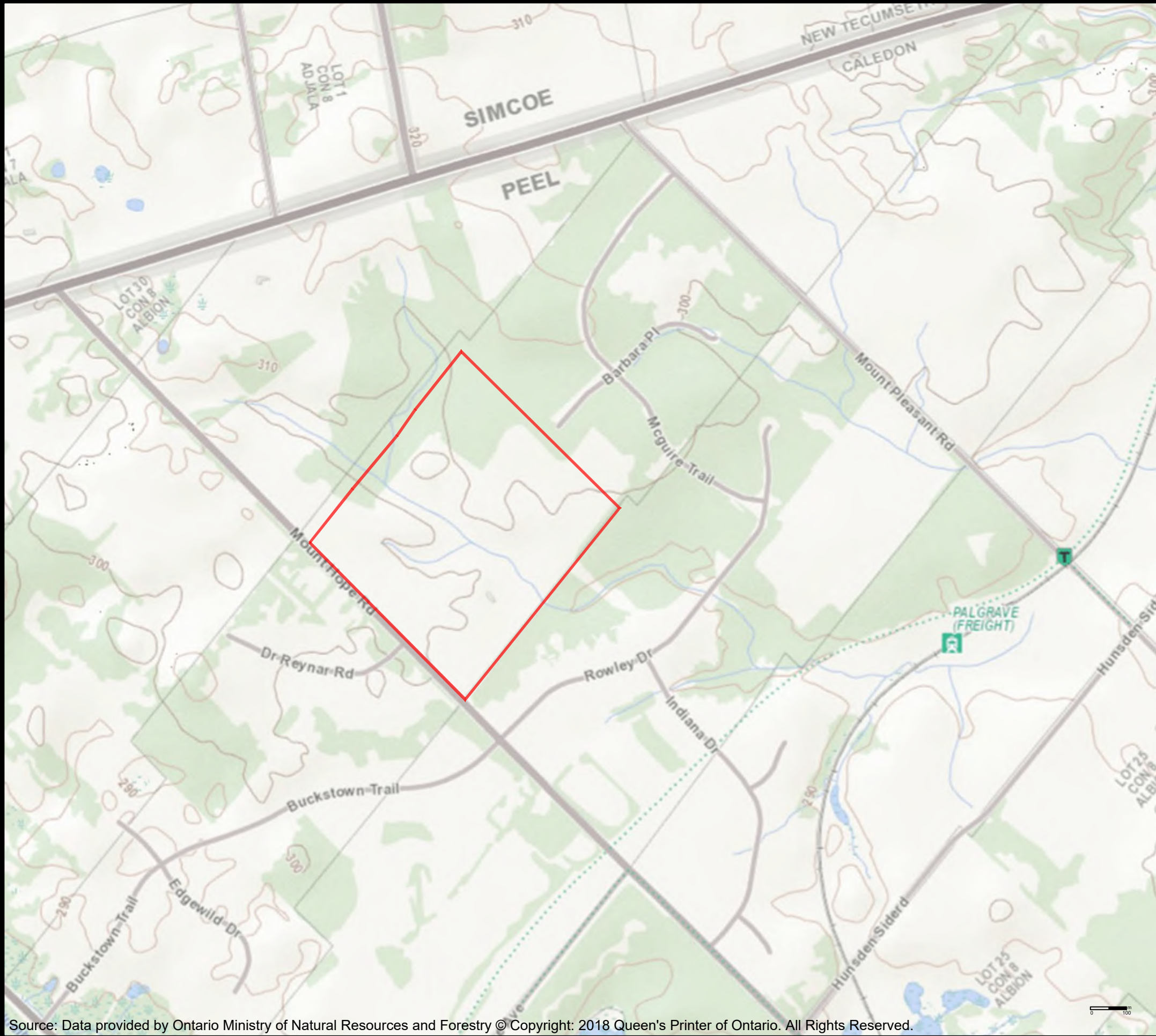
SP18-334-00

Date:

November 2019

Figure Number:

1-2



Source: Data provided by Ontario Ministry of Natural Resources and Forestry © Copyright: 2018 Queen's Printer of Ontario. All Rights Reserved.

Legend

Building as Symbol

Building to Scale

Airport

Heliport \ Hospital Heliport

Seaplane Base

Ferry Route

Trail Head \ Trail

Railway \ Train Station

Railway with Bridge

Railway with Tunnel

Road (Major → Minor)

Winter Road

Road with Bridge

Road with Tunnel

Primary, Kings or 400 Series Highway

Secondary Highway

Tertiary Highway

District, County, Regional or Municipal Road

Toll Highway

One Way Road

Road with Permanent Blocked Passage

Road with Address Ranges

Hydro Line, Communication Line or Unknown Transmission Line

Natural Gas Pipeline, Water Pipeline or Unknown Pipeline

Spot Height

Index Contour

Contour

Wooded Area

Wetland

Waterbody

Waterbody Elevation

Watercourse

Falls

Rapids

Rapids \ Falls

Rapids

Rocks

Lock Gate

Dam \ Hydro Wall

Dam \ Hydro Wall

Provincial \ State Boundary

International Boundary

Upper Tier \ District Municipal Boundary

Lower Tier \ Single Tier Municipal Boundary

Lot Line

Indian Reserve

Provincial Park

National Park

Conservation Reserve

Military Lands

SIRATI & PARTNERS

Geotechnical Hydrogeological & Environmental Solutions

12700- Keele Street
King City, ON. L7B 1H5
Phone# 905 833 1582, Fax# 905 833 5360

North:

Legend:

Property Boundary

Project Title:

Nitrate Impact Assessment

Site Location:

17791 Mount Hope Road, Caledon, ON

Figure Title:

Topographic Map

Scale:

As Shown

Project Number:

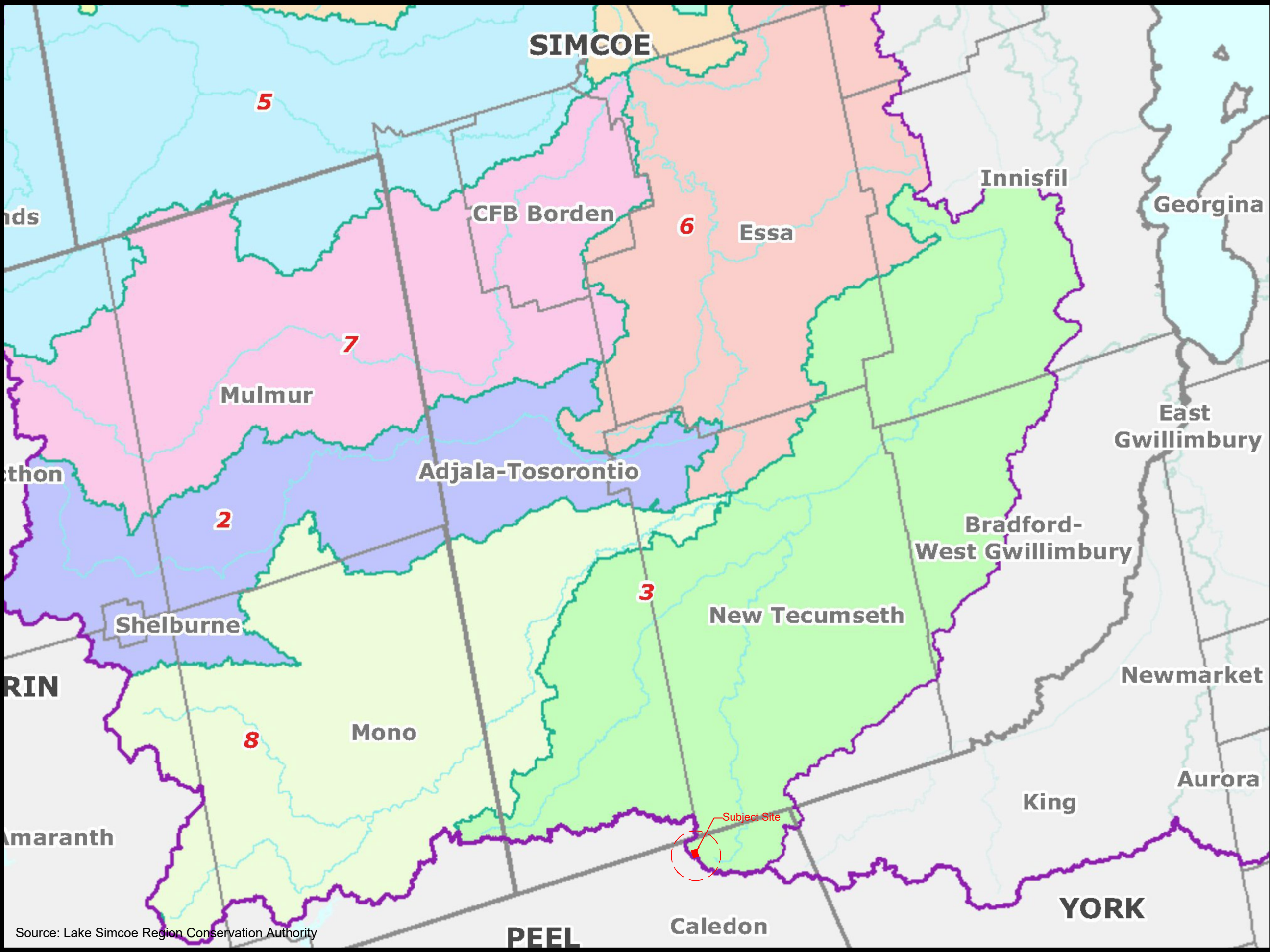
SP18-334-00

Date:

November 2019

Figure Number:

4-1



Source: Lake Simcoe Region Conservation Authority

SIRATI & PARTNERS

Geotechnical Hydrogeological & Environmental Solutions
12700- Keele Street
King City, ON. L7B 1H5
Phone# 905 833 1582, Fax# 905 833 5360

North:



Legend:



Subject Site



Approximate Site Location

- | | |
|--------------------------|--------------------------|
| 1, Blue Mountains W. | SWP Watershed Region |
| 2, Boyne R. | SWP Watershed Area |
| 3, Innisfil Cr. | Upper Tier Municipality |
| 4, Lower Nottawasaga R. | Lower Tiers Municipality |
| 5, Mad R. | Subwatershed Boundary |
| 6, Middle Nottawasaga R. | Water Body |
| 7, Pine R. | Main Water Courses |
| 8, Upper Nottawasaga R. | |
| 9, Willow Cr. | |

Project Title:

Nitrate Impact Assessment

Site Location:

17791 Mount Hope Road, Caledon, ON

Figure Title:

Innisfil Subwatershed Location Map

Scale:

N.T.S.

Project Number:

SP18-334-00

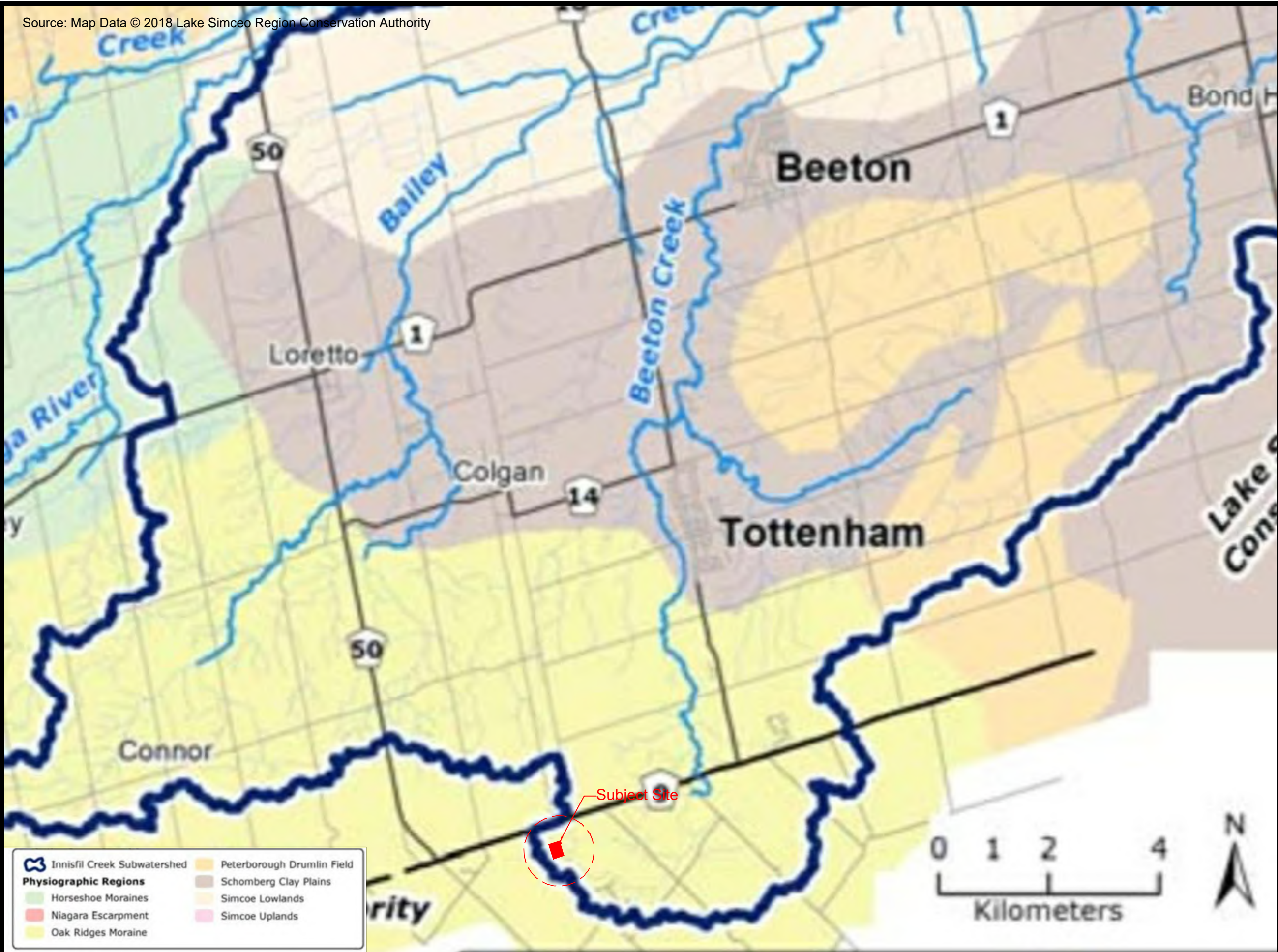
Date:


November 2019

Figure Number:


4-1a


Source: Map Data © 2018 Lake Simcoe Region Conservation Authority





 Innisfil Creek Subwatershed


Physiographic Regions


 Horseshoe Moraines


 Niagara Escarpment

 Oak Ridges Moraine

 Peterborough Drumlin Field

 Schomberg Clay Plains

 Simcoe Lowlands


 Simcoe Uplands

SIRATI & PARTNERS


Geotechnical Hydrogeological & Environmental Solutions


12700- Keele Street
King City, ON. L7B 1H5
Phone# 905 833 1582, Fax# 905 833 5360

North:



Legend:

 Subject Site

 Approximate Site Location

Project Title:

Nitrate Impact Assessment

Site Location:

17791 Mount Hope Road, Caledon, ON

Figure Title:

Physiography Map

Scale:

As Shown

Project Number:

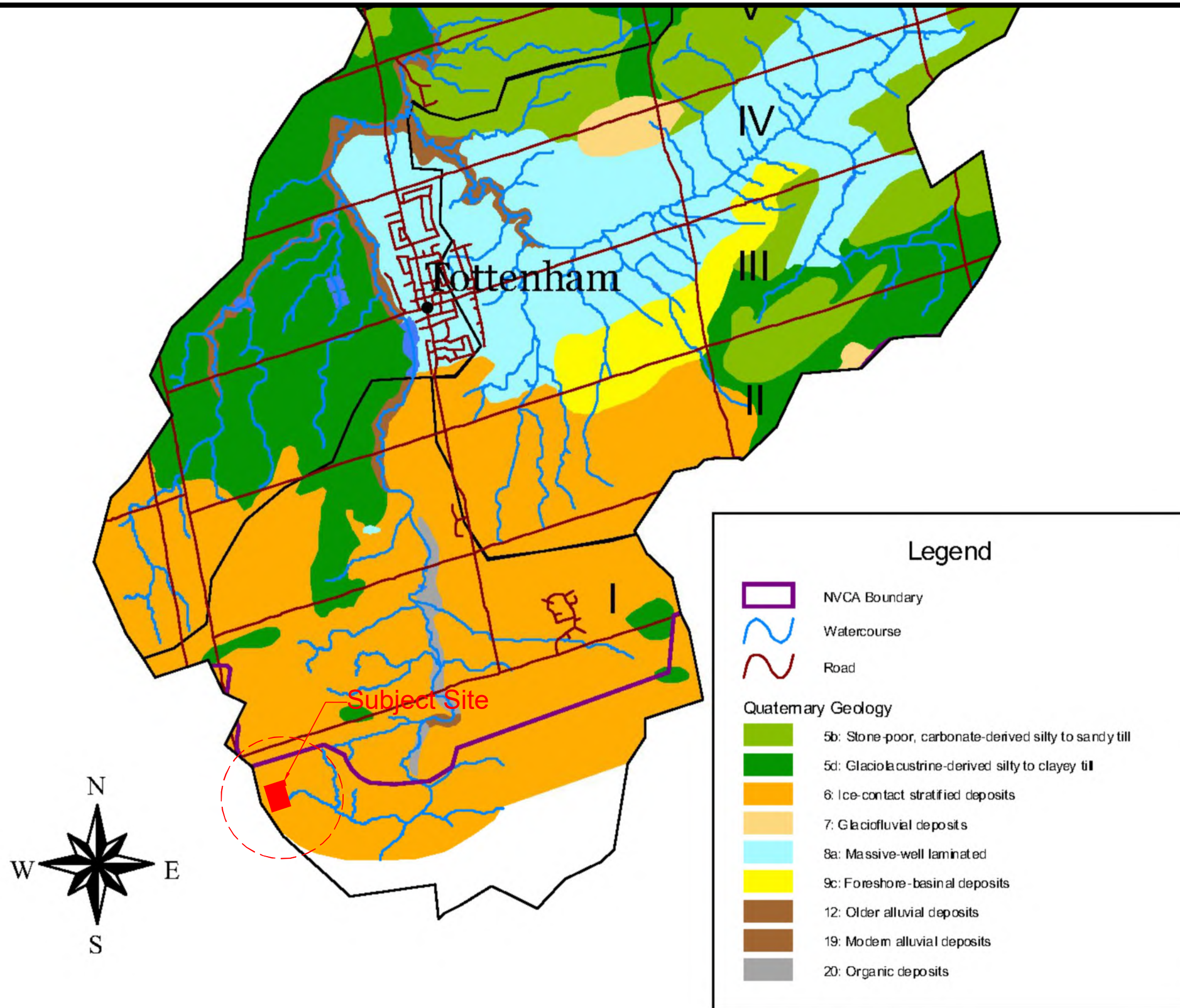
SP18-334-00

Date:

November 2019

Figure Number:

4-2



North:



Legend:



Subject Site



Approximate Site Location

Project Title:

Nitrate Impact Assessment

Site Location:

17791 Mount Hope Road, Caledon, ON

Figure Title:

Surficial Geology Map

Scale:

N.T.S.

Project Number:

SP18-334-00

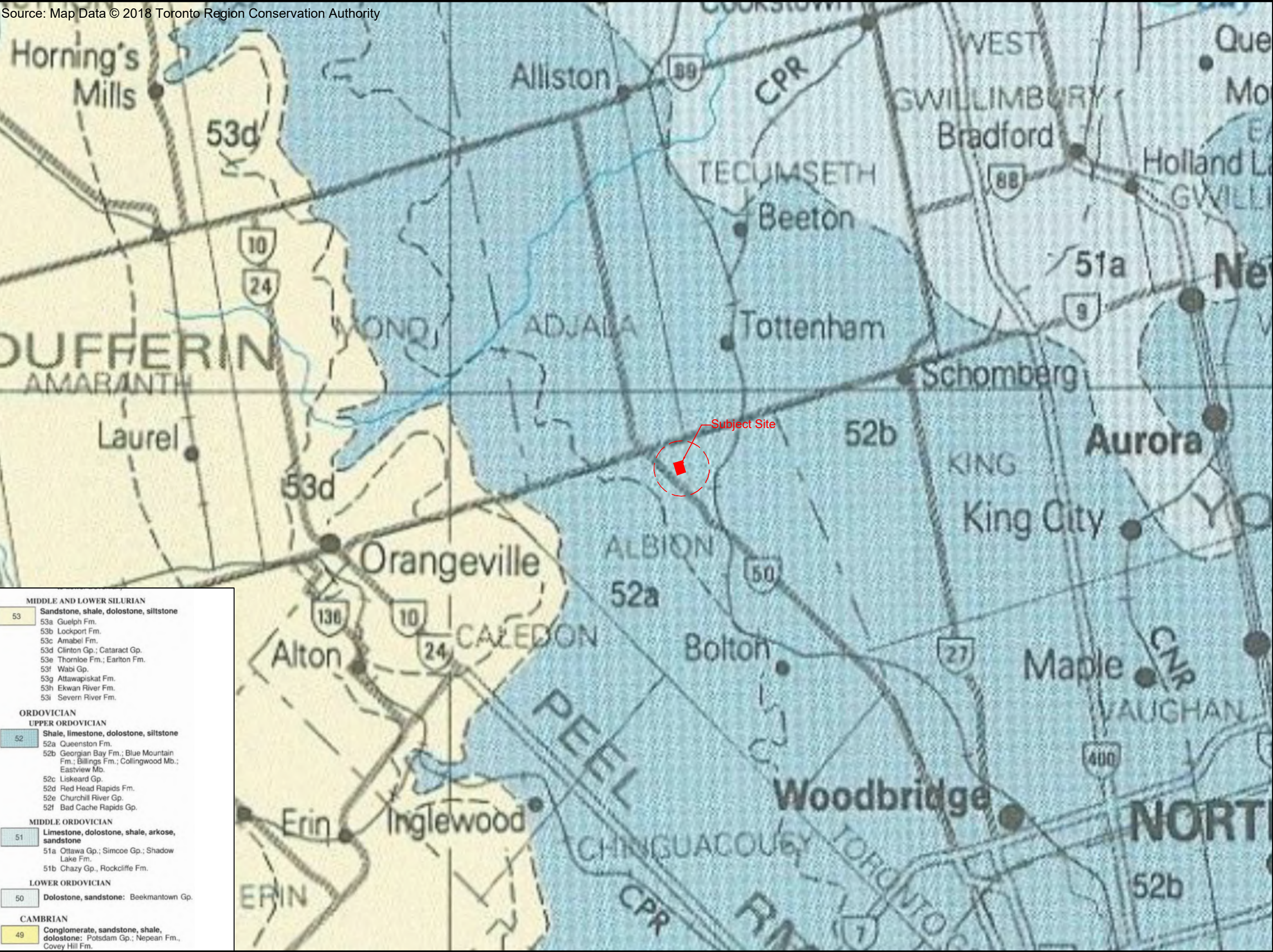
Date:

November 2019

Figure Number:

4-3

Source: Map Data © 2018 Toronto Region Conservation Authority



MIDDLE AND LOWER SILURIAN	
53	Sandstone, shale, dolostone, siltstone
53a	Guelph Fm.
53b	Lockport Fm.
53c	Amabel Fm.
53d	Clinton Gp.; Cataract Gp.
53e	Thornloe Fm.; Earleton Fm.
53f	Wabi Gp.
53g	Attawapiskat Fm.
53h	Ekwan River Fm.
53i	Severn River Fm.
ORDOVICIAN	
UPPER ORDOVICIAN	
52	Shale, limestone, dolostone, siltstone
52a	Queenston Fm.
52b	Georgian Bay Fm.; Blue Mountain Fm.; Billings Fm.; Collingwood Mb.; Eastview Mb.
52c	Liskeard Gp.
52d	Red Head Rapids Fm.
52e	Churchill River Gp.
52f	Bad Cache Rapids Gp.
MIDDLE ORDOVICIAN	
51	Limestone, dolostone, shale, arkose, sandstone
51a	Ottawa Gp.; Simcoe Gp.; Shadow Lake Fm.
51b	Chazy Gp.; Rockcliffe Fm.
LOWER ORDOVICIAN	
50	Dolostone, sandstone: Beekmantown Gp.
CAMBRIAN	
49	Conglomerate, sandstone, shale, dolostone: Potsdam Gp.; Nepean Fm.; Covey Hill Fm.

SIRATI & PARTNERS

Geotechnical Hydrogeological & Environmental Solutions
12700- Keele Street
King City, ON. L7B 1H5
Phone# 905 833 1582, Fax# 905 833 5360

North:



Legend:



Subject Site



Approximate Site Location

Project Title:

Nitrate Impact Assessment

Site Location:

17791 Mount Hope Road, Caledon, ON

Figure Title:

Bedrock Geology Map

Scale:

N.T.S.

Project Number:

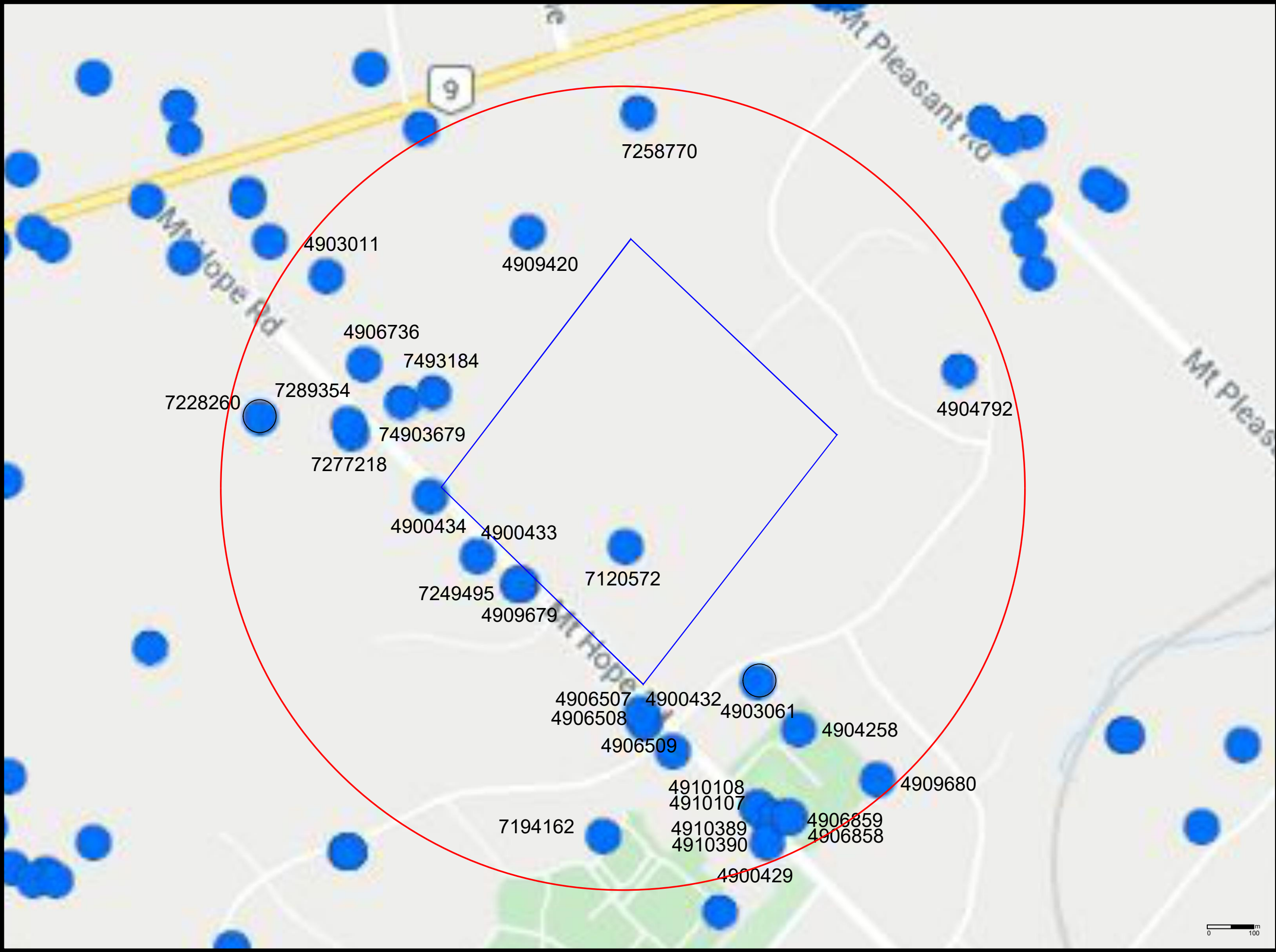
SP18-334-00

Date:

November 2019

Figure Number:




4-4



North:



Legend:

-  Subject Site
-  500m Study Area
-  MECP Well

Project Title:
Nitrate Impact Assessment

Site Location:
17791 Mount Hope Road, Caledon, ON

Figure Title:
MECP Water Well Location Map

Scale: As Shown	Project Number: SP18-334-00
---------------------------	---------------------------------------

Date: November 2019	Figure Number: 5-1
-------------------------------	------------------------------



North:



Legend:

- Property Boundary
- Monitoring Wells
- Boreholes

Project Title:

Nitrate Impact Assessment

Site Location:

17791 Mount Hope Road, Caledon, ON

Figure Title:

Borehole/Monitoring Well Location Plan

Scale:

As Shown

Project Number:

SP18-334-00

Date:

November 2019

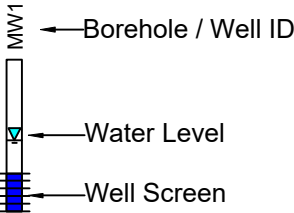
Figure Number:

6-1

North:

Legend:

- Fill
- Topsoil
- Silty Sand/Sandy Silt
- Sand



Note:
Groundwater level dated October 21, 2019

Project Title:
Nitrate Impact Assessment

Site Location:
17791 Mount Hope Road, Caledon, ON

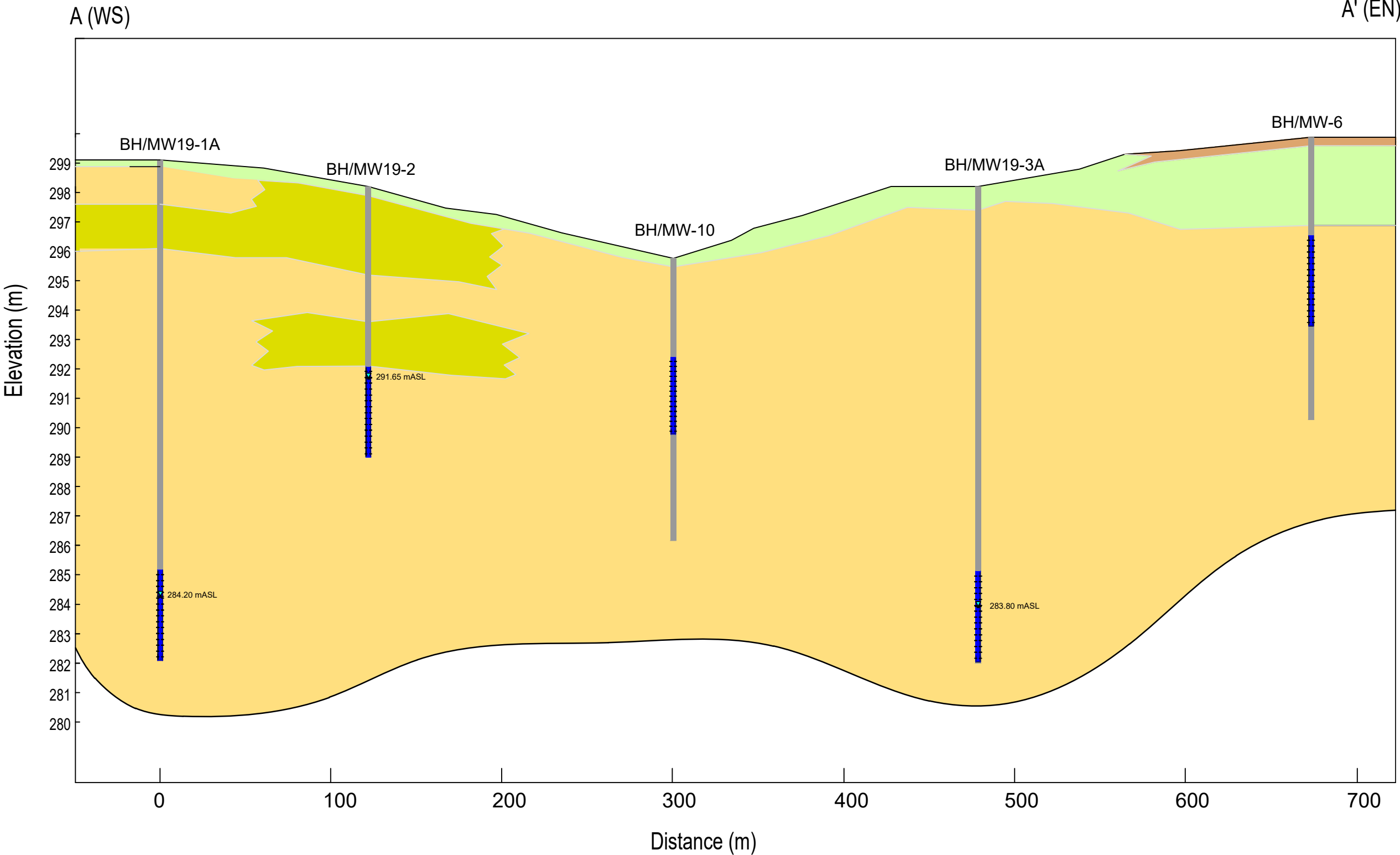
Figure Title:
Cross Section Profile A-A'

Scale:
N.T.S

Project Number:
SP18-334-00

Date:
November 2019

Figure Number:
6-2





North:



Legend:

- Property Boundary
- Monitoring Well & Groundwater Elevation
- Contour Line
- Inferred Shallow Groundwater Flow Direction

Note:
Groundwater Elevation were
obtained on October 21,2019

Project Title:
Nitrate Impact Assessment

Site Location:
17791 Mount Hope Road, Caledon, ON

Figure Title:
Groundwater Elevations and Inferred
Groundwater Flow Direction

Scale:
As Shown

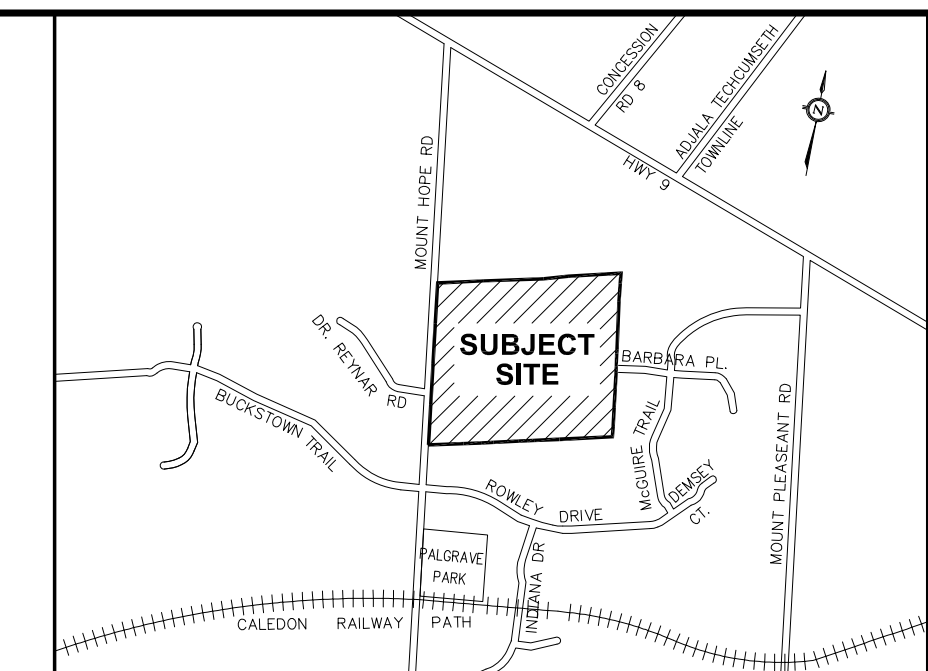
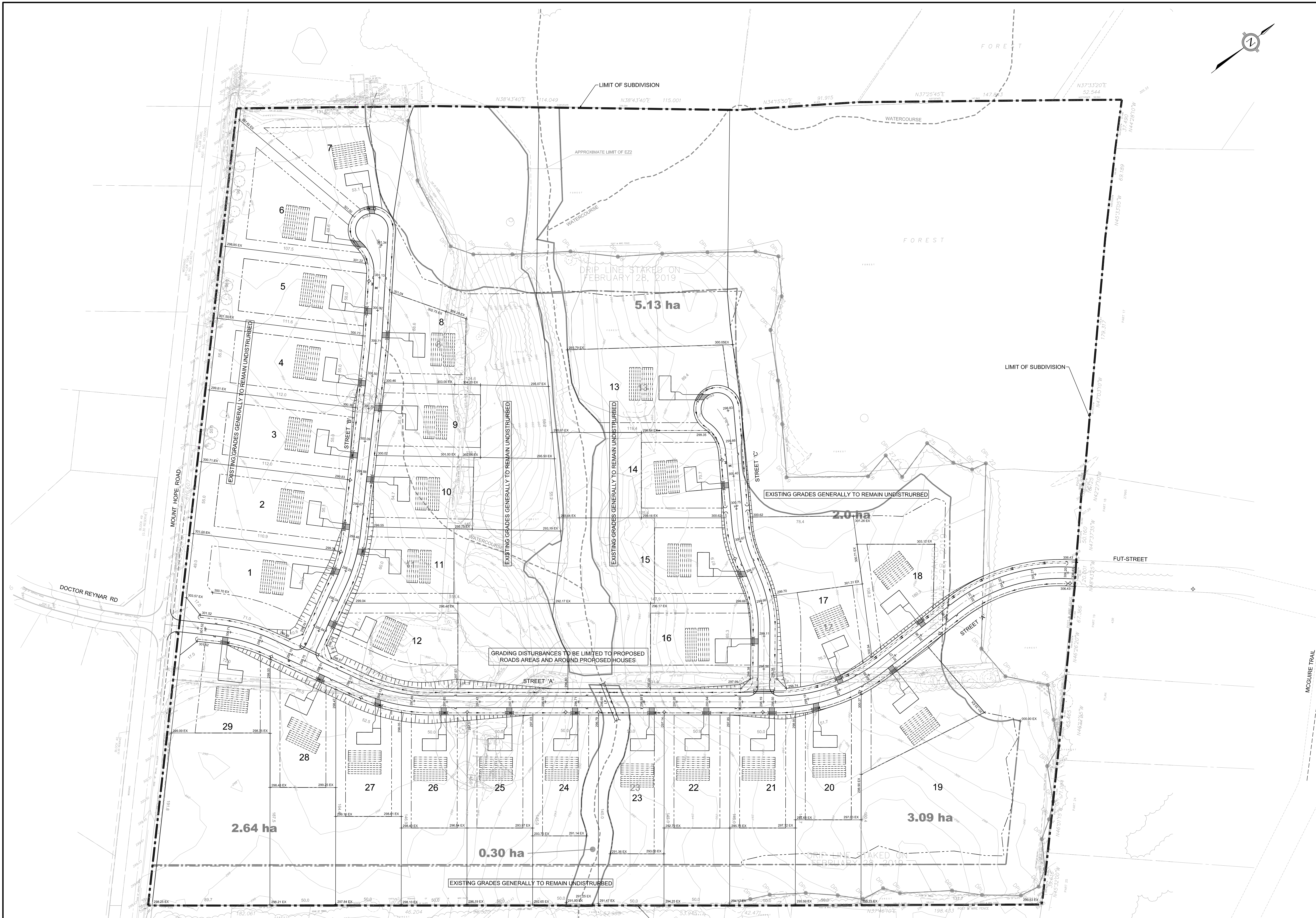
Project Number:
SP18-334-00

Date:
November 2019

Figure Number:
6-3

APPENDICES

APPENDIX A



- LEGEND :**
- PROPOSED DRIVEWAY WITH CULVERT
 - PROPOSED CULVERT
 - HYDRANT
 - PROPOSED WATER SERV. CONNECTION
 - PROPOSED UTILITY BOX
 - PROPOSED LIGHT POLE
 - PROPOSED VALVE & BOX
 - LIMIT OF DEVELOPMENT
 - STRUCTURE ENVELOP LINE
 - WATERCOURSE
 - EXISTING TREES
 - EDGE OF VEGETATION
 - SEPTIC TANK SYSTEM (TYP)
 - PROPOSED HOUSE (TYP)
 - EXISTING ELEVATION
 - PROPOSED ELEVATION

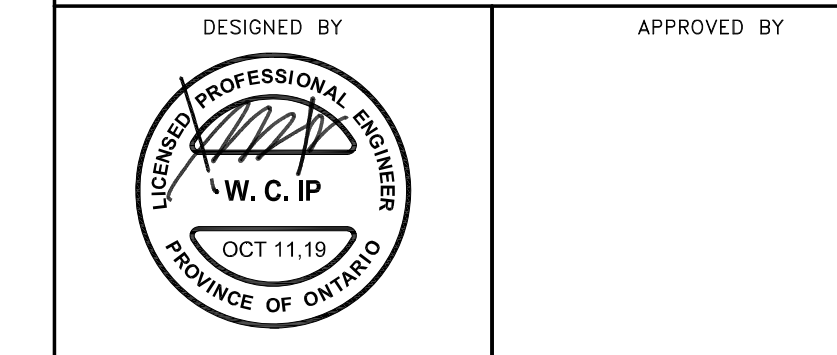
REVISIONS				
No.	BY	DATE	REVISION	CONS. TOWN CHECKED APPROVED
1				

APPROVED FOR CONSTRUCTION
THIS APPROVAL CONSTITUTES A GENERAL REVIEW AND DOES NOT CERTIFY DIMENSIONAL ACCURACY.
THIS APPROVAL IS SUBJECT TO THE FURTHER CERTIFICATION OF THE "AS CONSTRUCTED" WORKS BY A REGISTERED PROFESSIONAL ENGINEER OF THE PROVINCE OF ONTARIO.

DATE: _____ APPROVED BY: H. MONTZ, P. ENG. Town Engineer

ELEVATION NOTES
ELEVATION SHOWN HEREON ARE GEODETIC AND DERIVED FROM THE TOWN OF CALEDON BENCHMARKS.

LOCAL BENCHMARK
NO. 00819755806 ELEVATION = 277.870 METRES AND NO. 00819778416 ELEVATION = 218.849 METRES

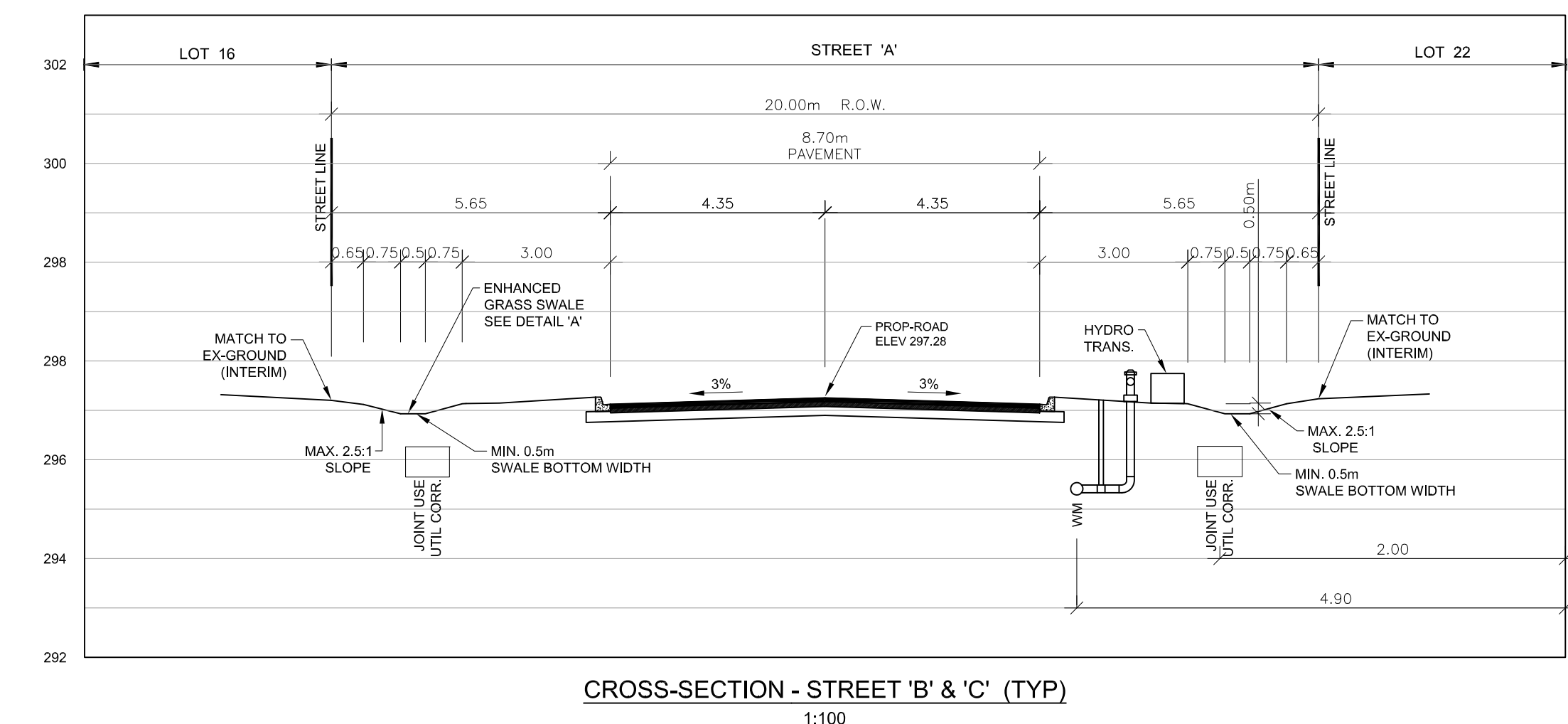
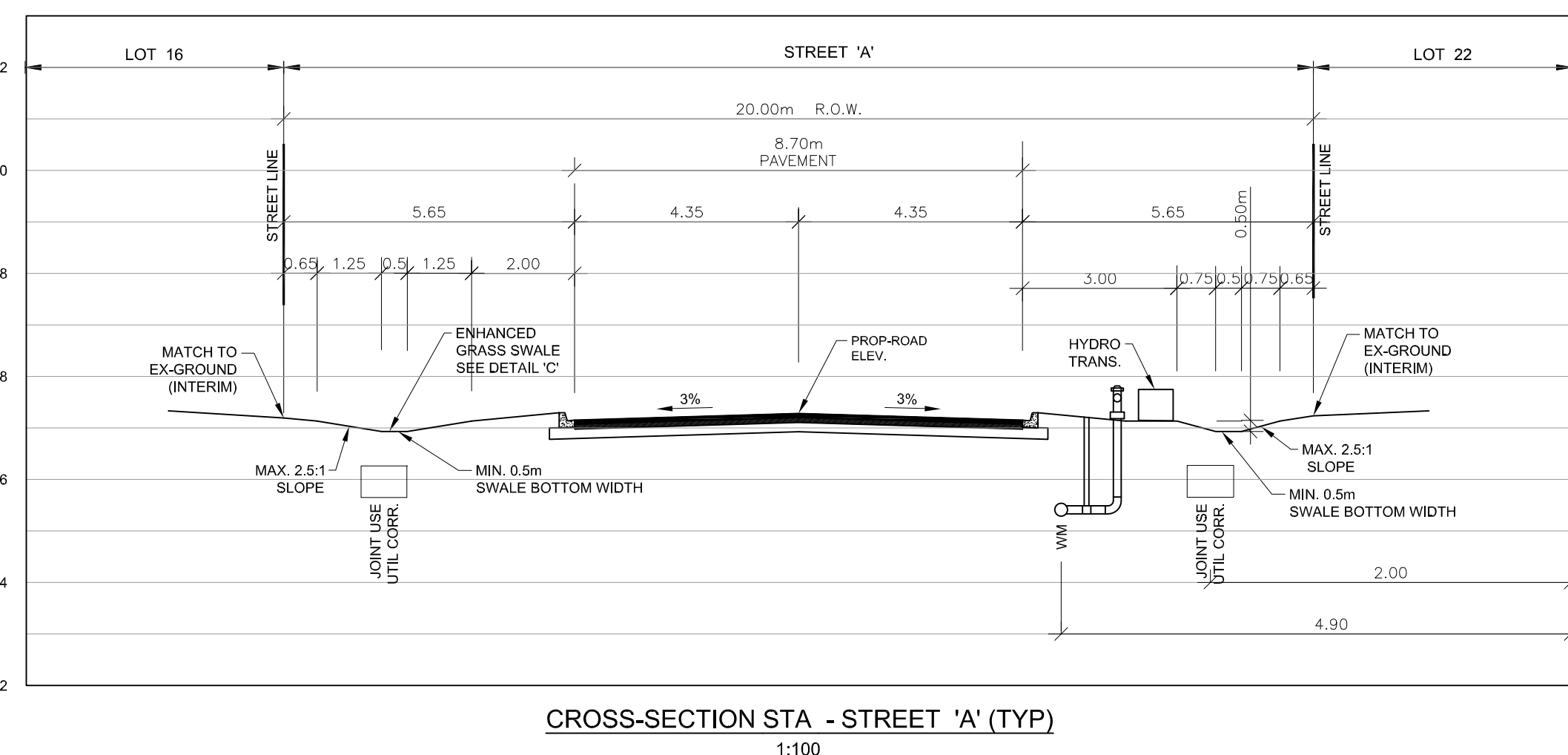


PROJECT: PALGRAVE ESTATES SUBDIVISION



TITLE: GRADING PLAN

SCALE: 1:1000	PROJECT No. 18-951
DESIGNED BY: M.K.	DRAWN BY: MALL CAD
CHECKED BY: A.J.	DATE: OCTOBER 2019
	PLAN No. GR1



APPENDIX B

LOG OF BOREHOLE BH 1

1 OF 1

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION: See Drawing 1

DRILLING DATA
 Method: Solid Stem Augers
 Diameter: 150 mm
 Date: Oct/19/2018
 Drilling Contractor:
 REF. NO.: SP18-334-10
 ENCL NO.: 2

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	Head Space Combustible Vapor Reading (ppm)	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)				
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m										WATER CONTENT (%)			GR
298.9	TOPSOIL:350 mm																	
0.0 298.6	SAND (REWORKED): trace gravel, brown, moist, loose possibly reworked, becoming light brown		1	SS	5													
0.4																		
297.4	SAND: light brown, moist, compact trace gravel becoming brown some gravel		2	SS	5													
1.5																		
292.8	GRAVELLY SAND: trace cobbles, brown, moist, compact		3	SS	7													
6.1																		
291.3	SILT: greyish brown, trace gravel, very moist to wet, very dense		4	SS	11													
7.6																		
289.7	END OF BOREHOLE:		5	SS	15													
9.2																		
	Notes: 1. Borehole was open and dry upon completion of drilling. 2. Monitoring well was installed in the borehole upon completion of drilling. 3. Monitoring well was dry on November 1, 2018 and November 28, 2018.																	

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, X 3: Numbers refer to Sensitivity

○ = 3% Strain at Failure

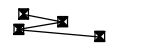



















SPCL SOIL LOG W/ VOC 0-12 PPM-2016 SP18-334-10.GPJ SPCL GDT 12/5/18

LOG OF BOREHOLE BH 2

1 OF 1

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION: See Drawing 1

DRILLING DATA
 Method: Solid Stem Augers
 Diameter: 150 mm
 Date: Oct/19/2018
 Drilling Contractor:
 REF. NO.: SP18-334-10
 ENCL NO.: 3

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	<div>Head Space Combustible Vapor Reading (ppm)</div> <div></div>	<div>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT</div> <div>W_P ————— W ————— W_L</div> <div>WATER CONTENT (%)</div>			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)					
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m														
299.1							299												
0.0 298.8	TOPSOIL: 300 mm		1	SS	4														
0.3	FILL: topsoil mixed with silty sand to sand, brown, moist																		
	SAND (REWORKED): trace silt, light brown, moist		2	SS	4		298												
																			
			3	SS	8		297												
296.8																			
2.3	SAND: light brown, moist, compact to dense		4	SS	15		296												
																			
			5	SS	21		295												
																			
	some gravel, trace cobbles, becoming brown		6	SS	21		294											7	85
																		3	5
							293												
	trace gravel		7	SS	25		292												
																			
							291												
	trace cobbles		8	SS	21		290												
																			
																			
	some gravel		9	SS	31														
289.4																			
9.7	END OF BOREHOLE:																		
	Notes: 1. Borehole was open and dry upon completion of drilling.																		

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3 , × 3 : Numbers refer to Sensitivity

○ s=3% Strain at Failure

SPCL SOIL LOG W/ VOC 0-12 PPM-2016 SP18-334-10.GPJ SPCL GDT 12/5/18

LOG OF BOREHOLE BH 3

1 OF 1

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION: See Drawing 1

DRILLING DATA
 Method: Solid Stem Augers
 Diameter: 150 mm
 Date: Oct/18/2018
 Drilling Contractor:
 REF. NO.: SP18-334-10
 ENCL NO.: 4

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	Head Space Combustible Vapor Reading (ppm)	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kNm ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m				W _p	W	W _L			
297.8	0.0 TOPSOIL: 450 mm		1	SS	5									GR SA SI CL
297.3	0.5 FILL: silty sand, trace gravel, dark brown, very moist to moist becoming sandy silt, trace clay, brown, moist		2	SS	6		297							IBL in ppm
296.3	1.5 SANDY SILT TO SILTY SAND: trace clay, brown, moist, loose to compact		3	SS	7		296							
294.8	3.0 SAND: trace gravel, trace silt, light brown, very moist, compact to very dense		4	SS	18		295							1 61 30 8
			5	SS	16		294							
			6	SS	29		293							
			7	SS	40		292							
			8	SS	31		291							
			9	SS	50/ 75 mm		289							
288.5	9.3 END OF BOREHOLE:													
	Notes: 1. Borehole was open and dry upon completion of drilling. 2. Monitoring well was installed in the borehole upon completion of drilling. 3. Monitoring well was dry on November 1, 2018 and November 28, 2018.													

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ = 3% Strain at Failure

SPCL SOIL LOG W/ VOC 0-12 PPM-2016 SP18-334-10.GPJ SPCL GDT 12/5/18

1 OF 1

DRILLING DATA

Method: Solid Stem Augers





Diameter: 150 mm

REF. NO.: SP18-334-10

Date: Oct/18/2018

ENCL NO.: 5

Drilling Contractor:

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	Head Space Combustible Vapor Reading (ppm)	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _P W W _L WATER CONTENT (%)	POCKET PEN. (GJ) (MPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m								
298.5													
0.0	FILL: sandy silt, trace gravel, trace topsoil, brown, moist		1	SS	7		298						IBL in ppm
			2	SS	32		297						
	POSSIBLE FILL: silty sand, trace cobbles, trace gravel, brown						296						
			3	SS	27		295						
297.0	SAND: light brown, moist, compact to dense		4	SS	32		294						
1.5							293						
			5	SS	17		292						
							291						
			6	SS	12		290						
			7	SS	31								
			8	SS	40								
	trace gravel		9	SS	26								
288.8													
9.7	END OF BOREHOLE:												
	Notes: 1. Borehole was open and dry upon completion of drilling.												

GROUNDWATER ELEVATIONS

GRAPH
NOTES

$+^3, \times^3$: Numbers refer to Sensitivity

○ $\epsilon = 3\%$ Strain at Failure

LOG OF BOREHOLE BH 5

1 OF 1

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION: See Drawing 1

DRILLING DATA
 Method: Solid Stem Augers
 Diameter: 150 mm
 Date: Oct/18/2018
 Drilling Contractor:
 REF. NO.: SP18-334-10
 ENCL NO.: 6

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	Head Space Combustible Vapor Reading (ppm)	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)		
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m											
294.1	TOPSOIL: 300 mm						294							GR SA SI CL		
0.0 293.8	FILL: silty sand, yellowish brown, moist sandy silt, trace clay, light brown, very moist to wet		1	SS	5											
0.3				2	SS	5										
292.6	CLAYEY SILT some sand, trace cobbles, trace gravel, light brown, very moist, firm		3	SS	7		292							2 17 54 27		
1.5																
291.8	SAND: light brown, moist, compact trace gravel		4	SS	13		291									
2.3				5	SS	11										
					6	SS	16									
					7	SS	28									
	SANDY SILT: brown, moist, dense		8	SS	32		286							1 28 65 6		
286.5																
7.6	SILT: trace sand, brown, very moist, very dense		9	SS	52		285							1 10 80 9		
285.0																
9.1	END OF BOREHOLE:															
284.4																
9.7	Notes: 1. Borehole was dry and open upon completion of drilling.															

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3 , × 3 : Numbers refer to Sensitivity

○ = 3% Strain at Failure

SPCL SOIL LOG W/ VOC 0-12 PPM-2016 SP18-334-10.GPJ SPCL GDT 12/5/18

LOG OF BOREHOLE BH 6

1 OF 1

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION: See Drawing 1

DRILLING DATA
 Method: Solid Stem Augers
 Diameter: 150 mm
 Date: Oct/18/2018
 Drilling Contractor:
 REF. NO.: SP18-334-10
 ENCL NO.: 7

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	Head Space Combustible Vapor Reading (ppm)	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kNm ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m				W _p	W	W _L			
299.9	TOPSOIL: 300 mm													GR SA SI CL
0.0 299.6 0.3	SAND (REWORKED): trace gravel, trace silt, dark brown, moist becoming brown		1	SS	5									IBL in ppm
1			2	SS	2		299							
2	becoming light brown		3	SS	0		298							
297.6	FILL: silty sand, light brown, moist		4	SS	2		297							
296.9	SAND: some silt, light brown, moist, compact to very dense		5	SS	11		296							
4							295							
5			6	SS	19		294							
6							293							
7			7	SS	36		292							
8			8	SS	59		291							
9	beoming greyish brown, very moist		9	SS	52									
290.2	END OF BOREHOLE:													
9.7	Notes: 1. Borehole was dry and open upon completion of drilling. 2. Monitoring well was installed in the borehole upon completion of drilling. 3. Borehole was dry on November 1, 2018 and November 27, 2018.													

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ = 3% Strain at Failure

SPCL SOIL LOG W/ VOC 0-12 PPM-2016 SP18-334-10.GPJ SPCL GDT 12/5/18

LOG OF BOREHOLE BH 7

1 OF 1

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION: See Drawing 1

DRILLING DATA
 Method: Solid Stem Augers
 Diameter: 150 mm
 Date: Oct/19/2018
 Drilling Contractor:
 REF. NO.: SP18-334-10
 ENCL NO.: 8

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	Head Space Combustible Vapor Reading (ppm)		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kNm ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m					W _p	W	W _L			GR SA SI CL
298.9	TOPSOIL: 300 mm														
0.0 298.6 0.3	SAND (REWORKED): trace silt, brown, moist, loose		1	SS	5										
298.1 1 0.8	SAND: trace silt, light brown, moist		2	SS	11		298								
			3	SS	16		297								
			4	SS	24		296								
	some silt, wet														
			5	SS	32		295								
294.3 4.6	SANDY SILT: brown, wet, compact		6	SS	30		294								
							293								
			7	SS	18		292								
291.3 7.6	SAND: brown, wet to moist, compact		8	SS	23		291								
289.8 9.1	GRAVELLY SAND: brown, moist, very dense		9	SS	60		290								
289.2 9.7	END OF BOREHOLE:														
	Notes: 1. Borehole was dry and open upon completion of drilling.														

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ = 3% Strain at Failure

SPCL SOIL LOG W/ VOC 0-12 PPM-2016 SP18-334-10.GPJ SPCL GDT 12/5/18

LOG OF BOREHOLE BH 8

1 OF 1

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION: See Drawing 1

DRILLING DATA
 Method: Solid Stem Augers
 Diameter: 150 mm
 Date: Oct/18/2018
 Drilling Contractor:
 REF. NO.: SP18-334-10
 ENCL NO.: 9

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	Head Space Combustible Vapor Reading (ppm)				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kNm ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			WATER CONTENT (%)				W _p	W	W _L			
302.8	0.0 TOPSOIL: 450 mm		1	SS	6												GR SA SI CL
302.3	0.5 FILL: silty sand, trace topsoil, dark brown, moist		2	SS	2		302										
			3	SS	2		301										
300.5	2.3 SAND: trace cobbles, trace gravel, light brown, moist, compact		4	SS	16		300										
299.8	3.0 SILTY SAND: light brown, very moist, compact		5	SS	14		299										
							298										
298.2	4.6 SAND: light brown, moist, compact to dense		6	SS	12		297										
			7	SS	9		296										
			8	SS	42		295										
			9	SS	31		294										
293.1	9.7 END OF BOREHOLE:																
	Notes: 1. Borehole was dry and open upon completion of drilling.																

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3 , × 3 : Numbers refer to Sensitivity

○ = 3% Strain at Failure

SPCL SOIL LOG W/ VOC 0-12 PPM-2016 SP18-334-10.GPJ SPCL GDT 12/5/18

LOG OF BOREHOLE BH 9

1 OF 1

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION: See Drawing 1

DRILLING DATA
 Method: Solid Stem Augers
 Diameter: 150 mm
 Date: Oct/19/2018
 Drilling Contractor:
 REF. NO.: SP18-334-10
 ENCL NO.: 10

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	Head Space Combustible Vapor Reading (ppm)	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m				W _p	W	W _L			
298.2														GR SA SI CL
0.0 297.9 0.3	TOPSOIL: 300 mm FILL: sandy silt to silty sand, trace topsoil, dark brown, wet		1	SS	6		298							
			2	SS	3		297							
			3	SS	4		296							
295.9														
2.3	SAND: light brown, moist, compact		4	SS	15		295							
			5	SS	29		294							
293.6							293							
4.6	GRAVELLY SAND : trace cobbles, light brown, moist, dense		6	SS	35		292							
			7	SS	25		291							
290.6							290							
7.6	SAND: trace silt, light brown, moist, dense		8	SS	41		289							
	trace gravel		9	SS	43									
288.5														
9.7	END OF BOREHOLE: Notes: 1. Borehole was dry and open upon completion of drilling. 2. Monitoring well was installed in the borehole upon completion of drilling. 3. Monitoring well was dry on November 1, 2018, and November 27, 2018.													

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3 , × 3 : Numbers refer to Sensitivity

○ = 3% Strain at Failure

LOG OF BOREHOLE BH 10B

1 OF 1

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION: See Drawing 1

DRILLING DATA
 Method: Solid Stem Augers
 Diameter: 150 mm
 Date: Oct/19/2018
 Drilling Contractor:
 REF. NO.: SP18-334-10
 ENCL NO.: 11

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	Head Space Combustible Vapor Reading (ppm)		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kNm ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m					W _p	W	W _L			GR SA SI CL
295.7	TOPSOIL: 300 MM														
0.0 295.4 0.3	FILL: topsoil mixed with silty sand, reddish brown, very moist, loose		1	SS	6		295								
1	SAND (REWORKED): brown, very moist, very loose		2	SS	0		294								
2			3	SS	0		293								
293.4															
2.3	SAND: brown, moist to very moist, very loose to very dense		4	SS	4		293								
3	trace cobbles		5	SS	5		292								
4							291								
5	trace gravel		6	SS	9		290								
6							289								
7			7	SS	18		288								
8	some gravel, trace clay, light brown		8	SS	50/ 125 mm		287								
9	some silt (pockets)		9	SS	38		286								
286.0 9.7	END OF BOREHOLE:														
	Notes: 1. Borehole was dry and open upon completion of drilling. 2. Monitoring well was installed in the borehole upon completion of drilling. 3. Borehole was dry on November 1, 2018 and November 27, 2018.														

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ = 3% Strain at Failure

SPCL SOIL LOG W/ VOC 0-12 PPM-2016 SP18-334-10.GPJ SPCL GDT 12/5/18

1 OF 3

DRILLING DATA

Method: Soil Stem Auger





Diameter: 150 mm

Date: Aug/23/2019

REF. NO.: SP19-334-00

ENCL NO.: 2

GROUNDWATER ELEVATIONS

	1st	2nd	3rd	4th
Measurement				

+³, ×³: Numbers refer to Sensitivity ○ **8**=3% Strain at Failure

2 OF 3

DRILLING DATA

Method: Soil Stem Auger	
Diameter: 150 mm	REF. NO.: SP19-334-00
Date: Aug/23/2019	ENCL NO.: 2

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement

1st 2nd 3rd 4th

GRAPH NOTES

+3, x3: Numbers refer to Sensitivity

○ 3% Strain at Failure

LOG OF BOREHOLE BH 19-1

3 OF 3

PROJECT: Proposed Residential Development					DRILLING DATA											
CLIENT: Palgrave Estate					Method: Solid Stem Auger											
PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario					Diameter: 150 mm											
DATUM: Geodetic					Date: Aug/23/2019											
BH LOCATION:					REF. NO.: SP19-334-00											
ENCL NO.: 2																
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			"N" BLOWS 0.3 m	SHEAR STRENGTH (kPa)				WATER CONTENT (%)				
	6. Groundwater level was observed at 12.98 mbgs on October 8, 2019.															

SPCL SOIL LOG SP18-334-10 - 2019.GPJ SPCL GDT 10/22/19

GROUNDWATER ELEVATIONS

 Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+³, ×³: Numbers refer to Sensitivity

○ s=3% Strain at Failure

LOG OF BOREHOLE BH 19-1A

1 OF 2

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION:

DRILLING DATA
 Method: Hollow Stem Auger
 Diameter: 200 mm
 Date: Oct/10/2019
 REF. NO.: SP19-334-00
 ENCL NO.: 3

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT				POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)							WATER CONTENT (%)		
								○ UNCONFINED	● QUICK TRIAXIAL	+	×				FIELD VANE & Sensitivity	LAB VANE	W _p
299.1							299										
299.0																	
0.2																	

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

SPCL SOIL LOG SP18-334-10 - 2019.GPJ SPCL GDT 10/22/19

2 OF 2

DRILLING DATA

Method: Hollow Stem Auger

Diameter: 200 mm

Date: Oct/10/2019

REF. NO.: SP19-334-00

ENCL NO.: 3

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

LOG OF BOREHOLE BH 19-2

1 OF 2

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION:

DRILLING DATA
 Method: Solid Stem Auger
 Diameter: 150 mm
 Date: Aug/23/2019

REF. NO.: SP19-334-00
 ENCL NO.: 4

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)				W _p W W _L					GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE & Sensitivity				WATER CONTENT (%)								
								● QUICK TRIAXIAL × LAB VANE												
298.2							20	40	60	80	100	10	20	30						
0.0	FILL: sand, some cobbles, some gravel, brown to grey, moist	XXXX	1	SS	5															
297.9	SILTY SAND: brown, moist, loose		4	SS	21															
0.3																				
	trace cobbles, dark brown, very loose		2	SS	5															

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

SPCL SOIL LOG SP18-334-10 - 2019.GPJ SPCL.GDT 10/22/19

2 OF 2

DRILLING DATA

Method: Soil Stem Auger	
Diameter: 150 mm	REF. NO.: SP19-334-00
Date: Aug/23/2019	ENCL NO.: 4

[illegible]



1st 2nd 3rd 4th

LOG OF BOREHOLE BH 19-3

1 OF 2

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION:

DRILLING DATA
 Method: Solid Stem Auger
 Diameter: 150 mm
 Date: Aug/23/2019
 REF. NO.: SP19-334-00
 ENCL NO.: 5

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)			WATER CONTENT (%)					
								20 40 60 80 100	○ UNCONFINED + FIELD VANE & Sensitivity	● QUICK TRIAXIAL × LAB VANE	W _p W W _L					
298.2	0.0		1	SS	12											GR SA SI CL
297.4																IBL in ppm
0.8			2	SS	4											
	trace cobbles, loose			3	SS	5										
				4	SS	5										
				5	SS	4										
	becoming grey, very moist and very dense			6	SS	53										
	becoming dense		7	SS	41											
			8	SS	36											

SPCL SOIL LOG SP18-334-10 - 2019.GPJ SPCL GDT 10/22/19

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

2 OF 2

DRILLING DATA

Method: Soil Stem Auger

Diameter: 150 mm

Date: Aug/23/2019

REF. NO.: SP19-334-00

ENCL NO.: 5


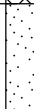
GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ **ε**=3% Strain at Failure

LOG OF BOREHOLE BH 19-3A

1 OF 2

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION:

DRILLING DATA
 Method: Hollow Stem Auger
 Diameter: 200 mm
 Date: Oct/11/2019
 REF. NO.: SP19-334-00
 ENCL NO.: 6

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)		W _p	W	W _L				WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE & Sensitivity	×	LAB VANE						
298.2							20 40 60 80 100	20 40 60 80 100	10 20 30						GR SA SI CL	
0.0	POSSIBLE FILL: sand, brown, moist														IBL in ppm	
297.4																
0.8	SAND: brown, moist, very loose															
1																
	trace cobbles, loose															
2																
3																
4																
5																
6	becoming grey, very moist and very dense															
7																
8																
9	becoming dense															
10																

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH
NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ s=3% Strain at Failure

SPCL SOIL LOG SP18-334-10 - 2019.GPJ SPCL GDT 10/22/19

LOG OF BOREHOLE BH 19-3A

2 OF 2

PROJECT: Proposed Residential Development
 CLIENT: Palgrave Estate
 PROJECT LOCATION: Mount Hope Rd., Caledon, Ontario
 DATUM: Geodetic
 BH LOCATION:

DRILLING DATA
 Method: Hollow Stem Auger
 Diameter: 200 mm
 Date: Oct/11/2019
 REF. NO.: SP19-334-00
 ENCL NO.: 6

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	SHEAR STRENGTH (kPa)			WATER CONTENT (%)			GR	SA			SI	CL		
						20 40 60 80 100			20 40 60 80 100	W _p W W _L									
	SAND: brown, moist, very loose(Continued)						○ UNCONFINED + FIELD VANE & Sensitivity												
287.5 10.7	SAND: light brown, moist		8	DO			● QUICK TRIAXIAL × LAB VANE												
287.0 11.3	Augered to 16.8 mbgs																		

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3 , × 3 : Numbers refer to Sensitivity

○ s=3% Strain at Failure

SPCL SOIL LOG SP18-334-10 - 2019.GPJ SPCL GDT 10/22/19

APPENDIX C

CLIENT NAME: MISC AGAT CLIENT ON, ON

ATTENTION TO: Sudhakar Kurli

PROJECT: SP18-334-30

AGAT WORK ORDER: 19T529356

WATER ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

DATE REPORTED: Oct 22, 2019

PAGES (INCLUDING COVER): 9

VERSION*: 1

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

***NOTES**

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



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19T529356

PROJECT: SP18-334-30

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

CLIENT NAME: MISC AGAT CLIENT ON

SAMPLING SITE:

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

Water Quality Assessment (mg/L)

DATE RECEIVED: 2019-10-10

DATE REPORTED: 2019-10-22

20191008-001-				
SAMPLE DESCRIPTION: BH19+2				
SAMPLE TYPE: Water				
DATE SAMPLED: 2019-10-08				
Parameter	Unit	G / S	RDL	608065
Electrical Conductivity	µS/cm		2	811
pH	pH Units		NA	7.62
Saturation pH (Calculated)				6.89
Langelier Index (Calculated)				0.73
Total Hardness (as CaCO ₃) (Calculated)	mg/L		0.5	367
Total Dissolved Solids	mg/L		20	594
Alkalinity (as CaCO ₃)	mg/L		5	272
Bicarbonate (as CaCO ₃)	mg/L		5	272
Carbonate (as CaCO ₃)	mg/L		5	<5
Hydroxide (as CaCO ₃)	mg/L		5	<5
Fluoride	mg/L		0.25	<0.25
Chloride	mg/L		0.50	20.1
Nitrate as N	mg/L		0.25	29.3
Nitrite as N	mg/L		0.25	<0.25
Bromide	mg/L		0.25	<0.25
Sulphate	mg/L		0.50	20.0
Ortho Phosphate as P	mg/L		0.50	<0.50
Reactive Silica	mg/L		0.05	13.0
Ammonia as N	mg/L		0.02	<0.02
Total Phosphorus	mg/L		0.02	3.72
Total Organic Carbon	mg/L		1.0	8.5
Colour	TCU		5	<5
Turbidity	NTU		3.0	6890
Calcium	mg/L		0.05	132
Magnesium	mg/L		0.05	9.02
Sodium	mg/L		0.05	9.58
Potassium	mg/L		0.05	1.31
Aluminum	mg/L		0.004	0.060

Certified By:

Divine Basily



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19T529356

PROJECT: SP18-334-30

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

CLIENT NAME: MISC AGAT CLIENT ON

SAMPLING SITE:

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

Water Quality Assessment (mg/L)

DATE RECEIVED: 2019-10-10

DATE REPORTED: 2019-10-22

20191008-001-				
SAMPLE DESCRIPTION: BH19+2				
SAMPLE TYPE: Water				
DATE SAMPLED: 2019-10-08				
Parameter	Unit	G / S	RDL	608065
Antimony	mg/L		0.003	<0.003
Arsenic	mg/L		0.003	<0.003
Barium	mg/L		0.002	0.112
Beryllium	mg/L		0.001	<0.001
Boron	mg/L		0.010	0.027
Cadmium	mg/L		0.001	<0.001
Chromium	mg/L		0.003	<0.003
Cobalt	mg/L		0.001	0.004
Copper	mg/L		0.003	<0.003
Iron	mg/L		0.010	<0.010
Lead	mg/L		0.001	<0.001
Manganese	mg/L		0.002	1.29
Mercury	mg/L		0.0001	<0.0001
Molybdenum	mg/L		0.002	<0.002
Nickel	mg/L		0.003	<0.003
Selenium	mg/L		0.004	<0.004
Silver	mg/L		0.002	<0.002
Strontium	mg/L		0.005	1.09
Thallium	mg/L		0.006	<0.006
Tin	mg/L		0.002	<0.002
Titanium	mg/L		0.002	<0.002
Tungsten	mg/L		0.010	<0.010
Uranium	mg/L		0.002	<0.002
Vanadium	mg/L		0.002	<0.002
Zinc	mg/L		0.005	0.008
Zirconium	mg/L		0.004	<0.004
% Difference/ Ion Balance (Calculated)	%		NA	4.46

Certified By:

Divine Basily



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19T529356

PROJECT: SP18-334-30

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

CLIENT NAME: MISC AGAT CLIENT ON

SAMPLING SITE:

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

Water Quality Assessment (mg/L)

DATE RECEIVED: 2019-10-10

DATE REPORTED: 2019-10-22

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

608065 Elevated RDL indicates the degree of sample dilution prior to the analysis in order to keep analytes within the calibration range of the instrument and to reduce matrix interference.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Divine Basily

Quality Assurance

CLIENT NAME: MISC AGAT CLIENT ON

PROJECT: SP18-334-30

SAMPLING SITE:

AGAT WORK ORDER: 19T529356

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

Water Analysis															
RPT Date: Oct 22, 2019			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Water Quality Assessment (mg/L)

Electrical Conductivity	608780		1200	1200	0.0%	< 2	108%	80%	120%						
pH	608780		7.69	7.60	1.2%	NA	99%	90%	110%						
Alkalinity (as CaCO3)	608780		506	506	0.0%	< 5	96%	80%	120%						
Bicarbonate (as CaCO3)	608780		506	506	0.0%	< 5									
Carbonate (as CaCO3)	608780		<5	<5	NA	< 5									
Hydroxide (as CaCO3)	608780		<5	<5	NA	< 5									
Fluoride	604149		<0.25	<0.25	NA	< 0.05	101%	90%	110%	102%	90%	110%	91%	85%	115%
Chloride	604149		14.6	15.1	3.4%	< 0.10	90%	90%	110%	101%	90%	110%	101%	85%	115%
Nitrate as N	604149		<0.25	<0.25	NA	< 0.05	93%	90%	110%	107%	90%	110%	104%	85%	115%
Nitrite as N	604149		<0.25	<0.25	NA	< 0.05	NA	90%	110%	106%	90%	110%	105%	85%	115%
Bromide	604149		<0.25	<0.25	NA	< 0.05	103%	90%	110%	102%	90%	110%	101%	85%	115%
Sulphate	604149		172	179	4.0%	< 0.10	98%	90%	110%	105%	90%	110%	95%	85%	115%
Ortho Phosphate as P	604149		<0.50	<0.50	NA	< 0.10	95%	90%	110%	100%	90%	110%	95%	80%	120%
Reactive Silica	582369		2.86	2.84	0.7%	< 0.05	100%	90%	110%	105%	90%	110%	101%	80%	120%
Ammonia as N	601989		1.04	1.03	1.0%	< 0.02	104%	90%	110%	101%	90%	110%	93%	70%	130%
Total Phosphorus	607866		0.03	0.03	NA	< 0.02	95%	80%	120%	98%	90%	110%	98%	70%	130%
Total Organic Carbon	608860		8.3	9.2	10.3%	< 0.5	106%	90%	110%	104%	90%	110%	90%	80%	120%
Colour	608065	608065	<5	<5	NA	< 5	100%	90%	110%						
Turbidity	602035		<0.5	<0.5	NA	< 0.5	99%	90%	110%						
Calcium	609113		102	103	1.0%	< 0.05	98%	90%	110%	98%	90%	110%	96%	70%	130%
Magnesium	609113		10.7	10.6	0.9%	< 0.05	99%	90%	110%	98%	90%	110%	96%	70%	130%
Sodium	609113		12.7	12.5	1.6%	< 0.05	101%	90%	110%	100%	90%	110%	97%	70%	130%
Potassium	609113		15.0	14.8	1.3%	< 0.05	99%	90%	110%	99%	90%	110%	97%	70%	130%
Aluminum	608206		0.131	0.127	3.1%	< 0.004	105%	90%	110%	101%	90%	110%	100%	70%	130%
Antimony	608206		<0.003	<0.003	NA	< 0.003	107%	90%	110%	95%	90%	110%	95%	70%	130%
Arsenic	608206		0.004	<0.003	NA	< 0.003	103%	90%	110%	97%	90%	110%	105%	70%	130%
Barium	608206		0.054	0.053	1.9%	< 0.002	97%	90%	110%	96%	90%	110%	91%	70%	130%
Beryllium	608206		<0.001	<0.001	NA	< 0.001	103%	90%	110%	99%	90%	110%	107%	70%	130%
Boron	608206		0.139	0.141	1.4%	< 0.010	102%	90%	110%	97%	90%	110%	101%	70%	130%
Cadmium	608206		<0.001	<0.001	NA	< 0.001	101%	90%	110%	100%	90%	110%	101%	70%	130%
Chromium	608206		<0.003	<0.003	NA	< 0.003	100%	90%	110%	98%	90%	110%	95%	70%	130%
Cobalt	608206		<0.001	<0.001	NA	< 0.001	99%	90%	110%	97%	90%	110%	97%	70%	130%
Copper	608206		<0.003	<0.003	NA	< 0.003	102%	90%	110%	100%	90%	110%	97%	70%	130%
Iron	608206		1.01	0.995	1.5%	< 0.010	102%	90%	110%	97%	90%	110%	101%	70%	130%
Lead	608206		<0.001	<0.001	NA	< 0.001	104%	90%	110%	102%	90%	110%	98%	70%	130%
Manganese	608206		0.045	0.045	0.0%	< 0.002	108%	90%	110%	106%	90%	110%	100%	70%	130%
Mercury	606734		<0.0001	<0.0001	NA	< 0.0001	101%	90%	110%	103%	80%	120%	99%	80%	120%
Molybdenum	608206		0.013	0.013	0.0%	< 0.002	99%	90%	110%	96%	90%	110%	98%	70%	130%
Nickel	608206		<0.003	<0.003	NA	< 0.003	101%	90%	110%	99%	90%	110%	98%	70%	130%

AGAT QUALITY ASSURANCE REPORT (V1)

Page 5 of 9

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation. RPDs calculated using raw data. The RPD may not be reflective of duplicate values shown, due to rounding of final results.

Results relate only to the items tested. Results apply to samples as received.

Quality Assurance

CLIENT NAME: MISC AGAT CLIENT ON

PROJECT: SP18-334-30

SAMPLING SITE:

AGAT WORK ORDER: 19T529356

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

Water Analysis (Continued)

RPT Date: Oct 22, 2019			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Selenium	608206		0.012	0.011	NA	< 0.004	101%	90%	110%	97%	90%	110%	84%	70%	130%
Silver	608206		<0.002	<0.002	NA	< 0.002	104%	90%	110%	104%	90%	110%	89%	70%	130%
Strontium	608206		3.77	3.70	1.9%	< 0.005	99%	90%	110%	98%	90%	110%	91%	70%	130%
Thallium	608206		<0.006	<0.006	NA	< 0.006	104%	90%	110%	99%	90%	110%	97%	70%	130%
Tin	608206		<0.002	<0.002	NA	< 0.002	103%	90%	110%	97%	90%	110%	99%	70%	130%
Titanium	608206		0.005	0.005	NA	< 0.002	100%	90%	110%	95%	90%	110%	97%	70%	130%
Tungsten	608206		<0.010	<0.010	NA	< 0.010	98%	90%	110%	92%	90%	110%	96%	70%	130%
Uranium	608206		0.015	0.015	0.0%	< 0.002	104%	90%	110%	102%	90%	110%	104%	70%	130%
Vanadium	608206		<0.002	<0.002	NA	< 0.002	101%	90%	110%	98%	90%	110%	99%	70%	130%
Zinc	608206		0.052	0.051	1.9%	< 0.005	106%	90%	110%	103%	90%	110%	105%	70%	130%
Zirconium	608206		<0.004	<0.004	NA	< 0.004	93%	90%	110%	93%	90%	110%	92%	70%	130%

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By:

Divine Basily

+

Method Summary

CLIENT NAME: MISC AGAT CLIENT ON

PROJECT: SP18-334-30

SAMPLING SITE:
AGAT WORK ORDER: 19T529356

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Electrical Conductivity	INOR-93-6000	SM 2510 B	PC TITRATE
pH	INOR-93-6000	SM 4500-H+ B	PC TITRATE
Saturation pH (Calculated)		SM 2320 B	CALCULATION
Langelier Index (Calculated)		SM 2330B	CALCULATION
Total Hardness (as CaCO ₃) (Calculated)	MET-93-6105	EPA SW-846 6010C & 200.7	CALCULATION
Total Dissolved Solids	INOR-93-6028	SM 2540 C	BALANCE
Alkalinity (as CaCO ₃)	INOR-93-6000	SM 2320 B	PC TITRATE
Bicarbonate (as CaCO ₃)	INOR-93-6000	SM 2320 B	PC TITRATE
Carbonate (as CaCO ₃)	INOR-93-6000	SM 2320 B	PC TITRATE
Hydroxide (as CaCO ₃)	INOR-93-6000	SM 2320 B	PC TITRATE
Fluoride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Chloride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrate as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Bromide	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Ortho Phosphate as P	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Reactive Silica	INOR-93-6070	QuickChem 10-114-27-1-A & SM 4500 Si-F	LACHAT FIA
Ammonia as N	INOR-93-6059	SM 4500-NH ₃ H	LACHAT FIA
Total Phosphorus	INOR-93-6057	QuikChem 10-115-01-3-A & SM 4500-P I	LACHAT FIA
Total Organic Carbon	INOR-93-6049	EPA 415.1 & SM 5310	SHIMADZU CARBON ANALYZER
Colour	INOR-93-6046	SM 2120 B	SPECTROPHOTOMETER
Turbidity	INOR-93-6044	SM 2130 B	NEPHELOMETER
Calcium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Magnesium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Sodium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Potassium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Aluminum	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Antimony	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Barium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Boron	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Cadmium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Chromium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Copper	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Iron	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Lead	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Manganese	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Mercury	MET-93-6100	EPA SW 846 7470 & 245.1	CVAAS
Molybdenum	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Nickel	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Selenium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Silver	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Strontium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Thallium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS

Method Summary

CLIENT NAME: MISC AGAT CLIENT ON

PROJECT: SP18-334-30

SAMPLING SITE:

AGAT WORK ORDER: 19T529356

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Tin	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Titanium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Tungsten	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Uranium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Zinc	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Zirconium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
% Difference/ Ion Balance (Calculated)		SM 1030 E	CALCULATION

CLIENT NAME: MISC AGAT CLIENT ON, ON

ATTENTION TO: Sudhakar Kurli

PROJECT: SP18-334-30

AGAT WORK ORDER: 19T533219

WATER ANALYSIS REVIEWED BY: Jacky Zhu, Spectroscopy Technician

DATE REPORTED: Oct 28, 2019

PAGES (INCLUDING COVER): 9

VERSION*: 1

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

***NOTES**

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

AGAT Laboratories (V1)

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)
Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation. Measurement Uncertainty is not taken into consideration when stating conformity with a specified requirement.

*Results relate only to the items tested. Results apply to samples as received.
All reportable information as specified by ISO 17025:2017 is available from AGAT Laboratories upon request*



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19T533219

PROJECT: SP18-334-30

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

CLIENT NAME: MISC AGAT CLIENT ON

SAMPLING SITE:

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

Water Quality Assessment (mg/L)

DATE RECEIVED: 2019-10-21

DATE REPORTED: 2019-10-28

		20191018-BH19- 20191018-BH19-			
		SAMPLE DESCRIPTION:		1	3
		SAMPLE TYPE:		Water	Water
		DATE SAMPLED:		2019-10-18	2019-10-18
Parameter	Unit	G / S	RDL	635183	635200
Electrical Conductivity	µS/cm		2	637	743
pH	pH Units		NA	7.79	7.71
Saturation pH (Calculated)				6.97	6.88
Langelier Index (Calculated)				0.82	0.83
Total Hardness (as CaCO ₃) (Calculated)	mg/L		0.5	330	378
Total Dissolved Solids	mg/L		20	494	554
Alkalinity (as CaCO ₃)	mg/L		5	237	268
Bicarbonate (as CaCO ₃)	mg/L		5	237	268
Carbonate (as CaCO ₃)	mg/L		5	<5	<5
Hydroxide (as CaCO ₃)	mg/L		5	<5	<5
Fluoride	mg/L		0.10	<0.10	<0.10
Chloride	mg/L		0.20	29.9	29.8
Nitrate as N	mg/L		0.10	21.5	27.0
Nitrite as N	mg/L		0.10	<0.10	<0.10
Bromide	mg/L		0.10	<0.10	<0.10
Sulphate	mg/L		0.20	15.3	20.7
Ortho Phosphate as P	mg/L		0.20	<0.20	<0.20
Reactive Silica	mg/L		0.05	10.1	13.3
Ammonia as N	mg/L		0.02	<0.02	<0.02
Total Phosphorus	mg/L		0.02	0.39	2.76
Total Organic Carbon	mg/L		1.0	4.3	12.9
Colour	TCU		5	<5	<5
Turbidity	NTU		3.0	24900	7300
Calcium	mg/L		0.05	116	130
Magnesium	mg/L		0.05	9.89	12.9
Sodium	mg/L		0.05	8.80	10.8
Potassium	mg/L		0.05	1.77	1.95
Aluminum	mg/L		0.004	0.350	4.36

Certified By:

Jacky Zh



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19T533219

PROJECT: SP18-334-30

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

CLIENT NAME: MISC AGAT CLIENT ON

SAMPLING SITE:

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

Water Quality Assessment (mg/L)

DATE RECEIVED: 2019-10-21

DATE REPORTED: 2019-10-28

		20191018-BH19- 20191018-BH19-			
SAMPLE DESCRIPTION:		1		3	
SAMPLE TYPE:		Water		Water	
DATE SAMPLED:		2019-10-18		2019-10-18	
Parameter	Unit	G / S	RDL	635183	635200
Antimony	mg/L		0.003	<0.003	<0.003
Arsenic	mg/L		0.003	<0.003	<0.003
Barium	mg/L		0.002	0.229	0.342
Beryllium	mg/L		0.001	<0.001	<0.001
Boron	mg/L		0.010	0.037	0.041
Cadmium	mg/L		0.001	<0.001	<0.001
Chromium	mg/L		0.003	0.003	0.008
Cobalt	mg/L		0.001	0.012	0.046
Copper	mg/L		0.003	<0.003	0.030
Iron	mg/L		0.010	0.128	3.12
Lead	mg/L		0.001	<0.001	0.013
Manganese	mg/L		0.002	2.23	3.11
Mercury	mg/L		0.0001	<0.0001	<0.0001
Molybdenum	mg/L		0.002	<0.002	<0.002
Nickel	mg/L		0.003	0.088	0.025
Selenium	mg/L		0.004	<0.004	<0.004
Silver	mg/L		0.002	<0.002	<0.002
Strontium	mg/L		0.005	1.65	1.49
Thallium	mg/L		0.006	<0.006	<0.006
Tin	mg/L		0.002	<0.002	<0.002
Titanium	mg/L		0.002	0.009	0.015
Tungsten	mg/L		0.010	<0.010	<0.010
Uranium	mg/L		0.002	<0.002	<0.002
Vanadium	mg/L		0.002	<0.002	0.007
Zinc	mg/L		0.005	0.018	0.087
Zirconium	mg/L		0.004	<0.004	<0.004
% Difference/ Ion Balance (Calculated)	%		NA	2.76	2.90

Certified By:



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19T533219

PROJECT: SP18-334-30

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

CLIENT NAME: MISC AGAT CLIENT ON

SAMPLING SITE:

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

Water Quality Assessment (mg/L)

DATE RECEIVED: 2019-10-21

DATE REPORTED: 2019-10-28

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

635183-635200 Elevated RDL indicates the degree of sample dilution prior to the analysis in order to keep analytes within the calibration range of the instrument and to reduce matrix interference.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Quality Assurance

CLIENT NAME: MISC AGAT CLIENT ON

PROJECT: SP18-334-30

SAMPLING SITE:

AGAT WORK ORDER: 19T533219

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

Water Analysis															
RPT Date: Oct 28, 2019			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Water Quality Assessment (mg/L)

Electrical Conductivity	637812		25	24	4.1%	< 2	104%	80%	120%						
pH	637812		5.23	4.81	8.4%	NA	100%	90%	110%						
Total Dissolved Solids	635183	635183	494	496	0.4%	< 20	98%	80%	120%						
Alkalinity (as CaCO ₃)	637812		<5	<5	NA	< 5	100%	80%	120%						
Bicarbonate (as CaCO ₃)	637812		<5	<5	NA	< 5									
Carbonate (as CaCO ₃)	637812		<5	<5	NA	< 5									
Hydroxide (as CaCO ₃)	637812		<5	<5	NA	< 5									
Fluoride	633483		<0.25	<0.25	NA	< 0.05	108%	90%	110%	103%	90%	110%	99%	85%	115%
Chloride	633483		179	171	4.6%	< 0.10	96%	90%	110%	106%	90%	110%	94%	85%	115%
Nitrate as N	633483		<0.25	<0.25	NA	< 0.05	97%	90%	110%	108%	90%	110%	106%	85%	115%
Nitrite as N	633483		<0.25	<0.25	NA	< 0.05	105%	90%	110%	102%	90%	110%	106%	85%	115%
Bromide	633483		<0.25	<0.25	NA	< 0.05	105%	90%	110%	102%	90%	110%	101%	85%	115%
Sulphate	633483		53.5	53.5	0.0%	< 0.10	94%	90%	110%	106%	90%	110%	108%	85%	115%
Ortho Phosphate as P	633483		<0.50	<0.50	NA	< 0.10	94%	90%	110%	102%	90%	110%	99%	80%	120%
Reactive Silica	632809		12.8	12.8	0.0%	< 0.05	100%	90%	110%	104%	90%	110%	94%	80%	120%
Ammonia as N	632928		<0.02	<0.02	NA	< 0.02	103%	90%	110%	96%	90%	110%	87%	70%	130%
Total Phosphorus	634539		<0.02	<0.02	NA	< 0.02	104%	80%	120%	109%	90%	110%	108%	70%	130%
Total Organic Carbon	638469		4.60	4.30	6.7%	< 0.5	103%	90%	110%	108%	90%	110%	83%	80%	120%
Colour	653186		7	7	NA	< 5	95%	90%	110%						
Turbidity	635183	635183	24900	25000	0.4%	< 0.5	99%	90%	110%						
Calcium	634801		84.1	83.5	0.7%	< 0.05	93%	90%	110%	94%	90%	110%	96%	70%	130%
Magnesium	634801		19.2	19.0	1.0%	< 0.05	94%	90%	110%	95%	90%	110%	94%	70%	130%
Sodium	634801		20.5	20.3	1.0%	< 0.05	92%	90%	110%	92%	90%	110%	92%	70%	130%
Potassium	634801		5.77	5.76	0.2%	< 0.05	91%	90%	110%	91%	90%	110%	93%	70%	130%
Aluminum	630780		0.012	0.012	NA	< 0.004	103%	90%	110%	103%	90%	110%	101%	70%	130%
Antimony	630780		<0.003	<0.003	NA	< 0.003	104%	90%	110%	96%	90%	110%	97%	70%	130%
Arsenic	630780		<0.003	<0.003	NA	< 0.003	99%	90%	110%	100%	90%	110%	106%	70%	130%
Barium	630780		0.220	0.216	1.8%	< 0.002	97%	90%	110%	99%	90%	110%	97%	70%	130%
Beryllium	630780		<0.001	<0.001	NA	< 0.001	93%	90%	110%	98%	90%	110%	106%	70%	130%
Boron	630780		0.069	0.071	2.9%	< 0.010	103%	90%	110%	105%	90%	110%	98%	70%	130%
Cadmium	630780		<0.001	<0.001	NA	< 0.001	101%	90%	110%	102%	90%	110%	117%	70%	130%
Chromium	630780		<0.003	<0.003	NA	< 0.003	103%	90%	110%	103%	90%	110%	100%	70%	130%
Cobalt	630780		<0.001	<0.001	NA	< 0.001	100%	90%	110%	102%	90%	110%	99%	70%	130%
Copper	630780		0.013	0.012	NA	< 0.003	101%	90%	110%	103%	90%	110%	98%	70%	130%
Iron	630780		<0.010	<0.010	NA	< 0.010	106%	90%	110%	98%	90%	110%	92%	70%	130%
Lead	630780		<0.001	<0.001	NA	< 0.001	101%	90%	110%	104%	90%	110%	98%	70%	130%
Manganese	630780		0.046	0.045	2.2%	< 0.002	104%	90%	110%	104%	90%	110%	96%	70%	130%
Mercury	635183	635183	<0.0001	<0.0001	NA	< 0.0001	100%	90%	110%	99%	80%	120%	103%	80%	120%
Molybdenum	630780		0.195	0.193	1.0%	< 0.002	100%	90%	110%	100%	90%	110%	99%	70%	130%

AGAT QUALITY ASSURANCE REPORT (V1)

Page 5 of 9

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation. RPDs calculated using raw data. The RPD may not be reflective of duplicate values shown, due to rounding of final results.

Results relate only to the items tested. Results apply to samples as received.

Quality Assurance

CLIENT NAME: MISC AGAT CLIENT ON

PROJECT: SP18-334-30

SAMPLING SITE:

AGAT WORK ORDER: 19T533219

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

Water Analysis (Continued)

RPT Date: Oct 28, 2019			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Nickel	630780		<0.003	<0.003	NA	< 0.003	104%	90%	110%	105%	90%	110%	101%	70%	130%
Selenium	630780		<0.004	<0.004	NA	< 0.004	98%	90%	110%	101%	90%	110%	107%	70%	130%
Silver	630780		<0.002	<0.002	NA	< 0.002	104%	90%	110%	106%	90%	110%	105%	70%	130%
Strontium	630780		2.71	2.63	3.0%	< 0.005	96%	90%	110%	98%	90%	110%	103%	70%	130%
Thallium	630780		<0.006	<0.006	NA	< 0.006	104%	90%	110%	105%	90%	110%	99%	70%	130%
Tin	630780		<0.002	<0.002	NA	< 0.002	105%	90%	110%	100%	90%	110%	99%	70%	130%
Titanium	630780		<0.002	<0.002	NA	< 0.002	102%	90%	110%	101%	90%	110%	98%	70%	130%
Tungsten	630780		<0.010	<0.010	NA	< 0.010	102%	90%	110%	98%	90%	110%	97%	70%	130%
Uranium	630780		0.006	0.006	NA	< 0.002	97%	90%	110%	100%	90%	110%	98%	70%	130%
Vanadium	630780		<0.002	<0.002	NA	< 0.002	99%	90%	110%	101%	90%	110%	99%	70%	130%
Zinc	630780		0.009	0.008	NA	< 0.005	100%	90%	110%	105%	90%	110%	105%	70%	130%
Zirconium	630780		<0.004	<0.004	NA	< 0.004	92%	90%	110%	98%	90%	110%	96%	70%	130%

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By:


Method Summary

CLIENT NAME: MISC AGAT CLIENT ON

PROJECT: SP18-334-30

SAMPLING SITE:
AGAT WORK ORDER: 19T533219

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Electrical Conductivity	INOR-93-6000	SM 2510 B	PC TITRATE
pH	INOR-93-6000	SM 4500-H+ B	PC TITRATE
Saturation pH (Calculated)		SM 2320 B	CALCULATION
Langelier Index (Calculated)		SM 2330B	CALCULATION
Total Hardness (as CaCO ₃) (Calculated)	MET-93-6105	EPA SW-846 6010C & 200.7	CALCULATION
Total Dissolved Solids	INOR-93-6028	SM 2540 C	BALANCE
Alkalinity (as CaCO ₃)	INOR-93-6000	SM 2320 B	PC TITRATE
Bicarbonate (as CaCO ₃)	INOR-93-6000	SM 2320 B	PC TITRATE
Carbonate (as CaCO ₃)	INOR-93-6000	SM 2320 B	PC TITRATE
Hydroxide (as CaCO ₃)	INOR-93-6000	SM 2320 B	PC TITRATE
Fluoride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Chloride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrate as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Bromide	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Ortho Phosphate as P	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Reactive Silica	INOR-93-6070	QuickChem 10-114-27-1-A & SM 4500 Si-F	LACHAT FIA
Ammonia as N	INOR-93-6059	SM 4500-NH ₃ H	LACHAT FIA
Total Phosphorus	INOR-93-6057	QuikChem 10-115-01-3-A & SM 4500-P I	LACHAT FIA
Total Organic Carbon	INOR-93-6049	EPA 415.1 & SM 5310	SHIMADZU CARBON ANALYZER
Colour	INOR-93-6046	SM 2120 B	SPECTROPHOTOMETER
Turbidity	INOR-93-6044	SM 2130 B	NEPHELOMETER
Calcium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Magnesium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Sodium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Potassium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Aluminum	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Antimony	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Barium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Boron	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Cadmium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Chromium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Copper	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Iron	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Lead	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Manganese	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Mercury	MET-93-6100	EPA SW 846 7470 & 245.1	CVAAS
Molybdenum	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Nickel	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Selenium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Silver	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Strontium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Thallium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS



Method Summary

CLIENT NAME: MISC AGAT CLIENT ON

PROJECT: SP18-334-30

SAMPLING SITE:

AGAT WORK ORDER: 19T533219

ATTENTION TO: Sudhakar Kurli

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Tin	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Titanium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Tungsten	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Uranium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Zinc	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Zirconium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
% Difference/ Ion Balance (Calculated)		SM 1030 E	CALCULATION

APPENDIX D

Date	PET	P	Soil			Snow			
			P-PET	Moisture	AET	PET-AET	Storage	Surplus	ROtotal
Jan-62	8.1	48	-7.6	144.3	6.2	1.9	47.5	0	12.7
Feb-62	8.5	72.1	-7.5	138.9	6.4	2.1	118.6	0	6.4
Mar-62	16.4	12.2	18.7	157.6	16.4	0	95.4	0	3.5
Apr-62	33.8	42.2	54	200	33.8	0	47.7	11.5	9.5
May-62	66.9	58.4	12.4	200	66.9	0	23.8	12.4	12.8
Jun-62	78.7	50	-19.3	180.7	78.7	0	11.9	0	7.5
Jul-62	82.4	90.9	9.9	190.6	82.4	0	6	0	7
Aug-62	77.5	37.3	-36.1	156.2	75.8	1.7	0	0	3.1
Sep-62	45.1	86.4	37	193.2	45.1	0	0	0	4.9
Oct-62	31.7	134.4	96	200	31.7	0	0	89.2	51.6
Nov-62	15.5	113.5	79.6	200	15.5	0	13.9	79.6	66.8
Dec-62	9.6	71.1	18.3	200	9.6	0	56.1	18.3	41.2
Jan-63	7.6	25.7	-7.6	192.4	7.6	0	81.8	0	20.1
Feb-63	7.6	15	-7.6	185.1	7.3	0.3	96.8	0	10.1
Mar-63	18.2	57.2	49.8	200	18.2	0	84.4	34.9	24.2
Apr-63	33	59.4	65.6	200	33	0	42.2	65.6	47
May-63	51.2	95	60.1	200	51.2	0	21.1	60.1	56.8
Jun-63	80.7	14.5	-56.4	143.6	80.7	0	10.5	0	26.8
Jul-63	92.7	70.9	-20.1	129.2	87	5.7	5.3	0	16.6
Aug-63	69.8	80	11.5	140.7	69.8	0	0	0	10.5
Sep-63	43.7	65.8	18.8	159.5	43.7	0	0	0	6.5
Oct-63	37.7	18.3	-20.3	143.3	33.6	4.1	0	0	2.5
Nov-63	19.8	71.1	47.8	191.1	19.8	0	0	0	4.4
Dec-63	8.2	58.9	-1.3	189.8	8.1	0.1	51.8	0	0.7
Jan-64	10.3	72.6	25.9	200	10.3	0	87.1	15.7	9.2
Feb-64	9.6	31.8	4.2	200	9.6	0	104.9	4.2	6.4
Mar-64	17.6	73.4	59.4	200	17.6	0	99.2	59.4	34.8
Apr-64	31.2	71.9	86.7	200	31.2	0	49.6	86.7	63.3
May-64	62.5	59.7	19.1	200	62.5	0	24.8	19.1	42.4
Jun-64	77.7	33.8	-33.2	166.8	77.7	0	12.4	0	21.4
Jul-64	98	152.7	53.3	200	98	0	6.2	20	27.5
Aug-64	66.8	136.1	68.7	200	66.8	0	0	68.7	51.1
Sep-64	48.3	21.6	-27.8	172.2	48.3	0	0	0	23.2
Oct-64	27.8	36.3	6.7	178.9	27.8	0	0	0	12.9
Nov-64	18.1	32.3	12.6	191.5	18.1	0	0	0	7.1
Dec-64	10.7	65.3	22.8	200	10.7	0	30.4	14.3	11.3
Jan-65	8.6	88.9	3	200	8.6	0	107.3	3	6.8
Feb-65	9.8	96.5	24.8	200	9.8	0	168.2	24.8	16.6
Mar-65	14.8	50	36.4	200	14.8	0	166.2	36.4	26.9
Apr-65	26.2	48	87.8	200	26.2	0	98	87.8	59
May-65	61.7	75.2	58.7	200	61.7	0	49	58.7	61.6
Jun-65	73.5	35.3	-15.5	184.5	73.5	0	24.5	0	30.7
Jul-65	77	58.7	-8.9	176.3	76.3	0.7	12.3	0	17.4
Aug-65	72.9	96.5	24.9	200	72.9	0	6.1	1.2	12.7

Sep-65	51.7	80.8	31.2	200	51.7	0	0	31.2	23.5
Oct-65	27.8	121.2	87.3	200	27.8	0	0	87.3	59.5
Nov-65	16.3	93.5	65.5	200	16.3	0	7.6	65.5	63.5
Dec-65	12.5	74.2	40.6	200	12.5	0	26.5	40.6	52.3
Jan-66	8.4	67.6	-1.9	198.1	8.4	0	87.4	0	25.2
Feb-66	10.5	37.1	14.5	200	10.5	0	98.9	12.6	19.3
Mar-66	19.6	60.2	59.9	200	19.6	0	77.6	59.9	41.4
Apr-66	28.8	48	54.2	200	28.8	0	40.2	54.2	49.2
May-66	47	69.1	38.8	200	47	0	20.1	38.8	46.3
Jun-66	81.2	101.3	25.1	200	81.2	0	10.1	25.1	39
Jul-66	96.2	40.4	-52.8	147.2	96.2	0	5	0	19
Aug-66	78.5	74.7	-2.5	145.4	77.8	0.7	0	0	12.2
Sep-66	45.1	87.9	38.4	183.8	45.1	0	0	0	8.6
Oct-66	28.8	52.3	20.8	200	28.8	0	0	4.6	7
Nov-66	17.7	112.5	89.4	200	17.7	0	0	89.4	52.3
Dec-66	10.3	72.1	22.8	200	10.3	0	37.8	22.8	36.1
Jan-67	11.1	66.3	29.4	200	11.1	0	62.2	29.4	33.5
Feb-67	8.1	46.7	-8.1	191.9	8.1	0	108.9	0	16.1
Mar-67	16.4	22.1	22	200	16.4	0	92	14	15.5
Apr-67	32	74.9	85.1	200	32	0	46	85.1	53.8
May-67	43.9	45.2	22.1	200	43.9	0	23	22.1	38.3
Jun-67	89.1	191.8	104.6	200	89.1	0	11.5	104.6	79.9
Jul-67	86	78.7	-5.5	194.5	86	0	5.7	0	39.1
Aug-67	70.7	111.8	41.3	200	70.7	0	0	35.8	41.1
Sep-67	45.4	75.9	26.7	200	45.4	0	0	26.7	34.9
Oct-67	29.6	99.8	65.2	200	29.6	0	0	65.2	53.2
Nov-67	14.5	66.8	37.6	200	14.5	0	12.3	37.6	45.3
Dec-67	11.4	88.1	42.9	200	11.4	0	44	42.9	45
Jan-68	7.9	65.5	-7.9	192.1	7.9	0	109.5	0	21.4
Feb-68	8.4	29.7	-8.4	184	8.1	0.3	139.2	0	10.7
Mar-68	19.9	55.4	72.2	200	19.9	0	100.5	56.3	35.4
Apr-68	36.4	40.4	52.2	200	36.4	0	50.3	52.2	44.9
May-68	49.4	92.7	63.8	200	49.4	0	25.1	63.8	58
Jun-68	78.2	62	-6.8	193.2	78.2	0	12.6	0	29.8
Jul-68	91.5	68.6	-20.1	173.8	90.9	0.7	6.3	0	16.8
Aug-68	78	150.4	71.1	200	78	0	0	45	36.7
Sep-68	56.1	125.5	63.2	200	56.1	0	0	63.2	52.4
Oct-68	33.9	67.3	30	200	33.9	0	0	30	41.5
Nov-68	16.2	107.7	77.6	200	16.2	0	9.3	77.6	62.4
Dec-68	9.5	73.7	17.3	200	9.5	0	55.2	17.3	38.6
Jan-69	9.5	63.5	13.5	200	9.5	0	95.1	13.5	26.2
Feb-69	10.1	39.4	12.5	200	10.1	0	111.5	12.5	19.4
Mar-69	15.9	56.1	38.5	200	15.9	0	111.9	38.5	30
Apr-69	34.2	117.3	133.1	200	34.2	0	55.9	133.1	86.8
May-69	54.5	84.1	53.4	200	54.5	0	28	53.4	71.4
Jun-69	72.6	85.6	22.7	200	72.6	0	14	22.7	49.2
Jul-69	88.7	56.1	-28.5	171.5	88.7	0	7	0	25.3

Aug-69	86.2	56.4	-25.6	149.6	82.5	3.6	0	0	14
Sep-69	51.4	15.7	-36.5	122.3	42.2	9.2	0	0	6.4
Oct-69	29.2	82	48.7	171	29.2	0	0	0	6.9
Nov-69	17.2	102.6	80.6	200	17.2	0	0	51.6	32
Dec-69	9.1	52.3	6.2	200	9.1	0	36.4	6.2	17.3
Jan-70	7.2	45.2	-7.2	192.8	7.2	0	81.6	0	8.3
Feb-70	9.1	23.1	-2	190.9	9.1	0.1	97.5	0	4.3
Mar-70	15.2	48.8	26.3	200	15.2	0	103.9	17.2	11.6
Apr-70	32.8	72.6	88.1	200	32.8	0	51.9	88.1	53
May-70	59.4	70.9	33.9	200	59.4	0	26	33.9	45.2
Jun-70	79.2	53.6	-15.3	184.7	79.2	0	13	0	23.5
Jul-70	95.6	90.7	-2.9	182	95.4	0.2	6.5	0	14.9
Aug-70	80	86.4	8.6	190.6	80	0	0	0	9.5
Sep-70	52.4	110.7	52.8	200	52.4	0	0	43.4	29.8
Oct-70	32.5	101.1	63.6	200	32.5	0	0	63.6	49
Nov-70	17.8	57.2	36.7	200	17.8	0	0	36.7	43.1
Dec-70	9.4	80.3	17.1	200	9.4	0	52.9	17.1	29.7
Jan-71	7.7	44.2	-7.7	192.3	7.7	0	97.1	0	14.3
Feb-71	10.4	67.3	24.8	200	10.4	0	128.4	17.1	16.6
Mar-71	14.9	36.8	24.4	200	14.9	0	125.3	24.4	20.7
Apr-71	28.6	25.9	56.4	200	28.6	0	64.9	56.4	39.5
May-71	54.5	31	7.4	200	54.5	0	32.5	7.4	24.4
Jun-71	85.9	81.5	7.8	200	85.9	0	16.2	7.8	19.4
Jul-71	86.6	87.1	4.3	200	86.6	0	8.1	4.3	14.2
Aug-71	75.6	97.5	25.1	200	75.6	0	0	25.1	22.3
Sep-71	57.8	21.8	-37.1	162.9	57.8	0	0	0	9.8
Oct-71	39.1	37.8	-3.2	160.3	38.5	0.6	0	0	6.3
Nov-71	16.5	45	26.5	186.8	16.5	0	0	0	4.1
Dec-71	12	106.4	56.6	200	12	0	34.8	43.5	25.7
Jan-72	9.3	56.4	7.7	200	9.3	0	73.7	7.7	15.8
Feb-72	8.8	56.1	-2.7	197.3	8.8	0	123.5	0	7.8
Mar-72	14.1	87.6	36.3	200	14.1	0	159.5	33.6	21.9
Apr-72	25.9	59.9	94	200	25.9	0	96.9	94	59.9
May-72	61.3	56.1	40.4	200	61.3	0	48.5	40.4	51.7
Jun-72	71.3	109.5	57	200	71.3	0	24.2	57	58.4
Jul-72	92.7	36.8	-45.6	154.4	92.7	0	12.1	0	28.3
Aug-72	76.6	42.7	-30	131.3	69.8	6.8	6.1	0	15.4
Sep-72	53	50.5	1	132.3	53	0	0	0	9.1
Oct-72	25.8	116.3	84.7	200	25.8	0	0	17	17.6
Nov-72	14.9	62.2	35	200	14.9	0	10	35	25.7
Dec-72	10.9	124.2	57	200	10.9	0	63.6	57	42.9
Jan-73	10.3	44.2	17.1	200	10.3	0	79.7	17.1	29.4
Feb-73	8.7	42.9	-4.9	195.1	8.7	0	118.7	0	14.4
Mar-73	23.7	98	119.9	200	23.7	0	68.6	115	69.1
Apr-73	34	76.7	73.1	200	34	0	34.3	73.1	72.7
May-73	51.9	98	58.4	200	51.9	0	17.2	58.4	68.5
Jun-73	87.5	78	-4.8	195.2	87.5	0	8.6	0	35.7

Jul-73	97.4	46	-45.1	151.2	96.3	1.1	0	0	18.2
Aug-73	92.2	115.8	17.8	168.9	92.2	0	0	0	13.7
Sep-73	51.7	50	-4.2	165.4	51.1	0.7	0	0	6.5
Oct-73	34.1	95.3	56.4	200	34.1	0	0	21.8	17.7
Nov-73	17.1	89.2	68	200	17.1	0	0	68	44.5
Dec-73	10.3	75.7	25	200	10.3	0	39	25	34.1
Jan-74	9.8	102.1	28.6	200	9.8	0	101.4	28.6	31.9
Feb-74	8.5	69.6	-7.3	192.7	8.5	0	169.8	0	15.3
Mar-74	17.4	60.5	67.2	200	17.4	0	144.1	59.9	39.2
Apr-74	35.1	104.1	135.8	200	35.1	0	72.1	135.8	91.9
May-74	49.7	106.2	87.3	200	49.7	0	36	87.3	92.3
Jun-74	79.2	64.8	0.4	200	79.2	0	18	0.4	46.9
Jul-74	96.2	33.5	-55.4	144.6	96.2	0	9	0	23.5
Aug-74	84	96.5	16.6	161.3	84	0	0	0	15.7
Sep-74	47.7	51.1	0.8	162.1	47.7	0	0	0	8
Oct-74	28.3	36.6	6.5	168.6	28.3	0	0	0	4.6
Nov-74	17.4	100.1	78.1	200	17.4	0	0	46.6	29.4
Dec-74	12.2	41.7	15.5	200	12.2	0	12.8	15.5	21.3
Jan-75	11	52.6	16.8	200	11	0	36.5	16.8	19.5
Feb-75	10.9	90.7	31	200	10.9	0	84	31	26.1
Mar-75	15.5	66.3	35.1	200	15.5	0	98.3	35.1	31.2
Apr-75	25.3	57.9	64.4	200	25.3	0	64.2	64.4	49.5
May-75	71.6	59.4	16.9	200	71.6	0	32.1	16.9	35
Jun-75	86.9	66.5	-7.7	192.3	86.9	0	16	0	19.3
Jul-75	99.2	85.1	-10.4	182.3	98.8	0.4	8	0	12.3
Aug-75	81.5	117.9	38.5	200	81.5	0	0	20.9	20.3
Sep-75	45.1	65	16.6	200	45.1	0	0	16.6	18.8
Oct-75	32.5	28.4	-5.5	194.5	32.5	0	0	0	9.2
Nov-75	21.3	52.6	28.7	200	21.3	0	0	23.2	18.1
Dec-75	9.5	83.3	19.4	200	9.5	0	53.3	19.4	18.5
Jan-76	7.6	88.4	-7.6	192.4	7.6	0	141.7	0	8.7
Feb-76	12	91.2	66.7	200	12	0	152.3	59	35.8
Mar-76	19.3	106.4	111.1	200	19.3	0	124.8	111.1	76
Apr-76	35.8	72.6	95.6	200	35.8	0	62.4	95.6	87.7
May-76	52.2	85.3	60	200	52.2	0	31.2	60	76.3
Jun-76	89.1	76.5	-0.8	199.2	89.1	0	15.6	0	39.8
Jul-76	89.9	112.8	25.1	200	89.9	0	7.8	24.3	35.8
Aug-76	85.1	110.5	27.7	200	85.1	0	0	27.7	34.4
Sep-76	48.9	116.8	62.1	200	48.9	0	0	62.1	51.3
Oct-76	25	74.4	45.7	200	25	0	0	45.7	49.3
Nov-76	13.5	35.8	12.1	200	13.5	0	9	12.1	30
Dec-76	8.2	41.7	-2.9	197.1	8.2	0	45.3	0	14.6
Jan-77	6.7	72.7	-6.7	190.5	6.6	0.1	118	0	7.2
Feb-77	9.7	33.3	8.3	198.8	9.7	0	133	0	3.9
Mar-77	21.3	85.2	102.1	200	21.3	0	91.3	101	55.7
Apr-77	36.2	40.7	48.1	200	36.2	0	45.7	48.1	52.2
May-77	65.6	23.7	-20.3	179.7	65.6	0	22.8	0	26.3

Jun-77	74.4	73	6.3	186	74.4	0	11.4	0	16.2
Jul-77	99.8	90.3	-8.3	178.3	99.3	0.6	5.7	0	10.8
Aug-77	76.1	164	85.4	200	76.1	0	0	63.7	43.2
Sep-77	51.1	142.9	84.7	200	51.1	0	0	84.7	67
Oct-77	28.5	86.8	54	200	28.5	0	0	54	61.2
Nov-77	17.6	85.9	64.3	200	17.6	0	0	64.3	64.6
Dec-77	9.7	114.6	34.1	200	9.7	0	69.1	34.1	49
Jan-78	8	82.5	-8	192	8	0	151.6	0	23.7
Feb-78	7.5	17.2	-7.5	184.8	7.2	0.3	168.8	0	11.8
Mar-78	14.7	50	35.5	200	14.7	0	167.7	20.4	16.9
Apr-78	27.9	61.6	107.7	200	27.9	0	90.9	107.7	64.8
May-78	60.2	100.2	80.4	200	60.2	0	45.4	80.4	76.2
Jun-78	79.7	64.8	4.6	200	79.7	0	22.7	4.6	41.1
Jul-78	94.4	23.8	-60.5	139.5	94.4	0	11.4	0	20.1
Aug-78	82.5	153.8	69.3	200	82.5	0	5.7	8.8	21.6
Sep-78	49.2	152.2	101.1	200	49.2	0	0	101.1	65.1
Oct-78	29	45.2	13.9	200	29	0	0	13.9	38
Nov-78	16.5	63.1	43.8	200	16.5	0	0	43.8	42.5
Dec-78	10.7	72.8	26.7	200	10.7	0	33.9	26.7	34.7
Jan-79	8.3	67.2	-3.2	196.8	8.3	0	95.8	0	16.8
Feb-79	7	29.2	-7	189.9	6.9	0.1	125	0	8.3
Mar-79	20.5	83.4	92.9	200	20.5	0	91.9	82.8	48.6
Apr-79	29.7	114.2	124.7	200	29.7	0	45.9	124.7	90.8
May-79	55.2	87.4	50.8	200	55.2	0	23	50.8	72.3
Jun-79	80.7	78.4	5.3	200	80.7	0	11.5	5.3	40.5
Jul-79	93.8	25	-64.3	135.7	93.8	0	5.7	0	19.6
Aug-79	74.7	89.2	15.8	151.4	74.7	0	0	0	13.6
Sep-79	50.8	37.4	-15.2	139.9	47.1	3.7	0	0	6.4
Oct-79	28.8	112.2	77.7	200	28.8	0	0	17.6	16.7
Nov-79	17.2	110.4	88	200	17.2	0	0	88	54.7
Dec-79	11.8	91.2	45.2	200	11.8	0	31.8	45.2	49.8
Jan-80	9.7	47.4	8.2	200	9.7	0	60.8	8.2	28.3
Feb-80	8.6	19.3	-7.3	192.7	8.6	0	78.8	0	13.9
Mar-80	16.3	64	38.3	200	16.3	0	86.6	31.1	24
Apr-80	32.4	111.7	117	200	32.4	0	43.3	117	75.3
May-80	62.5	34.2	-8.3	191.7	62.5	0	21.7	0	36.6
Jun-80	69.1	102	38.6	200	69.1	0	10.8	30.3	37.7
Jul-80	95	156.2	58.8	200	95	0	5.4	58.8	53.5
Aug-80	87.2	46	-38.1	161.9	87.2	0	0	0	25.1
Sep-80	48.9	86	32.8	194.7	48.9	0	0	0	15.7
Oct-80	25.3	66	37.4	200	25.3	0	0	32	25
Nov-80	15.2	50.8	26.6	200	15.2	0	7	26.6	26.1
Dec-80	8.4	59.4	1.9	200	8.4	0	55.7	1.9	13.4
Jan-81	7.2	13	-7.2	192.8	7.2	0	68.7	0	6.5
Feb-81	12.6	53.7	35.8	200	12.6	0	72.7	28.6	18.9
Mar-81	18.5	31.2	25.9	200	18.5	0	58.5	25.9	22.7
Apr-81	34.7	43.6	36	200	34.7	0	29.3	36	31

May-81	53.5	60	18.1	200	53.5	0	14.6	18.1	26.5
Jun-81	82.2	101.8	21.8	200	82.2	0	7.3	21.8	27.8
Jul-81	95.6	115.4	21.3	200	95.6	0	0	21.3	27.8
Aug-81	78	136	51.2	200	78	0	0	51.2	43.4
Sep-81	48.9	88.8	35.5	200	48.9	0	0	35.5	40.5
Oct-81	26	91.6	61.1	200	26	0	0	61.1	53.1
Nov-81	16.9	61.8	42.1	200	16.9	0	0	42.1	48.1
Dec-81	10.8	44.6	12.5	200	10.8	0	20.4	12.5	29.8
Jan-82	7.1	63.2	-7.1	192.9	7.1	0	83.6	0	14.4
Feb-82	9.1	21	-2.6	190.3	9	0.1	98.1	0	7.3
Mar-82	16.4	70.2	47.1	200	16.4	0	103	37.5	24
Apr-82	29.2	56	75	200	29.2	0	52.1	75	51.4
May-82	69	60.6	14.6	200	69	0	26.1	14.6	34.7
Jun-82	70.4	132.6	68.6	200	70.4	0	13	68.6	56.8
Jul-82	96.2	83.8	-10.1	189.9	96.2	0	6.5	0	29.3
Aug-82	69.8	132.6	62.7	200	69.8	0	0	52.6	45.5
Sep-82	49.5	110.8	55.7	200	49.5	0	0	55.7	52.8
Oct-82	31.3	41.2	7.9	200	31.3	0	0	7.9	29.6
Nov-82	17.7	134.4	110.3	200	17.7	0	0	110.3	75.4
Dec-82	13.3	102.2	63.5	200	13.3	0	21.9	63.5	69.7
Jan-83	10.2	37.6	7.4	200	10.2	0	41.3	7.4	37.4
Feb-83	11.8	32.2	13.3	200	11.8	0	47.8	13.3	25.7
Mar-83	19.4	66	46.4	200	19.4	0	45.7	46.4	37.9
Apr-83	30.4	96.2	83.8	200	30.4	0	22.9	83.8	64.6
May-83	48.7	126.4	82.8	200	48.7	0	11.4	82.8	77.6
Jun-83	82.2	35	-43.2	156.8	82.2	0	5.7	0	37.4
Jul-83	104.3	75.4	-26.9	135.7	98.4	5.8	0	0	21.6
Aug-83	88.3	81.2	-11.2	128.1	84.7	3.6	0	0	13
Sep-83	56.4	43.4	-15.2	118.4	50.9	5.5	0	0	6.6
Oct-83	30.3	82	47.6	165.9	30.3	0	0	0	6.3
Nov-83	16.9	77	56.6	200	16.9	0	0	22.5	15.9
Dec-83	8.9	96.1	15.6	200	8.9	0	70.7	15.6	14.9
Jan-84	7.9	41.5	-7.9	192.1	7.9	0	112.2	0	7
Feb-84	13.3	74	66.1	200	13.3	0	104.7	58.3	34.7
Mar-84	14	75.8	28.2	200	14	0	137.2	28.2	31.5
Apr-84	34.7	50.2	81.6	200	34.7	0	68.6	81.6	58.5
May-84	55.2	82.2	57.2	200	55.2	0	34.3	57.2	60.7
Jun-84	84.3	54.6	-15.2	184.8	84.3	0	17.2	0	31
Jul-84	92.1	49.4	-36.6	150.9	89.3	2.8	8.6	0	16.6
Aug-84	88.9	73.8	-10.2	143.3	86.4	2.5	0	0	10.8
Sep-84	46.3	86.7	36.1	179.4	46.3	0	0	0	7.9
Oct-84	32.9	49.6	14.3	193.6	32.9	0	0	0	4.2
Nov-84	16.5	78.4	52.8	200	16.5	0	5.7	46.4	27.5
Dec-84	12.7	97.7	57.8	200	12.7	0	29.8	57.8	44
Jan-85	8.2	63.3	-5.8	194.2	8.2	0	90.7	0	20.6
Feb-85	9.9	108.9	27.8	200	9.9	0	160.8	22	22.3
Mar-85	18.4	95.7	97.4	200	18.4	0	137.9	97.4	62.2

Apr-85	37.4	43.3	72.7	200	37.4	0	68.9	72.7	68.2
May-85	60.6	91.6	60.9	200	60.6	0	34.5	60.9	68.1
Jun-85	72.2	26.6	-29.7	170.3	72.2	0	17.2	0	33.1
Jul-85	92.7	59.6	-27.4	147	88.6	4.1	8.6	0	18.8
Aug-85	78.5	148.7	71.4	200	78.5	0	0	18.3	24.5
Sep-85	56.8	118.9	56.2	200	56.8	0	0	56.2	42.6
Oct-85	30.7	62.4	28.6	200	30.7	0	0	28.6	35.7
Nov-85	16.4	114.6	84.4	200	16.4	0	8.8	84.4	63.5
Dec-85	9.4	58.8	11.6	200	9.4	0	45.9	11.6	35.8
Jan-86	9.5	30.8	3.6	200	9.5	0	63.3	3.6	19.6
Feb-86	9.4	64.3	6.1	200	9.4	0	111.7	6.1	13.1
Mar-86	19.8	59.3	64.9	200	19.8	0	84.3	64.9	40.9
Apr-86	37.1	63.1	64.9	200	37.1	0	42.1	64.9	55
May-86	66.5	72.1	23.1	200	66.5	0	21.1	23.1	41.1
Jun-86	74.9	106.9	37.2	200	74.9	0	10.5	37.2	42.7
Jul-86	101.1	122	20.1	200.0 1	1.1	0	5.3	20.1	34.8
Aug-86	75.2	145.6	68.4	200	75.2	0	0	68.4	55.8
Sep-86	50.8	218.9	157.2	200	50.8	0	0	157.2	113.8
Oct-86	29.8	64.4	31.4	200	29.8	0	0	31.4	70.4
Nov-86	15.1	33.4	17	200	15.1	0	0	17	43.3
Dec-86	11.6	53.8	21.2	200	11.6	0	19.6	21.2	33
Jan-87	9.9	70.4	16.4	200	9.9	0	62.8	16.4	24.9
Feb-87	10	20	2.3	200	10	0	70.3	2.3	13.3
Mar-87	20.5	68.7	60.7	200	20.5	0	55.2	60.7	39.5
Apr-87	39	85	69.3	200	39	0	27.6	69.3	57.4
May-87	66.1	33.6	-20.3	179.7	66.1	0	13.8	0	28.2
Jun-87	88	62	-22.2	159.7	85.8	2.3	6.9	0	16.4
Jul-87	109.6	95.1	-12.3	149.9 1	7.1	2.5	0	0	11.4
Aug-87	81.5	91.6	5.5	155.4	81.5	0	0	0	7.9
Sep-87	53.3	68.5	11.7	167.1	53.3	0	0	0	5.1
Oct-87	26.6	79.5	48.9	200	26.6	0	0	16	12.8
Nov-87	16.8	93.2	72.2	200	16.8	0	0	72.2	44.7
Dec-87	12.2	44.9	17.6	200	12.2	0	13.7	17.6	30.4
Jan-88	9.5	52.8	6.8	200	9.5	0	49.6	6.8	18.5
Feb-88	9.2	91.4	7.9	200	9.2	0	123.3	7.9	13.5
Mar-88	17.7	32.2	38.3	200	17.7	0	98.6	38.3	26.5
Apr-88	32.4	58.9	72.9	200	32.4	0	49.3	72.9	52.2
May-88	64.8	52.4	9.6	200	64.8	0	24.7	9.6	32
Jun-88	80.7	48.2	-22.6	177.4	80.7	0	12.3	0	17.1
Jul-88	108.9	61.2	-44.6	137.9 1	3.9	5	6.2	0	10.4
Aug-88	90	73	-14.5	127.9	85.5	4.5	0	0	7.3
Sep-88	50.8	106.1	50	177.9	50.8	0	0	0	7.1
Oct-88	25.6	93.5	63.2	200	25.6	0	0	41.1	26.2
Nov-88	18.2	101.9	78.6	200	18.2	0	0	78.6	55.1
Dec-88	10.5	37	7.4	200	10.5	0	18.4	7.4	29.4
Jan-89	11.6	49	19.2	200	11.6	0	35.6	19.2	25.1
Feb-89	9.1	39.6	-2.4	197.6	9.1	0	68.4	0	12.2

Mar-89	15.8	58	29.5	200	15.8	0	79.8	27.1	20.8
Apr-89	29.7	47.5	55.3	200	29.7	0	39.9	55.3	39.8
May-89	57.6	106.2	63.2	200	57.6	0	19.9	63.2	55.6
Jun-89	84.8	132	50.6	200	84.8	0	10	50.6	57
Jul-89	99.2	26.2	-64.4	135.6	99.2	0	0	0	26.5
Aug-89	80	100.6	15.6	151.2	80	0	0	0	17.6
Sep-89	51.1	39.7	-13.4	141.1	47.8	3.3	0	0	8.3
Oct-89	30.7	75.2	40.7	181.9	30.7	0	0	0	6.9
Nov-89	15	154.6	110.6	200	15	0	23.1	92.5	53.7
Dec-89	6.8	41	-6.8	193.2	6.8	0	64.1	0	23.9
Jan-90	12.4	60.2	42.1	200	12.4	0	68.2	35.3	31.2
Feb-90	11.1	60.2	25.8	200	11.1	0	90.6	25.8	28.7
Mar-90	20	64.4	62.6	200	20	0	70	62.6	47.4
Apr-90	37.6	49.6	44.6	200	37.6	0	35	44.6	47.3
May-90	53.8	124	81.5	200	53.8	0	17.5	81.5	69.4
Jun-90	84.3	109.8	28.8	200	84.3	0	8.8	28.8	51.5
Jul-90	94.4	80.4	-9.3	190.7	94.4	0	0	0	27
Aug-90	82	88.1	1.7	192.4	82	0	0	0	15.9
Sep-90	50.8	90.9	35.6	200	50.8	0	0	28	24.3
Oct-90	29.6	134.4	98.1	200	29.6	0	0	98.1	65.7
Nov-90	18.6	83.1	60.4	200	18.6	0	0	60.4	63.8
Dec-90	12	98	51.2	200	12	0	32.1	51.2	58.1
Jan-91	9.1	48	3.8	200	9.1	0	66.8	3.8	30
Feb-91	12	63.3	35.8	200	12	0	80.9	35.8	34.1
Mar-91	20.2	106.1	92.4	200	20.2	0	70.6	92.4	66.4
Apr-91	37.6	133.6	124.6	200	37.6	0	35.3	124.6	100.3
May-91	72.9	65.6	7	200	72.9	0	17.6	7	53.6
Jun-91	91.3	44.1	-40.6	159.4	91.3	0	8.8	0	27.4
Jul-91	98.6	93	-1.4	158.2	98.3	0.3	0	0	17.2
Aug-91	87.8	76.6	-15	146.3	84.6	3.1	0	0	10.1
Sep-91	48.3	51.1	0.2	146.6	48.3	0	0	0	5.7
Oct-91	32.9	100.2	62.3	200	32.9	0	0	8.9	11
Nov-91	15.6	59.6	34.6	200	15.6	0	7	34.6	22.7
Dec-91	10.9	64	25	200	10.9	0	33.7	25	24
Jan-92	10.3	42.5	11.8	200	10.3	0	53.3	11.8	17.9
Feb-92	11.1	46.2	17.4	200	11.1	0	70.3	17.4	18.1
Mar-92	16.7	52.6	32.1	200	16.7	0	72.8	32.1	26
Apr-92	30.6	107.2	107.6	200	30.6	0	36.4	107.6	71.5
May-92	56.6	85.6	42.9	200	56.6	0	18.2	42.9	58.8
Jun-92	71.3	55.4	-9.6	190.4	71.3	0	9.1	0	30
Jul-92	79.9	126.6	49.5	200	79.9	0	0	39.9	39.9
Aug-92	70.7	173.8	94.5	200	70.7	0	0	94.5	72.7
Sep-92	49.8	91.4	37	200	49.8	0	0	37	55.1
Oct-92	26.5	48.6	19.7	200	26.5	0	0	19.7	37.5
Nov-92	15.9	167.2	127.4	200	15.9	0	17	127.4	88.2
Dec-92	11.6	70.6	35.8	200	11.6	0	38.3	35.8	60.3
Jan-93	10.3	85.9	29.1	200	10.3	0	83.6	29.1	45.1

Feb-93	7.9	34	-7.9	192.1	7.9	0	117.6	0	21.9
Mar-93	15.7	33.2	26.3	200	15.7	0	108	18.4	20.9
Apr-93	33	75.6	92.8	200	33	0	54	92.8	60.3
May-93	55.2	61.6	30.3	200	55.2	0	27	30.3	46.5
Jun-93	76.3	111.4	43	200	76.3	0	13.5	43	48.8
Jul-93	98.6	80.4	-15.5	184.5	98.6	0	6.7	0	25.6
Aug-93	86.2	54.4	-27.7	158.9	84	2.1	0	0	13.5
Sep-93	44	68.8	21.3	180.3	44	0	0	0	8.8
Oct-93	27.8	72.3	40.9	200	27.8	0	0	21.2	16.9
Nov-93	15.9	63.4	38.4	200	15.9	0	6.4	38.4	28.5
Dec-93	10.8	20	1	200	10.8	0	14.2	1	13.8
Jan-94	6.2	69	-6.2	193.8	6.2	0	83.2	0	6.7
Feb-94	8.1	18	-8.1	185.9	7.9	0.3	101.2	0	3.4
Mar-94	17.2	35.4	31.6	200	17.2	0	86.9	17.5	11.4
Apr-94	34.5	87.4	92	200	34.5	0	43.5	92	55.6
May-94	52.5	107.6	71.4	200	52.5	0	21.7	71.4	66.7
Jun-94	85.3	49.4	-27.5	172.5	85.3	0	10.9	0	33.1
Jul-94	98	54.7	-40.6	137.5	92.4	5.6	5.4	0	18.1
Aug-94	74.2	50	-21.3	122.8	67.6	6.7	0	0	10.2
Sep-94	50.4	63	9.4	132.2	50.4	0	0	0	7
Oct-94	30.9	59.5	25.6	157.9	30.9	0	0	0	4.9
Nov-94	18.9	71	48.5	200	18.9	0	0	6.4	7.7
Dec-94	12.5	38.4	13.8	200	12.5	0	11	13.8	10.1
Jan-95	11.2	116.9	50.2	200	11.2	0	64.1	50.2	32
Feb-95	8.7	24.2	-6.2	193.8	8.7	0	85.7	0	14.8
Mar-95	20.4	3.4	13.9	200	20.4	0	54.7	7.7	11.4
Apr-95	27.4	93.2	82.4	200	27.4	0	33.8	82.4	51.1
May-95	56.9	76.2	32.4	200	56.9	0	16.9	32.4	43.4
Jun-95	90.2	79.8	-6	194	90.2	0	8.4	0	23.8
Jul-95	101.1	65.9	-30	164.9	1	0.2	0	0	13.2
Aug-95	91.1	62.2	-32	138.5	85.5	5.6	0	0	8.1
Sep-95	46.5	45.4	-3.4	136.1	45.5	1	0	0	4.7
Oct-95	33.3	146.3	105.7	200	33.3	0	0	41.9	29.5
Nov-95	13.8	142.2	90.7	200	13.8	0	33.1	90.7	61.1
Dec-95	9.1	34	4.4	200	9.1	0	53.2	4.4	30.8
Jan-96	8.6	66.8	2.2	200	8.6	0	108.8	2.2	16.6
Feb-96	9.8	43.8	10.8	200	9.8	0	131.6	10.8	13.9
Mar-96	15.5	62.8	43	200	15.5	0	134.7	43	29.5
Apr-96	28.1	97.8	126.2	200	28.1	0	73.6	126.2	81.8
May-96	53.2	93	72	200	53.2	0	36.8	72	79.2
Jun-96	85.9	149.2	74.3	200	85.9	0	18.4	74.3	81.9
Jul-96	88.7	112.4	27.2	200	88.7	0	9.2	27.2	56.5
Aug-96	83.5	52	-24.9	175.1	83.5	0	0	0	28
Sep-96	51.7	155.1	95.6	200	51.7	0	0	70.7	55.8
Oct-96	29.9	65.2	32	200	29.9	0	0	32	43.3
Nov-96	14.2	40.6	16.8	200	14.2	0	8.2	16.8	29.8
Dec-96	12.5	107.7	64.4	200	12.5	0	35.7	64.4	49.6

Jan-97	8.9	87.5	7.9	200	8.9	0	105.9	7.9	27.7
Feb-97	11.5	77.6	45.2	200	11.5	0	125.3	45.2	37.7
Mar-97	16.7	84	64.5	200	16.7	0	126.1	64.5	52.4
Apr-97	30.8	29.6	60.3	200	30.8	0	63	60.3	56.8
May-97	45.5	90.8	72.2	200	45.5	0	31.5	72.2	68.3
Jun-97	91.9	79.7	-0.4	199.6	91.9	0	15.8	0	35.9
Jul-97	92.7	58.3	-29.4	170.2	92.6	0.1	7.9	0	18.9
Aug-97	73.3	72.5	3.4	173.6	73.3	0	0	0	11.6
Sep-97	51.7	63.7	8.8	182.4	51.7	0	0	0	7.2
Oct-97	29.6	50.6	18.5	200	29.6	0	0	0.9	5
Nov-97	15.4	70.6	43.4	200	15.4	0	9	43.4	25.7
Dec-97	11.9	30.6	10	200	11.9	0	16.8	10	17.3
Jan-98	11.3	129.2	58.6	200	11.3	0	73.4	58.6	40.2
Feb-98	13.6	40.8	35.1	200	13.6	0	64.4	35.1	37.5
Mar-98	20	117.8	94.9	200	20	0	63	94.9	69.8
Apr-98	36	39.2	32.8	200	36	0	31.5	32.8	51.1
May-98	74.8	56.7	-5.2	194.8	74.8	0	15.8	0	27.4
Jun-98	83.8	57	-21.7	173.7	83.2	0.6	7.9	0	15.1
Jul-98	95	47.8	-41.7	137.5	89.5	5.5	0	0	8.5
Aug-98	85.1	96.4	6.5	143.9	85.1	0	0	0	7.9
Sep-98	55	44	-13.2	134.4	51.3	3.7	0	0	3.7
Oct-98	31.1	13.6	-18.2	122.2	25.1	6	0	0	1.4
Nov-98	17.6	45.2	25.5	147.7	17.6	0	0	0	2.5
Dec-98	12.3	51	22	169.7	12.3	0	15.3	0	1.7
Jan-99	8.6	125.5	8	177.6	8.6	0	123.6	0	0.7
Feb-99	13.4	40.6	48.2	200	13.4	0	101.5	25.8	14.1
Mar-99	19.2	15.5	25.9	200	19.2	0	71.4	25.9	19.9
Apr-99	33.2	48.2	48.3	200	33.2	0	35.7	48.3	36.3
May-99	73.9	85	24.7	200	73.9	0	17.9	24.7	33.5
Jun-99	89.1	68.7	-14.9	185.1	89.1	0	8.9	0	18.1
Jul-99	113	63.4	-43.9	144.5	9.7	3.3	0	0	10.5
Aug-99	77.1	70.7	-9.9	137.3	74.3	2.7	0	0	7.2
Sep-99	55.4	71.6	12.7	150	55.4	0	0	0	5.4
Oct-99	29.9	64.1	31	181	29.9	0	0	0	4.1
Nov-99	19.2	102.4	78.1	200	19.2	0	0	59.1	35.1
Dec-99	11.9	55	23.2	200	11.9	0	18.4	23.2	28.1
Jan-00	9.6	46.1	5.9	200	9.6	0	48.5	5.9	16.7
Feb-00	12.1	55.7	29	200	12.1	0	61.9	29	23.8
Mar-00	23.7	40.6	41.6	200	23.7	0	35.3	41.6	34
Apr-00	32	67	49.3	200	32	0	17.7	49.3	44.1
May-00	62.5	164.9	103	200	62.5	0	8.8	103	80.1
Jun-00	83.8	219	133.1	200	83.8	0	0	133.1	113.4
Jul-00	87.1	91.2	-0.5	199.5	87.1	0	0	0	55.8
Aug-00	78.5	68.4	-13.5	186	78.5	0	0	0	29
Sep-00	51.7	110.6	53.4	200	51.7	0	0	39.4	38
Oct-00	33.7	29.6	-5.6	194.4	33.7	0	0	0	17.7
Nov-00	16.4	65.4	46.2	200	16.4	0	0	40.6	31.3

Dec-00	8.2	74.7	0.5	200	8.2	0	65.7	0.5	14.8
Jan-01	10.4	11.5	4.7	200	10.4	0	61.9	4.7	9.7
Feb-01	10.9	70.5	27.6	200	10.9	0	92.8	27.6	19.7
Mar-01	17.4	30.5	27.2	200	17.4	0	77.9	27.2	23.7
Apr-01	35.5	41	42.3	200	35.5	0	38.9	42.3	34.7
May-01	63.2	79.2	31.5	200	63.2	0	19.5	31.5	36
Jun-01	84.3	94.4	15.1	200	84.3	0	9.7	15.1	28.3
Jul-01	89.9	73.6	-10.2	189.8	89.9	0	0	0	15.5
Aug-01	91.7	48.6	-45.5	146.6	89.4	2.3	0	0	8.3
Sep-01	51.7	84.4	28.5	175.1	51.7	0	0	0	7.2
Oct-01	31.1	150.3	111.7	200	31.1	0	0	86.8	52.4
Nov-01	21.2	85.6	60.2	200	21.2	0	0	60.2	56.8
Dec-01	13.8	37	15.1	200	13.8	0	6.8	15.1	35.1
Jan-02	12.5	31.5	9.4	200	12.5	0	15.5	9.4	22.5
Feb-02	12.4	45.8	17.5	200	12.4	0	30.2	17.5	20.7
Mar-02	18.8	54.1	29.9	200	18.8	0	33.8	29.9	26.5
Apr-02	34.7	112.5	89.1	200	34.7	0	16.9	89.1	62.6
May-02	49.7	111.4	64.6	200	49.7	0	8.5	64.6	66.4
Jun-02	85.3	74.8	-5.8	194.2	85.3	0	0	0	34.1
Jul-02	110.3	66.6	-47	148.6 1	8.9	1.4	0	0	18.5
Aug-02	87.2	35	-54	108.5	73.4	13.9	0	0	9.3
Sep-02	62.7	52.5	-12.8	101.5	56.8	5.9	0	0	6.4
Oct-02	27.8	78	46.3	147.8	27.8	0	0	0	5.8
Nov-02	15.7	56	31.8	179.6	15.7	0	6.3	0	3.2
Dec-02	11.1	33.5	9	188.6	11.1	0	18.8	0	1.2
Jan-03	8	29	-8	181.1	7.5	0.5	47.8	0	0.2
Feb-03	8.5	50.5	-7.1	174.7	7.9	0.7	96.8	0	0.2
Mar-03	17.9	38.6	36	200	17.9	0	80.3	10.7	6.5
Apr-03	30.4	33.6	41.6	200	30.4	0	40.2	41.6	25.2
May-03	54.8	95.6	56.1	200	54.8	0	20.1	56.1	44.6
Jun-03	82.7	77.3	0.8	200	82.7	0	10	0.8	24.1
Jul-03	96.2	38.8	-54.3	145.7	96.2	0	5	0	12.1
Aug-03	87.8	99.9	12.1	157.8	87.8	0	0	0	10.1
Sep-03	52.7	107.8	49.7	200	52.7	0	0	7.6	11.7
Oct-03	28.3	95.6	62.5	200	28.3	0	0	62.5	39.2
Nov-03	18.2	116.4	92.4	200	18.2	0	0	92.4	69.2
Dec-03	12.2	80.6	40.9	200	12.2	0	25.2	40.9	54.4
Jan-04	7.4	72.7	-7.4	192.6	7.4	0	97.9	0	26.1
Feb-04	10.8	20	11.8	200	10.8	0	95.1	4.3	15.5
Mar-04	20.3	110	101.5	200	20.3	0	79.3	101.5	62.3
Apr-04	32.8	71.8	75.1	200	32.8	0	39.7	75.1	70.3
May-04	57.6	117	73.4	200	57.6	0	19.8	73.4	75.9
Jun-04	77.7	57.5	-13.2	186.8	77.7	0	9.9	0	37.9
Jul-04	92.1	116.7	28.7	200	92.1	0	0	15.5	31.1
Aug-04	72.9	60.8	-15.1	184.9	72.9	0	0	0	15.7
Sep-04	57.1	39.7	-19.4	167	55.6	1.5	0	0	8.3
Oct-04	30.9	58.4	24.6	191.6	30.9	0	0	0	6.1

Nov-04	17.9	73.9	52.4	200	17.9	0	0	44	27.1
Dec-04	10	103.7	33.2	200	10	0	58.8	33.2	30.1
Jan-05	8.5	64	0.5	200	8.5	0	113.6	0.5	14.7
Feb-05	10.7	78.5	34.9	200	10.7	0	145.4	34.9	25.8
Mar-05	16.3	56.5	49.6	200	16.3	0	134.7	49.6	38.5
Apr-05	33.4	97.1	126.2	200	33.4	0	67.3	126.2	86.5
May-05	50.3	47.2	28.2	200	50.3	0	33.7	28.2	57.3
Jun-05	103.4	32.3	-55.9	144.1 1	3.4	0	16.8	0	29.1
Jul-05	106.9	141.7	36.1	180.3 1	6.9	0	8.4	0	20.8
Aug-05	88.3	148.3	61	200	88.3	0	0	41.2	34.9
Sep-05	58.5	76.6	14.2	200	58.5	0	0	14.2	24.7
Oct-05	32.7	51	15.8	200	32.7	0	0	15.8	20.9
Nov-05	18.2	122.9	98.6	200	18.2	0	0	98.6	64.5
Dec-05	10.2	97.3	32.8	200	10.2	0	52.6	32.8	47.3
Jan-06	13	109.9	77	200	13	0	69.3	77	64.5
Feb-06	10.5	141	47.6	200	10.5	0	150.4	47.6	56.3
Mar-06	19.1	62.9	76.3	200	19.1	0	115.9	76.3	67.4
Apr-06	35.3	95.1	113	200	35.3	0	57.9	113	93.9
May-06	61.3	106.1	68.4	200	61.3	0	29	68.4	84.1
Jun-06	86.4	53.9	-20.7	179.3	86.4	0	14.5	0	42.1
Jul-06	108.2	100.4	-5.6	174.3 1	7.6	0.6	7.2	0	24.7
Aug-06	83.5	52.6	-26.3	151.3	80.1	3.4	0	0	12.5
Sep-06	49.2	163.3	105.9	200	49.2	0	0	57.3	41.7
Oct-06	28.8	122.2	87.2	200	28.8	0	0	87.2	66.5
Nov-06	19.3	50.8	29	200	19.3	0	0	29	47.2
Dec-06	14.5	59.6	34.6	200	14.5	0	8.2	34.6	42
	506	901	358	2295	482	4	425	361	395