PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

74 Berkeley Street, Toronto, ON M5A 2W7
Tel: 647-795-8153 | www.pecg.ca

Hydrogeological Assessment to Support Townhome Development at 231, 235, 237, 241, 245 and 249 Durham Road No. 8 (formerly Reach Street), Uxbridge, ON

PECG Project #
170521

Prepared For
2452595 Ontario Ltd.

March 18, 2019

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

74 Berkeley Street, Toronto, ON M5A 2W7
Tel: 647-795-8153 | www.pecg.ca

March 18, 2019

2452595 Ontario Ltd.
220 Duncan Mill Rd. Ste 401
Toronto, ON
M3B 3J5

Dear Mr. Bonakdar,

Re: Hydrogeological Assessment to Support Townhome Development at 231, 235, 237, 241, 245 and 249 Durham Road No. 8 (formerly Reach Street), Uxbridge, ON
Project #: 170521

Palmer Environmental Consulting Group Inc. (PECG) is pleased to submit the attached report describing the results of PECG's Hydrogeological Assessment and Water Balance Analysis to support the proposed townhome development at 231, 235, 237, 241, 245 and 249 Durham Road No. 8 (formerly Reach Street), in Uxbridge, Ontario.

This report provides the results of the hydrogeological investigation, including lithology and groundwater conditions, infiltration rate measurements, phosphorous budgeting, and the pre-and-post development water budget results in support of development approvals and preliminary design of the site.

Through integration between PECG's hydrogeology program and the stormwater management design completed by engineers at Sabourin Kimble & Associates Inc. (SKA), infiltration rates have not only been balanced from pre-to-post development, but increased by 98% using an innovative LID treatment train approach. This increased infiltration will help support groundwater recharge to the Oak Ridges Moraine Aquifer and support nearby groundwater supported features such as Uxbridge Brook. In addition, the LID features were calculated to decrease phosphorus loading from the site by 33%, exceeding the targets of the Lake Simcoe Protection Plan, and providing a benefit from site development.

We trust that this information meets your current needs. If you have any questions or require further information, please do not hesitate to contact us.

Yours truly,
Palmer Environmental Consulting Group Inc.

Bobby Katanchi, M.Sc., P.Geo
Senior Hydrogeologist

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Table of Contents

List of Figures

List of Tables

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

List of Appendices

1. Introduction and Background

Palmer Environmental Consulting Group Inc. (PECG) was retained by 2452595 Ontario Ltd. to complete a hydrogeological assessment to support townhome development at 231, 235, 237, 241, 245 and 249 Durham Road No. 8 (formerly Reach Street), in Uxbridge, ON (hereby known as the "site" or "study area"). The property is approximately 3.62 ha in size, and presently consists of single family rural residential homes and two woodlot areas (**Figure 1**).

The existing ground surface elevation ranges from approximately 279 meters above sea level (masl) on the north-western portion of the site to approximately 288 masl on the south-eastern portion of the site, near the top of the bank. Based on the Site Plan by Hunt Design Associates Inc. (Hunt, 2019), the proposed land development includes 62 townhome units consisting of a mix of bungalow, street and rear lane townhouses divided within 11 "Blocks", and one roadway. It is our understanding that the proposed units will be built with one (1) level of basement (**Appendix A**).

1.1 Scope of Work

PECG's scope of work for the hydrogeological assessment includes the following tasks:

- Characterize the hydrogeological conditions of the site, including groundwater elevation and groundwater flow;
- Measure the hydraulic conductivity of the soils using single well response tests (i.e., slug tests) completed at select monitoring well locations;
- Assess groundwater quality;
- Complete percolation tests to determine the infiltration rate of the native soils at the site, and assess the suitability for the proposed Low Impact Development (LID) strategies;
- Conduct regular groundwater level monitoring from monitoring wells and private residential wells;
- Complete a pre- and post-development phosphorous budget to satisfy the requirements of the Lake Simcoe Protection Plan (LSPP);
- Complete a pre- and post-development water budget analysis to assess changes to infiltration and runoff;
- Assess the site's location in relation to Wellhead Protection Areas (WHPAs) and conformance with the South Georgian Bay Lake Simcoe Source Protection Plan; and,
- Prepare a Hydrogeological Assessment Report.

Information from the following sources were reviewed as part of the study:

- Sirati & Partners Consultants Ltd, 2018. Preliminary Geotechnical Report, Proposed New Development 241 Durham Road No. 8 (Formerly Reach Street), Uxbridge, ON;
- Available geology, hydrogeology, and physiography mapping (e.g., Ontario Geological Survey (OGS) Surficial Geology Mapping);
- Ontario Ministry of Municipal Affairs and Housing (OMMAH) Supplementary Guidelines to the Ontario Building Code 1997. SG-6 Percolation Time and Soil Descriptions;
- Ministry of the Environment Conservation and Parks (MECP) Water Well Records database;
- MECP Phosphorus Budget Tool;
- MECP Source Protection Information Atlas; and,
- The South Georgian Bay Lake Simcoe Source Water Protection Plan.

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

CLIENT: 2452595 Ont Ltd (Morris Bonakdar)
PROJECT: 241 Durham Road No. 8

0 10 20 30 40 50
metres

N

DRAWN: B. Elder
CHECKED: N. Boyes
PROJECT: 170521
DATE: Feb 25, 2019

Scale 1:2000
UTM Zone 17N
NAD 1983

Legend

- Borehole
- Monitoring Well
- Private Well (Address)
- Site Boundary

Site Locations

FIGURE 1

Document Path: C:\Egnyte\Shared\Projects\Active\17052 - Uxbridge - 2452595 Ont Ltd (Morris Bonakdar)\170521 - 241 Durham Road No. 8\Mapping\mxd\170521_Figure1_Sites.mxd

2. Existing Conditions

2.1 Regional Conditions

2.1.1 Physiography and Geology

The site is located within the Peterborough Drumlin Field physiographic region (Chapman and Putnam, 1984), and is located approximately 500 m north of the Oak Ridges Moraine physiographic region. Topography within the Peterborough Drumlin Field is characterized as a network of wide, flat-floored valleys formed by sub-glacial meltwater, with frequent drumlinized relief features. The drumlin field covers an area of approximately 5,000 km^2 and includes over 3,000 well developed drumlin ridges. These drumlin features are not present near the study area.

The surficial geology is characterized as ice-contact stratified deposits of sand, gravel, and minor silt, clay and till. Although relatively sparse in the study area, the Peterborough Drumlin Field is typically rich with Newmarket Till. Based on a review of the MECP Water Well Records within the study area (**Table 1**), the Newmarket Till is not present at or near surface at the site location.

Bedrock consists of the Blue Mountain Formation, described as interbedded grey-green to dark grey shale and limestone (Armstrong and Dodge, 2007). The depth to bedrock in this area is typically greater than 100 m and will not be encountered during project construction.

2.1.2 Drainage

The site is located within the Uxbridge Brook Watershed. This watershed has a total area of 178 km^2, and crosses the Regional Municipality of Durham and the Regional Municipality of York. Uxbridge Brook is interpreted to be groundwater support at it's headwaters in the Oak Ridges Moraine (ORM), and generally flows north before discharging to Pefferlaw Brook, approximately 8.5 km south of Lake Simcoe (LSRCA, 1997). Uxbridge Brook is located approximately 750 m south of the project boundary.

The Uxbridge Brook Headwater Wetland Complex encompasses the Uxbridge Brook watercourse, and its limit is located approximately 550 m south of the project boundary. This wetland is a designated Provincially Significant Wetland (PSW), and covers a total area of approximately 159.6 ha. This wetland is defined as significant class 1 and has been assessed to serve a critical ecological function within the Uxbridge Brook Watershed (LSRCA, 1997).

2.1.3 Hydrogeological Setting

Hydrostratigraphic units can be subdivided into two (2) distinct groups based on their capacity to allow groundwater movement. An aquifer is classically defined as a layer of soil that is permeable enough to permit a usable supply of water to be extracted. Conversely, an aquitard is a layer of soil that inhibits groundwater movement due to its low permeability. Within the study area, shallow groundwater flow is influenced by two major hydrostratigraphic units: the Oak Ridges Aquifer Complex (ORAC), and the Newmarket Till Aquitard. Each of these units are described below.

The ***Oak Ridges Aquifer Complex (ORAC)*** forms a near surface aquifer across most of the moraine. This unit is primarily composed of highly permeable coarse sand and gravel, and is capable of yielding sufficient water supply for larger capacity domestic and municipal water wells. Wells screened within the

ORAC indicate intermediate to high transmissivity values ranging from 335 m^2/day to 1,771 m^2/day (Hunter et al., 1996). Within Uxbridge, transmissivity values of up to 780 m^2/day have been reported (Hunter et al., 1996). The ORAC also plays a significant regional role in groundwater recharge due to the high permeability of the unit combined with unconfined hummocky terrain which promotes infiltration.

The ***Newmarket Till Aquitard*** is a dense sandy silt to silty sand till unit deposited by the Laurentide ice sheet approximately 18,000 - 20,000 years ago. This unit has a low hydraulic conductivity, generally in the range of 10^{-11} to 10^{-6} m/sec (Interim Waste Authority, 1994b). The aquitard effectively acts to separate the upper aquifer systems associated with the Oak Ridges Moraine from lower aquifers, including the Thorncliffe Formation and Sunnybrook Diamicton. In some areas, however, tunnel channels aquifers have formed within the Newmarket Till as a result of erosional activity followed by the infilling of ORM sediment. These channels can form a hydraulic connection between the Oak Ridges Moraine and the lower aquifers, and are capable of forming high yield aquifers (Sharpe et al., 1996). Groundwater flow within the Newmarket Till is typically in a downwards direction.

2.2 Water Supply

Based on a search of the MECP Water Well Record Database, fifty (50) water well records are located within a 500 m radius of the site (**Figure 2**). Of these wells, thirty-seven (37) are classified for domestic use, one (1) for agricultural use, and the remaining twelve (12) wells are either abandoned, test wells, or not in use. A summary of the MECP Water Well Records is provided in **Table 1**.

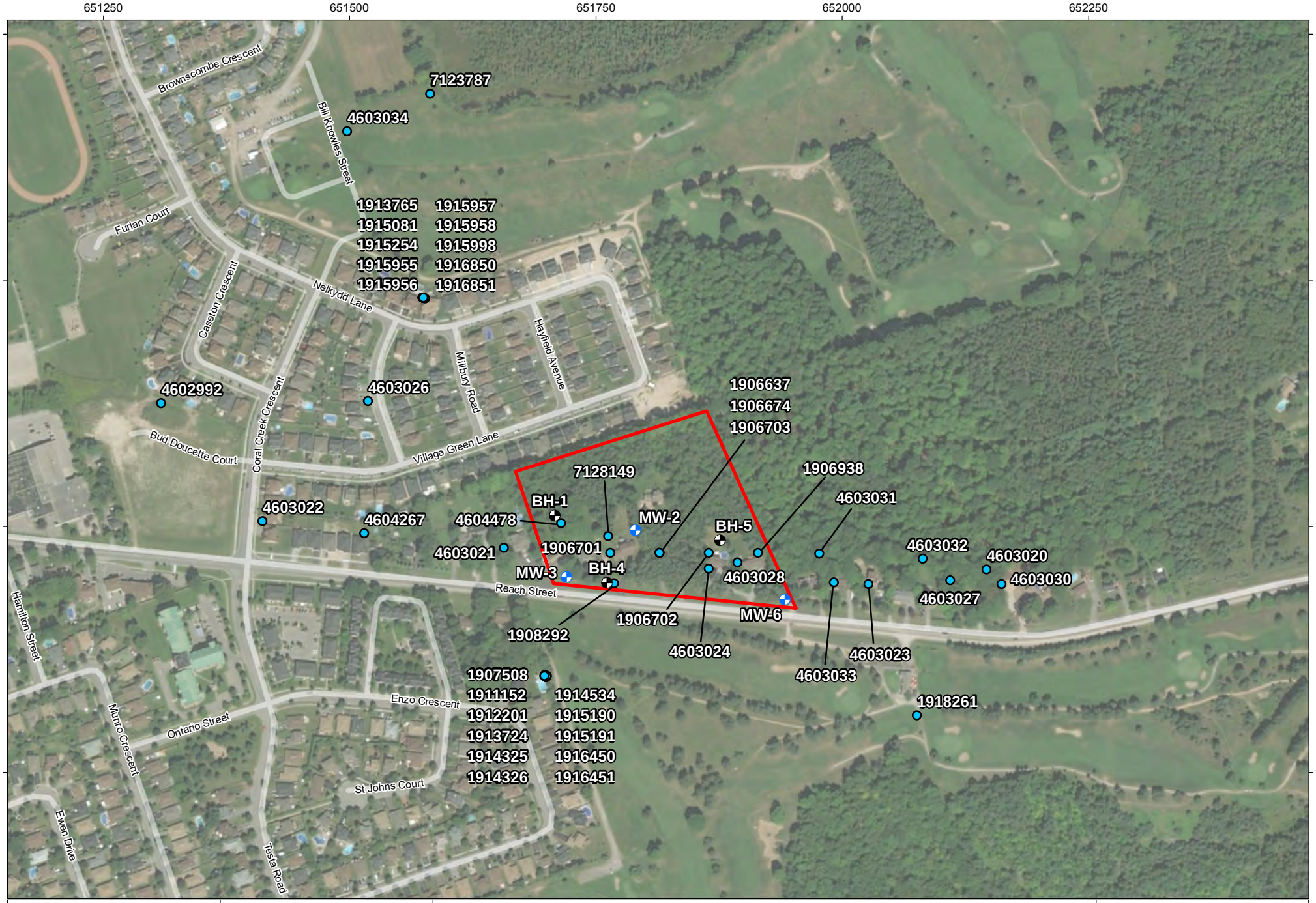
Municipal water supply is readily available to the Uxbridge Community. Currently, the community relies on groundwater from three (3) municipal water supply wells (MW5, MW6, and MW7). MW5 and MW7 are located approximately 550 m west of the site, and MW6 is approximately 2 km west. These wells are between 58.2 m and 76.5 m in depth, and obtain water from the Thorncliffe Aquifer Complex (TAC). At MW5 and MW7, the TAC is likely connected to the Oak Ridges Moraine Aquifer through a tunnel channel aquifer within the Newmarket Till aquitard. At MW6, the tunnel channel is absent, such that the TAC is effectively confined in this location (South Georgian Bay-Lake Simcoe Source Protection Committee, 2015). The locations of these wells are shown in **Appendix D**.

Table 1. MECP Water Well Record Summary

Well ID	Elevation (masl)	Depth (m)	Water Level (mbgs)	Water Use	Water Status	Interpreted Lithology
7123787	N/A	4.57	N/A	N/A	test hole	sand silt
7128149	N/A	N/A	N/A	N/A	N/A	N/A
1906637	281.94	28.35	15.85	Domestic	water supply	sand
1906674	281.94	23.47	9.75	Domestic	water supply	sand
1906701	281.94	25.30	10.06	Domestic	water supply	sand
1906702	281.94	27.74	15.24	Domestic	water supply	sand gravel
1906703	281.94	27.74	12.19	Domestic	water supply	clay
1906938	281.94	24.38	11.58	Domestic	water supply	sand
1907508	N/A	32.31	15.24	Domestic	water supply	clay gravel
1908292	282.85	18.90	10.67	Domestic	water supply	sand
1911152	N/A	31.70	4.57	Domestic	water supply	sand
1912201	N/A	39.01	16.76	Domestic	water supply	N/A
1912336	N/A	15.85	7.62	Domestic	water supply	sand
1912420	N/A	17.37	7.62	Domestic	water supply	clay

Well ID	Elevation (masl)	Depth (m)	Water Level (mbgs)	Water Use	Water Status	Interpreted Lithology
1913724	N/A	25.91	7.62	Domestic	water supply	clay silt
1913765	N/A	N/A	N/A	N/A	abandoned-other	N/A
1914325	N/A	35.36	24.38	Domestic	water supply	gravel
1914326	N/A	35.36	24.38	Domestic	water supply	gravel
1914534	N/A	29.57	9.14	Domestic	water supply	sand
1915081	N/A	21.34	6.10	Domestic	water supply	sand
1915082	N/A	19.20	6.10	Domestic	water supply	sand
4602992	277.37	77.72	5.49	Not Used	test hole	sand gravel clay
4603020	281.94	18.29	15.24	Domestic	water supply	sand
4603021	280.42	31.39	20.42	Domestic	water supply	sand
4603022	281.94	27.74	11.58	Domestic	water supply	N/A
4603023	283.46	35.05	15.24	Domestic	water supply	sand
4603024	283.46	25.91	19.81	Domestic	water supply	sand
4603026	278.89	42.67	9.14	Domestic	water supply	N/A
4603027	281.94	25.91	19.81	Domestic	water supply	sand
4603028	283.46	42.67	24.38	Domestic	water supply	sand
4603030	281.94	34.75	20.42	Domestic	water supply	N/A
4603031	283.46	22.86	16.76	Domestic	water supply	sand gravel
4603032	283.46	39.01	21.95	Domestic	water supply	sand
4603033	283.46	24.99	17.37	Domestic	water supply	sand
4603034	275.84	28.35	7.62	Irrigation	water supply	N/A
4604267	281.94	24.38	6.10	Domestic	water supply	N/A
4604478	281.94	50.29	6.10	Domestic	water supply	clay
1915190	N/A	30.18	3.05	Domestic	water supply	clay
1915191	N/A	19.81	N/A	Domestic	abandoned-supply	clay
1915254	N/A	78.33	7.01	N/A	observation wells	soil
1915955	N/A	92.05	N/A	N/A	abandoned-supply	gravel
1915956	N/A	46.33	N/A	N/A	abandoned-supply	sand gravel
1915957	N/A	49.38	N/A	N/A	observation wells	sand
1915958	N/A	95.10	N/A	N/A	abandoned-supply	clay gravel
1915998	N/A	49.38	4.57	Irrigation	water supply	clay gravel
1916450	N/A	N/A	N/A	N/A	abandoned-supply	N/A
1916451	N/A	35.97	24.38	Domestic	water supply	sand
1916851	N/A	84.43	-*	Not Used	Unknown	sand silt
1916850	N/A	72.24	6.71	Not Used	Unknown	sand silt
1918261	N/A	93.00	62.00	Domestic	water supply	sand silt

**Value provided on drill log is illegible and not reliable.*



PALMER ENVIRONMENTAL CONSULTING GROUP INC.

CLIENT: 2452595 Ont Ltd (Morris Bonakdar)
PROJECT: 241 Durham Road No. 8

0 50 100 metres

N

DRAWN: B. Elder
CHECKED: M. Gillman
PROJECT: 170521
DATE: Feb 15, 2018

Scale 1:5000
UTM Zone 17N
NAD 1983

Legend

- MECP Water Well
- Borehole
- Monitoring Well
- Site Boundary

Image (2012) Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

MECP Water Well Records (WWR)

FIGURE 2

Document Path: C:\Egnyte\Shared\Projects\Active\17052 - 2452595 Ont Ltd (Morris Bonakdar)\170521 - 241 Durham Road No. 8\Mapping\mxd\170521_Figure3_WWR.mxd

2.3 Local Conditions

2.3.1 Drilling and Monitoring Well Installations

On January 26, 2018, six (6) boreholes were drilled within the site area under the supervision of Sirati & Partners Consultants Ltd. (SPCL) personnel. The locations of the boreholes are shown on **Figure 1**. Boreholes were drilled using continuous flight auger methods to depths ranging from 6.7 to 8.2 metres below ground surface (mbgs). Samples were collected at regular intervals using a 51 mm O.D. split-barrel sampler. Three of the boreholes (MW2, MW3, and MW6) were completed as monitoring wells using 51 mm diameter PVC and a 1.5 m length of screen. Details of the boreholes and monitoring wells installations are provided in **Table 2**. Completed borehole logs by SPCL are provided in **Appendix B**.

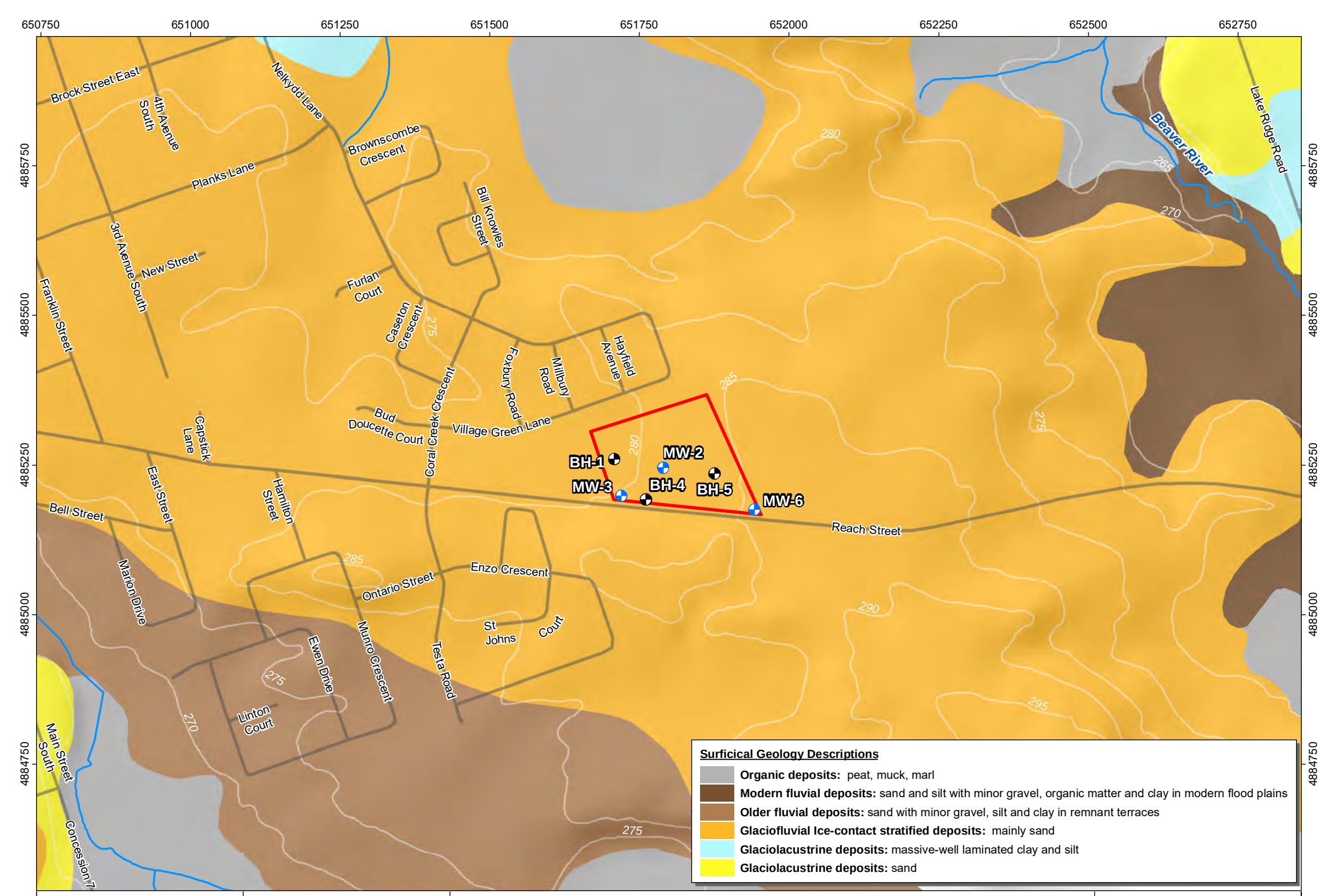
Table 2. Borehole and Monitoring Well Installation Details

BH/MW ID	Surface Elevation (masl)	Depth (mbgs)	Screened Interval (mbgs)	Screened Geology
BH1	282.5	8.2	n/a – borehole only	Sand and sandy silt
BH2/MW2	283.5	6.7	4.7 to 6.7	Sandy silt
BH3/MW3	282.8	6.7	4.7 to 6.7	Sand and sandy silt
BH4	284.5	6.7	n/a – borehole only	Sand and sandy silt
BH5	286.9	6.7	n/a – borehole only	Sand
BH6/MW6	289.0	6.7	4.7 – 6.7	Sandy silt

2.3.2 Surficial Geology

Borehole drilling by SPCL identified an overlying layer of topsoil and/or asphalt across the site. Underlying the topsoil or asphalt is a layer of fill materials consisting of sand to silty sands, which extends to depths up to 1.8 mbgs. Below the fill material, native overburden materials consisting of sand and sandy silt of the ORAC were encountered to depths of at least 8.2 mbgs, and the bottom of the unit was not penetrated during the drilling investigation (i.e., the Newmarket Till aquitard was not encountered). The SPCL borehole logs are provided in **Appendix B**.

Soil conditions encountered during drilling investigations are consistent with the soil descriptions reported in the MECP Water Well Records (**Table 1**) and with the Ontario Geological Survey (OGS) surficial geology mapping of the site (**Figure 3)**. Glaciofluvial ice-contact stratified deposits made up of mostly sand was found in the SPCL borehole logs as well as MECP Water Well Records. This is representative of the ORAC, and based on MECP Water Well Records, is expected to have a thickness of up to 30 m in this area below which the Newmarket Till would be expected. A mixture of non-cohesive sands and silts were noted in thirty-four (34) of the forty-one (41) MECP Water Well Records with soil descriptions listed in **Table 1**.



PALMER ENVIRONMENTAL CONSULTING GROUP INC.

CLIENT: 2452595 Ont Ltd (Morris Bonakdar)
PROJECT: 241 Durham Road No. 8

0 50 100 150 200 metres

N

DRAWN: B. Elder
CHECKED: M. Gillman
PROJECT: 170521
DATE: Feb 15, 2018

Scale 1:8000
UTM Zone 17N
NAD 1983

Legend

- Borehole
- Monitoring Well
- Site Boundary
- Watercourse
- Road
- Contour (5 m)

Notes:
Surficial Geology provided by Ontario Geological Survey; Surficial geology of Southern Ontario (2010).

Surficial Geology

FIGURE 3

Document Path: C:\Egnyte\Shared\Projects\Active\17052 - 2452595 Ont Ltd (Morris Bonakdar)\170521 - 241 Durham Road No. 8\Mapping\mxd\170521_Figure2_SurfGeo.mxd

3. Hydrogeological Investigation

3.1 Groundwater Level and Flow

Water levels at monitoring wells MW2, MW3, and MW6 were measured by PECG personnel on February 2, 2018, October 15, 2018, November 8, 2018, and January 4, 2019. The monitoring wells were observed as "dry" during each site visit, indicating that the groundwater elevation was lower than 6.7 meters below ground surface (mbgs). A summary of the water level measurements collected during the site visits is provided in **Table 3**.

Table 3. Groundwater Levels from Monitoring Wells

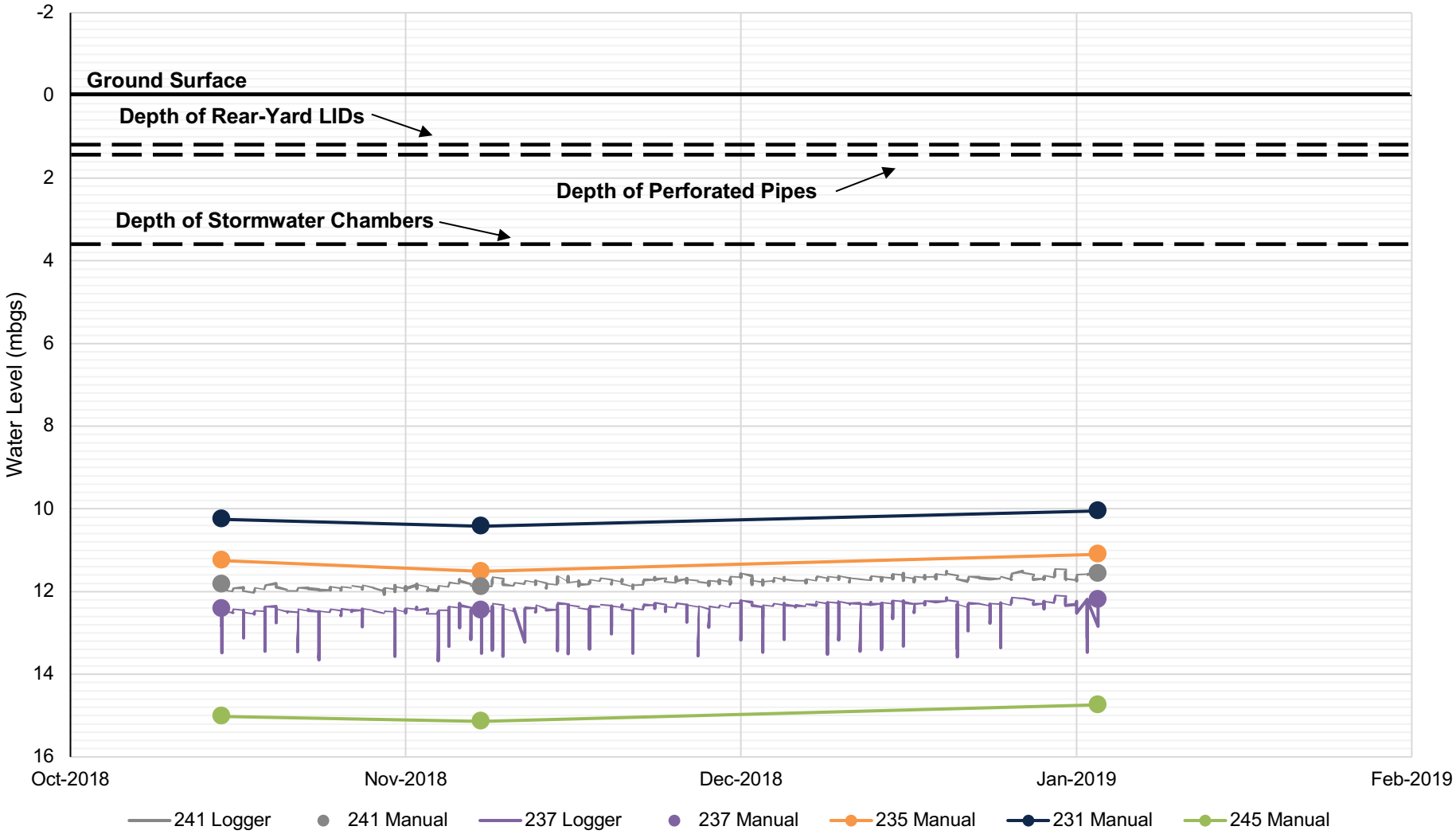
Monitoring Well	Stratigraphic Unit	Ground Surface Elevation (masl)	Water Level							
			masl	mbgs	masl	mbgs	masl	mbgs	masl	mbgs
			Feb 2, 2018		Oct 15, 2018		Nov 8, 2018		Jan 4, 2019	
MW2	Sandy silt	283.5	<276.8	>6.7	<276.8	>6.7	<276.8	>6.7	<276.8	>6.7
MW3	Sand and sandy silt	282.8	<276.1	>6.7	<276.1	>6.7	<276.1	>6.7	<276.1	>6.7
MW6	Sandy silt	289.0	<282.3	>6.7	<282.3	>6.7	<282.3	>6.7	<282.3	>6.7

Groundwater level monitoring was expanded to include the five private wells located within the site boundary to estimate the depth to the water table (231, 235, 237, 241, and 245 Durham Road). Water levels from these wells were measured by PECG personnel on October 15, 2018, November 8, 2018 and January 4, 2019 using a combination of automatic data loggers and manual measurements. Data loggers were installed at 237 and 241 Durham Road to provide continuous water level data. Manual water level monitoring results are summarized in **Table 4**. The water table ranged between 10.05 mbgs (231 Durham Road) and 15.14 mbgs (245 Durham Road). Over the course of monitoring, the water table demonstrated very little fluctuation, ranging from 0.26 m at 237 Durham Road to 0.41 m at 235 Durham Road (**Figure 4**). This suggests that the groundwater levels are relatively stable, which is a result of the strong recharge conditions at the site.

Figure 4 also presents the depth of the proposed Low Impact Development (LID) features for the site, relative to the water table. The LID features are further described in Section 3.8 and in **Appendix C**, but it is clear from the groundwater monitoring that the LIDs will be at least 6 m above the water table.

The groundwater flow direction can be estimated using the groundwater elevations obtained from the monitoring events displayed in **Table 4**. Groundwater flow at this site is directed to the south towards Uxbridge Brook (**Figure 5**).

Figure 4. Depth to Groundwater



PALMER ENVIRONMENTAL CONSULTING GROUP INC.

CLIENT: 2452595 Ont Ltd (Morris Bonakdar)
PROJECT: 241 Durham Road No. 8

0 10 20 30 40 50
metres

DRAWN: B. Elder
CHECKED: N. Boyes
PROJECT: 170521
DATE: Feb 25, 2019

Scale 1:2000
UTM Zone 17N
NAD 1983

Legend

- Borehole
- Monitoring Well
- Private Well (Address)
- Site Boundary
- Equipotential Line
- Groundwater Flow Direction

Groundwater Flow

FIGURE 5

Document Path: C:\Egnyte\Shared\Projects\Active\17052 - Uxbridge - 2452595 Ont Ltd (Morris Bonakdar)\170521 - 241 Durham Road No. 8\Mapping\mxd\170521_Figure1_Sites.mxd

Table 4. Private Well Groundwater Levels

Private Well Address	Well Stick Up (m)	Well Depth (m)	Elevation (m)	October 15, 2018		November 8, 2018		January 4, 2019	
				Water Level (mbgs)		Water Level (mbgs)		Water Level (mbgs)	
				mbgs	masl	mbgs	masl	mbgs	masl
231 Durham Road	0.16	50.3	281.5	10.25	271.3	10.42	271.1	10.05	271.5
235 Durham Road	0.62	26.2	282.3	11.25	271.0	11.51	271.7	11.10	271.2
237 Durham Road	0.16	27.7	283.0	12.41	270.6	12.45	270.6	12.19	270.8
241 Durham Road	0.36	-*	283.3	11.82	271.4	11.88	271.4	11.57	271.7
245 Durham Road	0	25.9	285.7	15.02	270.6	15.14	270.6	14.74	271.0

**241 Durham Road Well Depth not available on MECP well database*

3.2 Hydraulic Conductivity

3.2.1 Grain Size Analysis

As single well response tests (i.e., slug tests) could not be completed due to insufficient water present within the monitoring wells, the hydraulic conductivity of the soils was estimated using grain size distribution curves completed by SPCL (**Appendix B**). The grain size analysis was completed using the Hazen Method, which is typically suited for relatively permeable sandy soils by incorporating the 10% "finer than" grain size data (Hazen, 1892).

This analysis incorporated the soil samples collected at shallow depths (2.5 mbgs) to better represent the surficial soils at the site. Therefore, the grain size distribution for the sandy silt sample collected at 8.2 mbgs from BH1 was omitted from the analysis as it is understood that the excavations for development will not extend to this depth.

The calculated hydraulic conductivities values based on this method are summarized in **Table 5**. The estimated hydraulic conductivity (k value) of the sand collected from BH1 is approximately $3.6x10^{-7}$ m/sec, and the k value of the sand collected from BH3 is approximately $7.6x10^{-5}$ m/sec. The lower k value at BH1 is due to the higher percentage of fine-grained silts and clays in the sample. The geometric mean k value is approximately $5.2x10^{-6}$ m/sec.

Table 5. Summary Table of Calculated Hydraulic Conductivity Values

Monitoring Well	Method of Analysis	Geology	Hydraulic Conductivity (m/s)	Geometric Mean Hydraulic Conductivity (m/s)
BH1	Hazen Method	Sand	$3.6x10^{-7}$	$5.2x10^{-6}$

BH3	Hazen Method	Sand	$7.6x10^{-5}$	

3.3 Infiltration Rate

3.3.1 Empirical Relationship

An estimate of the infiltration rate for the study area was produced based on accepted literature values from the Ontario Ministry of Municipal Affairs and Housing (OMMAH) Supplementary Guidelines to the Ontario Building Code 1997, and provided in the Low Impact Development Stormwater Management Planning and Design Guide, **Appendix C** (TRCA/CVC, 2010). The empirically derived relationship is as follows:

$$K = 6x10^{-11}I^{3.7363}$$

Where:
K = hydraulic conductivity (cm/sec)
I = infiltration rate (mm/hr).

Based on the geometric mean hydraulic conductivity value of $5.2x10^{-6}$ m/s, the resulting infiltration rate is expected to be approximately 72 mm/hour. This value indicates the native soils at the proposed infiltration locations are suitable to infiltrate water at the site, particularly given the deep water table.

3.3.2 Field Testing

3.3.2.1 Guelph Permeameter

Site specific infiltration rates of the shallow unsaturated soils at the site were determined using a Guelph Permeameter during a site visit by PECG personnel on May 4, 2018. Five (5) test locations (Test 1 – Test 5) were selected on the site near existing boreholes and monitoring wells, including BH-1, MW-2, MW-3, BH-5, and MW-6 (**Figure 6**).

Infiltration testing with the Guelph Permeameter (GP) was conducted between depths of between 0.71 and 0.97 mbgs. This method involves measuring the steady state rate of percolation within a 2-3/8" diameter auger hole while maintaining a constant hydraulic head pressure (H) within the GP water reservoir (Reynolds and Elrick, 1986). Once the head pressure is applied, the rate of fall within the reservoir is monitored until a steady state of change (r) is achieved. This value is used to determine the field saturated hydraulic conductivity (K_{fs}) by applying it to the Reynolds and Elrick (1985) equations. The value of K_{fs} can then be applied to the OMMAH equation described above to calculate the rate of infiltration within the surficial soils.

Two single head infiltration tests were completed at each test location (SH-1 and SH-2). Prior to testing, the surficial soils were dug away to approximately 0.3 m below ground surface (mbgs). A riverside auger was then used to excavate the test pit to the correct testing depths, and a description of the soils was recorded. A summary of the infiltration test results, including the depths of the tests and soil descriptions, is provided in **Table 6**. Testing employed the combined reservoir technique to optimize results for more permeable materials.

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

CLIENT: 2452595 Ont Ltd (Morris Bonakdar)
PROJECT: 241 Durham Road No. 8

0 10 20 30 40 50
metres

N

DRAWN: B. Elder
CHECKED: M. Gillman
PROJECT: 170521
DATE: Feb 15, 2018

Scale 1:2000
UTM Zone 17N
NAD 1983

Legend

- Borehole
- Monitoring Well
- Site Boundary
- Infiltration Test Location

Image (2012) Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Infiltration Test Locations

FIGURE 6

Document Path: C:\Egnyte\Shared\Projects\Active\17052 - 2452595 Ont Ltd (Morris Bonakdar)\170521 - 241 Durham Road No. 8\Mapping\mxd\170521_Figure1_Sites.mxd

Table 6. Summary of Infiltration Test Locations

Infiltration Test ID	Nearest Borehole/ Monitoring Well	Depth of Test (mbgs)	Soil Descriptions
Test 1 (BH-1)	MW-3	0 – 0.48 0.48 – 0.61 0.61 – 0.71	Sandy silt, trace organics, trace clay, dark brown, moist Sandy silt, some sand, light brown, moist Fine to medium sand and silt
Test 2 (MW-3)	BH-1	0 – 0.36 0.36 – 0.51 0.51 – 0.66 0.66 – 0.79 0.79 – 0.91	Topsoil, brown, moist Silt and clay, moist Silty clay with some sand Silty sand, some clay Sand, some silt
Test 3 (MW-6)	MW-6	0 – 0.36 0.36 – 0.61 0.61 – 0.97	Fill Silty sand, brown, moist Sand, brown, moist
Test 4 (BH-5)	BH-5	0 – 0.25 0.25 – 0.41 0.41 – 0.81	Topsoil, organics Silty sand, moist Sand, moist
Test 5 (MW-2)	MW-2	0 – 0.18 0.18 – 0.33 0.33 – 0.46 0.46 – 0.64 0.64 – 0.91	Topsoil Silty sand with gravel (fill) Silt and some gravel, grey layer (fill) Sandy silt, moist Sand, moist

Field saturated hydraulic conductivity (K_{fs}) values were then calculated using the Guelph Permeameter K-sat Calculator (2012) for the single head, combined reservoirs method. Using this method, the geometric mean K_{fs} value of the sand and sandy silt ORAC deposits is approximately $5.5x10^{-6}$ m/sec, with values ranging from $1.9x10^{-6}$ m/sec to $1.5x10^{-5}$ m/sec (**Table 7**). This is consistent with the geometric mean k value calculated using the Hazen method, which computed a value of $5.2x10^{-6}$ m/sec (**Section 3.2.1**).

Infiltration rates were estimated using the empirical relationship described in **Section 3.3.1**. Infiltration rates ranged between 55 mm/hr (SH-1 near BH-1) to 96 mm/hr (SH-2 near MW-6), and averaged approximately 73 mm/hr. This is consistent with the infiltration rate calculated using the grain size analysis and empirical relationship, which was approximately 72 mm/hr.

Table 7. Summary of Guelph Permeameter Infiltration Testing Results

Infiltration Test ID	Test Number	H (m)	R (cm/min)	K_{fs} (m/sec)	Infiltration Rate (mm/hr)
Test 1 (BH-1)	SH-1	0.05	1.8	$5.7x10^{-6}$	74
	SH-2	0.10	2.4	$5.2x10^{-6}$	72
Test 2 (MW-3)	SH-1	0.05	0.6	$1.9x10^{-6}$	55
	SH-2	0.10	1.2	$3.5x10^{-6}$	65
Test 3 (MW-6)	SH-1	0.05	3.6	$1.1x10^{-5}$	89
	SH-2	0.10	6.9	$1.5x10^{-5}$	96
Test 4 (BH-5)	SH-1	0.05	1.2	$3.8x10^{-6}$	66
	SH-2	0.10	3.0	$6.5x10^{-6}$	76
Test 5 (MW-2)	SH-1	0.05	1.8	$5.7x10^{-6}$	74
	SH-2	0.10	2.4	$5.2x10^{-6}$	72
Geometric Mean (m/sec):				**$5.5x10^{-6}$**	**73**

3.3.2.2 In-Well Infiltration Testing

In-well infiltration testing was completed by PECG personnel on July 3, 2018 at three (3) dry monitoring well locations on site, MW-2, MW-3, and MW-6 (**Figure 6**). In-well infiltration testing allowed PECG to collect infiltration data at depths of between 4.7 and 6.7 mbgs, which is much deeper than what is possible using the Guelph Permeameter method. This method is consistent with industry accepted standard practises for determining infiltration rates of soils. The methodology is based on ASTM International, 2018, Standard Test Method for Field Measurement of Hydraulic Conductivity Using Borehole Infiltration.

The monitoring wells used for the in-well infiltration testing were screened within unsaturated soils. This conclusion was confirmed through regular water level monitoring which indicated the wells were dry during all monitoring events (**Table 3**). The deep water table measured at the private wells of between 10.05 mbgs (231 Durham Road) and 15.14 mbgs (245 Durham Road) further confirm that the monitoring wells would be continuously dry during the year.

A data logger was installed within each monitoring well to record water levels at a 2-second frequency. Two initial infiltration tests were completed at each well by inserting 5-gallons of water and measuring the subsequent change in hydraulic head. This was done to measure the dry well infiltration response. Following these two tests, water was added to each monitoring well at a constant rate for approximately 45 mins to ensure that the sand pack around each monitoring well location was field saturated. The constant influx of water was then stopped, and the receding hydraulic head response was measured (**Figures 7, 8, & 9**), yielding the wet well infiltration rate.

Field saturated hydraulic conductivity (K_{fs}) values were calculated using the displacement-time data analyzed using the Hvorslev (1951) method for unconfined aquifers, modelled using Aqtesolv™ software. Using this method, the geometric mean calculated K_{fs} value of the sand and sandy silt ORAC deposits is approximately $4.6x10^{-6}$ m/sec, with values ranging from $9.3x10^{-6}$ m/sec to $3.1x10^{-6}$ m/sec (**Table 8**). This is consistent with the geometric mean hydraulic conductivity (**Section 3.2.1**), as well as the values calculated using the Guelph Permeameter method (**Section 3.3.2.1**).

Infiltration rates were estimated using the empirical relationship described in **Section 3.3.1**. Infiltration rates ranged from 63 mm/hr (MW-3) to 84 mm/hr (MW-6), with a geometric mean of approximately 69 mm/hr (**Table 8**). This is consistent with the infiltration rates calculated using the other methods.

Table 8. Summary of In-Well Infiltration Testing Results

Well ID	K_{fs} (m/sec)	Infiltration Rate (mm/hr)
MW-2	$3.3x10^{-6}$	64
MW-3	$3.1x10^{-6}$	63
MW-6	$9.2x10^{-6}$	84
Geometric Mean (m/sec)	**$4.6x10^{-6}$**	**69**

Figure 7. MW-2 In-Well Infiltration Response Curves

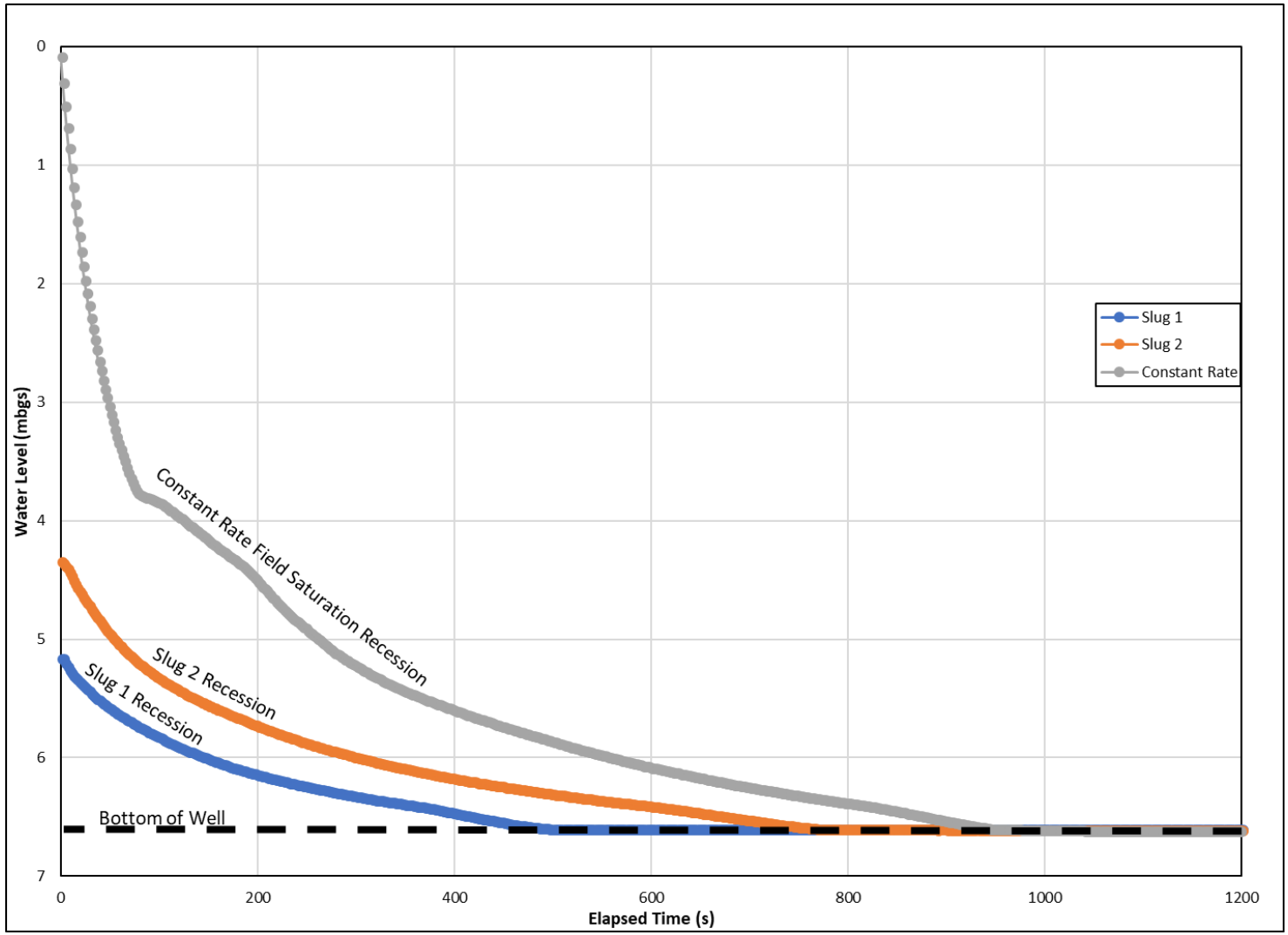


Figure 8. MW-3 In-Well Infiltration Response Curves

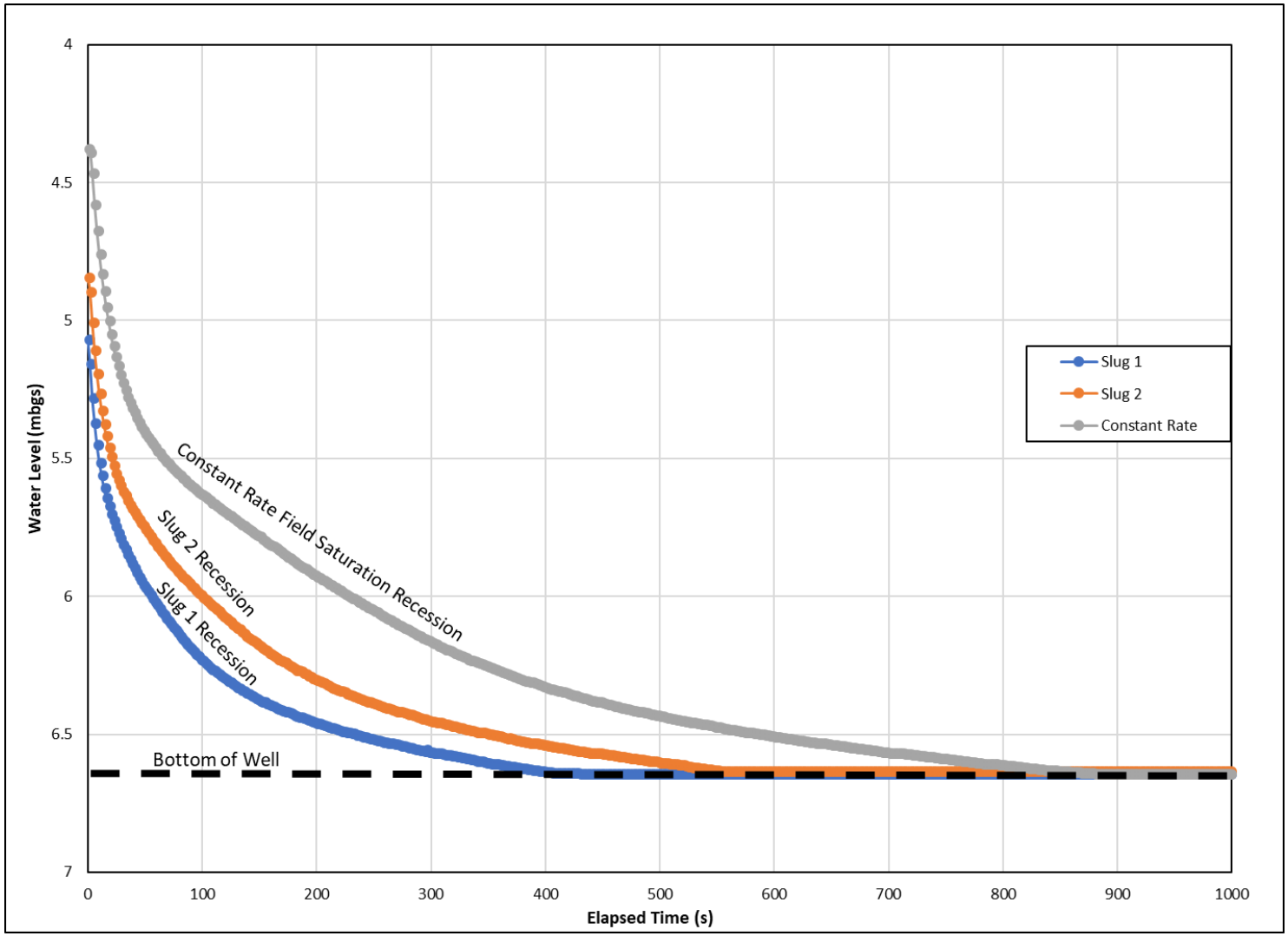
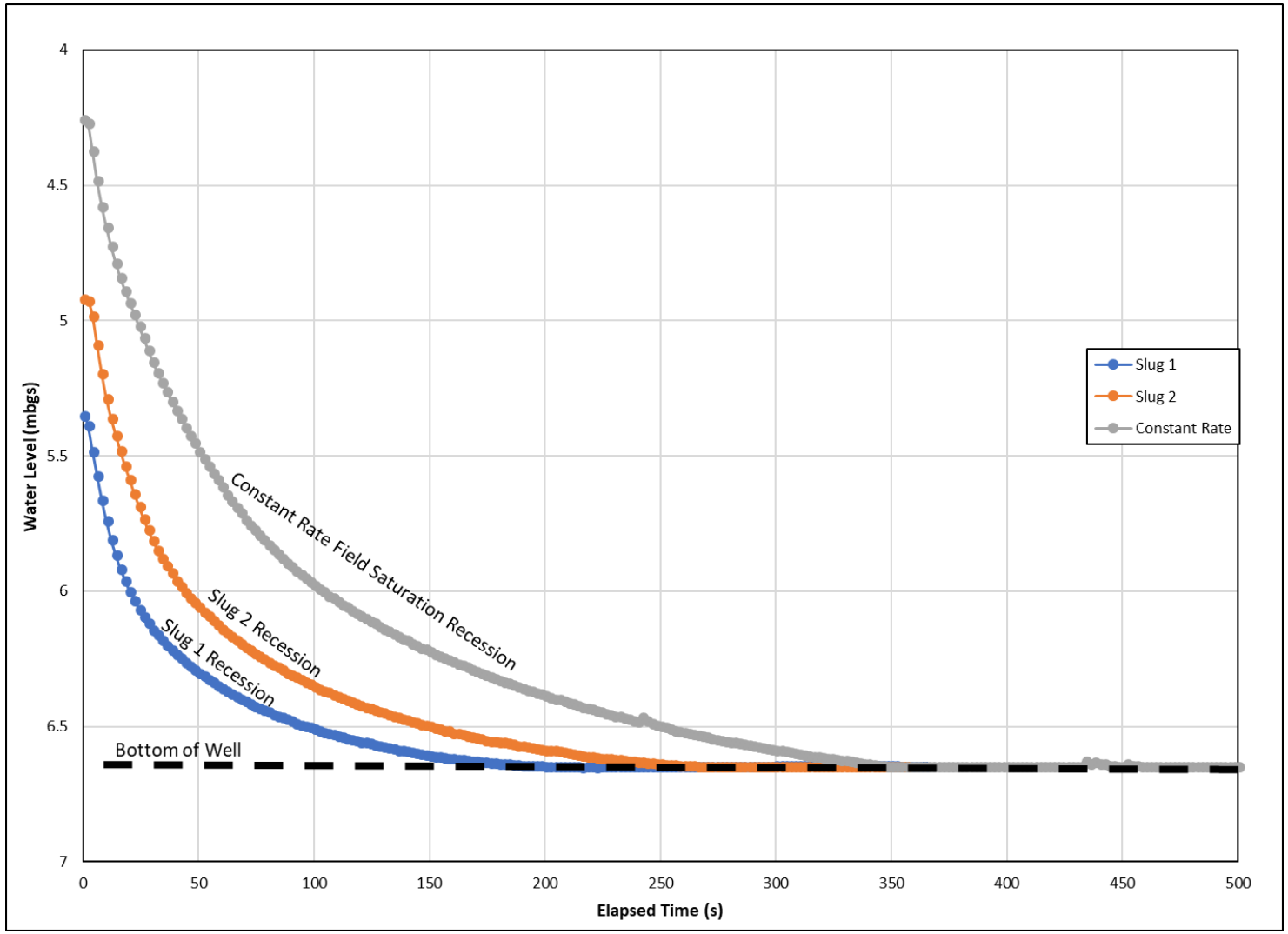


Figure 9. MW-6 In-Well Infiltration Response Curves



3.3.3 Summary of Infiltration Results

The average infiltration rates as determined through each method of testing are summarized in **Table 9**. Soil infiltration characteristics and the deep water table make this site suitable for a wide variety of high volume infiltration methods, such as the LID system proposed by SKA, presented in **Appendix C2** (SKA, 2019).

Table 9. Summary of Infiltration Results

Infiltration Calculation Method	K_{fs} (m/sec)	Infiltration Rate (mm/hr)
Empirical Relationship	$5.2x10^{-6}$	72
Guelph Permeameter	$5.5x10^{-6}$	73
In-Well Infiltration	$4.6x10^{-6}$	69
Geometric Mean	$5.1x10^{-6}$	71

3.4 Groundwater Quality

Groundwater quality sampling was not completed from the monitoring wells as the water table was below the depths of the wells. As an alternative, water samples were collected from two (2) private wells located on site (241 Durham Road, and 231 Durham Road). Sampling was completed on November 8, 2018. These wells were tested for a suite of water quality parameters including physical tests, anions and nutrients, organic and inorganic carbon, silica, bacteriological tests, and dissolved metals.

Based on the results, the groundwater quality of this area does not indicate any exceedances of the Ontario Drinking Water Quality Standards (ODWS) for health-related parameters listed under the Maximum Allowable Concentration (MAC) criteria. The complete chemical analysis is presented in **Table 10** and the Certificate of Analysis is provided in **Appendix F**.

Table 10. Groundwater Quality Results

Parameter	Lowest Detection Limit	Units	ODWS MAC Criteria	241 Durham Road	231 Durham Road
				Nov 8, 2018	Nov 8, 2018
Physical Tests (Water)					
Colour, Apparent	2.0	CU	-	46.4	36.0
Conductivity	3.0	umhos/cm	-	217	651
pH	0.10	pH units	-	8.17	7.89
Redox Potential	-1000	mV	-	251	288
Total Dissolved Solids	20	mg/L	-	118	468
Turbidity	0.10	NTU	-	47.2	33.2
Anions and Nutrients (Water)					
Alkalinity, Bicarbonate (as CaCO3)	10	mg/L	-	113	138
Alkalinity, Carbonate (as CaCO3)	10	mg/L	-	<10	<10
Alkalinity, Hydroxide (as CaCO3)	10	mg/L	-	<10	<10

Parameter	Lowest Detection Limit	Units	ODWS MAC Criteria	241 Durham Road	231 Durham Road
				Nov 8, 2018	Nov 8, 2018
Alkalinity, Total (as CaCO3)	10	mg/L	-	113	138
Ammonia, Total (as N)	0.020	mg/L	-	0.079	0.027
Bromide (Br)	0.10	mg/L	-	<0.10	<0.10
Chloride (Cl)	0.50	mg/L	-	1.54	86.2
Computed Conductivity	-	uS/cm	-	202	629
Conductivity % Difference	-	%	-	-7.2	-3.4
Fluoride (F)	0.020	mg/L	1.5	0.036	0.021
Hardness (as CaCO3)	-	mg/L	-	111	304
Ion Balance	-	%	-	125	108
Langelier Index	-	-	-	0.2	0.6
Nitrate and Nitrite as N	0.022	mg/L	10	<0.022	<0.022
Nitrate (as N)	0.020	mg/L	10	<0.020	<0.020
Nitrite (as N)	0.010	mg/L	1	<0.010	<0.010
Saturation pH	-	pH	-	7.92	7.34
Orthophosphate-Dissolved (as P)	0.0030	mg/L	-	<0.0030	<0.0030
TDS (Calculated)	-	mg/L	-	113	355
Sulfate (SO4)	0.30	mg/L	-	1.23	64.6
Anion Sum	-	me/L	-	1.95	6.06
Cation Sum	-	me/L	-	2.44	6.53
Cation – Anion Balance	-	%	-	11.2	3.7
Organic / Inorganic Carbon (Water)					
Dissolved Organic Carbon	0.50	mg/L	-	2.02	1.39
Inorganic Parameters (Water)					
Silica	0.11	mg/L	-	4.7	4.28
Bacteriological Tests (Water)					
E. Coli	-	CFU/100mL	0	0	0
Dissolved Metals (Water)					
Aluminum (Al)-Dissolved	0.0050	mg/L		<0.0050	<0.0050
Antimony (Sb)-Dissolved	0.00010	mg/L	0.006	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00010	mg/L	0.01	0.00107	<0.00010
Barium (Ba)-Dissolved	0.00010	mg/L	1	0.0369	0.0307
Beryllium (Be)-Dissolved	0.00010	mg/L	-	<0.00010	<0.00010
Bismuth (Bi)-Dissolved	0.000050	mg/L	-	<0.000050	<0.000050
Boron (B)-Dissolved	0.010	mg/L	5	<0.010	<0.010
Cadmium (Cd)-Dissolved	0.000010	mg/L	0.005	<0.000010	<0.000010
Calcium (Ca)-Dissolved	0.050	mg/L	-	24.3	93.7
Chromium (Cr)-Dissolved	0.00050	mg/L	0.05	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00010	mg/L	-	<0.00010	0.00098
Copper (Cu)-Dissolved	0.00020	mg/L	-	0.00048	<0.00020
Iron (Fe)-Dissolved	0.010	mg/L	-	1.74	<0.010
Lead (Pb)-Dissolved	0.000050	mg/L	0.01	0.000268	0.000086
Magnesium (Mg)-Dissolved	0.050	mg/L	-	12.2	17.0
Manganese (Mn)-Dissolved	0.00050	mg/L	-	0.0998	0.761
Molybdenum (Mo)-Dissolved	0.000050	mg/L	-	0.000690	0.000758

Parameter	Lowest Detection Limit	Units	ODWS MAC Criteria	241 Durham Road	231 Durham Road
				Nov 8, 2018	Nov 8, 2018
Nickel (Ni)-Dissolved	0.00050	mg/L	-	<0.00050	0.00068
Phosphorus (P)-Dissolved	0.050	mg/L	-	<0.050	<0.050
Potassium (K)-Dissolved	0.050	mg/L	-	1.28	1.11
Selenium (Se)-Dissolved	0.000050	mg/L	0.05	0.000149	0.000093
Silicon (Si)-Dissolved	0.050	mg/L	-	2.20	2.00
Silver (Ag)-Dissolved	0.000050	mg/L	-	<0.000050	<0.000050
Sodium (Na)-Dissolved	0.50	mg/L	20	4.30	9.80
Strontium (Sr)-Dissolved	0.0010	mg/L	-	0.0893	0.179
Sulfur (S)-Dissolved	5.0	mg/L	-	<5.0	21.5
Thallium (Tl)-Dissolved	0.000010	mg/L	-	<0.000010	<0.000010
Tin (Sn)-Dissolved	0.00010	mg/L	-	0.00521	0.00195
Titanium (Ti)-Dissolved	0.00030	mg/L	-	<0.00030	<0.00030
Tungsten (W)-Dissolved	0.00010	mg/L	-	<0.00010	<0.00010
Uranium (U)-Dissolved	0.000010	mg/L	0.02	0.000010	0.000191
Vanadium (V)-Dissolved	0.00050	mg/L	-	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0010	mg/L	-	0.0187	0.583
Zirconium (Zr)-Dissolved	0.00030	mg/L	-	<0.00030	<0.00030

3.5 Phosphorous Budget

The Lake Simcoe Phosphorus Offsetting Program (LSPOP) requires that all new developments must control 100% of the phosphorus from leaving their property. Based on the Lake Simcoe Region Conservation Authority (LSRCA) Phosphorus Offsetting Policy and the MECP Phosphorus Budget Tool (V2.0 Release Update – March 30, 2012) PECG estimated the pre- and post-development phosphorous budget for the site. The phosphorous budget summary based on the MECP Tool is presented in **Appendix E**. The post development assessment is based on the drainage areas and proposed LID works for the site as presented in **Appendix C2**.

An innovative LID treatment train approach has been presented by engineers a SKA that includes: rear yard swales with a granular cistern (LID1 – LID6), granular cisterns below perforated pipes (PP1-PP7), and two Storm Chambers that will receive and infiltrate overflow from the swales and perforated pipes. Based on the guidance document for the MECP Phosphorus Budget Tool, a treatment train approach can be taken resulting in additive effects of each mitigative LID. In areas were rear yard swales (87% phosphorus reduction, overflow into a series of 2 storm chambers (also 87% reduction), the sum of the reductions is 98% (=0.87 +[(1-0.87)*0.87] = 0.98).

Based on a total pre-development area of 3.62 ha, subdivided into 2.47 ha of development and 1.15 ha of forest, the total pre-development phosphorous load was calculated to be 0.36 kg/year. Based on the site plan and proposed treatment systems designed by engineers at SKA (i.e., implementing a treatment train approach), the post-development load was estimated to be reduced to 0.20 kg/year, and the effects of amortized construction phase loading assuming an 8-month long construction phase was estimated to add 0.04 kg/year. The combined post-development phosphorus load including the construction phase loading is therefore 0.24 kg/year.

The pre- to post-development change in phosphorus loading represents a reduction by 44% from pre-development conditions without construction phase loading (-0.16 kg/year), and a reduction of 33% with construction phase loading (-0.12 kg/year). The reduction of phosphorus loading post-development is a result of the implementation of infiltration trenches and perforated pipe systems (**Appendix C2**) and best management practices (BMPs), as well as the use of a treatment train approach as mitigation.

The innovative and detailed measured proposed by SKA to control stormwater runoff and promote infiltration at the site has resulted in a significantly reduced phosphorus load post-development. This exceeds the requirements of the LSPP and provides a benefit for the watershed.

3.6 Pre-Development Water Budget

3.6.1 Methodology

A pre-development water budget was completed for the overall study area using a monthly soil-moisture balance approach (Thornthwaite and Mather, 1957). The water balance calculations estimate average annual evapotranspiration (evaporation and plant transpiration) using factors such as monthly precipitation, temperature and latitude. Long term climate data were obtained from the nearest meteorological station to the study area, the Udora climate station (44°15'N, -79°09'W), over the 30-year duration from 1981 to 2010.

The average available water surplus, which is the water available for infiltration and runoff purposes, was calculated by subtracting the average annual evapotranspiration from the average annual precipitation. Based on soil conditions at the site, a soil moisture retention value of 150 mm was utilized to represent the soil type and vegetation cover. The resulting annual water surplus was then partitioned using infiltration coefficients based on MOEE (1995) and modified based on site specific conditions. This approach takes into consideration three factors: topography/slope, soil type, and land cover, which are summed to provide a representative infiltration factor for the area. A summary of the infiltration factors used in the water balance assessment are provided in **Table 11**. The total average annual infiltration over pervious areas was then calculated by multiplying the applicable water surplus value by the sum of the three individual factors.

Table 11. Summary of Infiltration Factors

Area Description	Infiltration Factor Value
SOIL TYPE	
• Ice-contact stratified drift: *sand and gravel, minor silt, clay and silt*	0.45
TOPOGRAPHY/SLOPE	
• <1% slope	0.20
PRE-DEVELOPMENT LAND COVER	
• Wooded Area/Lawn	0.15
OVERALL INFILTRATION RATE FOR SITE	**0.80**

An impervious factor was additionally utilized to account for areas within the site occupied by pre-existing residential lots. Over these surfaces, the available water for infiltration and runoff is considered to be precipitation minus evaporation (P-E). Impervious surfaces prevent infiltration, and the absence of vegetation removes the Transpiration (T) component from the water balance. Evaporation is small compared with T and is estimated to be approximately 10% of annual precipitation.

3.6.2 Results

The calculated actual ET (or AET) based on the Thornthwaite and Mather monthly water balance model is approximately 519 mm/year (**Table 12**). The actual evapotranspiration is calculated based on a potential ET (or PET) and soil-moisture storage withdrawal. Monthly PET is estimated using monthly temperature data and is defined as a water loss from a homogeneous vegetation covered area that never lacks water (Thornthwaite, 1948; Mather, 1978). The calculated PET for the study area is 596 mm/year, or about 59% of the total precipitation. In general, there is a soil moisture deficit of 76 mm/year.

The estimated water surplus within the site is approximately 367 mm/year (**Table 12**). The water surplus has two components: a runoff component which is the overland flow when the soil moisture capacity is exceeded, and an infiltration component. Using the method in the MECP SWM manual and MOEE (1995) for guidance, and with the consideration that approximately 0.30 ha of the property consists of existing residential land use, it is estimated that approximately 23% (3,087 m^3/year) of the surplus runs off, and the remaining 77% (10,451 m^3/year) infiltrates the soils. Results are summarized in **Table 13**. Runoff may eventually either recharge the local groundwater system, or form part of a perched water table.

Table 12. Summary of Annual Water Surplus Values by Zone

Water Balance (mm)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Precipitation (mm)		64.9	45.9	53.1	67.9	82.1	106.6	86.4	73.9	87.3	74.9	83.2	60	886.2
Temperature (°C)		-7	-6.6	-1.3	5.7	12.2	18	19.9	19.3	15.1	8.6	2.4	-4	7
Potential Evapotranspiration (PET)		0	0	0	30	76	116	131	117	78	39	8	0	596
P – PET		65	46	53	38	6	-9	-45	-43	9	36	75	60	290
Change in Soil Moisture Storage		0	0	0	-28	-33	-21	-6	6	20	26	28	0	-8
Soil Moisture Storage 150 mm	Soil Moisture Storage	150	150	150	122	89	68	62	68	88	114	142	150	-
	Actual Evapotranspiration (AET)	0	0	0	30	76	128	92	68	78	39	8	0	519
	Soil Moisture Deficit (mm)	0	0	0	0	0	-12	39	49	0	0	0	0	76
	Surplus (P – AET)	**65**	**46**	**53**	**38**	**6**	**-21**	**-6**	**6**	**9**	**36**	**75**	**60**	**366.9**

3.7 Post-Development Water Budget (Without Mitigation)

3.7.1 Methodology

A post-development water budget for the site was completed using a soil-moisture balance approach (Thornthwaite and Mather, 1957) combined with the land use plan provided by Hunt Design Associates (2019) (**Appendix A**). Each land use was assigned an impervious factor based on its percentage of imperviousness cover.

Over impervious areas, the percent of imperviousness was determined using areas provided in the proposed LID design plan (SKA, 2019) (**Appendix C2**). This reduces calculation error and improves consistency between the pre- and post-development results of the water budget. An infiltration coefficient of 0.30 was applied where fill materials will be used, and in areas expected to be left untouched such as the woodlot and LSRCA buffer, the surplus was partitioned using the site-specific infiltration and runoff factors determined under pre-development conditions (MOEE, 1995). Infiltration and runoff estimates for the pervious surfaces were then calculated by multiplying the water surplus value by the factors.

3.7.2 Results

Based on the proposed land use (Hunt, 2019), and the imperviousness of the site reported in the proposed LID design plan (SKA, 2019), the total infiltration and runoff volumes for the site following development are 4,311 m^3/year and 17,996 m^3/year, respectively. The results of the calculations are provided in **Table 14**. This represents a decrease in infiltration by approximately 59% from the pre-development scenario (10,451 m^3/year), and an increase in runoff by approximately 483% from pre-development (3,087 m^3/year). The 59% decrease in infiltration assumes no mitigation strategies are in place, and therefore represents a "worst case" scenario. This volume is therefore the target when designing and implementing LID measures on site.

3.8 Post-Development Water Budget (With Mitigation)

3.8.1 Methodology

A post-development water budget for the site, including proposed LID strategies, was completed using the land use plan (Hunt, 2019) (**Appendix A**), and the LID design plan (SKA, 2019) (**Appendix C1**). The percent of imperviousness cover for each drainage area was also provided in the LID design plan.

Three (3) LID strategies have been proposed as a method to balance infiltration volumes post-development: rear yard swales with a granular cistern (LID1 – LID6), granular cisterns below perforated pipes (PP1-PP7), and two Storm Chambers that will receive and infiltrate overflow from the swales and perforated pipes. Locations of the proposed LIDs are shown in **Appendix C2**. The depth of the LID is expected to range between 1.5 and 3.8 mbgs, which was compared to the water table depth on **Figure 4**. It is clear that the LID features will be between 6 and 10 m above the water table at the site. The rear yard swales are designed to accept approximately 50% of the adjacent townhouse roof runoff from blocks along the perimeter of the site, and granular cisterns below perforated pipes are designed to accept runoff from the remaining site area. Overflow from the perforated pipes and rear yard LID systems will be directed to two Stormwater Chambers (Stormwater Chamber 1 and 2) located in the north section of the development plan, which will provide additional water storage and infiltration.

The LID system was sized and designed by SKA to accommodate a 40 mm precipitation event. The total average annual precipitation was determined by adding the daily events which are less than or equal to 40 mm per day, and averaging the annual sums from the 30-year climate normals (1981 to 2010). Precipitation data for this analysis was obtained from the Toronto Lester B. Pearson International Airport Climate Station. Any water storage unable to be accommodated by the Stormwater Chambers following the LID and perforated pipe systems will be converted to runoff.

3.8.2 Results

The results of the post-development water balance inclusive of the proposed LIDs is provided on **Table 15**. Based on the proposed land use and LID measures, approximately 15,837 m^3/year of additional infiltration is retained through the use of LIDs. The total infiltration post-development is therefore 20,148 m^3/year, which includes infiltration that occurs without the aid of LIDs on grassed lawns and retained forest areas (4,311 m^3/year, **Section 3.7.2**). When compared to the pre-development conditions, this represents a 98% increase in infiltration. With the increase in infiltration, the total runoff is expected to be subsequently reduced to 2,159 m^3/year, compared with 3,087 m^3/year pre-development, which is a decrease of 30%. The changes in the water budget from pre-to-post development are summarized in **Table 16**.

Table 13. Summary of Pre-Development Water Balance Results

Land Use	Area (ha)	Impervious Surfaces				Pervious Surfaces						Total Runoff (m^3/yr)	Total Infiltration (m^3/yr)
		Factor	Area (ha)	Surplus (m/yr)	Runoff (m^3/yr)	Area (ha)	Surplus (m/yr)	Runoff Coefficient	Runoff (m^3/yr)	Infiltration Coefficient	Infiltration (m^3/yr)		
Forested / Grassed Area	3.32	0.00	0.00	0.798	0.00	3.32	0.367	0.20	2,438	0.80	9,752	*2,438*	*9,752*
Rural Residential	0.30	0.20	0.06	0.798	474	0.24	0.367	0.20	175	0.80	698	*649*	*698*
TOTAL	**3.62**	**-**	**0.06**	**-**	**474**	**3.56**	**-**	**-**	**2,613**	**-**	**10,451**	***3,087***	***10,451***

Table 14. Summary of Post-Development Water Balance Results (no LID)

LID Catchment	Surficial Geology	Catchment Area (ha)	Impervious Surfaces				Pervious Surfaces						Total Runoff (m^3/yr)	Total Infiltration (m^3/yr)
			Percent Imperviousness (%)	Area (ha)	Surplus (m/yr)	Runoff (m^3/yr)	Area (ha)	Surplus (m/yr)	Runoff Coefficient	Runoff (m^3/yr)	Infiltration Coefficient	Infiltration (m^3/yr)		
LID 1	Sand	0.12	75	0.09	0.798	718	0.03	0.373	0.30	34	0.70	78	752	78
LID 2	Sand	0.31	73	0.23	0.798	1,796	0.09	0.373	0.30	95	0.70	222	1,891	222
LID 3	Sand	0.11	75	0.08	0.798	659	0.03	0.373	0.30	31	0.70	72	689	72
LID 4	Sand	0.06	71	0.04	0.798	340	0.02	0.373	0.30	19	0.70	45	360	45
LID 5	Sand	0.08	80	0.06	0.798	508	0.02	0.373	0.30	18	0.70	43	526	43
LID 6	Sand	0.12	76	0.09	0.798	732	0.03	0.373	0.30	32	0.70	74	764	74
PP 1 – 7	Sand	1.90	78	1.49	0.798	11,878	0.41	0.373	0.30	461	0.70	1,076	12,339	1,076
LSRCA Buffer + Woodlot	Sand	0.92	0	0.00	0.798	0	0.92	0.367	0.20	675	0.80	2,700	675	2,700
TOTAL		**3.620**		**2.08**		**16,631**	**1.54**			**1,365**		**4,311**	**17,996**	**4,311**

Table 15. Summary of Post-Development Water Balance Results (with LID)

LID Catchment	LID Type	LID Trench Width (m)	LID Area (m^2)	Depth to Water Table (Approx.) (m)	Separation b/w Water Table and Base of LID (m)	LID Depth (m)	Depth of Water in LID (m)	Porosity	LID Volume (m^3)	Contributing Area (m^2)	Runoff Coefficient	Rainfall Event Storage (mm)	Runoff Volume to LID based on Rainfall Event (m^3)	Volume Retained in LID (m^3)	Volume Directed to Storm Chamber (m^3)	Percolation Rate (mm/hr)	Drawdown Time (hr)	mm/yr of rainfall based on Event Storage	Total Infiltration (m^3/yr)
LID 1	Rear Yard	1.0	126	>6.7	>1	1.20	0.70	0.40	34.80	1200	0.75	40.0	36.00	34.80	1.20	28.8	24.0	760.2	684.2
LID 2	Rear Yard	1.0 – 1.5	344	>6.7	>1	1.20	0.70	0.40	95.10	3100	0.73	40.0	90.00	90.00	0.00	28.8	24.0	760.2	1710.5
LID 3	Rear Yard	1.5	88	>6.7	>1	1.20	0.70	0.40	24.30	1100	0.75	40.0	33.00	24.30	8.70	28.8	24.0	760.2	627.2
LID 4	Rear Yard	1.0 – 1.5	52	>6.7	>1	1.20	0.70	0.40	14.40	600	0.71	40.0	17.04	14.40	2.64	28.8	24.0	760.2	323.8
LID 5	Rear Yard	1.0 – 1.5	62	>6.7	>1	1.20	0.70	0.40	17.10	800	0.80	40.0	25.44	17.10	8.34	28.8	24.0	760.2	483.5
LID 6	Rear Yard	1.0 – 1.5	56	>6.7	>1	1.20	0.70	0.40	15.50	1200	0.76	40.0	36.68	15.50	21.18	28.8	24.0	760.2	697.1
PP 1 – 7	Perforated Pipe to STM Chamber	varies	955	>6.7	>1	1.20	0.70	0.40	264.00	19000	0.78	40.0	595.16	264.00	331.16	28.8	24.0	760.2	11310.9
TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	***15,837***

The increase in infiltration and decrease in runoff volumes post-development is a reflection of the uniquely high recharge conditions at the site. As the study area is comprised of high permeability sand and silt surficial soils of the ORAC, and has a deep water table (10.05 – 15.02 mbgs) promoting infiltration, nearly all of the water captured in the rear yard LIDs, perforated pipes, and Stormwater Chambers will be infiltrated.

It is expected that the 98% increase in infiltration will have an overall positive impact on natural conditions in the area. Based on the direction of groundwater flow within the site, shown in **Figure 5**, infiltration will be directed south towards Uxbridge Brook, and the associated Uxbridge Brook Headwaters Wetland Complex. The headwaters of Uxbridge Brook are supported by groundwater discharge, and this reach is known to support coldwater fish habitat (LSRCA, 1997).

To maintain groundwater quality of the infiltrated water, much of the water directed to the LID system will be from clean roof runoff (SKA, 2019). In addition, all water from paved surfaces will be directed through properly sized oil/water separators and then through the LID treatment train consisting of fine granular materials in both the perforated pipe system and the Storm Chambers. These measures are expected to maintain the quality of the infiltrated water.

Table 16. Summary of Pre-to-Post Development Water Balance Results

Stage	Units	Runoff	Infiltration
Pre-Development	m^3/yr	3,087	10,451
Post-Development (no LID)	m^3/yr	17,996	4,311
Change Pre-to-Post Development (no LID)	% Change	483%	-59%
	Difference (m^3)	14,909	-6,140
LID Mitigation	Additional Infiltration from LID (m^3/yr)	-15,837	15,837
	Totals (m^3/yr)	**2,159**	**20,148**
Change Pre-to-Post Development (with LID)	% Change	-30%	93%
	Difference (m^3/yr)	-928	9,697

4. Hydrogeological Considerations for Construction

4.1 Source Water Protection

On January 2015, a Source Water Protection Plan was completed that encompasses the Lake Simcoe Source Protection Area (LSRCA, 2015). The Source Water Protection Plan identifies three main regulatory factors under the *Clean Water Act (2006)* relating to local hydrogeology to consider for site development: Significant Groundwater Recharge Areas (SGRAs), Highly Vulnerable Aquifers (HVAs), and Wellhead Protection Areas (WHPAs).

Based on the MECP Source Protection Information mapping, the proposed development is outside of the delineated WHPAs for the Uxbridge municipal supply wells, and is approximately 125 m west of the WHPA-D for the supply wells MW5 and MW7. The study area does fall within designated WHPA-Q1 and WHPA-Q2 areas and is therefore subject to the recharge management policy. This policy states that a hydrogeological assessment and water balance must be completed to ensure pre-development infiltration volumes at the site are maintained post-development.

The majority of the site is situated within a Significant Groundwater Recharge Area and has been assigned a vulnerability score of 6 (**Appendix D**). As the potential for recharge is high, consideration should be given to maintaining or improving infiltration in this region. The site area is additionally situated within a HVA. In these areas, the risk of groundwater contamination is greater due to highly permeable materials at surface. As the study area has been assigned a SWPP vulnerability score of 6, no significant threat is expected which would require stormwater management and/or water balance restrictions.

4.2 Short Term Dewatering

The proposed site development consists of townhouses with one (1) level of basement, founded at approximately 280 masl or 3 mbgs. The deepest LID feature will be constructed at approximately 3.8 mbgs (**Figure 4**). Therefore, dewatering is not expected to be required, as the water table is between approximately 10.05 mbgs and 15.02 mbgs, corresponding to an approximate elevation of range of 270.6 and 271.7 masl.

As construction dewatering will not be required, a Permit To Take Water (PTTW) from the MECP and/or registration on the Environmental and Sector Registry (EASR) are not expected to be needed. No groundwater monitoring is recommended as construction works will take place between approximately 6 and 10 m above the groundwater table.

4.3 Long Term Drainage

Following townhome construction, long term groundwater flow to the underdrain system for the building/basement will be a function of the upward flux through the sand and silt units, leakage through the shoring system around the buildings, and the infiltration rate at the site. Since both the MECP water well records and SPCL borehole data indicate the water table is greater than 6 m below the townhouse foundations, it is not expected that long term drainage will be required.

5. Summary and Conclusions

Based on the results of our investigation, the following summary of conclusions and recommendations are presented:

- The proposed development at 241 Durham Road No. 8 in Uxbridge, Ontario is approximately 3.62 ha in size, and consists of 11 blocks consisting of townhomes and bungalows built with one (1) level of basement, and one roadway.

- Based on the Sirati & Partners Consultants Ltd (SPCL) geotechnical investigation, the soil conditions at the site generally consist of native sand and sandy silt of the ORAC formation with overlying sand to silty sand textured fill materials. The fill material was identified to approximately 1.8 mbgs. The bottom of the native sand unit was not penetrated during the drilling investigation.

- Based on a search of the MECP Water Well Records, fifty (50) water well records are present within a 500 m radius of the site. Of these wells, thirty-seven (37) are described as water supply (domestic) wells, and the remaining thirteen (13) water well records consisted of test holes, observation and monitoring wells or were abandonment records. Municipal water supply is available to all residents of Uxbridge through three (3) municipal water supply wells, MW5, MW6, and MW7. Municipal wells MW5 and MW7 are located approximately 550 m west of the site, and MW6 is approximately 2 km west.

- Groundwater levels were investigated at the three (3) monitoring wells installed by SPCL in February 2018, October 2018, November 2018, and January 2019, and were found to be dry. Water levels were therefore collected from private wells on site, which indicated a water table depth of between approximately 10.05 mbgs and 15.02 mbgs.

- The hydraulic conductivity of the sand was calculated using the Hazen method on grain size distribution curves provided by SPCL, as Single Well Response Tests (SWRTs) were not possible due to insufficient water in the monitoring wells. The geometric mean K value calculated using this method is $5.2x10^{-6}$ m/sec, which corresponds to an infiltration rate of 72 mm/hr.

- Grain size analyses, Guelph Permeameter testing, In-well Infiltration test methods were each used to determine the hydraulic conductivity and infiltration rates of the surficial soils. These methods revealed hydraulic conductivities of $5.2x10^{-6}$ m/s (72 mm/hr), $5.5x10^{-6}$ m/s (73 mm/hr), and $4.6x10^{-6}$ m/s (69 mm/hr) respectively. The geomean of these K values is $5.1x10^{-6}$ m/s (71 mm/hr).

- Under pre-development conditions, infiltration volumes at the site are approximately 10,451 m^3/year, and runoff is approximately 3,087 m^3/year. Without mitigation techniques in place, in the post-development scenario, infiltration rates will decrease by 59% to 4,311 m^3/year, and runoff will increase by 483% to 17,996 m^3/year.

- By implementing the proposed LID mitigation strategies (SKA, 2019), it is expected that infiltration will increase by 98% from pre-development to 20,148 m^3/year, and runoff will decrease by 30% to 2,159 m^3/year. The proposed LID strategies are therefore more than sufficient to balance infiltration pre-to-post development. It is anticipated this will have an overall positive impact on the

natural environment, and infiltration within the site flows south towards Uxbridge Brook, which is supported by groundwater discharge.

- To maintain groundwater quality of the infiltrated water, much of the water directed to the LID system will be from clean roof runoff (SKA, 2019). In addition, all water from paved surfaces will be directed through properly sized oil/water separators and then through the LID treatment train consisting of fine granular materials in both the perforated pipe system and the Storm Chambers. These measures are expected to maintain the quality of the infiltrated water.

- Short-term construction dewatering and long-term foundation drainage are not expected to be required as the water table is more than 5 m lower than the proposed foundation base.

- Based on a comparison of pre-development and post-development phosphorus loads and in consideration of construction phase loading, the MECP phosphorus budgeting tool indicates that the phosphorus load will be reduced by 44% from pre-development conditions without construction phase loading (-0.16 kg/year), and reduced by 33% with construction phase loading (-0.12 kg/year). This exceeds the requirements of the LSPP.

6. Statement of Limitations

The extent of this study was limited to the specific scope of work for which we were retained and that is described in this report. PECG has assumed that the information provided by the client or any secondary sources of information are factual and accurate. PECG accepts no responsibility for any deficiency, misstatement or inaccuracy contained in this report as a result of omissions, misinterpretations or negligent acts from relied upon data. Judgment has been used by PECG in the interpretation of the information provided but subsurface physical and chemical characteristics may differ from regional scale geology mapping and vary between or beyond well/borehole locations given the inherent variability in geological conditions.

PECG is not a guarantor of the geological or groundwater conditions at the subject site, but warrants only that its work was undertaken and its report prepared in a manner consistent with the level of skill and diligence normally exercised by competent geoscience professionals practicing in the Province of Ontario. Our findings, conclusions and recommendations should be evaluated in light of the limited scope of our work.

The information and opinions expressed in the Report are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT PECG'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS PECG MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belongs to PECG. Any use which a third party makes of the Report is the sole responsibility of such third party. PECG accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without PECG's express written permission. Should the project design change following issuance of the Report, PECG must be provided the opportunity to review and revise the Report in light of such alteration or variation.

7. Certification

This report was prepared, reviewed and approved by the undersigned:

Prepared By:

Corinne Hanlon, M.Sc., P.Geo.
Hydrogeologist

Reviewed By:

Bobby Katanchi, M.Sc., P.Geo.
Senior Hydrogeologist

Approved By:

Jason Cole, M.Sc., P.Geo.
Principal, Senior Hydrogeologist

8. References

Armstrong, D.K. and J.E.P. Dodge, 2007.
Paleozoic Geology of Southern Ontario, Project Summary and Technical Document. Sedimentary Geoscience Section. Ontario Geological Survey. 26 p.

Chapman, L.J. and D.F. Putman, 1984.
Physiography of Southern Ontario. 1973. Special Volume No. 2. Toronto, Ontario. Ontario Geological Survey. 270 p.

Hunter and Associates and Raven Beck Environmental Ltd. 1996.
Hydrogeological evaluation of the Oak Ridges Moraine area: technical report. Part of Background Report 3 for the Oak Ridges Moraine Planning Study. Prepared for the Oak Ridges Moraine Technical Working Committee.

Lee, D. M., Elrick, D. E., Reynolds, W. D., & Clothier, B. E. (1985). A Comparison Of Three Field Methods For Measuring Saturated Hydraulic Conductivity. *Canadian Journal of Soil Science,65*(3), 563-573. doi:10.4141/cjss85-060

LSRCA, 1997:
Uxbridge Brook Watershed Plan, Prepared for the Township of Uxbridge.

Ministry of the Environment and Energy (MOEE), 1995.
Technical Information Requirements of Land Development Applications.

Ontario Ministry of Municipal Affairs and Housing (OMMAH), 1997.
Supplementary Guidelines to the Ontario Building Code 1997. SG-6 Percolation Time and Soil Descriptions. Toronto, Ontario.

Thornthwaite, C.W. and J.R. Mather, 1957.
Instructions and tables for computing potential evapotranspiration and water balance. Drexel Institute of Technology, Laboratory of Climatology. Publications in Climatology, Volume X. No. 3, 311 p.

Sharpe, D.R., Barnett P.J., Russell H.A.J., Brennand T.A., and G. Gorrell., 1996.
Regional Geological Mapping of the Oak Ridges Moraine, Greater Toronto Area, Southern Ontario. Geological Survey of Ontario.

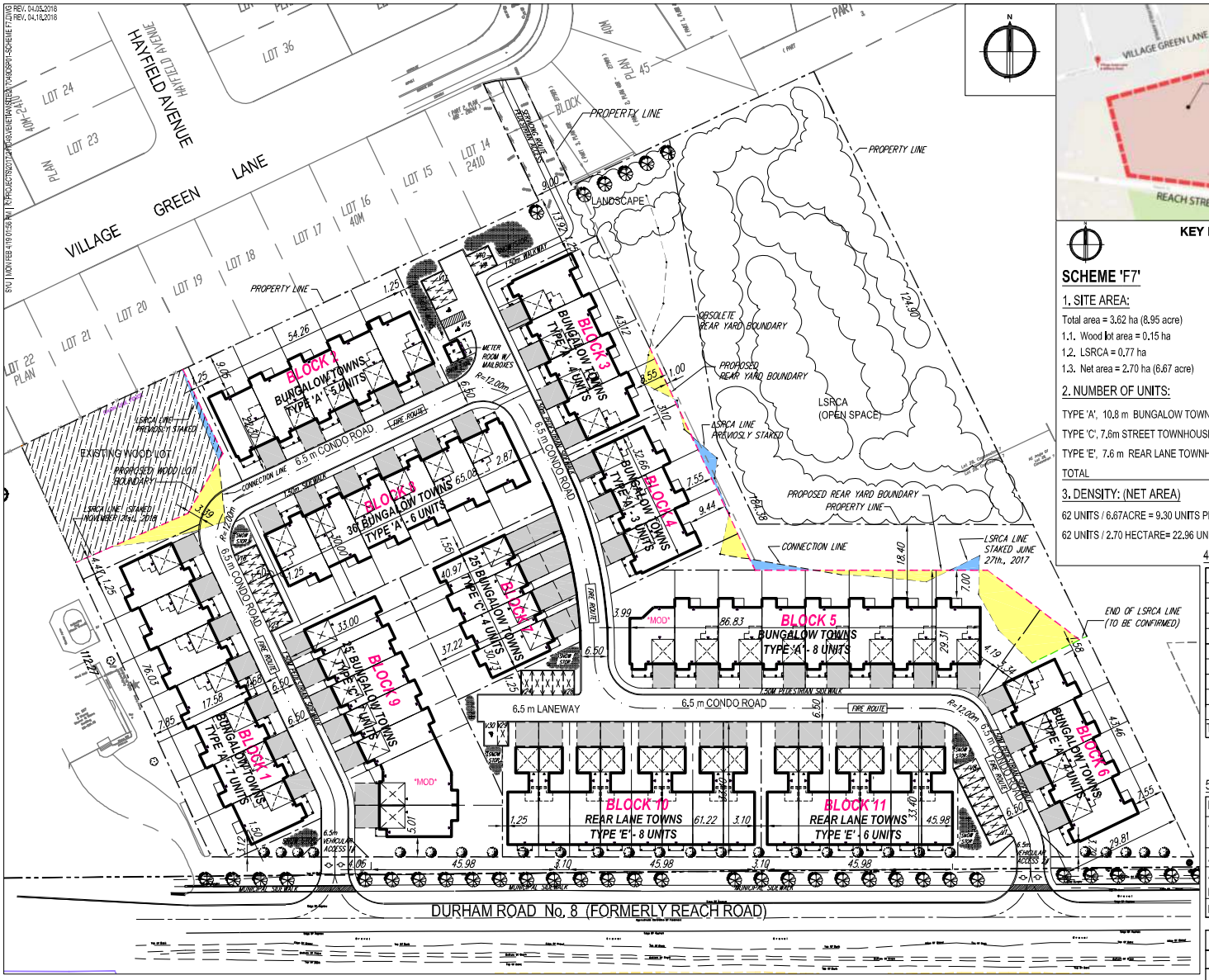
Sharpe, D.R., Dyke, L.D., Hinton, M.J., Pullan, S.E., Russell, H.A.J., Brennand, T.A., Barnett, P.J., and Pugin, A., 1996.
Groundwater prospects in the Oak Ridges Moraine area, southern Ontario: application of regional geological models. In: Current Research 1996-E. Geological Survey of Canada, p 181-190.

South Georgian Bay-Lake Simcoe Source Protection Committee, 2015.
Approved Assessment Report: Lake Simcoe and Couchiching-Black River Source Protection Area Part 1.

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Appendix A

Site Plan Drawing: Scheme E4 (Hunt Design Associates Inc., 2017)



KEY MAP - NOT TO SCALE

SCHEME 'F7'

1. SITE AREA:

Total area = 3.62 ha (8.95 acre)

1.1. Wood lot area = 0.15 ha

1.2. LSRCA = 0.77 ha

1.3. Net area = 2.70 ha (6.67 acre)

2. NUMBER OF UNITS:

TYPE 'A', 10.8 m BUNGALOW TOWNHOUSE,	1-1/2 STOREY	= 37 UNITS
TYPE 'C', 7.6m STREET TOWNHOUSES,	1-1/2 STOREY	= 11 UNITS
TYPE 'E', 7.6 m REAR LANE TOWNHOUSE,	1-1/2 STOREY	= 14 UNITS
TOTAL		= 62 UNITS

3. DENSITY: (NET AREA)

62 UNITS / 6.67ACRE = 9.30 UNITS PER ACRE

62 UNITS / 2.70 HECTARE= 22.96 UNITS PER HECTARE

4. PARKING:

PARKING REQUIRED: 2.0 PER UNIT // 0.5 VISITOR SPACE			
	#UNITS	RES. SPACES	VISITOR. SPACES
TYPE 'A'	37	74	19
TYPE 'C'	11	22	6
TYPE 'E'	14	28	7

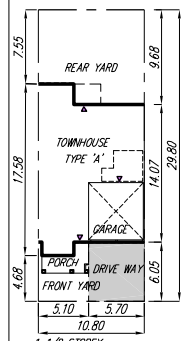
PARKING PROVIDED:				
	#UNITS	RES. SPACES	VISITOR. SPACES	
TYPE 'A'	37	74	74 (ON DRIVEWAY)	
TYPE 'B'	11	22	22 (ON DRIVEWAY)	30 spaces
TYPE 'E'	14	28	28 (ON DRIVEWAY)	
TOTAL PARKING PROVIDED		278 (4.48 / UNIT)		

5. AREA BALANCE OF LSRCA LINE AND WOOD LOT:

DEFINITION	AREA		LEGEND
AREA OF ENCROACHMENT LSRCA LINE AND WOOD LOT (TAKEN)	-521.36 sqm	-5611.87 sq.ft.	
AREA OF CONSERVED WOOD LOT	1374.87 sqm	14798.98 sq.ft.	
AREA OF ADDITIONAL LANDS OUTSIDE OF LSRCA TO BE CONVEYED TO LSRCA (GIVEN)	+84.80 sqm	+912.78 sq.ft.	
RESULT (LSRCA COMPENSATION)	-436.56 sqm	-4699.09 sq.ft.	

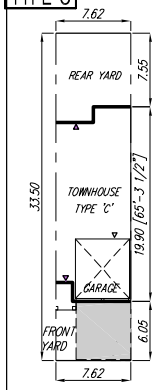
LEGEND:		
	OBSOLETE REAR YARD BOUNDARY	STAKE LINE
	PROPOSED REAR YARD BOUNDARY	FIRE ROUTE
	LSRCA LINE	PROPERTY LINE
		GROUND PARKING SPACE

TYPE 'A'



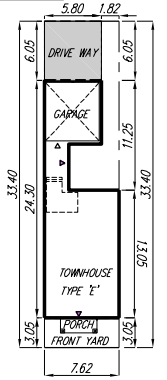
1-1/2 STOREY BUNGALOW TOWNHOUSE
10.8m X 29.8m
MAX. +/- 2250 SQ.FT.

TYPE 'C'



1-1/2 STOREY BUNGALOW TOWNHOUSE
7.62 m X 33.50 m
MAX. +/- 2131 SQ.FT.

TYPE 'E'



1-1/2 STOREY REAR LANE TOWNHOUSE
7.62 m X 33.40 m
MAX. +/- 2260 SQ.FT.

SITE PLAN

SCALE: 1:1000

HUNT DESIGN ASSOCIATES INC.
www.huntdesign.ca

VENETIAN GROUP - 217049

REACH STREET, UXBRIDGE, ONTARIO

SITE PLAN-SCHEME F7

SCALE = 1:1000

8966 Woodbine Ave, Markham, ON L3R 0J7 ■ T 905.737.5133 ■ F 905.737.7326 ■ FEB.4, 2019 ■ SY ■ 217049DSP01-SCHEME F7

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Appendix B

Borehole Logs (Sirati & Partners Consultants Ltd., 2018)

Sirati & Partners Consultants Ltd.
Geotechnical & Environmental Services
Engineering Solutions

LOG OF BOREHOLE BH1

PROJECT: Proposed Geotechnical Investigation
CLIENT: Palmer Environmental Consulting Group Ltd.
PROJECT LOCATION: Reach Street, Uxbridge
DATUM: Geodetic
BH LOCATION: See Drawing 1

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Jan/26/2018
Drilling Contractor:

REF. NO.: SP17-275-10
ENCL NO.: 2

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	CHEMICAL ANALYSIS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
282.5												
0.0 / 282.3	**TOPSOIL:** 250 mm											
0.3	**FILL:** Sand, trace silt, brown, very moist		1	SS	8		282		○			
1			2	SS	1				○			
280.7			3	SS	6		281		○			
1.8 / 2	**SAND:** trace to some silt, greyish brown, compact, moist		4	SS	28		280		○			83 8 9
279.5												
3.0	**SANDY SILT:** greyish brown, compact, moist		5	SS	24		279		○			
4												
			6	SS	21		278		○			
5												
6							277					
			7	SS	27		276		○			
7												
	becoming dense						275					
8 / 274.3			8	SS	35				○			27 63 10
8.2	**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
○ ε=3% Strain at Failure

SPCL SOIL LOG SP17-275-10.GPJ SPCL.GDT 2/2/18

Sirati & Partners Consultants Ltd.
Geotechnical & Environmental Services
Engineering Solutions

LOG OF BOREHOLE BH2

PROJECT: Proposed Geotechnical Investigation
CLIENT: Palmer Environmental Consulting Group Ltd.
PROJECT LOCATION: Reach Street, Uxbridge
DATUM: Geodetic
BH LOCATION: See Drawing 1

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Jan/28/2018
Drilling Contractor:

REF. NO.: SP17-275-10
ENCL NO.: 3

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
283.5							
0.0 / 283.3	**TOPSOIL:** 280 mm		1	SS	3		283
0.3 / 282.8	**FILL** sand, trace silt, brown, very moist						
0.8	**SAND:** trace silt, greyish brown, loose, moist		2	SS	5		
1							282
2 / 281.2			3	SS	10		
2.3	**SANDY SILT:** greyish brown, compact, moist		4	SS	25		281
3			5	SS	20		
4							280
							279
5			6	SS	21		
							278
6							
276.8			7	SS	25		277
6.7	**END OF BOREHOLE:**						

Notes:

1. Monitoring well was installed in the borehole upon completion of drilling
2. The monitoring well was observed to be dry on Feb. 2, 2018

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

CHEMICAL ANALYSIS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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

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

SPCL SOIL LOG SP17-275-10.GPJ SPCL.GDT 2/2/18

Sirati & Partners Consultants Ltd.
Geotechnical & Environmental Services
Engineering Solutions

LOG OF BOREHOLE BH3

PROJECT: Proposed Geotechnical Investigation
CLIENT: Palmer Environmental Consulting Group Ltd.
PROJECT LOCATION: Reach Street, Uxbridge
DATUM: Geodetic
BH LOCATION: See Drawing 1

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Jan/26/2018
Drilling Contractor:

REF. NO.: SP17-275-10
ENCL NO.: 4

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	CHEMICAL ANALYSIS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
282.8												
0.0 / 282.5	**TOPSOIL:** 300 mm		1	SS	1		282		○			
0.3 / 282.0	**FILL:** sand, trace silt, brown, very moist											
0.8	**SAND:** trace silt, greyish brown, very loose to compact, moist		2	SS	3				○			
			3	SS	8		281		○			
	becoming compact		4	SS	15				○			81 13 6
			5	SS	20		280		○			
							279					
			6	SS	20		278		○			
276.7							277					
6.1 / 276.1	**SANDY SILT:** greyish brown, compact, moist		7	SS	26				○			
6.7	**END OF BOREHOLE:**											

Notes:
1. Monitoring well was installed upon completion of drilling
2. The monitoring well was observed to be dry on Feb. 2, 2018

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

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

SPCL SOIL LOG SP17-275-10.GPJ SPCL.GDT 2/2/18

Sirati & Partners Consultants Ltd.
Geotechnical & Environmental Services
Engineering Solutions

LOG OF BOREHOLE BH4

PROJECT: Proposed Geotechnical Investigation
CLIENT: Palmer Environmental Consulting Group Ltd.
PROJECT LOCATION: Reach Street, Uxbridge
DATUM: Geodetic
BH LOCATION: See Drawing 1

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Jan/28/2018
Drilling Contractor:

REF. NO.: SP17-275-10
ENCL NO.: 5

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
284.5							
0.0 / 284.2	**TOPSOIL:** 300 mm		1	SS	4		284
0.3 / 283.7	**FILL:** sand, trace silt, brown, very moist						
0.8	**SAND:** trace silt, light brown, compact, moist		2	SS	16		283
			3	SS	18		
			4	SS	20		282
			5	SS	22		281
279.9							280
4.6	**SANDY SILT:** light brown, compact, moist		6	SS	25		279
			7	SS	28		278
277.8							
6.7	**END OF BOREHOLE:**						

Notes:
1. Borehole was open and dry upon completion of drilling

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)
CHEMICAL ANALYSIS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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

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

SPCL SOIL LOG SP17-275-10.GPJ SPCL.GDT 2/2/18

Sirati & Partners Consultants Ltd.
Geotechnical & Environmental Services
Engineering Solutions

LOG OF BOREHOLE BH5

PROJECT: Proposed Geotechnical Investigation
CLIENT: Palmer Environmental Consulting Group Ltd.
PROJECT LOCATION: Reach Street, Uxbridge
DATUM: Geodetic
BH LOCATION: See Drawing 1

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Jan/28/2018
Drilling Contractor:

REF. NO.: SP17-275-10
ENCL NO.: 6

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	CHEMICAL ANALYSIS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
286.9												
0.0 / 286.5	**TOPSOIL:** 400 mm		1	SS	1							
0.4 / 286.1	**FILL:** sand, trace silt, brown, very moist											
0.8	**SAND:** trace to some silt, greyish brown, loose, moist		2	SS	8		286					
			3	SS	9		285					
			4	SS	9							
	becoming compact		5	SS	15		284					
			6	SS	13		283					
			7	SS	21		282					
280.2							281					
6.7	**END OF BOREHOLE**											

Notes:
1. Borehole was open and dry upon completion of drilling

SPCL SOIL LOG SP17-275-10.GPJ SPCL.GDT 2/2/18

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

Sirati & Partners Consultants Ltd.
Geotechnical & Environmental Services
Engineering Solutions

LOG OF BOREHOLE BH6

PROJECT: Proposed Geotechnical Investigation
CLIENT: Palmer Environmental Consulting Group Ltd.
PROJECT LOCATION: Reach Street, Uxbridge
DATUM: Geodetic
BH LOCATION: See Drawing 1

DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Jan/26/2018
Drilling Contractor:

REF. NO.: SP17-275-10
ENCL NO.: 7

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
289.0							
0.0 / 288.6	**TOPSOIL:** 360 mm		1	SS	25		
0.4 / 288.2	**FILL:** sand, brown, very moist						
0.8	**SAND:** trace to some silt, greyish brown, loose to compact, moist		2	SS	5		288
1							
			3	SS	14		287
2 / 286.7							
2.3	**SANDY SILT:** greyish brown, compact, moist		4	SS	19		
3							286
			5	SS	22		
4							285
			6	SS	18		284
5							
6							283
			7	SS	27		
282.3							
6.7	END OF BOREHOLE:						

Notes:
1. Monitoring well was installed upon completion of drilling
2. The monitoring well was observed to be dry on Feb. 2, 2018

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)
CHEMICAL ANALYSIS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

SPCL SOIL LOG SP17-275-10.GPJ SPCL.GDT 2/2/18

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Appendix C

LID Design Plan (Sabourin Kimble & Associates, 2019)

C1. LID Design Plan Calculations (SKA, 2019)
C2. LID Plan (SKA, 2019)

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

C1. LID Design Plan Calculations (SKA, 2019)

Site Description

Total Site Area	**3.62**	Ha

General Infiltration Requirements

Total Mixed Impervious Surface Area (0.75 coefficient)	20540.0	m^2
Total Roof Impervious Area (0.85 coefficient)	6400.0	m^2
Total Site Impervious Area	20845.0	m^2

Storm to Infiltrate	40	mm
Total Site Volume to Infiltrate	**834**	m^3

Proposed Infiltration

LID Unit	**Down- stream LID Unit**	**Contact Area of Imperviousness** m^2	**Depth** m	**Proposed LID Infiltration Volume** m^3	**Drain Down Time** Hours
Rear Yard LID #1	Perforated Pipe #2	900.0	0.7	34.8	24.0
Perforated Pipe #0	Perforated Pipe #1	357.0	0.7	14.1	24.0
Perforated Pipe #1	Perforated Pipe #2	985.5	0.7	12.2	24.0
Perforated Pipe #2	Perforated Pipe #4	1003.0	0.7	22.1	24.0
Perforated Pipe #3	Perforated Pipe #4	1481.3	0.7	54.7	24.0
Perforated Pipe #4	Perforated Pipe #5	3723.8	0.7	35.9	24.0
Rear Yard LID #2	Perforated Pipe #5	2250.0	0.7	95.1	24.0
Perforated Pipe #5	Storm Chamber 1	672.4	0.7	25.7	24.0
Rear Yard LID #3	N/A	825.0	0.7	24.3	24.0
Rear Yard LID #5	Rear Yard LID #6	636.0	0.7	17.1	24.0
Perforated Pipe #6	Perforated Pipe #7	0.0	0.7	10.8	24.0
Rear Yard LID #6	Perforated Pipe #7	917.1	0.7	15.5	24.0
Perforated Pipe #7	Storm Chamber 1	1784.5	0.7	88.5	24.0
Rear Yard LID #4	Storm Chamber 1	426.0	0.7	14.4	24.0
Storm Chamber 1	Storm Chamber 2	4878.9	1.4	197.1	47.9
Storm Chamber 2	N/A	0.0	1.4	180.5	47.9
			TOTAL	**843**	

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Cumulative Infiltration Volumes

LID Unit	**Down- stream LID Unit**	**Required Infiltration Volume/Reach** m^3	Cummulative Infiltration Required m^3	**Infiltration Available per Reach** m^3	Cummulative Infiltration Available m^3	**Available Volume Infiltrated per Reach** m^3
Rear Yard LID #1	Perforated Pipe #2	36.0	36.0	34.8	34.8	**34.8**
Perforated Pipe #0	Perforated Pipe #1	14.3	14.3	14.1	14.1	**14.1**
Perforated Pipe #1	Perforated Pipe #2	39.4	53.7	12.2	26.3	**26.3**
Perforated Pipe #2	Perforated Pipe #4	40.1	129.8	22.1	83.2	**83.2**
Perforated Pipe #3	Perforated Pipe #4	59.3	59.3	54.7	54.7	**54.7**
Perforated Pipe #4	Perforated Pipe #5	149.0	338.0	35.9	173.8	**173.8**
Rear Yard LID #2	Perforated Pipe #5	90.0	90.0	95.1	95.1	**90.0**
Perforated Pipe #5	Storm Chamber 1	26.9	454.9	25.7	294.6	**294.6**
Rear Yard LID #3	N/A	33.0	33.0	24.3	24.3	**24.3**
Rear Yard LID #5	Rear Yard LID #6	25.4	25.4	17.1	17.1	**17.1**
Perforated Pipe #6	Perforated Pipe #7	0.0	25.4	10.8	27.9	**25.4**
Rear Yard LID #6	Perforated Pipe #7	36.7	36.7	15.5	15.5	**15.5**
Perforated Pipe #7	Storm Chamber 1	71.4	133.5	88.5	131.9	**131.9**
Rear Yard LID #4	Storm Chamber 1	17.0	17.0	14.4	14.4	**14.4**
Storm Chamber 1	Storm Chamber 2	195.2	800.6	197.1	637.9	**637.9**
Storm Chamber 2	N/A	0.0	800.6	180.5	818.4	**818.4**
Sum of Column=		**834**		**843**		**843**

Infiltration Summary

Total Site Volume Required to Infiltrate	834	m^3
Infiltration Volume Provided	843	m^3
Infiltration Volume Achieved	834	m^3
Remaining Volume Required	**0.0**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Rear Yard LID #1
Infiltration Requirements

Total area of imperviousness	900.0	m^2
Volume to infiltrate:	40.0	mm
Target Volume to be infiltrated:	36.0	m^3

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where
- **P=** 28.8 percolation rate of native soil (mm/h)
- **T=** 24.0 detention time (24 hours)

d= 0.69

$A = \frac{1000\ V}{Pnt}$

Where
- **A=** Bottom area of trench (m^2)
- **V=** 36.0 runoff volume to be infiltrated (m^3)
- **P=** 28.8 percolation rate of native soil (mm/h)
- **n=** 0.4 porosity of storage media (0.4 for clear stone)
- **t=** 24.0 detention time (24 hours)

P=K/f.s.
K = 72mm/hr infiltration rate
f.s.= 2.5

$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$

A= 130.2

Area Available for Infiltration

Contact Area	**126.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**87.09**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**34.84**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**1.16**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Perforated Pipe #0
Infiltration Requirements

Total area of imperviousness	357.0	m^2
Volume to infiltrate:	40.0	mm
Target Volume to be infiltrated:	14.3	m^3

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where
P= 28.8 percolation rate of native soil (mm/h)
T= 24.0 detention time (24 hours)

d= 0.69

$A = \frac{1000\ V}{Pnt}$

Where
A= Bottom area of trench (m^2)
V= 14.3 runoff volume to be infiltrated (m^3)
P=K/f.s. **P=** 28.8 percolation rate of native soil (mm/h)
K = 72mm/hr infiltration rate **n=** 0.4 porosity of storage media (0.4 for clear stone)
f.s.= 2.5 **t=** 24.0 detention time (24 hours)

$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$

A= 51.6

Area Available for Infiltration

Contact Area	**51.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**35.25**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**14.10**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**0.18**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Perforated Pipe #1
Infiltration Requirements

Volume to be infiltrated from Upstream Source:	**0.2**	**m^3**
Total area of imperviousness	985.5	m^2
Volume to infiltrate:	40.0	mm
Target Volume to be infiltrated:	39.4	m^3
Total Target Volume Required for LID Infiltration:	**39.6**	**m^3**

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where
P= 28.8 percolation rate of native soil (mm/h)
T= 24.0 detention time (24 hours)

d= 0.69

$A = \frac{1000\ V}{Pnt}$

Where
A= Bottom area of trench (m^2)
V= 39.4 runoff volume to be infiltrated (m^3)
P=K/f.s. **P=** 28.8 percolation rate of native soil (mm/h)
K = 72mm/hr infiltration rate **n=** 0.4 porosity of storage media (0.4 for clear stone)
f.s.= 2.5 **t=** 24.0 detention time (24 hours)

$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$

A= 142.6

Area Available for Infiltration

Contact Area	**44.00 m^2**
Depth of clearstone	0.69 m
Trench Volume	**30.41 m^3**
Void ratio	0.4
Total LID Infiltration Volume Available	**12.17 m^3**

Total Imperviousness to be infiltrated in downstream LID	**27.43**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Perforated Pipe #2
Infiltration Requirements

Volume to be infiltrated from Upstream Source:	**28.6**	**m^3**
Total area of imperviousness	1003.0	m^2
Volume to infiltrate:	40.0	mm
Reach Volume to be infiltrated:	40.1	m^3
Total Target Volume Required for LID Infiltration:	**68.7**	**m^3**

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where	**P=**	28.8	percolation rate of native soil (mm/h)
	T=	24.0	detention time (24 hours)
	d=	0.69	

$A = \frac{1000\ V}{Pnt}$

Where	**A=**		Bottom area of trench (m^2)
	V=	40.1	runoff volume to be infiltrated (m^3)
P=K/f.s.	**P=**	28.8	percolation rate of native soil (mm/h)
K = 72mm/hr infiltration rate	**n=**	0.4	porosity of storage media (0.4 for clear stone)
f.s.= 2.5	**t=**	24.0	detention time (24 hours)

$$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$$

A= 145.1

Area Available for Infiltration

Contact Area	**80.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**55.30**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**22.12**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**46.60**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Perforated Pipe #3
Infiltration Requirements

Total area of imperviousness	1481.3	m^2
Volume to infiltrate:	40.0	mm
Reach Volume to be infiltrated:	59.3	m^3

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where
P= 28.8 percolation rate of native soil (mm/h)
T= 24.0 detention time (24 hours)

d= 0.69

$A = \frac{1000\ V}{Pnt}$

Where
A= Bottom area of trench (m^2)
V= 59.3 runoff volume to be infiltrated (m^3)
P=K/f.s. **P=** 28.8 percolation rate of native soil (mm/h)
K = 72mm/hr infiltration rate **n=** 0.4 porosity of storage media (0.4 for clear stone)
f.s.= 2.5 **t=** 24.0 detention time (24 hours)

$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$

A= 214.3

Area Available for Infiltration

Contact Area	**198.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**136.86**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**54.74**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**4.51**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Perforated Pipe #4
Infiltration Requirements

Volume to be infiltrated from Upstream Source:	**51.1**	**m^3**
Total area of imperviousness	3723.8	m^2
Volume to infiltrate:	40.0	mm
Reach volume to be infiltrated:	149.0	m^3
Total Target Volume Required for LID Infiltration:	**200.1**	**m^3**

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where
P= 28.8 percolation rate of native soil (mm/h)
T= 24.0 detention time (24 hours)

d= 0.69

$A = \frac{1000\ V}{Pnt}$

Where
A= Bottom area of trench (m^2)
V= 200.1 runoff volume to be infiltrated (m^3)
P=K/f.s. **P=** 28.8 percolation rate of native soil (mm/h)
K = 72mm/hr infiltration rate **n=** 0.4 porosity of storage media (0.4 for clear stone)
f.s.= 2.5 **t=** 24.0 detention time (24 hours)

$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$

A= 723.6

Area Available for Infiltration

Contact Area	**130.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**89.70**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**35.88**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**164.18**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Rear Yard LID #2
Infiltration Requirements

Total area of imperviousness	2250.0	m^2
Volume to infiltrate:	40.0	mm
Target Volume to be infiltrated:	90.0	m^3

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where
P= 28.8 percolation rate of native soil (mm/h)
T= 24.0 detention time (24 hours)

d= 0.69

$A = \frac{1000\ V}{Pnt}$

Where
A= Bottom area of trench (m^2)
V= 90.0 runoff volume to be infiltrated (m^3)
P=K/f.s. **P=** 28.8 percolation rate of native soil (mm/h)
K = 72mm/hr infiltration rate **n=** 0.4 porosity of storage media (0.4 for clear stone)
f.s.= 2.5 **t=** 24.0 detention time (24 hours)

$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$

A= 325.5

Area Available for Infiltration

Contact Area	**344.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**237.77**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**95.11**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**0.00**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Perforated Pipe #5
Infiltration Requirements

Volume to be infiltrated from Upstream Source:	**164.2**	**m^3**
Total area of imperviousness	672.4	m^2
Volume to infiltrate:	40.0	mm
Volume to be infiltrated:	26.9	m^3
Total Target Volume Required for LID Infiltration:	**191.1**	**m^3**

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where
P= 28.8 percolation rate of native soil (mm/h)
T= 24.0 detention time (24 hours)

d= 0.69

$A = \frac{1000\ V}{Pnt}$

Where
A= Bottom area of trench (m^2)
V= 191.1 runoff volume to be infiltrated (m^3)
P= 28.8 percolation rate of native soil (mm/h)
n= 0.4 porosity of storage media (0.4 for clear stone)
t= 24.0 detention time (24 hours)

P=K/f.s.
K = 72mm/hr infiltration rate
f.s.= 2.5

$$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$$

A= 691.1

Area Available for Infiltration

Contact Area	**93.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**64.17**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**25.67**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**165.40**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Rear Yard LID #3
Infiltration Requirements

Total area of imperviousness	825.0	m^2
Volume to infiltrate:	40.0	mm
Target Volume to be infiltrated:	33.0	m^3

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where
P= 28.8 percolation rate of native soil (mm/h)
T= 24.0 detention time (24 hours)

d= 0.69

$A = \frac{1000\ V}{Pnt}$

Where
A= Bottom area of trench (m^2)
V= 33.0 runoff volume to be infiltrated (m^3)
P=K/f.s. **P=** 28.8 percolation rate of native soil (mm/h)
K = 72mm/hr infiltration rate **n=** 0.4 porosity of storage media (0.4 for clear stone)
f.s.= 2.5 **t=** 24.0 detention time (24 hours)

$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$

A= 119.4

Area Available for Infiltration

Contact Area	**88.00 m^2**
Depth of clearstone	0.69 m
Trench Volume	**60.83 m^3**
Void ratio	0.4
Total LID Infiltration Volume Available	**24.33 m^3**

Total Imperviousness to be infiltrated in downstream LID	**8.67**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Rear Yard LID #5
Infiltration Requirements

Total area of imperviousness	636.0	m^2
Volume to infiltrate:	40.0	mm
Target Volume to be infiltrated:	25.4	m^3

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where
P= 28.8 percolation rate of native soil (mm/h)
T= 24.0 detention time (24 hours)

d= 0.69

$A = \frac{1000\ V}{Pnt}$

Where
A= Bottom area of trench (m^2)
V= 25.4 runoff volume to be infiltrated (m^3)
P=K/f.s. **P=** 28.8 percolation rate of native soil (mm/h)
K = 72mm/hr infiltration rate **n=** 0.4 porosity of storage media (0.4 for clear stone)
f.s.= 2.5 **t=** 24.0 detention time (24 hours)

$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$

A= 92.0

Area Available for Infiltration

Contact Area	**62.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**42.85**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**17.14**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**8.30**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Perforated Pipe #6
Infiltration Requirements

Volume to be infiltrated from Upstream Source:	**8.3**	**m^3**
Total area of imperviousness	0.0	m^2
Volume to infiltrate:	40.0	mm
Volume to be infiltrated:	0.0	m^3
Total Target Volume Required for LID Infiltration:	**8.3**	**m^3**

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where
P= 28.8 percolation rate of native soil (mm/h)
T= 24.0 detention time (24 hours)

d= 0.69

$A = \frac{1000\ V}{Pnt}$

Where
A= Bottom area of trench (m^2)
V= 8.3 runoff volume to be infiltrated (m^3)
P=K/f.s. **P=** 28.8 percolation rate of native soil (mm/h)
K = 72mm/hr infiltration rate **n=** 0.4 porosity of storage media (0.4 for clear stone)
f.s.= 2.5 **t=** 24.0 detention time (24 hours)

$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$

A= 30.0

Area Available for Infiltration

Contact Area	**39.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**26.96**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**10.78**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**0.00**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Rear Yard LID #6
Infiltration Requirements

Total area of imperviousness	917.1	m^2
Volume to infiltrate:	40.0	mm
Target Volume to be infiltrated:	36.7	m^3

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where	**P=**	28.8	percolation rate of native soil (mm/h)
	T=	24.0	detention time (24 hours)
	d=	0.69	

$A = \frac{1000\ V}{Pnt}$

Where	**A=**		Bottom area of trench (m^2)
	V=	36.7	runoff volume to be infiltrated (m^3)
P=K/f.s.	**P=**	28.8	percolation rate of native soil (mm/h)
K = 72mm/hr infiltration rate	**n=**	0.4	porosity of storage media (0.4 for clear stone)
f.s.= 2.5	**t=**	24.0	detention time (24 hours)

$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$

A= 132.7

Area Available for Infiltration

Contact Area	**56.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**38.71**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**15.48**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**21.20**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Perforated Pipe #7
Infiltration Requirements

Volume to be infiltrated from Upstream Source:	**21.2**	**m^3**
Total area of imperviousness	1784.5	m^2
Volume to infiltrate:	40.0	mm
Volume to be infiltrated:	71.4	m^3
Total Target Volume Required for LID Infiltration:	**92.6**	**m^3**

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where
P= 28.8 percolation rate of native soil (mm/h)
T= 24.0 detention time (24 hours)

d= 0.69

$A = \frac{1000\ V}{Pnt}$

Where
A= Bottom area of trench (m^2)
V= 92.6 runoff volume to be infiltrated (m^3)
P= 28.8 percolation rate of native soil (mm/h)
n= 0.4 porosity of storage media (0.4 for clear stone)
t= 24.0 detention time (24 hours)

P=K/f.s.
K = 72mm/hr infiltration rate
f.s.= 2.5

$$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$$

A= 334.9

Area Available for Infiltration

Contact Area	**320.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**221.18**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**88.47**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**4.11**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Rear Yard LID #4
Infiltration Requirements

Total area of imperviousness	426.0	m^2
Volume to infiltrate:	40.0	mm
Target Volume to be infiltrated:	17.0	m^3

Maximum clearstone depth: $d = \frac{PT}{1000}$

Where
P= 28.8 percolation rate of native soil (mm/h)
T= 24.0 detention time (24 hours)

d= 0.69

$A = \frac{1000\ V}{Pnt}$

Where
A= Bottom area of trench (m^2)
V= 17.0 runoff volume to be infiltrated (m^3)
P=K/f.s. **P=** 28.8 percolation rate of native soil (mm/h)
K = 72mm/hr infiltration rate **n=** 0.4 porosity of storage media (0.4 for clear stone)
f.s.= 2.5 **t=** 24.0 detention time (24 hours)

$A = \frac{(1000)(12.5)}{(12.0)(0.4)(72.0)}$

A= 61.6

Area Available for Infiltration

Contact Area	**52.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**35.94**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**14.38**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**2.66**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Storm Chamber 1
Infiltration Requirements

Volume to be infiltrated from Upstream Source:	**172.17**	**m^3**
Total area of imperviousness	4878.9	m^2
Volume to infiltrate:	40.0	mm
Volume to be infiltrated:	195.2	m^3
Total Target Volume Required for LID Infiltration:	**367.3**	**m^3**

Drain Down Time: $T = \frac{1000d}{P}$

Where	**P=**	28.8	percolation rate of native soil (mm/h)
	d=	1.38	(m)
P=K/f.s.			
K = 72mm/hr infiltration rate	**T=**	47.92	detention time (Hours)
f.s.= 2.5			

Area Available for Infiltration

Contact Area	**357.00 m^2**
Depth of clearstone	1.38 m
Trench Volume	**492.66 m^3**
Void ratio	0.4
Total LID Infiltration Volume Available	**197.06 m^3**

Total Imperviousness to be infiltrated in downstream LID	**170.27**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

Storm Chamber 2
Infiltration Requirements

Volume to be infiltrated from Upstream Source:	**170.27**	**m^3**
Total area of imperviousness	0.0	m^2
Volume to infiltrate:	40.0	mm
Volume to be infiltrated:	0.0	m^3
Total Target Volume Required for LID Infiltration:	**170.3**	**m^3**

Drain Down Time: $T = \frac{1000d}{P}$

Where	**P=**	28.8	percolation rate of native soil (mm/h)
	d=	1.4	(m)
P=K/f.s.			
K = 72mm/hr infiltration rate	**T=**	47.92	detention time (Hours)
f.s.= 2.5			

Area Available for Infiltration

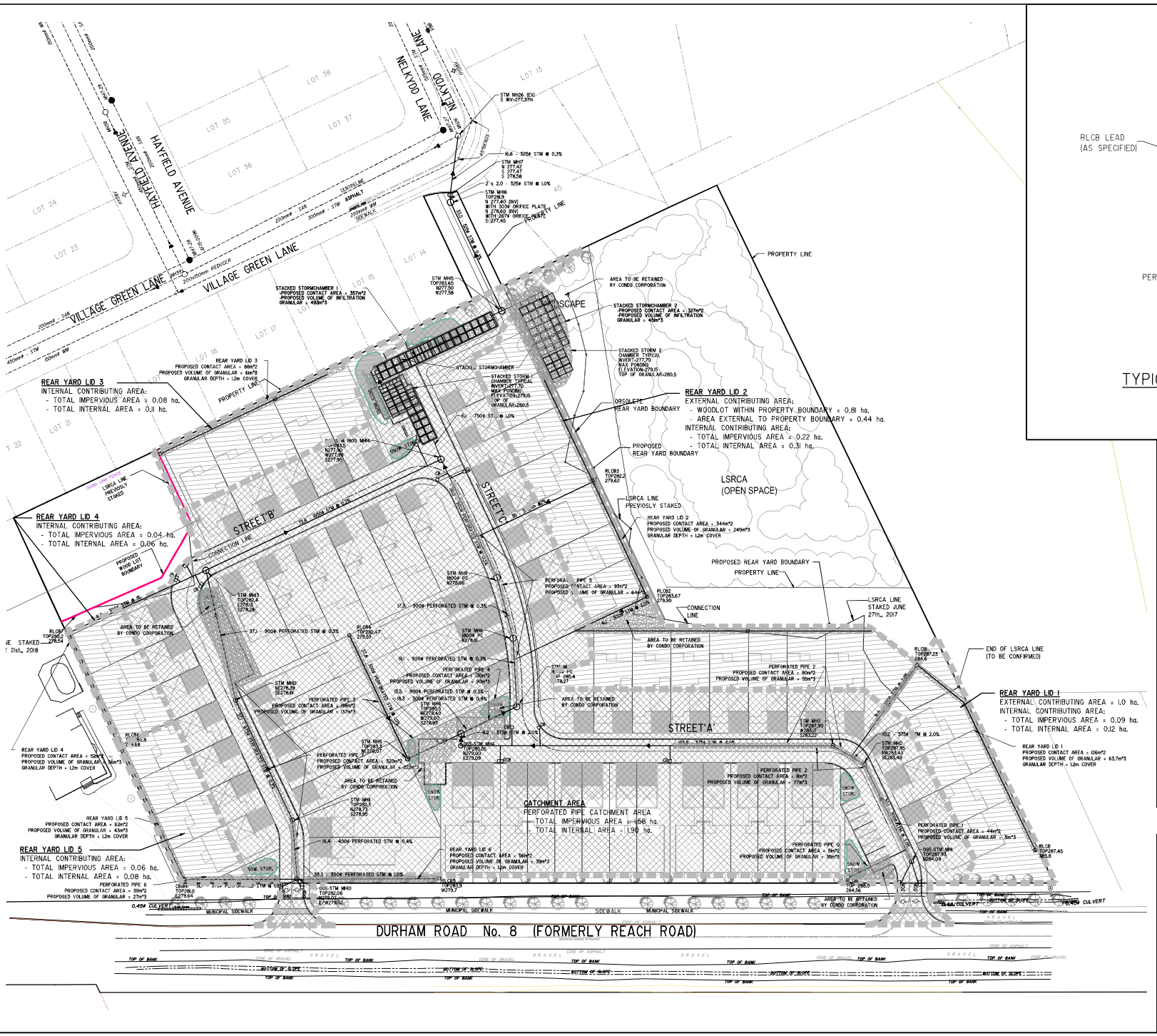
Contact Area	**327.00 m^2**
Depth of clearstone	1.38 m
Trench Volume	**451.26 m^3**
Void ratio	0.4
Total LID Infiltration Volume Available	**180.50 m^3**

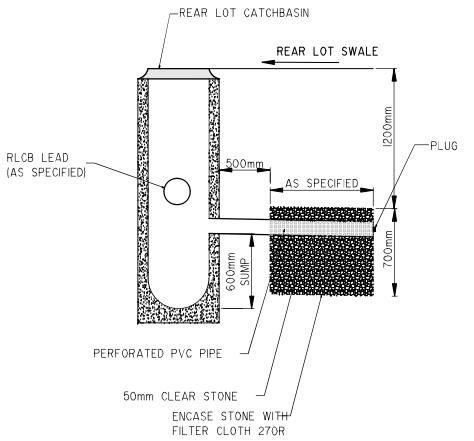
Total Imperviousness to be infiltrated in downstream LID	**0.00**	**m^3**

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

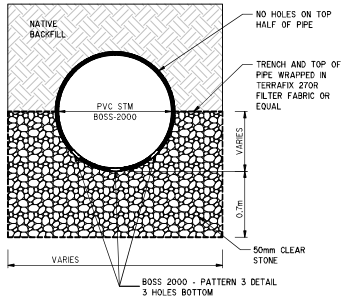
C2. Proposed LID Works (SKA, 2019)





TYPICAL PERVIOUS RLCB

NTS



PERFORATED PIPE TYPICAL DETAIL

N.T.S.

LEGEND

- LID CAPTURE BOUNDARY
- DIRECTION OF SEWER FLOW PROPOSED

SCALE 1:500

PROPOSED LID WORKS

SABOURIN KIMBLE & ASSOCIATES LTD.
CONSULTING ENGINEERS

PROJECT NUMBER	FIGURE NUMBER
17:386	6

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Appendix D

Source Water Protection (South Georgian Bay-Lake Simcoe Source Protection Committee, 2015)

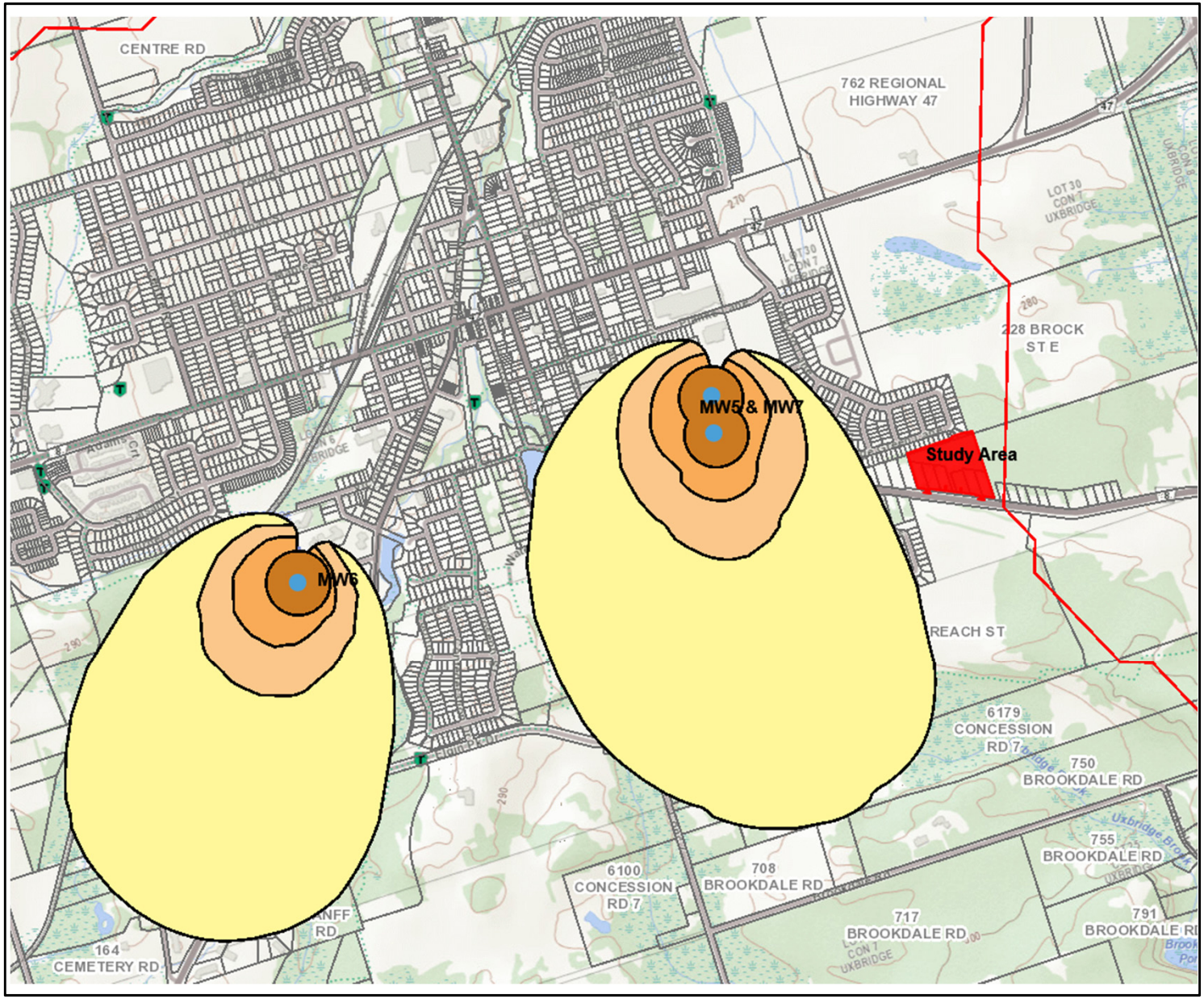
D1. Uxbridge – Wellhead Protection Areas

D2. Uxbridge – Significant Groundwater Recharge Areas

D3. Uxbridge – Highly Vulnerable Aquifer

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

D1. Uxbridge – Wellhead Protection Areas



Legend

- Study Area
- Uxbridge Municipal Supply Well
- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D
- WHPA-Q
- Roadway

N

500 m

Uxbridge – WHPA

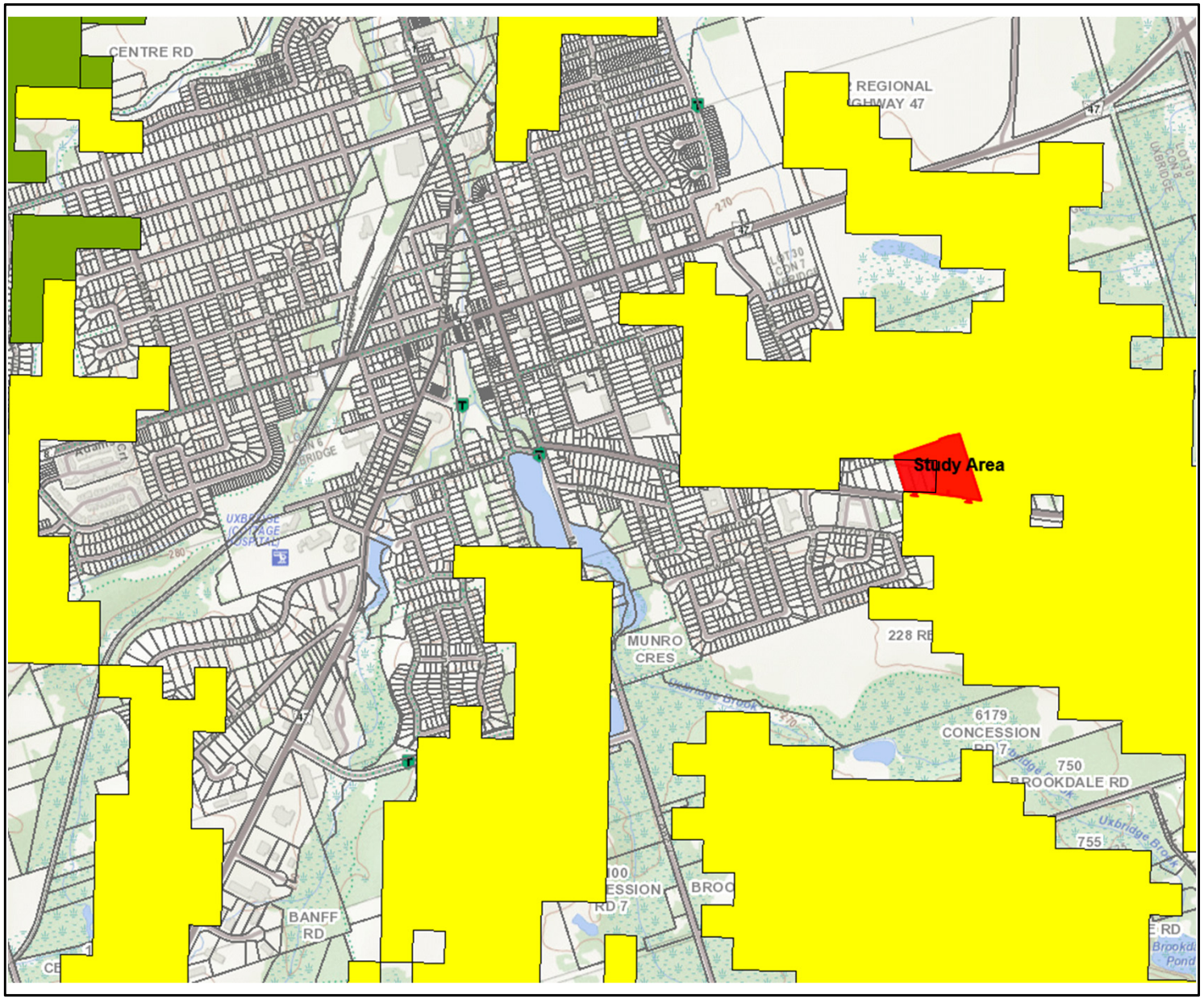
Source Water Protection Mapping

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix D1

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

D2. Uxbridge – Significant Groundwater Recharge Areas



Legend

- Study Area
- SGRA – Vulnerability Score 2
- SGRA – Vulnerability Score 4
- SGRA – Vulnerability Score 6
- Roadway

N

500 m

Uxbridge – SGRA

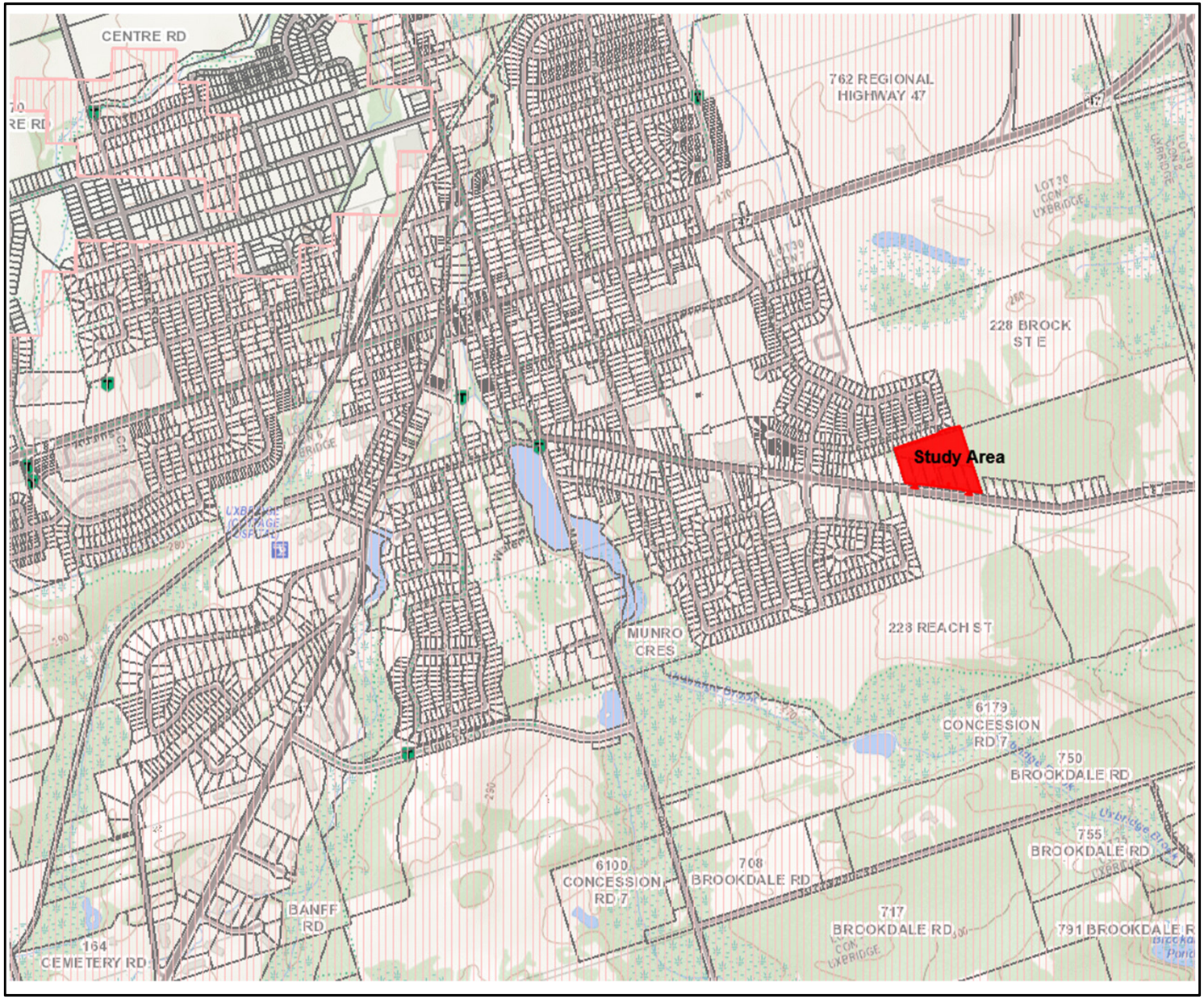
Source Water Protection Mapping

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix D2

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

D3. Uxbridge – Highly Vulnerable Aquifer



Legend

- Study Area
- HVA
- Roadway

N

500 m

Uxbridge – HVA

Source Water Protection Mapping

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Appendix D3

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Appendix E

MECP Phosphorus Budget Tool Summary (V2.0 Release Update - March 30, 2012)

Ontario
MINISTRY OF THE ENVIRONMENT

Database Version: **V 2.0 Release Update**
Update Date: **30-Mar-12**

Project DEVELOPMENT Summary

DEVELOPMENT: 241-Reach
Subwatershed: Pefferlaw-Uxbridge Brook

Total Pre-Development Area (ha):	**3.6200**	Total Pre-Development Phosphorus Load (kg/yr):	**0.36**

Pre-Development Land Use	Area (ha)	P coeff. (kg/ha)	P Load (kg/yr)
Forest	1.15	0.03	0.03
Low Intensity Development	2.47	0.13	0.32

POST-DEVELOPMENT LOAD

Post-Development Land Use	Area (ha)	P coeff. (kg/ha)	Best Management Practice applied with P Removal Efficiency		P Load (kg/yr)
Forest	0.92	0.03	Soakaways - Infiltration trenches	60%	0.01
High Intensity - Residential	1.89	1.32	Treatment Train Approach	98%	0.05
High Intensity - Residential	0.81	1.32	Perforated Pipe Infiltration/Exfiltration Systems	87%	0.14

Post-Development Area Altered:	**3.62**
Total Pre-Development Area:	**3.62**
Unaffected Area:	**0**

	P Load (kg/yr)
Pre-Development:	**0.36**
Post-Development:	**3.59**
Change (Pre - Post):	**-3.24**
910% Net Increase in Load	
Post-Development (with BMPs):	**0.20**
Change (Pre - Post):	**0.16**
44% Net Reduction in Load	

DEVELOPMENT: 241-Reach
Subwatershed: Pefferlaw-Uxbridge Brook

CONSTRUCTION PHASE LOAD

Site-Specific Input:		Constant / Lookup:	
		Calculation:	

Sub Area: Development

Duration of Construction (months):	12	R (rainfall / runoff for Lake Simcoe)	90
Duration of Exposed Soil (months):	3	K (soil erodability factor):	0.02
Surface Slope Gradient (%):	0.5	NN (determined by slope):	0.2
Length of Slope (m):	315	BMP prevention Efficiency:	90%
Slope Area (ha):	2.7	BMP capture Efficiency:	70%
% slope erosion prevention applied to:	0.3	LS (slope length gradient factor):	*0.66*
% slope runoff capture applied to:	0.7	C (portion of year of exposed soil):	*0.25*
Subwatershed Soil [P] (kg/kg):	0.0004	P (prevention + capture):	*0.37*
		Soil Loss (kg/year):	*735.694*
		Phosphorus Load (kg):	*0.29*

Developed AREA (ha): 2.70000004768

	Total
Construction Phase Phosphorus Load with BMPs (kg):	0.29
Construction Phase Phosphorus Load no BMPs (kg):	0.79

SUMMARY WITH IMPLEMENTATION OF BMPs	**P Load (kg/yr)**
Pre-Development:	**0.36**
Construction Phase Amortized Over 8 Years :	0.04
Post-Development:	**0.20**
Post-Development + Amortized Construction:	**0.24**
Pre-Development Load - Post-Development Load:	**0.16**
Conclusion:	**44% Reduction in Load**
Pre-Development Load - (Post-Development + Amortized Construction Load):	**0.12**
Conclusion:	**33% Reduction in Load**

Based on a comparison of Pre-Development and Post-Development loads, and in consideration of Construction Phase loads, the Ministry would encourage the Municipality to:

Approve development as site specific appropriate.

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Appendix F

Certificate of Analysis (ALS, 2018)

PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
ATTN: Bobby Katanchi
74 Berkeley Street
Toronto on M5A 2W7

Date Received: 08-NOV-18
Report Date: 16-NOV-18 12:06 (MT)
Version: FINAL REV. 2

Client Phone: 416-317-9393

Certificate of Analysis

Lab Work Order #: L2194429

Project P.O. #: NOT SUBMITTED
Job Reference: 170521
C of C Numbers: 17-639640
Legal Site Desc:

Comments: 16-NOV-18 Report type revision to compare to Ontario Drinking Water standards as per client request. -A.Fazekas

Amanda Fazekas
Account Manager

Summary of Guideline Exceedances

Guideline ALS ID	Client ID	Grouping	Analyte	Result	Guideline Limit	Unit
Ontario Drinking Water Regulation (ODWQS) JAN.1,2018 - Schedule 1 (Microbiological) and 2 (Chemical) Standards (JAN,2018)						
(No parameter exceedances)						
Ontario Drinking Water Regulation (ODWQS) JAN.1,2018 - Ontario DW Aesthetic and Operational Guidelines						
L2194429-1	241 REACH ST.	Physical Tests	Colour, Apparent	46.4	5	CU
			Turbidity	47.2	5	NTU
		Anions and Nutrients	Hardness (as CaCO3)	111	80-100	mg/L
		Dissolved Metals	Iron (Fe)-Dissolved	1.74	0.3	mg/L
			Manganese (Mn)-Dissolved	0.0998	0.05	mg/L
L2194429-2	231 REACH ST.	Physical Tests	Colour, Apparent	36.0	5	CU
			Turbidity	33.2	5	NTU
		Anions and Nutrients	Hardness (as CaCO3)	304	80-100	mg/L
		Dissolved Metals	Manganese (Mn)-Dissolved	0.761	0.05	mg/L

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Physical Tests - WATER

Analyte	Unit	Guide Limits #1	Guide Limits #2	Lab ID: L2194429-1 / Sample Date: 08-NOV-18 / Sample ID: 241 REACH ST.	Lab ID: L2194429-2 / Sample Date: 08-NOV-18 / Sample ID: 231 REACH ST.
Colour, Apparent	CU	-	5	46.4	36.0
Conductivity	umhos/cm	-	-	217	651
pH	pH units	-	6.5-8.5	8.17	7.89
Redox Potential	mV	-	-	251 PEHR	288 PEHR
Total Dissolved Solids	mg/L	-	500	118 DLDS	468 DLDS
Turbidity	NTU	-	5	47.2	33.2

Guide Limit #1: Schedule 1 (Microbiological) and 2 (Chemical) Standards (JAN,2018)
Guide Limit #2: Ontario DW Aesthetic and Operational Guidelines

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

Anions and Nutrients - WATER

				Lab ID	L2194429-1	L2194429-2
				Sample Date	08-NOV-18	08-NOV-18
				Sample ID	241 REACH ST.	231 REACH ST.
Analyte	Unit	Guide Limits #1	#2			
Alkalinity, Bicarbonate (as CaCO3)	mg/L	-	-		113	138
Alkalinity, Carbonate (as CaCO3)	mg/L	-	-		<10	<10
Alkalinity, Hydroxide (as CaCO3)	mg/L	-	-		<10	<10
Alkalinity, Total (as CaCO3)	mg/L	-	30-500		113	138
Ammonia, Total (as N)	mg/L	-	-		0.079	0.027
Bromide (Br)	mg/L	-	-		<0.10	<0.10
Chloride (Cl)	mg/L	-	250		1.54	86.2
Computed Conductivity	uS/cm	-	-		202	629
Conductivity % Difference	%	-	-		-7.2	-3.4
Fluoride (F)	mg/L	1.5	-		0.036	0.021
Hardness (as CaCO3)	mg/L	-	80-100		111	304
Ion Balance	%	-	-		125	108
Langelier Index		-	-		0.2	0.6
Nitrate and Nitrite as N	mg/L	10.0	-		<0.022	<0.022
Nitrate (as N)	mg/L	10	-		<0.020	<0.020
Nitrite (as N)	mg/L	1	-		<0.010	<0.010
Saturation pH	pH	-	-		7.92	7.34
Orthophosphate-Dissolved (as P)	mg/L	-	-		<0.0030	<0.0030
TDS (Calculated)	mg/L	-	-		113	355
Sulfate (SO4)	mg/L	-	500		1.23	64.6
Anion Sum	me/L	-	-		1.95	6.06
Cation Sum	me/L	-	-		2.44	6.53
Cation - Anion Balance	%	-	-		11.2	3.7

Guide Limit #1: Schedule 1 (Microbiological) and 2 (Chemical) Standards (JAN,2018)
Guide Limit #2: Ontario DW Aesthetic and Operational Guidelines

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Organic / Inorganic Carbon - WATER

		Guide Limits			
Lab ID				L2194429-1	L2194429-2
Sample Date				08-NOV-18	08-NOV-18
Sample ID				241 REACH ST.	231 REACH ST.
Analyte	**Unit**	**#1**	**#2**		
Dissolved Carbon Filtration Location		-	-	LAB	LAB
Dissolved Organic Carbon	mg/L	-	5	2.02	1.39

Guide Limit #1: Schedule 1 (Microbiological) and 2 (Chemical) Standards (JAN,2018)
Guide Limit #2: Ontario DW Aesthetic and Operational Guidelines

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Inorganic Parameters - WATER

				Lab ID	L2194429-1	L2194429-2
				Sample Date	08-NOV-18	08-NOV-18
				Sample ID	241 REACH ST.	231 REACH ST.
		Guide Limits				
Analyte	Unit	#1	#2			
Silica	mg/L	-	-	4.70	4.28	

Guide Limit #1: Schedule 1 (Microbiological) and 2 (Chemical) Standards (JAN,2018)
Guide Limit #2: Ontario DW Aesthetic and Operational Guidelines

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Bacteriological Tests - WATER

Analyte	Unit	Guide Limits #1	Guide Limits #2	Lab ID: L2194429-1 / Sample Date: 08-NOV-18 / Sample ID: 241 REACH ST.	Lab ID: L2194429-2 / Sample Date: 08-NOV-18 / Sample ID: 231 REACH ST.
E. Coli	CFU/100mL	0	-	0	0

Guide Limit #1: Schedule 1 (Microbiological) and 2 (Chemical) Standards (JAN,2018)
Guide Limit #2: Ontario DW Aesthetic and Operational Guidelines

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Dissolved Metals - WATER

Analyte	Unit	Guide Limits #1	Guide Limits #2	Lab ID / Sample Date / Sample ID: L2194429-1, 08-NOV-18, 241 REACH ST.	Lab ID / Sample Date / Sample ID: L2194429-2, 08-NOV-18, 231 REACH ST.
Dissolved Metals Filtration Location		-	-	FIELD	LAB
Aluminum (Al)-Dissolved	mg/L	-	0.1	<0.0050	<0.0050
Antimony (Sb)-Dissolved	mg/L	0.006	-	<0.00010	<0.00010
Arsenic (As)-Dissolved	mg/L	0.0100	-	0.00107	<0.00010
Barium (Ba)-Dissolved	mg/L	1	-	0.0369	0.0307
Beryllium (Be)-Dissolved	mg/L	-	-	<0.00010	<0.00010
Bismuth (Bi)-Dissolved	mg/L	-	-	<0.000050	<0.000050
Boron (B)-Dissolved	mg/L	5	-	<0.010	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.005	-	<0.000010	<0.000010
Calcium (Ca)-Dissolved	mg/L	-	-	24.3	93.7
Chromium (Cr)-Dissolved	mg/L	0.05	-	<0.00050	<0.00050
Cobalt (Co)-Dissolved	mg/L	-	-	<0.00010	0.00098
Copper (Cu)-Dissolved	mg/L	-	1	0.00048	<0.00020
Iron (Fe)-Dissolved	mg/L	-	0.3	1.74	<0.010
Lead (Pb)-Dissolved	mg/L	0.01	-	0.000268	0.000086
Magnesium (Mg)-Dissolved	mg/L	-	-	12.2	17.0
Manganese (Mn)-Dissolved	mg/L	-	0.05	0.0998	0.761
Molybdenum (Mo)-Dissolved	mg/L	-	-	0.000690	0.000758
Nickel (Ni)-Dissolved	mg/L	-	-	<0.00050	0.00068
Phosphorus (P)-Dissolved	mg/L	-	-	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	-	-	1.28	1.11
Selenium (Se)-Dissolved	mg/L	0.05	-	0.000149	0.000093
Silicon (Si)-Dissolved	mg/L	-	-	2.20	2.00
Silver (Ag)-Dissolved	mg/L	-	-	<0.000050	<0.000050
Sodium (Na)-Dissolved	mg/L	20	200	4.30	9.80
Strontium (Sr)-Dissolved	mg/L	-	-	0.0893	0.179
Sulfur (S)-Dissolved	mg/L	-	-	<5.0	21.5
Thallium (Tl)-Dissolved	mg/L	-	-	<0.000010	<0.000010
Tin (Sn)-Dissolved	mg/L	-	-	0.00521	0.00195
Titanium (Ti)-Dissolved	mg/L	-	-	<0.00030	<0.00030

Guide Limit #1: Schedule 1 (Microbiological) and 2 (Chemical) Standards (JAN,2018)
Guide Limit #2: Ontario DW Aesthetic and Operational Guidelines

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Dissolved Metals - WATER

Analyte	Unit	Guide Limits #1	Guide Limits #2	Lab ID: L2194429-1 Sample Date: 08-NOV-18 Sample ID: 241 REACH ST.	Lab ID: L2194429-2 Sample Date: 08-NOV-18 Sample ID: 231 REACH ST.
Tungsten (W)-Dissolved	mg/L	-	-	<0.00010	<0.00010
Uranium (U)-Dissolved	mg/L	0.02	-	0.000010	0.000191
Vanadium (V)-Dissolved	mg/L	-	-	<0.00050	<0.00050
Zinc (Zn)-Dissolved	mg/L	-	5	0.0187	0.583
Zirconium (Zr)-Dissolved	mg/L	-	-	<0.00030	<0.00030

Guide Limit #1: Schedule 1 (Microbiological) and 2 (Chemical) Standards (JAN,2018)
Guide Limit #2: Ontario DW Aesthetic and Operational Guidelines

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
PEHR	Parameter Exceeded Recommended Holding Time On Receipt: Proceed With Analysis As Requested.

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-AUTO-WT	Water	Automated Speciated Alkalinity	EPA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ALK-SPECIATED-WT	Water	pH Measurement for Spec. Alk	APHA 4500 H-Electrode
Water samples are analyzed directly by a calibrated pH meter.			
BR-IC-N-WT	Water	Bromide in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-IC-N-WT	Water	Chloride by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).			
COLOUR-APPARENT-WT	Water	Colour	APHA 2120
Apparent Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method after sample decanting. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.			
DOC-WT	Water	Dissolved Organic Carbon	APHA 5310B
Sample is filtered through a 0.45um filter, then injected into a heated reaction chamber which is packed with an oxidative catalyst. The water is vaporized and the organic carbon is oxidized to carbon dioxide. The carbon dioxide is transported in a carrier gas and is measured by a non-dispersive infrared detector.			
EC-MF-WT	Water	E. coli	SM 9222D
A 100 mL volume of sample is filtered through a membrane, the membrane is placed on mFC-BCIG agar and incubated at 44.5 –0 .2 °C for 24 – 2 h. Method ID: WT-TM-1200			
EC-WT	Water	Conductivity	APHA 2510 B
Water samples can be measured directly by immersing the conductivity cell into the sample.			
ETL-N2N3-WT	Water	Calculate from NO2 + NO3	APHA 4110 B
ETL-SILICA-CALC-WT	Water	Calculate from SI-TOT-WT	EPA 200.8
F-IC-N-WT	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
IONBALANCE-OP03-WT	Water	Detailed Ion Balance Calculation	APHA 1030E, 2330B, 2510A
MET-D-CCMS-WT	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**

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

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

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

NH3-WT	Water	Ammonia, Total as N	EPA 350.1

Sample is measured colorimetrically. When sample is turbid a distillation step is required, sample is distilled into a solution of boric acid and measured colorimetrically.

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

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

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

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

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

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

REDOX-POTENTIAL-WT	Water	Redox Potential	APHA 2580

This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

It is recommended that this analysis be conducted in the field.

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

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

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

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

TURBIDITY-WT	Water	Turbidity	APHA 2130 B

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

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

Chain of Custody Numbers:

17-639640

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

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

Reference Information

GLOSSARY OF REPORT TERMS

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

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

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

Quality Control Report

Workorder: L2194429 Report Date: 16-NOV-18

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-AUTO-WT	**Water**							
Batch R4329209								
WG2928594-3 CRM		**WT-ALK-CRM**						
Alkalinity, Total (as CaCO3)			86.9		%		80-120	12-NOV-18
WG2928594-4 DUP		**L2194534-1**						
Alkalinity, Total (as CaCO3)		<10	<10	RPD-NA	mg/L	N/A	20	12-NOV-18
WG2928594-2 LCS								
Alkalinity, Total (as CaCO3)			99.4		%		85-115	12-NOV-18
WG2928594-1 MB								
Alkalinity, Total (as CaCO3)			<10		mg/L		10	12-NOV-18
ALK-SPECIATED-WT	**Water**							
Batch R4328054								
WG2926975-12 DUP		**WG2926975-11**						
pH		7.86	7.85	J	pH units	0.01	0.2	09-NOV-18
WG2926975-10 LCS								
pH			6.99		pH units		6.9-7.1	09-NOV-18
BR-IC-N-WT	**Water**							
Batch R4329247								
WG2928543-15 DUP		**WG2928543-13**						
Bromide (Br)		<0.10	<0.10	RPD-NA	mg/L	N/A	20	12-NOV-18
WG2928543-12 LCS								
Bromide (Br)			98.2		%		85-115	12-NOV-18
WG2928543-11 MB								
Bromide (Br)			<0.10		mg/L		0.1	12-NOV-18
WG2928543-14 MS		**WG2928543-13**						
Bromide (Br)			96.1		%		75-125	12-NOV-18
CL-IC-N-WT	**Water**							
Batch R4329247								
WG2928543-15 DUP		**WG2928543-13**						
Chloride (Cl)		15.2	15.2		mg/L	0.0	20	12-NOV-18
WG2928543-12 LCS								
Chloride (Cl)			102.0		%		90-110	12-NOV-18
WG2928543-11 MB								
Chloride (Cl)			<0.50		mg/L		0.5	12-NOV-18
WG2928543-14 MS		**WG2928543-13**						
Chloride (Cl)			105.6		%		75-125	12-NOV-18
COLOUR-APPARENT-WT	**Water**							

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
COLOUR-APPARENT-WT	**Water**							
Batch R4327896								
WG2927057-3 DUP		**L2193008-1**						
Colour, Apparent		4.7	4.4		CU	6.0	20	09-NOV-18
WG2927057-2 LCS								
Colour, Apparent			101.4		%		85-115	09-NOV-18
WG2927057-1 MB								
Colour, Apparent			<2.0		CU		2	09-NOV-18
DOC-WT	**Water**							
Batch R4331622								
WG2927299-3 DUP		**L2193967-5**						
Dissolved Organic Carbon		0.60	0.53		mg/L	13	25	12-NOV-18
WG2927299-2 LCS								
Dissolved Organic Carbon			104.6		%		70-130	12-NOV-18
WG2927299-1 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	12-NOV-18
WG2927299-4 MS		**L2193967-5**						
Dissolved Organic Carbon			107.9		%		70-130	12-NOV-18
EC-MF-WT	**Water**							
Batch R4328544								
WG2927043-1 MB								
E. Coli			0		CFU/100mL		1	10-NOV-18
EC-WT	**Water**							
Batch R4328054								
WG2926975-12 DUP		**WG2926975-11**						
Conductivity		442	442		umhos/cm	0.0	10	09-NOV-18
WG2926975-10 LCS								
Conductivity			97.9		%		90-110	09-NOV-18
WG2926975-9 MB								
Conductivity			<3.0		umhos/cm		3	09-NOV-18
F-IC-N-WT	**Water**							
Batch R4329247								
WG2928543-15 DUP		**WG2928543-13**						
Fluoride (F)		0.072	0.071		mg/L	0.7	20	12-NOV-18
WG2928543-12 LCS								
Fluoride (F)			101.1		%		90-110	12-NOV-18
WG2928543-11 MB								
Fluoride (F)			<0.020		mg/L		0.02	12-NOV-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F-IC-N-WT	**Water**							
Batch R4329247								
WG2928543-14 MS		**WG2928543-13**						
Fluoride (F)			101.9		%		75-125	12-NOV-18
MET-D-CCMS-WT	**Water**							
Batch R4329073								
WG2927669-4 DUP		**WG2927669-3**						
Aluminum (Al)-Dissolved		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	09-NOV-18
Antimony (Sb)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	09-NOV-18
Arsenic (As)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	09-NOV-18
Barium (Ba)-Dissolved		0.00047	0.00046		mg/L	0.2	20	09-NOV-18
Beryllium (Be)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	09-NOV-18
Bismuth (Bi)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	09-NOV-18
Boron (B)-Dissolved		0.011	0.011		mg/L	2.9	20	09-NOV-18
Cadmium (Cd)-Dissolved		<0.0000050	<0.000005(	RPD-NA	mg/L	N/A	20	09-NOV-18
Calcium (Ca)-Dissolved		0.545	0.551		mg/L	1.1	20	09-NOV-18
Chromium (Cr)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	09-NOV-18
Cobalt (Co)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	09-NOV-18
Copper (Cu)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	09-NOV-18
Iron (Fe)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	09-NOV-18
Lead (Pb)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	09-NOV-18
Magnesium (Mg)-Dissolved		0.190	0.186		mg/L	2.2	20	09-NOV-18
Manganese (Mn)-Dissolved		0.00115	0.00116		mg/L	0.9	20	09-NOV-18
Molybdenum (Mo)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	09-NOV-18
Nickel (Ni)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	09-NOV-18
Phosphorus (P)-Dissolved		<0.050	<0.050	RPD-NA	mg/L	N/A	20	09-NOV-18
Potassium (K)-Dissolved		0.322	0.313		mg/L	2.8	20	09-NOV-18
Selenium (Se)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	09-NOV-18
Silicon (Si)-Dissolved		0.159	0.157		mg/L	1.0	20	09-NOV-18
Silver (Ag)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	09-NOV-18
Sodium (Na)-Dissolved		4.24	4.19		mg/L	1.2	20	09-NOV-18
Strontium (Sr)-Dissolved		0.0016	0.0016		mg/L	0.3	20	09-NOV-18
Sulfur (S)-Dissolved		<0.50	<0.50	RPD-NA	mg/L	N/A	20	09-NOV-18
Thallium (Tl)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	09-NOV-18
Tin (Sn)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	09-NOV-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R4329073								
WG2927669-4 DUP		**WG2927669-3**						
Titanium (Ti)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	09-NOV-18
Tungsten (W)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	09-NOV-18
Uranium (U)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	09-NOV-18
Vanadium (V)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	09-NOV-18
Zinc (Zn)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	09-NOV-18
Zirconium (Zr)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	09-NOV-18
WG2927669-2 LCS								
Aluminum (Al)-Dissolved			106.2		%		80-120	09-NOV-18
Antimony (Sb)-Dissolved			99.2		%		80-120	09-NOV-18
Arsenic (As)-Dissolved			102.6		%		80-120	09-NOV-18
Barium (Ba)-Dissolved			103.3		%		80-120	09-NOV-18
Beryllium (Be)-Dissolved			103.5		%		80-120	09-NOV-18
Bismuth (Bi)-Dissolved			103.1		%		80-120	09-NOV-18
Boron (B)-Dissolved			102.1		%		80-120	09-NOV-18
Cadmium (Cd)-Dissolved			102.5		%		80-120	09-NOV-18
Calcium (Ca)-Dissolved			102.7		%		80-120	09-NOV-18
Chromium (Cr)-Dissolved			101.1		%		80-120	09-NOV-18
Cobalt (Co)-Dissolved			99.6		%		80-120	09-NOV-18
Copper (Cu)-Dissolved			102.2		%		80-120	09-NOV-18
Iron (Fe)-Dissolved			98.8		%		80-120	09-NOV-18
Lead (Pb)-Dissolved			104.7		%		80-120	09-NOV-18
Magnesium (Mg)-Dissolved			104.1		%		80-120	09-NOV-18
Manganese (Mn)-Dissolved			102.6		%		80-120	09-NOV-18
Molybdenum (Mo)-Dissolved			101.9		%		80-120	09-NOV-18
Nickel (Ni)-Dissolved			102.1		%		80-120	09-NOV-18
Phosphorus (P)-Dissolved			105.7		%		80-120	09-NOV-18
Potassium (K)-Dissolved			106.8		%		80-120	09-NOV-18
Selenium (Se)-Dissolved			100.4		%		80-120	09-NOV-18
Silicon (Si)-Dissolved			104.6		%		60-140	09-NOV-18
Silver (Ag)-Dissolved			104.4		%		80-120	09-NOV-18
Sodium (Na)-Dissolved			103.7		%		80-120	09-NOV-18
Strontium (Sr)-Dissolved			101.3		%		80-120	09-NOV-18
Sulfur (S)-Dissolved			98.1		%		80-120	09-NOV-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R4329073								
WG2927669-2 LCS								
Thallium (Tl)-Dissolved			102.0		%		80-120	09-NOV-18
Tin (Sn)-Dissolved			101.5		%		80-120	09-NOV-18
Titanium (Ti)-Dissolved			98.9		%		80-120	09-NOV-18
Tungsten (W)-Dissolved			103.5		%		80-120	09-NOV-18
Uranium (U)-Dissolved			106.3		%		80-120	09-NOV-18
Vanadium (V)-Dissolved			103.5		%		80-120	09-NOV-18
Zinc (Zn)-Dissolved			100.4		%		80-120	09-NOV-18
Zirconium (Zr)-Dissolved			99.97		%		80-120	09-NOV-18
WG2927669-1 MB								
Aluminum (Al)-Dissolved			<0.0050		mg/L		0.005	09-NOV-18
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	09-NOV-18
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	09-NOV-18
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	09-NOV-18
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	09-NOV-18
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	09-NOV-18
Boron (B)-Dissolved			<0.010		mg/L		0.01	09-NOV-18
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	09-NOV-18
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	09-NOV-18
Chromium (Cr)-Dissolved			<0.00050		mg/L		0.0005	09-NOV-18
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	09-NOV-18
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	09-NOV-18
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	09-NOV-18
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	09-NOV-18
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	09-NOV-18
Manganese (Mn)-Dissolved			<0.00050		mg/L		0.0005	09-NOV-18
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	09-NOV-18
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	09-NOV-18
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	09-NOV-18
Potassium (K)-Dissolved			<0.050		mg/L		0.05	09-NOV-18
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	09-NOV-18
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	09-NOV-18
Silver (Ag)-Dissolved			<0.000050		mg/L		0.00005	09-NOV-18
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	09-NOV-18
Strontium (Sr)-Dissolved			<0.0010		mg/L		0.001	09-NOV-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R4329073								
WG2927669-1 MB								
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	09-NOV-18
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	09-NOV-18
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	09-NOV-18
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	09-NOV-18
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	09-NOV-18
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	09-NOV-18
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	09-NOV-18
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	09-NOV-18
Zirconium (Zr)-Dissolved			<0.00030		mg/L		0.0003	09-NOV-18
WG2927669-5 MS		**WG2927669-6**						
Aluminum (Al)-Dissolved			99.8		%		70-130	09-NOV-18
Antimony (Sb)-Dissolved			109.2		%		70-130	09-NOV-18
Arsenic (As)-Dissolved			105.0		%		70-130	09-NOV-18
Barium (Ba)-Dissolved			N/A	MS-B	%		-	09-NOV-18
Beryllium (Be)-Dissolved			100.5		%		70-130	09-NOV-18
Bismuth (Bi)-Dissolved			83.9		%		70-130	09-NOV-18
Boron (B)-Dissolved			96.0		%		70-130	09-NOV-18
Cadmium (Cd)-Dissolved			101.3		%		70-130	09-NOV-18
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	09-NOV-18
Chromium (Cr)-Dissolved			98.6		%		70-130	09-NOV-18
Cobalt (Co)-Dissolved			97.3		%		70-130	09-NOV-18
Copper (Cu)-Dissolved			89.5		%		70-130	09-NOV-18
Iron (Fe)-Dissolved			92.9		%		70-130	09-NOV-18
Lead (Pb)-Dissolved			97.9		%		70-130	09-NOV-18
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	09-NOV-18
Manganese (Mn)-Dissolved			N/A	MS-B	%		-	09-NOV-18
Molybdenum (Mo)-Dissolved			97.4		%		70-130	09-NOV-18
Nickel (Ni)-Dissolved			96.1		%		70-130	09-NOV-18
Phosphorus (P)-Dissolved			106.2		%		70-130	09-NOV-18
Potassium (K)-Dissolved			N/A	MS-B	%		-	09-NOV-18
Selenium (Se)-Dissolved			108.8		%		70-130	09-NOV-18
Silicon (Si)-Dissolved			N/A	MS-B	%		-	09-NOV-18
Silver (Ag)-Dissolved			101.9		%		70-130	09-NOV-18
Sodium (Na)-Dissolved			N/A	MS-B	%		-	09-NOV-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R4329073								
WG2927669-5 MS		**WG2927669-6**						
Strontium (Sr)-Dissolved			N/A	MS-B	%		-	09-NOV-18
Sulfur (S)-Dissolved			N/A	MS-B	%		-	09-NOV-18
Thallium (Tl)-Dissolved			98.2		%		70-130	09-NOV-18
Tin (Sn)-Dissolved			101.2		%		70-130	09-NOV-18
Titanium (Ti)-Dissolved			99.4		%		70-130	09-NOV-18
Tungsten (W)-Dissolved			101.3		%		70-130	09-NOV-18
Uranium (U)-Dissolved			N/A	MS-B	%		-	09-NOV-18
Vanadium (V)-Dissolved			104.4		%		70-130	09-NOV-18
Zinc (Zn)-Dissolved			92.0		%		70-130	09-NOV-18
Zirconium (Zr)-Dissolved			97.8		%		70-130	09-NOV-18
Batch R4329466								
WG2928798-4 DUP		**WG2928798-3**						
Aluminum (Al)-Dissolved		0.0072	0.0075		mg/L	4.4	20	12-NOV-18
Antimony (Sb)-Dissolved		0.00036	0.00035		mg/L	2.3	20	12-NOV-18
Arsenic (As)-Dissolved		0.00246	0.00245		mg/L	0.3	20	12-NOV-18
Barium (Ba)-Dissolved		0.260	0.265		mg/L	1.7	20	12-NOV-18
Beryllium (Be)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	12-NOV-18
Bismuth (Bi)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	12-NOV-18
Boron (B)-Dissolved		0.062	0.061		mg/L	0.5	20	12-NOV-18
Cadmium (Cd)-Dissolved		0.0000082	0.0000105	J	mg/L	0.0000023	0.00001	12-NOV-18
Calcium (Ca)-Dissolved		53.5	52.9		mg/L	1.1	20	12-NOV-18
Chromium (Cr)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	12-NOV-18
Cobalt (Co)-Dissolved		0.00047	0.00047		mg/L	1.1	20	12-NOV-18
Copper (Cu)-Dissolved		0.00068	0.00069		mg/L	1.3	20	12-NOV-18
Iron (Fe)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	12-NOV-18
Lead (Pb)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	12-NOV-18
Magnesium (Mg)-Dissolved		41.2	41.1		mg/L	0.4	20	12-NOV-18
Manganese (Mn)-Dissolved		0.0345	0.0343		mg/L	0.3	20	12-NOV-18
Molybdenum (Mo)-Dissolved		0.0115	0.0114		mg/L	0.5	20	12-NOV-18
Nickel (Ni)-Dissolved		0.00171	0.00166		mg/L	2.7	20	12-NOV-18
Phosphorus (P)-Dissolved		<0.050	<0.050	RPD-NA	mg/L	N/A	20	12-NOV-18
Potassium (K)-Dissolved		3.79	3.82		mg/L	0.8	20	12-NOV-18
Selenium (Se)-Dissolved		0.000545	0.000538		mg/L	1.3	20	12-NOV-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R4329466								
WG2928798-4 DUP		**WG2928798-3**						
Silicon (Si)-Dissolved		8.70	8.65		mg/L	0.6	20	12-NOV-18
Silver (Ag)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	12-NOV-18
Sodium (Na)-Dissolved		40.3	40.4		mg/L	0.0	20	12-NOV-18
Strontium (Sr)-Dissolved		0.763	0.762		mg/L	0.1	20	12-NOV-18
Sulfur (S)-Dissolved		5.96	5.82		mg/L	2.4	20	12-NOV-18
Thallium (Tl)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	12-NOV-18
Tin (Sn)-Dissolved		0.00267	0.00269		mg/L	0.8	20	12-NOV-18
Titanium (Ti)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	12-NOV-18
Tungsten (W)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	12-NOV-18
Uranium (U)-Dissolved		0.000737	0.000752		mg/L	2.0	20	12-NOV-18
Vanadium (V)-Dissolved		0.00055	0.00055		mg/L	0.2	20	12-NOV-18
Zinc (Zn)-Dissolved		0.0012	0.0016	J	mg/L	0.0005	0.002	12-NOV-18
Zirconium (Zr)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	12-NOV-18
WG2928798-2 LCS								
Aluminum (Al)-Dissolved			107.4		%		80-120	12-NOV-18
Antimony (Sb)-Dissolved			93.0		%		80-120	12-NOV-18
Arsenic (As)-Dissolved			102.0		%		80-120	12-NOV-18
Barium (Ba)-Dissolved			99.5		%		80-120	12-NOV-18
Beryllium (Be)-Dissolved			103.0		%		80-120	12-NOV-18
Bismuth (Bi)-Dissolved			103.7		%		80-120	12-NOV-18
Boron (B)-Dissolved			98.9		%		80-120	12-NOV-18
Cadmium (Cd)-Dissolved			102.4		%		80-120	12-NOV-18
Calcium (Ca)-Dissolved			100.4		%		80-120	12-NOV-18
Chromium (Cr)-Dissolved			102.0		%		80-120	12-NOV-18
Cobalt (Co)-Dissolved			100.4		%		80-120	12-NOV-18
Copper (Cu)-Dissolved			101.0		%		80-120	12-NOV-18
Iron (Fe)-Dissolved			94.8		%		80-120	12-NOV-18
Lead (Pb)-Dissolved			99.5		%		80-120	12-NOV-18
Magnesium (Mg)-Dissolved			106.5		%		80-120	12-NOV-18
Manganese (Mn)-Dissolved			101.4		%		80-120	12-NOV-18
Molybdenum (Mo)-Dissolved			102.3		%		80-120	12-NOV-18
Nickel (Ni)-Dissolved			99.4		%		80-120	12-NOV-18
Phosphorus (P)-Dissolved			102.0		%		80-120	12-NOV-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R4329466								
WG2928798-2 LCS								
Potassium (K)-Dissolved			102.1		%		80-120	12-NOV-18
Selenium (Se)-Dissolved			101.4		%		80-120	12-NOV-18
Silicon (Si)-Dissolved			103.7		%		60-140	12-NOV-18
Silver (Ag)-Dissolved			96.4		%		80-120	12-NOV-18
Sodium (Na)-Dissolved			104.9		%		80-120	12-NOV-18
Strontium (Sr)-Dissolved			98.9		%		80-120	12-NOV-18
Sulfur (S)-Dissolved			96.5		%		80-120	12-NOV-18
Thallium (Tl)-Dissolved			104.1		%		80-120	12-NOV-18
Tin (Sn)-Dissolved			97.9		%		80-120	12-NOV-18
Titanium (Ti)-Dissolved			99.8		%		80-120	12-NOV-18
Tungsten (W)-Dissolved			96.1		%		80-120	12-NOV-18
Uranium (U)-Dissolved			96.9		%		80-120	12-NOV-18
Vanadium (V)-Dissolved			103.4		%		80-120	12-NOV-18
Zinc (Zn)-Dissolved			100.7		%		80-120	12-NOV-18
Zirconium (Zr)-Dissolved			97.5		%		80-120	12-NOV-18
WG2928798-1 MB								
Aluminum (Al)-Dissolved			<0.0050		mg/L		0.005	12-NOV-18
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	12-NOV-18
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	12-NOV-18
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	12-NOV-18
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	12-NOV-18
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	12-NOV-18
Boron (B)-Dissolved			<0.010		mg/L		0.01	12-NOV-18
Cadmium (Cd)-Dissolved			<0.000005(		mg/L		0.000005	12-NOV-18
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	12-NOV-18
Chromium (Cr)-Dissolved			<0.00050		mg/L		0.0005	12-NOV-18
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	12-NOV-18
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	12-NOV-18
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	12-NOV-18
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	12-NOV-18
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	12-NOV-18
Manganese (Mn)-Dissolved			<0.00050		mg/L		0.0005	12-NOV-18
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	12-NOV-18
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	12-NOV-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R4329466								
WG2928798-1 MB								
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	12-NOV-18
Potassium (K)-Dissolved			<0.050		mg/L		0.05	12-NOV-18
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	12-NOV-18
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	12-NOV-18
Silver (Ag)-Dissolved			<0.000050		mg/L		0.00005	12-NOV-18
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	12-NOV-18
Strontium (Sr)-Dissolved			<0.0010		mg/L		0.001	12-NOV-18
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	12-NOV-18
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	12-NOV-18
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	12-NOV-18
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	12-NOV-18
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	12-NOV-18
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	12-NOV-18
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	12-NOV-18
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	12-NOV-18
Zirconium (Zr)-Dissolved			<0.00030		mg/L		0.0003	12-NOV-18
WG2928798-5 MS		**WG2928798-3**						
Aluminum (Al)-Dissolved			88.8		%		70-130	12-NOV-18
Antimony (Sb)-Dissolved			84.6		%		70-130	12-NOV-18
Arsenic (As)-Dissolved			93.5		%		70-130	12-NOV-18
Barium (Ba)-Dissolved			N/A	MS-B	%		-	12-NOV-18
Beryllium (Be)-Dissolved			89.8		%		70-130	12-NOV-18
Bismuth (Bi)-Dissolved			85.2		%		70-130	12-NOV-18
Boron (B)-Dissolved			N/A	MS-B	%		-	12-NOV-18
Cadmium (Cd)-Dissolved			87.6		%		70-130	12-NOV-18
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	12-NOV-18
Chromium (Cr)-Dissolved			85.8		%		70-130	12-NOV-18
Cobalt (Co)-Dissolved			83.4		%		70-130	12-NOV-18
Copper (Cu)-Dissolved			80.5		%		70-130	12-NOV-18
Iron (Fe)-Dissolved			82.3		%		70-130	12-NOV-18
Lead (Pb)-Dissolved			83.6		%		70-130	12-NOV-18
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	12-NOV-18
Manganese (Mn)-Dissolved			N/A	MS-B	%		-	12-NOV-18
Molybdenum (Mo)-Dissolved			88.4		%		70-130	12-NOV-18

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R4329466								
WG2928798-5 MS		**WG2928798-3**						
Nickel (Ni)-Dissolved			81.1		%		70-130	12-NOV-18
Phosphorus (P)-Dissolved			93.1		%		70-130	12-NOV-18
Potassium (K)-Dissolved			N/A	MS-B	%		-	12-NOV-18
Selenium (Se)-Dissolved			106.5		%		70-130	12-NOV-18
Silicon (Si)-Dissolved			N/A	MS-B	%		-	12-NOV-18
Silver (Ag)-Dissolved			96.3		%		70-130	13-NOV-18
Sodium (Na)-Dissolved			N/A	MS-B	%		-	12-NOV-18
Strontium (Sr)-Dissolved			N/A	MS-B	%		-	12-NOV-18
Sulfur (S)-Dissolved			N/A	MS-B	%		-	12-NOV-18
Thallium (Tl)-Dissolved			82.3		%		70-130	12-NOV-18
Tin (Sn)-Dissolved			90.1		%		70-130	12-NOV-18
Titanium (Ti)-Dissolved			88.2		%		70-130	12-NOV-18
Tungsten (W)-Dissolved			86.5		%		70-130	12-NOV-18
Uranium (U)-Dissolved			N/A	MS-B	%		-	12-NOV-18
Vanadium (V)-Dissolved			89.3		%		70-130	12-NOV-18
Zinc (Zn)-Dissolved			83.4		%		70-130	12-NOV-18
Zirconium (Zr)-Dissolved			88.5		%		70-130	12-NOV-18
NH3-WT	**Water**							
Batch R4328037								
WG2927127-11 DUP		**L2194429-2**						
Ammonia, Total (as N)		0.027	0.026		mg/L	2.6	20	09-NOV-18
WG2927127-10 LCS								
Ammonia, Total (as N)			104.4		%		85-115	09-NOV-18
WG2927127-9 MB								
Ammonia, Total (as N)			<0.020		mg/L		0.02	09-NOV-18
WG2927127-12 MS		**L2194429-2**						
Ammonia, Total (as N)			95.5		%		75-125	09-NOV-18
NO2-IC-WT	**Water**							
Batch R4329247								
WG2928543-15 DUP		**WG2928543-13**						
Nitrite (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	25	12-NOV-18
WG2928543-12 LCS								
Nitrite (as N)			100.4		%		70-130	12-NOV-18
WG2928543-11 MB								
Nitrite (as N)			<0.010		mg/L		0.01	12-NOV-18

Quality Control Report

Workorder: L2194429 Report Date: 16-NOV-18

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7

Contact: Bobby Katanchi

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-IC-WT	**Water**							
Batch R4329247								
WG2928543-14 MS		**WG2928543-13**						
Nitrite (as N)			102.3		%		70-130	12-NOV-18
NO3-IC-WT	**Water**							
Batch R4329247								
WG2928543-15 DUP		**WG2928543-13**						
Nitrate (as N)		1.50	1.49		mg/L	0.1	25	12-NOV-18
WG2928543-12 LCS								
Nitrate (as N)			100.6		%		70-130	12-NOV-18
WG2928543-11 MB								
Nitrate (as N)			<0.020		mg/L		0.02	12-NOV-18
WG2928543-14 MS		**WG2928543-13**						
Nitrate (as N)			104.0		%		70-130	12-NOV-18
PO4-DO-COL-WT	**Water**							
Batch R4329039								
WG2927196-3 DUP		**L2194325-1**						
Orthophosphate-Dissolved (as P)		0.0120	0.0113		mg/L	6.0	30	09-NOV-18
WG2927196-2 LCS								
Orthophosphate-Dissolved (as P)			100.0		%		80-120	09-NOV-18
WG2927196-1 MB								
Orthophosphate-Dissolved (as P)			<0.0030		mg/L		0.003	09-NOV-18
WG2927196-4 MS		**L2194325-1**						
Orthophosphate-Dissolved (as P)			106.7		%		70-130	09-NOV-18
REDOX-POTENTIAL-WT	**Water**							
Batch R4328184								
WG2927241-1 DUP		**L2194429-2**						
Redox Potential		288	270		mV	6.5	25	09-NOV-18
SO4-IC-N-WT	**Water**							
Batch R4329247								
WG2928543-15 DUP		**WG2928543-13**						
Sulfate (SO4)		15.8	15.8		mg/L	0.2	20	12-NOV-18
WG2928543-12 LCS								
Sulfate (SO4)			102.6		%		90-110	12-NOV-18
WG2928543-11 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	12-NOV-18
WG2928543-14 MS		**WG2928543-13**						

Quality Control Report

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-WT	**Water**							
Batch R4329247								
WG2928543-14 MS		**WG2928543-13**						
Sulfate (SO4)			107.4		%		75-125	12-NOV-18
SOLIDS-TDS-WT	**Water**							
Batch R4329178								
WG2928378-3 DUP		**L2193368-1**						
Total Dissolved Solids		957	937		mg/L	2.1	20	11-NOV-18
WG2928378-2 LCS								
Total Dissolved Solids			97.1		%		85-115	11-NOV-18
WG2928378-1 MB								
Total Dissolved Solids			<10		mg/L		10	11-NOV-18
TURBIDITY-WT	**Water**							
Batch R4327723								
WG2927015-3 DUP		**L2193191-1**						
Turbidity		19.5	17.5		NTU	11	15	09-NOV-18
WG2927015-2 LCS								
Turbidity			105.0		%		85-115	09-NOV-18
WG2927015-1 MB								
Turbidity			<0.10		NTU		0.1	09-NOV-18

Quality Control Report

Workorder: L2194429 Report Date: 16-NOV-18

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Workorder: L2194429 Report Date: 16-NOV-18

Client: PALMER ENVIRONMENTAL CONSULTING GROUP INC. (Richmond Hill)
74 Berkeley Street
Toronto on M5A 2W7
Contact: Bobby Katanchi

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Redox Potential							
	1	08-NOV-18 08:30	09-NOV-18 15:00	0.25	30	hours	EHTR-FM
	2	08-NOV-18 08:30	09-NOV-18 15:00	0.25	30	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2194429 were received on 08-NOV-18 12:04.

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

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

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

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2194429-COFC

COC Number: 17 - 639640

Page of

Report To	Contact and company name below will appear on the final report	Report Format / Distribution	Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)
Company:	PALMER ENVIRONMENTAL CONSULTING	Select Report Format: ☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)	Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply
Contact:	BOBBY KRATANCHI	Quality Control (QC) Report with Report ☑ YES ☐ NO	PRIORITY (Business Days): 4 day [P4-20%] ☐ / 3 day [P3-25%] ☐ / 2 day [P2-50%] ☐
Phone:	416 317 9393	☑ Compare Results to Criteria on Report - provide details below if box checked	EMERGENCY: 1 Business day [E-100%] ☐ / Same Day, Weekend or Statutory holiday [E2-200% (Laboratory opening fees may apply)] ☐
	Company address below will appear on the final report	Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
Street:	74 BERKELEY ST.	Email 1 or Fax BOBBY@PECG.CA	For tests that can not be performed according to the service level selected, you will be contacted.
City/Province:	TORONTO / ON	Email 2 ADRIAN@PECG.CA	
Postal Code:	M5A 2W7	Email 3	
Invoice To	Same as Report To ☑ YES ☐ NO	Invoice Distribution	
	Copy of Invoice with Report ☑ YES ☐ NO	Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX	
Company:		Email 1 or Fax	
Contact:		Email 2	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:	170521	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):	L2194429	ALS Contact:	Sampler:

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

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Potential Hits	F. Coli	NH3	Anions	Colour, Turbidity	Metals	SAMPLES ON HOLD	Sample is hazardous (please provide further details)	NUMBER OF CONTAINERS
	241 Reach St	08-11-18	08:30	GW	X	X	X	X	X	X			
	231 Reach St	08-11-18	08:30	GW	X	X	X	X	X	X			

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

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
9.6				3.9			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: ADRIAN	Date: NOV 8, 2018	Time: 12:00	Received by:	Date: NOV 8/18	Time: 12:04	Received by:	Date: 11/8/18	Time: 1700

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JULY 2017 FRONT

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

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