PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

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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.

April 18, 2018

PALMER
ENVIRONMENTAL
CONSULTING
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Tel: 647-795-8153 | www.pecg.ca

April 18, 2018

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

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 estimate, water quality and phosphorous budgeting, and the pre-and-post development water budget results in support of development approvals and preliminary design of the site.

We trust that this information is sufficient for 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.

B. Katanchi

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

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1. Introduction and Background

Palmer Environmental Consulting Group Inc. (Palmer) 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 3.59 ha in size, and presently consists of single family residential land use, as well as two woodlot areas protected by the Lake Simcoe Region Conservation Authority (LSRCA) (**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, 2017), the proposed land development includes 61 townhome units divided within 12 "Blocks", one roadway, and one park area. It is our understanding that the proposed townhouses will be built with one (1) level of basement.

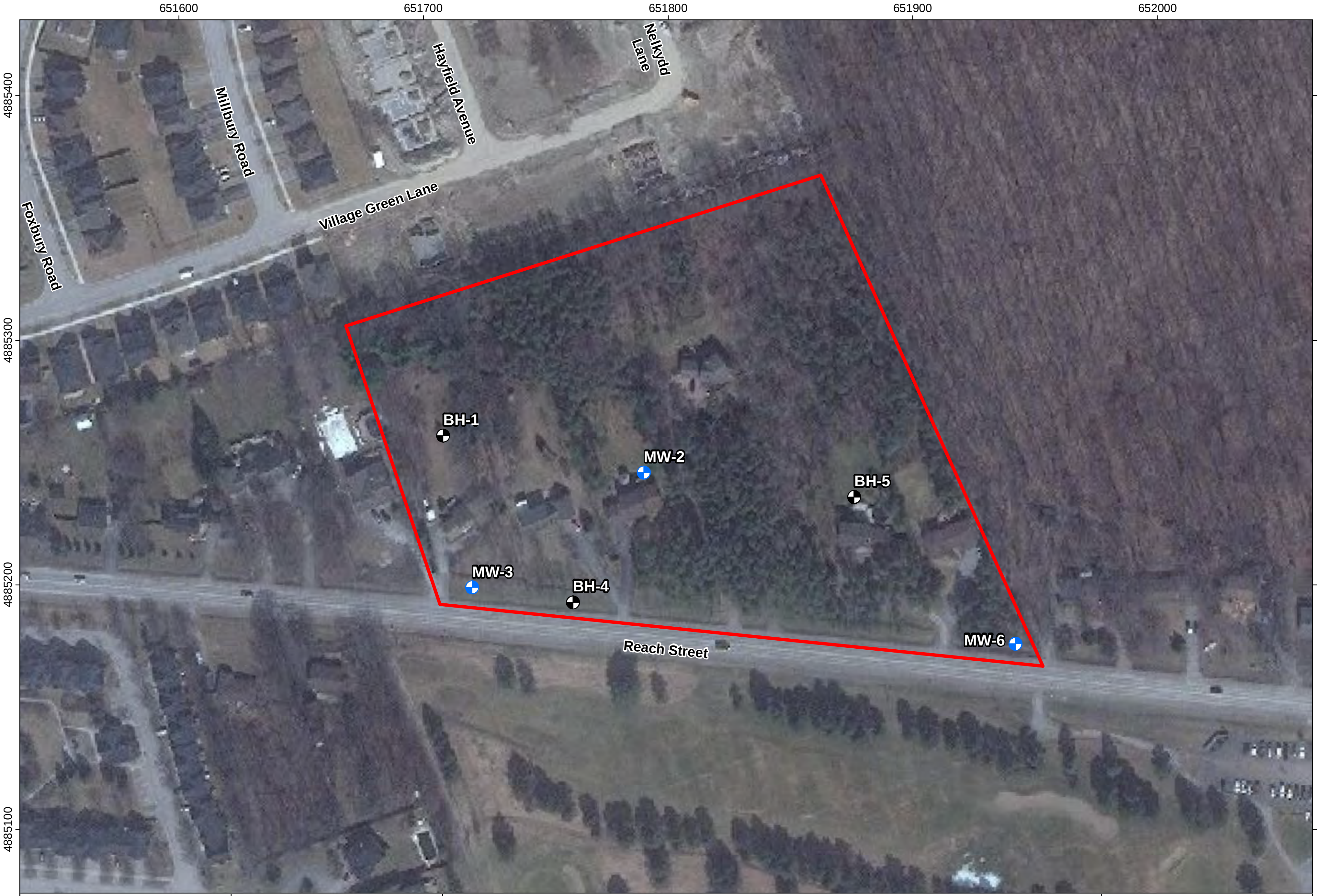
1.1 Scope of Work

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

- 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 to evaluate discharge options;
- Complete on-site percolation tests to determine the infiltration rate of the native soils at the site, and assess the suitability for proposed Low Impact Development (LID) strategies;
- Complete one (1) round of groundwater quality sampling;
- 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;
- Assess the site's location in relation to Wellhead Protection Areas (WHPAs) and conformance with the Lake Simcoe and Region Conservation Authority (LSRCA) Source Water Protection Act; and,
- Preparation of 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 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 and Climate Change (MOECC) Water Well Records database;
- MOECC 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: M. Gillman
PROJECT: 170521
DATE: Feb 15, 2018

Scale 1:2000
UTM Zone 17N
NAD 1983

Legend

◐ 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.

Site Locations

FIGURE 1

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

2. Existing Conditions

2.1 Regional Conditions

2.1.1 Physiography and Geology

The site is located within the Peterborough Drumlin Field (PDF) physiographic region (Chapman and Putnam, 1984), and is located approximately 500 m north of the Oak Ridges Moraine. Topography within the PDF 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.

Surficial geology in this area 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 MOECC Water Well Records within the study area (**Table 1**), the Newmarket Till is not present at or near surface.

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 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 may be influenced by the Oak Ridges Aquifer Complex (ORAC), and the Newmarket Till Aquitard. Each unit is described below.

The ***Oak Ridges Aquifer Complex (ORAC)*** forms a near surface aquifer across most of the moraine. The unit is primarily composed of coarse sand and gravel with high permeability, capable of yielding sufficient water for larger capacity domestic and municipal water supply. Wells screened within the ORAC possess intermediate to high transmissivity values ranging from 335 m^2/day to 1,771 m^2/day. 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 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. The regional aquitard has a low hydraulic conductivity, generally in the range of 10^{-11} to 10^{-6} m/sec (Interim Waste Authority, 1994b). Groundwater flow within the Newmarket Till is typically in a downwards direction. 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 have been eroded within the Newmarket Till and infilled with Oak Ridges Moraine sediment. These channels can form a hydraulic connection between the Oak Ridges Moraine sediments and the lower aquifers, and are capable of forming high yield aquifers (Sharpe et al., 1996).

2.2 Current Groundwater Use

Based on a search of the MOECC Water Well Record Database, fifty-one (51) 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 thirteen (13) wells are either abandoned, test wells, or not in use. A summary of the MOECC Water Well Records is provided in **Table 1**.

The Uxbridge community is municipally serviced from three (3) municipal water supply wells, MW5, MW6, and MW7. Municipal wells MW5 and MW7 are located approximately 550 m from the site, and MW6 is approximately 2 km away. 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 within the Newmarket Till aquitard. At MW6, the tunnel channel is absent, and the TAC is effectively confined in this location (South Georgian Bay-Lake Simcoe Source Protection Committee, 2015). The location of these wells is shown in **Appendix D**.

Table 1. MOECC Water Well Record Summary

Well ID	Elevation (masl)	Depth (m)	Water Level (mbgs)	Water Use	Water Status	GIN Lithology
7123787	N/A	4.57	N/A	N/A	test hole	sand silt unknown material
7128149	N/A	N/A	N/A	N/A	N/A	N/A
1906637	281.94	28.35	15.85	Domestic	water supply	sand unknown material
1906674	281.94	23.47	9.75	Domestic	water supply	sand unknown material
1906701	281.94	25.30	10.06	Domestic	water supply	sand unknown material
1906702	281.94	27.74	15.24	Domestic	water supply	sand gravel unknown mat.
1906703	281.94	27.74	12.19	Domestic	water supply	clay unknown material
1906938	281.94	24.38	11.58	Domestic	water supply	sand unknown material
1907508	N/A	32.31	15.24	Domestic	water supply	clay gravel unknown mat.
1908292	282.85	18.90	10.67	Domestic	water supply	sand unknown material
1911152	N/A	31.70	4.57	Domestic	water supply	sand unknown material
1912201	N/A	39.01	16.76	Domestic	water supply	unknown material
1912336	N/A	15.85	7.62	Domestic	water supply	sand
1912420	N/A	17.37	7.62	Domestic	water supply	clay
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 unknown material
1915081	N/A	21.34	6.10	Domestic	water supply	sand unknown material
1915082	N/A	19.20	6.10	Domestic	water supply	sand unknown material
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	unknown material
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	unknown material
4603027	281.94	25.91	19.81	Domestic	water supply	sand

Well ID	Elevation (masl)	Depth (m)	Water Level (mbgs)	Water Use	Water Status	GIN Lithology
4603028	283.46	42.67	24.38	Domestic	water supply	sand
4603030	281.94	34.75	20.42	Domestic	water supply	unknown material
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	unknown material
4604267	281.94	24.38	6.10	Domestic	water supply	unknown material
4604478	281.94	50.29	6.10	Domestic	water supply	clay
1915190	N/A	30.18	3.05	Domestic	water supply	clay unknown material
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 unknown material
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 unknown material
1916850	N/A	72.24	6.71	Not Used	not a well	sand silt unknown material
1916851	N/A	84.43	0.30	Not Used	not a well	sand unknown material
1916851	N/A	84.43	0.30	Not Used	not a well	sand silt
1918261	N/A	93.00	62.00	Domestic	water supply	sand silt

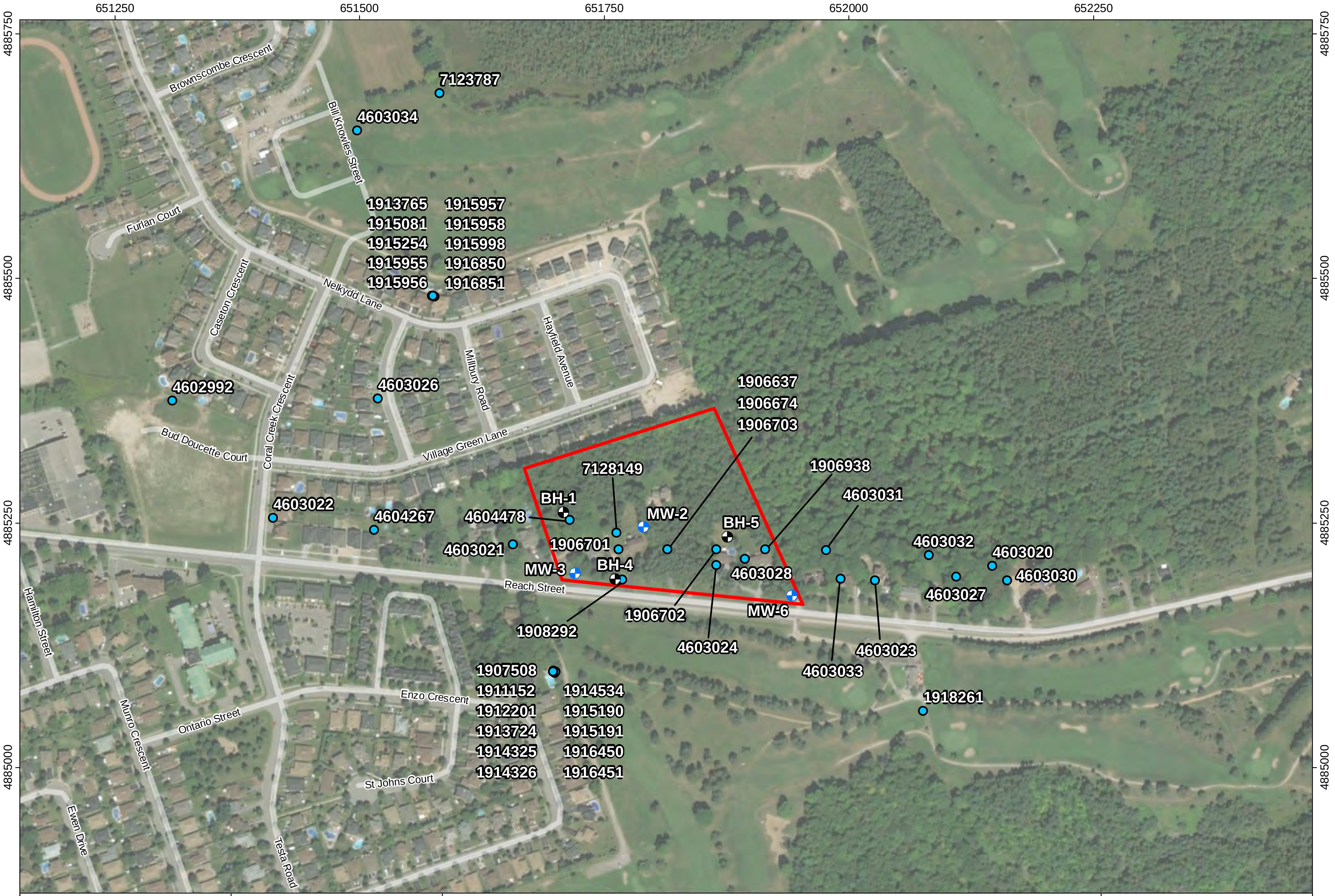
2.3 Site Specific Conditions

2.3.1 Drilling and Monitoring Well Installations

In January 2018, six (6) boreholes were drilled within the site area under the supervision of 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/MW	283.5	6.7	4.7 to 6.7	Sandy silt
BH3/MW	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/MW	289.0	6.7	4.7 – 6.7	Sandy silt



PALMER ENVIRONMENTAL CONSULTING GROUP INC.

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

0 50 100
metres

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

N

Scale 1:5000
UTM Zone 17N
NAD 1983

Legend

- ● MOECC 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.

MOECC Well Water Records (WWR)

FIGURE 2

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2.4 Site Specific Geological Conditions

Generally, 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 were encountered to depths of at least 8.2 mbgs, and were not penetrated during the drilling investigation. The borehole logs prepared by SPCL are provided in **Appendix B**.

Soil conditions reported in the MOECC Water Well Records (**Table 1**) are consistent with SPCL borehole logs and with the Ontario Geological Survey (OGS) surficial geology mapping of the site (**Figure 3**). A mixture of non-cohesive sands and silts were noted in twenty-nine (29) MOECC Water Well Records. The remainder of the MOECC wells either lacked soil characterization, or documented a clay to clay-gravel composition.

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. No groundwater was observed in any of the monitoring wells, indicating that at the time of measurement the groundwater elevation was lower than 6.7 mbgs. The results of the February 2, 2018 water level measurements are summarized in **Table 3**.

To provide an estimate of groundwater level within the study area, the MOECC Water Well Records within the site boundary were reviewed. The records of wells which were less than 25 m in depth and are within the study area limits include WWR #7128149, #1908292, #1906674, and #1906938. The recorded water levels at these wells range between approximately 9.75 mbgs and 11.58 mbgs. These levels are in agreeance with the absence of water observed in monitoring wells installed on site.

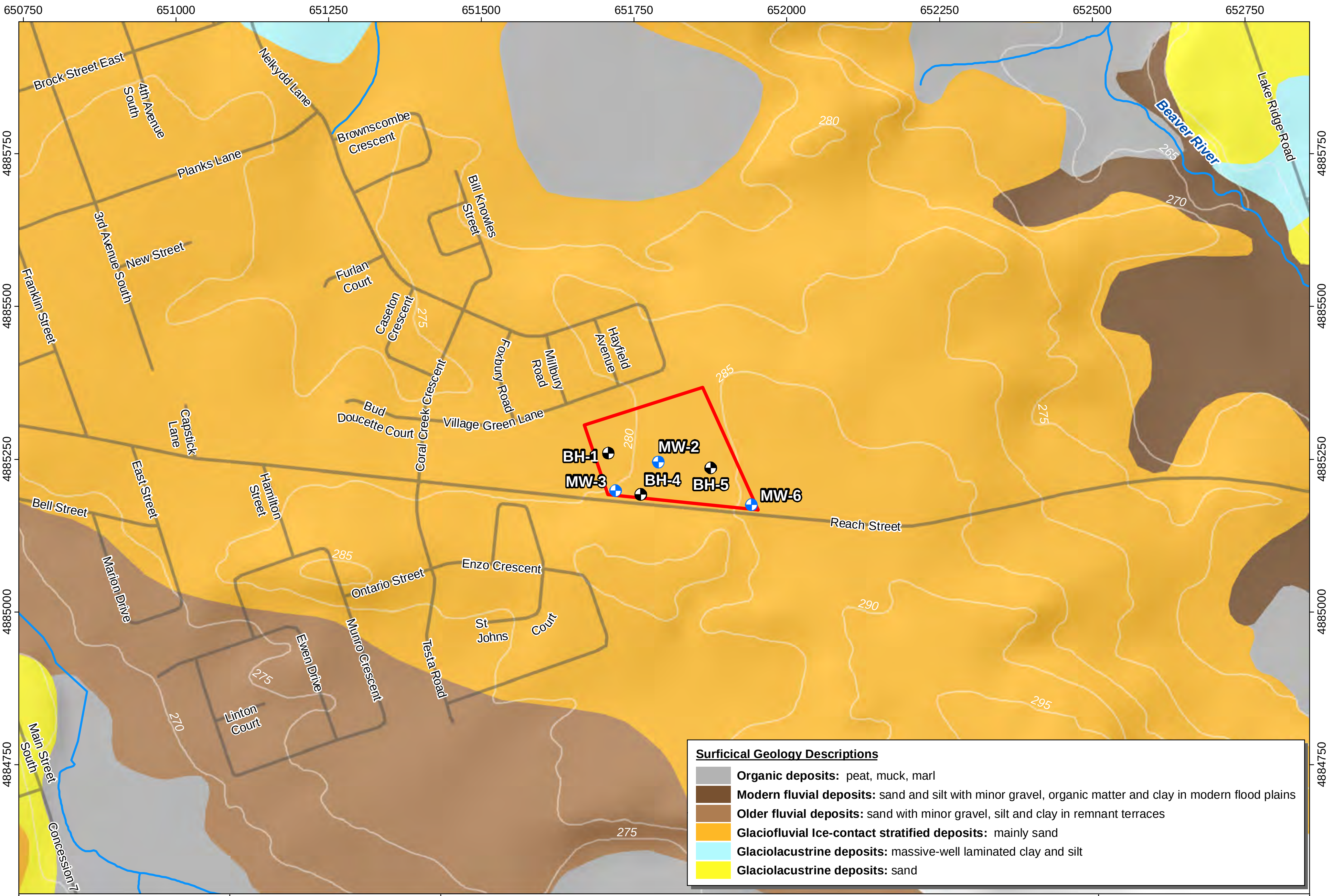
Table 3. Groundwater Monitoring Levels

Monitoring Well	Stratigraphic Unit	Ground Surface Elevation (masl)	Water Level	
			masl	mbgs
MW2	Sandy silt	283.5	<276.8	>6.7
MW3	Sand and sandy silt	282.8	<276.1	>6.7
MW6	Sandy silt	289.0	<282.3	>6.7

3.2 Hydraulic Conductivity

As single well response tests (i.e., slug tests) could not be completed due to insufficient water within the monitoring wells, hydraulic conductivity of the soils was estimated using grain size distributions 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).

To better represent the surficial soils at the site, only the soil samples collected at shallow depths were used for the analysis, including BH1 and BH3 which were collected at 2.5 mbgs. The grain size



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 distribution for the sandy silt sample collected at 8.2 mbgs from BH1 was not applied as it is understood that excavations will not extend to this depth.

The calculated hydraulic conductivities values based on this method are summarized in **Table 4**. Estimated hydraulic conductivity of the sand from BH1 is approximately $3.6x10^{-7}$ m/s and the sand unit in BH3 is approximately $7.6x10^{-5}$ m/s. The lower hydraulic conductivity results at BH1 is due to the greater percentage of fine grained silts and clays in the sample. The geometric mean value hydraulic conductivity at the site is approximately $5.2x10^{-6}$ m/s.

Table 4. 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

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. 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.

3.4 Water Quality and Phosphorous Budgeting

Groundwater quality monitoring was not completed due the water table existing below the monitoring well depths. As a result, groundwater quality analysis was not possible or required.

The Lake Simcoe Phosphorus Offsetting Program (LSPOP) requires that all new development must control 100% of the phosphorus from leaving their property. Based on the Lake Simcoe Region Conservation Authority (LSRCA) Phosphorus Offsetting Policy and the MOE Phosphorus Budget Tool (V2.0 Release Update - March 30, 2012) PECG estimated the phosphorous pre and post budget for the site. The phosphorous budget summary based on the MOE 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 C**.

Based on a total pre-development area of 3.59 ha, subdivided into 2.89 ha of low intensity development and 0.7 ha of forest, the total pre-development phosphorous load was calculated to be 0.40 kg/year. The post-development load was estimated to be 2.66 kg/year primarily based on change in land use from low intensity development to high intensity development. The use of infiltration trenches and perforated pipe systems (**Appendix C2**) to control stormwater runoff and promote infiltration significantly reduced the phosphorus load from the unmitigated version. The estimated construction phase loading was estimated to be 0.26 kg with standard best management practises (BMPs) and based on an estimated 12-month long construction phase. Overall, the difference between the pre-development load and post-development load, including the use of BMPs was estimated to be 0.02 kg/year (a 5% decrease in load).

Based on a comparison of pre-development and post-development loads and in consideration of construction phase loading, the MOE phosphorus budgeting tool suggests that since the phosphorus load can be fully met in a post development scenario to achieve the net zero phosphorus, the developer would not be required to provide phosphorus offsetting to the LSRCA.

4. Water Budget

4.1 Pre-Development Water Budget

4.1.1 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 5**. 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 5. 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.

4.1.2 Results

The calculated actual ET (or AET) based on the Thornthwaite and Mather monthly water balance model is between approximately 519 mm/year (**Table 6**). 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 6**). 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 MOE 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% (3,066 m^3/year) of the surplus runs off, and the remaining 77% (10,365 m^3/year) infiltrates the soils. Results are summarized in **Table 7**. Runoff may eventually either recharge the local groundwater system, or form part of a perched water table.

Table 6. 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**

4.2 Post-Development Water Budget (Without Mitigation)

4.2.1 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 (2017) (**Appendix A**). Each land use was assigned an impervious factor based on its percentage of imperviousness cover (**Appendix C**).

Over impervious areas, the percent of imperviousness was determined using areas provided in the proposed LID design plan (SKA, 2018) (**Appendix C2**). This reduces calculation error and improves consistency between phases of the water budget. It is expected that the application of fill materials across the site will slightly restrict infiltration. To accommodate for this, an infiltration coefficient of 0.30 was applied where fill materials will be used. 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.

4.2.2 Results

Based on the proposed land use (Hunt, 2017), and the imperviousness of the site reported in the proposed LID design plan (SKA, 2018), the total infiltration and runoff volumes for the site following development are 4,821 m^3/year and 16,467 m^3/year, respectively. The results of the calculations are provided in **Table 8**. This represents a decrease in infiltration by approximately 53% from the pre-development scenario (10,365 m^3/year), and an increase in runoff by approximately 437% from pre-development (3,066 m^3/year). The 53% 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 Low Impact Development (LID) measures on site.

4.3 Post-Development Water Budget (With Mitigation)

4.3.1 Methodology

A post-development water budget for the site, including proposed LID strategies, was completed using the land use plan (Hunt, 2017) (**Appendix A**), and the LID design plan (SKA, 2018) (**Appendix C1**). The percent of imperviousness cover for each drainage area was also provided in the LID design plan.

Two LID strategies have been proposed as a method to balance infiltration volumes post-development: rear yard bio-retention swales with a granular cistern (LID1 – LID3), and granular cisterns below perforated pipes (PP1-PP7). Locations of the proposed LIDs are shown in **Appendix C2**. The rear yard swales are designed to accept approximately 75% of the adjacent townhouse roof runoff from blocks along the perimeter of the site. The granular cisterns below perforated pipes are designed to accept the remaining 25% of the roof runoff from these blocks, as well as 100% of roof runoff from townhome blocks within the interior portion of the site, and 100% of the roadway runoff.

Each LID was sized and designed to accommodate 25 mm of runoff from the contributing area. The volume of water from a rain event that exceeds 25 mm, and therefore the capacity volume of the infiltration trench, will drain by gravity to the StormTech system. The StormTech system acts as the final granular gallery, and provides additional water storage. Representative values for the total annual precipitation events less than or equal to 25 mm were determined by averaging the annual sums of these events from 1981 to 2017 using daily climate data from the Toronto Lester B. Pearson International Airport Climate Station.

4.3.2 Results

Based on the proposed land use and LID measures, approximately 5,642 m^3/year of infiltration is retained through the use of LIDs. Therefore, the total infiltration and runoff volumes for the site following development are estimated to be 10,464 m^3/year and 10,825 m^3/year, respectively. The results of the calculations are provided in **Table 9**. This represents an increase in infiltration by approximately 1% from the pre-development scenario (10,365 m^3/year), and an increase in runoff by approximately 253% from pre-development (3,066 m^3/year). The changes in the water budget from pre-to-post development are summarized in **Table 10**.

Table 7. 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 (m3/yr)		
Forested / Grassed Area	3.29	0.00	0.00	0.798	0.00	3.29	0.367	0.20	2,417	0.80	9,667	*2,417*	*9,667*
Rural Residential	0.30	0.20	0.06	0.798	474	0.24	0.367	0.20	175	0.80	698	*649*	*698*
TOTAL	**3.59**	**-**	**0.06**	**-**	**474**	**3.53**	**-**	**-**	**2,591**	**-**	**10,365**	***3,066***	***10,365***

Table 8. Summary of Post-Development Water Balance Results (no LID)

ID	Surficial Geology	Catchment Area (ha)	Impervious Surfaces				Pervious Surfaces						Total Runoff (m^3/a)	Total Infiltration (m^3/a)
			Percent Imperviousness (%)	Area (ha)	Surplus (m/yr)	Runoff (m^3/a)	Area (ha)	Surplus (m/yr)	Runoff Coefficient	Runoff (m^3/a)	Infiltration Coefficient	Infiltration (m^3/a)		
LID 1	Sand	0.14	39%	0.06	0.798	439	0.09	0.373	0.30	95	0.70	222	*534*	*222*
LID 2	Sand	0.35	51%	0.18	0.798	1,425	0.17	0.373	0.30	192	0.70	447	*1,617*	*447*
LID 3	Sand	0.14	49%	0.07	0.798	548	0.07	0.373	0.30	80	0.70	186	*628*	*186*
PP 1 – 7	Sand	1.93	81%	1.57	0.798	12,529	0.36	0.373	0.30	403	0.70	940	*12,931*	*940*
LSRCA Buffer + Woodlot	Sand	1.03	0%	0.00	0.798	0	1.03	0.367	0.20	756	0.80	3,026	*756*	*3,026*
TOTAL	**-**	**3.59**	**-**	**1.87**	**-**	**14,941**	**1.75**	**-**	**-**	**1,526**	**-**	**4,821**	***16,467***	***4,821***

Table 9. Summary of Post-Development Water Balance Results (with LID)

ID	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	Runoff to LID based on 25 mm Rainfall (m^3)	Percolation Rate (mm/hr)	Drawdown Time (hr)	Annual Rainfall Volume ≤ 25 mm (mm/yr)	Additional Infiltration from LID (m^3/yr)
LID 1	Rear Yard	1.0	62	>6.7	>1	1.30	0.70	0.40	17.10	1,400	0.30	10.50	28.8	24.3	734.7	308.6
LID 2	Rear Yard	1.0 – 1.5	170	>6.7	>1	1.30	0.70	0.40	47.00	3,500	0.30	26.25	28.8	24.3	734.7	771.4
LID 3	Rear Yard	1.5	71	>6.7	>1	1.30	0.70	0.40	19.70	1,400	0.30	10.50	28.8	24.3	734.7	308.6
PP 1 – 7	Perforated Pipe to STM Chamber	Varies	1,248	>6.7	>1	1.30	0.70	0.40	391.50	19,300	0.30	144.75	28.8	24.3	734.7	4,253.8
TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	***5,642***

Table 10. Summary of Pre-to-Post Development Water Balance Results

Stage	Units	Runoff	Infiltration
Pre-Development	m^3/yr	3,066	10,365
Post-Development (no LID)	m^3/yr	16,467	4,821
Change Pre-to-Post Development (no LID)	% Change	+437%	-53%
	Difference (m^3)	+13,401	-5,544
LID Mitigation	Additional Infiltration from LID (m^3/yr)	-5,642	+5,642
	Totals (m^3/yr)	10,825	10,464
Change Pre-to-Post Development (with LID)	% Change	+253%	+1%
	Difference (m^3/yr)	+7,759	+98

Based on a comparison between the pre and post-development water balance, there is a predicted 1% increase in infiltration post-development. The presence of high permeability sand and silt surficial soils in combination with the low water table indicates that the site conditions are ideal for implementing infiltration-based LID strategies to maintain infiltration volumes post-development.

5. Hydrogeological Considerations for Construction

5.1 Source Water Protection

In 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 MOECC 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 WHPA-Q1 and WHPA-Q2, 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 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.

5.2 Short Term Dewatering

The proposed site development consists of townhouses with one (1) level of basement, founded at approximately 281 masl. Therefore, it is not expected that dewatering will not be required, as the water table is between approximately 9.45 mbgs and 11.58 mbgs, corresponding to an approximate elevation of range of 270.02 and 272.55 masl. As construction dewatering will not be required, a Permit To Take Water (PTTW) from the MOECC and/or registration on the Environmental and Sector Registry (EASR) are not needed.

5.3 Long Term Drainage

Following townhome construction, long term groundwater flow to the underdrain system for the building/underground parking 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 MOECC 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.

6. Summary and Conclusions

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

- The proposed development at 231, 235, 237, 241, 245 and 249 Durham Road No. 8 (Reach Street) in Uxbridge, Ontario is approximately 3.59 ha in size, and consists of 12 townhome blocks built with one (1) level of basement, one roadway, and park area.

- Based on the Sirati & Partners Consultants Ltd (SPCL) geotechnical investigation, the soil conditions at the site generally consist of native sand and sandy silt underlying 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 MOECC Water Well Records, fifty-one (51) 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 fourteen (14) 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 from the site, and MW6 is approximately 2 km away.

- Groundwater levels were investigated at the three (3) monitoring wells installed by SPCL in February 2018. No water was encountered during the site visit, indicating that the water table is lower than 6.7 mbgs. MOECC well records from the site indicate a water table depth of between approximately 9.75 mbgs and 11.58 mbgs.

- Hydraulic conductivity of the sand was calculated using the Hazen method on grain size distribution curves 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.

- The deep water table and presence of high permeability soils at surface make this site ideal to implement infiltration-based LID mitigation measures.

- Under pre-development conditions, infiltration volumes at the site are approximately 10,365 m^3/year, and runoff is approximately 3,066 m^3/year. Without mitigation techniques in place, in the post-development scenario, infiltration rates will decrease by 53% to 4,821 m^3/year, and runoff will increase by 437% to 16,467 m^3/year. The use of LID mitigation techniques to balance pre-to-post infiltration rates are therefore recommended.

- By implementing the proposed LID mitigation strategies (SKA, 2018), it is expected that infiltration will increase by 1% from pre-development to 10,464 m^3/year. The proposed LID strategies are therefore sufficient to balance infiltration pre-to-post development.

- The proposed foundation base levels are more than 5 m above the water table and therefore construction dewatering will not be required. Maintenance pumping should be expected from perched water within the upper granular layers and from precipitation.

- Based on a comparison of pre-development and post-development phosphorus loads and in consideration of construction phase loading, the MOE phosphorus budgeting tool suggests that since the phosphorus load can be fully met in a post development scenario to achieve the net zero phosphorus, the developer would not be required to provide phosphorus offsetting.

7. 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.

8. Certification

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

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Environmental Scientist

Reviewed By: B. Katanchi

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Principal, Senior Hydrogeologist

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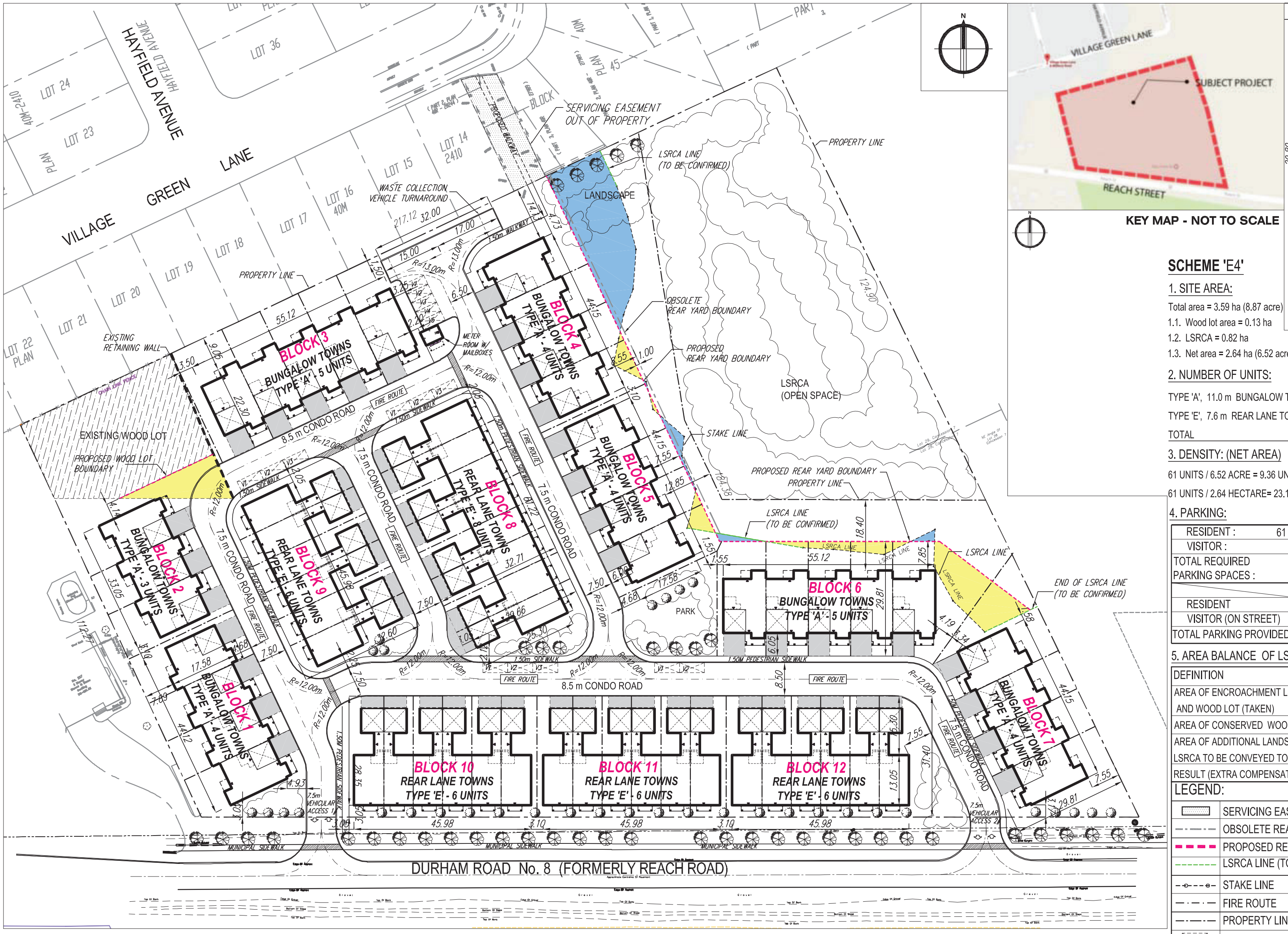
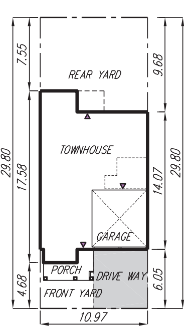
Appendix A

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



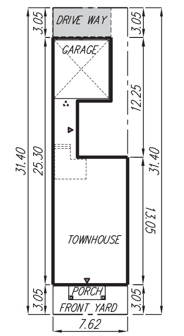
KEY MAP - NOT TO SCALE

TYPE 'A' (BLOCK 1-7)



1-1/2 STOREY
BUNGALOW TOWNHOUSE
11.0m X 29.8m
MAX. +/- 2265 SQ.FT.

TYPE 'E' (BLOCK 8-12)



1-1/2 STOREY REAR LANE TOWNHOUSE
7.62 m X 31.40 m
MAX. +/- 2150 SQ.FT.

SCHEME 'E4'

1. SITE AREA:

Total area = 3.59 ha (8.87 acre)
1.1. Wood lot area = 0.13 ha
1.2. LSRCA = 0.82 ha
1.3. Net area = 2.64 ha (6.52 acre)

2. NUMBER OF UNITS:

TYPE 'A', 11.0 m BUNGALOW TOWNHOUSE,	1-1/2 STOREY	= 29 UNITS
TYPE 'E', 7.6 m REAR LANE TOWNHOUSE,	1-1/2 STOREY	= 32 UNITS
TOTAL		= 61 UNITS

3. DENSITY: (NET AREA)

61 UNITS / 6.52 ACRE = 9.36 UNITS PER ACRE

61 UNITS / 2.64 HECTARE= 23.11 UNITS PER HECTARE

4. PARKING:

RESIDENT : 61 UNITS X 2 SPACES/UNIT=122
VISITOR : 61 UNITS X 0.25 = 16
TOTAL REQUIRED PARKING SPACES : =138

	TYPE A	TYPE E	SUBTOTAL
RESIDENT	116	96	212
VISITOR (ON STREET)	16		
TOTAL PARKING PROVIDED	228 (3.74 / UNIT)		

5. AREA BALANCE OF LSRCA LINE AND WOOD LOT:

DEFINITION	AREA		LEGEND
AREA OF ENCROACHMENT LSRCA LINE AND WOOD LOT (TAKEN)	-570.53 sqm	-6108.84 sq.ft.	🟨
AREA OF CONSERVED WOOD LOT	1157.52 sqm	12459.44 sq.ft.	▨
AREA OF ADDITIONAL LANDS OUTSIDE OF LSRCA TO BE CONVEYED TO LSRCA (GIVEN)	+577.74sqm	+6218.74 sq.ft.	🟦
RESULT (EXTRA COMPENSATION)	+7.21 sqm	+109.9 sq.ft.	

LEGEND:

▤	SERVICING EASEMENT
— · — ·	OBSOLETE REAR YARD BOUNDARY
- - - -	PROPOSED REAR YARD BOUNDARY
- - - - - - -	LSRCA LINE (TO BE CONFIRMED)
—o- - -o—	STAKE LINE
— · — · —	FIRE ROUTE
— · —— · —	PROPERTY LINE
☒	GROUND PARKING SPACE

SITE PLAN

SCALE: 1:1000

HUNT DESIGN ASSOCIATES INC.
www.huntdesign.ca

VENETIAN GROUP - 217049
REACH STREET, UXBRIDGE, ONTARIO
8966 Woodbine Ave, Markham, ON L3R 0J7 ■ T 905.737.5133 ■ F 905.737.7326 ■ OCT. 2017 ■ JZ ■

SITE PLAN-SCHEME E4
SCALE = 1:1000
217049DSP01-SCHEME E4

Appendix B

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

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

LOG OF BOREHOLE BH1

1 OF 1

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:

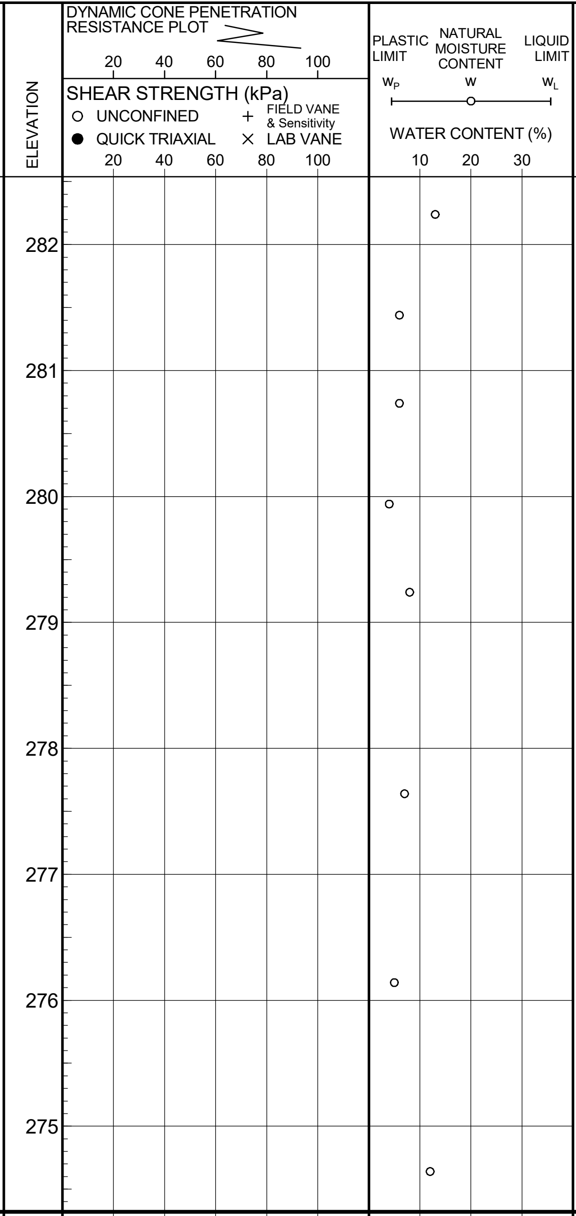
REF. NO.: SP17-275-10
ENCL NO.: 2

SOIL PROFILE

(m) ELEV DEPTH	DESCRIPTION
282.5	
0.0	**TOPSOIL:** 250 mm
282.3 0.3	**FILL:** Sand, trace silt, brown, very moist
280.7 1.8	**SAND:** trace to some silt, greyish brown, compact, moist
279.5 3.0	**SANDY SILT:** greyish brown, compact, moist
	becoming dense
274.3 8.2	**END OF BOREHOLE:** Notes: 1. Borehole was open and dry upon completion of drilling

SAMPLES

NUMBER	TYPE	"N" BLOWS 0.3 m	CHEMICAL ANALYSIS AND GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
1	SS	8				
2	SS	1				
3	SS	6				
4	SS	28		83	8	9
5	SS	24				
6	SS	21				
7	SS	27				
8	SS	35		27	63	10



STRATA PLOT | GROUND WATER CONDITIONS | POCKET PEN. (Cu) (kPa) | NATURAL UNIT WT (kN/m^3)

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

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

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

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

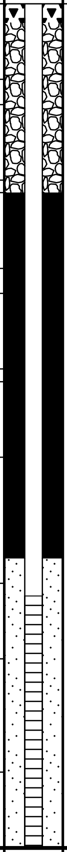
DRILLING DATA
Method: Solid Stem Augers
Diameter: 150 mm
Date: Jan/28/2018
Drilling Contractor:

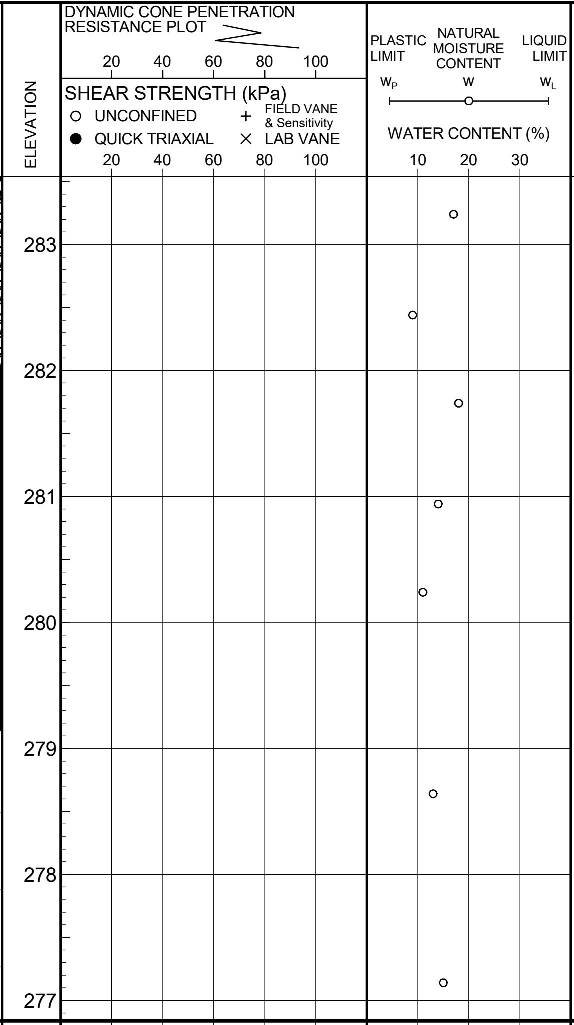
REF. NO.: SP17-275-10
ENCL NO.: 3

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS/0.3 m
283.5				
0.0 283.3	**TOPSOIL:** 280 mm			
0.3	**FILL** sand, trace silt, brown, very moist	1	SS	3
282.8 0.8	**SAND:** trace silt, greyish brown, loose, moist	2	SS	5
		3	SS	10
281.2 2.3	**SANDY SILT:** greyish brown, compact, moist	4	SS	25
		5	SS	20
		6	SS	21
276.8		7	SS	25
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





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 ▼

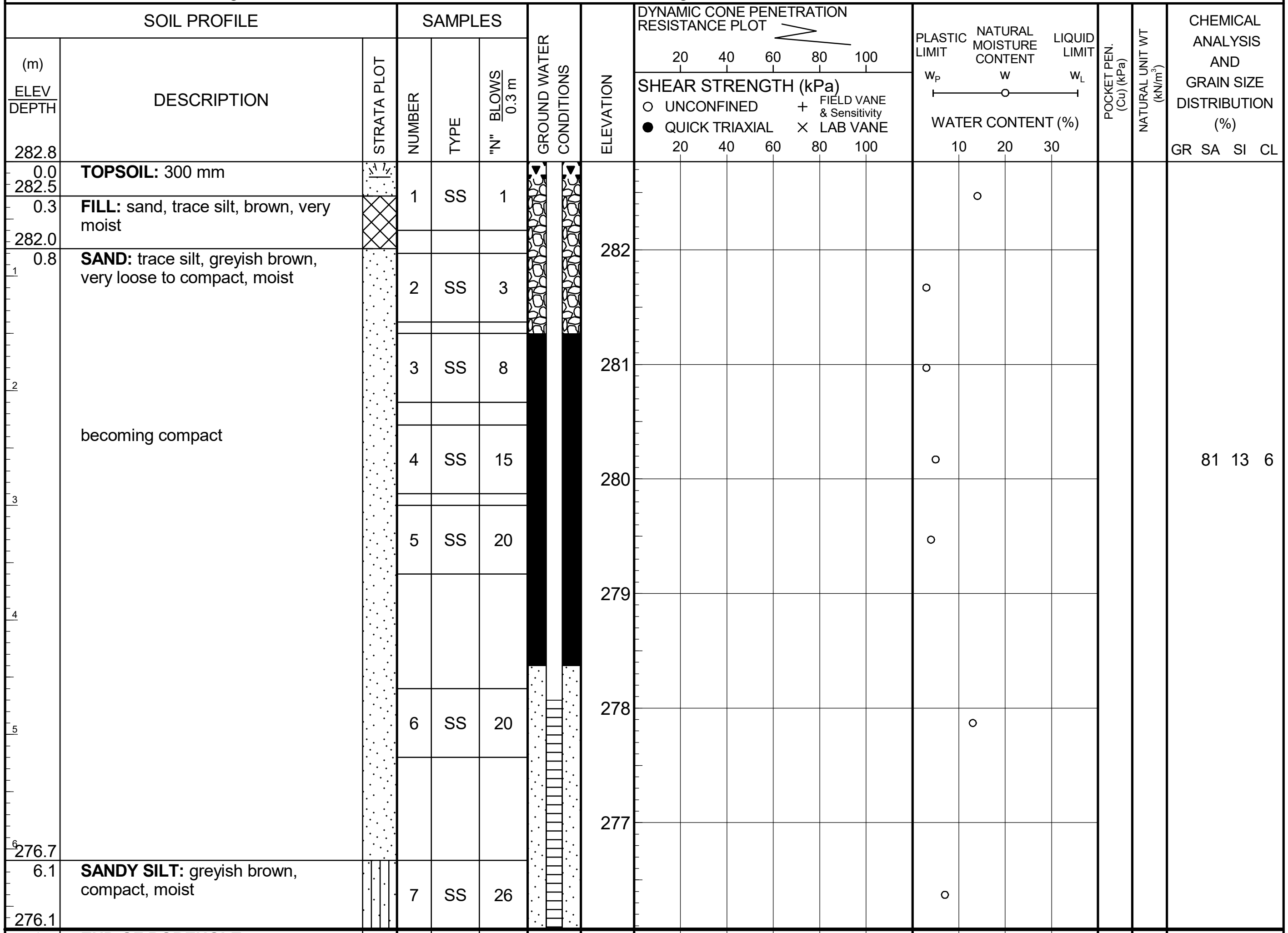
GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

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	NUMBER	TYPE	"N" BLOWS/0.3 m	CHEMICAL ANALYSIS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
282.8					
0.0	**TOPSOIL:** 300 mm	1	SS	1	
282.5 0.3	**FILL:** sand, trace silt, brown, very moist				
282.0 0.8	**SAND:** trace silt, greyish brown, very loose to compact, moist	2	SS	3	
		3	SS	8	
	becoming compact	4	SS	15	81 13 6
		5	SS	20	
		6	SS	20	
276.7 6.1	**SANDY SILT:** greyish brown, compact, moist	7	SS	26	
276.1 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

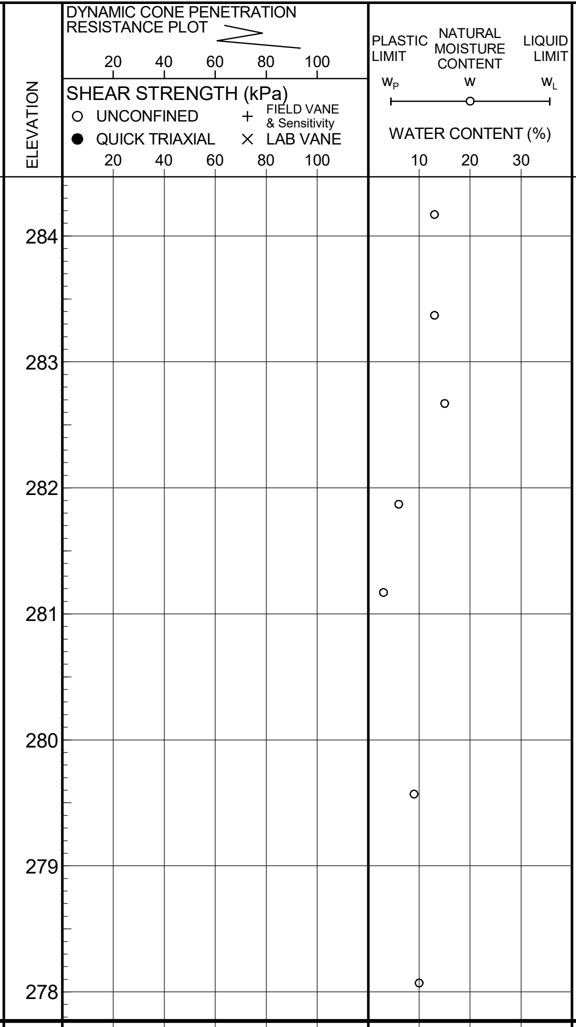
LOG OF BOREHOLE BH4

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	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS / 0.3 m	GROUND WATER CONDITIONS
284.5					
0.0	**TOPSOIL:** 300 mm	1	SS	4	
284.2 0.3	**FILL:** sand, trace silt, brown, very moist				
283.7 0.8	**SAND:** trace silt, light brown, compact, moist	2	SS	16	
		3	SS	18	
		4	SS	20	
		5	SS	22	
279.9 4.6	**SANDY SILT:** light brown, compact, moist	6	SS	25	
		7	SS	28	
277.8 6.7	**END OF BOREHOLE:** Notes: 1. Borehole was open and dry upon completion of drilling				



POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	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

LOG OF BOREHOLE BH5

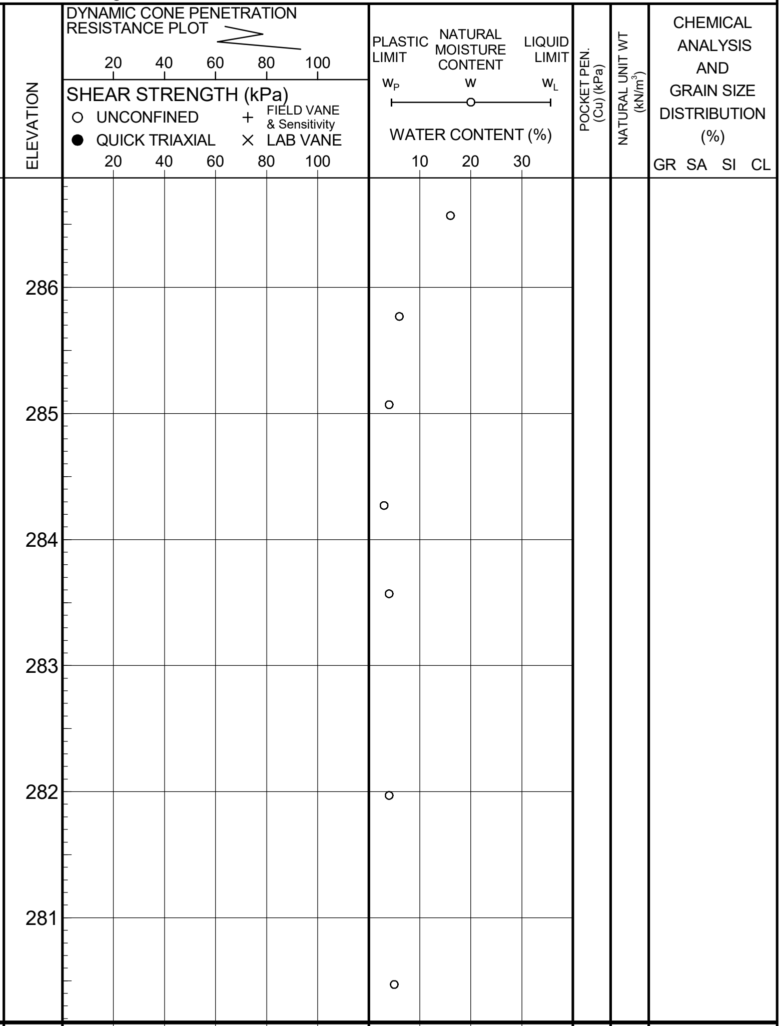
PROJECT: Proposed Geotechnical Investigation
CLIENT: Palmer Environmental Consulting Group Ltd.
PROJECT LOCATION: Reach Street, Uxbridge
DATUM: Geodetic
BH LOCATION: See Drawing 1

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

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

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS
(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	
286.9					
0.0	**TOPSOIL:**400 mm	1	SS	1	
286.5 0.4	**FILL:** sand, trace silt, brown, very moist				
286.1 0.8	**SAND:** trace to some silt, greyish brown, loose, moist	2	SS	8	
		3	SS	9	
		4	SS	9	
	becoming compact	5	SS	15	
		6	SS	13	
		7	SS	21	
280.2 6.7	**END OF BOREHOLE**				

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



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

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

LOG OF BOREHOLE BH6

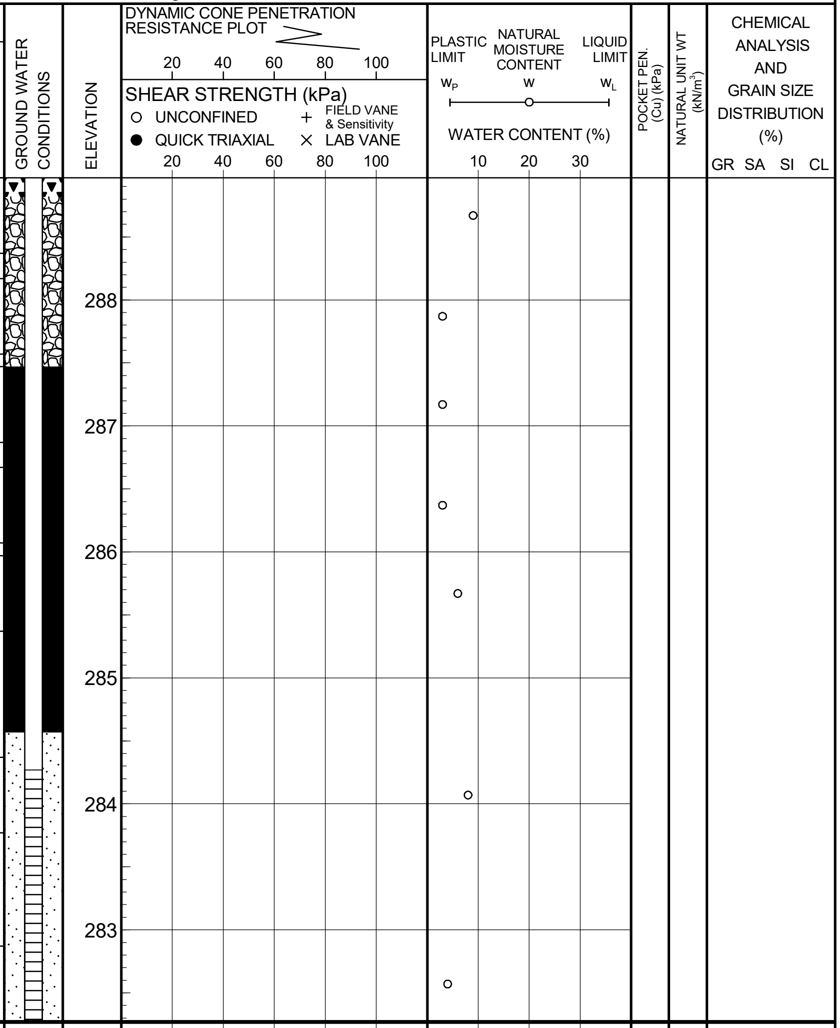
PROJECT: Proposed Geotechnical Investigation
CLIENT: Palmer Environmental Consulting Group Ltd.
PROJECT LOCATION: Reach Street, Uxbridge
DATUM: Geodetic
BH LOCATION: See Drawing 1

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	SOIL PROFILE DESCRIPTION
289.0 0.0	**TOPSOIL:** 360 mm
288.6 0.4	**FILL:** sand, brown, very moist
288.2 0.8	**SAND:** trace to some silt, greyish brown, loose to compact, moist
286.7 2.3	**SANDY SILT:** greyish brown, compact, moist
282.3 6.7	END OF BOREHOLE:

SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m
1	SS	25
2	SS	5
3	SS	14
4	SS	19
5	SS	22
6	SS	18
7	SS	27



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

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Appendix C

LID Design Plan (Sabourin Kimble & Associates, 2018)

C1. LID Design Plan Calculations (SKA, 2018)
C2. LID Plan (SKA, 2018)

C1. LID Design Plan Calculations (SKA, 2018)

REAR YARD LID#1

Infiltration Requirements

Total area of imperviousness	550.0	m^2
Volume to infiltrate:	25.0	mm
Target Volume to be infiltrated:	13.8	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=	13.8	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= 49.7

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	**0.00**	m^3

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REAR YARD LID#2

Infiltration Requirements

Total area of imperviousness	1786.2	m^2
Volume to infiltrate:	25.0	mm
Target Volume to be infiltrated:	44.7	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=	44.7	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= 161.5

Area Available for Infiltration

Contact Area	**170.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**117.50**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**47.00**	**m^3**

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

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REAR YARD LID#3

Infiltration Requirements

Total area of imperviousness	686.9	m^2
Volume to infiltrate:	25.0	mm
Target Volume to be infiltrated:	17.2	m^3

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

Where

P= 28.8 percolation rate of native soil (mm/h)

T= 24.0 detention time (24 hours)

d= 0.69

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

Where

A= Bottom area of trench (m^2)

V= 17.2 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= 62.1

Area Available for Infiltration

Contact Area	**71.30**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**49.28**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**19.71**	**m^3**

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

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Perforated Pipe #1

Infiltration Requirements

Total area of imperviousness	3035.4	m^2
Volume to infiltrate:	25.0	mm
Target Volume to be infiltrated:	75.9	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= 75.9 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= 274.5

Area Available for Infiltration

Contact Area	**80.40**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**55.57**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**22.23**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**53.66**	**m^3**

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Perforated Pipe #2
Infiltration Requirements

Total area of imperviousness	639.2	m^2
Volume to infiltrate:	25.0	mm
Target Volume to be infiltrated:	16.0	m^3

Maximum clearstone depth: **d=**

$$d = \frac{PT}{1000}$$

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=	16.0	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= 57.8

Area Available for Infiltration

Contact Area	**77.80**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**53.78**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**21.51**	**m^3**

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

Perforated Pipe #3

Infiltration Requirements

Volume to be infiltrated from Upstream Source:	**53.7**	**m^3**
Total area of imperviousness	5578.1	m^2
Volume to infiltrate:	25.0	mm
Volume to be infiltrated:	139.5	m^3
Total Target Volume Required for LID Infiltration:	**193.1**	**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=	193.1	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= 698.5

Area Available for Infiltration

Contact Area	**115.50 m^2**
Depth of clearstone	0.69 m
Trench Volume	**79.83 m^3**
Void ratio	0.4
Total LID Infiltration Volume Available	**31.93 m^3**

Total Imperviousness to be infiltrated in downstream LID	**161.18**	m^3

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Perforated Pipe #4

Infiltration Requirements

Volume to be infiltrated from Upstream Source:	**161.2**	**m^3**
Total area of imperviousness	0.0	m^2
Volume to infiltrate:	25.0	mm
Volume to be infiltrated:	0.0	m^3
Total Target Volume Required for LID Infiltration:	**161.2**	**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=	161.2	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= 583.0

Area Available for Infiltration

Contact Area	**435.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**300.67**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**120.27**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**40.91**	**m^3**

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Perforated Pipe #5
Infiltration Requirements

Volume to be infiltrated from Upstream Source:	**40.9**	**m^3**
Total area of imperviousness	1646.6	m^2
Volume to infiltrate:	25.0	mm
Volume to be infiltrated:	41.2	m^3
Total Target Volume Required for LID Infiltration:	**82.1**	**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= 82.1 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= 296.8

Area Available for Infiltration

Contact Area	**103.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**71.19**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**28.48**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**53.59**	**m^3**

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Perforated Pipe #6

Infiltration Requirements

Total area of imperviousness	2400.8	m^2
Volume to infiltrate:	25.0	mm
Volume to be infiltrated:	60.0	m^3
Total Target Volume Required for LID Infiltration:	**60.0**	**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=	60.0	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= 217.1

Area Available for Infiltration

Contact Area	**101.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**69.81**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**27.92**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**32.10**	**m^3**

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Perforated Pipe #7
Infiltration Requirements

Volume to be infiltrated from Upstream Source:	**32.10**	**m^3**
Total area of imperviousness	1381.0	m^2
Volume to infiltrate:	25.0	mm
Volume to be infiltrated:	34.5	m^3
Total Target Volume Required for LID Infiltration:	**66.6**	**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=	66.6	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= 241.0

Area Available for Infiltration

Contact Area	**106.00**	**m^2**
Depth of clearstone	0.69	m
Trench Volume	**73.27**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**29.31**	**m^3**

Total Imperviousness to be infiltrated in downstream LID	**37.31**	m^3

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Storm Chamber
Infiltration Requirements

Volume to be infiltrated from Upstream Source:	**90.91**	**m^3**
Total area of imperviousness	654.0	m^2
Volume to infiltrate:	25.0	mm
Volume to be infiltrated:	16.4	m^3
Total Target Volume Required for LID Infiltration:	**107.3**	**m^3**

Drain Down Time:

$$T=\frac{1000d}{P}$$

Where **P=** 28.8 percolation rate of native soil (mm/h)
d= 1.2 (m)
P=K/f.s.
K = 72mm/hr infiltration rate **T=** 41.67 detention time (Hours)
f.s.= 2.5

Area Available for Infiltration

Contact Area	**229.00**	**m^2**
Depth of clearstone	1.20	m
Trench Volume	**274.80**	**m^3**
Void ratio	0.4	
Total LID Infiltration Volume Available	**109.92**	**m^3**

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

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Site Description

Total Site Area	**3.5908**	Ha

General Infiltration Requirements

Total Impervious Ground Surface Area	7778.8	m^2
Total Roof Area	10563.8	m^2
Total Site Impervious Area	18342.6	m^2

Storm to Infiltrate	25	mm
Total Site Volume to Infiltrate	**459**	m^3

Proposed Infiltration

LID Unit	**Down- stream LID Unit**	**Contact Area** m^2	**Depth** m	**Proposed LID Infiltration Volume** m^3	**Drain Down Time** Hours
Rear Yard LID#1	Perf Pipe#3	62.0	0.7	17.1	24.0
Rear Yard LID#2	Perf Pipe#5	170.0	0.7	47.0	24.0
Rear Yard LID#3	na	71.3	0.7	19.7	24.0
Perf Pipe#1	Perf Pipe#3	80.4	0.7	22.2	24.0
Perf Pipe#2	Perf Pipe#3	77.8	0.7	21.5	24.0
Perf Pipe#3	Perf Pipe#4	115.5	0.7	31.9	24.0
Perf Pipe#4	Perf Pipe#5	435.0	0.7	120.3	24.0
Perf Pipe#5	STM Chamber	103.0	0.7	28.5	24.0
Perf Pipe#6	Perf Pipe#7	101.0	0.7	27.9	24.0
Perf Pipe#7	STM Chamber	106.0	0.7	29.3	24.0
STM Chamber	na	229.0	1.2	109.9	41.7
			TOTAL	**475**	

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	Perf Pipe#3	13.8	13.8	17.1	17.1	**13.8**
Rear Yard LID#2	Perf Pipe#5	44.7	44.7	47.0	47.0	**44.7**
Rear Yard LID#3	na	17.2	17.2	19.7	19.7	**17.2**
Perf Pipe#1	Perf Pipe#3	75.9	75.9	22.2	22.2	**22.2**
Perf Pipe#2	Perf Pipe#3	16.0	16.0	21.5	21.5	**16.0**
Perf Pipe#3	Perf Pipe#4	139.5	231.3	31.9	75.7	**31.9**
Perf Pipe#4	Perf Pipe#5	0.0	231.3	120.3	195.9	**120.3**
Perf Pipe#5	STM Chamber	41.2	272.5	28.5	224.4	**28.5**
Perf Pipe#6	Perf Pipe#7	60.0	60.0	27.9	27.9	**27.9**
Perf Pipe#7	STM Chamber	34.5	94.5	29.3	57.2	**29.3**
STM Chamber	na	16.4	383.4	109.9	391.6	**107.3**
Sum of Column=		**459**		**475**		**459**

Infiltration Summary

Total Site Volume Required to Infiltrate	459	m^3
Infiltration Volume Provided	475	m^3
Infiltration Volume Achieved	459	m^3
Remaining Volume Required	**0.0**	m^3

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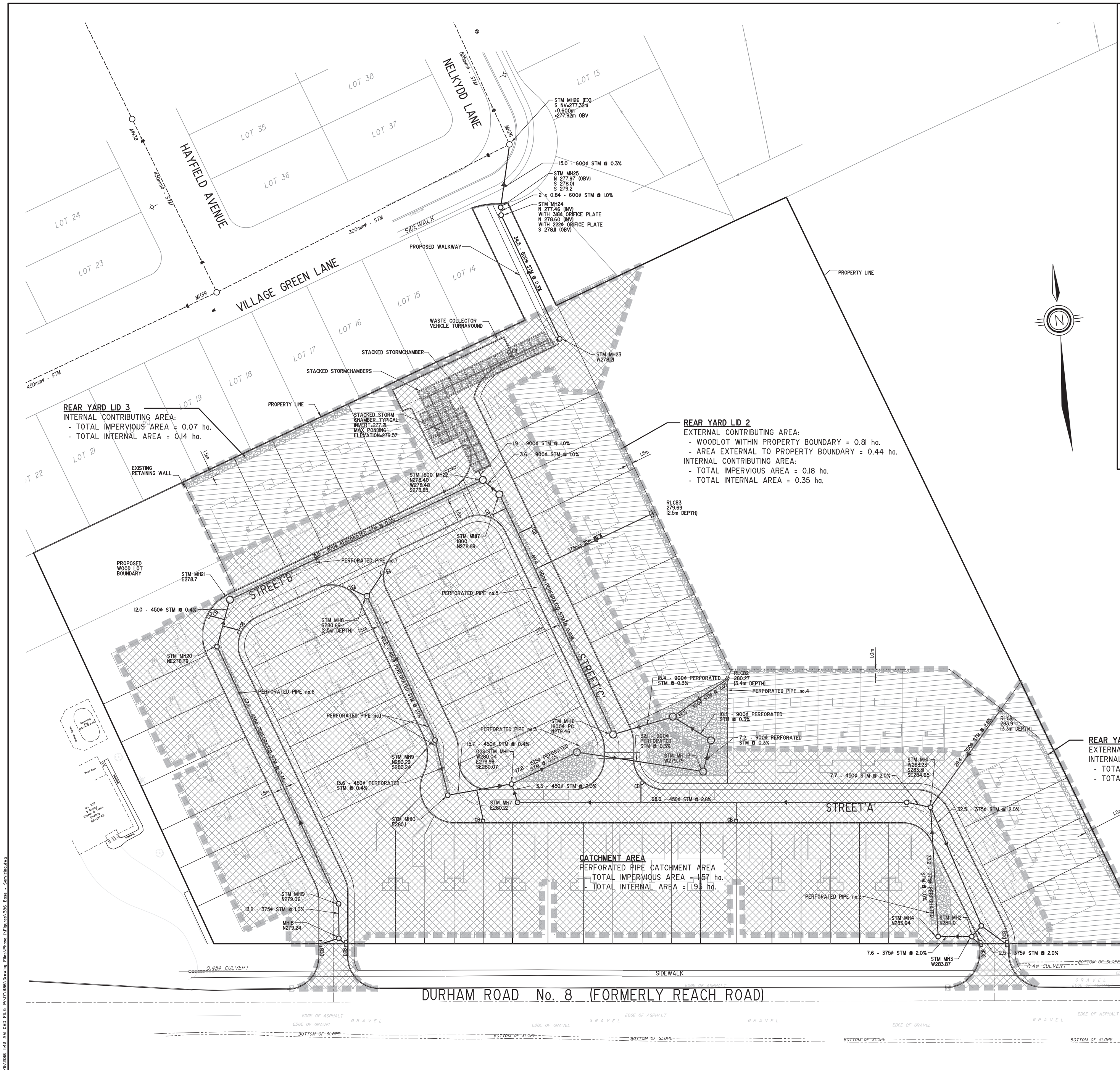
C2. Proposed LID Works (SKA, 2018)



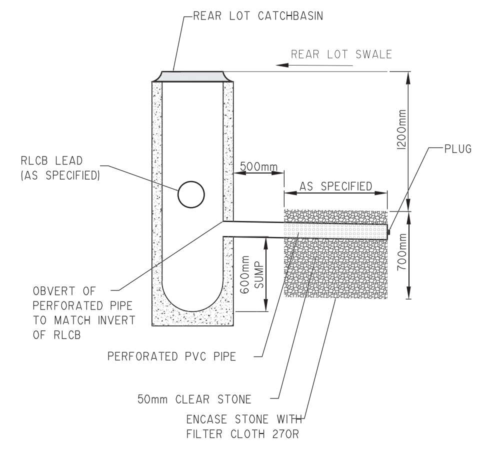
REAR YARD LID 3
INTERNAL CONTRIBUTING AREA:
- TOTAL IMPERVIOUS AREA = 0.07 ha.
- TOTAL INTERNAL AREA = 0.14 ha.

REAR YARD LID 2
EXTERNAL CONTRIBUTING AREA:
- WOODLOT WITHIN PROPERTY BOUNDARY = 0.81 ha.
- AREA EXTERNAL TO PROPERTY BOUNDARY = 0.44 ha.

INTERNAL CONTRIBUTING AREA:
- TOTAL IMPERVIOUS AREA = 0.18 ha.
- TOTAL INTERNAL AREA = 0.35 ha.

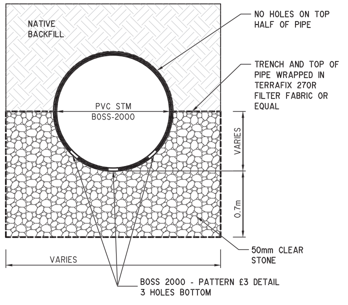
REAR YARD LID 1
EXTERNAL CONTRIBUTING AREA = 1.0 ha.
INTERNAL CONTRIBUTING AREA:
- TOTAL IMPERVIOUS AREA = 0.06 ha.
- TOTAL INTERNAL AREA = 0.14 ha.

CATCHMENT AREA
PERFORATED PIPE CATCHMENT AREA
- TOTAL IMPERVIOUS AREA = 1.57 ha.
- TOTAL INTERNAL AREA = 1.93 ha.



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

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PROJECT NUMBER	FIGURE NUMBER
17:386	6

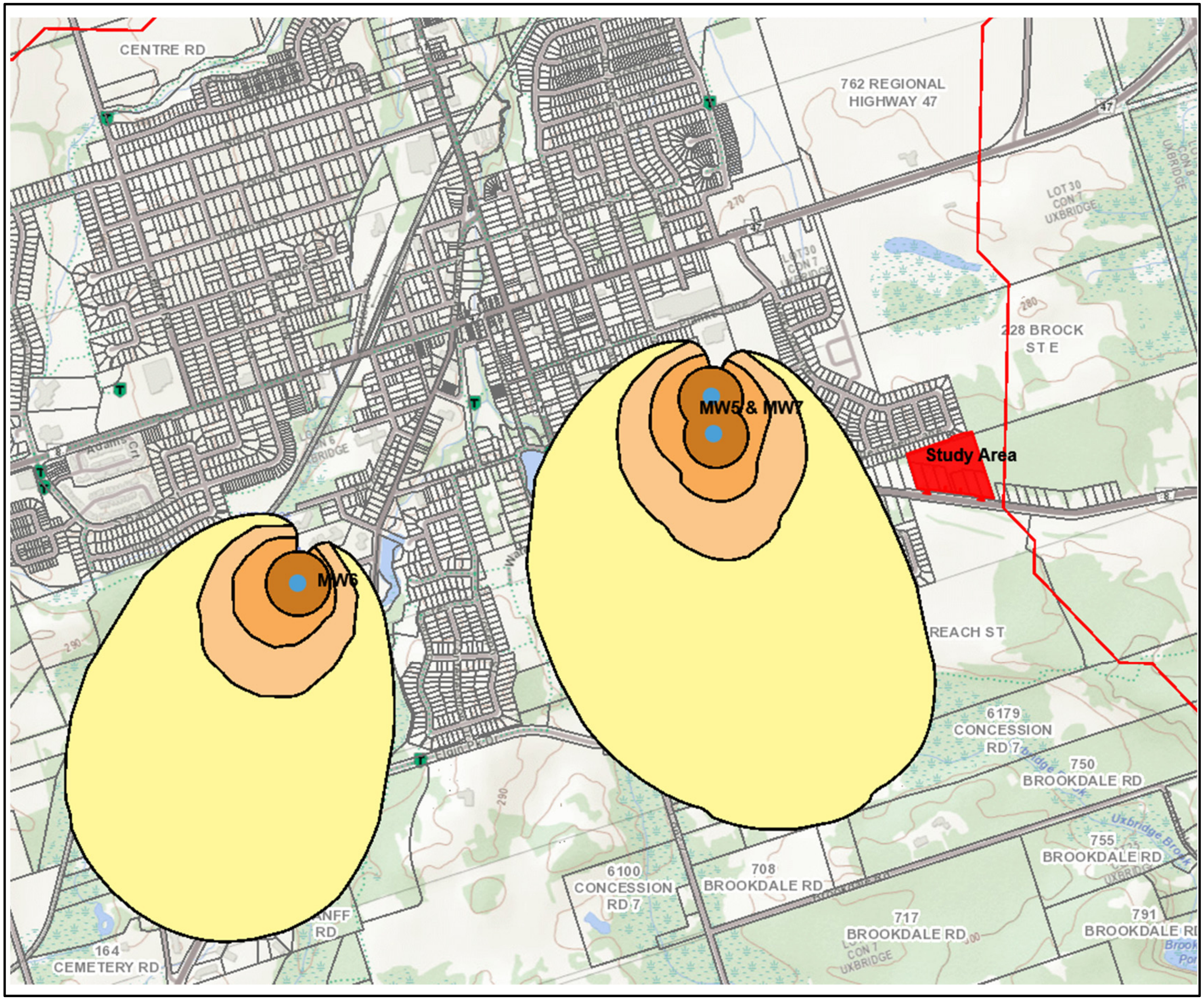
PLOT DATE: 4/9/2018 11:43 AM CAD FILE: P:\17\386\Drawing Files\Phase 1\Figures\386 Base - Servicing.dwg

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

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

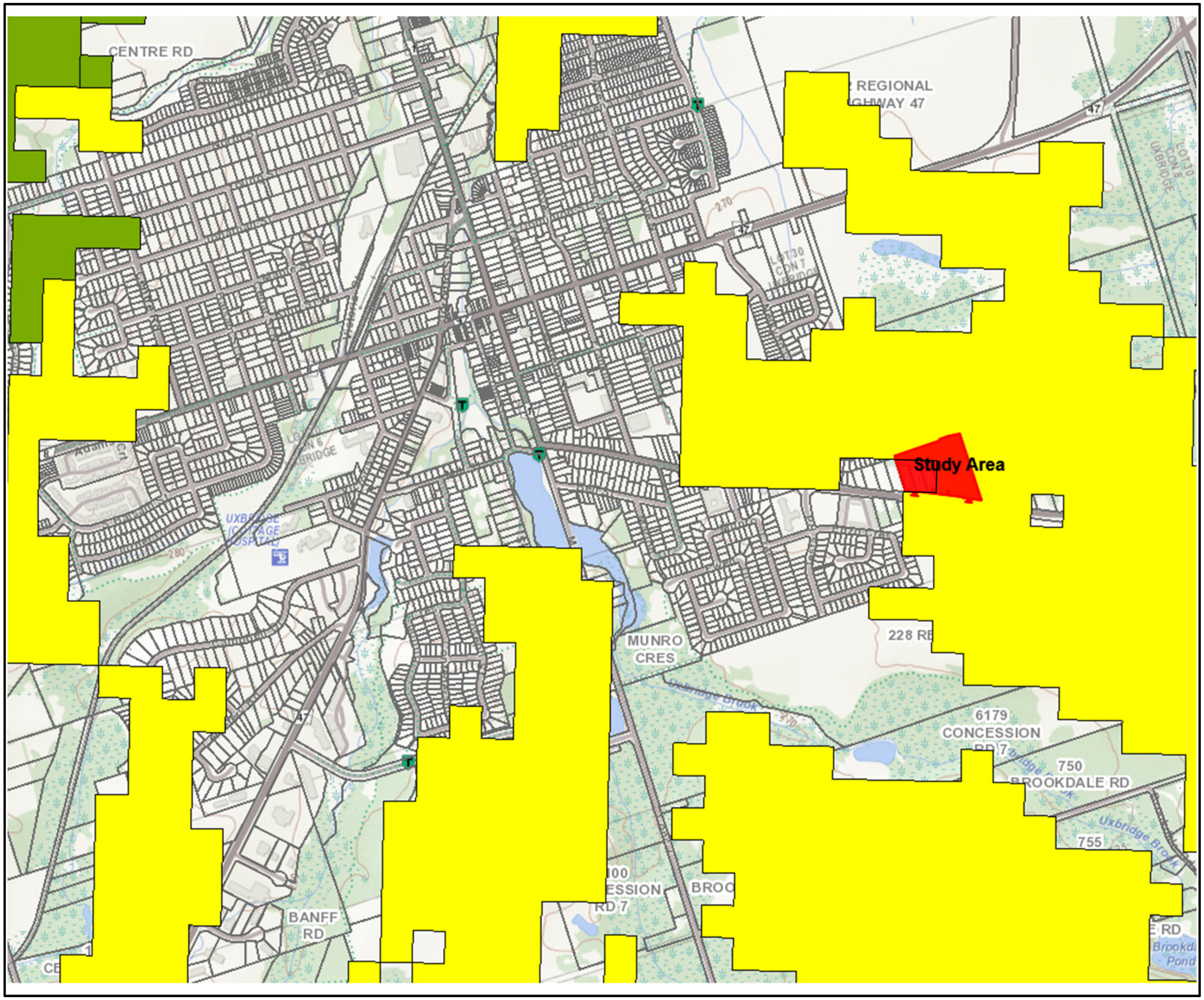
Uxbridge – WHPA

Source Water Protection Mapping

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

Appendix D1

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

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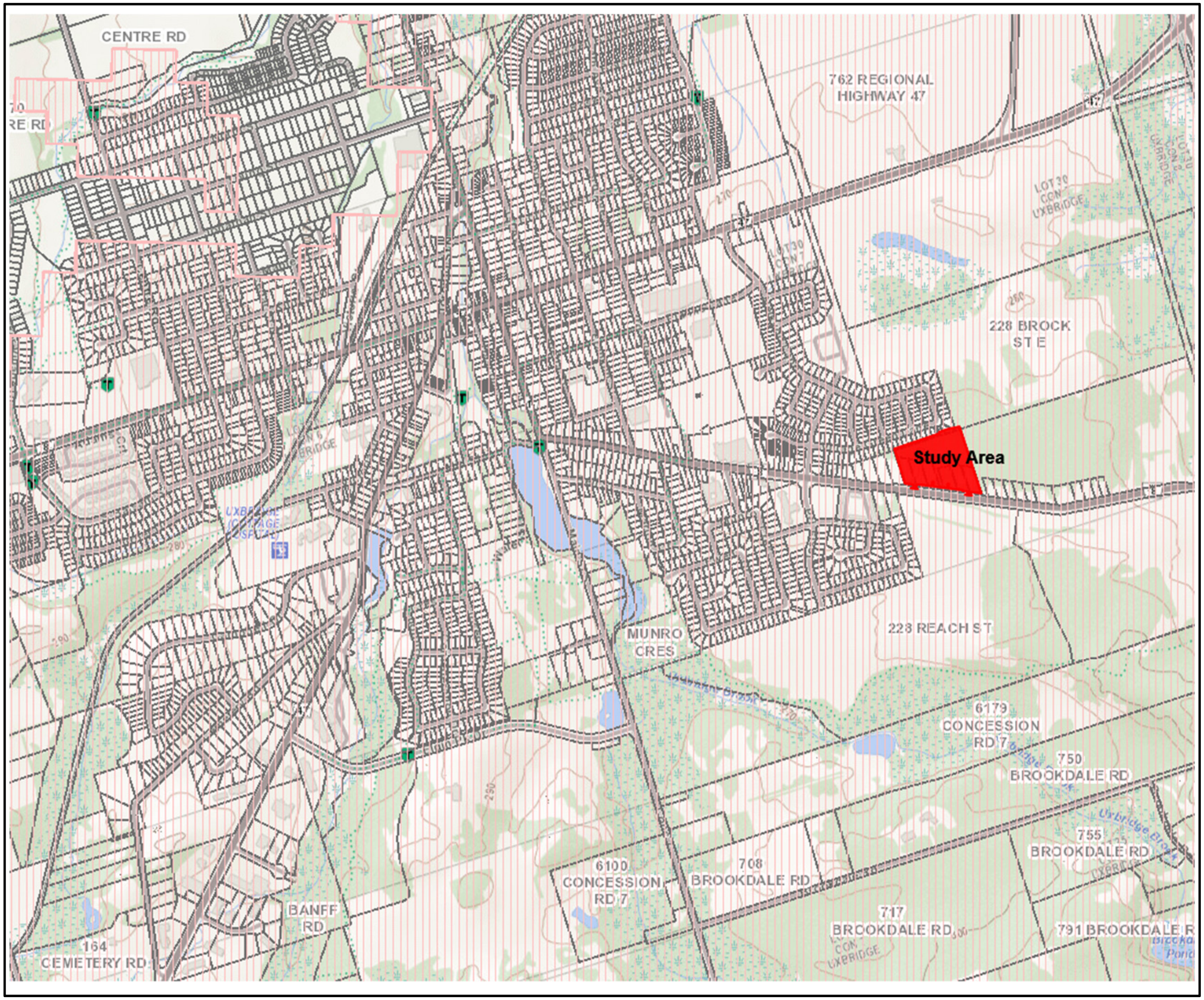
Appendix D2

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

Appendix E

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

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

Ontario

MINISTRY OF THE ENVIRONMENT

Project DEVELOPMENT Summary

DEVELOPMENT: **241-Reach**
Subwatershed: **Pefferlaw-Uxbridge Brook**

Total Pre-Development Area (ha):	**3.5900**	Total Pre-Development Phosphorus Load (kg/yr):	**0.40**

Pre-Development Land Use	Area (ha)	P coeff. (kg/ha)	P Load (kg/yr)
Forest	0.7	0.03	0.02
Low Intensity Development	2.89	0.13	0.38

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	1.03	0.03	Soakaways - Infiltration trenches	60%	0.01
High Intensity - Residential	1.93	1.32	Perforated Pipe Infiltration/Exfiltration Systems	87%	0.33
Low Intensity Development	0.63	0.13	Soakaways - Infiltration trenches	60%	0.03

Post-Development Area Altered:	**3.59**
Total Pre-Development Area:	**3.59**
Unaffected Area:	**0**

	P Load (kg/yr)
Pre-Development:	**0.40**
Post-Development:	**2.66**
Change (Pre - Post):	**-2.26**

571% Net Increase in Load

Post-Development (with BMPs):	**0.38**
Change (Pre - Post):	**0.02**

5% 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):	2.56	BMP capture Efficiency:	70%
% slope erosion prevention applied to:	0.3	LS (slope length gradient factor):	*0.68*
% 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):	*649.5328*
		Phosphorus Load (kg):	*0.26*

Developed AREA (ha): 2.55999994278

	Total
Construction Phase Phosphorus Load with BMPs (kg):	0.26
Construction Phase Phosphorus Load no BMPs (kg):	0.70

SUMMARY WITH IMPLEMENTATION OF BMPs	**P Load (kg/yr)**
Pre-Development:	**0.40**
Construction Phase Amortized Over 8 Years :	0.03
Post-Development:	**0.38**
Post-Development + Amortized Construction:	**0.41**
Pre-Development Load - Post-Development Load:	**0.02**
Conclusion:	**5% Reduction in Load**
Pre-Development Load - (Post-Development + Amortized Construction Load):	**-0.01**
Conclusion:	**3% Increase 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 IF all reasonable and construction phase BMP's have been identified for implementation, documented and accounted for in the application.