GeoPro Consulting Limited

Geotechnical-Hydrogeology-Environmental-Materials-Inspection

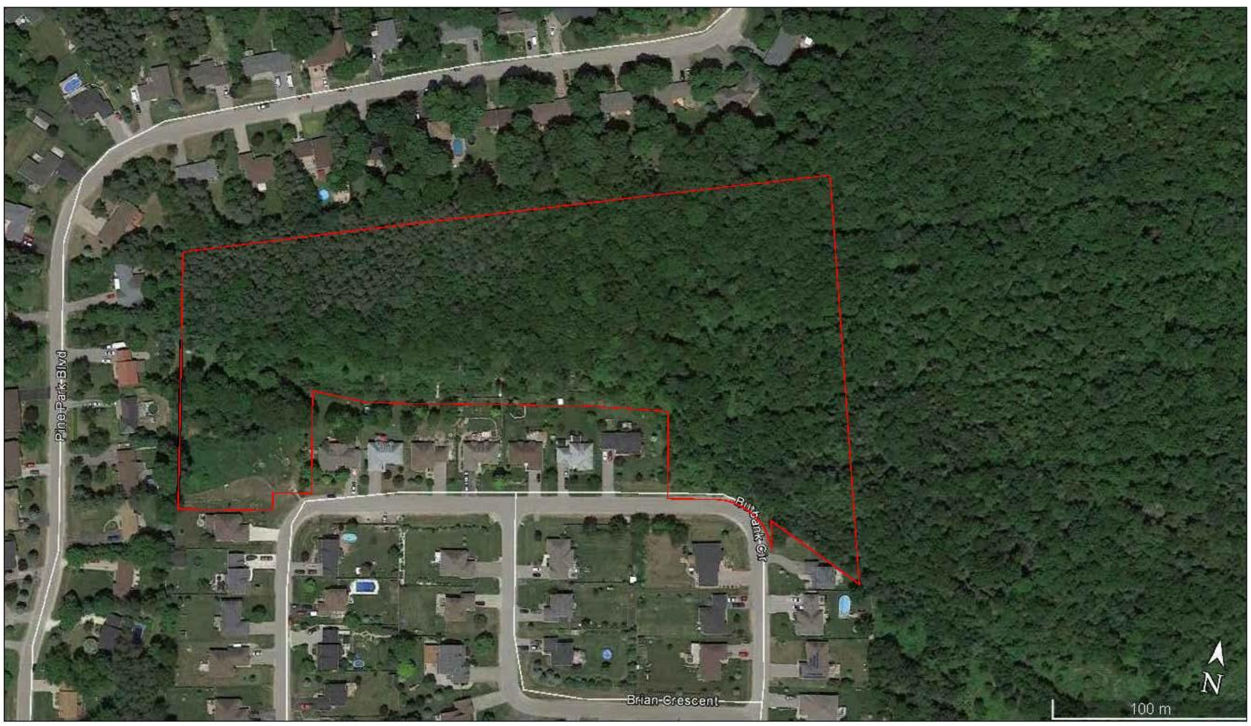
Preliminary Hydrogeological Site Assessment (including Water Balance Study)

Proposed Subdivision Development (Second Phase)

North of Burbank Circle, Everett, Ontario

Prepared For:

Winzen Development Limited



GeoPro Project No.: 16-1710H

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Professional, Proficient, Proactive

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GeoPro CONSULTING LIMITED

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1.0 INTRODUCTION

GeoPro Consulting Limited ("GeoPro") was retained by Winzen Developments Limited ("the Client") to conduct a hydrogeological Site assessment including water balance study for the proposed Second Phase subdivision development located north of Burbank Circle in Everett, Township of Adjala-Tosorontio ("the Town"), County of Simcoe, Ontario ("the Site"). The Site is located northeast of the intersection of Highway 13 and County Road 5, in Everett, Ontario. The approximate site location is shown on Drawing No. 1.

It is understood that the subdivision application which consists of residential developments on a total of forty-five (45) lots based on the Town's sewer systems has been submitted to the Town and County of Simcoe. The proposed developments may include the mitigative measures such as soakaway pits, semi-permeable pavers and roadside ditches to address the water balance associated with the proposed development. In response to the comments made by the Town and County of Simcoe, a water balance study and ground water condition investigation were requested to support the proposed designs.

It should be noted that no detailed design drawing or information of the proposed subdivision development was provided when preparing this hydrogeological report. In this regard, this hydrogeological site assessment is considered to be preliminary.

1.1 Purposes

The purposes of this preliminary hydrogeological site assessment including water balance study were to investigate the subsurface soil and groundwater conditions and assess the site-specific water balance in terms of the designs proposed for the site development.

1.2 Scope of Work

The preliminary hydrogeological site assessment was carried out consisting of the following tasks:

1) Conducting a search and review of the available data resources for the site background information, including geology, hydrogeology and Ministry of the Environment and Climate Change ("MOECC") Water Well Records ("WWR") and previous investigation reports;
2) Data search and review of the data on precipitation and temperature from the database of Environment Canada;
3) Completing installation of additional monitoring wells;
4) Conducting groundwater monitoring and testing;
5) Performing infiltration tests using Guelph Permeameter at selected locations; and,
6) Completing data processing, interpretation and report preparation.

This report has been prepared for the Client. Third party use of this report without GeoPro's consent is prohibited. The limitation conditions presented in this report form an integral part of the report and they must be considered in conjunction with this report.

1.3 Previous Investigations and Reports

1.3.1 Geotechnical Investigation by GeoPro

GeoPro conducted a geotechnical investigation in 2017 at the Site. A report entitled "*Geotechnical Investigation, Proposed Subdivision Developments, North of Burbank Circle, Everett, Ontario*" dated April 3, 2017 was prepared by GeoPro.

During the geotechnical investigation, a total of four (4) boreholes (BH1 to BH4) were drilled at the Site to the depths ranging from about 4.6 m below the ground surface ("mBGS") to 8.1 mBGS, and one (1) monitoring well (51 mm diameter) was installed at BH1, two (2) monitoring wells (38 mm diameter) were installed at BH2 and BH3, and one (1) piezometer (19 mm diameter) was installed at BH4 for groundwater monitoring and testing.

The information obtained from the geotechnical investigation has been incorporated into this preliminary hydrogeological site assessment report. The approximate borehole/monitoring well and piezometer locations are shown on Drawing No. 2. A copy of Borehole Logs is included in Appendix A.

It should be noted that during this preliminary hydrogeological site assessment, monitoring wells at BH2 and BH3 and piezometer at BH4 were noted to have been damaged/compromised. BH1 was used in this preliminary hydrogeological site assessment.

2.0 SITE CONDITIONS

2.1 Site Feature Observations

A site visit was made on November 17, 2017 to observe the general site features.

The Site was noted to be occupied vacant area and forested area south of Pine Park Boulevard and north of Burbank Circle, and generally bounded by residential houses and forested area.

A small creek, identified as a tributary of Pine River was noted to run from west to east in the area of the south property boundary of the Site.

All previous monitoring wells installed by GeoPro was found to be destroyed except for BH1.

2.2 Fieldwork

The field work for this preliminary hydrogeological site assessment was carried out on November 17, 22 and 23, 2017, which consisted of hand augering, soil sampling, temporary monitoring well installation, groundwater monitoring and in-situ borehole permeability testing, and Guelph Permeameter infiltration testing.

2.2.1 Temporary Monitoring Well Installation

A total of seven (7) boreholes (BH02 to BH08) were hand augered on November 23, 2017 at the Site to depths ranging from approximately 0.5 mBGS to 2.2 mBGS. Soil samples were retrieved for visual observation. After the hand augering, a temporary well was installed in each of the augered holes using a 1.25 inch PVC slotted screen for groundwater monitoring and testing.

The details of soil stratigraphy and other features observed and interpreted from the retrieved soil samples are presented in the Borehole Logs in Appendix A. The approximate monitoring well locations are shown on Drawing No. 2.

It should be noted that BH06, BH07 and BH08 were located by the side of the creek, which were installed for observation of the water levels. No borehole logs were prepared for these holes.

2.2.2 Borehole Permeability Testing (Slug Testing)

Borehole permeability tests were carried out in the existing monitoring well BH1 on November 17, 2017 and in four (4) temporary monitoring wells at BH02 to BH05 on November 23, 2017.

Prior to the slug testing, initial water levels were measured manually using a water level finder, and the monitoring wells were purged using Waterra pumps (tubing and footvalves) to remove the sediments settled in the well.

The field slug test was completed either using a rising head method in which a certain amount of groundwater was removed from the tested monitoring well or using a falling head method in which a certain volume of potable was added into the tested monitoring well, and the recovery of water level was measured and recorded. Before purging or introducing the water, a datalogger was placed in the monitoring well to record the change in water head versus time throughout the test. The retrieved water level data was plotted on a semi-logarithmic scale using Hvorslev's method to estimate the hydraulic conductivity values.

2.2.3 Guelph Permeameter Infiltration Testing

Guelph Permeameter Infiltration Testing was carried out at four (4) locations (G1 to G4) at depths of approximately 0.51 mBGS to 0.76 mBGS on November 22, 2017. The approximate test locations are shown on Drawing 2. In each test, the single water reservoir was used with a constant water column set as 5 cm and water consumption was recorded until the water consumption reaches at a constant rate.

2.3 Physiography and Drainage

The Site is located within a boundary physiographical region of Simcoe Uplands and Simcoe Lowlands in an area comprised of Sand Plains, according to the "Physiography Map of South Central Portion of Southern Ontario" (Map 2226, Scale 1:253,440) prepared by the Ontario Department of Mines and Northern Affairs, and based on database maintained by Ontario Geological Survey ("OGS").

The Site is located within the Pine River Subwatershed in the Nottawasaga Valley Watershed, under the jurisdiction of the Nottawasaga Valley Conservation Authority ("NVCA"). A tributary of Pine River runs from west to east at the south boundary of the Site, which joins the main Pine River about 8.9 km northeast of the Site.

2.4 Geology

2.4.1 Bedrock Geology

Based on Bedrock Geology of Ontario Southern Sheet, Map 2544 (1: 1,000,000), the bedrock at the Site consisted of Upper Ordovician deposits of shale, limestone, dolostone, and siltstone.

2.4.2 Surficial Geology

Based on the surficial geology information, the Site and its surrounding area are covered with glaciofluvial deposits (river deposits and delta topset facies) and coarse-textured glaciolacustrine deposits of sand and gravel with minor silt and clay, as shown on Drawing No. 3.

2.4.3 Site Stratigraphy

The soil stratigraphy at the Site generally consisted of fill materials and/or topsoil, underlain by cohesionless soils of sand to fine sand, locally with silt layers. The fill materials generally consisted of silty sand to sand, and extended to a depth of about 1.4 mBGS.

Detailed descriptions of soil strata encountered in the boreholes advanced at the Site are provided in Borehole Logs in Appendix A.

2.5 Hydrogeology

The preliminary hydrogeological conditions at the Site were evaluated using the water well data collected from the MOECC database, the information obtained in the previous geotechnical investigation, and the data collected from the additional work conducted at the Site.

2.5.1 MOECC Water Well Records

A search of the MOECC WWR database was conducted focusing on the area within a 500 m radius of the entire proposed alignment site. The locations of the MOECC water wells are shown on Drawing No. 4. A summary of water well records is included in Appendix B.

No water wells were identified at the Site. Based on the water well records, groundwater was encountered at the depths of 0.9 mBGS to 53.0 mBGS in overburden deposits.

2.5.2 Groundwater Levels

Groundwater conditions were observed in the advanced boreholes during and immediately upon completion of drilling. The results of observations are included in the Borehole Logs in Appendix A.

Groundwater levels were measured on March 7 and November 23, 2017 in the monitoring wells installed at the Site. The monitoring well construction details and the measured groundwater levels are summarized in the following table.

Monitoring Well ID	Well Elevation (m)	Screen Interval/ Elevation (mBGS/m)	Water Level (mBGS) / Groundwater Elevation (m)	
			Date of Monitoring: (March 7, 2017)	Date of Monitoring: (November 23, 2017)
BH1	241.02	3.8 ~ 5.3 (237.2 ~ 235.7)	2.74 / 238.28	3.05 / 237.97
BH2	-	2.1 ~ 3.6	1.37	-
BH3	-	3.1 ~ 4.6	1.10	-
BH4	-	3.1 ~ 4.6	0.80	-
BH02	245.91	0.7 ~ 2.2 (245.2 ~ 243.7)	-	1.43 / 244.48
BH03	242.13	0.4 ~ 1.9 (241.7 ~ 240.2)	-	1.08 / 241.06
BH04	242.76	0.7 ~ 1.0 (242.1 ~ 241.8)	-	0.20 / 242.56
BH05	238.01	0.0 ~ 1.4 (238.0 ~ 236.6)	-	0.71 / 237.30
BH06	238.08	0.0 ~ 05 (238.08 ~ 236.61)	-	0.35 / 237.73
BH07	237.68	0.0 ~ 05 (237.68 ~ 237.18)	-	0.27 / 237.41
BH08	237.37	0.0 ~ 05 (237.37 ~ 236.87)	-	0.20 / 237.17

As shown in above table, the measured groundwater levels ranged from 0.20 mBGS to 3.05 mBGS, and the elevations ranged from 237.17 m to 244.48 m.

Based on the obtained groundwater level elevations, shallow groundwater elevation contours were prepared. As shown on Drawing No. 5, the shallow groundwater flow directions were inferred to be generally towards the creek. On the north side of the small creek, the groundwater flow direction was in a general direction of southeast, with the horizontal hydraulic gradient calculated to be approximately 6.7% to 20% m/m; while on the south side of the small creek, the groundwater flow direction was in a general direction of northeast, with the horizontal hydraulic gradient calculated to be approximately 6.7% to 12% m/m.

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to weather events.

3.0 SOIL PERCOLATION TIME/INFILTRATION RATE

The percolation times and soil infiltration rates for the soils were estimated based on the results obtained from Guelph Permeameter infiltration tests and from the single well response tests (slug tests).

3.1 Guelph Permeameter Infiltration Test Method

Guelph Permeameter infiltration testing is one of the recommended infiltration test methods discussed in Stormwater Management Criteria (SWMC), Version 1.0, dated August 2012, issued by the Toronto and Region Conservation Authority ("TRCA").

Guelph Permeameter Infiltration Testing was carried out at four (4) locations (G1 to G4) as shown on Drawing No. 2 at depth ranging from 0.5 mBGS to 0.8 mBGS. Based on the results obtained from Guelph Permeameter infiltration tests, the field saturated hydraulic conductivity (K_{fs}) values were estimated. The results of Guelph Permeameter tests and data processing are presented in Appendix C, and are summarized in the following table.

Test Location	Soil Depth (mBGS)	Primary Soil	Hydraulic Conductivity (cm/s)
G1	0.8	Fill: silty sand to sand	3.1×10^{-4}
G2	0.8	Topsoil; Sand to Fine Sand	2.2×10^{-3}
G3	0.8	Topsoil; Reworked Silty Sand	1.8×10^{-3}
G4	0.5	Topsoil; Sand to Fine Sand	2.1×10^{-4}

3.2 Single Well Response Test (Slug Test) Method

As discussed, borehole permeability tests were carried out in the existing monitoring well BH1 and four (4) temporary monitoring wells (BH02 to BH05). Records of slug tests and K-value estimation are included in Appendix D. A summary of K values estimated as per slug tests is presented in the following table.

Monitoring Well No.	Screen Depth (mBGS)	Tested Soil Depth (mBGS)	Soil Type	Estimated K-Value (cm/s)
BH1	3.8 ~ 5.3	3.8 ~ 5.3	Sand to Fine Sand	8.0×10^{-3}
BH02	0.7 ~ 2.2	1.3 ~ 2.2	Sand to Fine Sand	3.1×10^{-4}
BH03	0.4 ~ 1.9	1.0 ~ 1.9	Sand to Fine Sand	2.9×10^{-4}

Monitoring Well No.	Screen Depth (mBGS)	Tested Soil Depth (mBGS)	Soil Type	Estimated K-Value (cm/s)
BH04	0.7 ~ 1.0	0.7 ~ 1.0	Sand to Fine Sand	1.0×10^{-3}
BH05	0.0 ~ 1.4	0.1 ~ 1.4	Topsoil; Sand to Fine Sand	1.2×10^{-5}

Based on the slug test results, the estimated hydraulic conductivity values of the screened soils ranged from 1.2×10^{-5} cm/s to 8.0×10^{-3} cm/s.

3.3 Soil Percolation Time/Infiltration Rate

The percolation times and soil infiltration rates for the soils were assessed and calculated using the obtained hydraulic conductivity values as per the methods described in Supplementary Standards SB-6, issued by Ministry of Municipal Affairs and Housing (2006), and in TRCA's Stormwater Management Criteria ("SWMC"), Version 1.0, dated August 2012, and were modified based on our experience.

The calculated soil percolation times and infiltration rates are presented in the following table.

Depth (mBGS)	Test Location	Tested Soil Depth (mBGS)	Primary Soil (Tested)	Hydraulic Conductivity (cm/s)	Percolation Time T, (min/cm)	Infiltration Rate 1/T, (mm/hour)
0.5 ~ 0.8	G4	0.5	Topsoil; Sand to Fine Sand	2.1×10^{-4}	23	26
	G1	0.8	Fill: silty sand to sand	3.1×10^{-4}	21	29
	G2	0.8	Topsoil; Sand to Fine Sand	2.2×10^{-3}	12	50
	G3	0.8	Topsoil; Rework Silty Sand	1.8×10^{-3}	13	46
0.0 ~ 1.4	BH05	0.1 ~ 1.4	Topsoil; Sand to Fine Sand	1.2×10^{-5}	38	16
0.4 ~ 2.2	BH03	1.0 ~ 1.9	Sand to Fine Sand	2.9×10^{-4}	21	29
	BH04	0.7 ~ 1.0	Sand to Fine Sand	1.0×10^{-3}	15	40
	BH02	1.3 ~ 2.2	Sand to Fine Sand	3.1×10^{-4}	21	29
3.8 ~ 5.3	BH1	3.8 ~ 5.3	Sand to Fine Sand	8.0×10^{-3}	6	100

As indicated above, the soils at the depth from 0.5 mBGS to 0.8 mBGS were tested to have the hydraulic conductivity values in the order of 10^{-3} cm/s to 10^{-4} cm/s, the percolation times ranging from 12 min/cm to 23 min/min, and the infiltration rates from 26 mm/hour to 50 mm/hour; the soils to the depths of about 2.2 mBGS were tested to have hydraulic conductivity values in the order of 10^{-3} cm/s to 10^{-5} cm/s, the percolation times ranging from 15 min/cm to 38 min/min, and the infiltration rates from 16 mm/hour to 40 mm/hour; and the soils tested at one (1) location at the depths between 3.8 mBGS and 5.3 mBGS were found to have the hydraulic conductivity of 8×10^{-3} cm/s, the percolation time of 6 min/cm and the infiltration rate at 100 mm/hour.

As per SWMC, the infiltration rate used to design an infiltration facility should incorporate a safety correction factor that compensates for the potential reduction in soil permeability due to compaction or smearing during construction, the gradual accumulation of fine sediments over the lifespan of the infiltration facility, and the uncertainty in measured values when less permeable soil horizons exist within 1.5 metres below the proposed bottom elevation of the infiltration facility.

4.0 WATER BALANCE ASSESSMENT

4.1 Pre-Development Geographical Blocks

As discussed, the Site was generally covered with native soils of sand to fine sand deposits below fill materials and/or topsoil. Based on the Draft Plan of Subdivision dated March 1, 2017 provide by the Client, topography at the Site was determined to be "rolling to hilly".

According to aerial photos and observations during site visit, the Site is currently occupied by vacant areas, mature forest and/or wetland area.

Based on the observed site features and available information including surficial geology, land use, land vegetation cover, soil types and related soil moistures, the pre-development area of the Site could be divided into three (3) geographical blocks, which are shown on Drawing No. 6 and summarized in the following table.

Zone No.	Location	Percentage Area of Site	Soil Type	Vegetation Cover	Soil Moisture Retention (mm)	Topography
1	Southwest and Southeast Corner Area	5.2%	Sand to Fine Sand	Urban Lawns	50	Rolling to Hilly
2	West-East Central Line Area	11.6%		Pasture and Shrubs	100	
3	Rest Area of the Site	83.2%		Mature Forests / Wet Lands	250	

4.2 Post-Development Geographical Blocks

4.2.1 Proposed Development Concept

Based on the Draft Plan of Subdivision provide by the Client, the proposed development consists of forty-five (45) units of single residential houses and one (1) Road "Street A", with the total area of the Site to be 4.33 ha (43,300 m^2). A copy of the draft plan is provided in Appendix E.

4.2.2 Post-Development Geographical Blocks

The soil type and topography of post-development area were assumed to be the same as the pre-development area conditions.

The details of the building designs for the proposed residential buildings including the footprint area and driveway area are not available when preparing this preliminary hydrogeological site assessment report. Therefore, for the preliminary water balance assessment, the paved area of each residential property was assumed to be 50% of the property area, and the rest area of each residential property was assumed to be occupied by urban lawns.

Accordingly, the pre-development area of the Site would be divided into three (3) geographical blocks as shown on Drawing No. 7. The conditions of the three (3) geographical blocks are summarized in the following table.

Zone No.	Location	Percentage Area of Site	Soil Type	Vegetation Cover	Soil Moisture Retention (mm)	Topography
A	Proposed "Street A" Area	19.3%	Sand to Fine Sand	Paved Area	0	Rolling to Hilly
B	West-East Central Line Area	9.9%		Pasture and Shrubs	100	
C	Proposed Residential Properties Area	35.4%		Urban Lawns	50	
		35.4%		Paved Area	0	

4.3 Climate and Precipitation

The climatic data for the Site was obtained from Environment Canada, referring to a climate station in Alliston. The Canadian Climatic Normals 1981 to 2010 for ALLISTON NELSON Station (ID: 6110218, 44°09'05.028" N, 79°52'20.088" W), at an elevation of 221.0 m above sea level ("mASL") were collected. The monthly and annual averages for precipitation and temperatures are presented in Appendix F.

4.4 Site-Level Water Balance

Based on the Thornthwaite and Mather methodology (1957), water balance quantifies the movement of water in the hydrologic cycle. Precipitation ("P") falls as rain and snow. It can run off towards lakes and streams ("R"), infiltrate to the groundwater table ("I"), or evapotranspire into the atmosphere by evaporation from the Earth's surface and by transpiration from vegetation ("ET"). When long-term average values of P, R, I, and ET are used there is minimal or no net change to groundwater storage ("ΔS") at a reference site.

The annual water budget can be stated as:

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

Where:

P = Precipitation (mm/year)

ET = Evapotranspiration (mm/year)

R = Runoff (mm/year)

I = Infiltration (mm/year)

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

4.5 Precipitation and Evapotranspiration

Based on the Canada Climate Normals data from Environment Canada for ALLISTON NELSON Station for the years from 1981 to 2010, the average annual precipitation for the site area was recorded to be approximately 834 mm/year.

Evapotranspiration varies based on the characteristics of the land surface cover (i.e., type of vegetation, soil moisture conditions, perviousness of surface, etc.). Potential evapotranspiration ("PET") is defined as the amount of evapotranspiration that would occur if an unlimited water supply is available. The actual rate of evapotranspiration ("AET") is often less than the PET under dry conditions (i.e., during the summer when there is a soil moisture deficit). In this report, the PET was calculated using the 1981 to 2010 ALLISTON NELSON Station data according to Thornthwaite Formula and Trow's adjustment method, and the AET was calculated based on the Thornthwaite Soil Moisture Balance Approach with water holding capacity of different soil types as outlined in Table 3.1, MOE SWMPDM (2003). A summary of the calculations is presented in Appendix G.

Impervious surface prevents infiltration. No Transpiration ("T") will occur on paved or impervious areas. It is assumed that 10% of annual precipitation will become the evaporation component of evapotranspiration ("ET") on paved or impervious areas.

The difference between mean annual precipitation and mean annual evapotranspiration is referred to as the water surplus.

4.6 Infiltration and Runoff

Part of the water surplus travels across the ground surface as surface water or overland runoff and the remainder infiltrates the surficial soil.

The rate of infiltration in pervious area at a site is expected to vary, based on a number of factors including topography, soil type and land cover as introduced in Table 3.1, MOE SWMPDM (2003).

<u>Pre-Development</u>

Based on the pre-development site conditions for the areas shown on Drawing No. 6, the infiltration factor of each geographical block at pre-development area of the Site is summarized in the following table.

Geographical Block No.	Infiltration Factors			Cumulative Infiltration Factor
	Topography	Soils	Cover	
1	0.15	0.35	0.1	0.6
	Rolling to Hilly	Sand to Fine Sand	Cultivated Land	
2	0.15	0.35	0.15	0.65
	Rolling to Hilly	Sand to Fine Sand	Shrubs Land	
3	0.15	0.35	0.2	0.7
	Rolling to Hilly	Sand to Fine Sand	Woodland	

<u>Post-Development</u>

Based on the post-development site conditions for the areas shown on Drawing No. 7, the infiltration factor of each geographical block in the post-development area of the Site is summarized in the following table.

Geographical Block No.	Infiltration Factors			Cumulative Infiltration Factor
	Topography	Soils	Cover	
A	No Infiltration on Paved Area			0.0
B	0.15	0.35	0.1	0.6
	Rolling to Hilly	Sand to Fine Sand	Cultivated Land	
C (Unpaved Area)	0.15	0.35	0.2	0.7
	Rolling to Hilly	Sand to Fine Sand	Woodland	
C (Paved Area)	No Infiltration on Paved Area			0.0

The calculated volumes of infiltration and runoff in the stage of pre-development and post-development are presented in Appendix G and are discussed as follows.

4.6.1 Pre-development Water Budget

Water budget including infiltration and runoff volumes under the pre-development conditions was assessed for the divided three (3) geographical blocks, which is summarized in the following table.

Geographical Block No.	Surficial Area	Estimated Annual Infiltration		Estimated Annual Surface Runoff	
	m²	mm/year	m³/year	mm/year	m³/year
1	5.2% 2,251.6	184	414	123	277
2	11.6% 5,022.8	182	914	98	492
3	83.2% 36,025.6	176	6,341	75	2,702
Total Area	43,300	***Total:***	7,669	***Total:***	3,471

Based on calculations, a total of 7,669 m³ per year will infiltrate into subsurface, while a total volume of 3,471 m³ per year will become runoff.

4.6.2 Preliminary Post-Development Water Budget without Mitigative Measures

Based on the draft plan, the proposed development will consist of residential houses with driveways, and local roadway, which are paved or impervious areas and where infiltration may not take place.

Assuming that 10% of annual precipitation will evaporate on impervious areas, the total water surplus on the impervious surfaces will be 90% of the annual precipitation, which is calculated to be 750.6 mm/year. On pervious surface, the annual water surplus was determined using the soil moisture balance approach as discussed.

The water budget under the preliminary post-development conditions was assessed for the three (3) new blocks formed due to the development, and is summarized in the following table.

Geographical Block No.	Surficial Area	Estimated Annual Infiltration		Estimated Annual Surface Runoff	
	m²	mm/year	m³/year	mm/year	m³/year
A	19.3% 8,356.9	0	0	751	6,276
B	9.9% 4,286.7	168	720	112	480
C (Unpaved Area)	35.4% 15,328.2	215	3,296	92	1,410

Geographical Block No.	Surficial Area	Estimated Annual Infiltration		Estimated Annual Surface Runoff	
	m²	mm/year	m³/year	mm/year	m³/year
C (Paved Area)	35.4% 15,328.2	0	0	751	11,511
Total Area	43,300	***Total:***	4,016	***Total:***	19,677
		Change as compared to Pre-development	-3,653 (-47.6%)		+16,207 (+470%)

As presented in the above table, the infiltration volume was calculated to be 4,016 m^3 per year, which is a deficit of 3,653 m^3 per year (about 47.6%) after the development without mitigative measures. On the other hand, the surface runoff will be 19,677 m^3/year, which increases by 16,207 m^3/year (about 4.7 times) after the development without mitigative measures.

4.6.3 Preliminary Post-Development Water Budget by Directing Roof Water to Soakaway Pits

It is understood that soakaway pits would be considered for the proposed development as mitigative measures to reduce the runoff volume and increase the infiltration. The design concept would include directing the rooftop drainage from low and medium density residential land use to the proposed soakaway pits to assist with water retention and provide a longer duration for infiltration. However, no detailed design of the directing roof water to soakaway pit system was provided when preparing this preliminary hydrogeological site assessment. To assess the potential effectiveness of these design measures for the proposed development, it is assumed that all runoff from the building roofs will be directed to soakaway systems.

Based on the assumptions, the preliminary post-development water budget was re-assessed, and the preliminary results are presented in Appendix G.

Based on the preliminary calculation, a total of 3,384 m^3/year of the roof water will be added to the infiltration due to application of the roof water collection and diversion to soakaway pits. On the other hand, the same amount of water budget will be reduced from the runoff.

4.6.4 Other Proposed Mitigative Measures

Other than application of soakaway pits, other mitigative measures including semi-permeable pavers and roadside ditches would also be proposed to the Site to reduce the runoff volume and increase the infiltration.

No design drawing or information about the location and distribution of these kinds of mitigative measures was provided when preparing this preliminary hydrogeological site assessment. Therefore, no water budget estimation could be prepared for this preliminary hydrogeological site assessment.

4.6.5 Summary of Water Budget

Based on the above preliminary assessments, infiltration would be significantly improved by directing roof water to soakaway pits in the development to increase the infiltration volume at post-development stage. A summary of the preliminary water budget assessments is presented in the following table.

Stage	Infiltration (m^3/year)	Runoff (m^3/year)
Pre-development	7,669	3,471
Un-mitigated Post-development	4,016	19,677
Directing Roof Drainage	+ 3,384	- 3,384
Post-development with Directing Roof Drainage	7,400	16,293
Difference	-269 (-4%) from Pre-Development	+ 12,822 (+369%) from Pre-development

As shown in the above table, with mitigative measure of directing roof water to soakaway pits, the preliminarily estimated post-development infiltration rate is 7,400 m^3/a, which represents a 4% deficit from pre-development conditions. This preliminarily estimated deficit could be balanced within the margin of error for these preliminary calculations, and therefore the post-development infiltration for the Second Phase Site is preliminary considered to be balanced with the proposed mitigative measures.

The runoff increased due to the proposed development would be connected to the Town's sewer system.

5.0 PRELIMINARY SUMMARY AND PRELIMINARY COMMENTS

Based on the preliminary investigations carried out at the Site, the following findings and comments could be preliminarily made.

1) The soil stratigraphy at the Site generally consisted of fill materials and/or topsoil, underlain by cohesionless soils of sand to fine sand, locally with silt layers. The fill materials generally consisted of silty sand to sand, and extended to a depth of about 1.4 mBGS.
2) The measured groundwater levels ranged from 0.20 mBGS to 3.05 mBGS, and the elevations ranged from 237.17 m to 244.48 m. The local shallow groundwater was inferred to be towards the creek or ditch which is located near the south property boundary, and flows easterly to the Pine River.
3) Considering that water levels measured at the locations (BH02, BH03 and BH04) north of the creek ranged from about 0.2 mBGS to 1. 4, the shallow groundwater levels should be taken into account during the building foundation design.

4) Based on the soil infiltration assessment, the soils at the Site have the estimated hydraulic conductivity in the order of 10^{-3} cm/s to 10^{-5} cm/s, percolation times calculated to range from 6 min/cm to 38 min/min, and the infiltration rates calculated to range from 16 mm/hour to 100 mm/hour. Based on TRCA's SWMC, the soils at the Site would be considered to be suitable for application of LID measures.
5) Based on the water balance assessment, appreciable changes would be anticipated in the infiltration and runoff due to the proposed developments at the Second Phase Site. About 47.6% of infiltration volume would be decreased after the proposed Second Phase development, while runoff volume would increase as much as about 4.7 times the pre-development runoff volume.
6) It is understood that the proposed Second Phase development will be connected to the Town's sewer systems for the surface water drainage, and mitigative measures such as soakaway pits would be used to increase the infiltration at the Site. Based on the preliminary calculations, the infiltration water budget could be maintained and balanced when the mitigative measures are applied.
7) According to Ontario Regulation 903, the monitoring wells should be abandoned or decommissioned when they are no longer used. The decommissioning shall be completed by a licensed well contractor following Ontario Regulation 903.

6.0 CLOSURE

We trust that the information contained in this report is complete within our terms of reference. If you have any questions or require further information, please do not hesitate to contact our office.

Sincerely,

GeoPro Consulting Limited

Geotechnical - Hydrogeology - Environmental - Materials Testing – Inspection

Draft

Kaiying Qiu, B.Sc, M.Sc.
Junior Hydrogeologist

Draft

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

7.0 REFERENCES

Chapman, L.J. and D.F. Putnam. 1984. The Physiography of Southern Ontario. 3rd ed. Ontario Geological Survey Special Volume 2, Ontario Ministry of Natural Resources, Ontario, Canada.

C.W. Fetter, 2001, Applied Hydrogeology, 4th Edition, Prentice-Hall Inc.,

D.P. Coduto, 1999, Geotechnical engineering: Principles and Practice, Prentice-Hall Inc.,

Powers, J. Patrick et al, 2007 Construction Dewatering and Groundwater Control, New methods and Applications, Third Edition, John Wiley and Sons Inc.

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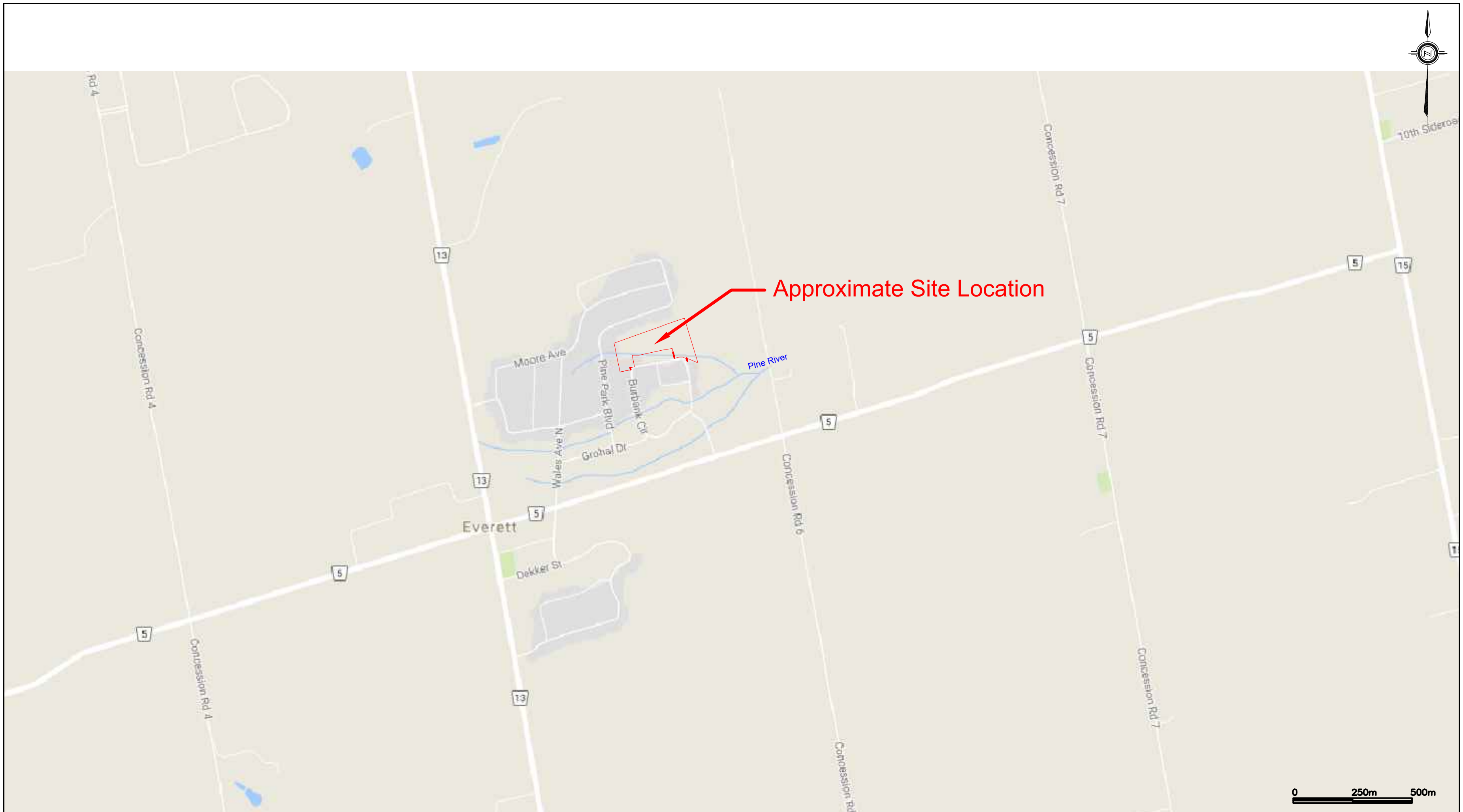
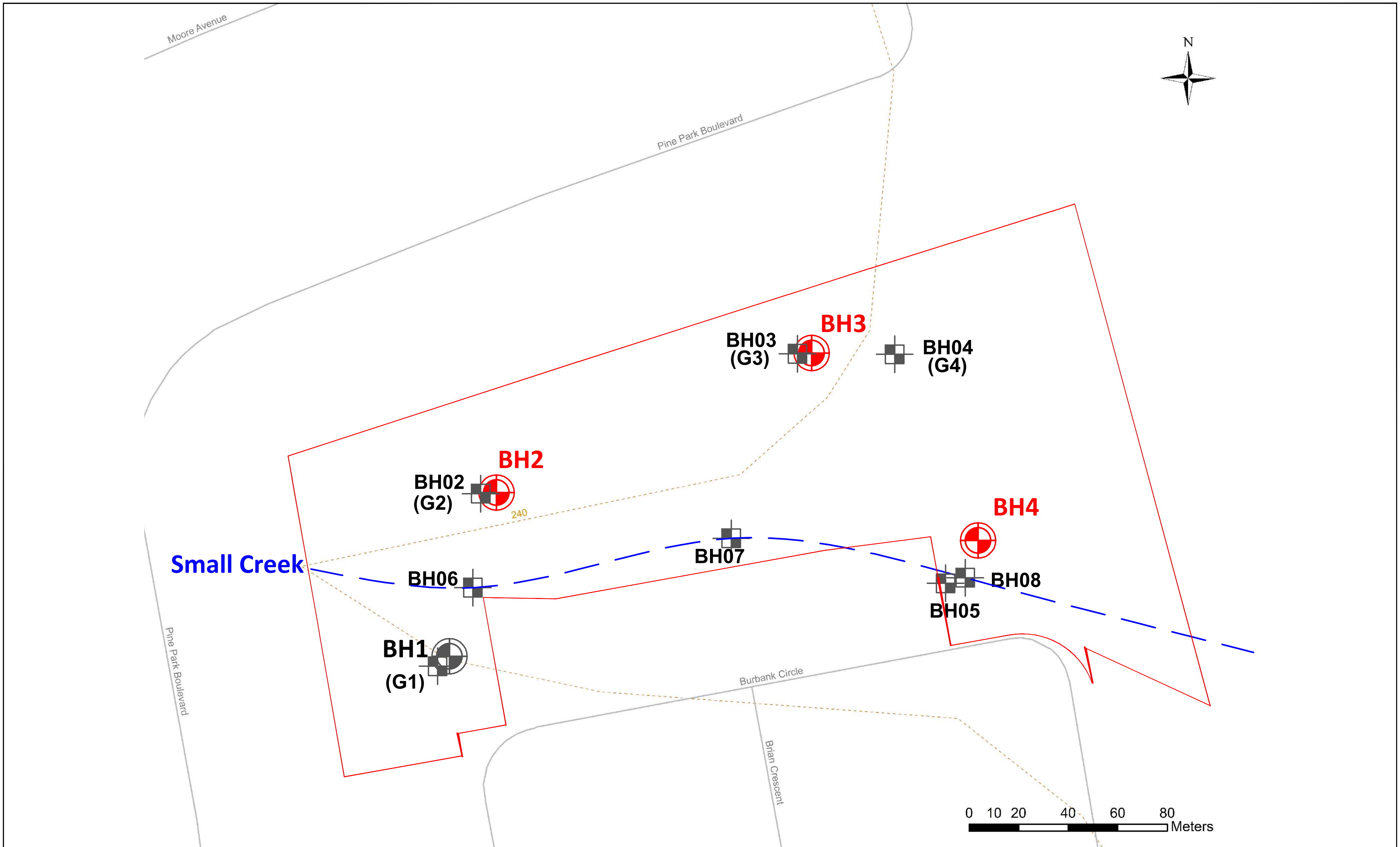
DRAWINGS



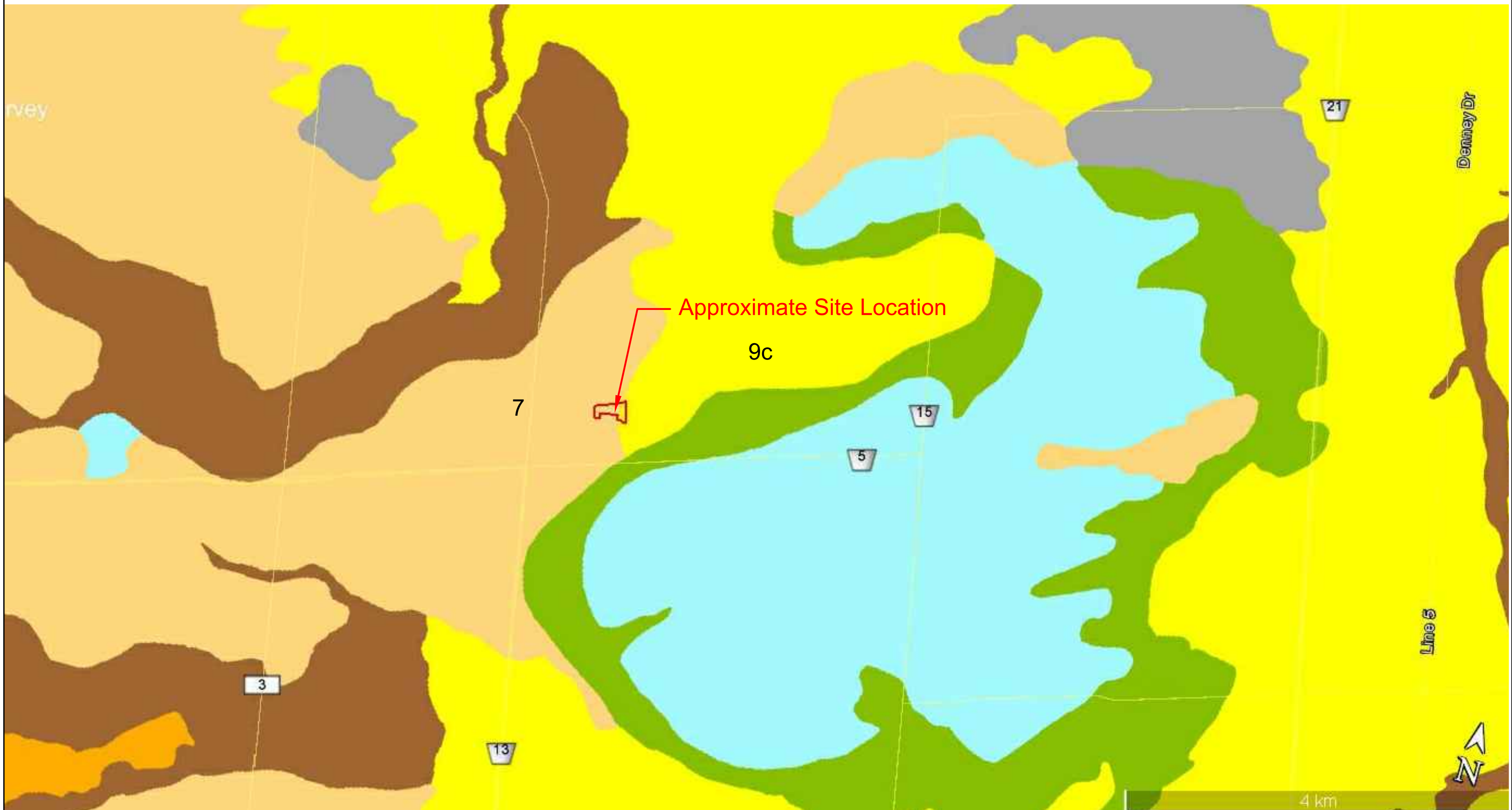
Client:	Winzen Developments Limited			Project No.: 16-1710H	Drawing No.: 1
Drawn:	KY	Approved:	BG	Title:	Site Location Plan
Date:	December 2017	Scale:	As Shown	Project:	Preliminary Hydrogeological Site Assessment Proposed Everett Development (Second Phase) North of Burbank Circle, Everett, Ontario
Original Size:	Letter	Rev:	BG		GeoPro Consulting Limited



Legend:

- Damaged/Compromised Monitoring Well Location
- Existing Monitoring Well Location
- Temporary Well Location
- (G1) Guelph Permeameter Test Location

Client: **Winzen Developments Limited**		Project No.: **17-1710H**	Drawing No.: **2**
Drawn: **KY**	Approved: **BG**	Title: **Monitoring and Testing Location Plan**	
Date: **December 2017**	Scale: **As shown**	Project: **Preliminary Hydrogeological Site Assessment Proposed Everett Development (Second Phase) North of Burbank Circle, Everett, Ontario**	
Original Size: **Letter**	Rev: **BG**	*GeoPro Consulting Limited*	

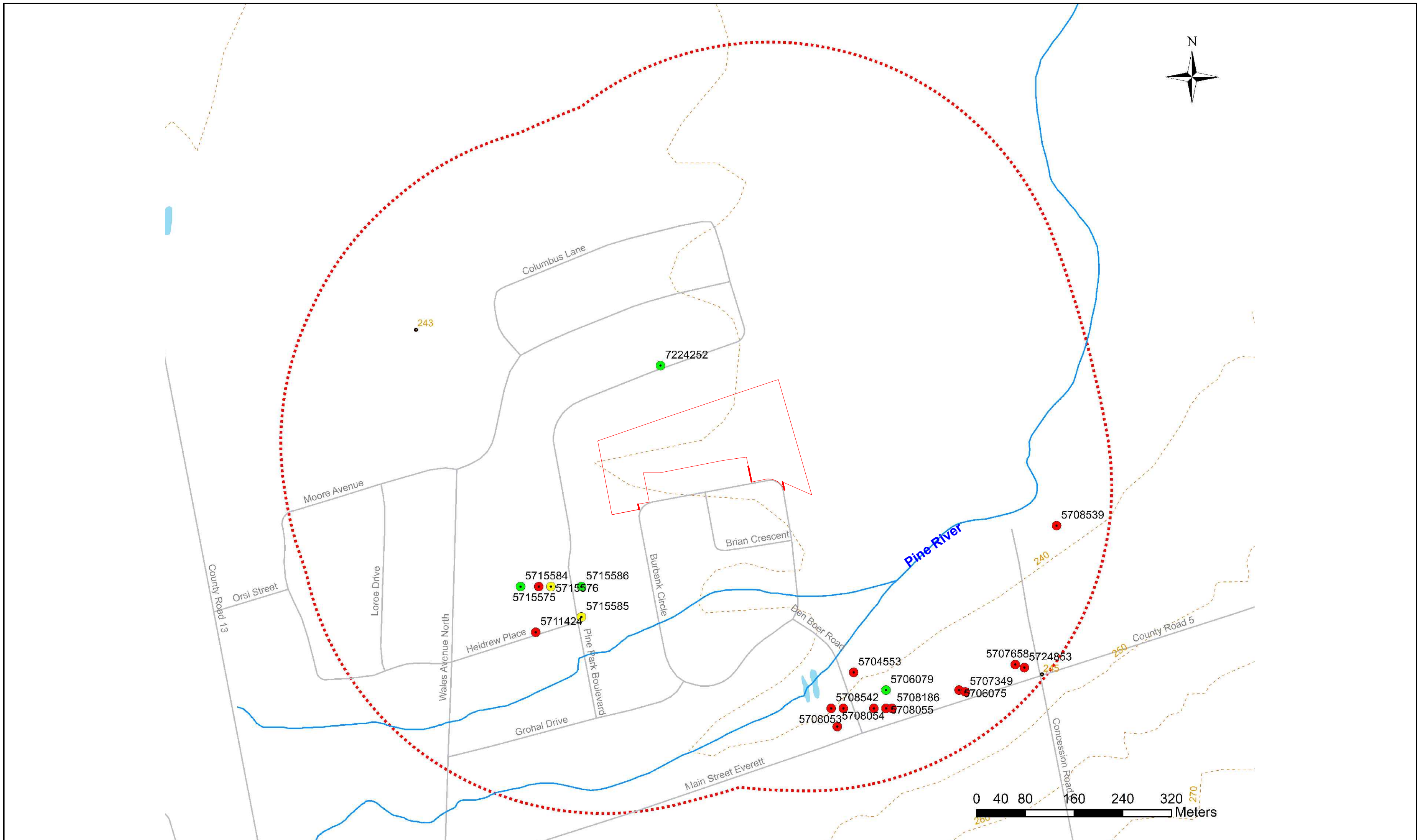


Legend

9c Coarse-textured glaciolacustrine deposits
sand, gravel, minor silt and clay
Foreshore and basinal deposits

7 Glaciofluvial deposits
river deposits and delta topset facies

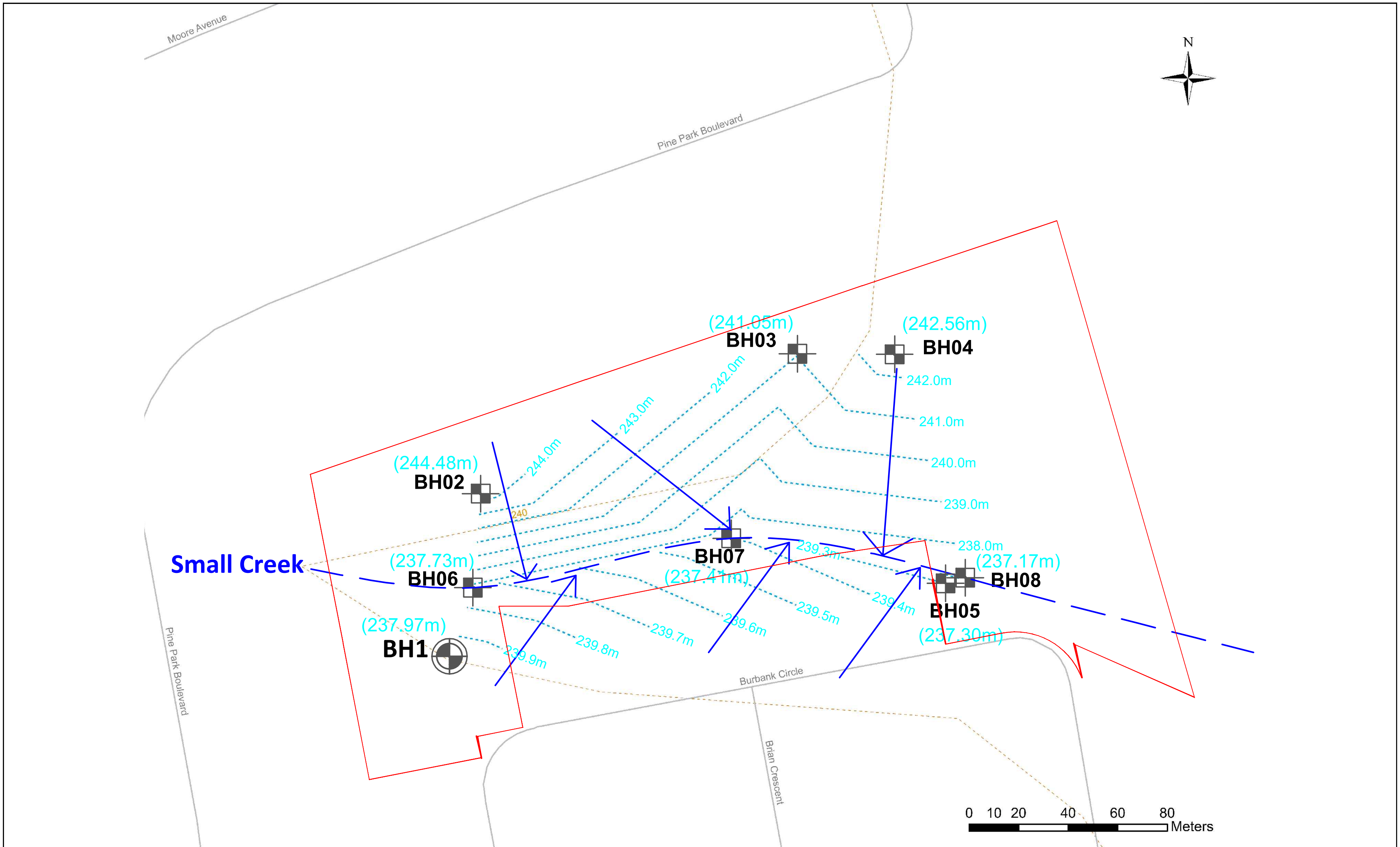
Client: **Winzen Developments Limited**		Project No.: **16-1710H**	Drawing No.: **3**
Drawn: **KY**	Approved: **BG**	Title: **Surficial Geology**	
Date: **December 2017**	Scale: **As Shown**	Project: **Preliminary Hydrogeological Site Assessment Proposed Everett Development (Second Phase) North of Burbank Circle, Everett, Ontario**	
Original Size: **Letter**	Rev: **BG**	GeoPro Consulting Limited	



Legend

- Domestic / Industrial
- Municipal
- Not Used / Unknown Use
- Elevation contour
- 500m Radius From The Site
- Approximate Location of The Site

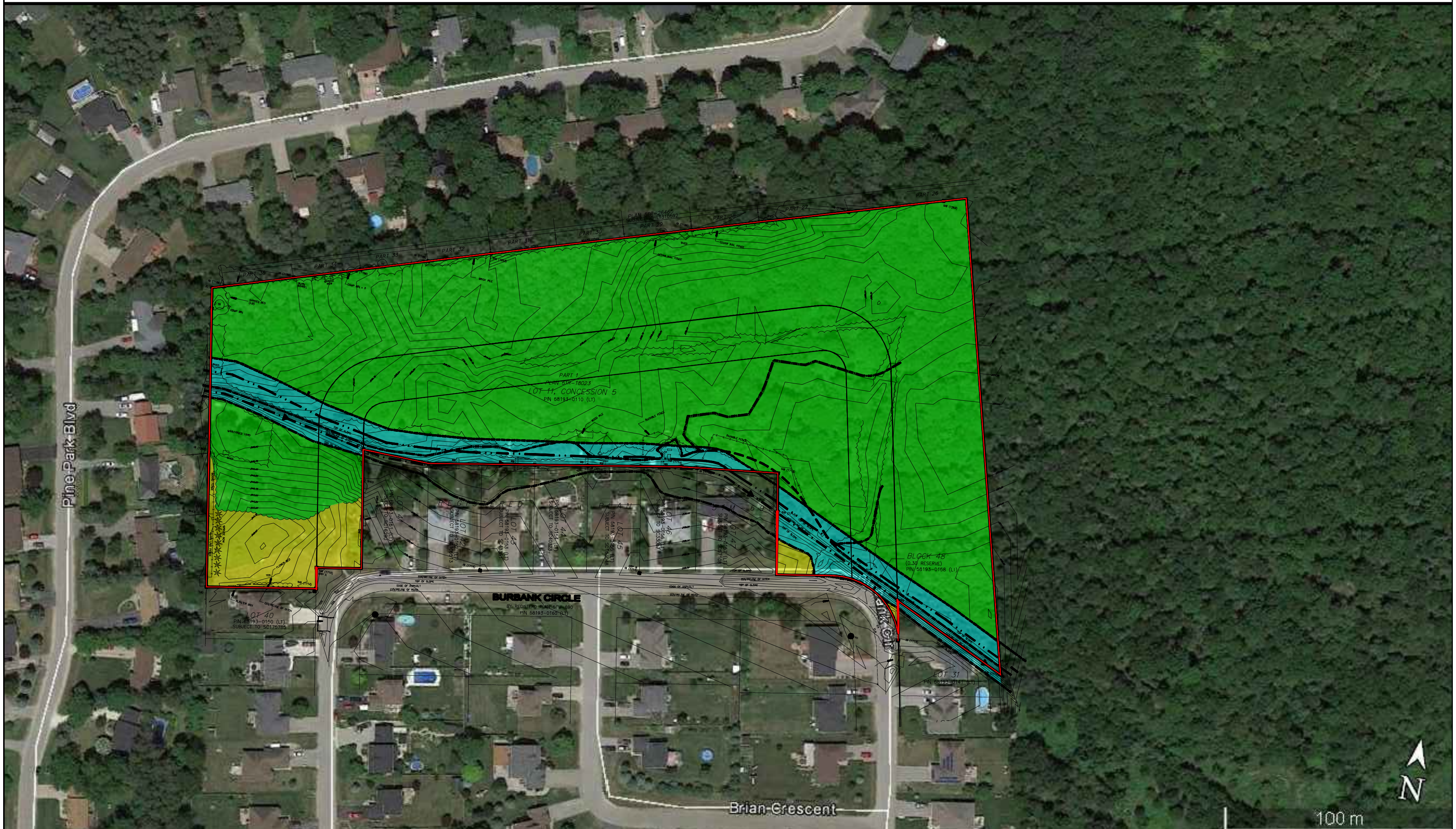
Client: **Winzen Developments Limited**		Project No.: **16-1710H**	Drawing No.: **4**
Drawn: **KY**	Approved: **BG**	Title: **MOECC Water Well Location Plan**	
Date: **December 2017**	Scale: **As Shown**	Project: **Preliminary Hydrogeological Site Assessment Proposed Everett Development (Second Phase) North of Burbank Circle, Everett, Ontario**	
Original Size: **Letter**	Rev: **BG**	**GeoPro Consulting Limited**	



Legend:

- Monitoring Well Location
- Temporary Well Location
- Shallow Groundwater Elevation Contour (238.0 m)
- (237.30 m) Groundwater Elevation (m) in Shallow Well Dated November 23, 2017
- Inferred Shallow Groundwater Flow Direction

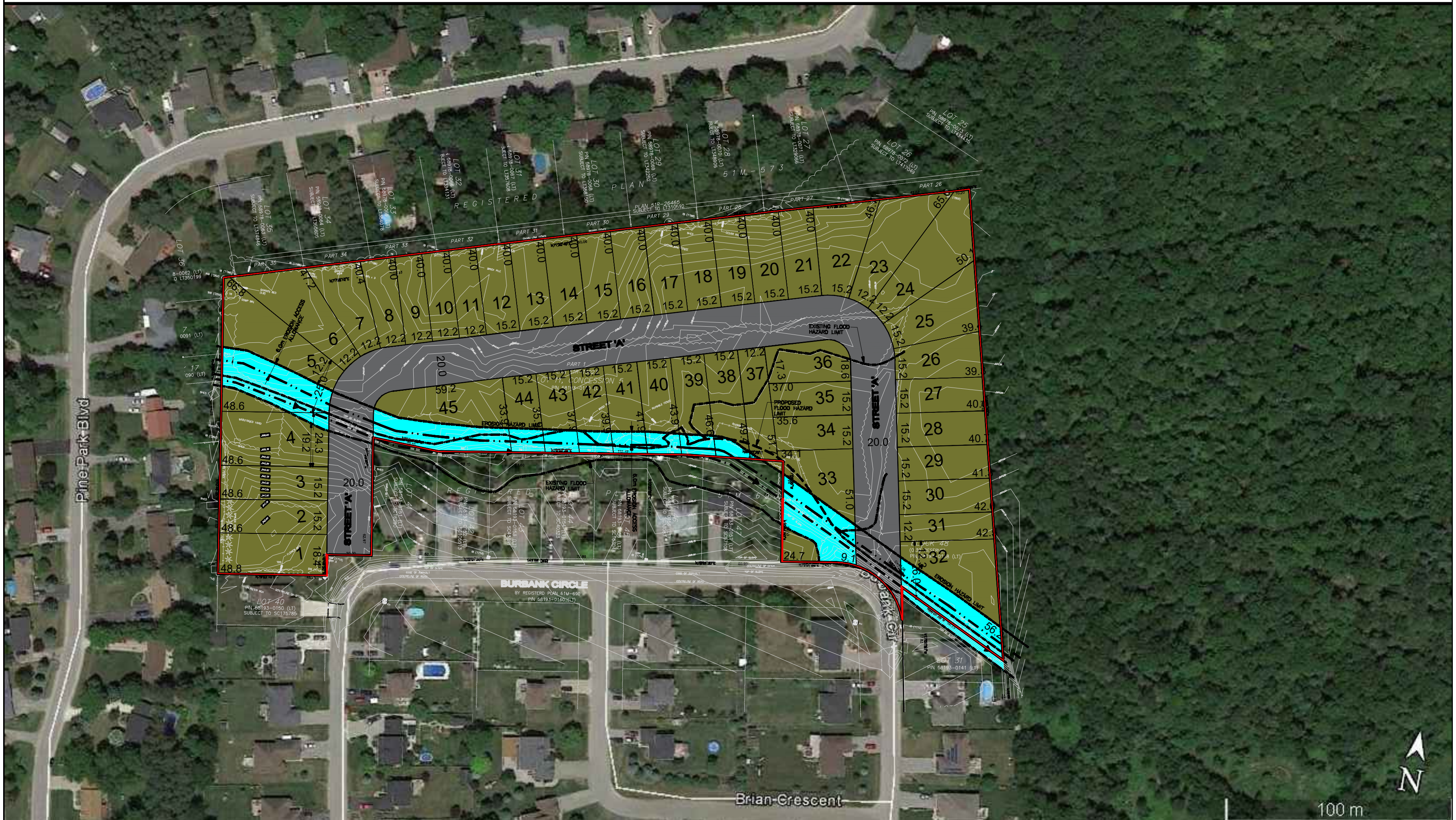
Client:	Winzen Developments Limited			Project No.: 17-1710H	Drawing No.: 5
Drawn:	KY	Approved:	BG	Title:	Shallow Groundwater Elevation Contour and Inferred Shallow Groundwater Flow Direction
Date:	December 2017	Scale:	As shown	Project:	Preliminary Hydrogeological Site Assessment Proposed Everett Development (Second Phase) North of Burbank Circle, Everett, Ontario
Original Size:	Letter	Rev:	BG		GeoPro Consulting Limited



Legend

(red outline)	Approximate Location of The Site
(yellow)	**Block 1 (5.2%): Vacant Area** Soil Type: Sand to Fine Sand Vegetation Cover: Urban Lawns
(cyan)	**Block 2 (11.6%): Ditch / Small Creek** Soil Type: Sand to Fine Sand Vegetation Cover: Pasture and Shrubs
(green)	**Block 3 (83.2%): Forests / Wet Land Area** Soil Type: Sand to Fine Sand Vegetation Cover: Mature Forests / Wet Lands

Client:	Winzen Developments Limited	Project No.: 16-1710H	Drawing No.: 6
Drawn: KY	Approved: BG	Title:	(Pre-Development) Geographical Blocks
Date: December 2017	Scale: As Shown	Project:	Preliminary Hydrogeological Site Assessment Proposed Everett Development (Second Phase) Burbank Circle, Everett, Ontario
Original Size: Letter	Rev: BG		GeoPro Consulting Limited



Legend

Approximate Location of The Site

Block A (19.3%): Proposed Street
Soil Type: Paved Area
Vegetation Cover: Paved Area

Block B (9.9%): Ditch / Small Creek
Soil Type: Sand to Fine Sand
Vegetation Cover: Pasture and Shrubs

Block C (70.8%):Proposed Residential Properties
Soil Type: Sand to Fine Sand
Vegetation Cover: Paved Area and Urban Lawns

Client:	**Winzen Developments Limited**	Project No.: **16-1710H**	Drawing No.: **7**
Drawn: **KY**	Approved: **BG**	Title:	**(Post-Development) Geographical Blocks**
Date: **December 2017**	Scale: **As Shown**	Project:	**Preliminary Hydrogeological Site Assessment Proposed Everett Development (Second Phase) Burbank Circle, Everett, Ontario**
Original Size: **Letter**	Rev: **BG**		GeoPro Consulting Limited

APPENDIX A

LOG OF BOREHOLE BH02

PROJECT: Hydrogeological Site Assessment for Proposed Everett Development (Second Phase)
CLIENT: Winzen Developments Limited
PROJECT LOCATION: Everett, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Hand Auger
FIELD ENGINEER: WS
SAMPLE REVIEW: BG
CHECKED: BG
DIAMETER: 60 mm
DATE: 2017-11-23
REF. NO.: 16-1710G
ENCL. NO.: 6

ELEV DEPTH (m)	DESCRIPTION	SAMPLES (NUMBER / TYPE / "N" BLOWS/0.3m)	GROUND WATER	ELEVATION
245.9				
0.0	**TOPSOIL:** (280 mm)			
245.6 0.3	**SAND TO FINE SAND:** trace to some silt, trace gravel, trace rootlets, trace organics, brown, moist to wet, very loose to dense		244.5/Nov 23	245 244
243.7 2.2	**END OF BOREHOLE**			

Column headings: SOIL PROFILE; STRATA PLOT; SAMPLES; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, X Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Notes:
1) Water encountered at a dpeth of 1.43 mBGS during hand augering.
2) Temporary well was installed upon completion of hand augering.

Water Level Readings:

Date	W.L.Depth (m)
November 23, 2017	1.43

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

GeoPro CONSULTING LIMITED

LOG OF BOREHOLE BH03

PROJECT: Hydrogeological Site Assessment for Proposed Everett Development (Second Phase)
CLIENT: Winzen Developments Limited
PROJECT LOCATION: Everett, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Hand Auger
FIELD ENGINEER: WS
SAMPLE REVIEW: BG
CHECKED: BG
DIAMETER: 60 mm
DATE: 2017-11-23
REF. NO.: 16-1710G
ENCL. NO.: 7

ELEV DEPTH (m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	ELEVATION	DYNAMIC PENETRATION TEST / SHEAR STRENGTH (kPa)	WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
242.1 / 0.0	**TOPSOIL:** (300 mm)						242				
241.8 / 0.3	**REWORKED SILTY SAND:** trace rootlets, trace organics, brown to dark brown, moist, very loose										
241.4 / 0.8	**SAND TO FINE SAND:** trace silt, trace rootlets, brown, moist to wet, loose to compact					241.1/Nov 23	241				
240.2 / 1.9	**END OF BOREHOLE** Notes: 1) Water encountered at a dpeth of 1.08 mBGS during hand augering. 2) Temporary well was installed upon completion of hand augering. Water Level Readings: Date W.L.Depth (m) November 23, 2017										

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m: 20 40 60 80
SHEAR STRENGTH (kPa): ● Unconfined ✕ Field Vane & Sensitivity ▲ Quick Triaxial ⊠ Penetrometer + Lab Vane: 20 40 60 80
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%): 10 20 30 40

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

GeoPro CONSULTING LIMITED

LOG OF BOREHOLE BH04

PROJECT: Hydrogeological Site Assessment for Proposed Everett Development (Second Phase)
CLIENT: Winzen Developments Limited
PROJECT LOCATION: Everett, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Hand Auger
FIELD ENGINEER: WS
SAMPLE REVIEW: BG
CHECKED: BG
DIAMETER: 60 mm
DATE: 2017-11-23
REF. NO.: 16-1710G
ENCL. NO.: 8

ELEV DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	"N" BLOWS/0.3m	GROUND WATER	ELEVATION	DYNAMIC PENETRATION TEST / SHEAR STRENGTH (kPa)	WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
242.8											
0.0	**TOPSOIL:** (300 mm)					242.6/Nov 23					
242.5 0.3	**SAND TO FINE SAND:** trace to some silt, trace gravel, trace rootlets, trace organics, layers of silt, brown, moist to wet, very loose to compact						242				
241.8 1.0	**END OF BOREHOLE** Notes: 1) Water encountered at a dpeth of 0.2 mBGS during hand augering. 2) Temporary well was installed upon completion of hand augering. Water Level Readings: Date W.L.Depth (m) November 23, 2017										

DYNAMIC PENETRATION TEST: O SPT, Cone, blows/0.3m: 20 40 60 80
SHEAR STRENGTH (kPa): ● Unconfined, X Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%): 10 20 30 40

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH05

PROJECT: Hydrogeological Site Assessment for Proposed Everett Development (Second Phase)
CLIENT: Winzen Developments Limited
PROJECT LOCATION: Everett, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Hand Auger
FIELD ENGINEER: WS
SAMPLE REVIEW: BG
CHECKED: BG

DIAMETER: 60 mm
DATE: 2017-11-23
REF. NO.: 16-1710G
ENCL. NO.: 9

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	ELEVATION	DYNAMIC PENETRATION TEST / SHEAR STRENGTH (kPa)	WATER CONTENT (%)	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
238.0 / 0.0	**TOPSOIL:** (300 mm)										
237.7 / 0.3	**SAND TO FINE SAND:** trace to some silt, trace gravel, trace rootlets, trace organics, layers of silt, brown, moist to wet, very loose to compact					237.3/Nov 23	237				
236.6 / 1.4	**END OF BOREHOLE** Notes: 1) Water encountered at a dpeth of 0.71 mBGS during hand augering. 2) Temporary well was installed upon completion of hand augering. Water Level Readings: Date W.L.Depth (m) November 23, 2017										

Legend: DYNAMIC PENETRATION TEST — SPT, Cone, blows/0.3m (20, 40, 60, 80). SHEAR STRENGTH (kPa) — Unconfined; Field Vane & Sensitivity; Quick Triaxial; Penetrometer; Lab Vane (20, 40, 60, 80). Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) (10, 20, 30, 40).

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

GeoPro CONSULTING LIMITED

LOG OF BOREHOLE BH1

PROJECT: Geotechnical Investigation for Proposed Subdivision Development
CLIENT: Winzen Developments Limited
PROJECT LOCATION: Everett, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: WS
SAMPLE REVIEW: BG
CHECKED: BG
DIAMETER: 155 mm
DATE: 2017-02-02
REF. NO.: 16-1710G
ENCL. NO.: 2

ELEV / DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER
241.0 / 0.0	**TOPSOIL:** (230 mm)				
240.8 / 0.2	**FILL:** silty sand to sand, trace rootlets, trace organics, dark brown to brown, moist, very loose to loose	1A	AS		
		1B	AS		
		2A	SS	24	
		2B	SS	7	
239.7 / 1.4	**SAND TO FINE SAND:** trace to some silt, brown, moist to wet, loose to compact	3	SS	7	
		4	SS	9	238.3/Jul 03
	---wet ---containing layers of fine sandy silt				238.0/Nov 23
		5	SS	46	
		6	SS	41	
232.9 / 8.1	**END OF BOREHOLE**				

Notes:
1) Borehole caved in at a depth of 2.4 mBGS upon completion of drilling.
2) Monitoring well was installed upon completion of drilling.

Water Level Readings:
Date W.L.Depth (m)
March 7, 2017

Chart columns: DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m: 20, 40, 60, 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20, 40, 60, 80); Plastic Limit W_P, Natural Moisture Content W, Liquid Limit W_L; WATER CONTENT (%) (10, 20, 30, 40); UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL).

ELEVATION: 240, 239, 238, 237, 236, 235, 234, 233

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

GeoPro CONSULTING LIMITED

LOG OF BOREHOLE BH2

PROJECT: Geotechnical Investigation for Proposed Subdivision Development

CLIENT: Winzen Developments Limited

PROJECT LOCATION: Everett, ON

DATUM: Geodetic

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Split Spoon

FIELD ENGINEER: WS

SAMPLE REVIEW: BG

CHECKED: BG

DIAMETER: 51 mm

DATE: 2017-02-06

REF. NO.: 16-1710G

ENCL. NO.: 3

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT (blows/0.3m)
0.0	**TOPSOIL:** (280 mm)					
0.3	**SAND TO FINE SAND:** trace to some silt, trace gravel, trace rootlets, trace organics, brown, moist to wet, very loose to dense	1	AS			
	--containing wood fragments	2	SS	23		○
					1.4 mBGLJul 03	
		3	SS	8		○
		4	SS	8		○
		5	SS	19		○
4.6	**END OF BOREHOLE**	6	SS	50		○

Column headings: SOIL PROFILE (ELEV DEPTH (m), DESCRIPTION, STRATA PLOT); SAMPLES (NUMBER, TYPE, "N" BLOWS/0.3m); GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20, 40, 60, 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20, 40, 60, 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) (10, 20, 30, 40); UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL)

Notes:
1) Water encountered at a dpeth of 1.5 mBGS during drilling.
2) Monitoring well was installed upon completion of drilling.

Water Level Readings:

Date	W.L.Depth (m)
March 7, 2017	1.37

01 - GEOPRO SOIL LOG GEOPRO 16-1255 BH LOG PROJECT DATA 20171214 -RL.GPJ 2017-12-15 14:50

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

GeoPro CONSULTING LIMITED

LOG OF BOREHOLE BH3

PROJECT: Geotechnical Investigation for Proposed Subdivision Development
CLIENT: Winzen Developments Limited
PROJECT LOCATION: Everett, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Split Spoon
FIELD ENGINEER: WS
SAMPLE REVIEW: BG
CHECKED: BG

DIAMETER: 51 mm
DATE: 2017-02-06
REF. NO.: 16-1710G
ENCL. NO.: 4

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT (blows/0.3m)
0.0	**TOPSOIL:** (300 mm)	1A	AS			
0.3	**REWORKED SILTY SAND:** trace rootlets, trace organics, brown to dark brown, moist, very loose	1B	AS			
0.8	**SAND TO FINE SAND:** trace silt, trace rootlets, brown, moist to wet, loose to compact	2	SS	7	1.1 mBGLJul 03	○
		3	SS	7		○
		4	SS	4		○
2.9	**SILT:** trace sand, brown, wet, compact					
3.1	**SAND TO FINE SAND:** trace silt, brown, wet, compact to dense	5	SS	5		○
4.6	**END OF BOREHOLE**	6	SS	18		○

Column headings: SOIL PROFILE (ELEV DEPTH (m), DESCRIPTION, STRATA PLOT); SAMPLES (NUMBER, TYPE, "N" BLOWS/0.3m); GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit W_P, Natural Moisture Content W, Liquid Limit W_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Notes:
1) Water encountered at a dpeth of 1.5 mBGS during drilling.
2) Monitoring well was installed upon completion of drilling.

Water Level Readings:

Date	W.L.Depth (m)
March 7, 2017	1.10

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

GeoPro CONSULTING LIMITED

PROJECT: Geotechnical Investigation for Proposed Subdivision Development
CLIENT: Winzen Developments Limited
PROJECT LOCATION: Everett, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Split Spoon
FIELD ENGINEER: WS
SAMPLE REVIEW: BG
CHECKED: BG
DIAMETER: 51 mm
DATE: 2017-02-06
REF. NO.: 16-1710G
ENCL. NO.: 5

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	REMARKS
0.0	**TOPSOIL:** (300 mm)	1A	AS			
0.3	**SAND TO FINE SAND:** trace to some silt, trace gravel, trace rootlets, trace organics, layers of silt, brown, moist to wet, very loose to compact	1B	AS		0.8 mBGLJul 03	
		2	SS	27		
		3	SS	18		
		4	AS			
		5	SS	5		
4.6	**END OF BOREHOLE** Notes: 1) Water encountered at a dpeth of 1.5 mBGS during drilling. 2) Monitoring well was installed upon completion of drilling. Water Level Readings: Date W.L.Depth (m) March 7, 2017 0.80	6	SS	49		

DYNAMIC PENETRATION TEST: SPT, Cone, blows/0.3m (20, 40, 60, 80)
SHEAR STRENGTH (kPa): Unconfined, Field Vane & Sensitivity, Quick Triaxial, Penetrometer, Lab Vane (20, 40, 60, 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) 10 20 30 40
UNIT WT (kN/m³)
REMARKS 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

APPENDIX B

WELL ID	EAST83	NORTH83	TYPE
5704553	585611.1	4894032	Domestic
5706075	585784.1	4894003	Domestic
5707349	585794.3	4894000	Domestic
5707658	585876.3	4894045	Domestic
5707847	585094.1	4894173	Domestic
5708052	585644.1	4893973	Domestic
5708053	585594.1	4893973	Domestic
5708054	585584.1	4893943	Domestic
5708055	585664.1	4893973	Domestic
5708186	585674.1	4893973	Domestic
5708539	585944.2	4894273	Domestic
5708542	585574.1	4893973	Domestic
5724853	585891.3	4894040	Domestic
Total:			13
5711424	585089.1	4894098	Industrial
Total:			1
5715576	585114.1	4894173	Municipal
5715585	585164.1	4894123	Municipal
Total:			2
5715586	585164.1	4894173	Not Used
Total:			1
5706079	585664.1	4894003	Unknown
5715575	585114.1	4894173	Unknown
5715584	585064.1	4894173	Unknown
7224252	585294	4894536	Unknown
Total:			4

Summary of Well Type in 500m Radius from the Site			
Well Type	**Number of Records**		**SUM**
Domestic	13	14	21
Industrial	1		
Municipal	2	2	
Not Used	1	5	
Unknown	4		

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
TOSORONTIO TOWNSHIP CON 05 011	17 585674 4893973 W	1971/07 1830	30	FR 0010	10/12/1/1:0	DO		5708186 ()	LOAM MSND 0001 BRWN MSND 0018 GREY CLAY STNS 0020
TOSORONTIO TOWNSHIP CON 05 011	17 585784 4894003 W	1968/10 1830	30	FR 0020	5//2/:	DO		5706075 ()	LOAM MSND 0004 GREY CLAY 0020 CLAY MSND STNS 0025
TOSORONTIO TOWNSHIP CON 05 011	17 585664 4894003 W	1968/07 3203	5	FR 0024				5706079 () A	LOAM 0001 CLAY 0016 MSND 0017 CLAY STNS 0024 CLAY MSND 0030 CLAY 0073 STNS 0074 CLAY 0123 BLDR 0125
TOSORONTIO TOWNSHIP CON 05 011	17 585794 4894000 W	1970/06 1830	30	FR 0012 FR 0028	12/14//1:0	DO		5707349 ()	BRWN CLAY MSND 0012 BRWN MSND STNS 0014 GREY CLAY MSND 0028 GREY MSND CLAY STNS 0032
TOSORONTIO TOWNSHIP CON 05 011	17 585876 4894045 W	1970/11 1830	30	FR 0005	5/6//1:0	DO		5707658 ()	BRWN LOAM MSND 0001 BRWN CLAY 0005 BRWN CSND 0007 GREY CLAY STNS 0015
TOSORONTIO TOWNSHIP CON 05 011	17 585094 4894173 W	1970/06 3108	7	UK 0021	6/19/50/21:30	DO	0023 100033 10	5707847 ()	BRWN LOAM MSND 0001 BRWN FSND 0010 GREY MSND 0021 BRWN CSND 0028 BRWN MSND 0040 BRWN FSND 0043
TOSORONTIO TOWNSHIP CON 05 011	17 585644 4893973 W	1971/07 1830	30	FR 0010	10/12/1/1:0	DO		5708052 ()	LOAM MSND 0002 BRWN MSND CLAY 0010 BRWN MSND 0019 GREY CLAY STNS 0020
TOSORONTIO TOWNSHIP CON 05 011	17 585594 4893973 W	1971/07 1830	30	FR 0010	10/12/1/1:0	DO		5708053 ()	LOAM MSND 0002 BRWN MSND CLAY 0010 BRWN MSND 0018 GREY CLAY STNS 0020
TOSORONTIO TOWNSHIP CON 05 011	17 585584 4893943 W	1971/06 1830	30	FR 0009	9/10/1/1:0	DO		5708054 ()	LOAM MSND 0002 BRWN MSND CLAY 0008 BRWN GRVL MSND 0010 GREY CLAY MSND STNS 0018
TOSORONTIO TOWNSHIP CON 05 011	17 585611 4894032 W	1964/10 4608	30	FR 0004	4//3/:	DO		5704553 ()	LOAM 0001 MSND 0015
TOSORONTIO TOWNSHIP CON 05 011	17 585664 4893973 W	1971/07 1830	30	FR 0010	10/12/1/1:0	DO		5708055 ()	LOAM MSND 0002 BRWN MSND CLAY 0010 BRWN MSND 0019 GREY CLAY STNS 0020
TOSORONTIO TOWNSHIP CON 05 011	17 585294 4894536 W	2014/05 4645	1.5					7224252 (Z183949) A	
TOSORONTIO TOWNSHIP CON 05 011	17 585574 4893973 W	1971/11 4608	30	FR 0012	6/17/4/1:0	DO		5708542 ()	GREY SAND 0026
TOSORONTIO TOWNSHIP CON 05 011	17 585089 4894098 W	1974/05 5206				IN DO		5711424 ()	BRWN FSND 0064 BLUE CLAY 0155 STNS CLAY 0185 GRVL CLAY 0205
TOSORONTIO TOWNSHIP CON 05 011	17 585114 4894173 W	1978/06 4816	2	FR 0007	2///:		0052 10	5715575 ()	FSND 0007 CSND GRVL 0030 FSND 0063 CLAY 0065
TOSORONTIO TOWNSHIP CON 05 011	17 585114 4894173 W	1978/07 4816	8 8	FR 0007	5/28/43/99:59	MN	0041 20	5715576 ()	FSND 0007 CSND GRVL 0030 FSND 0063 CLAY 0065
TOSORONTIO TOWNSHIP CON 05 011	17 585064 4894173 W	1978/08 4816	2	FR 0008			0042 10	5715584 ()	FSND 0008 CSND GRVL 0011 MSND CSND 0020 SAND GRVL 0050 FSND MSND 0064 CLAY 0068
TOSORONTIO TOWNSHIP CON 05 011	17 585164 4894123 W	1978/08 4816	8	FR 0008	8/36/35/99:59	MN	0040 20	5715585 ()	FSND 0008 CSND 0010 FGVL 0011 MSND CSND 0020 MSND FGVL 0050 FSND MSND 0064 CLAY 0068

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
TOSORONTIO TOWNSHIP CON 05 011	17 585164 4894173 W	1978/08 4816	6	FR 0174	24/59/148/24:0	NU	0174 15	5715586 ()	SAND GRVL LYRD 0064 CLAY 0125 SAND CLAY 0155 SAND GRVL CLAY 0174 CSND 0195 LMSN FCRD 0207 LMSN 0213
TOSORONTIO TOWNSHIP CON 05 011	17 585891 4894040 W	1988/06 4778	6 5	FR 0032	/27/12/3:0	DO	0032 8	5724853 (55183)	BRWN SAND CLAY 0011 BLUE CLAY 0014 BLUE CLAY SAND SILT 0032 BRWN FSND 0040 BLUE CLAY STNS 0050
TOSORONTIO TOWNSHIP CON 06 011	17 585944 4894273 W	1971/12 4608	30	FR 0003	3/7/2/1:0	DO		5708539 ()	GREY SAND 0011

Notes:
UTM: UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
DATE CNTR: Date Work Completedand Well Contractor Licence Number
CASING DIA: .Casing diameter in inches
WATER: Unit of Depth in Fee. See Table 4 for Meaning of Code

PUMP TEST: Static Water Level in Feet / Water Level After Pumping in Feet / Pump Test Rate in GPM / Pump Test Duration in Hour : Minutes
WELL USE: See Table 3 for Meaning of Code
SCREEN: Screen Depth and Length in feet
WELL: WEL (AUDIT #) Well Tag . A: Abandonment; P: Partial Data Entry Only
FORMATION: See Table 1 and 2 for Meaning of Code

1. Core Material and Descriptive terms

Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
BLDR	BOULDERS	FCRD	FRACTURED	IRFM	IRON FORMATION	PORS	POROUS	SOFT	SOFT
BSLT	BASALT	FGRD	FINE-GRAINED	LIMY	LIMY	PRDG	PREVIOUSLY DUG	SPST	SOAPSTONE
CGRD	COARSE-GRAINED	FGVL	FINE GRAVEL	LMSN	LIMESTONE	PRDR	PREV. DRILLED	STKY	STICKY
CGVL	COARSE GRAVEL	FILL	FILL	LOAM	TOPSOIL	QRTZ	QUARTZITE	STNS	STONES
CHRT	CHERT	FLDS	FELDSPAR	LOOS	LOOSE	QSND	QUICKSAND	STNY	STONEY
CLAY	CLAY	FLNT	FLINT	LTCL	LIGHT-COLOURED	QTZ	QUARTZ	THIK	THICK
CLN	CLEAN	FOSS	FOSILIFEROUS	LYRD	LAYERED	ROCK	ROCK	THIN	THIN
CLYY	CLAYEY	FSND	FINE SAND	MARL	MARL	SAND	SAND	TILL	TILL
CMTD	CEMENTED	GNIS	GNEISS	MGRD	MEDIUM-GRAINED	SHLE	SHALE	UNKN	UNKNOWN TYPE
CONG	CONGLOMERATE	GRNT	GRANITE	MGVL	MEDIUM GRAVEL	SHLY	SHALY	VERY	VERY
CRYS	CRYSTALLINE	GRSN	GREENSTONE	MRBL	MARBLE	SHRP	SHARP	WBRG	WATER-BEARING
CSND	COARSE SAND	GRVL	GRAVEL	MSND	MEDIUM SAND	SHST	SCHIST	WDFR	WOOD FRAGMENTS
DKCL	DARK-COLOURED	GRWK	GREYWACKE	MUCK	MUCK	SILT	SILT	WTHD	WEATHERED
DLMT	DOLOMITE	GVLY	GRAVELLY	OBDN	OVERBURDEN	SLTE	SLATE		
DNSE	DENSE	GYPS	GYPSUM	PCKD	PACKED	SLTY	SILTY		
DRTY	DIRTY	HARD	HARD	PEAT	PEAT	SNDS	SANDSTONE		
DRY	DRY	HPAN	HARDPAN	PGVL	PEA GRAVEL	SNDY	SANDYOAPSTONE		

2. Core Color

Code	Description
WHIT	WHITE
GREY	GREY
BLUE	BLUE
GREN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED
BLCK	BLACK
BLGY	BLUE-GREY

3. Well Use

Code	Description	Code	Description
DO	Domestic	OT	Other
ST	Livestock	TH	Test Hole
IR	Irrigation	DE	Dewatering
IN	Industrial	MO	Monitoring
CO	Commercial	MT	Monitoring TestHole
MN	Municipal		
PS	Public		
AC	Cooling And A/C		
NU	Not Used		

4. Water Detail

Code	Description	Code	Description
FR	Fresh	GS	Gas
SA	Salty	IR	Iron
SU	Sulphur		
MN	Mineral		
UK	Unknown		

APPENDIX C

Constant Head Permeameter Test Report

G1

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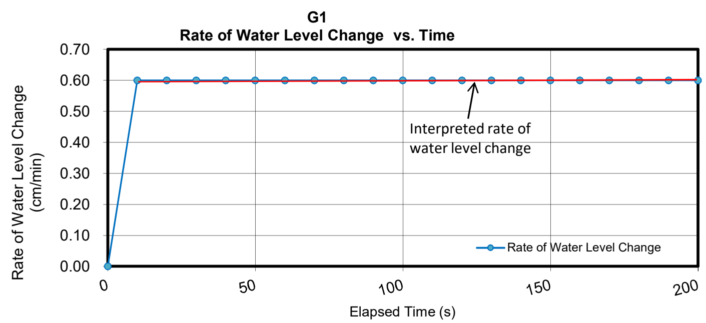

Elapsed Time (s)	Water Level in Reservoir (cm)	Water Level Change (cm)	Infiltration (cm/min)
0.0	6.0	-	-
10.0	6.1	0.1	0.60
20.0	6.2	0.1	0.60
30.0	6.3	0.1	0.60
40.0	6.4	0.1	0.60
50.0	6.5	0.1	0.60
60.0	6.6	0.1	0.60
70.0	6.7	0.1	0.60
80.0	6.8	0.1	0.60
90.0	6.9	0.1	0.60
100.0	7.0	0.1	0.60
110.0	7.1	0.1	0.60
120.0	7.2	0.1	0.60
130.0	7.3	0.1	0.60
140.0	7.4	0.1	0.60
150.0	7.5	0.1	0.60
160.0	7.6	0.1	0.60
170.0	7.7	0.1	0.60
180.0	7.8	0.1	0.60
190.0	7.9	0.1	0.60
200.0	8.0	0.1	0.60

Combined Reservoir Surface Area =	**35.22**	cm^2
Borehole Depth =	76	cm
Interpreted Rate of Water Level Change (R1) =	**1.0E-02**	**cm/s**
Steady Intake Water Rate (Q_1) =	**2.2E-02**	**cm^3/s**
hole radius (a) =	3	cm
Water column height in hole (H_1) =	5	cm

H1	**5 cm**	**water column height in borehole, first test**
a	3 cm	well radius
α	0.04	slope fitting parameter (estimated based on soil structure)
R1	**1.00E-02 cm/s**	
X	**35.22 cm^2**	**surface area for combined reservior used**
Y	2.170 cm^2	surface area for inner reservoir used
Q1=X1*R1	**0.352 cm^3/s**	**Flow rate based on combined reservoir area and average rate of infiltration**
Q1=Y1*R1	0.022 cm^3/s	Flow rate based on inner reservoir area and average rate of infiltration
	2	**Shape Factor, where:** 1: compacted, structure-less clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc 2: Soils which are both fine-textured (clayey or silty) and unstructured; may also include some fine sands 3: Structured soils from clays to loams; also incudes unstructured medium and fine sands 4: Coarse and/or gravelly sands; may also include some highly structured soils with large/numerous
C1	**0.84205855**	**Shape factor coefficient**

K_{fs} = 3.07E-04 cm/s

= 1.84E-02 cm/min

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi \left(\frac{H_1}{a^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)a^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_1Q_1$ $G_3 = \frac{(2H_2^2 + a^2C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_4 = \frac{(2H_1^2 + a^2C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_3Q_1 - G_4Q_2$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	

Soil Texture-Structure Category	$\alpha^*(cm^{-1})$	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_2/a}{2.081 + 0.121(H_2/a)}\right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)^{0.683}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$

DATE:	2017/11/23	prepared by:	KY
PROJECT:	16-1710H	checked by:	BG

Constant Head Permeameter Test Report

G2

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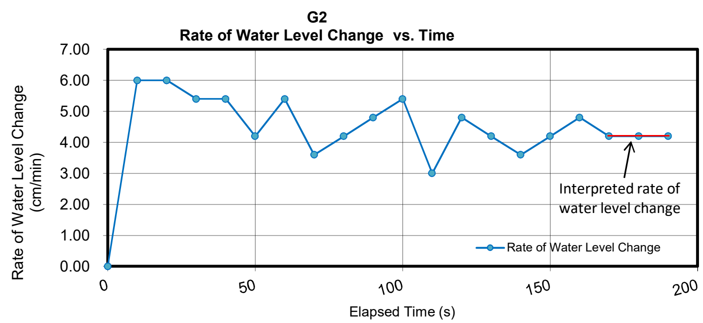

Elapsed Time (s)	Water Level in Reservoir (cm)	Water Level Change (cm)	Infiltration (cm/min)
0.0	12.0	-	-
10.0	13.0	1.0	6.00
20.0	14.0	1.0	6.00
30.0	14.9	0.9	5.40
40.0	15.8	0.9	5.40
50.0	16.5	0.7	4.20
60.0	17.4	0.9	5.40
70.0	18.0	0.6	3.60
80.0	18.7	0.7	4.20
90.0	19.5	0.8	4.80
100.0	20.4	0.9	5.40
110.0	20.9	0.5	3.00
120.0	21.7	0.8	4.80
130.0	22.4	0.7	4.20
140.0	23.0	0.6	3.60
150.0	23.7	0.7	4.20
160.0	24.5	0.8	4.80
170.0	25.2	0.7	4.20
180.0	25.9	0.7	4.20
190.0	26.6	0.7	4.20

Combined Reservoir Surface Area =	**35.22**	cm^2
Borehole Depth =	76	cm
Interpreted Rate of Water Level Change (R1) =	**7.0E-02**	**cm/s**
Steady Intake Water Rate (Q_1) =	**1.5E-01**	**cm^3/s**
hole radius (a) =	3	cm
Water column height in hole (H_1) =	5	cm

H1	**5 cm**	**water column height in borehole, first test**
a	3 cm	well radius
α	0.04	slope fitting parameter (estimated based on soil structure)
R1	**7.00E-02 cm/s**	
X	**35.22 cm^2**	**surface area for combined reservior used**
Y	2.170 cm^2	surface area for inner reservior used
Q1=X1*R1	**2.465 cm^3/s**	**Flow rate based on combined reservoir area and average rate of infiltration**
Q1=Y1*R1	0.152 cm^3/s	Flow rate based on inner reservoir area and average rate of infiltration
	2	**Shape Factor, where:** 1: compacted, structure-less clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc 2: Soils which are both fine-textured (clayey or silty) and unstructured; may also include some fine sands 3: Structured soils from clays to loams; also incudes unstructured medium and fine sands 4: Coarse and/or gravelly sands; may also include some highly structured soils with large/numerous
C1	**0.84205855**	**Shape factor coefficient**

K_{fs} = 2.15E-03 cm/s
= 1.29E-01 cm/min

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_1Q_1$ $G_3 = \frac{(2H_2^2 + a^2C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	$G_4 = \frac{(2H_1^2 + a^2C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_3Q_1 - G_4Q_2$

Soil Texture-Structure Category	$\alpha^*(cm^{-1})$	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_2/a}{2.081 + 0.121(H_2/a)}\right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)^{0.683}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$

DATE: 2017/11/23 prepared by: KY
PROJECT: 16-1710H checked by: BG

Constant Head Permeameter Test Report	Appendix C
G3	

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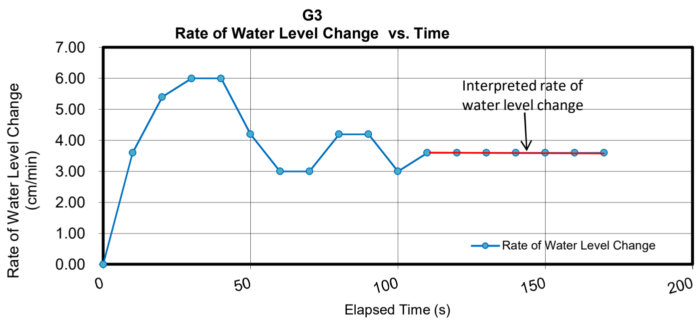


Elapsed Time (s)	Water Level in Reservoir (cm)	Water Level Change (cm)	Infiltration (cm/min)
0.0	15.0	-	-
10.0	15.6	0.6	3.60
20.0	16.5	0.9	5.40
30.0	17.5	1.0	6.00
40.0	18.5	1.0	6.00
50.0	19.2	0.7	4.20
60.0	19.7	0.5	3.00
70.0	20.2	0.5	3.00
80.0	20.9	0.7	4.20
90.0	21.6	0.7	4.20
100.0	22.1	0.5	3.00
110.0	22.7	0.6	3.60
120.0	23.3	0.6	3.60
130.0	23.9	0.6	3.60
140.0	24.5	0.6	3.60
150.0	25.1	0.6	3.60
160.0	25.7	0.6	3.60
170.0	26.3	0.6	3.60

Combined Reservoir Surface Area =	**35.22**	cm^2
Borehole Depth =	76	cm
Interpreted Rate of Water Level Change (R1) =	**6.0E-02**	**cm/s**
Steady Intake Water Rate (Q_1) =	**1.3E-01**	**cm^3/s**
hole radius (a) =	3	cm
Water column height in hole (H_1) =	5	cm

H1	**5 cm**	**water column height in borehole, first test**
a	3 cm	well radius
α	0.04	slope fitting parameter (estimated based on soil structure)
R1	**6.00E-02 cm/s**	
X	**35.22 cm^2**	**surface area for combined reservoir used**
Y	2.170 cm^2	surface area for inner reservoir used
Q1=X1*R1	**2.113 cm^3/s**	**Flow rate based on combined reservoir area and average rate of infiltration**
Q1=Y1*R1	0.130 cm^3/s	Flow rate based on inner reservoir area and average rate of infiltration
	2	**Shape Factor, where:** 1: compacted, structure-less clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc 2: Soils which are both fine-textured (clayey or silty) and unstructured; may also include some fine sands 3: Structured soils from clays to loams; also incudes unstructured medium and fine sands 4: Coarse and/or gravelly sands; may also include some highly structured soils with large/numerous
C1	**0.84205855**	**Shape factor coefficient**

K_{fs} = 1.84E-03 cm/s
= 1.10E-01 cm/min

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi \left(\frac{H_1}{a^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)a^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_1Q_1$ $G_3 = \frac{(2H_2^2 + a^2C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_4 = \frac{(2H_1^2 + a^2C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_3Q_1 - G_4Q_2$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	

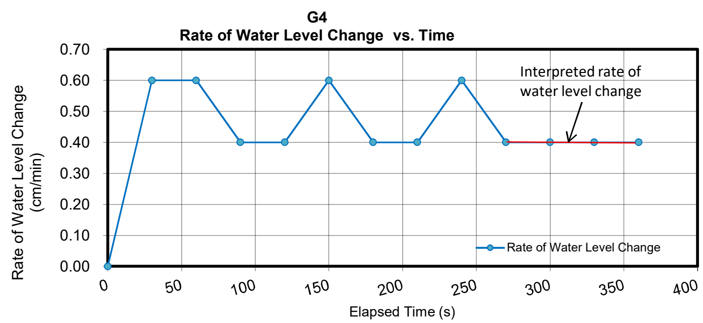
Soil Texture-Structure Category	$\alpha^*(cm^{-1})$	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_2/a}{2.081 + 0.121(H_2/a)}\right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)^{0.683}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$

DATE:	2017/11/23	prepared by:	KY
PROJECT:	16-1710H	checked by:	BG

Constant Head Permeameter Test Report	Appendix C
G4	Page 4 of 4

GeoPro Consulting Limited

Geotechnical-Hydrogeology-Environmental-Materials-Inspection



Elapsed Time (s)	Water Level in Reservoir (cm)	Water Level Change (cm)	Infiltration (cm/min)
0.0	12.0	-	-
30.0	12.3	0.3	0.60
60.0	12.6	0.3	0.60
90.0	12.8	0.2	0.40
120.0	13.0	0.2	0.40
150.0	13.3	0.3	0.60
180.0	13.5	0.2	0.40
210.0	13.7	0.2	0.40
240.0	14.0	0.3	0.60
270.0	14.2	0.2	0.40
300.0	14.4	0.2	0.40
330.0	14.6	0.2	0.40
360.0	14.8	0.2	0.40

Combined Reservoir Surface Area =	**35.22**	cm^2
Borehole Depth =	51	cm
Interpreted Rate of Water Level Change (R1) =	**6.7E-03**	**cm/s**
Steady Intake Water Rate (Q_1) =	**1.4E-02**	**cm^3/s**
hole radius (a) =	3	cm
Water column height in hole (H_1) =	5	cm

H1	**5 cm**	**water column height in borehole, first test**
a	3 cm	well radius
α	0.04	slope fitting parameter (estimated based on soil structure)
R1	**6.67E-03 cm/s**	
X	**35.22 cm^2**	**surface area for combined reservior used**
Y	2.170 cm^2	surface area for inner reservoir used
Q1=X1*R1	**0.235 cm^3/s**	**Flow rate based on combined reservoir area and average rate of infiltration**
Q1=Y1*R1	0.014 cm^3/s	Flow rate based on inner reservoir area and average rate of infiltration
	2	**Shape Factor, where:** 1: compacted, structure-less clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc 2: Soils which are both fine-textured (clayey or silty) and unstructured; may also include some fine sands 3: Structured soils from clays to loams; also incudes unstructured medium and fine sands 4: Coarse and/or gravelly sands; may also include some highly structured soils with large/numerous
C1	**0.84205855**	**Shape factor coefficient**

K_{fs} = 2.05E-04 cm/s

= 1.23E-02 cm/min

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{a^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)a^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1 H_2(H_2 - H_1) + a^2(H_1 C_2 - H_2 C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1 H_2(H_2 - H_1) + a^2(H_1 C_2 - H_2 C_1))}$ $K_{fs} = G_2 Q_2 - G_1 Q_1$ $G_3 = \frac{(2H_2^2 + a^2 C_2)C_1}{2\pi(2H_1 H_2(H_2 - H_1) + a^2(H_1 C_2 - H_2 C_1))}$ $G_4 = \frac{(2H_1^2 + a^2 C_1)C_2}{2\pi(2H_1 H_2(H_2 - H_1) + a^2(H_1 C_2 - H_2 C_1))}$ $\Phi_m = G_3 Q_1 - G_4 Q_2$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	

Soil Texture-Structure Category	$\alpha^*(cm^{-1})$	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_2/a}{2.081 + 0.121(H_2/a)}\right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)^{0.683}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$

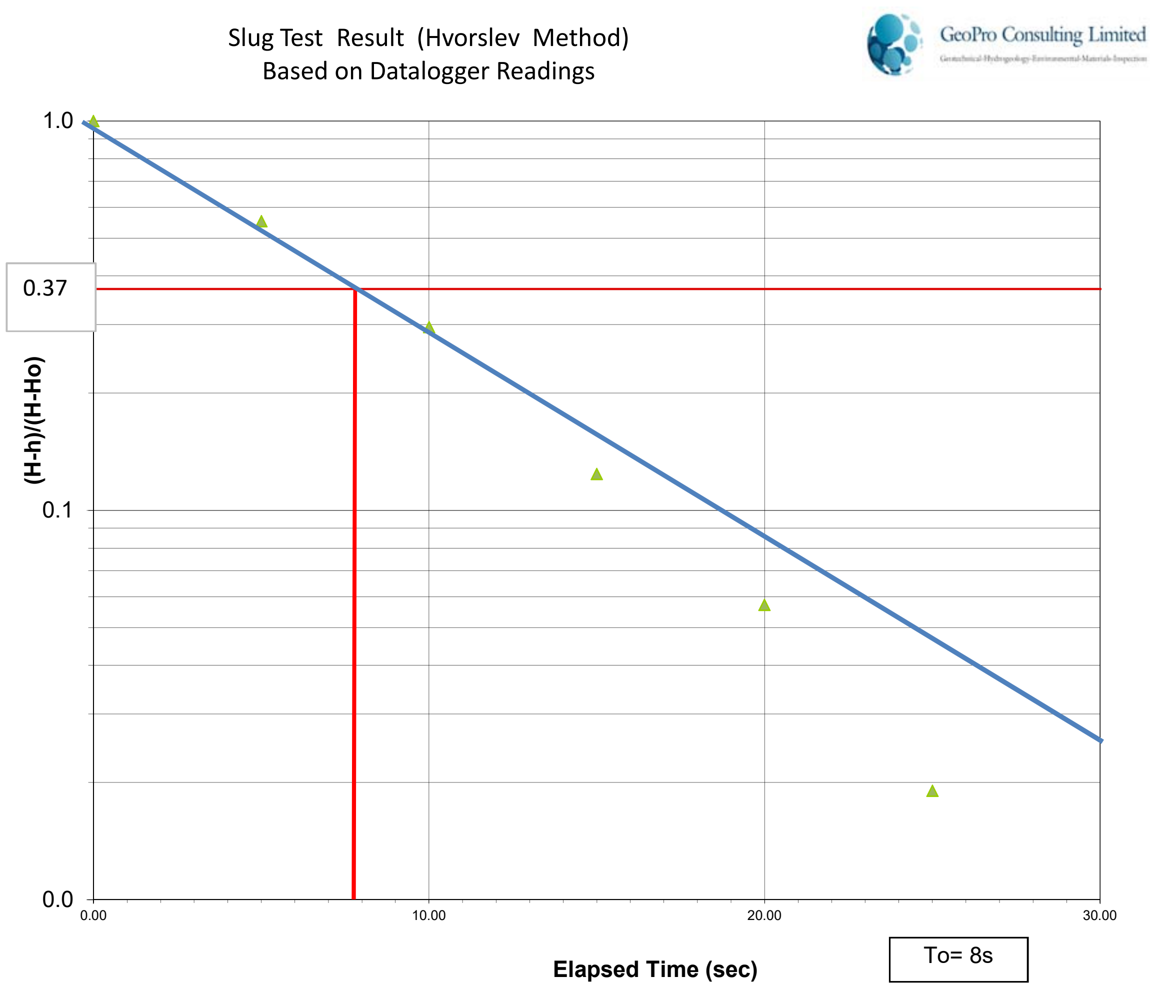
DATE:	2017/11/23	prepared by:	KY
PROJECT:	16-1710H	checked by:	BG

APPENDIX D

Slug Test: BH1
(Based on data from Datalogger - Rising Head Method -November 17, 2017)

Project Location: North of Burbank Circle, Everett, Ontario

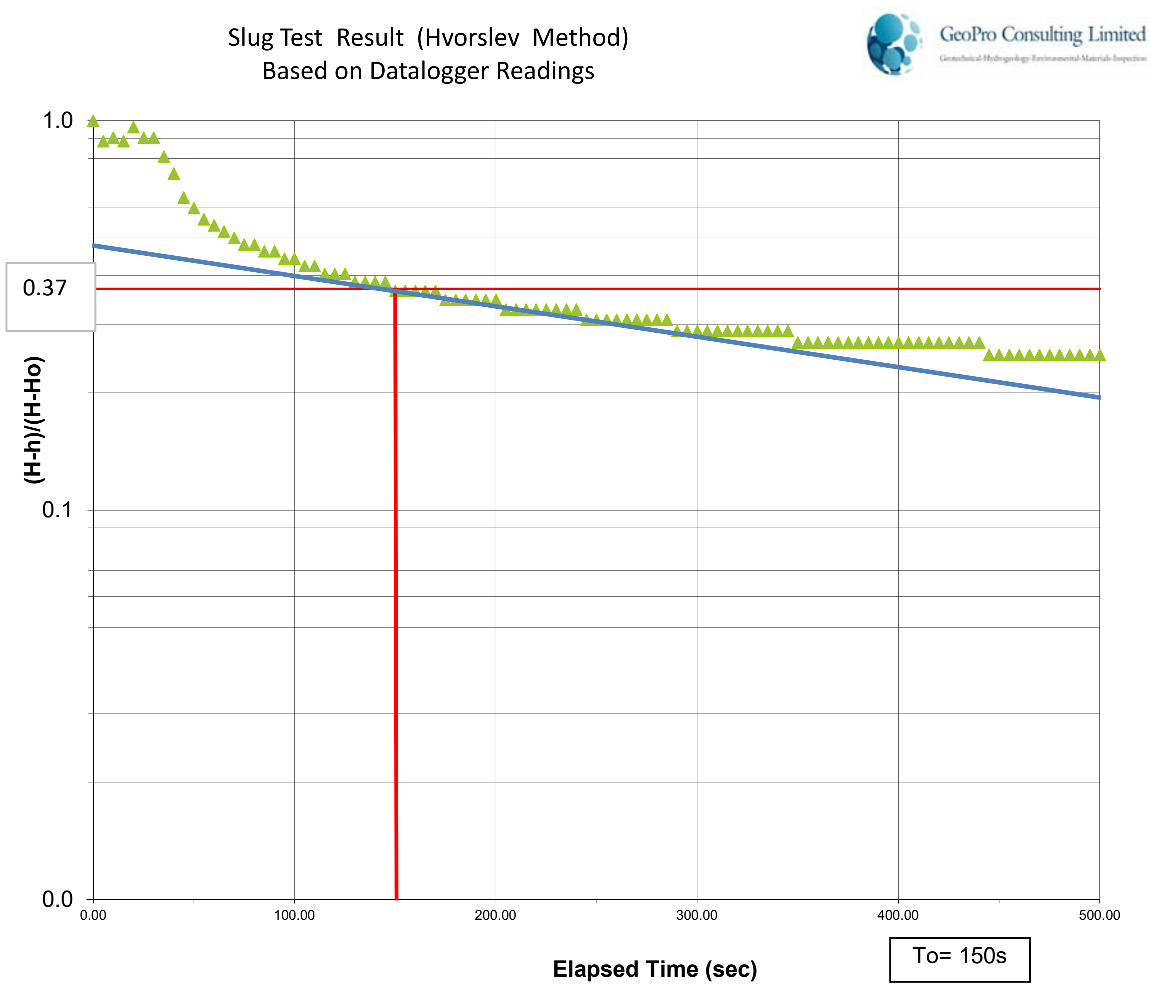
Project No. : 16-1710H		H =	Assumed Initial Water Head	
Conducted by:	Will Sun	Ho =	Water Head at time = 0	
Interpretted by:	Kaiying Qiu	h =	Water Head/Level at time t	
Well Number:	BH1			
Screen Depth (mBGS):	3.8 ~ 5.3			
Well Elevation (mASL):	241.02	L =	150	cm
Well Diameter:	2.0" ID	R =	7.75	cm
Static Water Level (mBGS):	2.84	r =	2.55	cm
Finish Reading (H)	11.451	To =	8	sec
Start Reading (h_0)	11.136	$K = r^2 \ln(L/R)/(2LTo)$ =	**8.0E-03**	cm/s



Slug Test: BH02
(Based on data from Datalogger - Falling Head Method -November 23, 2017)

Project Location: North of Burbank Circle, Everett, Ontario

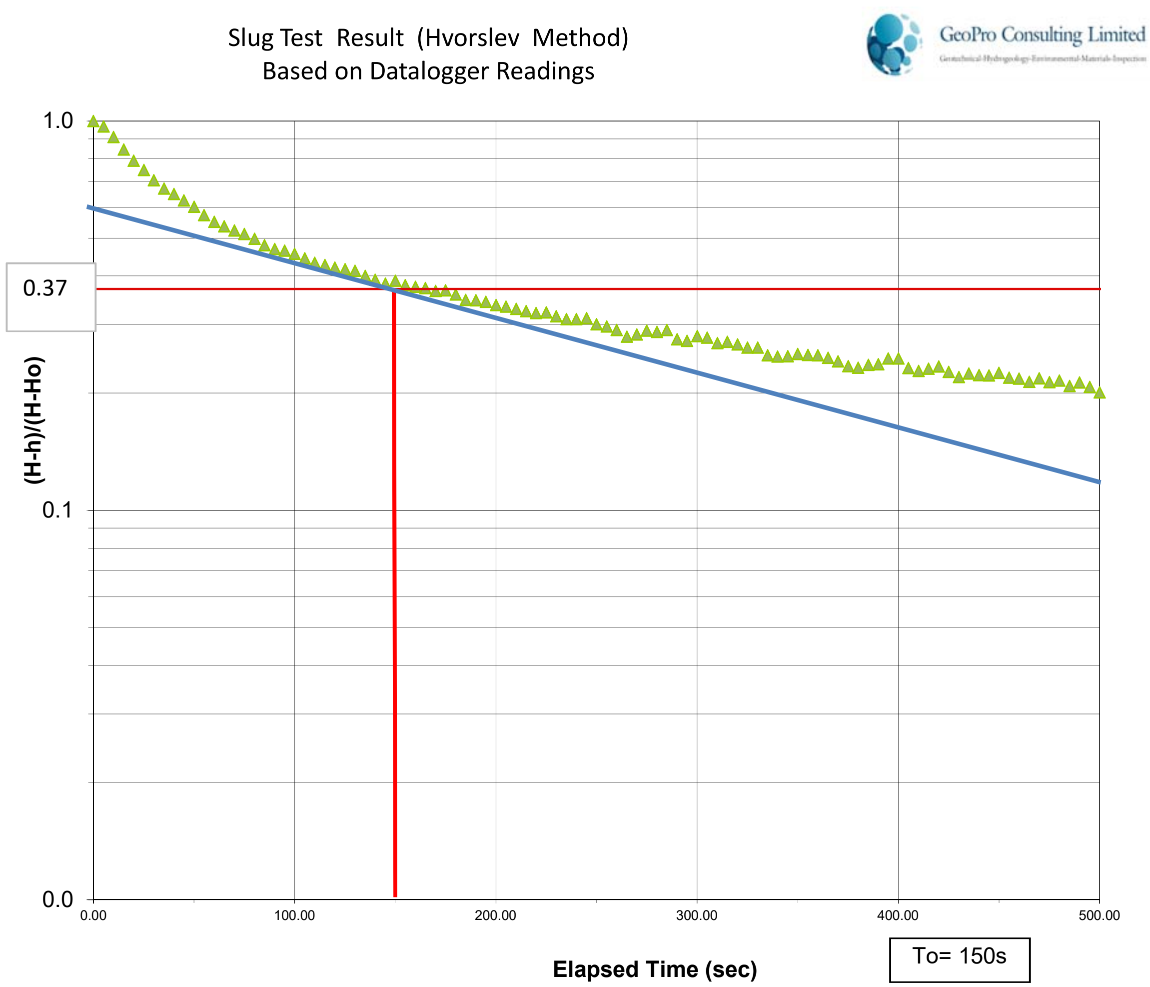
Project No. : 16-1710H		H =	Assumed Initial Water Head	
Conducted by:	Will Sun	Ho =	Water Head at time = 0	
Interpretted by:	Kaiying Qiu	h =	Water Head/Level at time t	
Well Number:	BH02			
Screen Depth (mBGS):	0.7 ~ 2.2			
Well Elevation (mASL):	245.91	L =	92.6	cm
Well Diameter:	1.25" ID	R =	3	cm
Static Water Level (mBGS):	1.43	r =	1.59	cm
Finish Reading (H)	10.614	To =	150	sec
Start Reading (h_0)	10.77	$K = r^2\ln(L/R)/(2LTo)$ =	**3.1E-04**	cm/s



Slug Test: BH03
(Based on data from Datalogger - Falling Head Method -November 23, 2017)

Project Location: North of Burbank Circle, Everett, Ontario

Project No. : 16-1710H		H =	Assumed Initial Water Head	
Conducted by:	Will Sun	Ho =	Water Head at time = 0	
Interpretted by:	Kaiying Qiu	h =	Water Head/Level at time t	
Well Number:	BH03			
Screen Depth (mBGS):	0.4 ~ 1.9			
Well Elevation (mASL):	242.13	L =	102.7	cm
Well Diameter:	1.25" ID	R =	3	cm
Static Water Level (mBGS):	1.08	r =	1.59	cm
Finish Reading (H)	10.7323	To =	150	sec
Start Reading (h_0)	10.9391	$K = r^2 \ln(L/R)/(2LTo)$ =	**2.9E-04**	cm/s

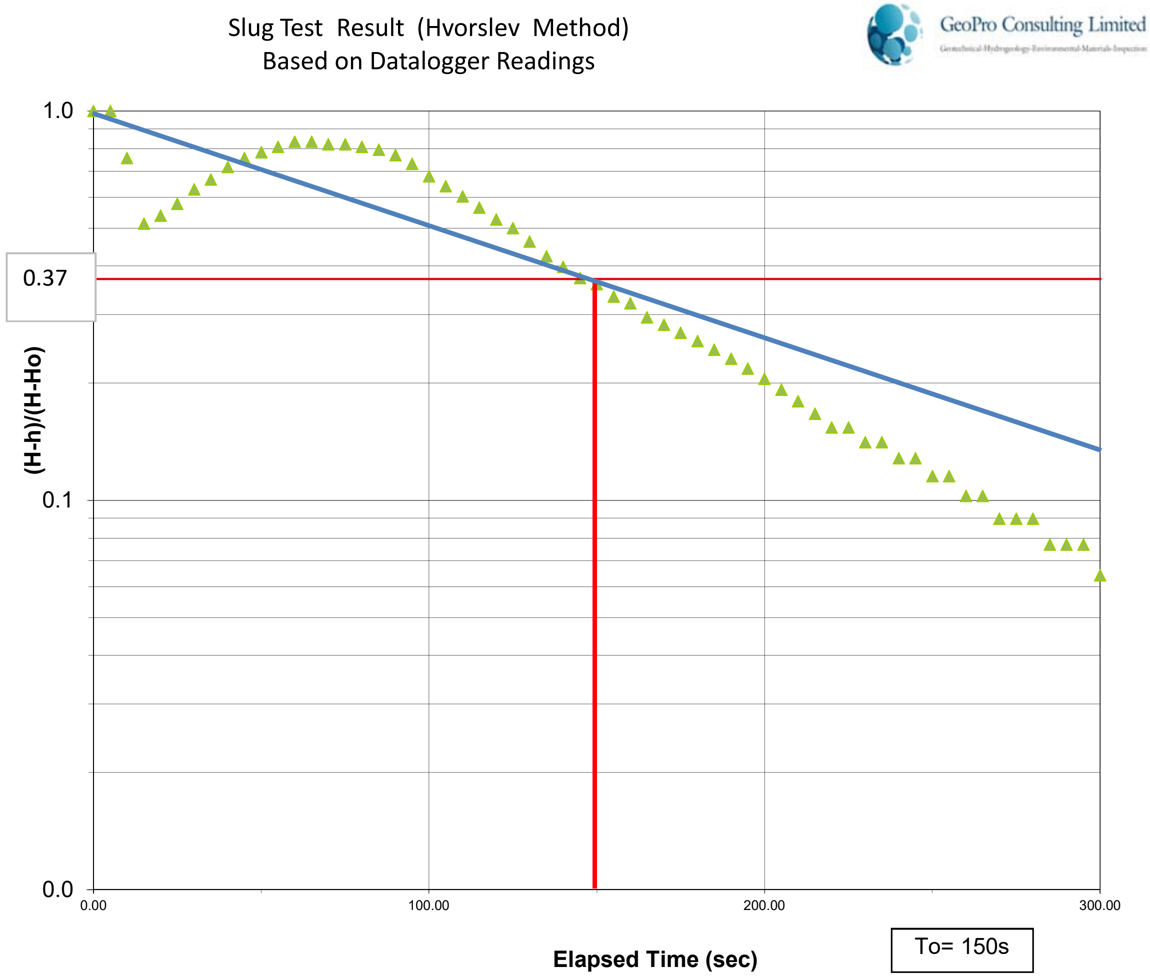


Slug Test: BH04
(Based on data from Datalogger - Falling Head Method -November 23, 2017)

Project Location: North of Burbank Circle, Everett, Ontario

Project No. : 16-1710H		H =	Assumed Initial Water Head	
Conducted by:	Will Sun	Ho =	Water Head at time = 0	
Interpretted by:	Kaiying Qiu	h =	Water Head/Level at time t	
Well Number:	BH04			
Screen Depth (mBGS):	0.7 ~ 1.0			
Well Elevation (mASL):	242.76	L =	30	cm
Well Diameter:	1.25" ID	R =	3	cm
Static Water Level (mBGS):	0.2	r =	1.59	cm
Finish Reading (H)	10.44	To =	150	sec
Start Reading (h_0)	10.674	$K = r^2 \ln(L/R)/(2LTo)$ =	**1.0E-03**	cm/s

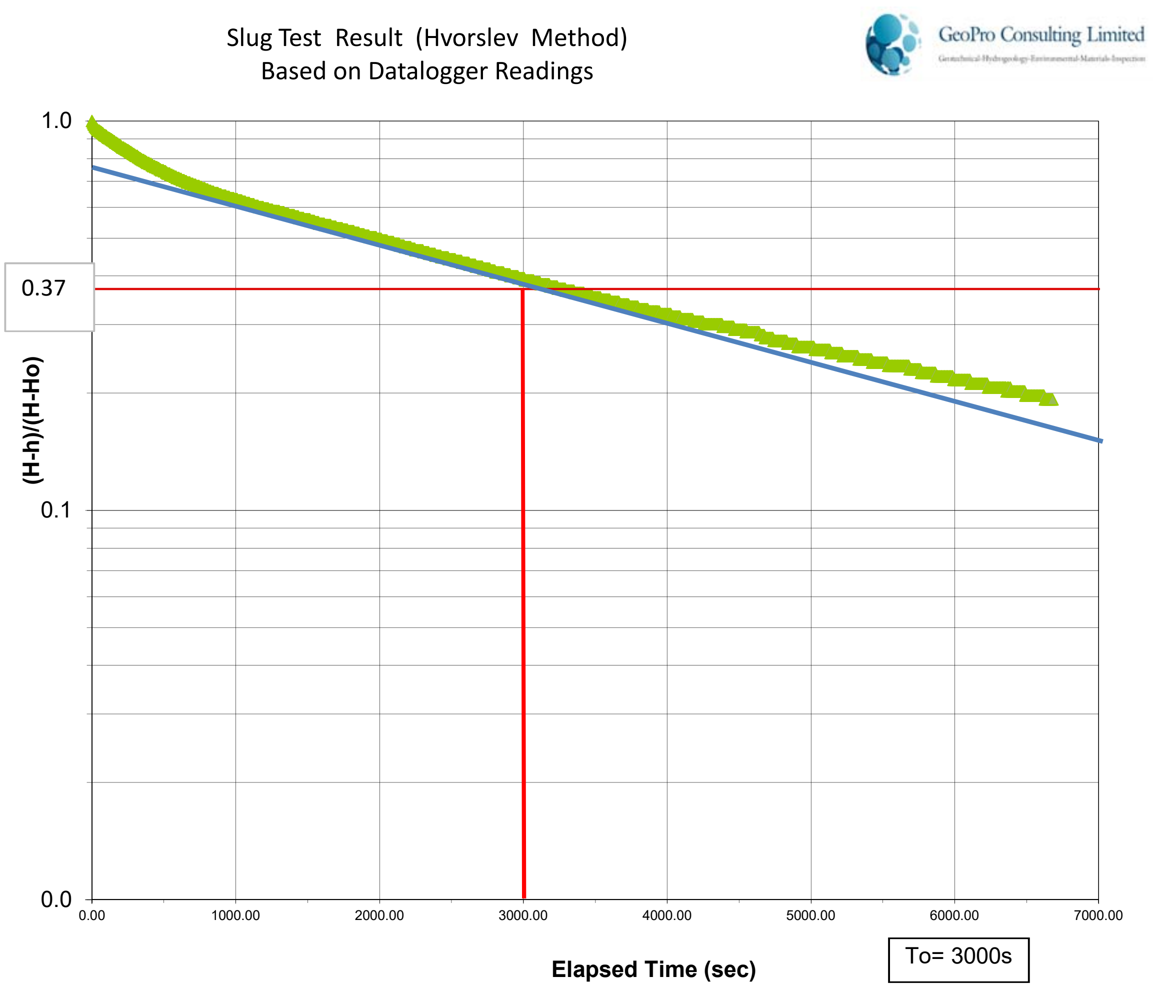
GeoPro Consulting Limited



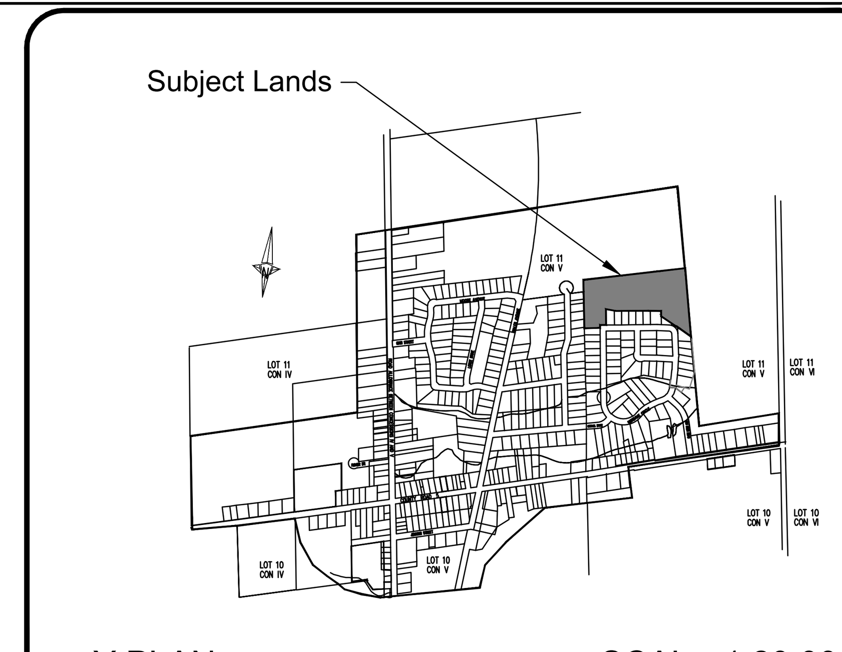
Slug Test: BH05
(Based on data from Datalogger - Falling Head Method -November 23, 2017)

Project Location: North of Burbank Circle, Everett, Ontario

Project No. : 16-1710H		H =	Assumed Initial Water Head	
Conducted by:	Will Sun	Ho =	Water Head at time = 0	
Interpretted by:	Kaiying Qiu	h =	Water Head/Level at time t	
Well Number:	BH05			
Screen Depth (mBGS):	0.0 ~ 1.4			
Well Elevation (mASL):	238.01	L =	132.9	cm
Well Diameter:	1.25" ID	R =	3	cm
Static Water Level (mBGS):	0.71	r =	1.59	cm
Finish Reading (H)	10.809	To =	3000	sec
Start Reading (h_0)	11.448	$K = r^2 \ln(L/R)/(2LTo)$ =	**1.2E-05**	cm/s



APPENDIX E



Draft Plan of Subdivision

Part of □ast Half Lot 11□Concession 5
Geographical Township of Tosorontio□
Now in the

Township of Adjala□Tosorontio
County of Simcoe

2017

OWN□R□S C□RTIFICAT□

I□TH□ UND□RSIGN□D□B□ING TH□ R□GIST□R□D OWN□R OF TH□ SUBJ□CT LANDS□H□R□BY AUTHORIZ□ TH□ JON□S CONSULTING GROUP LTD.□TO PR□PAR□ THIS DRAFT PLAN OF SUBDIVISION AND TO SUBMIT SAM□ TO TH□ TOWNSHIP OF ADJALA□TOSORONTIO FOR APPROVAL.

DAT□ — OWN□R NAM□

SURV□YOR□S C□RTIFICAT□

I C□RTIFY THAT TH□ BOUNDARI□S OF TH□ LANDS TO B□ SUBDIVID□D AND TH□IR R□LATIONSHIP TO ADJAC□NT LANDSAR□ ACCURAT□LY AND CORR□CTLY SHOWN.

DAT□ — RODN□Y G□Y□R□OLS, ONTARIO LAND SURV□YOR

ADDITIONAL INFORMATION R□□UIR□D UND□R
S□CTION 51□17□OF TH□ PLANNING ACT

- a□SHOWN ON DRAFT PLAN
- b□SHOWN ON DRAFT PLAN
- c□SHOWN ON □□Y PLAN
- d□R□SID□NTIAL□
- e□SHOWN ON DRAFT PLAN
- f□SHOWN ON DRAFT PLAN
- g□SHOWN ON DRAFT PLAN
- h□MUNICIPAL PIP□D WAT□R TO B□ PROVID□D
- i□SANDY SILT
- j□SHOWN ON DRAFT PLAN
- □□ALL MUNICIPAL S□RVIC□S TO B□ PROVID□D
- l□SHOWN ON DRAFT PLAN

SUBDIVISION STATISTICS	AR□A □ha.□	UNITS
SINGL□ R□SID□NTIAL □15.2m □LOTS x□x□	x.xx ha.	33 units
SINGL□ R□SID□NTIAL □12.2m □LOTS x□x□	x.xx ha.	12 units
ROAD □STR□□T □A□□	x.xx ha.	
TOTAL	4.33 ha.	45 units

20 0 20 40 METRES
SCALE = 1:500 (A1)

YOUNG □□V□R□TT

DRAFT PLAN OF SUBDIVISION

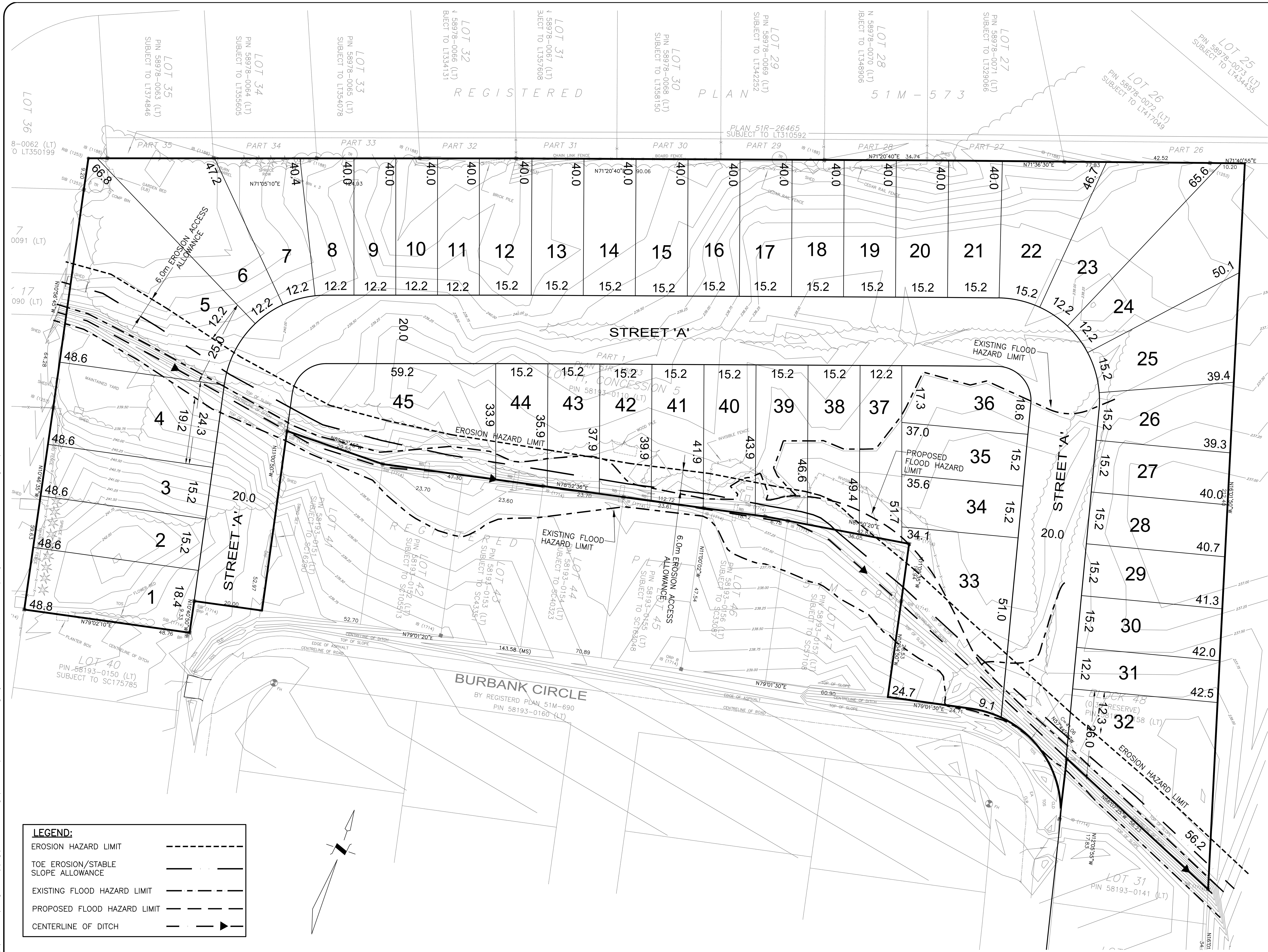
Brandi L. Clement — REGISTERED PROFESSIONAL PLANNER — R.P.P.

Date Issued:	March 1, 2017
Checked By:	BC
Project No.:	YOU–99107
Drawn By:	m.c.r.
Drawing Name:	YOU–99107–DP–1.dwg

SCHEDULE OF REVISIONS		
DATE	DESCRIPTION	DRAWN

JONES CONSULTING GROUP LTD.
PLANNERS & ENGINEERS
229 Mapleview Drive □ast□Unit 1□Barrie□Ontario□L4N 0W5
Phone: 705□734□2538 Fax: 705□734□1056
www.jonesconsulting.com

YOUNG □□V□R□TT
TOWNSHIP OF ADJALA□TOSORONTIO



APPENDIX F

Summary of Historical Climatic Data

Station: *ALLISTON NELSON
Station ID: 6110218

GeoPro Consulting Limited
Geotechnical-Hydrogeology-Environmental-Materials-Inspection

Latitude: 44°09'05.028" N   Longitude: 79°52'20.088" W   Elevation: 221.0 m

Temperture:	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**DEC**	**Year**
Daily Average (°C)	-6.5	-5.2	-0.7	6.7	13.1	18.4	21	20	15.9	9.2	3.1	-2.9	7.7
Precipitation													
Rainfall (mm)	18.8	19.7	30.4	59.4	78.3	81.0	77.6	82.3	80.1	66.8	62.5	25.0	682
Snowfall (cm)	35.1	29.7	23.4	4.1	0.0	0.0	0.0	0.0	0.0	4.5	19.1	36.3	152
Precipitation (mm)	53.9	49.5	53.8	63.6	78.3	81.0	77.6	82.3	80.1	71.3	81.6	61.3	834

Note:
WMO Standards for "CLIMATE NORMALS" - Class "A": No more than 3 consecutive or 5 total missing years between 1981 to 2010.
* This station meets WMO standards for temperature and precipitation

APPENDIX G

Project: 16-1710H

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Water Surplus Estimation within Pervious Aseas in Geographical Block 1 (Pre-development)

Based on Table 3.1 in MOE SWMPDM (2003) with a Water Holding Capacity of 50 mm

Historical Climate Data from ALLISTON NELSON Station (1981 - 2010)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Potential Evapotranspiration (PET) Calculation													
Daily Average Temperature (˚C)	-6.5	-5.2	-0.7	6.7	13.1	18.4	21	20	15.9	9.2	3.1	-2.9	7.7
Monthly Heat Index	0.00	0.00	0.00	1.56	4.30	7.19	8.78	8.16	5.76	2.52	0.48	0.00	38.75
Unadjusted PET, UPET(mm)	0.00	0.00	0.00	29.39	61.87	90.22	104.48	98.97	76.71	41.79	12.49	0.00	515.91
Adjusting factor for UPET (Latitude 44˚ N)	0.81	0.81	1.02	1.13	1.27	1.28	1.30	1.20	1.04	0.94	0.80	0.76	
Adjusted PET (mm)	0	0	0	33	79	116	136	119	80	39	10	0	612
Actual Evapotranspiration (AET) Caculation													
Precipitation, P (mm)	54	50	54	64	78	81	78	82	80	71	82	61	834
P-PET (mm)	54	50	54	31	0	-35	-58	-37	0	32	72	61	
Accumulated Potential Water Loss, APWL (mm)	0	0	0	0	0	-35	-93	-130	0	0	0	0	
Water Holding Capacity (mm)	50	50	50	50	50	50	50	50	50	50	50	50	
Soil Moisture Storage, S (mm) *	223	272	50	50	50	25	8	4	4	36	107	169	
Change in Soil Moisture Storage (including snow accumulation), ΔS (mm)	54	50	0	0	0	-25	-17	-4	0	32	72	61	
AET (mm)	0	0	0	33	79	106	95	86	80	39	10	0	528
Moisture Deficit, D (mm)	0	0	0	0	0	10	41	33	0	0	0	0	
Water Surplus													
Rainfall Surplus (mm)	0	0	54	31	0	0	0	0	0	0	0	0	85
Snowmelt Surplus (mm)	0	0	222	0	0	0	0	0	0	0	0	0	222
Total Available Water Surplus (mm)**	0	0	276	31	0	0	0	0	0	0	0	0	307
Infiltration													
Cumulative MOECC Infiltration Factor = 0.6													
Potential Infiltration (mm)	0	0	166	18	0	0	0	0	0	0	0	0	184
Runoff													
Potential Surface Water Runoff (mm)	0	0	110	12	0	0	0	0	0	0	0	0	123

* Includes above ground potential snow accumulation for months when mean temperature is below -1 ˚C

** Total water surplus does not incorporate any delay in the transmission of water available for runoff

Project: 16-1710H

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Water Surplus Estimation within Pervious Aseas in Geographical Block 2 (Pre-development)

Based on Table 3.1 in MOE SWMPDM (2003) with a Water Holding Capacity of 100 mm

Historical Climate Data from ALLISTON NELSON Station (1981 - 2010)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Potential Evapotranspiration (PET) Calculation													
Daily Average Temperature (˚C)	-6.5	-5.2	-0.7	6.7	13.1	18.4	21	20	15.9	9.2	3.1	-2.9	7.7
Monthly Heat Index	0.00	0.00	0.00	1.56	4.30	7.19	8.78	8.16	5.76	2.52	0.48	0.00	38.75
Unadjusted PET, UPET(mm)	0.00	0.00	0.00	29.39	61.87	90.22	104.48	98.97	76.71	41.79	12.49	0.00	515.91
Adjusting factor for UPET (Latitude 44˚ N)	0.81	0.81	1.02	1.13	1.27	1.28	1.30	1.20	1.04	0.94	0.80	0.76	
Adjusted PET (mm)	0	0	0	33	79	116	136	119	80	39	10	0	612
Actual Evapotranspiration (AET) Caculation													
Precipitation, P (mm)	54	50	54	64	78	81	78	82	80	71	82	61	834
P-PET (mm)	54	50	54	31	0	-35	-58	-37	0	32	72	61	
Accumulated Potential Water Loss, APWL (mm)	0	0	0	0	0	-35	-93	-130	0	0	0	0	
Water Holding Capacity (mm)	100	100	100	100	100	100	100	100	100	100	100	100	
Soil Moisture Storage, S (mm) *	246	296	100	100	100	70	39	27	27	59	131	192	
Change in Soil Moisture Storage (including snow accumulation), ΔS (mm)	54	50	0	0	0	-29	-31	-12	0	32	72	61	
AET (mm)	0	0	0	33	79	110	109	94	80	39	10	0	554
Moisture Deficit, D (mm)	0	0	0	0	0	5	27	25	0	0	0	0	
Water Surplus													
Rainfall Surplus (mm)	0	0	53	31	0	0	0	0	0	0	0	0	84
Snowmelt Surplus (mm)	0	0	196	0	0	0	0	0	0	0	0	0	196
Total Available Water Surplus (mm)**	0	0	249	31	0	0	0	0	0	0	0	0	280
Infiltration													
Cumulative MOECC Infiltration Factor = 0.65													
Potential Infiltration (mm)	0	0	162	20	0	0	0	0	0	0	0	0	182
Runoff													
Potential Surface Water Runoff (mm)	0	0	87	11	0	0	0	0	0	0	0	0	98

* Includes above ground potential snow accumulation for months when mean temperature is below -1 ˚C

** Total water surplus does not incorporate any delay in the transmission of water available for runoff

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Water Surplus Estimation within Pervious Aseas in Geographical Block 3 (Pre-development)

Based on Table 3.1 in MOE SWMPDM (2003) with a Water Holding Capacity of 250 mm
Historical Climate Data from ALLISTON NELSON Station (1981 - 2010)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Potential Evapotranspiration (PET) Calculation													
Daily Average Temperature (˚C)	-6.5	-5.2	-0.7	6.7	13.1	18.4	21	20	15.9	9.2	3.1	-2.9	7.7
Monthly Heat Index	0.00	0.00	0.00	1.56	4.30	7.19	8.78	8.16	5.76	2.52	0.48	0.00	38.75
Unadjusted PET, UPET(mm)	0.00	0.00	0.00	29.39	61.87	90.22	104.48	98.97	76.71	41.79	12.49	0.00	515.91
Adjusting factor for UPET (Latitude 44˚ N)	0.81	0.81	1.02	1.13	1.27	1.28	1.30	1.20	1.04	0.94	0.80	0.76	
Adjusted PET (mm)	0	0	0	33	79	116	136	119	80	39	10	0	612
Actual Evapotranspiration (AET) Caculation													
Precipitation, P (mm)	54	50	54	64	78	81	78	82	80	71	82	61	834
P-PET (mm)	54	50	54	31	0	-35	-58	-37	0	32	72	61	
Accumulated Potential Water Loss, APWL (mm)	0	0	0	0	0	-35	-93	-130	0	0	0	0	
Water Holding Capacity (mm)	250	250	250	250	250	250	250	250	250	250	250	250	
Soil Moisture Storage, S (mm) *	367	417	250	250	250	217	172	148	149	181	252	314	
Change in Soil Moisture Storage (including snow accumulation), ΔS (mm)	54	50	0	0	0	-32	-45	-24	0	32	72	61	
AET (mm)	0	0	0	33	79	113	123	106	80	39	10	0	583
Moisture Deficit, D (mm)	0	0	0	0	0	2	13	13	0	0	0	0	
Water Surplus													
Rainfall Surplus (mm)	0	0	54	31	0	0	0	0	0	0	0	0	84
Snowmelt Surplus (mm)	0	0	167	0	0	0	0	0	0	0	0	0	167
Total Available Water Surplus (mm)**	0	0	221	31	0	0	0	0	0	0	0	0	251
Infiltration													
Cumulative MOECC Infiltration Factor = 0.7													
Potential Infiltration (mm)	0	0	155	21	0	0	0	0	0	0	0	0	176
Runoff													
Potential Surface Water Runoff (mm)	0	0	66	9	0	0	0	0	0	0	0	0	75

* Includes above ground potential snow accumulation for months when mean temperature is below -1 ˚C

** Total water surplus does not incorporate any delay in the transmission of water available for runoff

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Water Surplus Estimation within Impervious Aseas in Geographical Block A (Post-development)

Historical Climate Data from ALLISTON NELSON Station (1981 - 2010)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Potential Evapotranspiration (PET) Calculation													
Daily Average Temperature (˚C)	-6.5	-5.2	-0.7	6.7	13.1	18.4	21	20	15.9	9.2	3.1	-2.9	7.7
Monthly Heat Index	0.00	0.00	0.00	1.56	4.30	7.19	8.78	8.16	5.76	2.52	0.48	0.00	38.75
Unadjusted PET, UPET(mm)	0.00	0.00	0.00	29.39	61.87	90.22	104.48	98.97	76.71	41.79	12.49	0.00	515.91
Adjusting factor for UPET (Latitude 44˚ N)	0.81	0.81	1.02	1.13	1.27	1.28	1.30	1.20	1.04	0.94	0.80	0.76	
Adjusted PET (mm)	0	0	0	33	79	116	136	119	80	39	10	0	612
Water Surplus													
Rainfall Surplus (mm)	19	20	31	59	78	81	78	82	80	67	63	25	682
Snowmelt Surplus (mm)	35	30	23	5	0	0	0	0	0	4	19	36	152
Total Available Water Surplus (mm)*	54	50	54	64	78	81	78	82	80	71	82	61	834
Assumed Evaporation, E (mm)*	5	5	5	6	8	8	8	8	8	7	8	6	83
Infiltration													
Cumulative MOECC Infiltration Factor = 0													
Potential Infiltration (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Runoff													
Potential Surface Water Runoff (mm)	49	45	48	57	70	73	70	74	72	64	73	55	751

* Total water surplus does not incorporate any delay in the transmission of water available for runoff

** 10% of total available water surplus is assumed to be evaporate on impervious areas

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Water Surplus Estimation within Pervious Aseas in Geographical Block B (Post-development)

Based on Table 3.1 in MOE SWMPDM (2003) with a Water Holding Capacity of 100 mm
Historical Climate Data from ALLISTON NELSON Station (1981 - 2010)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Potential Evapotranspiration (PET) Calculation													
Daily Average Temperature (˚C)	-6.5	-5.2	-0.7	6.7	13.1	18.4	21	20	15.9	9.2	3.1	-2.9	7.7
Monthly Heat Index	0.00	0.00	0.00	1.56	4.30	7.19	8.78	8.16	5.76	2.52	0.48	0.00	38.75
Unadjusted PET, UPET(mm)	0.00	0.00	0.00	29.39	61.87	90.22	104.48	98.97	76.71	41.79	12.49	0.00	515.91
Adjusting factor for UPET (Latitude 44˚ N)	0.81	0.81	1.02	1.13	1.27	1.28	1.30	1.20	1.04	0.94	0.80	0.76	
Adjusted PET (mm)	0	0	0	33	79	116	136	119	80	39	10	0	612
Actual Evapotranspiration (AET) Caculation													
Precipitation, P (mm)	54	50	54	64	78	81	78	82	80	71	82	61	834
P-PET (mm)	54	50	54	31	0	-35	-58	-37	0	32	72	61	
Accumulated Potential Water Loss, APWL (mm)	0	0	0	0	0	-35	-93	-130	0	0	0	0	
Water Holding Capacity (mm)	100	100	100	100	100	100	100	100	100	100	100	100	
Soil Moisture Storage, S (mm) *	246	296	100	100	100	70	39	27	27	59	131	192	
Change in Soil Moisture Storage (including snow accumulation), ΔS (mm)	54	50	0	0	0	-29	-31	-12	0	32	72	61	
AET (mm)	0	0	0	33	79	110	109	94	80	39	10	0	554
Moisture Deficit, D (mm)	0	0	0	0	0	5	27	25	0	0	0	0	
Water Surplus													
Rainfall Surplus (mm)	0	0	53	31	0	0	0	0	0	0	0	0	84
Snowmelt Surplus (mm)	0	0	196	0	0	0	0	0	0	0	0	0	196
Total Available Water Surplus (mm)**	0	0	249	31	0	0	0	0	0	0	0	0	280
Infiltration													
Cumulative MOECC Infiltration Factor = 0.6													
Potential Infiltration (mm)	0	0	150	18	0	0	0	0	0	0	0	0	168
Runoff													
Potential Surface Water Runoff (mm)	0	0	100	12	0	0	0	0	0	0	0	0	112

* Includes above ground potential snow accumulation for months when mean temperature is below -1 ˚C

** Total water surplus does not incorporate any delay in the transmission of water available for runoff

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Water Surplus Estimation within Impervious Aseas in Geographical Block C (Post-development)

Historical Climate Data from ALLISTON NELSON Station (1981 - 2010)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Potential Evapotranspiration (PET) Calculation													
Daily Average Temperature (˚C)	-6.5	-5.2	-0.7	6.7	13.1	18.4	21	20	15.9	9.2	3.1	-2.9	7.7
Monthly Heat Index	0.00	0.00	0.00	1.56	4.30	7.19	8.78	8.16	5.76	2.52	0.48	0.00	38.75
Unadjusted PET, UPET(mm)	0.00	0.00	0.00	29.39	61.87	90.22	104.48	98.97	76.71	41.79	12.49	0.00	515.91
Adjusting factor for UPET (Latitude 44˚ N)	0.81	0.81	1.02	1.13	1.27	1.28	1.30	1.20	1.04	0.94	0.80	0.76	
Adjusted PET (mm)	0	0	0	33	79	116	136	119	80	39	10	0	612
Water Surplus													
Rainfall Surplus (mm)	19	20	31	59	78	81	78	82	80	67	63	25	682
Snowmelt Surplus (mm)	35.	30	23	5	0	0	0	0	0	4	19	36	152
Total Available Water Surplus (mm)*	54	50	54	64	78	81	78	82	80	71	82	61	834
Assumed Evaporation, E (mm)*	5	5	5	6	8	8	8	8	8	7	8	6	83
Infiltration													
Cumulative MOECC Infiltration Factor = 0													
Potential Infiltration (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0
Runoff													
Potential Surface Water Runoff (mm)	49	45	48	57	70	73	70	74	72	64	73	55	751

* Total water surplus does not incorporate any delay in the transmission of water available for runoff

** 10% of total available water surplus is assumed to be evaporate on impervious areas

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Water Surplus Estimation within Pervious Aseas in Geographical Block C (Post-development)

Based on Table 3.1 in MOE SWMPDM (2003) with a Water Holding Capacity of 50 mm
Historical Climate Data from ALLISTON NELSON Station (1981 - 2010)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Potential Evapotranspiration (PET) Calculation													
Daily Average Temperature (˚C)	-6.5	-5.2	-0.7	6.7	13.1	18.4	21	20	15.9	9.2	3.1	-2.9	7.7
Monthly Heat Index	0.00	0.00	0.00	1.56	4.30	7.19	8.78	8.16	5.76	2.52	0.48	0.00	38.75
Unadjusted PET, UPET(mm)	0.00	0.00	0.00	29.39	61.87	90.22	104.48	98.97	76.71	41.79	12.49	0.00	515.91
Adjusting factor for UPET (Latitude 44˚ N)	0.81	0.81	1.02	1.13	1.27	1.28	1.30	1.20	1.04	0.94	0.80	0.76	
Adjusted PET (mm)	0	0	0	33	79	116	136	119	80	39	10	0	612
Actual Evapotranspiration (AET) Caculation													
Precipitation, P (mm)	54	50	54	64	78	81	78	82	80	71	82	61	834
P-PET (mm)	54	50	54	31	0	-35	-58	-37	0	32	72	61	
Accumulated Potential Water Loss, APWL (mm)	0	0	0	0	0	-35	-93	-130	0	0	0	0	
Water Holding Capacity (mm)	50	50	50	50	50	50	50	50	50	50	50	50	
Soil Moisture Storage, S (mm) *	223	272	50	50	50	25	8	4	4	36	107	169	
Change in Soil Moisture Storage (including snow accumulation), ΔS (mm)	54	50	0	0	0	-25	-17	-4	0	32	72	61	
AET (mm)	0	0	0	33	79	106	95	86	80	39	10	0	528
Moisture Deficit, D (mm)	0	0	0	0	0	10	41	33	0	0	0	0	
Water Surplus													
Rainfall Surplus (mm)	0	0	54	31	0	0	0	0	0	0	0	0	84
Snowmelt Surplus (mm)	0	0	222	0	0	0	0	0	0	0	0	0	223
Total Available Water Surplus (mm)**	0	0	276	31	0	0	0	0	0	0	0	0	307
Infiltration													
Cumulative MOECC Infiltration Factor = 0.7													
Potential Infiltration (mm)	0	0	193	21	0	0	0	0	0	0	0	0	215
Runoff													
Potential Surface Water Runoff (mm)	0	0	83	9	0	0	0	0	0	0	0	0	92

* Includes above ground potential snow accumulation for months when mean temperature is below -1 ˚C
** Total water surplus does not incorporate any delay in the transmission of water available for runoff

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Water Surplus Estimation within Pervious Aseas in Geographical Block 1 (Pre-development)

Based on Table 3.1 in MOE SWMPDM (2003) with a Water Holding Capacity of 50 mm
Historical Climate Data from ALLISTON NELSON Station (1981 - 2010)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Potential Evapotranspiration (PET) Calculation													
Daily Average Temperature (˚C)	-6.5	-5.2	-0.7	6.7	13.1	18.4	21	20	15.9	9.2	3.1	-2.9	7.7
Monthly Heat Index	0.00	0.00	0.00	1.56	4.30	7.19	8.78	8.16	5.76	2.52	0.48	0.00	38.75
Unadjusted PET, UPET(mm)	0.00	0.00	0.00	29.39	61.87	90.22	104.48	98.97	76.71	41.79	12.49	0.00	515.91
Adjusting factor for UPET (Latitude 44˚ N)	0.81	0.81	1.02	1.13	1.27	1.28	1.30	1.20	1.04	0.94	0.80	0.76	
Adjusted PET (mm)	0	0	0	33	79	116	136	119	80	39	10	0	612
Actual Evapotranspiration (AET) Caculation													
Precipitation, P (mm)	54	50	54	64	78	81	78	82	80	71	82	61	834
P-PET (mm)	54	50	54	31	0	-35	-58	-37	0	32	72	61	
Accumulated Potential Water Loss, APWL (mm)	0	0	0	0	0	-35	-93	-130	0	0	0	0	
Water Holding Capacity (mm)	50	50	50	50	50	50	50	50	50	50	50	50	
Soil Moisture Storage, S (mm) *	223	272	50	50	50	25	8	4	4	36	107	169	
Change in Soil Moisture Storage (including snow accumulation), ΔS (mm)	54	50	0	0	0	-25	-17	-4	0	32	72	61	
AET (mm)	0	0	0	33	79	106	95	86	80	39	10	0	528
Moisture Deficit, D (mm)	0	0	0	0	0	10	41	33	0	0	0	0	
Water Surplus													
Rainfall Surplus (mm)	0	0	54	31	0	0	0	0	0	0	0	0	84
Snowmelt Surplus (mm)	0	0	222	0	0	0	0	0	0	0	0	0	223
Total Available Water Surplus (mm)**	0	0	276	31	0	0	0	0	0	0	0	0	307
Infiltration													
Cumulative MOECC Infiltration Factor = 0.6													
Potential Infiltration (mm)	0	0	166	18	0	0	0	0	0	0	0	0	184
Runoff													
Potential Surface Water Runoff (mm)	0	0	110	12	0	0	0	0	0	0	0	0	123

* Includes above ground potential snow accumulation for months when mean temperature is below -1 ˚C

** Total water surplus does not incorporate any delay in the transmission of water available for runoff

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Post-Development Water Budget by Diverting Roof Water to Soakaway Pit in Geographical Block C

Proposed Development	Impervious Factor	Percentage of Total Area	Area (m2)	Impervious Area (m2)	Water Surplus (mm/year)	Impervious Area Directed to Pervious Area (m2)	Cumulative Infiltration Factor	Increased Infiltration (m3/year)	Decreased Runoff (m3/year)
Singler Units	0.6	35.4%	15,328	9,197	751	6,438	0.70	3,384	3,384
Total Area: 43,300 m2							**Total :**	3,384	3,384

LIMITATIONS TO THE REPORT

This report is intended solely for the Client named. The report is prepared based on the work has been undertaken in accordance with normally accepted geotechnical engineering practices in Ontario.

The comments and recommendations given in this report are based on information determined at the limited number of the test hole and test pit locations. Subsurface and groundwater conditions between and beyond the test holes and test pit may differ significantly from those encountered at the test hole and test pit locations. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole and test pit locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The report reflects our best judgment based on the information available to GeoPro Consulting Limited at the time of preparation. Unless otherwise agreed in writing by GeoPro Consulting Limited, it shall not be used to express or imply warranty as to any other purposes. No portion of this report shall be used as a separate entity, it is written to be read in its entirety. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated.

The design recommendations given in this report are applicable only to the project designed and constructed completely in accordance with the details stated in this report.

Should any comments and recommendations provided in this report be made on any construction related issues, they are intended only for the guidance of the designers. The number of test holes and test pits may not be sufficient to determine all the factors that may affect construction activities, methods and costs. Such as, the thickness of surficial topsoil or fill layers may vary significantly and unpredictably; the amount of the cobbles and boulders may vary significantly than what described in the report; unexpected water bearing zones/layers with various thickness and extent may be encountered in the fill and native soils. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and make their own conclusions as to how the subsurface conditions may affect their work and determine the proper construction methods.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. GeoPro Consulting Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.