Englobe
Soils Materials Environment

Dunnink Homes Ltd.

Scoped Hydrogeology Study
Hyland Road
Guelph, Ontario

Hydrogeology Study

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Property and Confidentiality

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INTRODUCTION

Englobe Corp. (Englobe) was retained to carry out a scoped hydrogeology study for the proposed residential subdivision development at the properties located at 46, 47 and 87 Hyland Road in Guelph, Ontario as shown on the Location Plan, Drawing 1 in Appendix 1. This work was authorized by Mr. John Dunnink, of Dunnink Homes following submission of a fee proposal.

The scope of work for this scoped hydrogeology study included a review of available topographic, geological and hydrogeological information for the Study Area and adjacent lands, and a subsurface investigation within the Study Area. The subsurface investigation was performed to identify the subsoil stratigraphy and hydrogeological properties, groundwater conditions and hydraulic gradients, and the relationship between groundwater and surface water features.

The objectives of this report are:

- To assess the geological and hydrogeological conditions beneath the Study Area;
- To describe the soil physical properties;
- To investigate water users, sensitive areas, and potential contaminant sources within the Study Area; and,
- To identify potential impacts and provide suggested mitigation measures.

1 STUDY PROCEDURE

The study methodology involved:

- Review of previous studies for information concerning hydrogeological and geological conditions in the study area;
- Compilation of water users by searching the Ontario Ministry of the Environment and Climate Change (MOECC) Water Well Record database for wells within a 600 m radius of the property;
- Advancement of three (3) boreholes in specified locations, each completed as a 50 mm diameter monitoring well;
- Surveying of locations and elevations of the on-site monitoring wells;
- Measurement of groundwater levels, and the elevation of groundwater beneath the subject property;
- Particle size distribution analysis of three (3) soil samples, and in-situ single-response hydraulic (slug) testing of three (3) on-site monitoring wells;
- Collection and analysis of three (3) groundwater samples, with comparison to the Provincial Water Quality Objective (PWQO) criteria;
- Assessment of the connectivity between groundwater and surface water features, if present;
- Investigation of other water users, sensitive areas, and potential contaminant sources within the vicinity of the Study Area;
- Evaluation of potential impacts and mitigation measures.

1.1 REVIEW OF PREVIOUS STUDY

Reports consulted as part of this study include:

- Functional Servicing and Stormwater Management Report, Hyland Road and Glenburnie Drive Extensions, City of Guelph, Ontario (Van Harten Surveying Inc. Report No. 21203-13 December 21, 2015).
- 46, 47 and 87 Hyland Road, Guelph Environmental Impact Study (Natural Resource Solutions Inc. Project No. 1400, December, 2015).
- 46, 47 & 87 Hyland Road – Proposed residential subdivision Terms of Reference for an Environmental Impact Study (City of Guelph Environmental Advisory Committee, February 12, 2014).
- Environmental Impact Study - Hyland Road, Guelph, Ontario Terms of Reference (Natural Resource Solutions Inc. Project No. 1400, January 3, 2014).
- Proposed Development 66, 78 and 82 Eastview Road, Guelph, Ontario (LVM Report No. 160-P-0000865-0-01-300-HD-R-0001-0A, July 23, 2012).

- 2006 Annual Report – Eastview Road Landfill Site – City of Guelph (Gartner Lee Limited GLL-70-131, April, 2007).
- Ground Water Resources Study, City of Guelph, Northeast Quadrant, Volume 1. (Jaggar Hims Limited, 1995).

1.2 FIELD PROGRAM

The present field program involved the advancement of three (3) boreholes (BH-01-16, BH-02-16 and BH-04-16) to depths ranging from 3.81 to 14.17 m to identify the subsurface soil and groundwater conditions at the locations shown on the appended Drawing 2 Site Plan. The boreholes were advanced on September 28, 2016 by Geo-Environmental Drilling Inc. under the full-time observation of a senior technician from Englobe using a CME-75 track-mounted drillrig equipped with continuous flight hollow stem augers.

Soil samples were recovered from the boreholes at regular 0.75 and 1.50 m depth intervals using a 50 mm diameter split-spoon sampler in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). Soil samples obtained from the boreholes were submitted for moisture content analysis and three (3) particle size distribution analyses. The laboratory results for moisture content are included on the borehole logs in Appendix 2. The laboratory results for the particle size distribution analyses are included in Appendix 5.

Based on the surficial geology in the area and the depth at which groundwater was encountered during borehole advancement, it was determined that the installation of mini piezometers would not be conducive to the study.

The borehole locations and ground surface elevations were surveyed by Englobe using a Sokkia Model GRX 2 Global Navigation Satellite System (GNSS) Rover. The borehole locations were referenced to Universal Trans Mercator North American Datum of 1983 (UTM NAD83) coordinates; the zone reference (17T) has been excluded for presentation purposes. The ground surface elevations are geodetic based on GNSS and local base station telemetry with a vertical root mean squared error of less than 20 mm. Table 101 in Appendix 3 outlines the coordinates obtained for borehole, monitoring well and surface water features located on site. Raw data obtained from the Sokkia unit in September 2016 is attached in Appendix 4.

1.3 MONITORING WELL INSTALLATIONS

During the borehole drilling program, monitoring wells were installed in three (3) boreholes BH-01-16, BH-02-16, and BH-04-16 for measurement of groundwater levels and saturated soil hydrogeological parameters. Initially five (5) monitoring wells were proposed assuming a shallow groundwater table. However, due to the depth of groundwater the decision to proceed with three (3) deep monitoring wells rather than five (5) shallow ones was made in order to intersect and screen a section of the saturated soils.

The 50 mm diameter monitoring wells were constructed by inserting slotted, Schedule 40 PVC well screen and riser pipe into the open auger holes. Sand was added in order to place a filter pack around the screen, until the level of the sand was approximately 300 mm above the top of the screen. Bentonite seals were then placed above the sand pack to prevent the infiltration of surface water. The tops of all the well riser pipes were vented to allow accurate measurement of stabilized groundwater levels, and the flush mount wells were concreted in place to house each of the monitoring wells. Details of the monitoring well installations and soil and groundwater conditions encountered are provided on the borehole logs included in Appendix 2.

All of the monitoring wells were constructed in accordance with Ontario Regulation 903 (as amended) as administered by the Ontario Ministry of the Environment and Climate Change (MOECC). Well records were submitted to the MOECC based on the cluster system whereby one well record can be submitted on behalf of an entire property. Provincial Site Cluster Tag Identification Numbers were placed on the boreholes listed in Table 1. A licensed well technician must properly decommission the monitoring wells prior to construction.

Table 1: Borehole with Provincial Site Cluster Tag Identification Number

BOREHOLE	PROVINCIAL SITE CLUSTER TAG IDENTIFICATION NUMBER
BH-04-16	A202673

Dedicated Waterra™ LPDE tubing and a turbine pump were used to develop each well through pumping. The wells were then allowed to equilibrate prior to collecting the groundwater level measurements and groundwater chemistry samples. Measurements of stabilized groundwater levels in the monitoring wells were obtained on October 24 and 31, 2016 and again on February 12, 2018 with measurements summarized in Table 102 in Appendix 3.

1.4 LABORATORY SOIL TESTING

All soil samples obtained during borehole drilling were returned to Englobe laboratory facilities for visual examination, with selected samples undergoing physical testing. The soil moisture content test results obtained from borehole samples are plotted on the borehole logs in Appendix 2, and the particle size distribution analyses are described in Section 1.5.1 below.

1.5 HYDRAULIC CONDUCTIVITY TESTING

Hydraulic conductivity estimates for the site soils were determined using two methods. The first method involves a calculated estimation of hydraulic conductivity based on grain size analysis of soil samples using the Kaubisch and Beyer formulae where applicable. The second method is applicable to saturated soils at depth, and involves single response insitu hydraulic (slug) tests of monitoring wells. The two methods used for this study are described in the following subsections.

1.5.1 Grain Size Analyses

Hydraulic conductivity values of near-surface soil samples were evaluated empirically using the particle size distribution test and the Kaubisch and Beyer formulae where the grain size analyses fell within the formulae criteria and limits. The calculated values correlate well with published hydraulic conductivity ranges (Freeze and Cherry, 1979) for the soil types encountered.

The particle size distribution analysis graphs are shown on Figure 1 in Appendix 5, and the calculated hydraulic conductivity values for the samples from the boreholes are included in the appended Table 103.

1.5.2 Slug Testing

Hydraulic conductivity estimates were determined for the saturated soils at depth using single response slug tests for all monitoring wells. Groundwater conditions were unconfined or phreatic.

Each monitoring well was developed prior to slug testing. Well purging was implemented to remove silt and sand introduced into the well during construction, and to remove fine soils from the coarse sand pack placed around the outside of the well screen.

The slug test procedure employs the hydrostatic time-lag method for groundwater recovery following the introduction of a slug of known volume into a monitoring well, and makes use of the theory of Hvorslev (1951), as described in Freeze and Cherry (1979).

Hvorslev's method is expressed by the following equation:

$$K = \frac{r^2 \ln\left(L/R\right)}{2LT_o}$$

where:

K = hydraulic conductivity of the tested material (m/sec)
r = inner radius of the well riser pipe (m)
R = outer radius of the well riser pipe (m)
L = length of screen and sand pack (m)
T_o = time lag (sec), where $(H-h)/(H-H_o) = 0.37$
h = water level at each time of measurement (m)
H_o = initial water level at start of test (m)
H = stabilized water level prior to introducing slug (m)

The time lag, T_0, is defined as the time required for the water level to recover to 63% of the stabilized level if the initial flow rate into the well is maintained. T_0 is determined graphically as the time for which (H-h) divided by ($H-H_0$) is equal to 0.37.

Slug test data was analyzed using the above formulae with MS-Excel spreadsheets. Graphed results of the slug tests completed for the monitoring wells are included in Appendix 6. A summary of the hydraulic conductivity estimates is provided in the appended Table 103, Appendix 3.

1.6 GROUNDWATER CHEMISTRY TESTING

Three groundwater samples were collected on October 24, 2016 from BH-01-16, BH-02-16 and BH-04-16 using low flow sampling techniques. A Geotech GeoPump2 peristaltic pump was used to sample the monitoring wells. A water quality meter was used to monitor the groundwater quality parameters to ensure water quality parameters had stabilized prior sampling. The groundwater samples were packed in coolers with ice and delivered to ALS Laboratory Services in Waterloo, Ontario. The samples were submitted for analysis of PWQO criteria. Analysis results are summarized in the appended Table 104 with comparison to PWQO criteria. The laboratory Certificates of Analysis are included in Appendix 8 for reference.

2 SUMMARIZED CONDITIONS

2.1 SITE DESCRIPTION

The site is located north and south of Hyland Road on lots 46, 47, and 87 in Guelph, Ontario. The site is 6.82 ha (City of Guelph Environmental Advisory Committee, 2014). Although the entire site is 6.82 ha, only 1.49 ha will be developed for the proposed sixteen (16) single family dwellings (Van Harten Surveying Inc., 2015). The majority of site is currently not developed and consists of thicket, mowed lawn and a portion of the Guelph Northeast Provincially Significant Wetland Complex (City of Guelph Environmental Advisory Committee, 2014). An existing garage located at 46 Hyland Road and an existing single family residence located at 47 Hyland Road will be demolished as part of the development (Van Harten Surveying Inc., 2015).The site is within the Hadati Creek subwatershed. The proposed development includes the construction of nine (9) fully serviced single family dwellings at the extension of Hyland Road, and seven (7) fully serviced single family dwellings at the extension of Glenburnie Drive (Van Harten Surveying Inc., 2015).

The Guelph Northeast Provincially Significant Wetland Complex is located on site, however based on the Functional Servicing and Stormwater Management Report produced by Van Harten Surveying Inc. (Report No. 21203-13, December 21, 2015) and the Natural Resource Solutions Inc. Environmental Impact Study (No. 1400, December 2015) it is excluded that any buildings will be located on the wetland. Post Development Drainage Catchment Areas for Proposed Hyland Road Cul-de-Sac and Proposed Glenburnie Drive Extension (Van Harten Surveying Inc., 2015) have been included as Figures 2 and 3 in Appendix 5. Based on lot parcels from GRCA mapping (2016) and these figures it is not anticipated that any of the single family dwellings will be constructed on top of the wetlands.

The closed Eastview Road Landfill Site is located approximately 865 m northwest of the Site. It has now been naturalized and is formally known as Pollinators Park. This site will be further discussed in Section 4.4 Potential Sources of Contamination.

An unnamed tributary flows adjacent to the Eastview Road Landfill Site is located approximately 756 m northeast of the site. The tributary enters a culvert at the southern end of the landfill property where it emerges and discharges to Hadati Creek. Hadati Creek is located approximately 1.6 km east of the site and discharges into Clythe Creek. Clythe Creek is located approximately 2.8 km southeast of the site.

Guelph Lake located within Guelph Lake Conservation Authority, owned by the Grand River Conservation Authority (GRCA) is located approximately 2.1 km north of the site. The Speed River drains out of Guelph Lake approximately 3.1 km north of the site and meanders south. The closest expression of the Speed River to the site is approximately 2.1 km east of the site between Speedvale Avenue West and Eramosa Road. The Eramosa River is located approximately 3.1 km southeast of the site.

Three City of Guelph municipal well fields (Helmar, Emma and Park #1 / Park #2) are located within the vicinity of the Site. The Helmar well field (WWR No. 6701133) is approximately 1.3 km north from the site. The Park #1 and Park #2 well field (WWR Nos. 6700855 and 6700858) is approximately 1.6 km south from the site, and lastly; the Emma Well (WWR No. 6704194) is approximately 1.7 km south of the site. These wells will be discussed further in Section 4.1 Water Users.

Ground surface elevations across the Study Area are found to be between 348 to 360 mASL. Topographic highs are experienced at the proposed Glenburnie extension where it slopes northeast toward the Guelph Northeast Provincially Significant Wetland Complex at an inferred elevation of roughly 343 mASL.

2.2 PHYSIOGRAPHY AND AREA GEOLOGY

The Surficial Geology Map of the Guelph Area (GRCA, 2016) and the Quaternary (Pleistocene) Geology Map of the Guelph Area (Karrow, 1963) indicates that the sediments within the Study Area are sandy till deposits of the Erie-Ontario ice lobe, interpreted as Wentworth Till. According to a Jaggar Hims Limited report produced for the City of Guelph in 1995 (Ground Water Resources Study, City of Guelph, Northeast Quadrant, 1995), there has been discrepancies in the naming of the till unit located within the Study Area. In Karrow's 1968 mapping, the till unit is identified as the Wentworth Till, however in 1974 Karrow revised the definition of both the Port Stanley Till and Wentworth Till to show regional relationships identified during field studies of the Guelph area. To reflect the changes in till definitions, till units located west of the Paris Moraine are now identified as the Port Stanley Till and not Wentworth Till. The Port Stanley till is encountered across the Study Area and is depicted on the appended Drawing 3 (Jaggar Hims Limited, 1992). The Ariss Esker is intermittently expressed surficially north of the site and is identified on the appended Drawing 3.

The Study Area is situated within the Guelph drumlin field physiographic region of Southern Ontario (Chapman and Putnam, 1984) and more specifically located within the drumlinized till plains and drumlins physiographic landforms as described by Chapman and Putnam (2007) and depicted on the appended Drawing 4.

Bedrock was encountered at roughly 24.4 mBGS (323.6 mASL) within the vicinity of the Study Area according to MOECC WWR No. 6701122. According to the Bedrock Topography of the Guelph Area (Karrow et al. 1979) and MOECC WWRs within a 600 m radius of the site, depth to bedrock in the Study Area is between 19.5 and 39.9 mBGS (64 – 131 fBGS), corresponding to approximate elevations between 326.6 and 306.2 mASL.

2.3 SUBSOIL CONDITIONS

The appended borehole logs from this investigation show varying soil conditions across the Study Area. The appended borehole logs describe the soil types, stratigraphies, results of SPT testing, moisture content profiles, pocket penetrometer test results, details of monitoring well construction, and groundwater measurements and observations.

The subsurface stratigraphy is illustrated in the cross section on the appended Drawing 5, and generally consists of fill overlying sand till and silts till. In few locations, the fill overlies sand, sand and gravel.

2.4 HYDRAULIC CONDUCTIVITY

Hydraulic conductivity estimates determined by the various testing methods are summarized in the appended Table 103. Three particle size distribution graphs are plotted on the appended Figure 1, and the graphical analyses of three slug tests are included in Appendix 6.

The analyzed soil samples varied from silt with some clay and trace sand and gravel to gravelly sandy silt with trace clay.

Table 2: Range of Hydraulic Conductivity Values

SOIL TYPE	HYDRAULIC CONDUCTIVITY (m/sec)		
	RANGE	GEOMETRIC MEAN	NUMBER OF SAMPLES
Silt with some clay and trace sand and gravel	$< 1.0 \times 10^{-9}$ to 3.2×10^{-7}	1.7×10^{-8}	4
Gravelly sandy silt with trace clay	7.8×10^{-7} to 9.8×10^{-7}	8.7×10^{-7}	2

2.5 GROUNDWATER ELEVATIONS AND FLOW DIRECTION

Groundwater is typically found within the granular deposits beneath the Study Area. The granular deposits occurring at varying depths across the Study Area are interpreted to be hydraulically connected and build an unconfined shallow overburden aquifer.

Across the Study Area, groundwater in the shallow overburden aquifer flows towards the Guelph Northeast Provincially Significant Wetland Complex in a northeasterly direction. The observed depth to water table in the boreholes varies across the site from approximately 2.4 to 4.4 mbgs. Shallow groundwater contours are shown on the appended Drawing 6. The depicted groundwater levels were measured on October 31, 2016.

2.6 GROUNDWATER CHEMISTRY ANALYSIS RESULTS

Groundwater samples were obtained from the three monitoring wells on October 24, 2016, placed in the appropriate containers in a cooler, and submitted to ALS Laboratories in Waterloo, Ontario for analysis of PWQO criteria. Analysis results are summarized in the appended Table 104 with comparison to PWQO criteria. The Laboratory Certificate of Analysis is included in Appendix 8 for reference.

2.6.1 PWQO Criteria

As presented in the appended Table 104, Monitoring Wells BH-01-16, BH-02-16 and BH-04-16 all had measured exceedances of total aluminum. Monitoring Well BH-02-16 exhibited additional exceedances for total copper, total iron, total lead, and total zinc. Monitoring Well BH-04-16 exhibited an additional exceedance for total arsenic. It is important to consider that, while the monitoring wells were developed and purged prior to sampling, the samples contained significant amounts of sediment as they were not filtered in the field. The parameters in exceedance concentrations are very likely related to particulate in the water samples as a result of the sampling methodology. Lastly, total phosphorus detection limits are higher than the PWQO limit therefore the potential exists that all three monitoring wells may be in exceedance of total phosphorus.

2.7 CLIMATE

Guelph's climate is characterized by variable annual temperatures and less variable total monthly precipitation. The average annual temperature was approximately 7.0°C and the inferred average total precipitation is 916.5 mm/yr[1]. Precipitation is typically lower in the fall and winter months, and late spring months experience higher amounts of runoff due to the effect of winter snow melt. Table 1 below lists monthly average precipitation and temperature data; from the Kitchener/Waterloo station located at the Region of Waterloo International Airport in Breslau (Latitude: 43°46'00" N Longitude: 80°38'00" W; Elevation: 321.60 m). This location was used as there are no Canadian Climate Normals from 1981-2010 available for stations within Guelph.

Table 3: Monthly Climate Summary data[1]

MONTH	PRECIPITATION mm/month	TEMPERATURE deg. Celsius
Jan	65.2	-6.5
Feb	54.9	-5.5
Mar	61.0	-1.0
Apr	74.5	6.2
May	82.3	12.5
Jun	82.4	17.6
Jul	98.6	20.0
Aug	83.9	18.9
Sep	87.8	14.5
Oct	67.4	8.2
Nov	87.1	2.5
Dec	71.2	-3.3
Total	916.5	--
Average	--	7.0

3 PRE-DEVELOPMENT WATER BALANCE

The water balance accounts for all water in- and out-flows in the hydrologic cycle. Precipitation (P) falls as rain and snow. Precipitation can run off towards wetlands, ponds, lakes, and streams (R), infiltrate to the groundwater table (I), or evaporate from surface water and vegetation (ET). When long-term average values of P, R, I, and ET are used then minimal or no net change to groundwater storage (ΔS) is assumed.

[1] Canadian Climate Centre, 1981-2010, for Region of Waterloo International Airport

The annual water balance can be stated as:

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

where:

P = Precipitation (mm/year)

ET = Evapo-transpiration (mm/year)

R = Runoff (mm/year)

I = Infiltration (mm/year)

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

3.1.1 Precipitation and Evapotranspiration

The average annual precipitation for the study area is assumed to be 917 mm/yr. An evapotranspiration rate of 442 mm/yr was inferred for this site. Based on these numbers, a water surplus of 475 mm/year (precipitation minus evapotranspiration) was determined. These numbers become the infiltration and runoff components.

3.1.2 Infiltration and Runoff

The pre-development recharge/infiltration rates from the GRCA dataset (shown on the appended Drawing 6) indicate mapped rates of 61, 92 and 245 mm/year across the Study Area. The average infiltration rate for the Study Area is interpreted to be approximately 133 mm/year.

It is important to consider that the localized infiltration rates commonly vary. The ability of soils to infiltrate under post-development conditions will change accordingly. It is important to note that infiltration rates may vary based on certain variables such as the saturated hydraulic conductivity of surface soils, land slope, rainfall intensity, relative soil moisture at the start of a rainfall event, and vegetative cover of the ground surface.

According to the appended Drawing 7, Average Annual Runoff, the mapped runoff for the Study Area is 46, 375, and 549 mm/year. This high value is inferred from the low hydraulic conductivity of the surficial soils across the Study Area.

The average annual pre-development water balance for the Study Area is presented in Table 4 below.

Table 4: Annual Pre-Development for the Study Area (SA)

HYDROLOGICAL COMPONENT	STUDY AREA mm/year	%
Total Precipitation	917	100.0
Evapotranspiration	442	48.2
Infiltration	133	14.5
Runoff	342	37.3

Based on these mapped values across the site, it is noted that the overall runoff component of the Study Area is relatively high, and the infiltration rate is relatively low. These runoff and infiltration values are a result of the poorly draining soils contributing to low infiltration rates.

3.2 INFILTRATION OF PRECIPITATION

Hydraulic conductivity values of sub-surface soils within the study area were calculated using a variety of methods. Based on the borehole lithological stratigraphy, near-surface soils are typically silt with some clay and trace sand and gravel to gravelly sandy silt resulting in a relatively low permeability. It is important to consider that the site infiltration rate calculated previously represents an average of the soil types encountered across the study area.

At-source infiltration of precipitation from rooftops and other impervious surfaces, or infiltration under roadways, will be dependent on the native soil types exposed by grading and/or the physical characteristics of fill placed; along with the thickness of unsaturated soils above the shallow groundwater table.

As the pre-development (current) infiltration rate across the site is low, and the wetland areas are supported in part by groundwater, measures to maintain infiltration volumes will be important to maintain the function of the wetlands. Depression-focused infiltration within the wetland areas will be maintained by maintaining groundwater flow to the wetlands.

It is noted that the rates presented in Table 4 above take into account the area included within the Study Area only, and do not account for additional infiltration resulting from runoff from the Study Area infiltrating within adjacent wetlands located outside the Study Area.

Under post-development conditions, maintenance of infiltration rates within the Study Area and runoff contributions from the Study Area to adjacent areas will be necessary to ensure the overall water balance within and outside of the Study Area is maintained. During a site reconnaissance completed in September 2016 it was noted that areas identified as a wetlands on GRCA mapping on the site were dry, and a woodlot was observed. Based on this information, it is noted that the delineated wetland area on site is not saturated year round.

By developing the Study Area in such a way that infiltration rates and spatial distribution of infiltration are maintained, and that seasonal runoff volumes to wetlands are maintained, changes in meteorological conditions will likely not adversely impact recharge/runoff rates across the study any differently than if the land remained undeveloped.

It is noted that the estimated water balance reflects past meteorological conditions and cannot take into consideration possible changes to these conditions in the future. However, by developing the Study Area in such a way that infiltration rates and spatial distribution of infiltration are maintained, and that seasonal runoff volumes to the wetlands are maintained, changes in the meteorological conditions will likely not adversely impact recharge/runoff rates across the study area any differently than if the land remained undeveloped.

3.3 POST-DEVELOPMENT WATER BALANCE CONSIDERATIONS

It is important to consider that cutting and filling during grading operations may result in different soil types being exposed at the ground surface, which would be expected to result in changes to soil infiltration rates.

Design of grading must consider shallow groundwater elevations as well as subsurface soil types to avoid the potential of localized groundwater mounding from at-source infiltration impacting footings and foundations.

The lowest underside of footing elevation on Hyland Road is 347.30 mASL and 351.81 mASL on Glenburnie Drive was provided by the client. The highest groundwater elevation measured on the Hyland Road segment of the site was 346.59 mASL in BH-01-16 on February 12, 2018, which is also the highest groundwater elevation measured across the proposed development. The measured groundwater elevation BH-04-16 on February 12, 2018 on the Glenburnie Drive was 345.89 mASL. Table 4 below compares the lowest underside of footing elevation on the lot that the corresponding monitoring well is currently installed on. The proposed single family homes on Lots 8-16 will be constructed with no basement. Further, the site will be filled, resulting in an even greater separation between lowest underside of footing and the shallow overburden aquifer. Based on this information, it is not likely that the shallow groundwater aquifer system on site will be impacted due site grading activities and development.

Table 5: Calculated Separation Between Underside of Footing and Measured Groundwater Elevations

MONITORING WELL	LOT WHERE MONITORING WELL IS INSTALLED	TOP OF FOUNDATION ELEVATION PROVIDED (MASL)	DEPTH TO UNDERSIDE OF FOOTING	UNDERSIDE OF FOOTING ELEVATION (MASL)	MEASURED GROUNDWATER ELEVATION (FEB. 18, 2018)	CALCULATED SEPARATION (M)
BH-01-16	Lot 12	349.50	4’6” (1.35 m)	348.15	346.59	1.56
BH-02-16	Lot 16	348.65	4’6” (1.35 m)	347.30	345.00	2.30
BH-04-16	Lot 3	354.42	8’6” (2.59 m)	351.83	345.89	5.94

As the Guelph Northeast Provincially Significant Wetland complex is inferred to be a recharge and discharge area, levels of salt and other contaminants in the water being infiltrated must be considered; and appropriate mitigation measures are recommended.

Post-development site infiltration should be designed to attempt to match pre-development rates within the Study Area through methods such as at-source infiltration from rooftops connected to soakaway pits, where feasible. Under post-development conditions, runoff contributions from the Study Area to the closest wetland should also match pre-development rates.

Based on post development drainage design for storm water management outlined in the Functional Servicing and Stormwater Management Report completed by Van Harten Surveying Inc., the post development drainage design will have storm water from the Hyland Road segment flowing to the wetland via a 450 mm culvert. It must be noted that this is alike to the current storm water management system and therefore it is likely that post development contributions to the wetland will differ marginally from pre development contributions. To address storm water at the Glenburnie Drive segment, it is proposed that the existing 300 mm diameter storm sewer on Glenburnie Drive will be extended into the newly developed cul-de-sac. The existing storm sewer discharges to the storm water management pond located on Fletcher Court which overflows into the wetland. Therefore it appears to be unlikely that contributions to the wetland will be affected (Van Harten Surveying Inc., 2015).

4 POTENTIAL IMPACTS OF LAND DEVELOPMENT

Ministry of Natural Resources (MNR) Water Resources Information Mapping (2004) indicates that the site is located within a low-use watershed under average annual flow conditions, and a medium-use watershed under summer low-flow conditions. These designations do not pose restrictions on water usage for the site.

4.1 WATER USERS

Well Records from the Ministry of the Environment and Climate Change (MOECC) Water Well Record (WWR) Database were reviewed to determine the number of private supply wells present within a 0.6 km radius of the Study Area. A total of thirty-six (36) wells were report by the MOECC; however, one (1) of these wells has no completion details and twenty-three (23) of these wells are identified as either monitoring wells, test holes, not in use, abandoned, or as wells with diameters of less than 50 mm (indicating they are small diameter monitoring wells rather than supply wells). These twenty-four (24) wells have been excluded from further consideration.

The remaining twelve (12) wells are plotted on the appended Drawing 9. According to the MOECC WWR database, all wells are completed in bedrock to depths between 29.0 mBGS (WWR No. 6701131) and 61.0 mBGS (WWR No. 6714999). A summary of the water well records is included in Appendix 7.

It is noted that the wells on Drawing 9 are plotted in urban residential and commercial/industrial areas. The urban areas are fully serviced, and the actual existence of a residential supply well is unlikely; however, the MOECC WWR coordinate data has been used in the absence of more reliable information. Further, it must be noted that the MOECC WWR number 6701122 has been placed on the map based on the sketch and field notes provided on the WWR. The coordinates provided on the water well record print out in Appendix 7 were disregarded as the record places the well erroneously within the Study Area.

Six (6) additional wells have been added to Drawing 9 in order to reflect the location of the municipal supply and observation wells in the vicinity of the site. Three municipal well fields are located within a 1.7 km radius of the site. These wells will be discussed in Sections 4.1.1 to 4.1.3 below. One (1) monitoring well was added to Drawing 9 as it was included on Cross Section A-A' (Drawing 5) to further illustrate sub surface soil conditions within the vicinity of the study area.

Maintaining the distribution of pre-development infiltration rates across the Study Area will help to preserve recharge to the shallow overburden aquifer; therefore, no impacts to shallow overburden water supply wells would be expected. Wells screened in deeper overburden and bedrock aquifers are principally supplied by precipitation that infiltrates over a much broader area, and are unlikely reliant upon infiltration within the Study Area.

As discussed in Section 3.3, the subdivision will be designed with the intention that the post-development water balance matches pre-development conditions.

4.1.1 Helmar Municipal Well

The Helmar Municipal Well Field is located at 637 Woodlawn Road East in the City of Guelph (Jaggar Hims Limited, 1995). It is approximately 1.3 km north of the Study Area. Based on available MOECC water well records there is one supply well (MOECC WWR No. 6701132) and one observation well (MOECC WWR No. 6701133). The municipal supply well is completed in bedrock to a depth of 79.2 mBGS (260 fBGS). Observation well No. 6701133 is completed into bedrock to a depth of 59.4 mBGS (195 fBGS). Based on the MOECC water well records, it appears the supply well (No. 6701132) was decommissioned on March 30, 1999 and the existing observation well (No. 6701133) was used as the municipal supply well henceforth. As these wells were completed in bedrock, open holes exist at the end of the casing in No. 6701133 is 12.2 mBGS (40 fBGS). According to a Jaggar Hims Limited report (1995), the Helmar municipal well was used infrequently. Further, it is reported that this area is prone to flooding during intense precipitation events and spring melt. Based on the

potentiometric surface in the bedrock, it is assumed that groundwater in the vicinity of the Helmar well flows northwest (Jaggar Hims Limited, 1995). Due to the depth and distance of this well from the Study Area, it is not expected that development of the Study Area will impact this municipal water supply.

4.1.2 Park # 1 and Park # 2 Municipal Wells

The Park Municipal Well Field is located at 183 Metcalfe Street in the City of Guelph (Jaggar Hims Limited, 1995). It is approximately 1.6 km south of the Study Area. Based on available MOECC water well records there are two production wells (MOECC WWR No. 6700855 and 6700858). Park # 1 Well (No. 6700855) is completed into dolostone bedrock at a depth of 57.0 mBGS (187 fBGS). Park # 2 Well (No. 6700858) is completed into dolostone to a depth of 47.5 mBGS (156 fBGS). As these wells were completed in bedrock, an open hole exists; the end of the casing in Park #2 (No. 6700858) is 7.9 mBGS (26 fBGS) according to the water well record. The water well record for the Park #1 Well (6700855) does not indicate where the open hole exists, however; it is assumed that it occurs below 8.5 mBGS (28 fBGS) where bedrock was encountered. Due to the depth and distance of this well from the Study Area, it is not expected that development of the Study Area will impact this municipal water supply.

4.1.3 Emma Municipal Well

The Emma Municipal Well is located at 93 Emma Street in the City of Guelph (Jaggar Hims Limited, 1995). It is approximately 1.7 km southeast of the Study Area. The Emma well is located approximately 400 m northeast of the Speed River (Jaggar Hims Limited, 1995). The MOECC water well record for this well is No. 6704194. This municipal supply well is completed into dolostone to a depth of 46.3 mBGS (152 fBGS). Open hole conditions exist at the contact between overburden and bedrock at a depth of 11.3 mBGS (37 fBGS). According to information from Jaggar Hims Limited (1995) report, groundwater flow within the area of the Emma well is assumed to be in a southwest direction toward the Speed River. Due to the depth, distance of this well from the Study Area and the assumed groundwater flow direction in the area of this well, it is not expected that development of the Study Area will impact this municipal water supply.

4.2 SENSITIVE AREAS

4.2.1 Well Head Protection Areas (WHPAs)

The Grand River Source Protection Area (GRSPA) Approved Assessment Report (2012) defines Wellhead Protection Areas (WHPAs) for the studied wellfields. WHPAs correspond to the travel time of groundwater flowing through an aquifer to a municipal well. The GRSPA identifies WHPA classes as follows:

- WHPA-A: 100 m radius from a municipal supply well;
- WHPA-B: between 100 m and the 2 year travel time;

- WHPA-C: Between the 2 year and 5 year travel time;
- WHPA-D: Between the 5 year and 25 year travel time;

As shown on the appended Drawing 10, the Study Area lies within WHPA-B of the Helmar, Emma, Park #1 and Park # 2 Wells. As mentioned in Sections 4.1.1 to 4.1.3 it is not anticipated that development of the Study Area will impact these wells.

4.2.2 WHPA Vulnerability

Wellhead Protection Area adjusted vulnerability scoring mapping combines the WHPA and the intrinsic vulnerability to provide vulnerability scoring inside the WHPA. The adjusted vulnerability score for a WHPA accounts for both the rate of vertical and horizontal movement of water to the well and range from 2 to 10, with 10 being the highest score. Generally, vulnerability scores increase in proximity to a supply well. The appended Drawing 11 shows the Study Area has a vulnerability score of 6.

4.2.3 Aquifer Intrinsic Vulnerability

Mapping of the intrinsic vulnerability within WHPAs is based on the Intrinsic Susceptibility Index (ISI). The ISI is intended to reflect the intrinsic degree of protection of an aquifer based on the thickness and properties of the materials overlying the aquifer, which is analogous to the vertical travel time of a contaminant to the given aquifer.

The appended Drawing 12 depicts the intrinsic vulnerability mapping (GRCA, 2015) of the bedrock aquifer, indicating that the Study Area is in an area of medium intrinsic vulnerability.

4.2.4 Groundwater Recharge Vulnerability

Significant Groundwater Recharge Areas (SGRAs) correspond to areas where recharge is greater than or equal to 115% of the average recharge rate within a watershed. According to GRCA mapping the Study Area is not located within an SGRA.

4.2.5 Wetlands

Wetlands are sensitive to changes in seasonal runoff volumes, and changes in shallow groundwater elevations. Runoff, coupled with groundwater inflows from the Shallow Overburden Aquifer, increases the footprint area of the wetlands.

Based on the general shallow groundwater flow direction and elevation, and the groundwater contours converging towards the Guelph Northeast Provincially Significant Wetland Complex, it is concluded that this Wetland Complex is partially dependent on groundwater flowing (and discharging) from the Study Area. The groundwater contours on the appended Drawing 6 suggests that a portion of groundwater discharges into the Guelph Northeast Provincially Significant Wetland Complex.

Pre-development surface water drainage along the northern section of the Study Area (off Hyland Road) is to the southeast with an existing 450 mm diameter outlet crossing Hyland Road and emptying into the Guelph Northeast Provincially Significant Wetland Complex. The pre- development surface water drainage along the southern portion of the Study Area (proposed Glenburnie extension) drains to the east into the on-site wetlands. Post-development runoff from the northern portion of the Study Area is expected to remain the same, however; post-development runoff from the southern portion of the Study area will be divided into two drainage areas. One section will drain to the extended 300 mm storm sewer located on Glenburnie Drive; the other section will drain toward the wetlands (Van Harten Surveying Inc., 2015).

As a result, any detrimental changes to the pre-development water balance, causing a reduction of the infiltration rates or lowering of groundwater levels in the shallow overburden aquifer, would adversely impact the wetland ecosystem by shrinking the size of this habitat. As discussed in Section 3.3 Post Development Water Balance Considerations, based on storm water management designs proposed for the site and measured groundwater elevations across the Study Area, it is unlikely that the pre-development water balance will be noticeably affected.

4.2.6 Streams

As shown on the appended Drawing 1, there are no streams within the vicinity of the Study Area. An unnamed tributary assumed to be associated with the Eastview Road Landfill Site is approximately 756 m northeast of the Study Area. It is not anticipated that surface water from the Study Area drains to this tributary. It is not likely that development of the Study Area will impact this tributary.

Hadati Creek, Clythe Creek, Speed River and the Eramosa River are not expected to be impacted by the development of the Study Area due to the distance to the referred streams and groundwater flow direction of water beneath the Study Area.

4.3 CONNECTIVITY BETWEEN GROUNDWATER AND SURFACE WATER

It is unlikely that development of the Study area will impact Hadati Creek, Clythe Creek, the Speed River or the Eramosa River. The Guelph Northeast Provincially Significant Wetland located on site could potentially be impacted due to development should the post development water balance not be maintained, such as a decrease in infiltration rates or a lowering of groundwater levels within the shallow overburden aquifer.

4.4 POTENTIAL SOURCES OF CONTAMINATION

All three groundwater samples from the shallow aquifer exhibited exceedances against the PWQO criteria for Total Aluminum. An additional exceedance of Total Arsenic was exhibited in BH-04-16 against PWQO criteria. Lastly, BH-02-16 exhibited exceedances against Total Copper, Total Iron and Total Lead against PWQO criteria.

Approximately 785 m northwest of the site is the closed City of Guelph's Eastview Road Sanitary Landfill Site. This landfill which is approximately 81 ha (45 of which has been landfilled) was in operation from 1963 until October 2003 after which it was closed (Jaggar Hims Limited, 1995; Gartner Lee Limited, 2007).

The Eastview Road Sanitary Landfill Site is underlain by a clay liner preventing infiltration of landfill leachate into the shallow groundwater aquifer system. The landfill was equipped with a leachate collection system and associated pumping stations which collect and transfer the landfill leachate to the city sanitary sewers for treatment at local waste water treatment plants (Jaggar Hims Limited, 1995).

The Study Area is outside the Issue Contributing Area for TCE according to the Grand River Source Protection Plan Volume II – Approved (GRSPR, 2015).

By ensuring the water balance is maintained and that the water chemistry of infiltrated water is not significantly degraded, the potential impacts to the overburden aquifer and on-site Guelph Northeast Provincially Significant Wetland Complex will be mitigated.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The hydrogeological studies conducted by Englobe have provided information about the subsurface stratigraphy across the proposed residential development, which comprises two segments, Hyland Road and Glenburnie Drive. The subsurface stratigraphy across the site is mainly sand and gravel or sand till overlying silt or silt till. MOECC WWR in the vicinity of the Study Area indicates that bedrock exists roughly 24.4 mBGS or around 323.6 mASL. The nature of the soils across the site allow up to about 100 mm/year infiltration of water.

Groundwater was encountered in the near surface granular soils between 1.1 to 2.9 mBGS on February 12, 2018. Separation between measured groundwater elevations and underside of footings for the proposed lots on Hyland Road are 1.56 m (Lot 12) and 2.30 m (Lot 16). The calculated separation between measured groundwater elevations and the underside of footings for the proposed lots on Glenburnie Drive are 5.94 m (Lot 3). The proposed single family homes on Lots 8-16 will be constructed with no basement. Further, the site will be filled, resulting in an even greater separation between lowest underside of footing and the shallow

overburden aquifer. Based on this information, it is not likely that the shallow groundwater aquifer system on site will be impacted due site grading activities and development.

Surface water features within the vicinity of the site include an unnamed tributary running adjacent to the now closed Eastview Road Sanitary Landfill as well as the Guelph Northeast Provincially Significant Wetland Complex. The proposed residential development was found to be within the WHPA B delineation for the City of Guelph's Helmar, Park #1 and Park #2, and Emma Wells. The municipal wells are located about 1.3 km north, 1.6 km and 1.7 km south of the site respectively. The Study Area has scored a 6 on the WHPA vulnerability, and has a medium level of intrinsic vulnerability.

At the Glenburnie Drive segment it is planned to extend the existing storm sewer on Glenburnie Drive into the proposed cul-de-sac. The existing storm sewer discharges to a storm water management pond which overflows into the wetland. As a result, it appears to be unlikely that flow contributions to the wetland will be compromised.

In the past (and currently) runoff from Hyland Road was (is) discharged to the wetland without treatment. During and after construction of the proposed residential development no polluting substances will be used; hence no contaminants into groundwater are expected. Onsite monitoring of groundwater quality and treatment of post-development runoff is considered of no imminent concern at the Hyland Road segment.

Runoff water chemistry can generally be addressed by SWM facilities through treatment of runoff from the proposed residential development prior to discharge to the Guelph Northeast Provincially Significant Wetland Complex. This is expected occur at the projected Glenburnie Drive segment.

5.2 RECOMMENDATIONS

The post development water balance should endeavour to match the pre development water balance, by maintaining spatial distribution of infiltration across the Study Area. In order to maintain the form and function of wetlands, the proposed residential development will need to conserve pre-development groundwater levels, and maintain runoff volumes with adequate water quality.

Englobe suggests matching, the pre-development infiltration rates within the granular soils through the use of LID measures. Infiltration of rainwater from rooftops should be considered for maintaining groundwater flow and levels balanced. A combination of spatially distributed at-source and other infiltration methods may be applied where subsurface soils are adequately permeable and there is sufficient separation between groundwater surface and footing elevations. During the design phase of the proposed residential development, grading and footing information should be compared to groundwater monitoring data to achieve adequate separation between the seasonally high groundwater table elevation and house footings.

By ensuring that the water balance is maintained and that the infiltrating water is kept unpolluted, potential negative impacts to the shallow overburden aquifer and on-site Guelph Northeast Provincially Significant Wetland Complex will be prevented.

6 STATEMENT OF LIMITATIONS

The hydrogeology recommendations provided in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known at the time of report preparation, we recommend that we be retained during the final design stage to verify that the hydrogeology recommendations have been correctly interpreted in the design. Also, if any further clarification and/or elaboration are needed concerning the hydrogeology aspects of the project, Englobe should be contacted.

The hydrogeology recommendations provided in this report are intended for the use of the owner and its retained designer. They are not intended as specifications or instructions to contractors. Any use which a contractor makes of this report, or decisions made based on it, are the responsibility of the contractor. The contractor must also accept the responsibility for means and methods of construction, seek additional information if required, and draw their own conclusions as to how the subsurface conditions may affect their work. Englobe accepts no responsibility and denies any liability whatsoever for any damages arising from improper or unauthorized use of the report or parts thereof.

It is important to note that the hydrogeology investigation involves a limited sampling of the site gathered at specific test hole locations and the conclusions in this report are based on this information gathered. The subsurface geotechnical, hydrogeology, environmental and geologic conditions between and beyond the test holes will differ from those encountered at the test holes. Also such conditions are not uniform and can vary over time. Should subsurface conditions be encountered which differ materially from those indicated at the test holes, we request that we be notified in order to assess the additional information and determine whether or not changes should be made as a result of the conditions.

The professional services provided for this project include only the hydrogeology aspects of the subsurface conditions at the site, unless otherwise stated specifically in the report. The recommendations and opinions given in this report are based on our professional judgement and are for the guidance of the Client and Consultant in the design of the specific project. No other warranties or guarantees, expressed or implied, are made.

REFERENCES

City of Guelph Environmental Advisory Committee. February 12, 2014. 46, 47 and 87 Hyland Road – Proposed residential subdivision Terms of Reference for an Environmental Impact Study.

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.

Chapman, L.J. and Putnam, D.F. 2007. The Physiography of Southern Ontario; Ontario Geological Survey, Miscellaneous Release – Data 228.

Freeze, R.A. and J.A. Cherry. 1979. *Groundwater*. Englewood Cliffs, New Jersey: Prentice-Hall. 614pp.

Gartner Lee Limited. April 2007. 2006 Annual Report – Closed Eastview Road Landfill Site. Report Reference No. GLL 70-131

Grand River Conservation Authority. 2016. Average Annual Recharge. Produced using information under Licence with the Grand River Conservation Authority, 2016.

Grand River Conservation Authority. 2016. Average Annual Runoff. Produced using information under Licence with the Grand River Conservation Authority, 2016.

Grand River Conservation Authority. 2016. Intrinsic Vulnerabiltiy. Produced using information under Licence with the Grand River Conservation Authority, 2016.

Grand River Conservation Authority. 2016. Physiography. Produced using information under Licence with the Grand River Conservation Authority, 2016.

Grand River Conservation Authority. 2016. Surficial Geology. Produced using information under Licence with the Grand River Conservation Authority, 2016.

Grand River Conservation Authority. 2016. Wellhead Protection Area. Produced using information under Licence with the Grand River Conservation Authority, 2016.

Grand River Conservation Authority. 2016. Wellhead Protection Area Vulnerability. Produced using information under Licence with the Grand River Conservation Authority, 2016.

Karrow, P.F. 1963. *Pleistocene Geology of the Guelph Area, Southern Ontario*; Ontario Geological Survey, Map 2153, 1:63,360.

Karrow, P.F., Miller, R.F. and Farrell, L. 1979. Bedrock Topography of the Guelph Area, Southern Ontario. Ontario Geological Survey, Preliminary Map P 2224, scale 1:50 000.

Kaubisch, M. 1986. The Indirect Determination of Hydrogeological Parameters Illustrated by Dump Materials of Lignite Mines. Ph.D. Thesis, Technical University of Freiberg, Germany.

Lake Erie Region Source Protection Committee. 2015. *Grand River Source Protection Area, Approved Assessment Report.*

Lake Erie Region Source Protection Committee. 2012. *Grand River Source Protection Area, City of Guelph Approved Source Protection Plan.*

MOE. March 2003. Stormwater Management Planning and Design Manual.

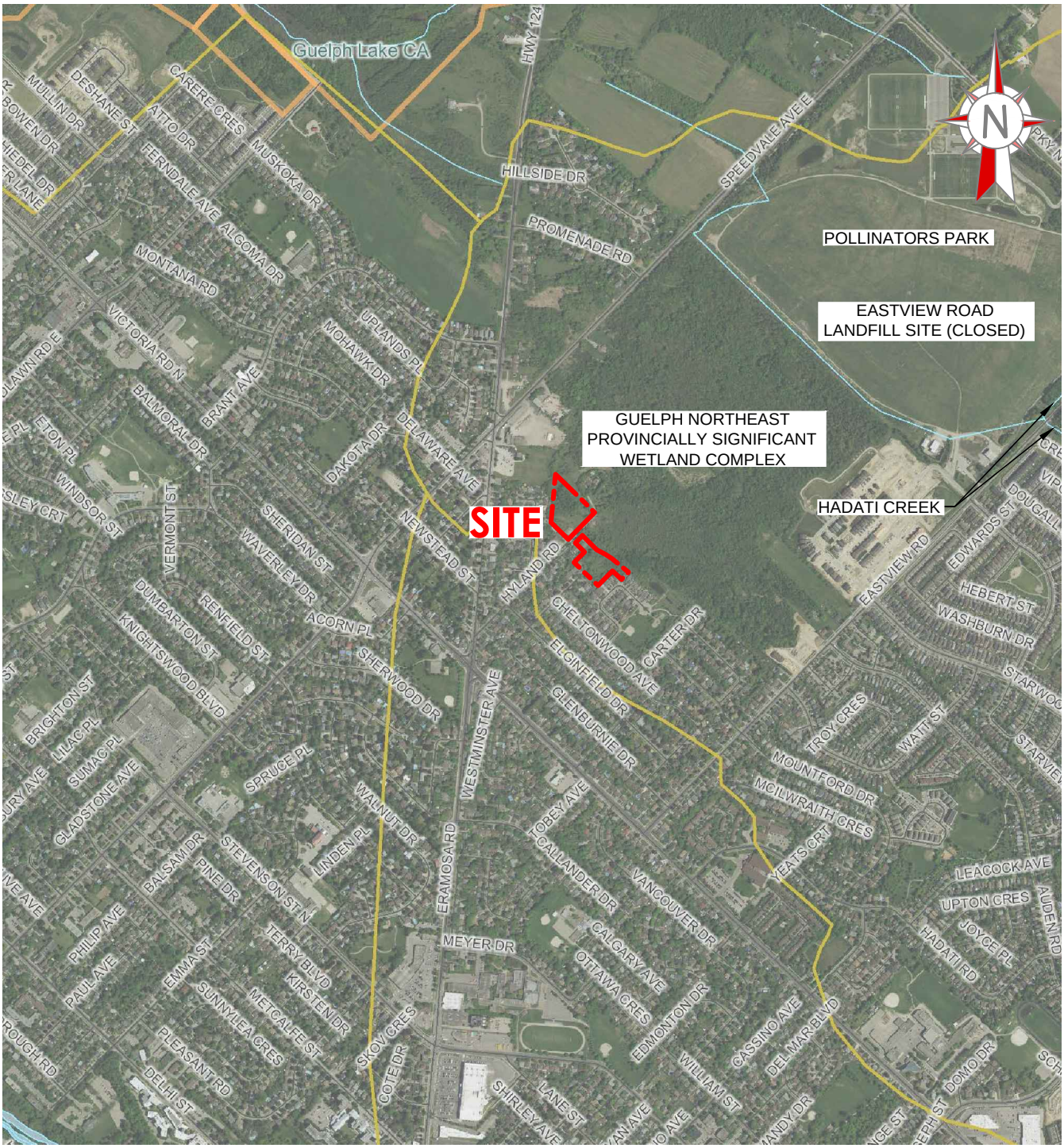
Natural Resource Solutions Inc. 46, 47 and 87 Hyland Road, Guelph Environmental Impact Study. December 2015. (Natural Resource Solutions Inc. Project No. 1400).

Van Harten Surveying Inc. December 21, 2015. Functional Servicing and Stormwater Management Report, Hyland Road and Glenburnie Drive Extensions, City of Guelph, Ontario (Van Harten Surveying Inc. Report No. 21203-13).

Appendix 1 Drawings

Drawing 1: Location Plan
Drawing 2: Site Plan
Drawing 3: Surficial Geology
Drawing 4: Physiography
Drawing 5: Cross Section A-A'
Drawing 6: Shallow Groundwater Contours
Drawing 7: Average Annual Recharge
Drawing 8: Average Annual Runoff
Drawing 9: MOECC Water Well Records
Drawing 10: Wellhead Protection Areas Map
Drawing 11: Wellhead Protection Area Vulnerability
Drawing 12: Intrinsic Vulnerability

Englobe



NOTES :
1-REFERENCES: GRAND RIVER CONSERVATION AUTHORITY, (2016).

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Project

Scoped Hydrogeology Study

Hyland Road, Guelph, Ontario

Title

LOCATION PLAN

Englobe Corp.
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Prepared	E.Ciochon	Discipline	HYDROGEOLOGY	Project manager	E. Brears
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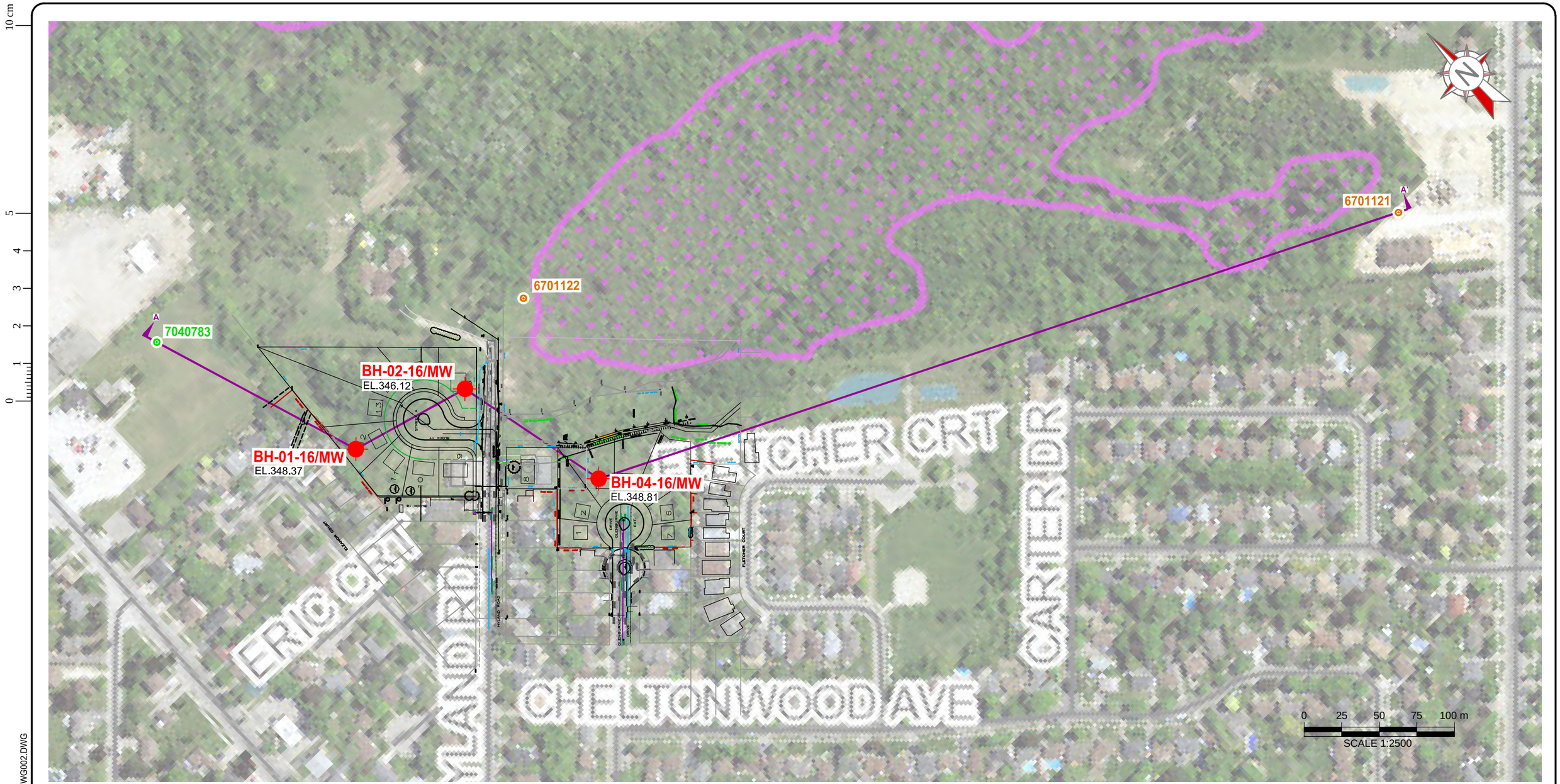
Checked	E. Brears	Date	2018-02-13		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0011569-0-01-300	HD	001	02



LEGEND :

- SITE OUTLINE
- BOREHOLE LOCATION
- EL. 348.81 GROUND SURFACE ELEVATION (m)
- A A' CROSS-SECTION
- MOECC WATER WELL LOCATION - Overburden
- MOECC WATER WELL LOCATION - Bedrock
- WETLAND (GRCA)

NOTES :

1-REFERENCE:

- VAN HARTEN SURVEYING LTD., DRAWING DATED DECEMBER 2015.
- GRAND RIVER CONSERVATION AUTHORITY, 2015 Aerial Photograph (2017).

2-WATER LEVEL MEASUREMENTS TAKEN OCTOBER 31, 2016.

Project

Scoped Hydrogeology Study

Hyland Road, Guelph, Ontario

Title

SITE PLAN

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Project manager: E. Brears
Sequence no.: 02 of 12

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0011569-0-01-300	HD	002	02

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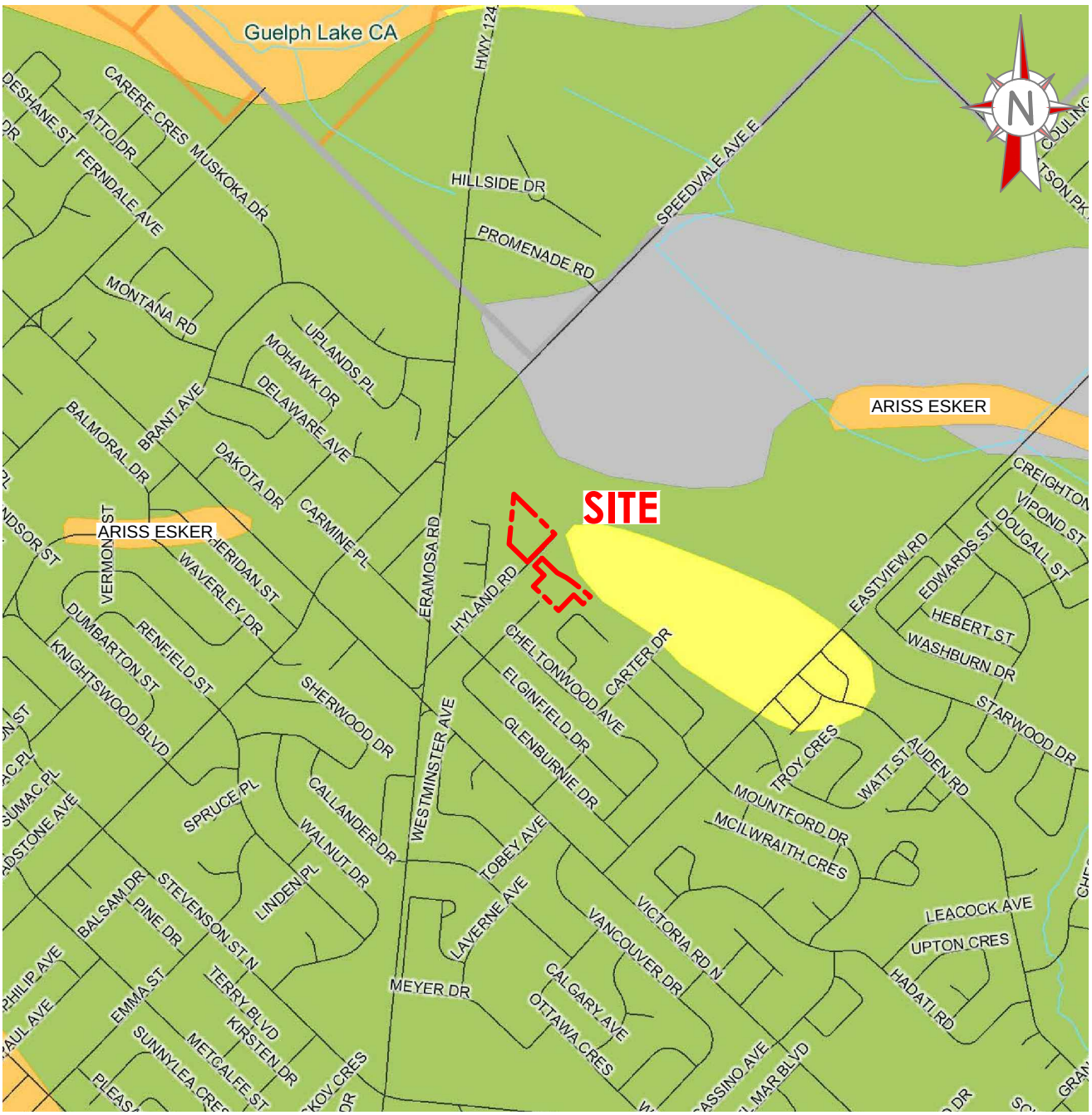

LEGEND:

- DIAMICTON
- GRAVEL
- ORGANIC DEPOSITS
- SAND

NOTES :
1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, 2015 SURFICIAL GEOLOGY MAP (2016).

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Project

Scoped Hydrogeology Study

Hyland Road, Guelph, Ontario

Title

SURFICIAL GEOLOGY MAP

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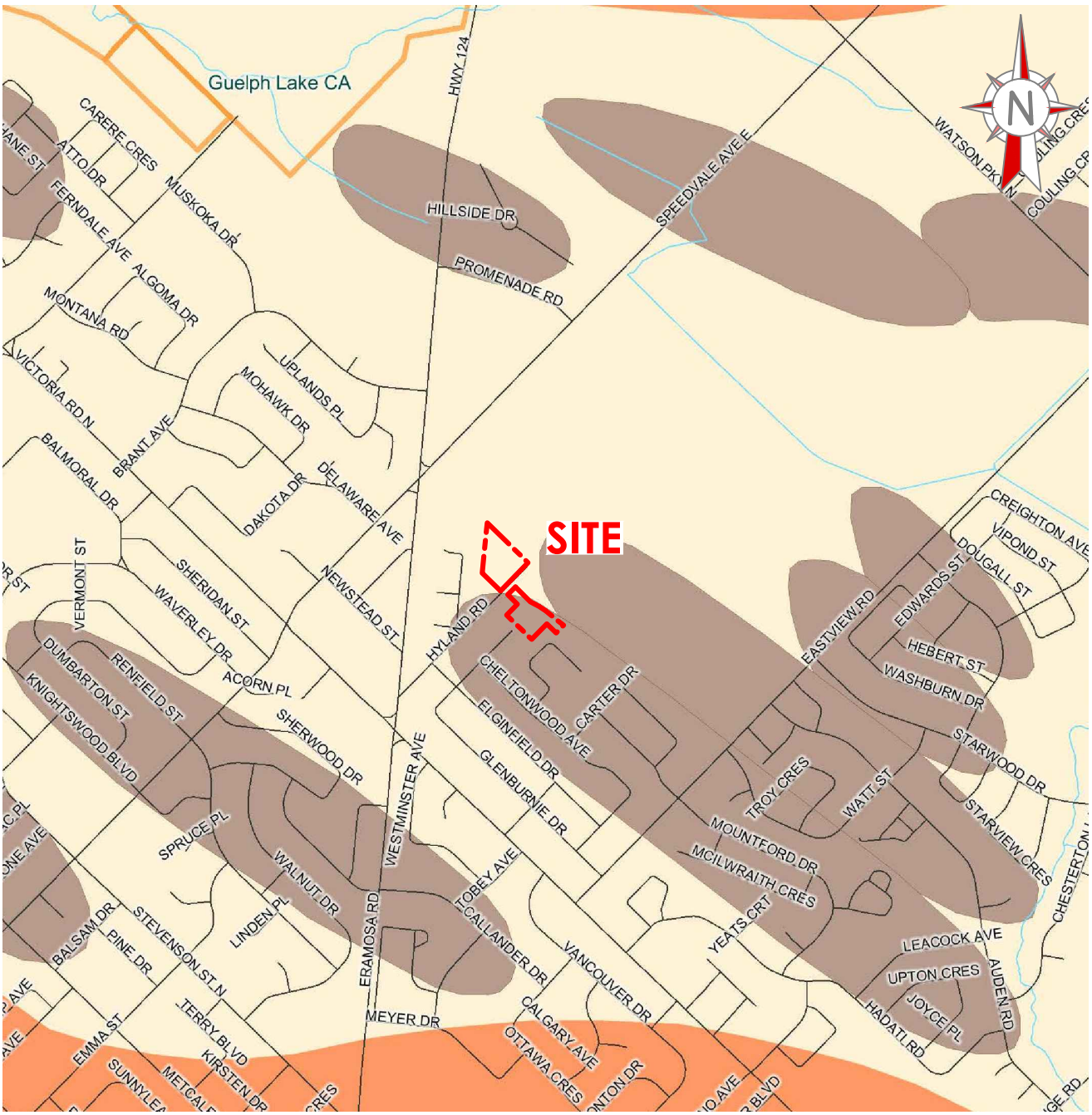
M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0011569-0-01-300	HD	003	02



LEGEND:

- TILL PLAINS (DRUMLINIZED)
- SPILLWAYS
- DRUMLINS

0 100 200 300 400 500 m

SCALE 1:15000

NOTES :
1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, 2015 PHYSIOGRAPHY MAP (2016).

Project

Scoped Hydrogeology Study

Hyland Road, Guelph, Ontario

Title

PHYSIOGRAPHY MAP

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Checked	E. Brears	Date	2018-02-13		

M. dept.	Project	Disc.	Dwg no.	Rev.
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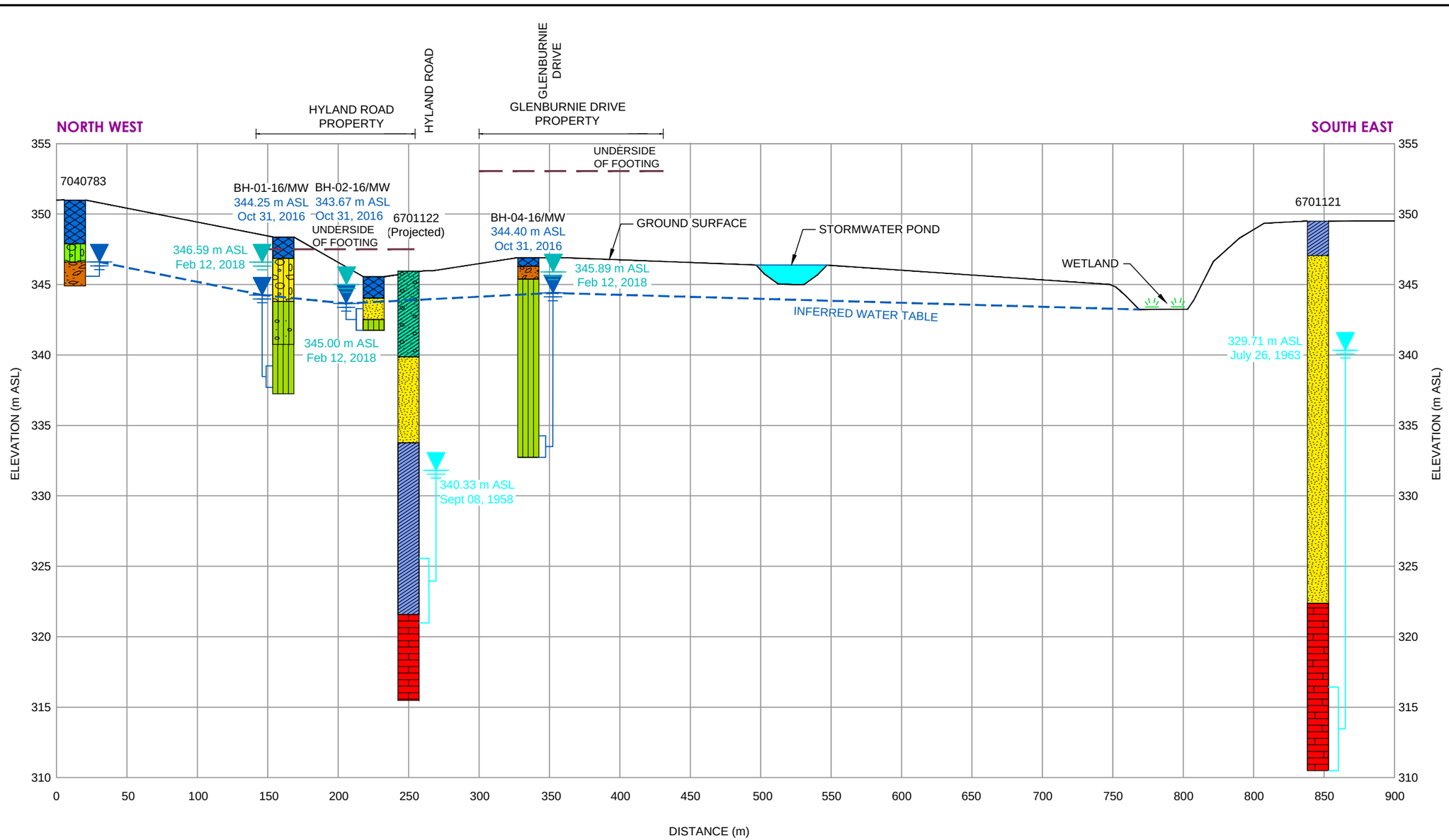

LEGEND :

- FILL
- TOPSOIL
- SAND
- SAND AND GRAVEL
- SILT
- SILT TILL
- CLAY
- GRAVEL AND CLAY
- BEDROCK
- WATER LEVEL
- SCREEN INTERVAL

NOTES :

1-Borehole coordinates and elevations based on Sokkia network data.

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

3-MW refers to monitoring well installed at borehole location.

4-Groundwater measurements taken on February 2018. Seasonal fluctuations in groundwater levels would be expected.
The inferred stratigraphy shown on this cross-section is based on the subsurface stratigraphy contacted at the Boreholes. The subsurface conditions between the Boreholes will vary.

Project

Scoped Hydrogeology Study

Hyland Road, Guelph, Ontario

Title

CROSS SECTION A - A'

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Checked	E. Brears	Date	2018-02-13		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0011569-0-01-300	HD	005	02

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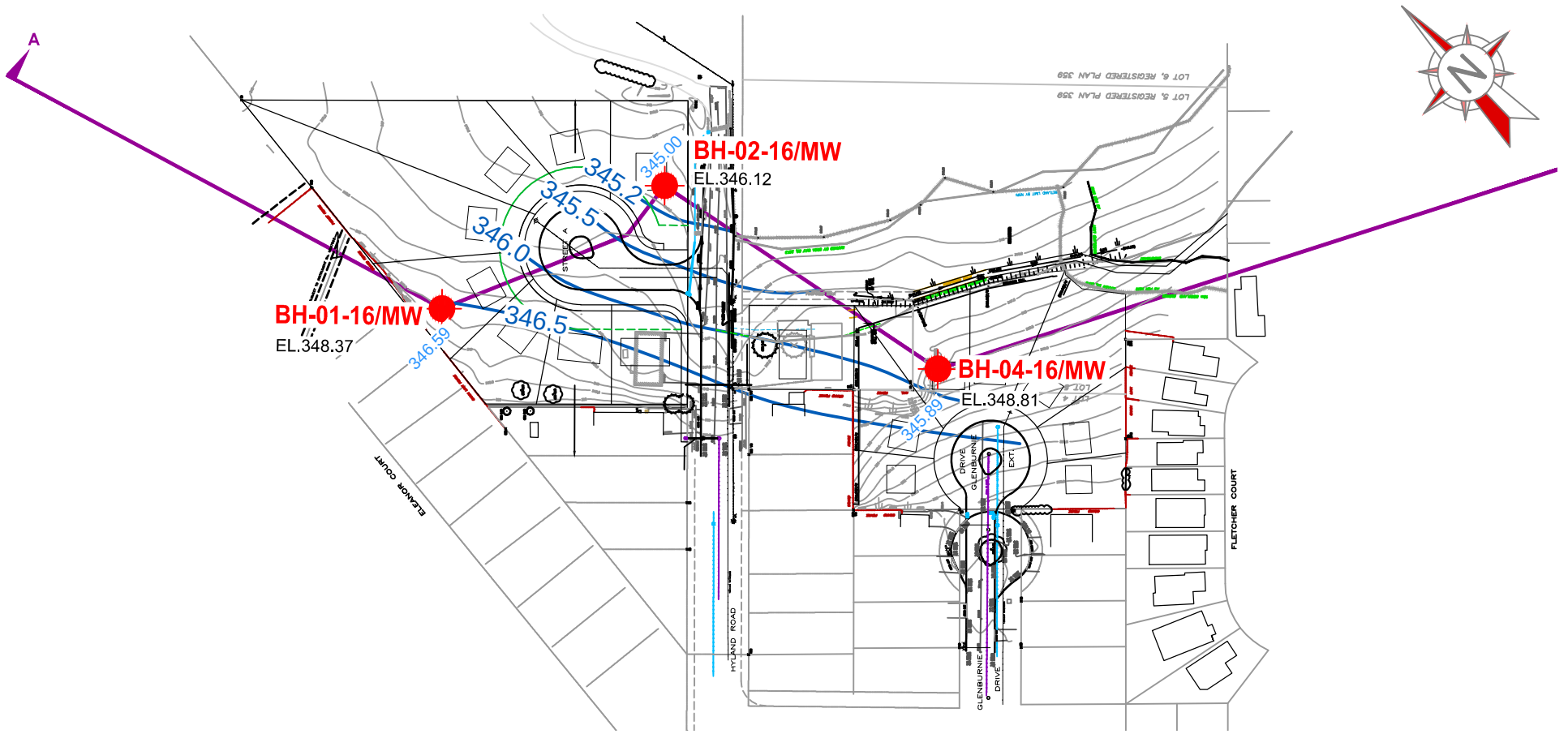

LEGEND :

- SITE OUTLINE
- BOREHOLE / MONITORING WELL LOCATION
- EL. 348.81 — GROUND SURFACE ELEVATION (m)
- SHALLOW GROUNDWATER CONTOUR
- 344.25 — GROUNDWATER ELEVATION (m ASL)
- A A' — CROSS-SECTION

NOTES :
1-REFERENCE: VAN HARTEN SURVEYING LTD., Drawing dated December 2015.
2-Water level measurements taken February 12, 2018.

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SCALE 1:2000

Project
Scoped Hydrogeology Study
Hyland Road, Guelph, Ontario

Title
SHALLOW GROUNDWATER CONTOURS

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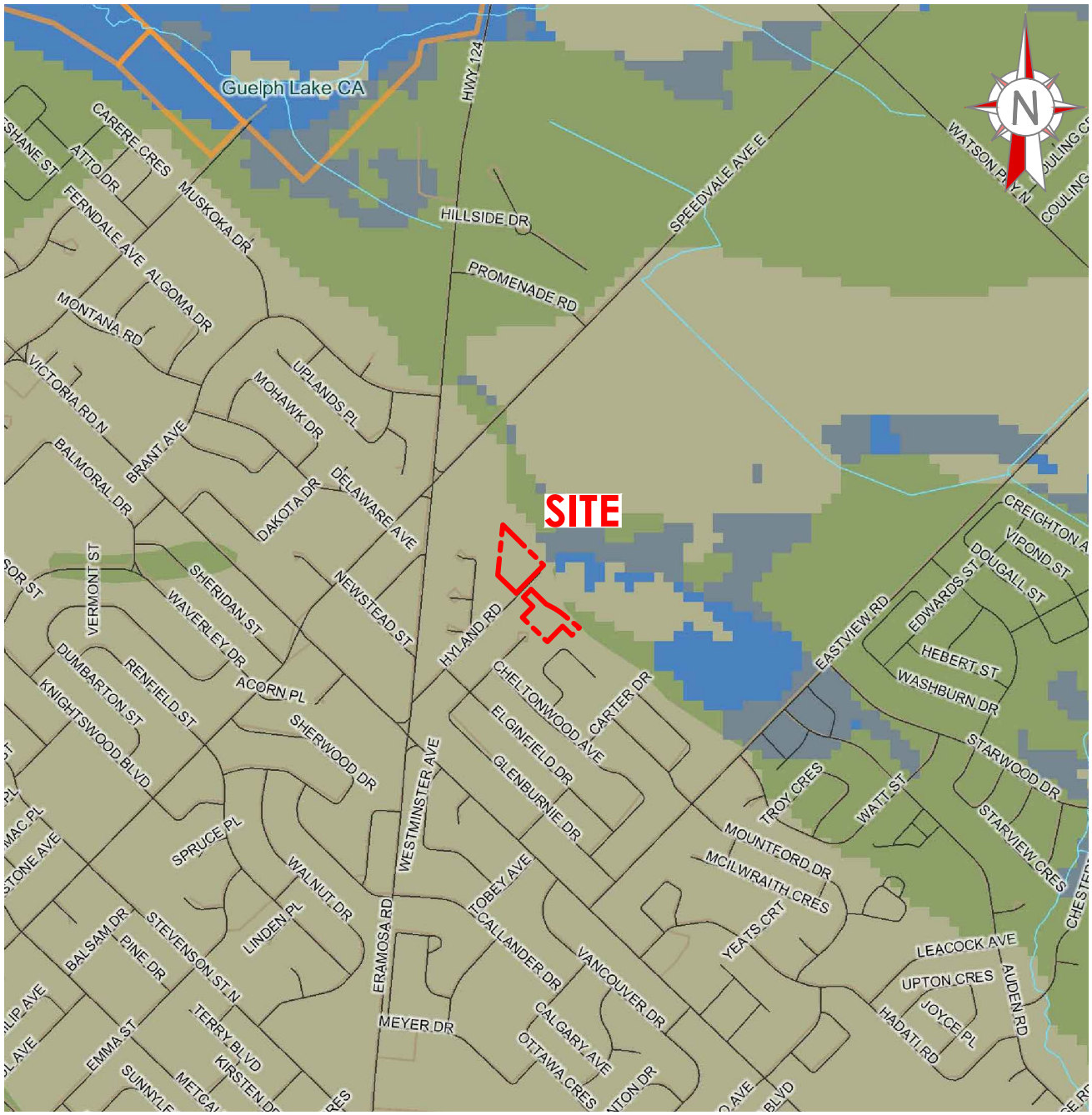
M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0011569-0-01-300	HD	006	02



LEGEND:

- less than 50 mm/yr
- 50 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- > 400

NOTES :

1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, 2015 Average Annual Recharge (2016).

0 100 200 300 400 500 m

SCALE 1:15000

Project

Scoped Hydrogeology Study

Hyland Road, Guelph, Ontario

Title

AVERAGE ANNUAL RECHARGE

Englobe Corp.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	E.Ciochon	Discipline	HYDROGEOLOGY	Project manager	E. Brears
Drawn	E.Ciochon	Scale	1 : 15000	Sequence no.	07 of 12
Checked	E. Brears	Date	2018-02-13		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0011569-0-01-300	HD	007	02

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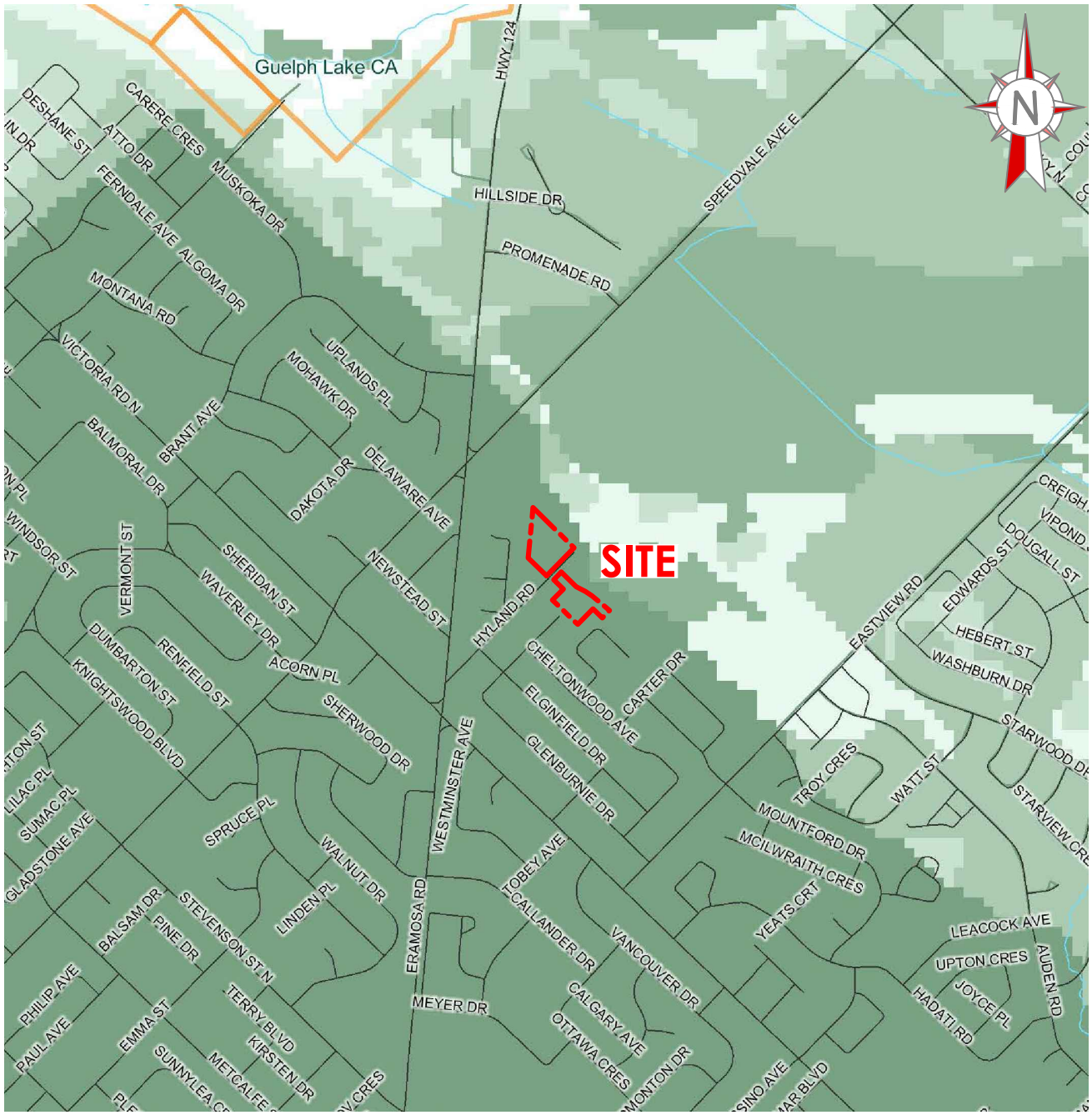


LEGEND:

	less than 50 mm/yr
	50 - 125
	125 - 250
	250 - 400
	> 400

NOTES :
1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, 2015 Runoff (2016).

0 100 200 300 400 500 m

SCALE 1:15000

G:\160\P0011569\Z4_CAD\P-0011569-0-01-300_DWG008.DWG

Project

Scoped Hydrogeology Study

Hyland Road, Guelph, Ontario

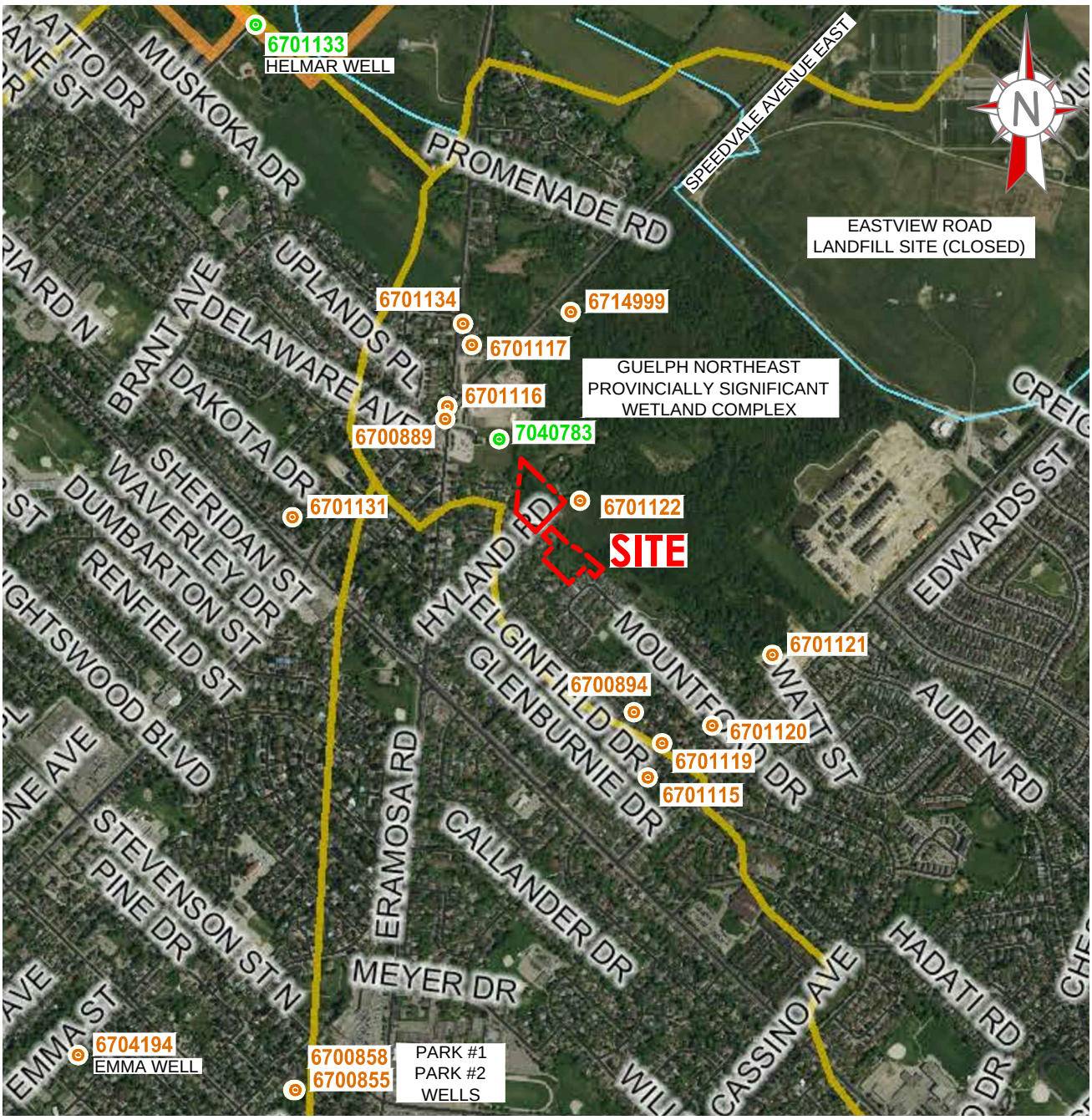
Title

AVERAGE ANNUAL RUNOFF

Englobe Corp.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	E.Ciochon	Discipline	HYDROGEOLOGY	Project manager	E. Brears
Drawn	E.Ciochon	Scale	1 : 15000	Sequence no.	08 of 12
Checked	E. Brears	Date	2018-02-13		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0011569-0-01-300	HD	008	02



NOTES :
1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, 2015 Aerial Photograph (2017).

LEGEND:

- MOECC WATER WELL LOCATION - Overburden
- MOECC WATER WELL LOCATION - Bedrock

0 100 200 300 400 500 m

SCALE 1:15000

Project

Scoped Hydrogeology Study

Hyland Road, Guelph, Ontario

Title

MOECC WATER WELL RECORDS MAP

Englobe

Englobe Corp.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	E.Ciochon	Discipline	HYDROGEOLOGY	Project manager	E. Brears
Drawn	E.Ciochon	Scale	1 : 15000	Sequence no.	09 of 12
Checked	E. Brears	Date	2018-02-13		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0011569-0-01-300	HD	009	02

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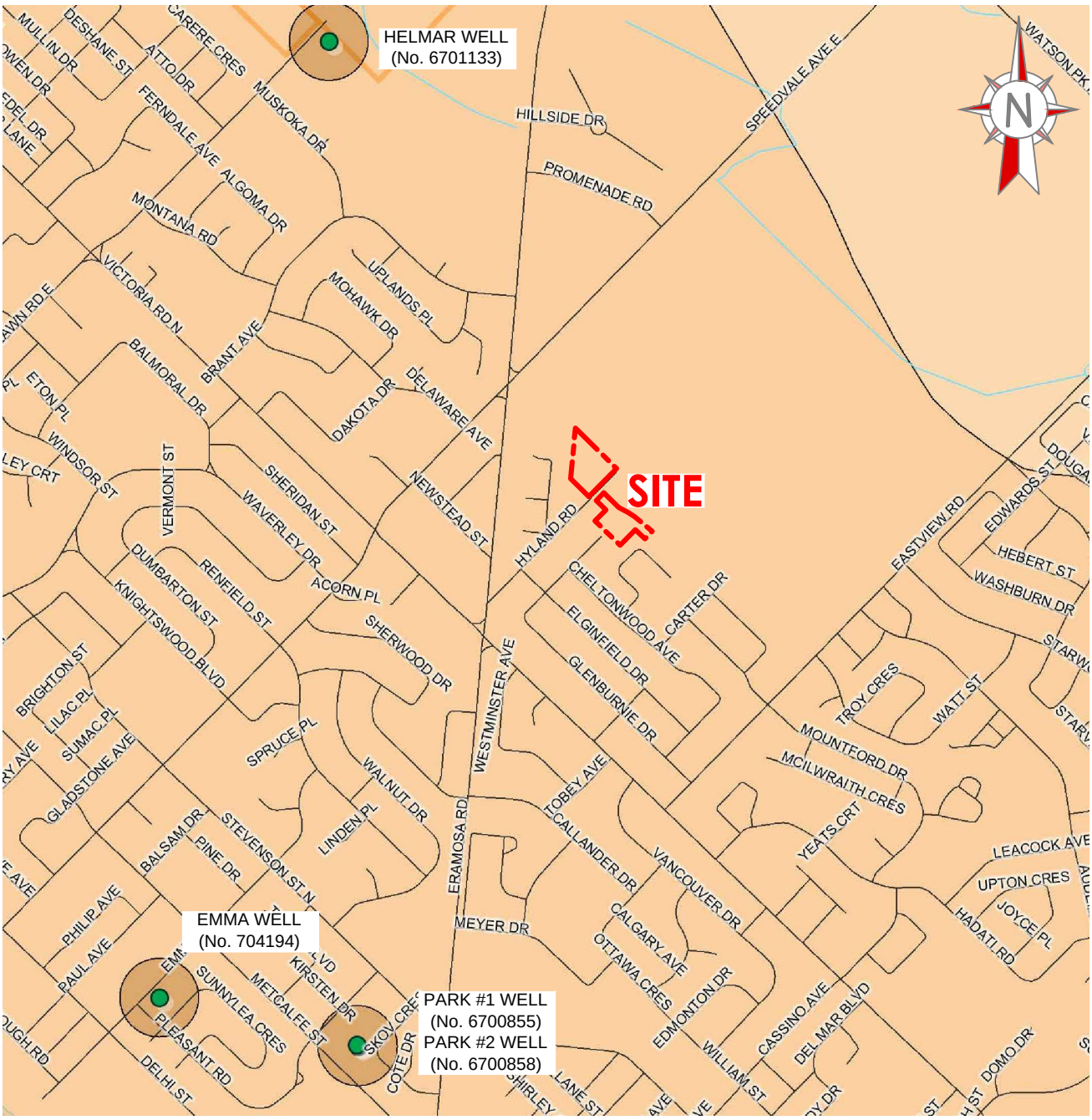

LEGEND:

- WHPA-A
- WHPA-B
- WHPA-C
- MUNICIPAL WELL

NOTES :
1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, 2015 Well Head Protection Area (2016).

0 100 200 300 400 500 m

SCALE 1:15000

Project

Scoped Hydrogeology Study

Hyland Road, Guelph, Ontario

Title

WELL HEAD PROTECTION AREA

Englobe Corp.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	E.Ciochon	Discipline	HYDROGEOLOGY
Drawn	E.Ciochon	Scale	1 : 15000
Checked	E. Brears	Date	2018-02-13

Project manager: E. Brears
Sequence no.: 10 of 12

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0011569-0-01-300	HD	010	02

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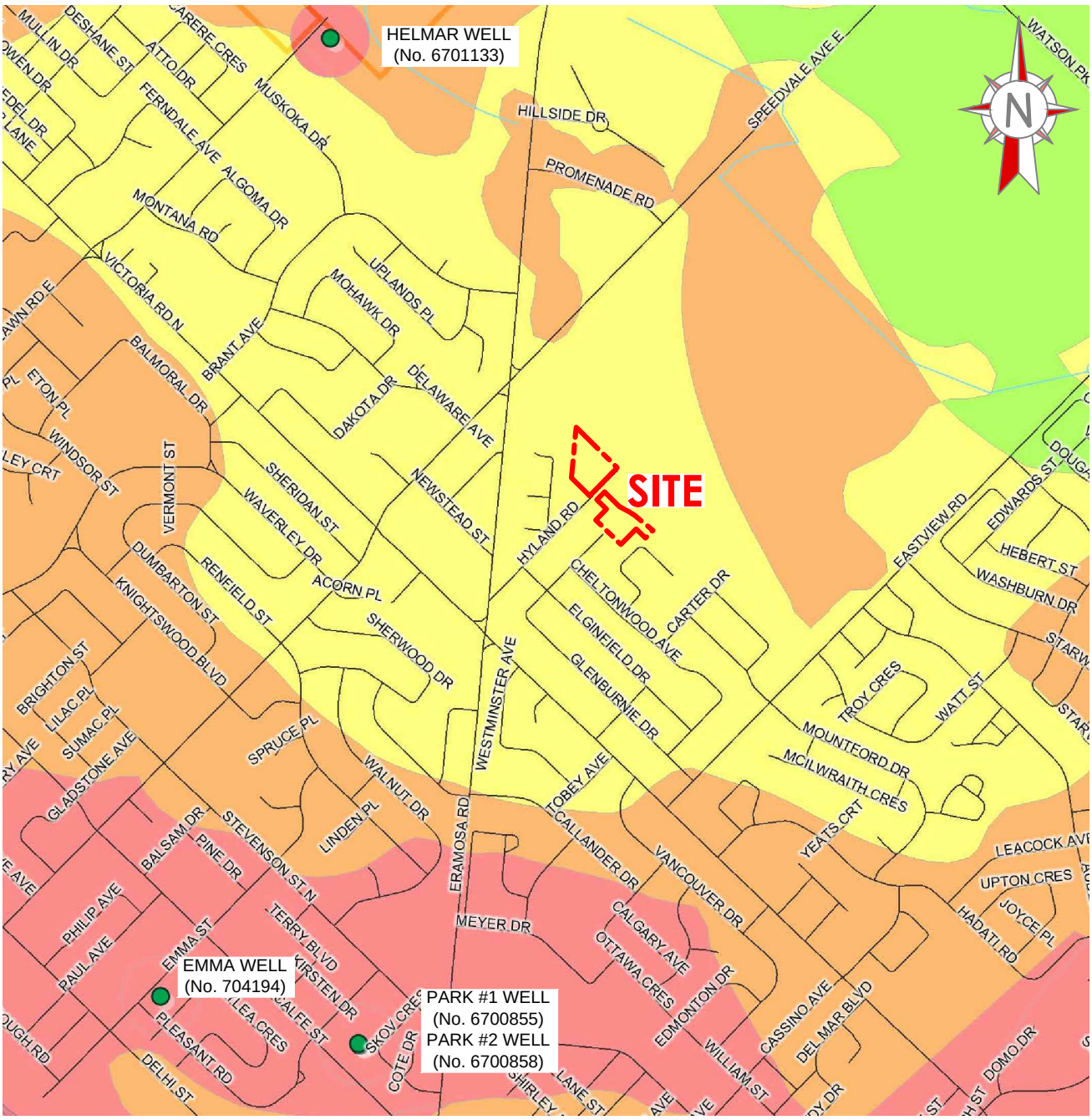

LEGEND:

10
8
6
4

MUNICIPAL WELL

NOTES :
1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, 2015 WELL HEAD PROTECTION VULNERABILITY (2016).

0 100 200 300 400 500 m

SCALE 1:15000

Project

Scoped Hydrogeology Study

Hyland Road, Guelph, Ontario

Title

WELL HEAD PROTECTION VULNERABILITY

Englobe Corp.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	E.Ciochon	Discipline	HYDROGEOLOGY	Project manager	E. Brears
Drawn	E.Ciochon	Scale	1 : 15000	Sequence no.	11 of 12
Checked	E. Brears	Date	2018-02-13		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0011569-0-01-300	HD	011	02

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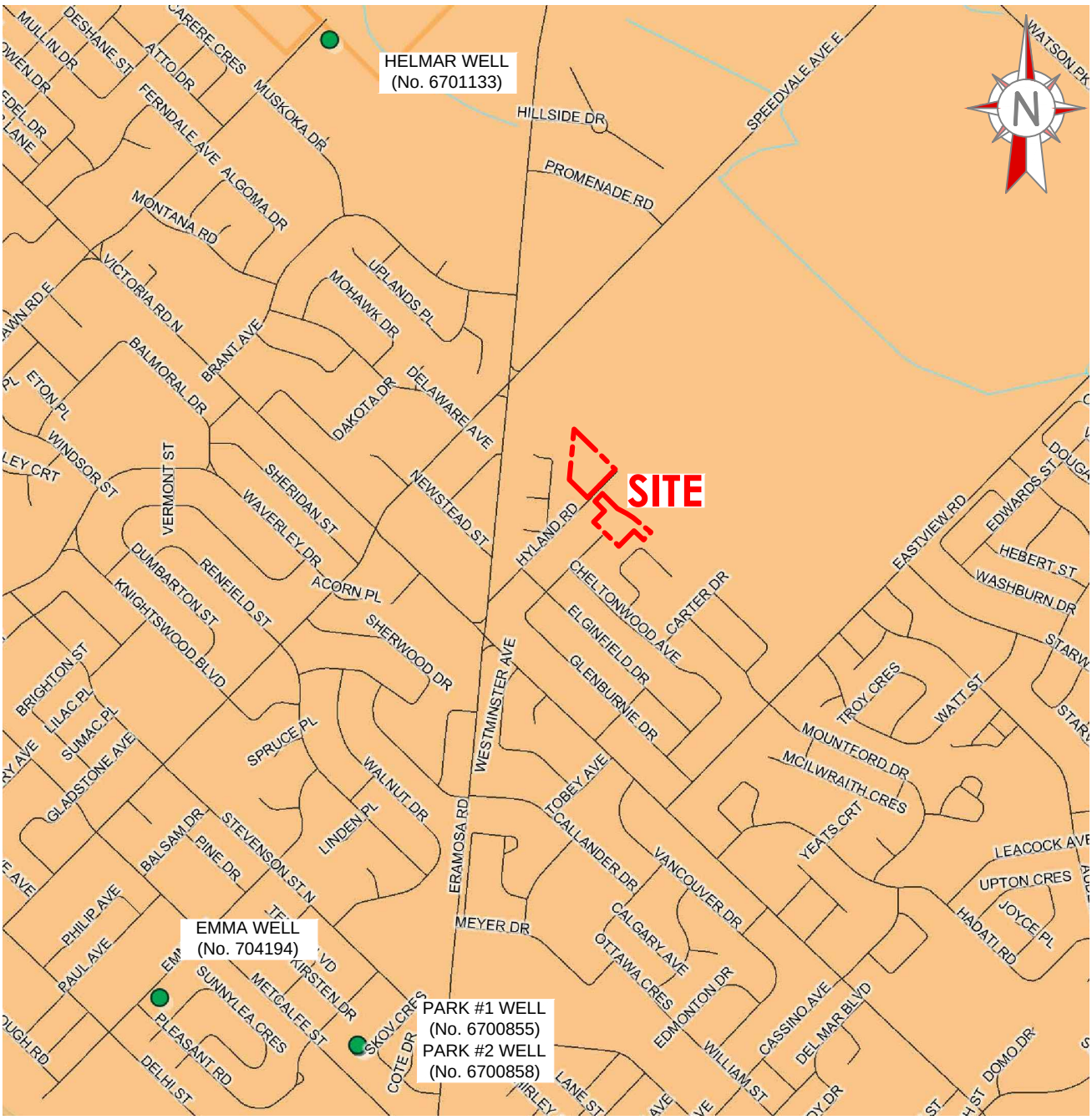

LEGEND:

Medium

NOTES :
1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, 2015 Intrinsic Vulnerability Map (2016).

0 100 200 300 400 500 m

SCALE 1:10000

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Project

Scoped Hydrogeology Study

Hyland Road, Guelph, Ontario

Title

INTRINSIC VULNERABILITY MAP

Englobe Corp.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	E.Ciochon	Discipline	HYDROGEOLOGY
Drawn	E.Ciochon	Scale	1 : 15000
Checked	E. Brears	Date	2018-02-13

Project manager: E. Brears
Sequence no.: 12 of 12

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0011569-0-01-300	HD	012	02

Appendix 2 Borehole Logs

List of Abbreviations

Boreholes BH-01-16, BH-02-16 and BH-04-16

LIST OF ABBREVIATIONS

The abbreviations commonly employed on the borehole logs, on the figures, and in the text of the report, are as follows:

Sample Types		Soil Tests and Properties	
AS	Auger Sample	SPT	Standard Penetration Test
CS	Core Sample	UC	Unconfined Compression
RC	Rock Core	FV	Field Vane Test
SS	Split Spoon	ø	Angle of internal friction
TW	Thinwall, Open	γ	Unit weight
WS	Wash Sample	w_p	Plastic limit
BS	Bulk Sample	w	Water content
GS	Grab Sample	w_L	Liquid limit
WC	Water Content Sample	I_L	Liquidity index
TP	Thinwall, Piston	I_p	Plasticity index
		PP	Pocket penetrometer

Penetration Resistances	
Dynamic Penetration Resistance	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) diameter 60º cone a distance 300 mm (12 in.). The cone is attached to 'A' size drill rods and casing is not used.
Standard Penetration Resistance, N (ASTM D1586)	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a standard split spoon sampler 300 mm (12 in.)
WH	sampler advanced by static weight of hammer
PH	sampler advanced by hydraulic pressure
PM	sampler advanced by manual pressure

Soil Description			
Cohesionless Soils		**SPT N-Value**	**Relative Density (D_r)**
Compactness Condition		(blows per 0.3 m)	(%)
Very Loose		0 to 4	0 to 20
Loose		4 to 10	20 to 40
Compact		10 to 30	40 to 60
Dense		30 to 50	60 to 80
Very Dense		over 50	80 to 100
Cohesive Soils		**Undrained Shear Strength (C_u)**	
Consistency		**kPa**	**psf**
Very Soft		less than 12	less than 250
Soft		12 to 25	250 to 500
Firm		25 to 50	500 to 1000
Stiff		50 to 100	1000 to 2000
Very Stiff		100 to 200	2000 to 4000
Hard		over 200	over 4000
DTPL	Drier than plastic limit	Low Plasticity, W_L <30	
APL	About plastic limit	Medium Plasticity, 30 < W_L < 50	
WTPL	Wetter than plastic limit	High Plasticity, W_L > 50	

Englobe

Ground Elevation: *348.37 m*
Northing: *4824674.8 m*
Easting: *560982.7 m*

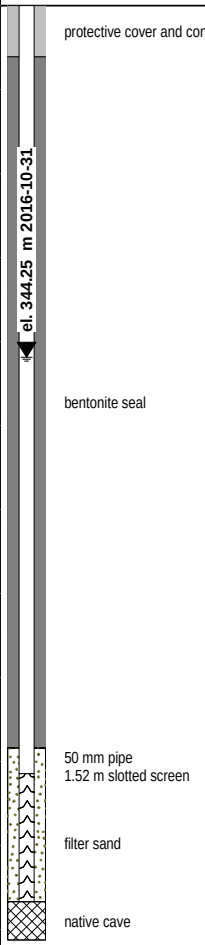
Borehole Number: **BH-01-16**
Job N°: *P-0011569-0-01-300*
Drill Date: *2016-09-28*
Field Tech: *D. Souter*
Drill Method: *Hollow Stem Auger*

Project: *Scoped Hydrogeology Study*
Location: *Hyland Road, Guelph, Ontario*

Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value
	Ground Elevation		348.37			
	FILL: dark brown topsoil, silt, some sand, moist		0.00 / 347.61			
1	compact brown silty sand, some topsoil, trace gravel, occasional cobbles		0.76 / 347.15	SS-1	7-8 9	17
	boulders 4' to 5'		1.22 / 346.85			
2	**SAND TILL:** compact brown silty sand, some gravel, occasional cobbles, moist		1.52	SS-2	4-8 8	16
				SS-3	9-11 9	20
3	dense		3.05 / 345.32	SS-4	12-16 18	34
4			343.80			
5	**SILT TILL:** dense grey/brown fine sandy silt, some gravel, moist		4.57	SS-5	25-20 23	43
6	very dense grey trace gravel		6.10 / 342.27	SS-6	28-50 /150 mm	
7			340.75			
8	**SILT:** very dense grey silt, some clay, trace sand, very moist		7.62	SS-7	15-25 28	53
9	trace gravel, wet with saturated sand seams		339.23 / 9.14	SS-9	21-24 25	49
10			337.70			
11	dense fine sandy silt, wet		10.67 / 337.25	SS-10	16-20 18	38
	Borehole terminated at 11.13 m.		11.13			
12						
13						
14						
15						

Dynamic Cone / Std Penetration: 20 40 60 80
Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 (Initial / Remold)
Water Content (%): WP WL; 10 20 30

Groundwater Observations and Standpipe Details



Reviewed by: *E. Brears*
Drafted by: *D. Kunac*
Sheet: *1 of 1*

Notes: *Auger samples AS-8 taken from 7.62 to 9.14 m, AS-11 taken from 9.75 to 10.67 m.*

Vertical Scale = 1 : 90.0

Englobe

Ground Elevation: *346.12 m*
Northing: *4824663.61 m*
Easting: *561055.41 m*

Borehole Number: **BH-02-16**
Job N°: *P-0011569-0-01-300*
Drill Date: *2016-09-28*
Field Tech: *D. Souter*
Drill Method: *Hollow Stem Auger*

Project: *Scoped Hydrogeology Study*
Location: *Hyland Road, Guelph, Ontario*

Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value
	Ground Elevation		346.12			
	FILL: dark brown topsoil, silt, trace sand and gravel, moist		0.00 / 345.71 / 0.41			
1	compact brown/grey/dark brown silty sand, some gravel and topsoil, occasional cobbles		344.60	SS-1	10-10 / 6	16
	SAND: compact brown sand, some silt, trace gravel, very moist		1.52	SS-2	8-9 / 10	19
2	silty sand, some gravel, wet to saturated		343.83 / 2.29	SS-3	5-6 / 10	16
3	**SILT:** compact gravelly sandy silt, trace clay		343.07 / 3.05	SS-4	9-7 / 7	14
	Borehole terminated at 3.81 m.		342.31 / 3.81			

Dynamic Cone: 20 40 60 80
Std Penetration: 20 40 60 80
Shear Strength (PP) kPa: 50 100 150 200
Initial
Remold
Shear Strength (FV) kPa: 50 100 150 200
WP WL
Water Content (%): 10 20 30

Groundwater Observations and Standpipe Details

el. 343.67 m 2016-10-31
protective cover and concrete
bentonite seal
50 mm pipe
1.52 m slotted screen
filter sand

Reviewed by: *E. Brears*
Drafted by: *D. Kunac*
Sheet: *1 of 1*

Notes: *Auger sample AS-5 taken from 3.05 to 3.81 m.*

Z:\Style_LVM_Ontario\Log Borehole_Log_LVM_Ontario.sty - Printed : 2016-11-23 08 h
Vertical Scale = 1 : 90.0
EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation: *348.81 m*
Northing: *4824564.7 m*
Easting: *561076.1 m*

Borehole Number: **BH-04-16**
Job N°: *P-0011569-0-01-300*
Drill Date: *2016-09-28*
Field Tech: *D. Souter*
Drill Method: *Hollow Stem Auger*

Project: *Scoped Hydrogeology Study*

Location: *Hyland Road, Guelph, Ontario*

Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value
	Ground Elevation		348.81			
	FILL: dark brown topsoil, silt, trace sand and gravel, occasional cobbles		0.00 / 348.20			
1	**SAND AND GRAVEL:** dense brown sand and gravel, some silt, numerous cobbles, moist		0.61 / 347.29	SS-1	14-24 15	39
2	**SILT:** some clay, trace sand and gravel		1.52 / 346.52	SS-2	8-8 8	16
	silty sand, moist to very moist		2.29 / 345.76	SS-3	7-9 10	19
3	dense		3.05 / 344.24	SS-4	13-21 25	46
4	very dense grey silty fine sand, trace gravel, moist		4.57	SS-5	21-46 57	103
5						
6				SS-6	38-50 /125 mm	
7						
8				SS-7	26-50 /100 mm	
9						
				SS-8	26 /100 mm	
10			338.14			
	very moist to wet, saturated layers 10.67 to 12.19 m		10.67	SS-9	28 /125 mm	
11						
12			336.62			
	very dense grey silt, some fine sand and clay, trace gravel, moist to wet, rods very wet 10.67 to 13.72 m		12.19	SS-11	16-50 /125 mm	
13						
				SS-12	18-24 24	48
14			334.64			
	Borehole terminated at 14.17 m.		14.17			
15						

Dynamic Cone / Std Penetration: 20 40 60 80
Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 — Initial / Remold
Water Content (%): WP WL — 10 20 30

Groundwater Observations and Standpipe Details

el. 344.40 m 2016-10-31

protective cover and concrete

bentonite seal

50 mm pipe
3.05 m slotted screen

filter sand

native cave

Reviewed by: *E. Brears*
Drafted by: *D. Kunac*
Sheet: *1 of 1*

Notes: *MOECC Well No. A202673. Auger sample AS-10 taken from 12.2 to 12.5 m.*

Z:\Style_LVM_OntarioLog Borehole_Log_LVM_Ontario.sty - Printed : 2016-11-23 08 h

Vertical Scale = 1 : 90.0

EQ-09-Ge-72 R.1 18.02.2011

Appendix 3 Tables

Englobe

TABLE 101

MEASURED COORDINATES

Hydrogeology Study Report
Hyland Road Subdivision
46, 47 and 87 Hyland Road
Guelph, Ontario

WELL NAME	GROUND SURFACE ELEVATION (mASL)	NORTHING	EASTING	DATE ACQUIRED
BH-01-16	348.37	4824674.8	560982.7	17-Sep-16
BH-02-16	346.11	4824663.6	561055.4	17-Sep-16
BH-04-16	348.81	4824564.7	561076.1	17-Sep-16

LOCATION	GROUND SURFACE ELEVATION (mASL)	NORTHING	EASTING	DATE ACQUIRED	REFERENCE NAME
1	345.09	4824666.3	561066.4	17-Sep-16	gue rush edge of dry wetland
2	345.18	4824665.1	561076.5	17-Sep-16	gue rush edge of dry wetland1
3	345.48	4824648.6	561060.5	17-Sep-16	gue rush edge of dry wetland2
4	345.30	4824588.9	561132.8	17-Sep-16	gue rush bedge of dry wetland3
5	344.48	4825252.8	561162.1	17-Sep-16	gue rush bedge of dry wetland4
6	344.13	4825190.9	561078.9	17-Sep-16	gue rush bedge of dry wetland5
7	343.88	4825192.6	561079.7	17-Sep-16	gue rush base clvrt
8	343.66	4825231.7	561117.4	17-Sep-16	gue rush base clvrt1
9	344.03	4825229.0	561141.8	17-Sep-16	gue rush base clvrt2
10	345.96	4824840.9	561807.9	17-Sep-16	gue rush swm wl
11	346.21	4824841.3	561808.2	17-Sep-16	gue rush top of scum

Notes:

1. mASL – metres above sea level.
2. Elevations obtained using Sokkia Model GRX 2 Global Navigation Satellite System (GNSS) Rover

TABLE 102

MEASURED GROUNDWATER ELEVATIONS

Hydrogeology Study Report
Hyland Road Subdivision
46, 47 87 Hyland Road
Guelph, Ontario

			October-24-16			October-31-16			February-12-18		
WELL NAME	GROUND SURFACE ELEVATION (mASL)	STICK UP (m)	DEPTH TO WL (mbTOP)	DEPTH TO WL (mBGS)	WL ELEVATION (mASL)	DEPTH TO WL (mbTOP)	DEPTH TO WL (mBGS)	WL ELEVATION (mASL)	DEPTH TO WL (mbTOP)	DEPTH TO WL (mBGS)	WL ELEVATION (mASL)
BH-01-16	348.37	0.88	5.05	4.17	344.20	5.00	4.12	344.25	2.66	1.78	346.59
BH-02-16	346.11	0.86	3.36	2.50	343.61	3.30	2.44	343.67	1.97	1.11	345.00
BH-04-16	348.81	0.79	5.25	4.46	344.35	5.20	4.41	344.40	3.71	2.92	345.89

Notes:

1. mBGS – metres below ground surface.
2. mASL – metres above sea level.
3. WL – water level.

TABLE 103

HYDRAULIC CONDUCTIVITY ESTIMATES

Scoped Hydrogeology Study Report
46, 47 & 87 Hyland Road
Guelph, Ontario

Borehole Name / Location	Ground Surface Elevation (mASL)	Grain Size Analyses			
		Soil Description	Sample Depth (mBGS)	Hydraulic Conductivity (m/sec)	Method
BH-01-16	348.37	Silt with some clay and trace sand	AS-8, 7.6-9.1	< 1.0×10^{-9}	Kaubisch, % P = 66
BH-02-16	346.11	Gravelly sandy silt with trace clay	AS-5 3.1-3.8	7.8×10^{-7}	Beyer Cu = 15 D_{10}= 0.01 D_{60}= 0.16
BH-04-16	348.81	Silt with some clay and trace sand and gravel	AS-10 10.7-12.2	1.6×10^{-9}	Kaubisch, % P = 57

Borehole Name / Location	Ground Surface Elevation (mASL)	Slug Tests			
		Soil Description	Screened Interval (mBGS)	Hydraulic Conductivity (m/sec)	Method
BH-01-16	348.37	Silt with some clay and trace gravel	9.2 - 10.7	3.2×10^{-7}	Slug out (rising head)
BH-02-16	346.11	Gravelly sandy silt with trace clay	2.2 – 3.8	9.8×10^{-7}	Water in (falling head)
BH-04-16	348.81	Silt with some clay and trace sand and gravel	10.7 – 13.7	2.6×10^{-7}	Slug in (falling head)

Notes:
1. mASL – metres Above Sea Level<
2. C_u = coefficient of uniformity value
3. P = percent of soil smaller than 0.02 mm

TABLE 104

GROUNDWATER CHEMISTRY ANALYSIS RESULTS

Hyland Road Subdivision
46, 47 87 Hyland Road

SAMPLE ID	UNITS	PWQO LIMIT	October 24, 2016		
			BH-01-16	BH-02-16	BH-04-16
Colour, Apparent	TCU	-	5.9	14.6	19.7
Conductivity	umhos/cm	-	672	1050	464
Hardness (as $CaCO_3$)	mg/L	-	334	526	223
pH	pH units	6.5-8.5	7.63	7.16	7.8
Total Dissolved Solids	mg/L	-	409 *	599 *	247 *
Turbidity	NTU	-	11.3	18.2	17.5
Alkalinity, Total (as $CaCO_3$)	mg/L	-	227	448 *	235
Ammonia, Total (as N)	mg/L	-	0.075	0.183	0.186
Chloride (Cl)	mg/L	-	27.1	68.4	3.90
Fluoride (F)	mg/L	-	0.104	0.105	0.109
Nitrate (as N)	mg/L	-	0.066	0.173	<0.020
Nitrite (as N)	mg/L	-	<0.10	0.043	<0.010
Orthophosphate - Dissolved (as P)	mg/L	-	0.0106	<0.0030	<0.0030
Sulfate (SO_4)	mg/L	-	94.3	26.6	24.4
Aluminum (Al)-Total	mg/L	0.015	**0.072**	**0.123**	**0.143**
Antimony (Sb)-Total	mg/L	0.02	0.00024	0.00017	0.00018
Arsenic (As)-Total	mg/L	0.005	0.00197	0.00115	**0.00964**
Barium (Ba)-Total	mg/L	-	0.120	0.116	0.0778
Beryllium (Be)-Total	mg/L	0.011	<0.00010	<0.00010	<0.00010
Bismuth (Bi)-Total	mg/L	-	<0.000050	<0.000050	<0.000050
Boron (B)-Total	mg/L	0.20	0.035	0.086	0.03
Cadmium (Cd)-Total	mg/L	0.0001	<0.000010	0.000036	<0.000010
Calcium (Ca)-Total	mg/L	-	72.3	114	38.4
Cesium (Cs)-Total	mg/L	-	<0.000010	0.000013	0.000016
Chromium (Cr)-Total	mg/L	-	<0.00050	<0.00050	0.00076
Cobalt (Co)-Total	mg/L	0.0009	0.00020	0.00026	0.00016
Copper (Cu)-Total	mg/L	0.001	<0.0010	**0.0016**	0.0010
Iron (Fe)-Total	mg/L	0.3	0.098	**0.319**	0.221
Lead (Pb)-Total	mg/L	0.001	0.00023	**0.00114**	0.00025
Magnesium (Mg)-Total	mg/L	-	37.2	58.7	30.7
Manganese (Mn)-Total	mg/L	-	0.0600	0.116	0.0293
Molybdenum (Mo)-Total	mg/L	0.04	0.00830	0.00292	0.00500
Nickel (Ni)-Total	mg/L	0.025	0.00070	0.00148	<0.00050
Phosphorus (P)-Total	mg/L	0.01	**<0.050**	**<0.050**	**<0.050**
Potassium (K)-Total	mg/L	-	4.47	3.44	1.75
Rubidium (Rb)-Total	mg/L	-	0.00125	0.00173	0.00075
Selenium (Se)-Total	mg/L	0.1	0.000271	0.000148	0.000057
Silicon (Si)-Total	mg/L	-	6.66	8.66	9.53
Silver (Ag)-Total	mg/L	0.0001	<0.000050	<0.000050	<0.000050
Sodium (Na)-Total	mg/L	-	11.6	23.9	14.3
Strontium (Sr)-Total	mg/L	-	0.191	0.269	0.283
Sulfur (S)-Total	mg/L	-	32.6	9.68	8.14
Tellurium (Te)-Total	mg/L	-	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Total	mg/L	0.0003	<0.000010	0.000020	<0.000010
Thorium (Th)-Total	mg/L	-	<0.00010	<0.00010	<0.00010
Tin (Sn)-Total	mg/L		0.00061	0.00144	0.00070
Titanium (Ti)-Total	mg/L		0.00320	0.00482	0.00642
Tungsten (W)-Total	mg/L	0.03	<0.00010	<0.00010	<0.00010
Uranium (U)-Total	mg/L	0.005	0.00169	0.000568	0.000360
Vanadium (V)-Total	mg/L	0.006	0.00121	0.00084	0.00063
Zinc (Zn)-Total	mg/L	0.02	0.0147	**0.0335**	0.0113
Zirconium (Zr)-Total	mg/L	0.004	<0.00030	<0.00030	<0.00030

Notes:

1. Criteria from Ontario Drinking Water Standards (MOECC, January 2016).
2. Criteria from Surface Water PWQO
3. Analytical analysis performed by ALS Laboratories, Waterloo, Ontario
4. Measurements in **bold and highlighted** text exceed Surface Water PWQO criteria limits
5. Detection limit for result exceeds the Surface Water PWQO Guideline Limit
6. The AO for sodium is 200 mg/L however; if this was drinking water the Medical Officer of Health would be notified to pass the information on to physicians working with patients with sodium reduced diets (applies to ODWS).

MAC - Maximum Acceptable Concentration (health related)
IMAC - Interim Maximum Acceptable Concentration (health related)
OG - Operational Guideline (parameters which must be controlled for effective treatment)
AO - Aesthetic Objective
TCU - True Colour Units
NTU - Nephelometric Turbidity Units

Appendix 4 Sokkia GRX 2 GNSS Data

September 2016

Englobe

Sokkia GRX 2 GNSS Data
September 2016

gue rush bh2	4824664	561055.4	346.108
gue rush bh1	4824675	560982.7	348.374
gue rush edge of dry wetland	4824666	561066.4	345.088
gue rush edge of dry wetland1	4824665	561076.5	345.177
gue rush edge of dry wetland2	4824649	561060.5	345.476
gue rush bh 3	4824531	561058.9	352.893
gue rush bh 4	4824565	561076.1	348.806
gue rush bh 5	4824529	561110.8	350.728
gue rush bedge of dry wetland3	4824589	561132.8	345.298
gue rush bedge of dry wetland4	4825253	561162.1	344.479
gue rush bedge of dry wetland5	4825191	561078.9	344.129
gue rush base clvrt	4825193	561079.7	343.884
gue rush base clvrt1	4825232	561117.4	343.664
gue rush base clvrt2	4825229	561141.8	344.03
gue rush swm wl	4824841	561807.9	345.958
gue rush top of scum	4824841	561808.2	346.211

Appendix 5 Figures

Englobe

PARTICLE SIZE ANALYSIS

Project: **Scoped Hydrogeology Study**

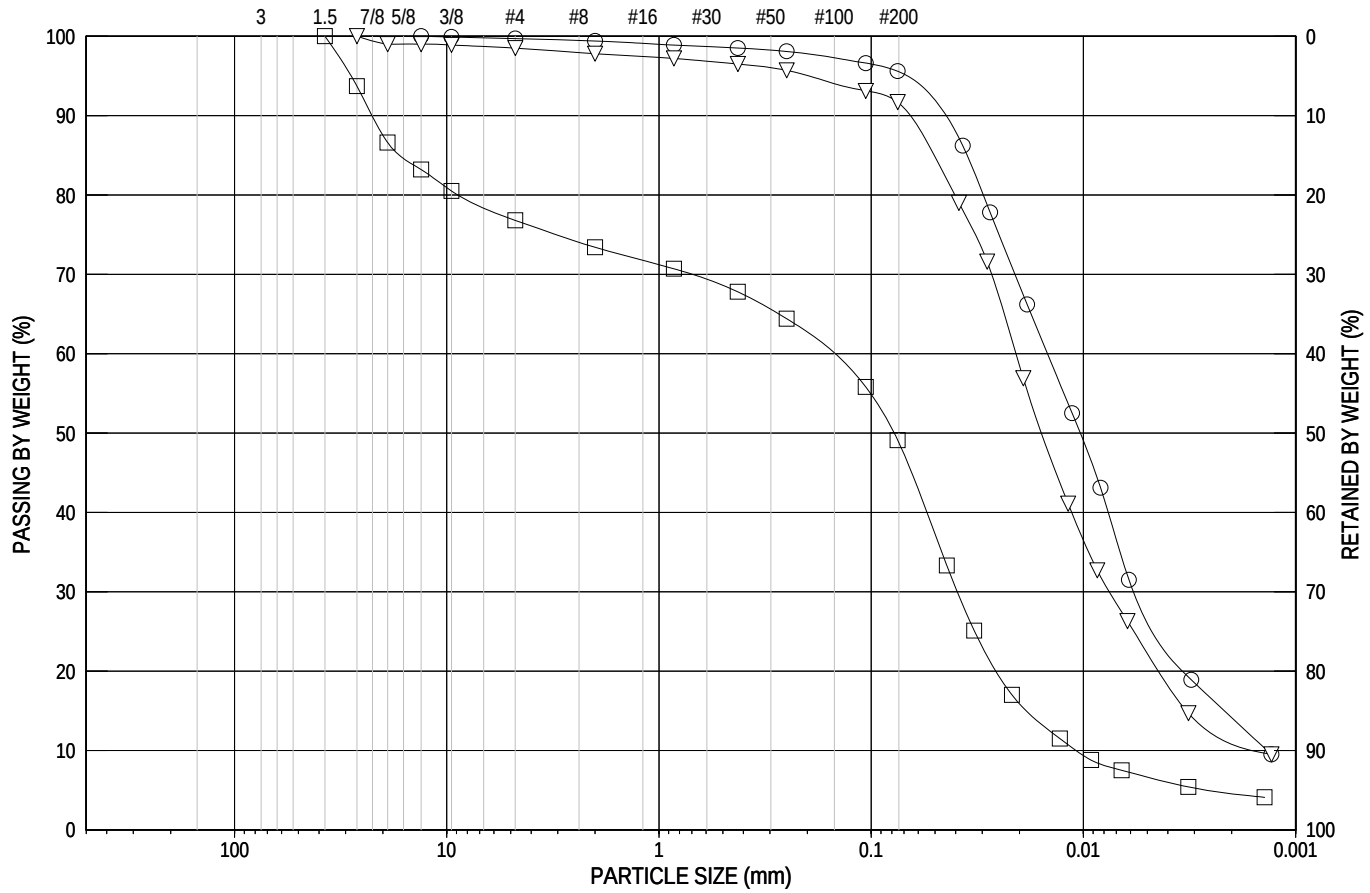
Location: **Hyland Road, Guelph, Ontario**

Figure No : **1**

File No : **P-0011569-0-01-300**

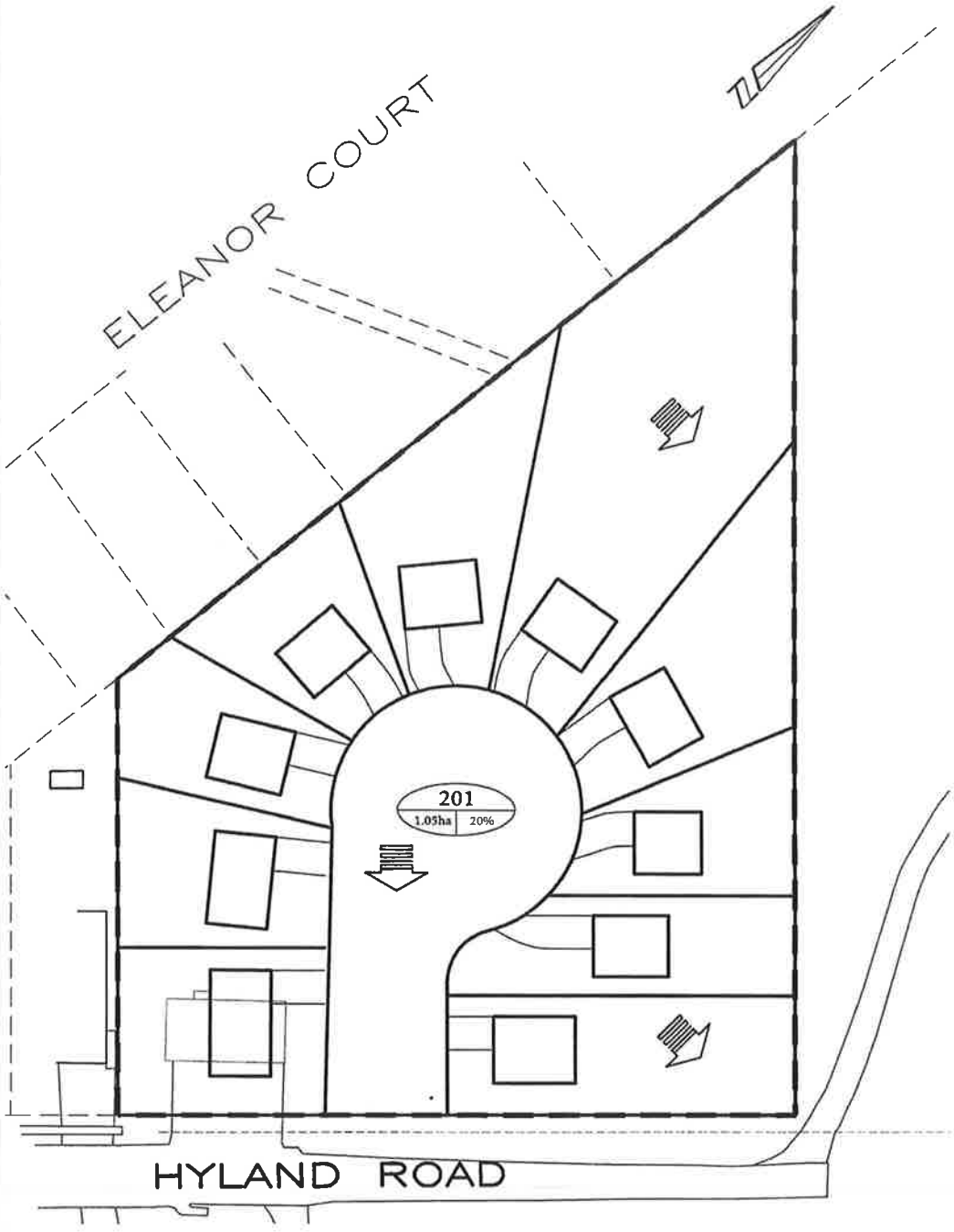
UNIFIED SOIL CLASSIFICATION

COBBLES	*GRAVEL*		*SAND*			*SILT OR CLAY*
	COARSE	FINE	COARSE	MEDIUM	FINE	
U.S. SIEVE SIZE IN INCHES			*U.S. STANDARD SIEVE No.*			*HYDROMETER*



Symbol	Borehole n°	Sample n°	Depth (ft)	Description
○	BH-01-16	SS-10	10.67 - 11.13	SILT, some Clay, trace Sand
□	BH-02-16	SS-4	3.05 - 3.51	Gravelly Sandy SILT, trace Clay
▽	BH-04-16	SS-9	10.67 - 12.19	SILT, some Clay, trace Sand and Gravel

POST DEVELOPMENT
DRAINAGE CATCHMENT AREAS
PROPOSED HYLAND ROAD CUL-DE-SAC
PART OF LOT 12, REGISTERED PLAN 359
DRAWING SCALE 1 : 750



LEGEND

MAJOR STORM OVERLAND FLOW ROUTE

CATCHMENT

C2
0.25ha | 75%

AREA % IMPERVIOUS

DRAINAGE AREA BOUNDARY

Van Harten SURVEYING INC.
LAND SURVEYORS and ENGINEERS

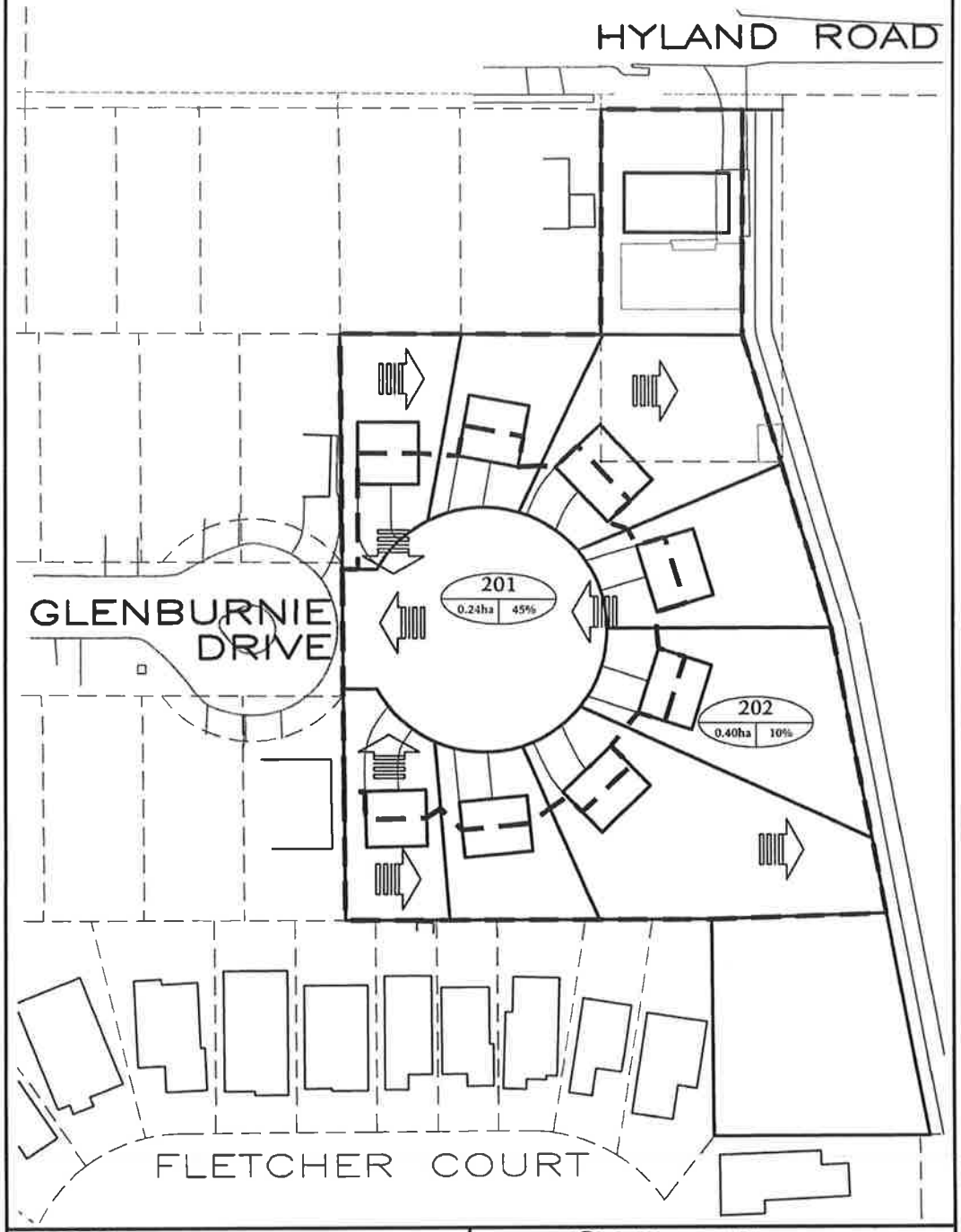
423 WOOLWICH STREET
GUELPH – ONTARIO, N1H 3X3
PHONE: (519) 821 – 2763
FAX: 821 – 2770
www.vanharten.com

660 RIDDELL ROAD, UNIT 1
ORANGEVILLE – ONTARIO, L9W 5G5
PHONE: (519) 940 – 4110
FAX: 519 – 940 – 4113
www.vanharten.com

DRAWN BY: M.V. | CHECKED BY: J.M.D. | PROJECT No. 21203-13

Mar 06,2015–2:23pm
L:\Guelph\359\catchments (87 HYLAND ROAD) UTM 2010.dwg

POST DEVELOPMENT
DRAINAGE CATCHMENT AREAS
PROPOSED GLENBURNIE DRIVE EXTENSION
PART OF LOTS 4 & 5, REGISTERED PLAN 359
DRAWING SCALE 1 : 750



LEGEND

MAJOR STORM OVERLAND FLOW ROUTE

C201 (0.25ha | 75%) — CATCHMENT AREA / % IMPERVIOUS

DRAINAGE AREA BOUNDARY

Van Harten SURVEYING INC.
LAND SURVEYORS and ENGINEERS

423 WOOLWICH STREET
GUELPH – ONTARIO, N1H 3X3
PHONE: (519) 821 – 2763
FAX: 821 – 2770
www.vanharten.com

660 RIDDELL ROAD, UNIT 1
ORANGEVILLE – ONTARIO, L9W 5G5
PHONE: (519) 940 – 4110
FAX: 519 – 940 – 4113
www.vanharten.com

DRAWN BY: M.V. | CHECKED BY: J.M.D. | PROJECT No. 21203-13

Mar 06,2015–2:23pm
L:\Guelph\359\catchments (87 HYLAND ROAD) UTM 2010.dwg

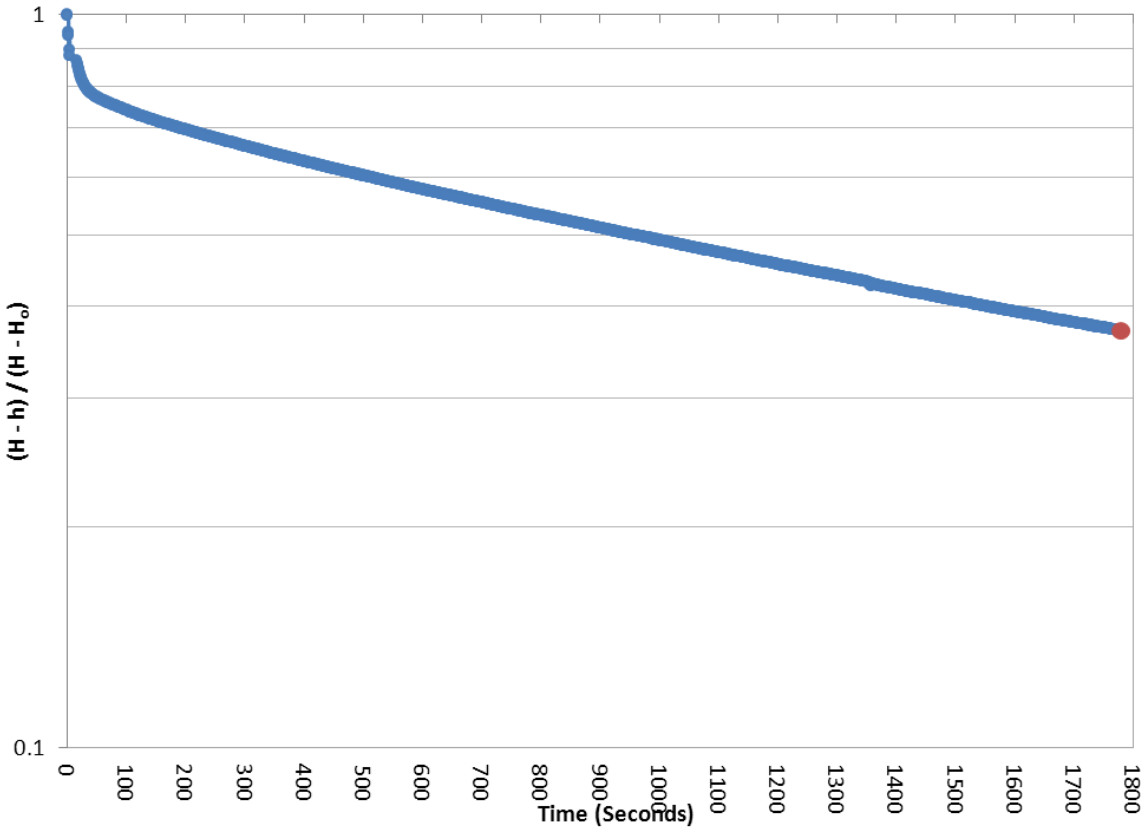
Appendix 6 Slug Test Analysis

Boreholes BH-01-16, BH-02-16 and BH-04-16

Slug Test Analysis Report

Project: Hyland Subdivision, Guelph – Scoped Hydrogeology Study
Project No.: P-0011569-0-01-300
Location: 46,47 & 87 Hyland Road, Guelph, Ontario

Test Well: BH-01-16
Test Date(s): October 31, 2016
Analysis Date: November 20, 2016
Test Conducted by: D. Souter
Analysis Performed by: E. Brears



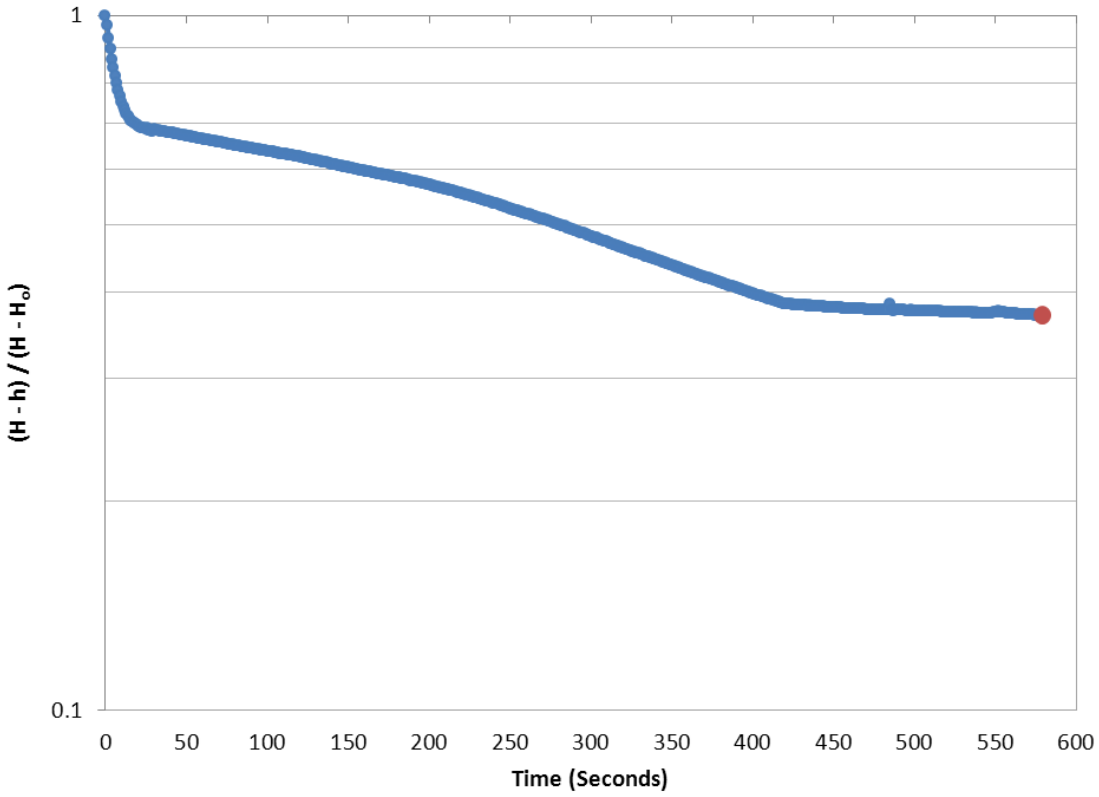
Time Lag: 1779 seconds
Hydraulic Conductivity (m/s): 3.2×10^{-7}
Soil Type: Fine silty sand
Notes:
Calculated using Hvorslev: Slug out, rising head

Englobe

Slug Test Analysis Report

Project: Hyland Subdivision, Guelph – Scoped Hydrogeology Study
Project No.: P-0011569-0-01-300
Location: 46,47 & 87 Hyland Road, Guelph, Ontario

Test Well: BH-02-16
Test Date(s): October 31, 2016
Analysis Date: November 20, 2016
Test Conducted by: D. Souter
Analysis Performed by: E. Brears



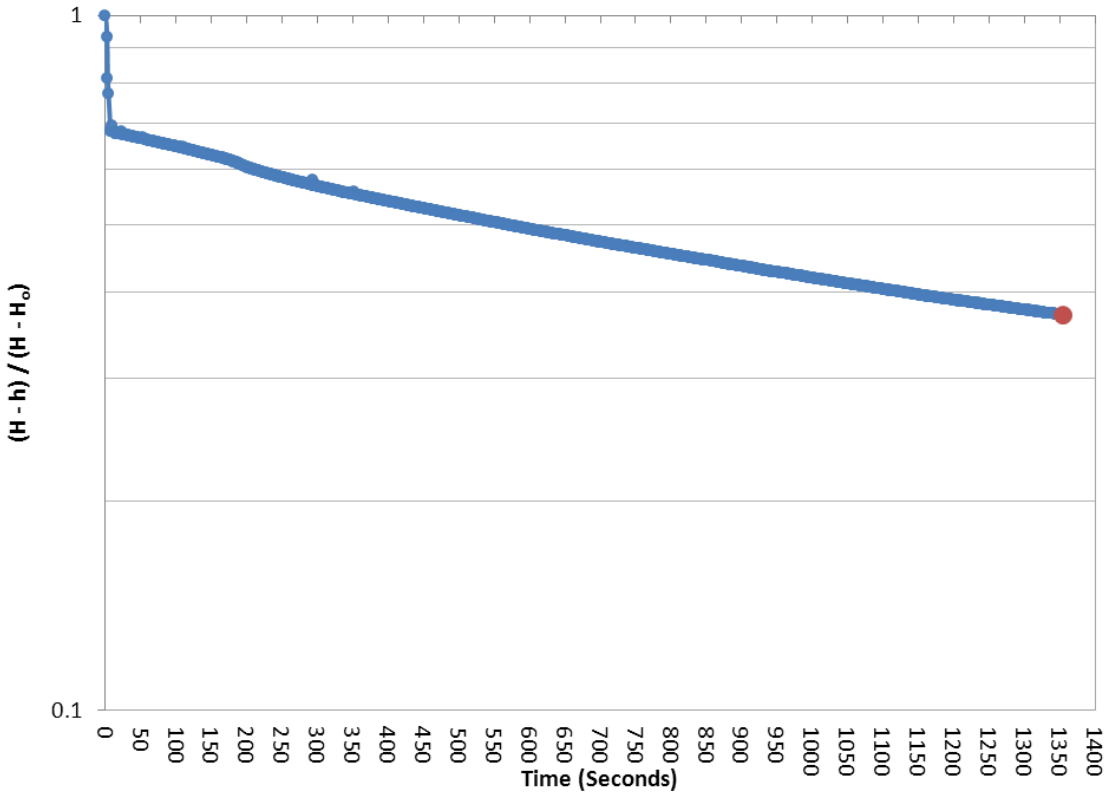
Time Lag: 579 seconds
Hydraulic Conductivity (m/s): 9.8×10^{-7}
Soil Type: Silty sand and gravel
Notes:
Calculated using Hvorslev: Water in, falling head

Englobe

Slug Test Analysis Report

Project: Hyland Subdivision, Guelph – Scoped Hydrogeology Study
Project No.: P-0011569-0-01-300
Location: 46,47 & 87 Hyland Road, Guelph, Ontario

Test Well: BH-04-16
Test Date(s): October 31, 2016
Analysis Date: November 20, 2016
Test Conducted by: D. Souter
Analysis Performed by: E. Brears



Time Lag: 1356 seconds
Hydraulic Conductivity (m/s): 2.6×10^{-7}
Soil Type: Silty fine sand to silt with some fine sand and clay
Notes:
Calculated using Hvorslev: Slug in, falling head

Englobe

Appendix 7 MOECC Water Well Records

As of September 27, 2016

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
WOOLWICH TOWNSHIP (E ()	17 561099 4825133 W	2004/07 2663	 06	FR 0100	059 / 070 004 / 1:0	DO		6509742 (Z07288) A007215 BLCK LOAM 0002 GREY CLAY STNS 0098 GRVL 0100
GUELPH TOWNSHIP DIV C 05(003)	17 561100 4825135 W	2004/07 2663	 06	FR 0623 FR 0197	057 / 057 012 / 1:0	DO		6714999 (Z07287) A007122 FILL 0016 GREY SAND 0115 GREY CLAY SAND 0131 BRWN LMSN 0144 BRWN LMSN 0295 BRWN LMSN 0525 GREY LMSN 0656
GUELPH TOWNSHIP ()	17 561618 4824392 W	2012/06 6607						7188875 (C17971) A115177 P
GUELPH TOWNSHIP ()	17 561588 4824651 W	2012/03 6809	 02			MT	 96.5 15	7182711 (Z147755) A119972 BRWN GRNT SAND SILT 0035 BRWN SAND WBRG 0068 GREY SILT TILL SAND 0092 GREY LMSN ROCK 0112
GUELPH TOWNSHIP ()	17 561614 4824177 W	2014/09 6875	 02					7234987 (Z189459) A
GUELPH TOWNSHIP ()	17 560802 4824235 W	2012/01 6607	 02	0009		MO	 5 10	7177418 (Z130553) A126273 BRWN SAND SILT CLAY 0013 BRWN SILT SAND CLAY 0015
GUELPH TOWNSHIP ()	17 560921 4824986 W	2012/11 7221	 04			DO		7192060 (Z159330) A
GUELPH TOWNSHIP ()	17 561586 4824064 W	2014/09 6875	 02					7234988 (Z189474) A
GUELPH TOWNSHIP ()	17 560967 4824971 W	2012/09 7320	 02			MO		7189815 (Z157875) A133260 A
GUELPH TOWNSHIP ()	17 560946 4824970 W	2012/08 7320	 02			TH	 5 10	7186634 (Z152395) A133262 BRWN SAND GRVL LOOS 0005 BRWN SILT CLAY SOFT 0014 GREY SILT CLAY DNSE 0015
GUELPH TOWNSHIP ()	17 560476 4824432 W	2013/05 6607						7212259 (C20885) A141541 P
GUELPH TOWNSHIP ()	17 560964 4824972 W	2012/08 7320	 02			TH	 10 10	7186635 (Z152396) A133260 BRWN SAND GRVL PCKD 0005 BRWN SAND GRVL SILT 0015 BRWN SAND GRVL LOOS 0020

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
GUELPH TOWNSHIP ()	17 560458 4824439 W	2015/03 6607	02			MO	57 3	7241315 (Z200020) A175413 A BRWN SAND GRVL 0025 BRWN SILT SAND DNSE 0060
GUELPH TOWNSHIP ()	17 560949 4824951 W	2012/09 7320	02			MO		7189816 (Z157874) A133262 A
GUELPH CITY ()	17 560465 4824458 W	2011/05 6607						7168150 (M10336) A110291 P
GUELPH CITY ()	17 560887 4824897 W	2015/02 7324						7258427 (C28194) A180030 P
GUELPH CITY ()	17 560459 4824186 W	2009/11 6607	02			MO		7136478 (M06215) A092191 BRWN SAND GRVL HARD 0012 BRWN SILT SAND GRVL 0020
GUELPH CITY ()	17 560697 4824076 W	2000/08 2663						6713459 (220621) A
GUELPH CITY ()	17 560929 4824835 W	2006/11 7190	06 02	FR 0014			8 12	7040783 (Z54265) A047971 BRWN FILL SAND GRVL 0010 BRWN SAND SILT GRVL 0014 GREY SAND GRVL WBRG 0020
GUELPH CITY ()	17 560484 4824408 W	2009/10 7238	02			MO		7134351 (M04681) A090733 BRWN SAND GRVL 0020
GUELPH CITY ()	17 560475 4824406 W	2015/05 6607						7254195 (C25947) A179878 P
GUELPH CITY ()	17 560446 4824402 W	2014/09 6607						7262614 (C24030) A157149 P
GUELPH CITY ()	17 560466 4824394 W	2013/09 7383	02	0015		MO	10 10	7208846 (Z166103) A151212 LOAM 0001 FSND SILT 0015 MSND GRVL 0020
GUELPH CITY ()	17 560471 4824402 W	2015/03 6607	02			MO	57 3	7241316 (Z200019) A175339 BRWN SAND GRVL 0030 BRWN SILT SAND DNSE 0060
GUELPH CITY (GUELPH DIV C 05(001))	17 561250 4824185 W	1961/09 2521	04 04	FR 0135	075 / 100 008 / 5:0	DO		6700894 () CLAY 0040 GRVL 0050 CLAY 0085 GRVL MSND 0101 GREY LMSN 0135
GUELPH CITY (GUELPH DIV C 05(001))	17 561283 4824030 W	1952/09 2521	04 04	FR 0125	070 / 090 010 / 0:30	DO		6701115 () CLAY 0050 GRVL 0110 LMSN 0125

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
GUELPH CITY (GUELPH DIV C 05(002)	17 560865 4825057 W	1956/09 2414	04 04	FR 0140	018 / 030 004 / 2:0	CO		6701117 () GRVL STNS 0017 CLAY MSND 0060 MSND 0070 MSND CLAY 0075 BRWN LMSN 0120 BLCK LMSN 0140 GREY LMSN 0147
GUELPH CITY (GUELPH DIV C 05(002)	17 560807 4824911 W	1955/12 2414	05 05	FR 0090	030 / 035 012 / 1:0	CO		6701116 () GRVL CLAY 0010 GRVL MSND 0020 CLAY GRVL 0025 GREY CLAY 0076 CLAY GRVL 0080 CLAY MSND 0083 BRWN LMSN 0110 BLCK LMSN 0117
GUELPH CITY (GUELPH DIV C 05(002)	17 561579 4824321 W	1958/09 2521	04 04	FR 0128	035 / 070 010 / 1:0	DO		6701121 () CLAY 0008 QSND 0081 BRWN LMSN 0128
GUELPH CITY (GUELPH DIV C 05(002)	17 561022 4824658 W	1963/07 2521	04 04	FR 0100	060 / 085 006 / 2:0	DO		6701122 () GRVL CLAY 0020 QSND 0040 CLAY 0080 BRWN LMSN 0100
GUELPH CITY (GUELPH DIV C 05(002)	17 561317 4824111 W	1957/08 2521	04 04	FR 0125	032 / 060 010 / 1:0	DO		6701119 () CLAY 0030 FSND 0060 CLAY 0071 GREY LMSN 0125
GUELPH CITY (GUELPH DIV C 05(002)	17 561436 4824153 W	1958/08 2521	04 04	FR 0116	035 / 080 010 / 1:0	DO		6701120 () CLAY 0064 BRWN LMSN 0116
GUELPH CITY (GUELPH DIV C 06(001)	17 560439 4824648 W	1947/09 2414	06 06	FR 0080	024 / 032 005 / 4:0	DO		6701131 () BRWN CLAY 0013 GRVL 0016 BRWN CLAY 0037 GRVL 0041 HPAN 0056 BRWN CLAY 0069 GRVL 0073 HPAN 0079 BRWN LMSN 0088 WHIT LMSN 0095
GUELPH CITY (GUELPH DIV C 06(001)	17 560802 4824881 W	1959/04 2414	04 04	FR 0086	023 / 027 010 / 2:0	CO		6700889 () LOAM 0002 BLCK CLAY GRVL 0012 MSND GRVL 0021 GREY CLAY 0064 GREY CLAY GRVL 0078 BRWN LMSN 0107
GUELPH CITY (GUELPH DIV C 06(002)	17 560844 4825107 W	1955/03 2414	05 05	FR 0088	028 / 030 005 / 3:0	IN		6701134 () STNS CLAY 0010 GRVL CLAY 0025 CLAY 0065 MSND CLAY 0076 MSND 0082 BRWN LMSN 0112 BLCK LMSN 0116

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
GUELPH CITY (GUELPH DIV F (D)	17 560623 4824663 W	1952/12 2414	10 10	FR 0100	040 / 153 136 / 8:0	NU		6701421 () LOAM 0002 CLAY MSND 0008 GRVL CLAY 0035 CLAY 0044 MSND 0063 CLAY 0074 BRWN LMSN 0101 BLCK LMSN 0125 GREY LMSN 0129 BRWN LMSN 0175 BLUE LMSN 0210 GREY LMSN 0251 BLUE LMSN 0285 BLUE SHLE 0293 RED SHLE 0295

Notes:
1. UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
2. Date Work Completed
3. Well Contractor Licence Number
4. Casing diameter in inches
5. Unit of Depth in Feet
6. See Table 4 for Meaning of Code
7. STAT LVL: Static Water Level in Feet ; PUMP LVL: Water Level After Pumping in Feet
8. Pump Test Rate in GPM, Pump Test Duration in Hour : Minutes
9. See Table 3 for Meaning of Code
10. Screen Depth and Length in feet
11. See Table 1 and 2 for Meaning of Code
12. A: Abandonment; P: Partial Data Entry Only

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	SANDY			

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. Water 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 & Test Hole
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 8 Laboratory Certificate of Analysis

ALS Environmental, Laboratory Work Order No. L1847734

EnGlobe Corp.
ATTN: ELYSHA BREARS
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5

Date Received: 24-OCT-16
Report Date: 31-OCT-16 12:17 (MT)
Version: FINAL

Client Phone: 519-741-1313

Certificate of Analysis

Lab Work Order #: L1847734

Project P.O. #: A05863
Job Reference: P-0011569-0-01-300
C of C Numbers: 15-557339
Legal Site Desc:

Mary-Lynn Pires
Client Services Supervisor

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1
L1847734-1 BH 01-16						
Sampled By: D. SOUTER on 24-OCT-16 @ 11:0						
Matrix: WATER						
Physical Tests						
Colour, Apparent	5.9		2.0	CU	25-OCT-16	
Conductivity	672		3.0	umhos/cm	25-OCT-16	
Hardness (as CaCO3)	334	HTC	10	mg/L	26-OCT-16	
pH	7.63		0.10	pH units	25-OCT-16	6.5-8.5
Total Dissolved Solids	409	DLDS	20	mg/L	26-OCT-16	
Turbidity	11.3		0.10	NTU	25-OCT-16	
Anions and Nutrients						
Alkalinity, Total (as CaCO3)	227		10	mg/L	25-OCT-16	
Ammonia, Total (as N)	0.075		0.020	mg/L	25-OCT-16	
Chloride (Cl)	27.1		0.50	mg/L	28-OCT-16	
Fluoride (F)	0.104		0.020	mg/L	28-OCT-16	
Nitrate (as N)	0.066		0.020	mg/L	28-OCT-16	
Nitrite (as N)	<0.010		0.010	mg/L	28-OCT-16	
Orthophosphate-Dissolved (as P)	0.0106		0.0030	mg/L	25-OCT-16	
Sulfate (SO4)	94.3		0.30	mg/L	28-OCT-16	
Total Metals						
Aluminum (Al)-Total	0.072		0.010	mg/L	26-OCT-16	*0.015
Antimony (Sb)-Total	0.00024		0.00010	mg/L	26-OCT-16	0.02
Arsenic (As)-Total	0.00197		0.00010	mg/L	26-OCT-16	0.005
Barium (Ba)-Total	0.120		0.00020	mg/L	26-OCT-16	
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	26-OCT-16	0.011
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	26-OCT-16	
Boron (B)-Total	0.035		0.010	mg/L	26-OCT-16	0.2
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	26-OCT-16	0.0001
Calcium (Ca)-Total	72.3		0.50	mg/L	26-OCT-16	
Cesium (Cs)-Total	<0.000010		0.000010	mg/L	26-OCT-16	
Chromium (Cr)-Total	<0.00050		0.00050	mg/L	26-OCT-16	
Cobalt (Co)-Total	0.00020		0.00010	mg/L	26-OCT-16	0.0009
Copper (Cu)-Total	<0.0010		0.0010	mg/L	26-OCT-16	0.001
Iron (Fe)-Total	0.098		0.050	mg/L	26-OCT-16	0.3
Lead (Pb)-Total	0.00023		0.00010	mg/L	26-OCT-16	0.001
Magnesium (Mg)-Total	37.2		0.050	mg/L	26-OCT-16	
Manganese (Mn)-Total	0.0600		0.00050	mg/L	26-OCT-16	
Molybdenum (Mo)-Total	0.00830		0.000050	mg/L	26-OCT-16	0.04
Nickel (Ni)-Total	0.00070		0.00050	mg/L	26-OCT-16	0.025
Phosphorus (P)-Total	<0.050		0.050	mg/L	26-OCT-16	**0.01
Potassium (K)-Total	4.47		0.050	mg/L	26-OCT-16	
Rubidium (Rb)-Total	0.00125		0.00020	mg/L	26-OCT-16	
Selenium (Se)-Total	0.000271		0.000050	mg/L	26-OCT-16	0.1
Silicon (Si)-Total	6.66		0.050	mg/L	26-OCT-16	
Silver (Ag)-Total	<0.000050		0.000050	mg/L	26-OCT-16	0.0001
Sodium (Na)-Total	11.6		0.50	mg/L	26-OCT-16	
Strontium (Sr)-Total	0.191		0.0010	mg/L	26-OCT-16	
Sulfur (S)-Total	32.6		0.50	mg/L	26-OCT-16	
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	26-OCT-16	
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	26-OCT-16	0.0003
Thorium (Th)-Total	<0.00010		0.00010	mg/L	26-OCT-16	

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

Surface Water PWQO

#1: Surface Water PWQO

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits
L1847734-1 BH 01-16						
Sampled By: D. SOUTER on 24-OCT-16 @ 11:0						
Matrix: WATER						#1
Total Metals						
Tin (Sn)-Total	0.00061		0.00010	mg/L	26-OCT-16	
Titanium (Ti)-Total	0.00320		0.00030	mg/L	26-OCT-16	
Tungsten (W)-Total	<0.00010		0.00010	mg/L	26-OCT-16	0.03
Uranium (U)-Total	0.00169		0.000010	mg/L	26-OCT-16	0.005
Vanadium (V)-Total	0.00121		0.00050	mg/L	26-OCT-16	0.006
Zinc (Zn)-Total	0.0147		0.0030	mg/L	26-OCT-16	0.02
Zirconium (Zr)-Total	<0.00030		0.00030	mg/L	26-OCT-16	0.004
L1847734-2 BH 02-16						
Sampled By: D. SOUTER on 24-OCT-16 @ 12:2						
Matrix: WATER						#1
Physical Tests						
Colour, Apparent	14.6		2.0	CU	25-OCT-16	
Conductivity	1050		3.0	umhos/cm	25-OCT-16	
Hardness (as CaCO3)	526	HTC	10	mg/L	26-OCT-16	
pH	7.16		0.10	pH units	25-OCT-16	6.5-8.5
Total Dissolved Solids	599	DLDS	20	mg/L	26-OCT-16	
Turbidity	18.2		0.10	NTU	25-OCT-16	
Anions and Nutrients						
Alkalinity, Total (as CaCO3)	448	DLHC	20	mg/L	25-OCT-16	
Ammonia, Total (as N)	0.183		0.020	mg/L	25-OCT-16	
Chloride (Cl)	68.4		0.50	mg/L	28-OCT-16	
Fluoride (F)	0.105		0.020	mg/L	28-OCT-16	
Nitrate (as N)	0.173		0.020	mg/L	28-OCT-16	
Nitrite (as N)	0.043		0.010	mg/L	28-OCT-16	
Orthophosphate-Dissolved (as P)	<0.0030		0.0030	mg/L	25-OCT-16	
Sulfate (SO4)	26.6		0.30	mg/L	28-OCT-16	
Total Metals						
Aluminum (Al)-Total	0.123		0.010	mg/L	26-OCT-16	*0.015
Antimony (Sb)-Total	0.00017		0.00010	mg/L	26-OCT-16	0.02
Arsenic (As)-Total	0.00115		0.00010	mg/L	26-OCT-16	0.005
Barium (Ba)-Total	0.116		0.00020	mg/L	26-OCT-16	
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	26-OCT-16	0.011
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	26-OCT-16	
Boron (B)-Total	0.086		0.010	mg/L	26-OCT-16	0.2
Cadmium (Cd)-Total	0.000036		0.000010	mg/L	26-OCT-16	0.0001
Calcium (Ca)-Total	114		0.50	mg/L	26-OCT-16	
Cesium (Cs)-Total	0.000013		0.000010	mg/L	26-OCT-16	
Chromium (Cr)-Total	<0.00050		0.00050	mg/L	26-OCT-16	
Cobalt (Co)-Total	0.00026		0.00010	mg/L	26-OCT-16	0.0009
Copper (Cu)-Total	0.0016		0.0010	mg/L	26-OCT-16	*0.001
Iron (Fe)-Total	0.319		0.050	mg/L	26-OCT-16	*0.3
Lead (Pb)-Total	0.00114		0.00010	mg/L	26-OCT-16	*0.001
Magnesium (Mg)-Total	58.7		0.050	mg/L	26-OCT-16	
Manganese (Mn)-Total	0.116		0.00050	mg/L	26-OCT-16	
Molybdenum (Mo)-Total	0.00292		0.000050	mg/L	26-OCT-16	0.04

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

Surface Water PWQO

#1: Surface Water PWQO

Sample Details Grouping	Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits
L1847734-2	BH 02-16						
Sampled By:	D. SOUTER on 24-OCT-16 @ 12:2						
Matrix:	WATER						#1
Total Metals							
	Nickel (Ni)-Total	0.00148		0.00050	mg/L	26-OCT-16	0.025
	Phosphorus (P)-Total	<0.050		0.050	mg/L	26-OCT-16	**0.01
	Potassium (K)-Total	3.44		0.050	mg/L	26-OCT-16	
	Rubidium (Rb)-Total	0.00173		0.00020	mg/L	26-OCT-16	
	Selenium (Se)-Total	0.000148		0.000050	mg/L	26-OCT-16	0.1
	Silicon (Si)-Total	8.66		0.050	mg/L	26-OCT-16	
	Silver (Ag)-Total	<0.000050		0.000050	mg/L	26-OCT-16	0.0001
	Sodium (Na)-Total	23.9		0.50	mg/L	26-OCT-16	
	Strontium (Sr)-Total	0.269		0.0010	mg/L	26-OCT-16	
	Sulfur (S)-Total	9.68		0.50	mg/L	26-OCT-16	
	Tellurium (Te)-Total	<0.00020		0.00020	mg/L	26-OCT-16	
	Thallium (Tl)-Total	0.000020		0.000010	mg/L	26-OCT-16	0.0003
	Thorium (Th)-Total	<0.00010		0.00010	mg/L	26-OCT-16	
	Tin (Sn)-Total	0.00144		0.00010	mg/L	26-OCT-16	
	Titanium (Ti)-Total	0.00482		0.00030	mg/L	26-OCT-16	
	Tungsten (W)-Total	<0.00010		0.00010	mg/L	26-OCT-16	0.03
	Uranium (U)-Total	0.000568		0.000010	mg/L	26-OCT-16	0.005
	Vanadium (V)-Total	0.00084		0.00050	mg/L	26-OCT-16	0.006
	Zinc (Zn)-Total	0.0335		0.0030	mg/L	26-OCT-16	*0.02
	Zirconium (Zr)-Total	<0.00030		0.00030	mg/L	26-OCT-16	0.004
L1847734-3	BH 04-16						
Sampled By:	D. SOUTER on 24-OCT-16 @ 14:3						
Matrix:	WATER						#1
Physical Tests							
	Colour, Apparent	19.7		2.0	CU	25-OCT-16	
	Conductivity	464		3.0	umhos/cm	25-OCT-16	
	Hardness (as CaCO3)	223	HTC	10	mg/L	26-OCT-16	
	pH	7.80		0.10	pH units	25-OCT-16	6.5-8.5
	Total Dissolved Solids	247	DLDS	20	mg/L	26-OCT-16	
	Turbidity	17.5		0.10	NTU	25-OCT-16	
Anions and Nutrients							
	Alkalinity, Total (as CaCO3)	235		10	mg/L	25-OCT-16	
	Ammonia, Total (as N)	0.186		0.020	mg/L	25-OCT-16	
	Chloride (Cl)	3.90		0.50	mg/L	28-OCT-16	
	Fluoride (F)	0.109		0.020	mg/L	28-OCT-16	
	Nitrate (as N)	<0.020		0.020	mg/L	28-OCT-16	
	Nitrite (as N)	<0.010		0.010	mg/L	28-OCT-16	
	Orthophosphate-Dissolved (as P)	<0.0030		0.0030	mg/L	25-OCT-16	
	Sulfate (SO4)	24.4		0.30	mg/L	28-OCT-16	
Total Metals							
	Aluminum (Al)-Total	0.143		0.010	mg/L	26-OCT-16	*0.015
	Antimony (Sb)-Total	0.00018		0.00010	mg/L	26-OCT-16	0.02
	Arsenic (As)-Total	0.00964		0.00010	mg/L	26-OCT-16	*0.005
	Barium (Ba)-Total	0.0778		0.00020	mg/L	26-OCT-16	
	Beryllium (Be)-Total	<0.00010		0.00010	mg/L	26-OCT-16	0.011

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

Surface Water PWQO

#1: Surface Water PWQO

Sample Details Grouping / Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1
L1847734-3 BH 04-16						
Sampled By: D. SOUTER on 24-OCT-16 @ 14:3						
Matrix: WATER						
Total Metals						
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	26-OCT-16	
Boron (B)-Total	0.030		0.010	mg/L	26-OCT-16	0.2
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L	26-OCT-16	0.0001
Calcium (Ca)-Total	38.4		0.50	mg/L	26-OCT-16	
Cesium (Cs)-Total	0.000016		0.000010	mg/L	26-OCT-16	
Chromium (Cr)-Total	0.00076		0.00050	mg/L	26-OCT-16	
Cobalt (Co)-Total	0.00016		0.00010	mg/L	26-OCT-16	0.0009
Copper (Cu)-Total	0.0010		0.0010	mg/L	26-OCT-16	0.001
Iron (Fe)-Total	0.221		0.050	mg/L	26-OCT-16	0.3
Lead (Pb)-Total	0.00025		0.00010	mg/L	26-OCT-16	0.001
Magnesium (Mg)-Total	30.7		0.050	mg/L	26-OCT-16	
Manganese (Mn)-Total	0.0293		0.00050	mg/L	26-OCT-16	
Molybdenum (Mo)-Total	0.00500		0.000050	mg/L	26-OCT-16	0.04
Nickel (Ni)-Total	<0.00050		0.00050	mg/L	26-OCT-16	0.025
Phosphorus (P)-Total	<0.050		0.050	mg/L	26-OCT-16	**0.01
Potassium (K)-Total	1.75		0.050	mg/L	26-OCT-16	
Rubidium (Rb)-Total	0.00075		0.00020	mg/L	26-OCT-16	
Selenium (Se)-Total	0.000057		0.000050	mg/L	26-OCT-16	0.1
Silicon (Si)-Total	9.53		0.050	mg/L	26-OCT-16	
Silver (Ag)-Total	<0.000050		0.000050	mg/L	26-OCT-16	0.0001
Sodium (Na)-Total	14.3		0.50	mg/L	26-OCT-16	
Strontium (Sr)-Total	0.283		0.0010	mg/L	26-OCT-16	
Sulfur (S)-Total	8.14		0.50	mg/L	26-OCT-16	
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	26-OCT-16	
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	26-OCT-16	0.0003
Thorium (Th)-Total	<0.00010		0.00010	mg/L	26-OCT-16	
Tin (Sn)-Total	0.00070		0.00010	mg/L	26-OCT-16	
Titanium (Ti)-Total	0.00642		0.00030	mg/L	26-OCT-16	
Tungsten (W)-Total	<0.00010		0.00010	mg/L	26-OCT-16	0.03
Uranium (U)-Total	0.000360		0.000010	mg/L	26-OCT-16	0.005
Vanadium (V)-Total	0.00063		0.00050	mg/L	26-OCT-16	0.006
Zinc (Zn)-Total	0.0113		0.0030	mg/L	26-OCT-16	0.02
Zirconium (Zr)-Total	<0.00030		0.00030	mg/L	26-OCT-16	0.004

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

Surface Water PWQO

#1: Surface Water PWQO

Reference Information

Sample Parameter Qualifier key listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference***
ALK-WT	Water	Alkalinity, Total (as CaCO3)	EPA 310.2
CL-IC-WT	Water	Chloride by IC	EPA 300.1 (mod)

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

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

COLOUR-WT	Water	Colour	APHA 2120

Apparent Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method after sample decanting. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.

EC-WT	Water	Conductivity	APHA 2510 B

Water samples can be measured directly by immersing the conductivity cell into the sample.

F-IC-N-WT	Water	Fluoride in Water by IC	EPA 300.1 (mod)

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

HARDNESS-CALC-WT	Water	Hardness	APHA 2340 B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

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

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

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

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

NH3-WT	Water	Ammonia, Total as N	EPA 350.1

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

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

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

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

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

PH-WT	Water	pH	APHA 4500 H-Electrode

Water samples are analyzed directly by a calibrated pH meter.

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

PH-WT	Water	pH	MOEE E3137A-R511

Water samples are analyzed directly by a calibrated pH meter.

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

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

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

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

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

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

A well-mixed sample is filtered though glass fibres filter. A known volume of the filtrate is evaporated and dried at 105–5°C overnight and then 180–10°C for 1hr.

Reference Information

TURBIDITY-WT	Water	Turbidity	APHA 2130 B

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

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

Chain of Custody numbers:

15-557339

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

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

GLOSSARY OF REPORT TERMS

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

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

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information.

Quality Control Report

Workorder: L1847734 Report Date: 31-OCT-16

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: ELYSHA BREARS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-WT	**Water**							
Batch R3579604								
WG2418772-7 CRM		**WT-ALK-CRM**						
Alkalinity, Total (as CaCO3)			101.5		%		80-120	25-OCT-16
WG2418772-8 DUP		**L1848195-2**						
Alkalinity, Total (as CaCO3)		25	25		mg/L	1.1	20	25-OCT-16
WG2418772-6 LCS								
Alkalinity, Total (as CaCO3)			100.3		%		85-115	25-OCT-16
WG2418772-5 MB								
Alkalinity, Total (as CaCO3)			<10		mg/L		10	25-OCT-16
CL-IC-WT	**Water**							
Batch R3583332								
WG2421813-4 DUP		**WG2421813-3**						
Chloride (Cl)		3.87	3.87		mg/L	0.2	25	28-OCT-16
WG2421813-2 LCS								
Chloride (Cl)			100.4		%		70-130	28-OCT-16
WG2421813-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	28-OCT-16
WG2421813-5 MS		**WG2421813-3**						
Chloride (Cl)			100.5		%		70-130	28-OCT-16
COLOUR-WT	**Water**							
Batch R3580487								
WG2419701-3 CRM		**WT-COLOUR-CRM**						
Colour, Apparent			93.2		%		80-120	25-OCT-16
WG2419701-4 DUP		**L1847566-1**						
Colour, Apparent		<2.0	<2.0	RPD-NA	CU	N/A	20	25-OCT-16
WG2419701-2 LCS								
Colour, Apparent			99.8		%		80-120	25-OCT-16
WG2419701-1 MB								
Colour, Apparent			<2.0		CU		2	25-OCT-16
EC-WT	**Water**							
Batch R3578976								
WG2417960-4 DUP		**WG2417960-3**						
Conductivity		394	394		umhos/cm	0.0	10	25-OCT-16
WG2417960-2 LCS								
Conductivity			98.9		%		90-110	25-OCT-16
WG2417960-1 MB								
Conductivity			<3.0		umhos/cm		3	25-OCT-16
F-IC-N-WT	**Water**							

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: ELYSHA BREARS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F-IC-N-WT	**Water**							
Batch R3583332								
WG2421813-4 DUP		**WG2421813-3**						
Fluoride (F)		0.110	0.107		mg/L	3.4	20	28-OCT-16
WG2421813-2 LCS								
Fluoride (F)			101.0		%		90-110	28-OCT-16
WG2421813-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	28-OCT-16
WG2421813-5 MS		**WG2421813-3**						
Fluoride (F)			97.0		%		75-125	28-OCT-16
MET-T-CCMS-WT	**Water**							
Batch R3579798								
WG2417873-9 DUP		**WG2417873-8**						
Aluminum (Al)-Total		<0.010	<0.010	RPD-NA	mg/L	N/A	20	25-OCT-16
Antimony (Sb)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	25-OCT-16
Arsenic (As)-Total		0.00012	0.00013		mg/L	2.0	20	25-OCT-16
Barium (Ba)-Total		0.0430	0.0435		mg/L	1.2	20	25-OCT-16
Beryllium (Be)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	25-OCT-16
Bismuth (Bi)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	25-OCT-16
Boron (B)-Total		<0.010	<0.010	RPD-NA	mg/L	N/A	20	25-OCT-16
Cadmium (Cd)-Total		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	25-OCT-16
Calcium (Ca)-Total		72.8	73.1		mg/L	0.4	20	25-OCT-16
Chromium (Cr)-Total		0.00090	0.00090		mg/L	0.3	20	25-OCT-16
Cesium (Cs)-Total		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	25-OCT-16
Cobalt (Co)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	25-OCT-16
Copper (Cu)-Total		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	25-OCT-16
Iron (Fe)-Total		<0.050	<0.050	RPD-NA	mg/L	N/A	20	25-OCT-16
Lead (Pb)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	25-OCT-16
Magnesium (Mg)-Total		29.2	29.1		mg/L	0.3	20	25-OCT-16
Manganese (Mn)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	25-OCT-16
Molybdenum (Mo)-Total		0.000289	0.000267		mg/L	7.8	20	25-OCT-16
Nickel (Ni)-Total		0.00055	0.00059		mg/L	7.5	20	25-OCT-16
Phosphorus (P)-Total		<0.050	<0.050	RPD-NA	mg/L	N/A	20	25-OCT-16
Potassium (K)-Total		1.30	1.29		mg/L	0.6	20	25-OCT-16
Rubidium (Rb)-Total		0.00068	0.00071		mg/L	3.3	20	25-OCT-16
Selenium (Se)-Total		0.000204	0.000199		mg/L	2.4	20	25-OCT-16
Silicon (Si)-Total		3.40	3.41		mg/L	0.3	20	25-OCT-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: ELYSHA BREARS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R3579798								
WG2417873-9 DUP		**WG2417873-8**						
Silver (Ag)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	25-OCT-16
Sodium (Na)-Total		5.93	5.76		mg/L	2.9	20	25-OCT-16
Strontium (Sr)-Total		0.368	0.370		mg/L	0.4	20	25-OCT-16
Sulfur (S)-Total		3.35	3.43		mg/L	2.3	25	25-OCT-16
Thallium (Tl)-Total		0.000017	0.000015		mg/L	10	20	25-OCT-16
Tellurium (Te)-Total		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	25-OCT-16
Thorium (Th)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	25	25-OCT-16
Tin (Sn)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	25-OCT-16
Titanium (Ti)-Total		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	25-OCT-16
Tungsten (W)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	25-OCT-16
Uranium (U)-Total		0.000562	0.000551		mg/L	1.9	20	25-OCT-16
Vanadium (V)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	25-OCT-16
Zinc (Zn)-Total		<0.0030	<0.0030	RPD-NA	mg/L	N/A	20	25-OCT-16
Zirconium (Zr)-Total		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	25-OCT-16
WG2417873-7 LCS								
Aluminum (Al)-Total			98.1		%		80-120	25-OCT-16
Antimony (Sb)-Total			102.6		%		80-120	25-OCT-16
Arsenic (As)-Total			99.8		%		80-120	25-OCT-16
Barium (Ba)-Total			99.9		%		80-120	25-OCT-16
Beryllium (Be)-Total			93.9		%		80-120	25-OCT-16
Bismuth (Bi)-Total			99.99		%		80-120	25-OCT-16
Boron (B)-Total			95.7		%		80-120	25-OCT-16
Cadmium (Cd)-Total			99.9		%		80-120	25-OCT-16
Calcium (Ca)-Total			102.3		%		80-120	25-OCT-16
Chromium (Cr)-Total			98.6		%		80-120	25-OCT-16
Cesium (Cs)-Total			97.3		%		80-120	25-OCT-16
Cobalt (Co)-Total			98.4		%		80-120	25-OCT-16
Copper (Cu)-Total			98.4		%		80-120	25-OCT-16
Iron (Fe)-Total			94.9		%		80-120	25-OCT-16
Lead (Pb)-Total			99.9		%		80-120	25-OCT-16
Magnesium (Mg)-Total			97.7		%		80-120	25-OCT-16
Manganese (Mn)-Total			98.4		%		80-120	25-OCT-16
Molybdenum (Mo)-Total			98.3		%		80-120	25-OCT-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: ELYSHA BREARS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R3579798								
WG2417873-7 LCS								
Nickel (Ni)-Total			98.5		%		80-120	25-OCT-16
Phosphorus (P)-Total			86.7		%		80-120	25-OCT-16
Potassium (K)-Total			94.2		%		80-120	25-OCT-16
Rubidium (Rb)-Total			100.9		%		80-120	25-OCT-16
Selenium (Se)-Total			99.98		%		80-120	25-OCT-16
Silicon (Si)-Total			102.6		%		80-120	25-OCT-16
Silver (Ag)-Total			99.7		%		80-120	25-OCT-16
Sodium (Na)-Total			98.6		%		80-120	25-OCT-16
Strontium (Sr)-Total			98.2		%		80-120	25-OCT-16
Sulfur (S)-Total			96.8		%		70-130	25-OCT-16
Thallium (Tl)-Total			96.4		%		80-120	25-OCT-16
Tellurium (Te)-Total			96.8		%		80-120	25-OCT-16
Thorium (Th)-Total			96.2		%		70-130	25-OCT-16
Tin (Sn)-Total			99.3		%		80-120	25-OCT-16
Titanium (Ti)-Total			98.7		%		80-120	25-OCT-16
Tungsten (W)-Total			98.3		%		80-120	25-OCT-16
Uranium (U)-Total			100.6		%		80-120	25-OCT-16
Vanadium (V)-Total			100.1		%		80-120	25-OCT-16
Zinc (Zn)-Total			95.0		%		80-120	25-OCT-16
Zirconium (Zr)-Total			94.0		%		80-120	25-OCT-16
WG2417873-6 MB								
Aluminum (Al)-Total			<0.010		mg/L		0.01	25-OCT-16
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	25-OCT-16
Arsenic (As)-Total			<0.00010		mg/L		0.0001	25-OCT-16
Barium (Ba)-Total			<0.00020		mg/L		0.0002	25-OCT-16
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	25-OCT-16
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	25-OCT-16
Boron (B)-Total			<0.010		mg/L		0.01	25-OCT-16
Cadmium (Cd)-Total			<0.000010		mg/L		0.00001	25-OCT-16
Calcium (Ca)-Total			<0.50		mg/L		0.5	25-OCT-16
Chromium (Cr)-Total			<0.00050		mg/L		0.0005	25-OCT-16
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	25-OCT-16
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	25-OCT-16
Copper (Cu)-Total			<0.0010		mg/L		0.001	25-OCT-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: ELYSHA BREARS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R3579798								
WG2417873-6 MB								
Iron (Fe)-Total			<0.050		mg/L		0.05	25-OCT-16
Lead (Pb)-Total			<0.00010		mg/L		0.0001	25-OCT-16
Magnesium (Mg)-Total			<0.050		mg/L		0.05	25-OCT-16
Manganese (Mn)-Total			<0.00050		mg/L		0.0005	25-OCT-16
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	25-OCT-16
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	25-OCT-16
Phosphorus (P)-Total			<0.050		mg/L		0.05	25-OCT-16
Potassium (K)-Total			<0.050		mg/L		0.05	25-OCT-16
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	25-OCT-16
Selenium (Se)-Total			<0.000050		mg/L		0.00005	25-OCT-16
Silicon (Si)-Total			<0.050		mg/L		0.05	25-OCT-16
Silver (Ag)-Total			<0.000050		mg/L		0.00005	25-OCT-16
Sodium (Na)-Total			<0.50		mg/L		0.5	25-OCT-16
Strontium (Sr)-Total			<0.0010		mg/L		0.001	25-OCT-16
Sulfur (S)-Total			<0.50		mg/L		0.5	25-OCT-16
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	25-OCT-16
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	25-OCT-16
Thorium (Th)-Total			<0.00010		mg/L		0.0001	25-OCT-16
Tin (Sn)-Total			<0.00010		mg/L		0.0001	25-OCT-16
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	25-OCT-16
Tungsten (W)-Total			<0.00010		mg/L		0.0001	25-OCT-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	25-OCT-16
Vanadium (V)-Total			<0.00050		mg/L		0.0005	25-OCT-16
Zinc (Zn)-Total			<0.0030		mg/L		0.003	25-OCT-16
Zirconium (Zr)-Total			<0.00030		mg/L		0.0003	25-OCT-16
WG2417873-10 MS		**WG2417873-8**						
Aluminum (Al)-Total			97.1		%		70-130	25-OCT-16
Antimony (Sb)-Total			104.4		%		70-130	25-OCT-16
Arsenic (As)-Total			95.9		%		70-130	25-OCT-16
Barium (Ba)-Total			N/A	MS-B	%		-	25-OCT-16
Beryllium (Be)-Total			94.2		%		70-130	25-OCT-16
Bismuth (Bi)-Total			90.1		%		70-130	25-OCT-16
Boron (B)-Total			113.0		%		70-130	25-OCT-16
Cadmium (Cd)-Total			97.5		%		70-130	25-OCT-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: ELYSHA BREARS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WT	**Water**							
Batch R3579798								
WG2417873-10 MS		**WG2417873-8**						
Calcium (Ca)-Total			N/A	MS-B	%		-	25-OCT-16
Chromium (Cr)-Total			96.0		%		70-130	25-OCT-16
Cesium (Cs)-Total			97.7		%		70-130	25-OCT-16
Cobalt (Co)-Total			94.8		%		70-130	25-OCT-16
Copper (Cu)-Total			95.3		%		70-130	25-OCT-16
Iron (Fe)-Total			92.2		%		70-130	25-OCT-16
Lead (Pb)-Total			90.9		%		70-130	25-OCT-16
Magnesium (Mg)-Total			N/A	MS-B	%		-	25-OCT-16
Manganese (Mn)-Total			97.1		%		70-130	25-OCT-16
Molybdenum (Mo)-Total			96.2		%		70-130	25-OCT-16
Nickel (Ni)-Total			92.8		%		70-130	25-OCT-16
Phosphorus (P)-Total			113.9		%		70-130	25-OCT-16
Potassium (K)-Total			99.0		%		70-130	25-OCT-16
Rubidium (Rb)-Total			99.97		%		70-130	25-OCT-16
Selenium (Se)-Total			97.2		%		70-130	25-OCT-16
Silicon (Si)-Total			N/A	MS-B	%		-	25-OCT-16
Silver (Ag)-Total			98.1		%		70-130	25-OCT-16
Sodium (Na)-Total			N/A	MS-B	%		-	25-OCT-16
Strontium (Sr)-Total			N/A	MS-B	%		-	25-OCT-16
Sulfur (S)-Total			N/A	MS-B	%		-	25-OCT-16
Thallium (Tl)-Total			88.9		%		70-130	25-OCT-16
Tellurium (Te)-Total			95.8		%		70-130	25-OCT-16
Thorium (Th)-Total			91.4		%		70-130	25-OCT-16
Tin (Sn)-Total			99.5		%		70-130	25-OCT-16
Titanium (Ti)-Total			95.4		%		70-130	25-OCT-16
Tungsten (W)-Total			92.7		%		70-130	25-OCT-16
Uranium (U)-Total			N/A	MS-B	%		-	25-OCT-16
Vanadium (V)-Total			99.8		%		70-130	25-OCT-16
Zinc (Zn)-Total			100.7		%		70-130	25-OCT-16
Zirconium (Zr)-Total			92.6		%		70-130	25-OCT-16
NH3-WT	**Water**							

Quality Control Report

Workorder: L1847734 Report Date: 31-OCT-16

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: ELYSHA BREARS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-WT	**Water**							
Batch R3579332								
WG2418112-11 DUP		**L1847736-1**						
Ammonia, Total (as N)		0.578	0.569		mg/L	1.5	20	25-OCT-16
WG2418112-10 LCS								
Ammonia, Total (as N)			99.2		%		85-115	25-OCT-16
WG2418112-9 MB								
Ammonia, Total (as N)			<0.020		mg/L		0.02	25-OCT-16
WG2418112-12 MS		**L1847736-1**						
Ammonia, Total (as N)			N/A	MS-B	%		-	25-OCT-16
NO2-IC-WT	**Water**							
Batch R3583332								
WG2421813-4 DUP		**WG2421813-3**						
Nitrite (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	25	28-OCT-16
WG2421813-2 LCS								
Nitrite (as N)			101.0		%		70-130	28-OCT-16
WG2421813-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	28-OCT-16
WG2421813-5 MS		**WG2421813-3**						
Nitrite (as N)			100.9		%		70-130	28-OCT-16
NO3-IC-WT	**Water**							
Batch R3583332								
WG2421813-4 DUP		**WG2421813-3**						
Nitrate (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	25	28-OCT-16
WG2421813-2 LCS								
Nitrate (as N)			100.6		%		70-130	28-OCT-16
WG2421813-1 MB								
Nitrate (as N)			<0.020		mg/L		0.02	28-OCT-16
WG2421813-5 MS		**WG2421813-3**						
Nitrate (as N)			99.3		%		70-130	28-OCT-16
PH-WT	**Water**							
Batch R3578972								
WG2417957-3 DUP		**WG2417957-2**						
pH		8.43	8.44	J	pH units	0.01	0.2	25-OCT-16
WG2417957-6 DUP		**WG2417957-5**						
pH		7.16	7.17	J	pH units	0.01	0.2	25-OCT-16
WG2417957-1 LCS								
pH			6.99		pH units		6.9-7.1	25-OCT-16
WG2417957-4 LCS								

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: ELYSHA BREARS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-WT	**Water**							
Batch R3578972								
WG2417957-4 LCS								
pH			7.03		pH units		6.9-7.1	25-OCT-16
PO4-DO-COL-WT	**Water**							
Batch R3579261								
WG2418332-7 DUP		**L1847471-3**						
Orthophosphate-Dissolved (as P)		0.0062	0.0056		mg/L	9.4	30	25-OCT-16
WG2418332-6 LCS								
Orthophosphate-Dissolved (as P)			99.4		%		70-130	25-OCT-16
WG2418332-5 MB								
Orthophosphate-Dissolved (as P)			<0.0030		mg/L		0.003	25-OCT-16
WG2418332-8 MS		**L1847471-3**						
Orthophosphate-Dissolved (as P)			93.2		%		70-130	25-OCT-16
SO4-IC-N-WT	**Water**							
Batch R3583332								
WG2421813-4 DUP		**WG2421813-3**						
Sulfate (SO4)		24.4	24.3		mg/L	0.3	20	28-OCT-16
WG2421813-2 LCS								
Sulfate (SO4)			100.7		%		90-110	28-OCT-16
WG2421813-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	28-OCT-16
WG2421813-5 MS		**WG2421813-3**						
Sulfate (SO4)			96.7		%		75-125	28-OCT-16
SOLIDS-TDS-WT	**Water**							
Batch R3583255								
WG2419604-3 DUP		**L1847734-1**						
Total Dissolved Solids		409	399		mg/L	2.5	20	26-OCT-16
WG2419604-2 LCS								
Total Dissolved Solids			96.4		%		85-115	26-OCT-16
WG2419604-1 MB								
Total Dissolved Solids			<10		mg/L		10	26-OCT-16
TURBIDITY-WT	**Water**							
Batch R3579253								
WG2418202-3 DUP		**L1847734-2**						
Turbidity		18.2	17.6		NTU	3.4	15	25-OCT-16
WG2418202-2 LCS								
Turbidity			97.3		%		85-115	25-OCT-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: ELYSHA BREARS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-WT	**Water**							
Batch R3579253								
WG2418202-1 MB								
Turbidity			<0.10		NTU		0.1	25-OCT-16

Quality Control Report

Workorder: L1847734 Report Date: 31-OCT-16

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: ELYSHA BREARS

Legend:

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

Sample Parameter Qualifier Definitions:

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

Hold Time Exceedances:

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

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

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

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

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1847734-COFC

COC Number: 15 - 557339

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Englobe
Contact:	Elysha Brears
Phone:	
	Company address below will appear on the final report
Street:	
City/Province:	Kitchener
Postal Code:	
Invoice To	Same as Report To ☐ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution

Select Report Format: ☐ PDF ☐ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax: Elysha.Brears@englobecorp.com
Email 2:
Email 3:

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax:
Email 2:

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

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

PRIORITY (Business Days): 4 day [P4] ☐ | 3 day [P3] ☐ | 2 day [P2] ☐
EMERGENCY: 1 Business day [E1] ☐ | Same Day, Weekend or Statutory holiday [E0] ☐

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

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

Project Information	
ALS Account # / Quote #:	
Job #:	P-0011569-0-01-306
PO / AFE:	A05863
LSD:	

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

ALS Lab Work Order # (lab use only): OCT24B L1847734 CG

ALS Contact:

Sampler: Dan Souter

Analysis Request

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

Gen Chem PKL

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Number of Containers
1	01-16	24-10-16	11:00	Water	4
2	02-16	"	12:20	"	4
3	03-16	"	14:30	"	4
					4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

PWQO

SAMPLE CONDITION AS RECEIVED (lab use only)

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

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
			5.0	5.5	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Dan Souter	Date: 24-10-16	Time: 1550	Received by:	Date:	Time:	Received by: AH	Date: 24 OCT 16	Time: 1645

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

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

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