# 190-216 Arkell Road
# Guelph, Ontario

## Hydrogeological Assessment Report

**Project Location:**
190 - 216 Arkell Road, Guelph, ON

**Prepared for:**
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**MTE File No.:** 42063-104

*Engineers, Scientists, Surveyors.*

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# 1.0 Introduction

## 1.1 Overview

MTE Consultants Inc. (MTE) was retained by Crescent Homes to conduct a Hydrogeological Assessment in support of a Draft Plan of Subdivision application for lands located at municipal addresses 190, 202, 210, and 216 Arkell Road in Guelph, herein referred to as the 'Subject Lands' (see **Figure 1).**

The Concept Plan for the Subject Lands was prepared by MHBC, dated April 28, 2021, and is presented in **Appendix A**.

The Draft Plan includes the following:

- One municipal road (Street A);
- Multiple Residential Blocks (Blocks 1-5);
- One Open Space Block (Block 6);
- One Stormwater Management Facility Block (Block 7); and
- One Road Widening Block (Block 8).

The proposed development is to be municipally serviced, including sanitary sewage collection, domestic water supply, storm drainage, and utilities.

This report is to be read in conjunction with the following reports:

- Preliminary Stormwater Management Report – 190-216 Arkell Road (dated October 10, 2018, Revised April 7, 2020, and December 3, 2021), prepared by MTE; and
- Functional Servicing Report – 190-216 Arkell Road (dated October 10,218, Revised April 7, 2020 and December 3, 2021), prepared by MTE.

## 1.2 Scope and Methodology

The purpose of this Hydrogeological Assessment is to develop a Hydrogeological Conceptual Site Model (HCSM) to aid in the evaluation of potential impacts on the existing groundwater and/or surface water systems, potential groundwater users, and natural ecosystem functions as a result of the proposed development of the Subject Lands. Hydrogeological information gathered through the Hydrogeological Assessment will be used to support the civil design.

The following scope of work was implemented to meet these objectives:

1) Background Review

- Review available mapping from the Ministry of Natural Resources and Forestry (MNRF), Ontario Geologic Society (OGS), Ministry of the Environment, Conservation and Parks (MECP), Grand River Conservation Authority (GRCA), and the City of Guelph.
- Site description.
- Proposed Development Design Features.
- Review of select wells within 500 m of the Subject Lands to identify:
  - Neighbouring wells;
  - Well depths;

    - Well construction details; and
    - Local geologic information.

2) Field Investigation
    - Advance six overburden boreholes and install four overburden groundwater monitoring wells on-Site overseen by Peto MacCallum Ltd (PML) to assess subsurface geologic conditions;
    - Installation of one mini-piezometer;
    - Fitting of the monitoring wells and mini-piezometer with electronic pressure transducers (data loggers) to monitor groundwater levels on a continuous basis;
    - Collecting manual groundwater measurement to facilitate the local groundwater flow direction interpretation;
    - Hydraulic field testing of monitoring wells to determine hydraulic conductivity and average linear groundwater velocity;
    - Collection of groundwater quality samples to document pre-construction (background) conditions; and
    - In-situ infiltration testing using a Guelph Permeameter to document existing infiltration rates of the native sediments.
3) Analysis and Reporting:
    - Provide a geologic and hydrogeological summary of the Subject Lands based on information gathered during the Hydrogeological Assessment;
    - Prepare geological cross-sections through the Subject Lands;
    - Assess the local shallow groundwater levels, flow direction, chemistry, and interaction with surface water;
    - Provide a seasonal high water table map to facilitate estimation of vertical separation distances from footings and utilities to the water table;
    - Estimate the pre-development water balance;
    - Provide an assessment of impacts the proposed development may have on water supply wells and surface water within 500 m of the Subject Lands; and
    - Provide a preliminary assessment of construction dewatering requirements (if any).

## 1.3 Additional Investigations

A Geotechnical Report was completed for the Subject Lands by Peto MacCallum Ltd. (Peto), dated April 20, 2017. Geological information collected during the geotechnical investigation was incorporated into the conceptual hydrogeological model of the Subject Lands.

A Phase I Environmental Site Assessment (ESA) was completed for the Subject lands by MTE, dated November 16, 2018 that identified potential environmental concerns within the limits of the Subject Lands. Therefore, a Phase II ESA was recommended.

A Phase II ESA was completed for the Subject Lands by MTE, dated January 10, 2020. Hydrogeological information collected during the Phase II ESA was incorporated into the conceptual hydrogeological model of the Subject Lands.

# 2.0 Subject Lands Description

The Subject Lands comprise an area of approximately 2.5 hectares (6.3 acres) and are located north of the Arkell Road and Summerfield Drive intersection. The Study Area for the Subject Lands, including the property boundary, geological cross-section locations, monitoring wells and existing features is illustrated on **Figure 2**.

The land use within the Subject Lands is residential. Currently, residential dwellings and associated landscaped and parking areas are present within the southern portion of the properties.

The City of Guelph Official Plan identifies the Subject Lands as within a 'Greenfield Area' and classifies the property as 'Low Density Greenfield Residential'. The City of Guelph Official Plan does not identify the Subject Lands as a Regulatory Floodplain; however, a Significant Natural Area is illustrated along the northwest boundary of the Subject Lands. The Ministry of Natural Resources and Forestry (MNRF) identifies this feature as the Torrence Creek Swamp Provincially Significant Wetland (PSW).

## 2.1 Adjacent Land Use

The Subject Lands are bounded to the southwest by a rural residential property and the Torrence Creek Swamp PSW is present further beyond. The Torrence Creek Swamp PSW is present to the north, a residential development is present to the east and Arkell Road is present to the south, with residential developments present further south.

The Burke Well and Pumping Station is located approximately 60 m southwest of the Subject Lands and houses one municipal well (Burke Well).

## 2.2 Topography and Drainage

The ground surface at the Subject Lands is generally flat with slopes ranging from 0.5% to 1.5%. Existing elevations within the Subject Lands range between 333.3 to 335.0 m above mean sea level (amsl). Under pre-development conditions, surface water runoff flows northwesterly towards the PSW.

A storm sewer is present along Arkell Road to the south, with three catch basins located within the roadway.

GRCA and MNRF online mapping illustrate a PSW north of the property, extending south and traversing the north property boundary. In addition, GRCA mapping illustrates a small surface water body within the west portion of the Subject Lands, presumed to be a landscaped feature. No other surface water bodies/courses are illustrated within or transecting the property.

The Subject Lands are located within the Torrance Creek Subwatershed. Tributaries of the Eramosa River (Torrance Creek) are located approximately 575 m north of the property. The Eramosa River flows to the Speed River which drains directly into the Grand River.

According to the GRCA, a large portion of the Subject Lands is located within a Regulation Limit, as defined by Ontario Regulation 150/06: *Grand River Conservation Authority: Regulation Of Development, Interference With Wetlands And Alterations To Shorelines And Watercourses.*

# 3.0 Field Program

## 3.1 Borehole Advancement and Monitoring Well Construction

A total of six boreholes (BH1 to BH6) were advanced at the Subject Lands between February 13 and March 21, 2017 as part of a geotechnical investigation completed by PML. Boreholes were advanced to depths ranging between approximately 6.6 to 8.1 mbgs and were observed by PML. Four of these boreholes were completed as groundwater monitoring wells.

These boreholes and monitoring wells allow for the assessment of the overburden geology and hydrogeological characteristics at the Subject Lands, including stabilized groundwater elevations and groundwater flow direction interpretations. The borehole locations and ground elevations were surveyed by MTE to a geodetic benchmark. Borehole and monitoring well locations are illustrated on **Figure 2**. Borehole logs are provided in **Appendix B**.

Following installation, monitoring wells were developed using Waterra$^{TM}$ Surge Blocks to remove any accumulated sediments from the bottom of the well and to remove fine materials from the well screen and sand pack.

Soil conditions observed during borehole advancement at the Subject Lands generally consist of topsoil ranging in thickness from 0.1 to 0.3 m underlain by native silt, sand, and sand and gravel to the maximum investigated depth of 8.1 m bgs. Fill was encountered at borehole locations BH1 and BH6 underlying the topsoil material. The fill material was observed to extend to approximately 0.5 to 0.7 m bgs and was comprised of sand and gravel or silt.

Bedrock was not encountered in any of the boreholes advanced at the Subject Lands; however, it is anticipated to be approximately 18 to 30 m bgs (refer to **Section 4.3**).

Representative samples of the overburden were collected from the boreholes by PML at regular depth intervals. All recovered samples were returned to PML's laboratory for detailed visual inspection, classification, and select particle size distribution analysis. Particle distribution size analyses charts have been provided in **Appendix E**.

Additional drilling was undertaken at the Subject Lands in October 2019, as part of the Phase II ESA being completed for the Subject Lands at that time. A total of six boreholes were advanced at the Subject Lands to depths ranging between 1.5 to 6.1 mbgs. Three of these boreholes were completed as groundwater monitoring wells. Borehole logs are provided in **Appendix B**.

Soil conditions observed during the drilling activities completed for the Phase II ESA were generally described as native silt / silty sand / sand and gravel materials. A silt unit was encountered at borehole location MW106-19 underlying the native coarser-grained sediments above.

## 3.2 Mini-Piezometer Installation

One mini-piezometer was installed within the PSW in the north portion of the Subject Lands on October 9, 2019. The mini-piezometer location is illustrated on **Figure 2**.

## 3.3 Elevation Survey and Water Levels

The monitoring wells, mini-piezometer and boreholes used in the hydrogeological assessment were surveyed to a geodetic datum by MTE. The elevation surveys allow for groundwater and surface water levels collected from each monitoring well and mini-piezometer to be converted to elevations in metres above mean sea level (mamsl), allowing for the assessment of horizontal and vertical hydraulic gradients and groundwater flow directions.

Manually measured groundwater levels were collected from the first set of four monitoring wells (where accessible) on 20 occasions between March 2, 2017, and August 4, 2021; and from the second set of three monitoring wells on nine occasions (where accessible) between September 5, 2019, and August 4, 2021. Manually measured groundwater and surface water levels were collected at the mini-piezometer on 12 occasions between October 8, 2019, and August 4, 2021. **Tables 1A, 1B, and 1C** summarize the manually measured groundwater and surface water levels and elevations.

Data loggers were installed within each of the first four monitoring wells on March 27, 2017. Data loggers measure the pressure (in centimetres of water) above the logger at a predetermined time interval, which can then be used to calculate a groundwater level and elevation. The data loggers installed at the Subject Lands were set to record a pressure at a time interval of every 1 hour. Groundwater elevation information attained from the data loggers and manually measured water levels has been compiled on hydrographs presented in **Appendix C**.

Groundwater elevations measured by data loggers were observed to range between 329.37 mamsl (MW2) and 334.02 mamsl (MW4) throughout the monitoring period. It is noted that the ground surface elevation at MW4 is 333.24 mamsl. Therefore, the measured maximum groundwater elevation at MW4 represents saturated conditions near ground surface. In addition, a wet area was observed at the ground surface in the vicinity of MW4 in 2017.

## 3.4 Monitoring Well Development and Groundwater Sampling

The monitoring wells were developed using a Hydrolift pump and Waterra™ tubing and foot-valve fitted with a surge block to remove accumulated sediments from the bottom of the well and to remove fine materials from the well screen and sand pack. Monitoring well development was deemed complete once a minimum of three well volumes was removed, water was observed to be silt-free, and/or recovery rates were observed to stabilize.

MTE collected groundwater samples from two on-Site monitoring wells (one hydraulically up-gradient [MW4] and one hydraulically down-gradient [MW2]) on October 5, 2018. Prior to sample collection, a minimum of three well volumes was purged from the well based on the recorded water levels.

The samples were placed in laboratory supplied sample containers and transported on ice, under chain-of-custody, to ALS Laboratories in Waterloo, Ontario. Standard QA/QC protocols were followed as outlined by the (MECP) guidance documents.

## 3.5 Hydraulic Conductivity Testing

Qualitatively, hydraulic conductivity (K) is a parameter describing the ease with which groundwater flows through a porous medium. Relatively large K values are attributed to permeable units, i.e. sand and gravel, while small values are attributed to less permeable material, i.e. silt or clay. Representative values for hydraulic conductivity for various soil types are presented in Freeze and Cherry (1979).

MTE conducted single well hydraulic response tests on select on-Site monitoring wells in March 2017 (MW2 and MW3) and May 2017 (MW4 and MW5) following well development. A slug of known displacement was rapidly introduced (falling head test) and removed (rising head test) from the well as a means of inducing an immediate groundwater level response. Groundwater level recovery was monitored using a data logger programmed to collect groundwater levels every half second. Where possible, response tests were carried out three times using solid slugs of different displacement volumes to assess the viability of assumptions underlying the slug test analysis methods.

Prior to analysis, recovery data was normalized to compare coincidence between tests. Coincidence between tests suggests assumptions underlying conventional analysis methods can be considered valid (Butler et. Al., 2003). For wells with acceptable coincidence responses, a single representative test was selected and analyzed using the Bouwer & Rice model using the AquiferTest© Pro software package (Waterloo Hydrogeologic Inc., 2016) to estimate the horizontal hydraulic conductivity (K) of the unconfined saturated materials beneath the Subject Lands.

### 3.6 In-Situ Infiltration Testing

MTE completed test pit and in-situ infiltration testing at the Subject Lands on November 19, 2021. Four test pits (TP101-21 through TP104-21) were advanced at the Subject Lands to depths ranging from 0.5 to 1.6 mbgs for infiltration testing purposes using a mini-excavator operated by Steve Neeb of Neeb Excavating Inc. which was observed by MTE. The test pit locations are illustrated on **Figure 2**.

Infiltration tests were completed using a Soil Moisture 2800 K1 Guelph Permeameter in 0.05 m diameter x 0.16 to 0.20 m deep boreholes which were hand augered through the base of the test pit bottom in native overburden sediments in which the permeameter base tip was placed. Water levels within the combined reservoir of the Guelph Permeameter were recorded at regular time intervals to obtain time-varying infiltration rates of the sediment unit being tested.

The field saturated hydraulic conductivity (Kfs) of the tested materials was calculated using the Guelph Permeameter K-sat calculator, available for download on the soil moisture website (soilmoisture.com).

## 4.0 Regional Hydrogeological Setting

### 4.1 Physiography

The Subject Lands are located within the physiographic region known as the Guelph Drumlin Field. This region primarily consists of stoney till within the drumlins and deep gravel terraces in the intervening areas (*Chapman and Putnam*, 1984). **Figure 3** illustrates the Subject Lands as being located within a drumlin field, and, in this area, the drumlins are almost entirely comprised of sandy Wentworth Till (Karrow, 1967).

### 4.2 Quaternary Geology

Geology throughout the City of Guelph is comprised of three distinct till units identified from youngest to oldest as the Wentworth Till, the Middle Maryhill Till and the Catfish Creek Till, overlying bedrock. The Wentworth Till is described as a coarse-grained sandy to silty sand till which is often bouldery or stony (Karrow, 1968). This unit is generally found at ground surface throughout the City of Guelph and includes glacial features such as drumlins, found within the Guelph drumlin field, and the Galt and Paris moraines. The till thickness is described as variable, ranging between 15 to 30 m below drumlins and moraines, while thicknesses are much lower within low-lying areas.

The Quaternary Geology Map (**Figure 4**) identifies regional surface deposits of sand and gravel within the area of the Subject Lands, which is consistent with the drumlin field landform surrounding the Subject Lands, as shown on **Figure 3**.

## 4.3 Paleozoic Geology

The City of Guelph is underlain by the Guelph Formation, characterized as sandstone, shale, dolostone and siltstone, as shown by **Figure 5**.

Bedrock was not encountered during the on-Site drilling programs (Section 3); however, according to the depth to bedrock reported in MECP well records in the area (namely MECP Well ID No.'s 6702585 and 6702584, located approximately 160 m and 240 m west, respectively) it is anticipated that bedrock is approximately 18 to 30 m bgs.

## 4.4 Water Well Records

### 4.4.1 Private Wells

Hydrogeological data related to private supply wells within 500 m of the Subject Lands were obtained from water well records on file with the MECP. Based on data in the MECP Water Well Information System (WWIS) online database (searched November 2, 2021), a total of 76 well records were located within 500 m of the Subject Lands. Of the 76 wells:

- 41 wells were identified as being water supply wells, including one municipal well and two located within the Limits of the Subject Lands;
- 19 wells were identified as test holes, observation or monitoring wells;
- One well was identified as a dewatering well;
- Nine wells were identified as "abandoned"; and
- Six well records did not specify the well final status.

### 4.4.2 Municipal Supply Wells

The Burke Well, located approximately 60 m southwest of the Subject Lands, represents the closest municipal well to the Subject Lands. This well is described by the City of Guelph as an "important current and future water source" for the City of Guelph as it provides 8% of the City's water supply. The Burke Well is a bedrock well, drawing from the deep aquifer system (Jagger Hims, 1998). The well depth is 79.6 m bgs within the Guelph – Middle Gasport Formation.

The Carter Wellfield is located approximately 1.8 km northeast of the Subject Lands and houses two wells (the Carter Wells) located approximately 3 m apart. The wells are bedrock wells, drawing from the shallow bedrock; however, the shallow bedrock in this area is interpreted to be hydraulically connected to the water table and therefore some water is supplied by Torrence Creek (LERSPC, 2015). As a result, the Carter Wells are classified as Groundwater Under the Direct Influence of Surface Water (GUDI) wells as outlined in Ontario Regulation 170/03: *Drinking Water Systems.* The well depths are 20.7 m bgs within the Guelph Formation.

## 4.5 Regional Groundwater Flow

The City of Guelph relies almost exclusively on groundwater for its potable water supply

(LERSPC, 2015). In total, 25 municipal supply wells are located throughout the City of Guelph, the majority of which draw water from the deep confined bedrock of the Gasport (formerly Amabel), Guelph, Eramosa and Goat Island Formations. A regional aquitard is present within the Eramosa Formation (the Vinemount Member), which confines the Gasport Formation (LERSPC, 2015).

The regional groundwater flow direction was determined based on the following:

- Regional groundwater elevations provided from the GRCA (updated 2021);

- The presence of a PSW north of the Subject Lands;
- The presence of Torrence Creek located approximately 575 m northeast of the Subject Lands;
- The presence of the Burke municipal well approximately 60 m southwest of the Subject Lands; and
- Ground surface topography in the area surrounding the Subject Lands generally slopes to the north.

Based on these factors, the regional groundwater flow is expected to be generally southerly to southwesterly in the vicinity of the Subject Lands, as shown on **Figure 6**.

# 5.0 Local Hydrogeological Setting

The monitoring wells and boreholes advanced during the geotechnical and environmental investigations were used to interpret the local hydrostratigraphic units and generate two geological cross-sections. Local geological cross-sections (Cross-section A-A' and Cross-section B-B') are presented on **Figures 7 and 8**.

*Geological Cross-Section A-A' (**Figure 7**):*

- Extends approximately 254 m from north to south through the Subject Lands and lands to the south.
- Illustrates relatively flat topography.
- Illustrates the subsurface to consist of topsoil underlain by coarse-grained sand and gravel / sand sediments. A layer of silt is present between the topsoil and coarse sediments in the vicinity of the proposed infiltration cell. The sand unit is underlain by a roughly 10 m thick silt unit overlying bedrock comprised of limestone and shale.
- Illustrates the local water table to be at an elevation of approximately 331.5 mamsl across the cross-section.
- Illustrates the seasonal high water table to be at an elevation of approximately 334.3 mamsl across the cross-section and the seasonal high water table is roughly present at ground surface in the north portion of the cross-section, within and in the vicinity of the PSW.

*Geological Cross-Section B-B' (**Figure 8**):*

- Extends approximately 174 m from west to east through the Subject Lands.
- Illustrates gently undulating topography.
- Illustrates the subsurface to consist of topsoil underlain by coarse-grained sand and gravel / sand sediments. A layer of silt is present between the topsoil and coarse sediments in the vicinity of MW3 and a layer of fill is present between the topsoil and sand and gravel unit in the vicinity of BH6, extending to the east where residential dwellings are located within the Subject Lands. A layer of silt is present underlying the coarse-grained sediments across the Subject Lands, located at 325.8 mamsl in the west portion of the Subject Lands and 331.8 mamsl in the east portion of the Subject Lands.

- Illustrates the local water table to be at an elevation of approximately 330.1 mamsl in the west portion of the cross-section and 330.7 mamsl in the east portion of the cross-section.

## 5.1 Groundwater Quality

Groundwater samples collected from the two monitoring wells on October 5, 2018 (MW2 and MW4) were submitted and analyzed for general chemistry parameters to document the groundwater chemistry prior to development. The analytical results are summarized in **Table 2**. Laboratory Certificates of Analysis are provided in **Appendix F**.

### 5.1.1 Anions and Nutrients

Detectable concentrations of Ammonia, Chloride, Fluoride, Nitrate, and Sulfate were reported for the samples collected from the two monitoring wells. The highest concentration of Nitrate (6.29 mg/L) was reported for monitoring location MW-4, which is located hydraulically up-gradient within the Subject Lands, adjacent to the PSW at the north end of the property. A nitrate concentration of 1.59 mg/L was reported at monitoring location MW-2 which is interpreted as hydraulically down-gradient.

### 5.1.2 Dissolved Metals

The following parameters were detected in one or both of the groundwater samples collected from the Subject Lands:

- Barium
- Calcium
- Copper
- Magnesium
- Potassium
- Silicon
- Sodium
- Strontium
- Zinc

Sodium and Chloride concentrations reported from monitoring location MW-2 were 60.4 mg/L and 76.0 mg/L, respectively. These concentrations were interpreted to results from road salt application on the roadway south of the Subject Lands. Concentrations of these parameters at monitoring location MW-4 were reported as 21.6 mg/L and 35.9 mg/L, respectively, indicating a reduction of the concentrations across the Subject Lands from south to north.

## 5.2 Hydraulic Conductivity

The normalized plots for MW2 through MW5 show an acceptable coincidence, suggesting the assumptions underlying conventional analysis methods are valid.

Based on the results of the in-situ response tests, horizontal hydraulic conductivity (K-value) estimates throughout the Subject Lands were calculated to range from $2.1 \times 10^{-6}$ m/sec to $2.1 \times 10^{-4}$ m/sec with a geometric mean of $2.5 \times 10^{-5}$ m/sec, which is consistent with average published values for sand and gravel soil (Freeze and Cherry, 1979). **Table 6.1** summarizes the K-value estimates for each analyzed data set. A summary of the analyses carried out in AquiferTest© Pro are provided in **Appendix E**.

**Table 5.2: Summary of Hydraulic Conductivity (K) Estimates**

| Well ID | Estimated Hydraulic Conductivity (m/sec) |
|---|---|
| BH/MW2 | $5.5 \times 10^{-5}$ |
| BH/MW3 | $1.6 \times 10^{-5}$ |
| BH/MW4 | $2.1 \times 10^{-6}$ |
| BH/MW5 | $2.1 \times 10^{-4}$ |
| Geometric Mean | $2.5 \times 10^{-5}$ |

## 5.3 Groundwater Flow and Average Linear Groundwater Velocity

Groundwater flow mapping was conducted for the Subject Lands using the August 4, 2021, groundwater elevation data.

The interpreted local shallow groundwater flow direction is southerly to westerly across the Subject Lands, as shown on **Figure 9A**. This is consistent with the regional groundwater flow direction (southwesterly, GRCA, 2021).

An average horizontal hydraulic gradient was calculated to be 0.01 m/m based on the August 4, 2021, groundwater levels.

Assuming an average horizontal conductivity of $2.5 \times 10^{-5}$ m/s (Section 5.2) and using the horizontal hydraulic gradient of 0.01 m/m calculated above, the average linear groundwater velocity was calculated using Darcy's Law in the following equation:

$$q = (-Ki)/n_e$$

Where:

q = groundwater flux ($m^3/m^2$/time)
K = effective hydraulic conductivity ($2.48 \times 10^{-5}$ m/s)
i = horizontal hydraulic gradient (0.01 m/m)
$n_e$ = effective soil porosity (0.3 typical for a sandy soil, Freeze and Cherry, 1979)

Using the above values, the average linear groundwater velocity at the Subject Lands is estimated to be approximately 26 m/year.

The seasonal high groundwater flow interpretation is presented on **Figure 9B**. The date selected for the seasonal high groundwater flow interpretation was May 6, 2017, since, based on the hydrographs, this date represents a time period within the 2017 spring freshet and the 2017 spring freshet resulted in the highest seasonal high water table during the monitoring period.

## 5.4 Groundwater / Surface Water Interaction

Manual surface water and groundwater measurements collected from MP1-19, installed within the PSW, are provided in **Table 1C.** Based on the measurements collected, and the repeatedly observed absence of standing water in the vicinity of the MP1-19, a downward vertical hydraulic gradient between the surface water and local groundwater is interpreted to be present in this area.

A comparison of the groundwater levels observed within MP1-19 to those observed in MW4, located approximately 10 m south of MP1-19, found that the groundwater levels with MP1-19

were consistently above those within MW4. Therefore, a downward vertical hydraulic gradient between the shallow and deeper groundwater is interpreted to be present in this area.

Based on the above, it is interpreted that surface water infiltrates to the subsurface within the wetland acting to recharge the groundwater.

## 5.5 In-Situ Infiltration Rates

Calculating the Infiltration Rate was based on the methodology outlined by the Sustainable Technologies Evaluation Program (STEP) updated guidance on Low Impact Development Stormwater Management Planning and Design. As outlined on the STEP website, the water component of STEP is a partnership between the Toronto and Region Conservation Authority, Credit Valley Conservation, and Lake Simcoe Region Conservation Authority. Additional information about STEP is provided on their website at sustainabletechnologies.ca.

STEP has reviewed the Low Impact Development Stormwater Management Planning and Design Guide first completed in 2010 and provided updated guidance to the 2010 Guide using a wiki website (wiki.sustainabletechnologies.ca). STEP recommends using the online wiki page as the primary resource for LID planning and design.

Based on the field measurements, a Kfs has been calculated for each of the tested locations, summarized in **Table 5.5** below.

**Table 5.5: Field Saturated Hydraulic Conductivity (Kfs) Summary (mm/hr)**

| Test Pit | Depth (mbgs) | Soil Type | Median Kfs[1] (cm/sec) | Median Kfs (mm/hr) |
|---|---|---|---|---|
| TP101-21 | 1.0 | Silty SAND | $8.9x10^{-5}$ | 3 |
| TP101-21 | 1.6 | SAND, trace silt, trace gravel | $3.5x10^{-4}$ | 13 |
| TP102-21 | 0.8 | SAND and GRAVEL | $5.8x10^{-3}$ | 209 |
| TP103-21 | 0.5 | SAND and GRAVEL | $5.4x10^{-3}$ | 194 |
| TP104-21 | 0.9 | SAND and GRAVEL | $4.3x10^{-3}$ | 155 |

The geotechnical report completed by PML provides infiltration rates for the “major near surface soil units” at the Subject Lands. The report states an infiltration rate of 30 mm/hr for the sand/sand and gravel units beneath the Subject Lands. A comparison of the infiltration rate provided by PML to the Infiltration Rates calculated above indicates that the sand and gravel units have a higher infiltration rate while the sand / silty sand units are lower. The discrepancy between the value provided in the geotechnical report, which is an infiltration estimate based on grain size, and the calculated infiltration rates above is attributed to the heterogeneity of the in-situ sediments.

# 6.0 Source Water Protection

The identification and assessment of vulnerable areas required through the Source Water Protection process has been completed for the Grand River Source Protection Area through a series of technical studies undertaken by the Lake Erie Region Source Protection Committee (LERSPC), the GRCA, and the City of Guelph, which have delineated the areas requiring protection and identifying land use activities that could pose potential threats. The results of those studies are summarized in Chapter 8 of the Grand River Source Protection Area Assessment Report (LERSPC, 2015).

## 6.1 Municipal Supply Wells and Wellhead Protection Area (WHPA) Vulnerability Assessment

With respect to source water protection, Wellhead Protection Areas (WHPA) are established for each municipal supply well through the delineation of well "capture zones." Part V of the Clean Water Act (CWA) Technical Rules (MOE, 2006) provides specific details for WHPA delineation.

The March 2010 City of Guelph Source Protection Project Groundwater and Surface Water Vulnerability Report defines a capture zone as:

> *"the projection onto the land surface of the portion of the three-dimensional volume through which groundwater travels towards a water supply well within a defined period of time."* (AquaResource Inc., 2010)

WHPAs are divided into four categories based on travel time to the well, and are summarized in the table below.

| Category | Description |
|---|---|
| WHPA-A | A radius of 100 m from the outer boundary of the well |
| WHPA-B | Time-of-travel to the well ≤2 years (not including WHPA-A) |
| WHPA-C | Time-of-travel to the well is >2 years, but ≤ 5 years |
| WHPA-D | Time-of-travel to the well is >5 years, but ≤ 25 years |

Based on data from GRCA Web-Mapping software, the majority of the Subject Lands are located within WHPA-B (≤ 2 year time-of-travel) of the nearby Burke municipal supply well. The southwest corner of the Subject Lands is observed to be located within WHPA-A (100 m zone), as shown on **Figure 10**.

The category of the WHPA and the characterization of the aquifer in terms of its susceptibility to surface/near surface sources of contamination allows for the calculation of a vulnerability score within a WHPA, which ranges from 2 to 10 (where 10 represents the highest vulnerability) (AquaResource Inc., 2010). Preferential pathways are also taken into consideration during the establishment of vulnerability scores, as they can allow contaminants to bypass natural features which protect the aquifer.

Both the vertical movement (intrinsic vulnerability) and horizontal movement (WHPA time-of-travel) of groundwater were incorporated into the establishment of the WHPA vulnerability scores. Usually, the most vulnerable areas in a WHPA (score of 8 to 10) are in WHPA-B (≤2 year time-of-travel) (Lake Erie Region Source Protection Committee, 2015).

As illustrated in **Figure 11**, the Subject Lands have been designated with three different WHPA vulnerability scores. A vulnerability score of 8 (considered moderate to high) has been assigned to more than half of the Subject Lands area, which is shown to extend toward the northern portion of the Subject Lands and beyond, into the wetland. The southeast corner of the Subject Lands has been assigned a moderate vulnerability score of 6, which implies that groundwater sources are adequately protected from surface contamination. Due to the close proximity to the Burke municipal supply well (approximately 60 m southwest of the Subject Lands), the southwest portion of the Subject Lands has been assigned a WHPA vulnerability score of 10, which represents the highest vulnerability.

## 6.2 Intrinsic Aquifer Vulnerability (IAV)

Intrinsic vulnerability of an aquifer is based on the idea that the natural environment (i.e. properties of the surface and subsurface including the unsaturated zone material, topography, depth to water table or depth to aquifer, preferential pathways, etc.) can provide some degree of protection against groundwater contamination from the surface, but does not take into consideration the properties of the contaminant itself (Liggett, Lapcevic, & Miller, May 2011). A map of intrinsic vulnerability is generated based on interpolating data between associated wells to generate a numerical score or index, with consideration given to observed static water levels, the overburden soil type, and the thickness of the unit above the aquifer. The generated maps are based on contaminant travel time from the ground surface through the subsurface and to the underlying contributing aquifer (AquaResource Inc., 2010).

**Figure 12** illustrates the Subject Lands in relation to the City of Guelph with respect to intrinsic vulnerability. According to the GRCA, the intrinsic vulnerability of the aquifer at the Subject Lands has been designated a score of medium, which represents the susceptibility of the aquifer to contamination.

## 6.3 Significant Groundwater Recharge Areas (SGRA)

Groundwater recharge occurs where precipitation and snowmelt infiltrate into the ground to feed aquifers, watercourses, and wetlands. SGRAs are typically associated with coarse-grained sediments (i.e. sands and gravels) or very shallow overburden material covering upland areas on the landscape. SGRA vulnerability scores of 2, 4, or 6 are assigned to areas which are designated as low, medium, or high SGRA vulnerability areas, respectively.

Based on the available GRCA online GIS data, the Subject Lands are depicted within a SGRA with an assigned medium vulnerability score of 4, as shown on **Figure 13.**

## 6.4 Potential Groundwater Quality Impacts

According to the Grand River Source Protection Plan, the analysis of the historical raw groundwater chemistry in each municipal well system for the City of Guelph has been used to determine whether any contaminants are present, and whether they have contributed to a decline in drinking water quality (Grand River Conservation Authority, 2015). Subsequently, zones of Issue Contributing Areas (ICA) were developed to define areas where past or current activities have or are likely to adversely affect the quality of drinking water in a given municipal well in which contaminants have already been measured at elevated levels.

An ICA is defined by the Grand River Source Protection Plan as:

> *"The area within which activities have or are likely to contribute to the elevated contaminant at the well...in most cases, an ICA is the 25 year time-of-travel capture zone."* (Grand River Conservation Authority, 2015)

According to GRCA online GIS data, the Subject Lands are not located within an Issue Contributing Area (ICA).

Elevated concentrations of contaminants associated with road salt application were identified as a concern to groundwater quality within the ICA (Lake Erie Region Source Protection Committee, 2015). The application of road salt and the handling and storage of road salt are prescribed drinking water threats under the Clean Water Act (CWA). Road salt as a drinking water threat refers to any product containing sodium and/or chloride that is used to maintain roads and pedestrian areas.

The MECP Tables of Drinking Water Threats identify sodium and chloride as contaminants that could make their way into surface and groundwater from road salt application, storage and handling. At typical concentrations in drinking water, sodium and chloride are not risks to human health. However, at concentrations greater than 20 mg/L, sodium intake may pose a health concern for people with dietary restrictions. At a concentration of 250 mg/L, chloride imparts a salty taste to drinking water.

Classifying the application of road salt as a significant drinking water threat is dependent on vulnerability zones, vulnerability score and the total impervious surface area. Although the Subject Lands are not located within an ICA, it is anticipated that the imperviousness of the Subject Lands will increase as a result of the proposed residential development and that road salt application will be required thereafter. Because the Subject Lands are located within an SGRA of medium vulnerability (i.e. vulnerability score of 6), it is reasonable to conclude that a Salt Management Plan (SMP) may be required. The need for a SMP, however, should be re-visited once a development plan for the Subject Lands has been finalized in order to help mitigate the effect of road salt on groundwater quality.

## 6.5 Groundwater under Direct Influence of Surface Water

The Grand River Source Protection Area Approved Assessment Report (LERSPC, 2021) delineates the vulnerability areas for groundwater wells whose water supply is groundwater under the direct influence (GUDI) of surface water. As stated in the AAR (2021), there are three GUDI systems in Guelph: The Glen Collector system, Arkell 1 Well, and the Carter Wells. Map 7-18 provided in the AAR shows the Burke well and the majority of the Subject Lands are located within an area defined as “Wellhead Protection Area E Vulnerability” which delineates the GUDI Vulnerability Area associated with the Carter Wells located approximately 1.8 km north of the Subject Lands. The GUDI Vulnerability area is shown on **Figure 15**.

As stated in the AAR, the Carter Wells consist of two wells that obtain water from the shallow bedrock of the Guelph Formation. The wells are located adjacent to Torrance Creek and the shallow bedrock groundwater system is hydraulically connected to the water table with some of the water supplied by Torrance Creek. The Vulnerability score associated with the GUDI Vulnerability Area (WHPA-E) is 8, representing an intermediate score based on the current and proposed land uses within the area and existing and proposed stormwater systems discharging to Torrance Creek.

# 7.0 Development Considerations

## 7.1 Seasonal High Groundwater Separation

The City of Guelph Development Engineering Manual specifies a minimum separation distance of 0.5 m between basement elevations and the seasonal high groundwater elevation and 1.0 m between the base of an infiltration gallery and the seasonal high water table (COGECIS, 2019). In addition, where the seasonal high water table is "higher or lower than the proposed permanent pool level of stormwater management ponds" a clay liner is required to ensure the permanent pool level is maintained (COGEGIS, 2019).

### 7.1.1 Finished Floor Elevations (FFE)

Based on the FFE provided on drawing AG1.1 (Area Grading Plan, MTE, December 3, 2021), the proposed FFE are sufficiently above the seasonal high groundwater table whereby the minimum separation distance requirement of 0.5 m is satisfied.

### 7.1.2 Stormwater Management Pond

The base elevation of the proposed SWM pond located in the west portion of the Subject Lands, provided on drawing AG1.1 (Area Grading Plan, MTE, December 3, 2021), is 333.20 mamsl. Seasonal high groundwater elevation contours within / in the vicinity of the SWM Facility indicate the seasonal high groundwater table is present at an elevation of approximately 333.15 mamsl beneath the SWM Facility. Therefore, there is minimal separation between the seasonal high groundwater elevation and the proposed base elevation of the SWM Facility.

### 7.1.3 Infiltration Galleries

An infiltration cell is proposed north of the SWM Facility with a proposed base elevation of 334.20 mamsl. Seasonal high groundwater table elevation contours within / in the vicinity of the infiltration cell indicate the seasonal high groundwater table is present at an elevation between 333.15 and 333.25 mamsl beneath the infiltration cell. Therefore, the base elevation of the proposed infiltration cell is sufficiently above the seasonal high groundwater table whereby the minimum separation distance of 1.0 m is satisfied.

Based on MTE drawing AG1.1, two additional infiltration galleries are proposed in the south portion of the Subject Lands; however, proposed base elevations have not been provided at this time. It is understood that the grade of the Subject Lands is proposed to be raised during development. Any soils brought to the Subject Lands for grading are required to have the same or better infiltration rates as current conditions. In addition, base elevations of the proposed infiltration galleries should be located a minimum of 1.0 m above the seasonal high water table.

If, upon final confirmation of building design and Site grading, it is anticipated that the water table may be intercepted during construction activities, the need for construction dewatering will have to be assessed, which may result in the need for a Permit to take Water (PTTW) or Environmental Activity Sector Registry (EASR).

Further assessment may be required once design details are finalized and could be conducted during the detailed design stage of the development process.

## 7.2 Water Balance

A monthly water balance was completed for the Subject Lands for pre- and post-development conditions using the Thornthwaite and Mather method (1957) as part of the Stormwater Management (SWM) Report completed for the Subject Lands by MTE. As outlined in the SWM Report, the City requires that Low Impact Design (LID) best management practices be used to mimic pre-development recharge rates. Infiltration galleries are proposed to direct flow from roofs on-Site wherever possible. The SWM facility will introduce an infiltration cell to further promote groundwater recharge. Additionally, increasing the amount of pervious landscaped areas throughout the Subject Lands will improve groundwater recharge by means of passive infiltration.

### 7.2.1 Infiltration to Groundwater

Based on the water balance calculations provided in the SWM report (under separate cover), the pre-development passive infiltration volume at the Subject Lands is 7,580 $m^3$/year whereas the post-development passive infiltration volume is 6,721 $m^3$/year. However; through the implementation of lot-level infiltration galleries (wherever possible) and an end-of-pipe infiltration cell operable during non-winter months, the post-development passive infiltration volume can be increased to 7,816 $m^3$/year. This equates to an equivalent infiltration rate across the Subject Lands of 251.6 mm/year, exceeding the target established in the Torrence Creek Subwatershed Study (TCSS) of 150mm/year.

### 7.2.2 Surface Runoff to Wetland

Based on calculations provided in the SWM report, the pre-development volume of runoff generated by the Subject Lands is 5,595 $m^3$/year.

Under post-development conditions, the total area of the Subject Lands that will drain to the PSW is approximately 2.04 hectares. The increased impervious areas under post-development conditions will inevitably result in an increased annual runoff volume to the PSW. Approximately 7,347$m^3$/year of runoff is generated by the Subject Lands under post-development conditions, which equates to an annual surplus of 1,752 $m^3$/year of surface runoff volume to the PSW complex. On a monthly basis, pre-development volumes are sustained and monthly distribution of excess runoff is well balanced (refer Figure 5.4 in the SWM Report).

## 7.3 Design Infiltration Rate

The STEP wiki-page pertaining to Design Infiltration Rates recommends that a safety correction factor between 2 to 3 be applied to the measured infiltration rate (i.e. the calculated Kfs value) from the in-Situ testing to apply conservatism. The following table is provided on the wiki-page which outlines factors that should be taken into consideration when determining an appropriate safety factor:

**Selecting a Safety Factor**

| Lower Value (closer to 2) | Higher Value (closer to 3) |
|---|---|
| Catchment <100 $m^2$ | Catchment >100 $m^2$ |
| Permeameter or Percolation Test on Site | Double Ring infiltrometer on Site, or grain size analysis is used |
| Loamy or Sandy Soil Texture | Clayey Soil Texture |

**Selecting a Safety Factor**

| Lower Value (closer to 2) | Higher Value (closer to 3) |
|---|---|
| No variation in geologic formation, soil texture or bulk density within 1.5 meters below the proposed bottom of the practice. | Variation in geologic formation, soil texture or bulk density within 1.5 meters below the proposed bottom of the practice. |
| No nearby sensitive receptors | Sensitive receptors in near proximity (e.g. septic systems, building foundations). |

Any soils brought to the Site for grading are required to have the same or better (i.e. higher) infiltration rates as current conditions.

# 8.0 Impact Assessment

## 8.1 Potential Well Interference

### 8.1.1 Private Wells

An MECP well record search indicates the presence of 40 domestic or livestock private water supply wells within a 500 m radius of the Subject Lands with two located within the limits of the Subject Lands. The well record details and impact assessment are summarized in **Table 3**. Individual well records are available through the MECP WWIS online database, searchable by Well ID.

A review of the well records found that the water supply wells within the Study Area were installed between 1950 and 1998. This area has undergone considerable development with residential subdivisions during this period. In addition, Figure 1 (Guelph Drinking Water System) within the 2020 Water Services' Annual and Summary Report completed by the City of Guelph shows the Subject Lands and lands within 500 m are located within a municipally serviced area.

Therefore, it is anticipated that these water supply wells are no longer used and impacts resulting from the proposed development are unlikely.

### 8.1.2 Municipal Wells

Two municipal wells fields, Burke and Carter, are located within a 2 km radius of the Subject Lands. In particular, the Burke well is located approximately 60 m southwest of the Subject Lands. GRCA online GIS mapping indicates that the majority of the Subject Lands is categorized within WHPA-B, where a small portion of the southwest corner of the Subject Lands is located within the Burke well WHPA-A. A review of available well records determined the Burke and Carter wells to be screened within bedrock at depths of approximately 79.9 m bgs and 20.7 m bgs, respectively. Construction of basements, if included in the development, will not extend to these depths, and therefore it is unlikely that any well interference will occur within the municipal wells located near the Subject Lands during the construction process.

## 8.2 Environmental Features

As outlined in Section 7.2.2, there in an increase in runoff volume to the PSW between pre- and post-development of 1,752 $m^3$/year. However, as shown on Figure 5.4 of the SWM Report, on a monthly basis, pre-development volumes are sustained and monthly distribution of excess runoff is well balanced. Therefore, it is unlikely that the PSW will be negatively impacted by the increased annual infiltration volume following development.

During construction, cut-off collars may be used in excavated utility trenches to maintain natural flow regimes across the property and preserve flow conditions.

# 9.0 Conclusions

Based on this hydrogeological investigation, MTE offers the following findings:

*Geology*

- Stratigraphic conditions beneath the Subject Lands consist of coarse-grained (sand or sand and gravel) materials characteristic of a drumlin landform; and
- Bedrock is anticipated to be approximately 18 to 30 m bgs.

*Hydrogeology*

- Groundwater elevations measured by data loggers were observed to range between 329.37 mamsl (MW2) and 334.02 mamsl (MW4) throughout the monitoring period. The measured maximum groundwater elevation at MW4 represents saturated conditions near ground surface and a wet area was observed at the ground surface in the vicinity of MW4 in 2017.
- It is interpreted that surface water infiltrates to the subsurface within the wetland acting to recharge the groundwater.
- The regional groundwater flow direction is expected to be southerly to southwesterly in the vicinity of the Subject Lands.
- The local groundwater flow direction is interpreted to be southerly to westerly across the Subject Lands which is consistent with the regional groundwater flow direction.
- The average horizontal hydraulic gradient is estimated to be 0.01 m/m based on groundwater levels collected August 4, 2021.
- Maximum and minimum hydraulic conductivity values for the shallow, unconfined groundwater aquifer beneath the Subject Lands were calculated to range between 2.1 x $10^{-6}$ m/sec to 2.1 x $10^{-4}$ m/sec, with a geometric mean of 2.5 x $10^{-5}$ m/sec.
- The groundwater velocity of the shallow groundwater aquifer beneath the Subject Lands was calculated to be approximately 26 m/year.

*Source Water Protection*

- The Burke municipal supply well is located approximately 60 m southwest of the Subject Lands;
- The majority of the Subject Lands are located with WHPA-B of the Burke well. The southwest corner of the Subject Lands are located within WHPA-A (100 m zone) of the Burke well;
- The Subject Lands have been designated with WHPA vulnerability scores of 8 (moderate to high), 6 (moderate), and 10 (the highest vulnerability score);
- The intrinsic vulnerability of the aquifer at the Subject Lands has been designated a score of medium;

- The Subject Lands are located within a SGRA with a vulnerability score of 4 (medium);
- The Subject Lands are not located within an ICA; and
- The Subject Lands are located within a GUDI Vulnerability area associated with the Carter Wells located approximately 1.8 km north, with a vulnerability score of 8 (intermediate score).

*Development Considerations*

- The FFE are sufficiently above the seasonal high groundwater table whereby the minimum separation distance requirement of 0.5 m is satisfied.
- There is minimal separation between the seasonal high groundwater elevation and the proposed base elevation of the SWM Facility (approximately 5 cm).
- The base elevation of the proposed infiltration cell is sufficiently above the seasonal high groundwater table whereby the minimum separation distance of 1.0 m is satisfied.
- Proposed base elevations of the infiltration galleries in the south portion of the Subject Lands have not been provided at this time. It is understood that the grade of the Subject Lands is proposed to be raised during development. Any soils brought to the Subject Lands for grading are required to have the same or better infiltration rates as current conditions. In addition, base elevations of the proposed infiltration galleries should be located a minimum of 1.0 m above the seasonal high water table.
- The post-development infiltration volume is estimated to be 7,816 $m^3$/year which is equivalent to an infiltration rate across the Subject Lands of 251.6 mm/year. This exceeds the target established in the TCSS (150mm/year).
- Approximately 7,347$m^3$/year of runoff is generated by the Subject Lands under post-development conditions, which equates to an annual surplus of 1,752 $m^3$/year of surface runoff volume to the PSW complex. On a monthly basis, pre-development volumes are sustained and monthly distribution of excess runoff is well balanced (refer Figure 5.4 in the SWM Report).
- Calculated infiltration rates from in-situ testing completed at the Site ranged from 3 mm/hr (silty sand unit) to 209 mm/hr (sand and gravel unit).

*Impact Assessment*

- It is anticipated that the water supply wells within the Study Area are no longer used and impacts resulting from the proposed development are unlikely.
- It is unlikely that any well interference will occur within the municipal wells located near the Subject Lands during the construction process based on the screened depths of the municipal wells and/or the distance from the Subject Lands.
- Although there in an increase in runoff volume to the PSW between pre- and post-development, on a monthly basis pre-development volumes are sustained and monthly distribution of excess runoff is well balanced. Therefore, it is unlikely that the PSW will be negatively impacted by the increased annual infiltration volume following development.

**As construction details were not available at the time of this report, assumptions were made for preliminary calculations. Further assessment may be required once design details are finalized.**

## 9.1 Recommendations and Monitoring

Based on findings of this hydrogeological investigation, MTE offers the following recommendations:

- Continuous groundwater monitoring should be ongoing, updated and utilized during final design of the development as well as updated information utilized during the design of the Draft Plan;
- On-site groundwater monitoring wells be maintained in accordance with Ontario Regulation 903 (as amended);
- Monitoring wells located within proposed construction areas will need to be decommissioned in accordance with Ontario Regulation 903 (as amended);
- Soils brought to the Subject Lands for grading must have the same or better infiltration rates as the current conditions;
- Based on policies outlined in the GRSPP, a Salt Management Plan is required for the Subject Lands, which will be undertaken by MTE during the final development design stages; and
- The use of cut-off collars during construction will assist in maintaining natural flow patterns across the property and preserve flow conditions to the existing wetland feature.

# 10.0 Limitations

Services performed by **MTE Consultants Inc.** (MTE) were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the Environmental Engineering & Consulting profession. No other warranty or representation expressed or implied as to the accuracy of the information, conclusions or recommendations is included or intended in this report.

This report was completed for the sole use of MTE and Crescent Homes. The assignment was carried out in accordance with the Scope of Work described in Section 1 as reviewed with and agreed to by the Client. MTE makes no representation that the present report has dealt with all of the important environmental issues, except as provided in the Scope of Work. This report is not intended to be exhaustive in scope or to imply a risk-free facility. As such, this report may not deal with all issues potentially applicable to the Site and may omit aspects which are or may be of interest to the reader.

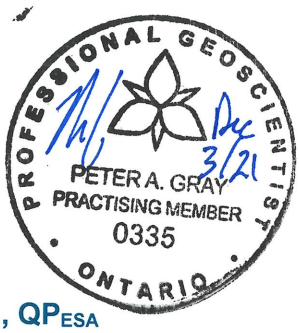
In addition, it should be recognized that a soil sample or groundwater level measurement represents one discrete portion of the Site at the time it is collected, and that the findings of this report are based on conditions as they existed during the time period of the investigation.

Any use which another party makes of this report, or any reliance on, or decisions to be made based upon it, are the responsibility of such parties. MTE accepts no responsibility for liabilities incurred by or damages, if any, suffered by another party as a result of decisions made or actions taken, based upon this report. Others with interest in the Site should undertake their own investigations and studies to determine how or if the condition affects them or their plans.

It should be recognized that the passage of time may affect the views, conclusions and recommendations (if any) provided in this report because environmental conditions of a property can change, along with regulatory requirements. Should additional or new information become available, MTE recommends that it be brought to our attention in order that we may determine whether it affects the contents of this report.

All of which is respectfully submitted,

**MTE Consultants Inc.**

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# Figures

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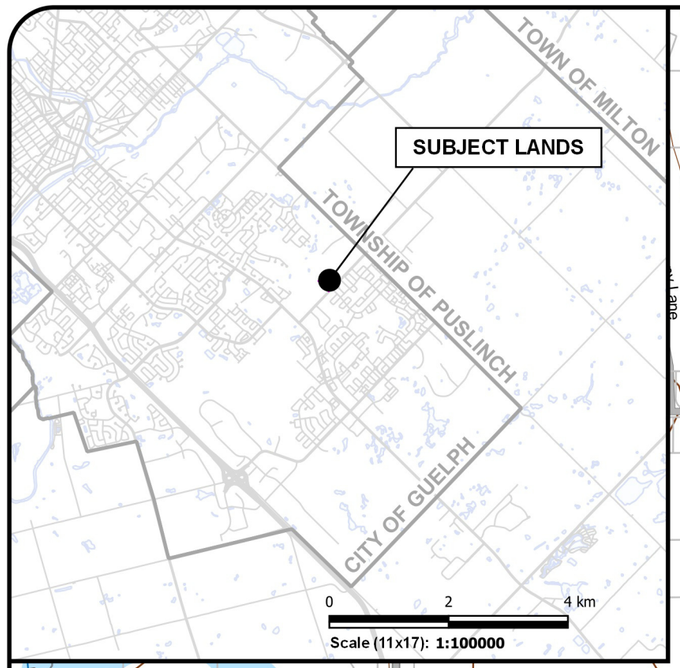





NORTH

PROJECT NORTH

## Legend

- Subject Lands
- Study Area (500m)
- Municipal Well (GRCA)
- MECP WWIS Water Supply Well

**Surface Water**

- Surface Water Body
- Watercourse
- Provincally Significant Wetland (GRCA)

**Ground Surface Elevation Contour (mamsl)**

- Major Contour (10m)
- Minor Contour (5m)

*Data Sources:*

*Contains Information made available under Grand River Conservation Authority's Open Data Licence v2.0*

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Project CRS: NAD83 / UTM zone 17N

MTE

Engineers,Scientists, Surveyors

Ph. (519) 743-6500

Client: Crescent Homes Ltd.

Project: Hydrogeological Assessment

Site: 190-216 Arkell Road, Guelph

Title: Key Map & Study Area

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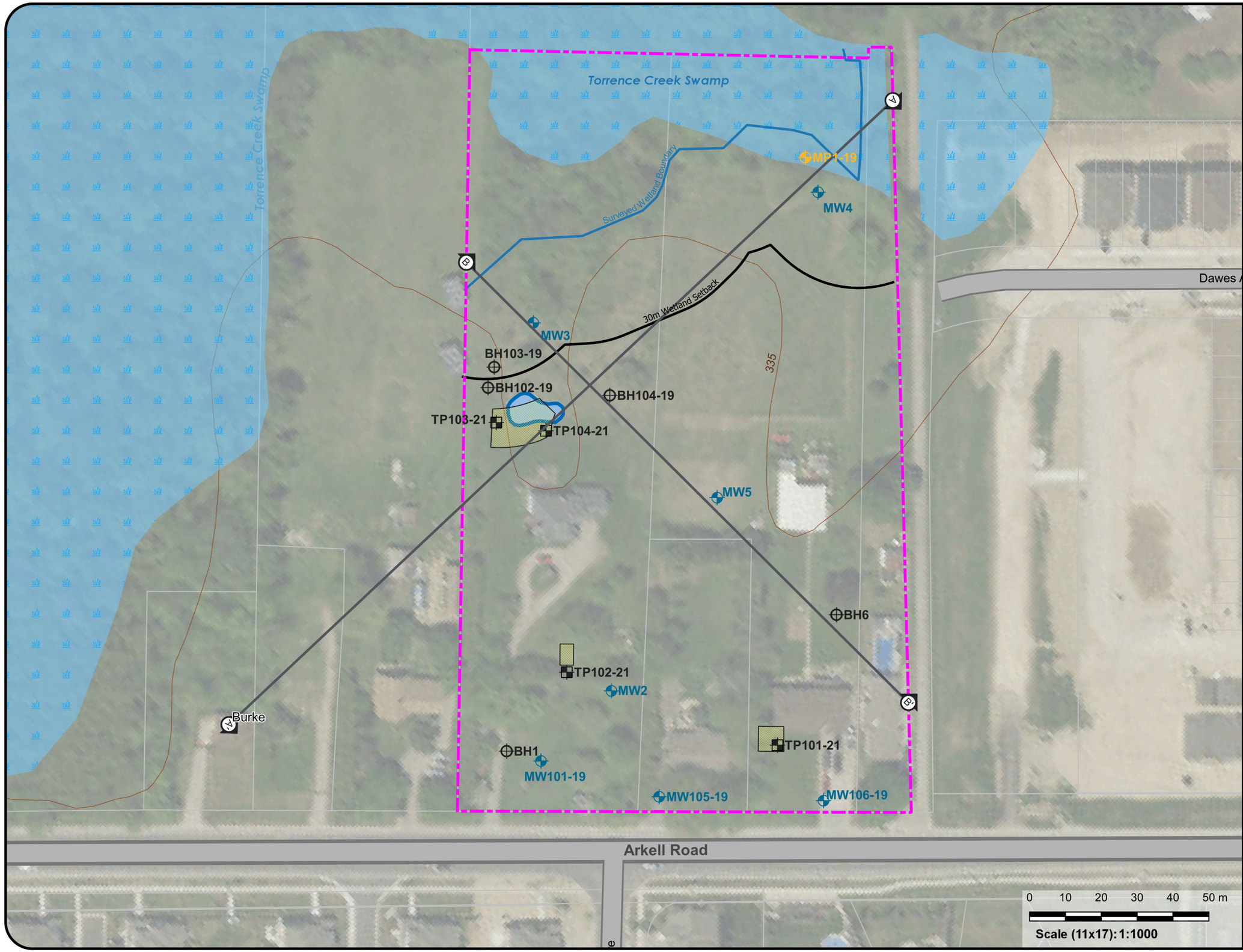
|---|---|---|---|
| Reviewed By | PAG | | |
| Prepared By | KLW | Project No | 42063-200 |
| Drawn By | KLW | Figure No | 1 |
| Date | November 2021 | | |




NORTH

PROJECT NORTH

## Legend

- Subject Lands
- Geological Cross Section Location
- Surveyed Wetland Boundary (NRSI)
- 30m Wetland Setback
- Municipal Well (GRCA)
- Proposed Infiltration Locations

**Investigative Locations**

- Monitoring Well
- Test Pit
- Minipiezometer
- Borehole

**Surface Water**

- Surface Water Body
- Watercourse
- Provincally Significant Wetland (GRCA

**Ground Surface Elevation Contour (mamsl)**

- Major Contour (10m)
- Minor Contour (5m)

*Data Sources:*

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*South Central Ontario Orthophotography Project (2018). Source: Data provided by Ontario Ministry of Natural Resources and Forestry. ©*

Project CRS: NAD83 / UTM zone 17N

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Engineers,Scientists, Surveyors
Ph. (519) 743-6500

Client: Crescent Homes Ltd.

Project: Hydrogeological Assessment

Site: 190-216 Arkell Road, Guelph

Title: Existing Features

| | | | |
|---|---|---|---|
| Reviewed By | PAG | | |
| Prepared By | KLW | Project No | 42063-200 |
| Drawn By | KLW | Figure No | 2 |
| Date | November 2021 | | |

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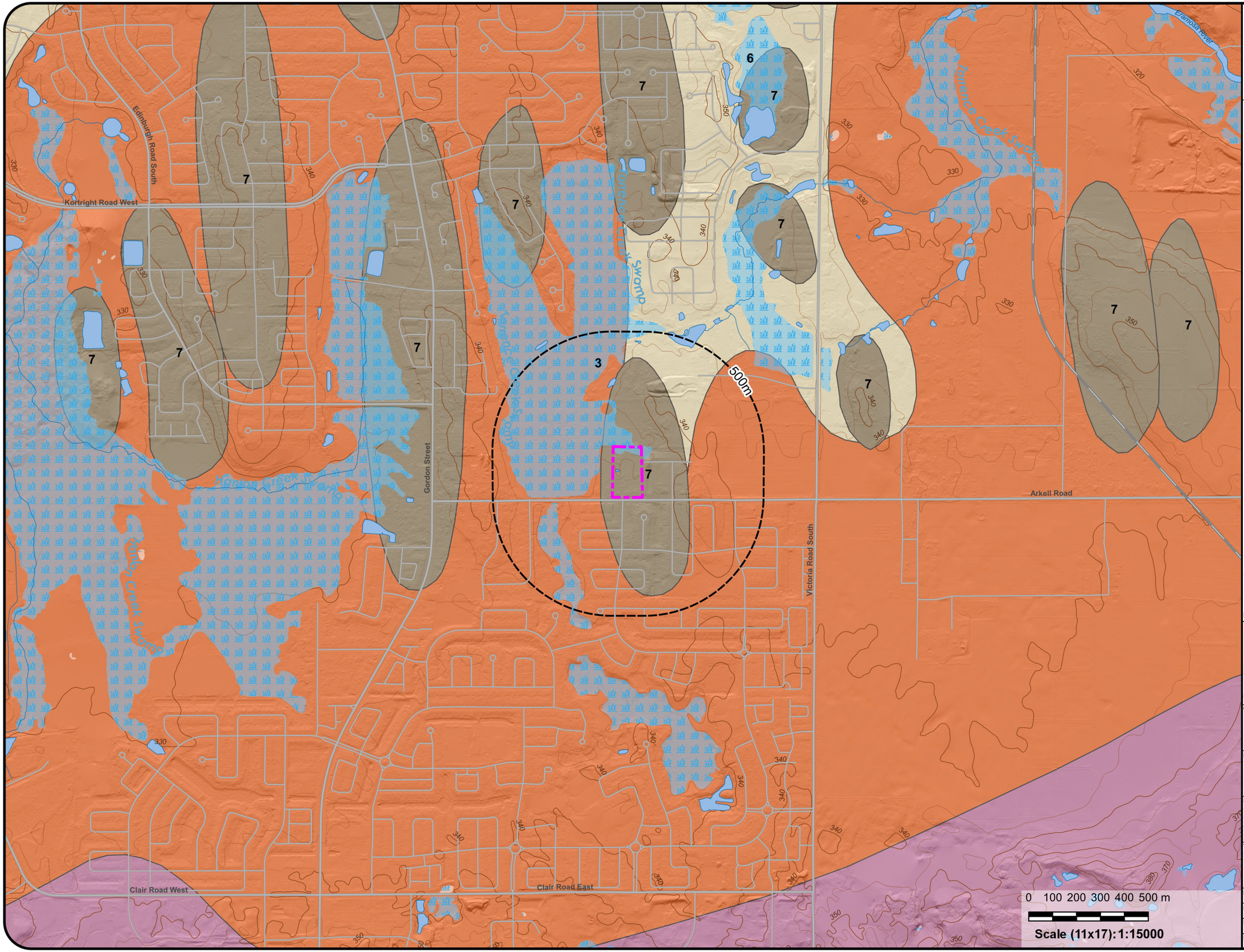


NORTH

PROJECT NORTH

## Legend

Subject Lands

### Surface Water

Surface Water Body

Watercourse

Provincally Significant Wetland (GRCA)

### Ground Surface Elevation Contour (mamsl)

Major Contour (10m)

Minor Contour (5m)

### Physiographic Landforms

2. Till Moraines

3. Spillways

6. Till Plains (Drumlinized)

7. Drumlins

0 100 200 300 400 500 m

Scale (11x17): 1:15000

*Data Sources:*

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Project CRS: NAD83 / UTM zone 17N

MTE

Engineers,Scientists, Surveyors

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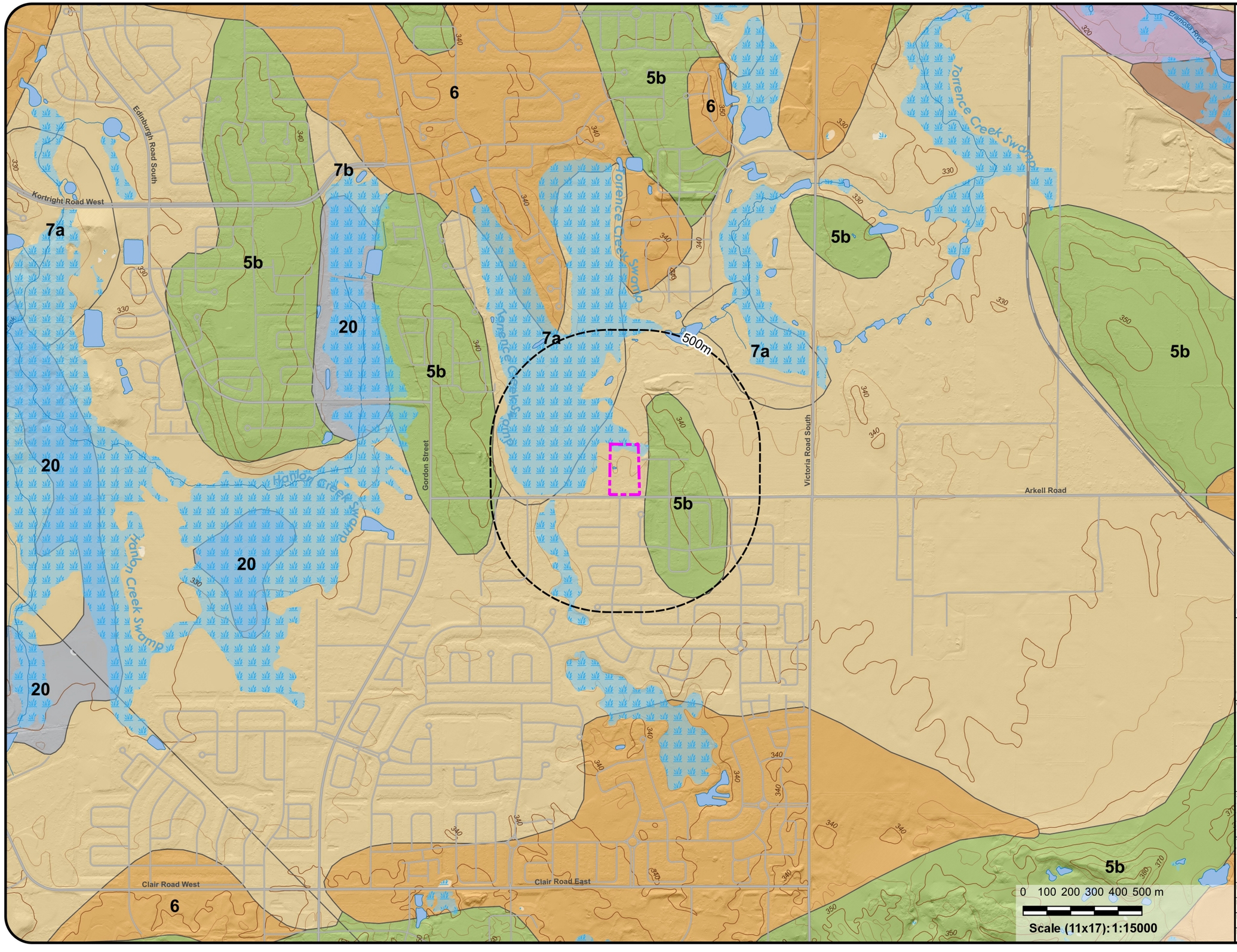
| | |
|---|---|
| Client | Crescent Homes Ltd. |
| Project | Hydrogeological Assessment |
| Site | 190-216 Arkell Road, Guelph |
| Title | Physiographic Landforms |
| Reviewed By | PAG |
| Prepared By | KLW |
| Drawn By | KLW |
| Date | November 2021 |
| Project No | 42063-200 |
| Figure No | 3 |




NORTH

PROJECT NORTH

## Legend

Subject Lands

**Surface Water**

- Surface Water Body
- Watercourse
- Provincally Significant Wetland (GRCA)

**Ground Surface Elevation Contour (mamsl)**

- Major Contour (10m)
- Minor Contour (5m)

**Quaternary Geology**

- 20. Organic Deposits: peat, muck, marl
- 7. Glaciofluvial deposits: river deposit and delta topset facies
- 7a. Sandy deposits
- 7b. Gravelly deposits
- 6. Ice-contact stratified deposit: sand and gravel, minor silt, clay and till
- 6. Ice-contact stratified deposit: sand and gravel, minor silt, clay and till
- 5. Till:
- 5b. Stone-poor, sandy silt to silty sand-textured till on Paleozoic terrain
- Paleozoic
- 3. Paleozoic bedrock

*Data Sources:*

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Project CRS: NAD83 / UTM zone 17N

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| | |
|---|---|
| Client | Crescent Homes Ltd. |
| Project | Hydrogeological Assessment |
| Site | 190-216 Arkell Road, Guelph |
| Title | Quaternary Geology |

| | | | |
|---|---|---|---|
| Reviewed By | PAG | | |
| Prepared By | KLW | Project No | 42063-200 |
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| Date | November 2021 | | |

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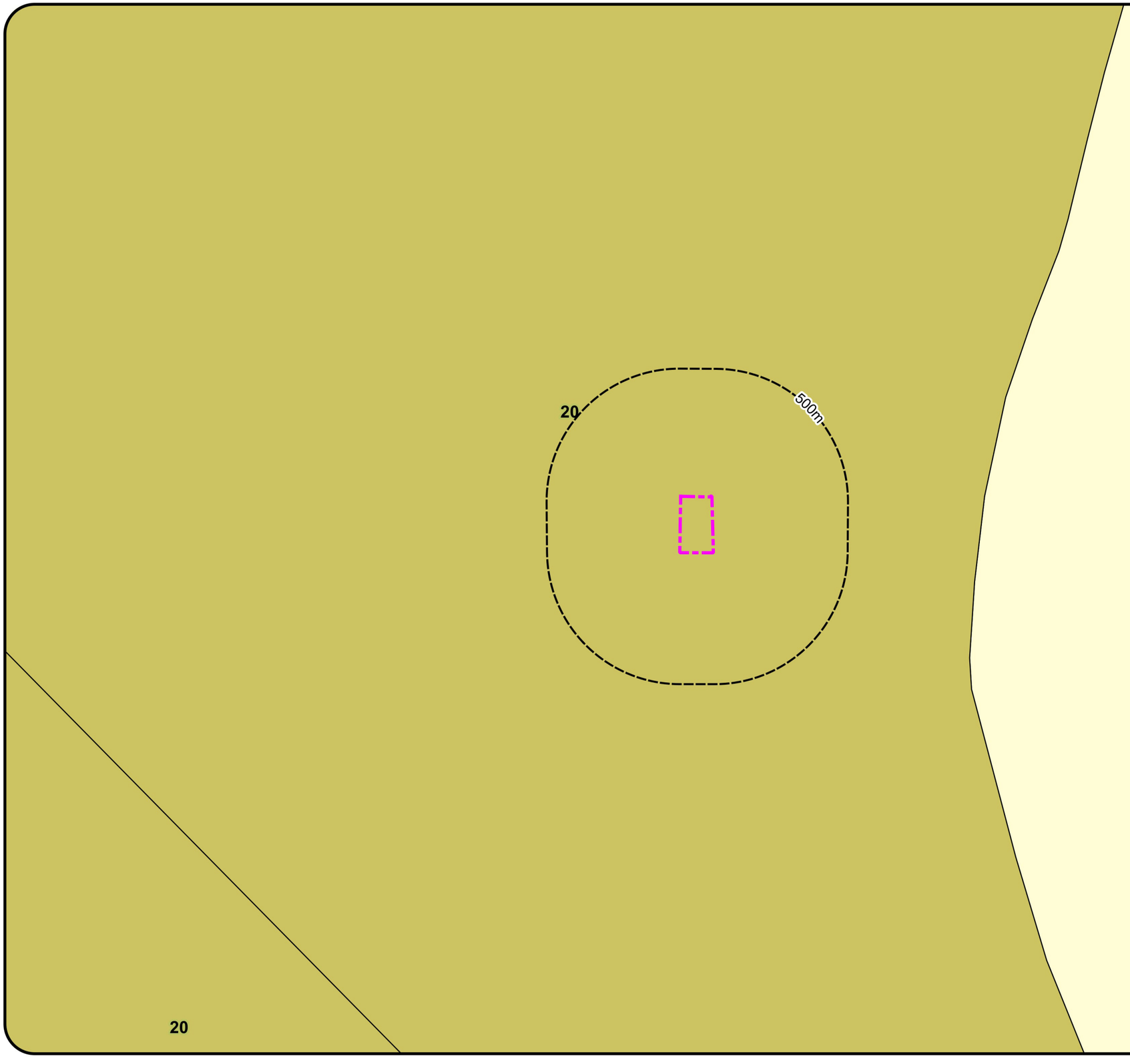



0 100 200 300 400 500 m

**Scale (11x17): 1:15000**

NORTH

PROJECT NORTH

## Legend

Subject Lands

**Surface Water**

Surface Water Body

Watercourse

Provincally Significant Wetland (GRCA)

**Ground Surface Elevation Contour (mamsl)**

Major Contour (10m)

Minor Contour (5m)

**Paleozoic Geology**

Upper Silurian

20. Guelph Formation: dolostone: sucrosic, fossiliferous, locally biohermal; includes bituminous dolostone on Bruce Peninsula

Lower Silurian

19. Amabel Formation: dolostone; thick-bedded, crinoidal, locally biohermal; includes bituminous dolostone in Guelph to Burlington area

*Data Sources:*



Project CRS: NAD83 / UTM zone 17N

MTE
Engineers,Scientists, Surveyors
Ph. (519) 743-6500

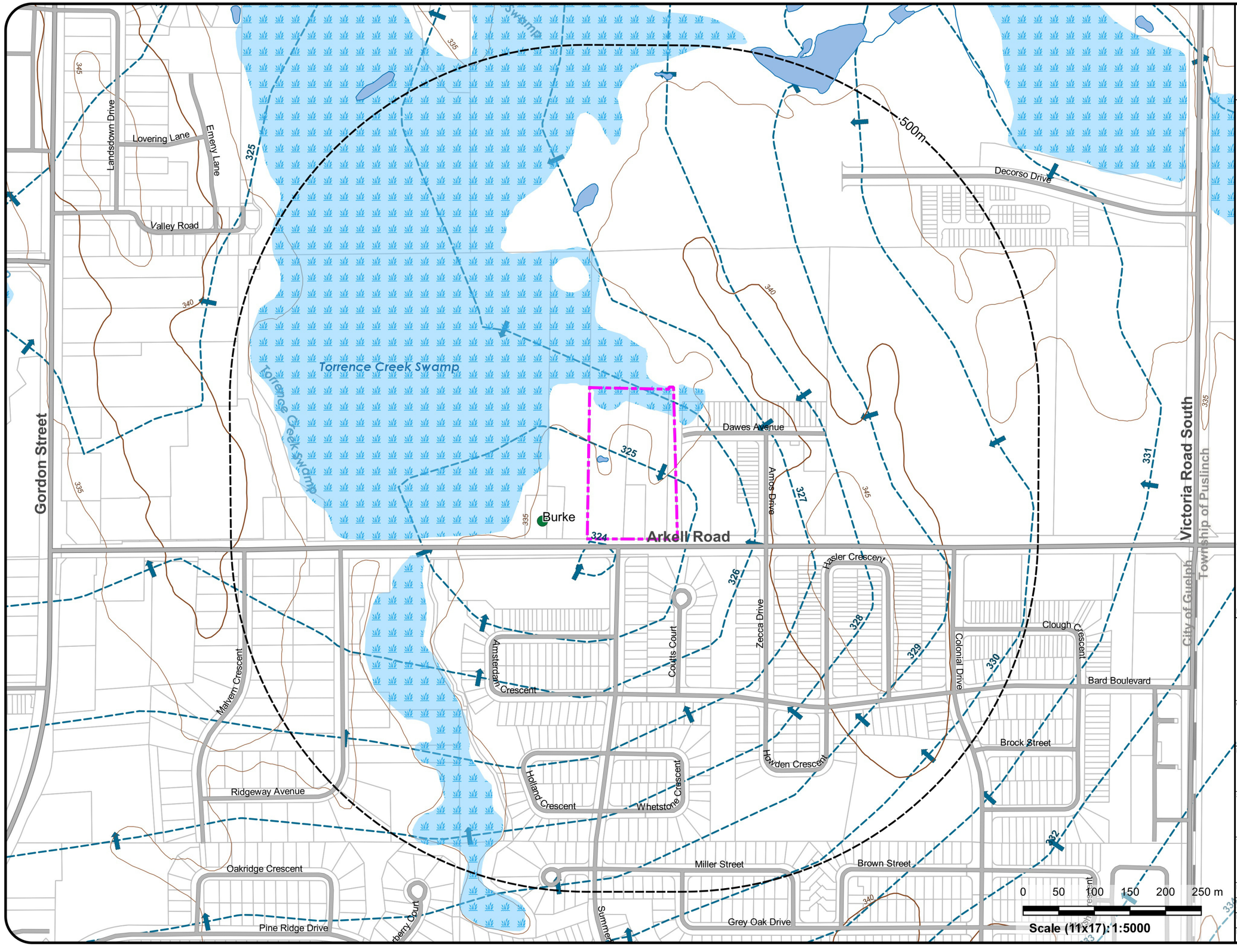
Client: Crescent Homes Ltd.

Project: Hydrogeological Assessment

Site: 190-216 Arkell Road, Guelph

Title: Bedrock Geology

| | | | |
|---|---|---|---|
| Reviewed By | PAG | | |
| Prepared By | KLW | Project No | 42063-200 |
| Drawn By | KLW | Figure No | 5 |
| Date | November 2021 | | |




NORTH

PROJECT NORTH

## Legend

- Subject Lands
- Study Area (500m)
- Regional Groundwater Elevation Contour (mamsl) & Flow Direction (GRCA, 2021)
- Municipal Well (GRCA)

### Surface Water

- Surface Water Body
- Watercourse
- Provincally Significant Wetland (GRC

### Ground Surface Elevation Contour (mamsl)

- Major Contour (10m)
- Minor Contour (5m)

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Project CRS: NAD83 / UTM zone 17N


MTE

Engineers,Scientists, Surveyors

Ph. (519) 743-6500


Client: Crescent Homes Ltd.

Project: Hydrogeological Assessment

Site: 190-216 Arkell Road, Guelph

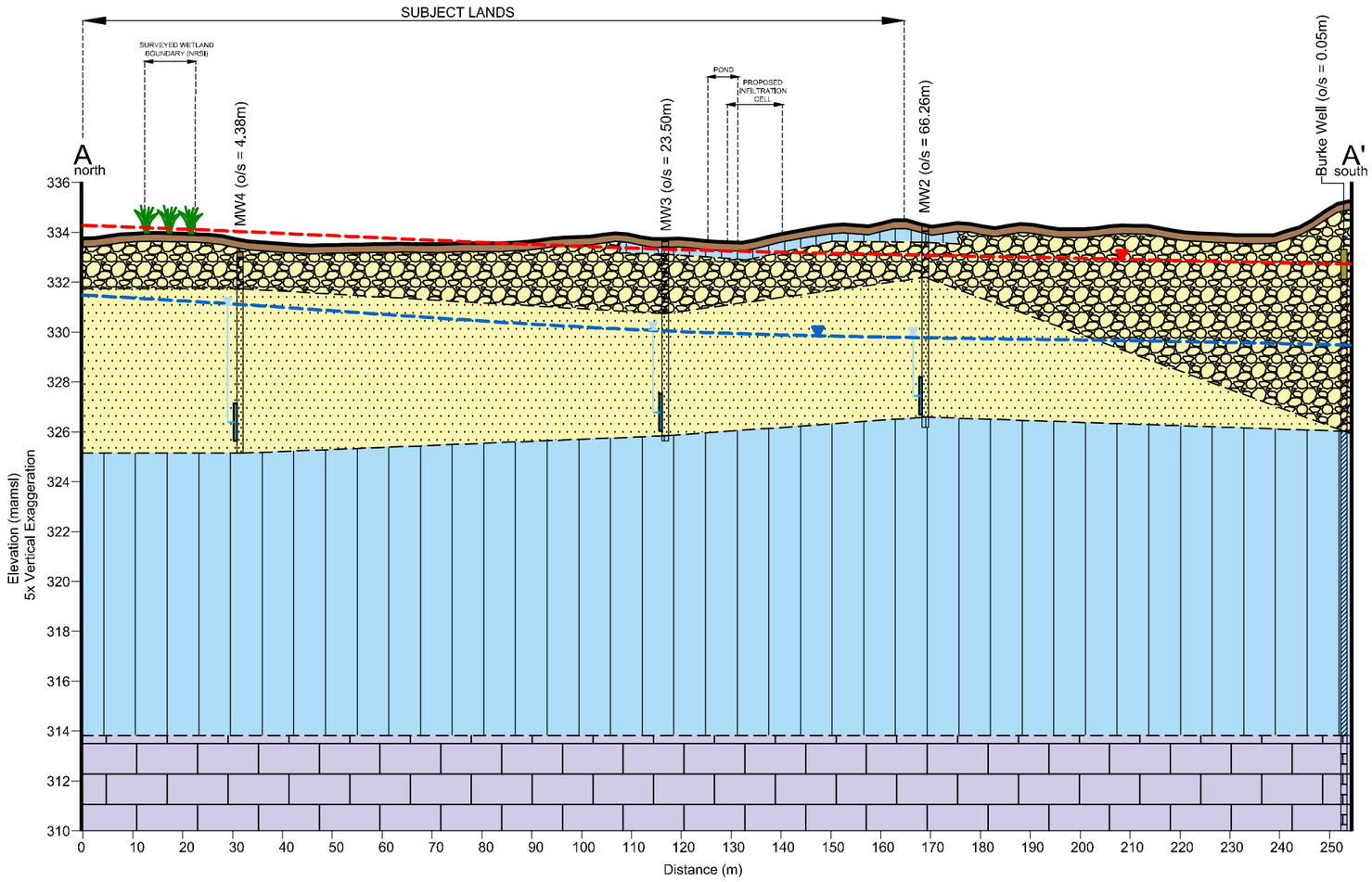
Title: Regional Groundwater Flow

| | | | |
|---|---|---|---|
| Reviewed By | PAG | | |
| Prepared By | KLW | Project No | 42063-200 |
| Drawn By | KLW | Figure No | 6 |
| Date | November 2021 | | |


Project No: 42063-200 Q:\42063\1041Hydrogeology\42063-104 QGIS.qgs

GWR2.6

November 07, 2021 - 18:14 - Plotted By: KWallace




## Legend

- Ground Surface (SWOOP, 2015)
- Interpreted Water Table (Aug. 4, 2021)
- Interpreted Seasonal High Water Table (May 6, 2017)

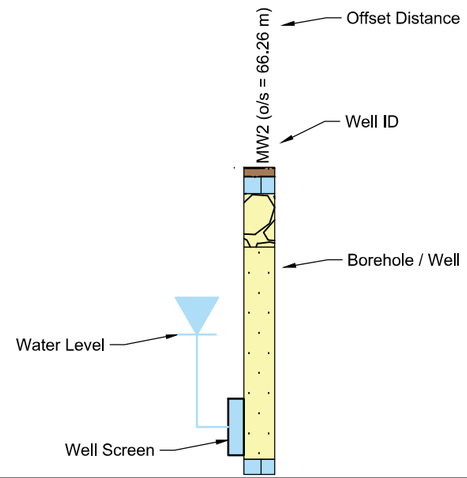
### Borehole Lithology

Topsoil, Fill, Sand, Sand and Gravel, Silt, Silt Till, Bedrock (Limestone)

### Interpreted Geology

Topsoil, Bedrock (Limestone), Fill, Sand and Gravel, Sand, Silt

## Well Detail




Notes:

1. Geological sequence is based on professional interpretation from sediments encountered during drilling. Actual geological conditions can vary between tested locations.
2. The inferred ground surface has been projected onto the geological cross-section. Distances between the ground surface and boreholes presented on the cross-section are a result of offset distances.
3. The interpreted water table has been projected onto the geological cross-section. Distances between the water levels presented within the wells and the interpreted water table are a result of offset distances.
4. Illustrated extents are approximates only.

MTE
Engineers, Scientists, Surveyors
Ph. (519) 743-6500

CLIENT: Crescent Homes Ltd.

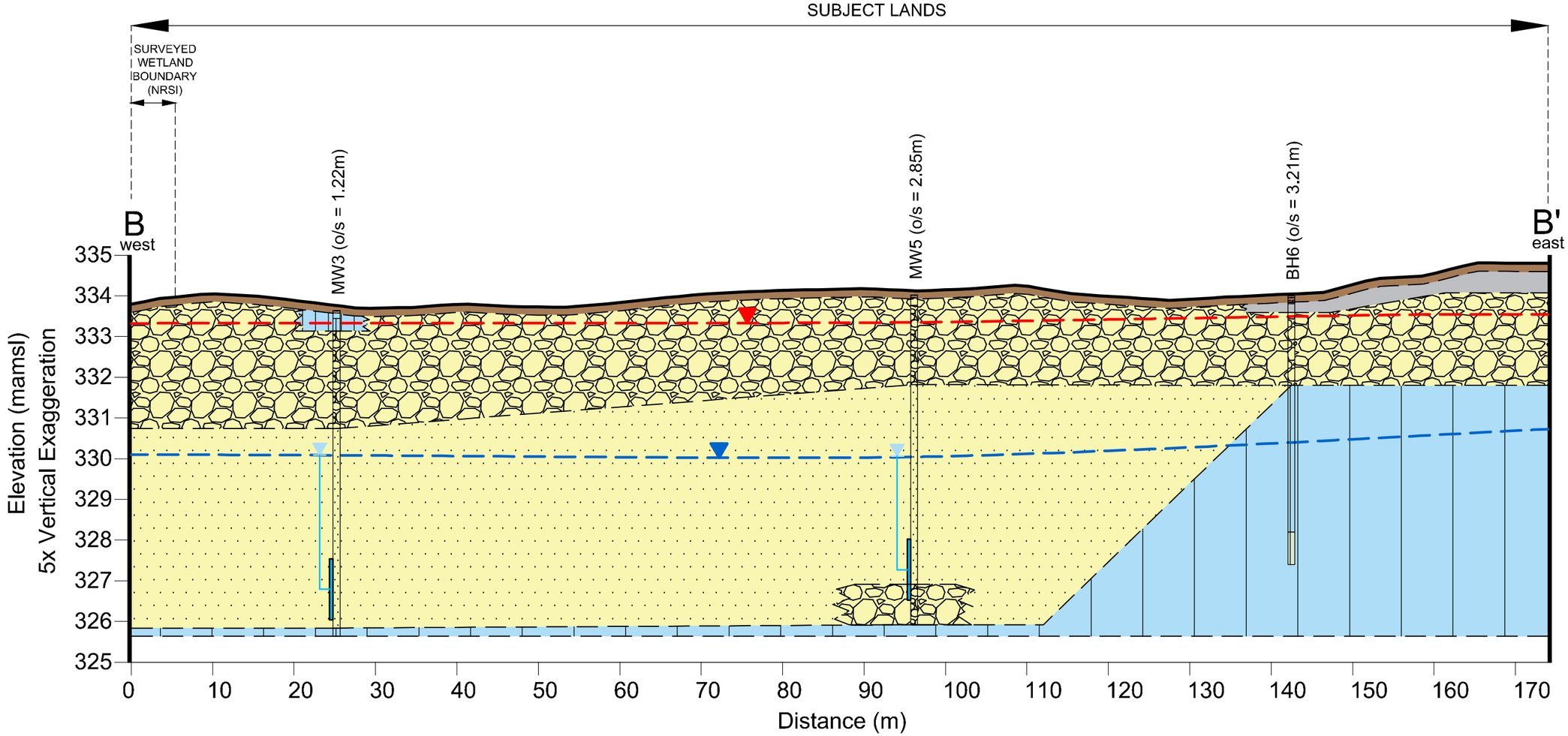
PROJECT: Hydrogeological Assessment

SITE: 190-216 Arkell Road
Guelph, ON

TITLE: Geological
Cross-Section A-A'

| | | | |
|---|---|---|---|
| Reviewed By | PAG | | |
| Prepared By | KLW | Project No. | 42063-104 |
| Drawn By | KLW | Figure No. | 7 |
| Date | Nov. 2021 | | |

Project: 42063-104 CAD: P:\P\42063\104\42063-104-EV2.DWG GWR2.7
Aug. 30, 2021 — 3:49 PM — Plotted By: KWallace




## Legend

- Ground Surface (SWOOP, 2015)
- Interpreted Water Table (Aug. 4, 2021)
- Interpreted Seasonal High Water Table (May 6, 2017)

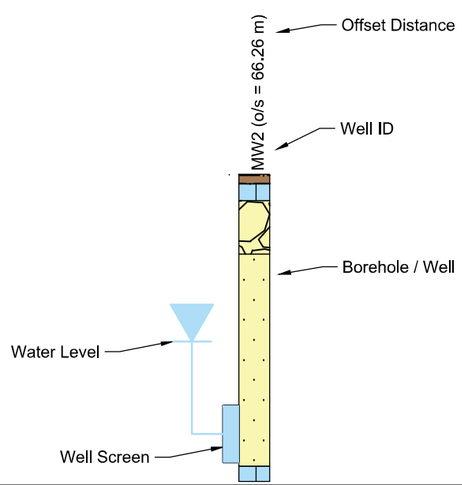
### Borehole Lithology

Topsoil, Fill, Sand, Sand and Gravel, Silt, Silt Till, Bedrock (Limestone)

### Interpreted Geology

Topsoil, Bedrock (Limestone), Fill, Sand and Gravel, Sand, Silt

## Well Detail




Notes:

1. Geological sequence is based on professional interpretation from sediments encountered during drilling. Actual geological conditions can vary between tested locations.
2. The inferred ground surface has been projected onto the geological cross-section. Distances between the ground surface and boreholes presented on the cross-section are a result of offset distances.
3. The interpreted water table has been projected onto the geological cross-section. Distances between the water levels presented within the wells and the interpreted water table are a result of offset distances.
4. Illustrated extents are approximates only.

MTE
Engineers, Scientists, Surveyors
Ph. (519) 743-6500

CLIENT: Crescent Homes Ltd.

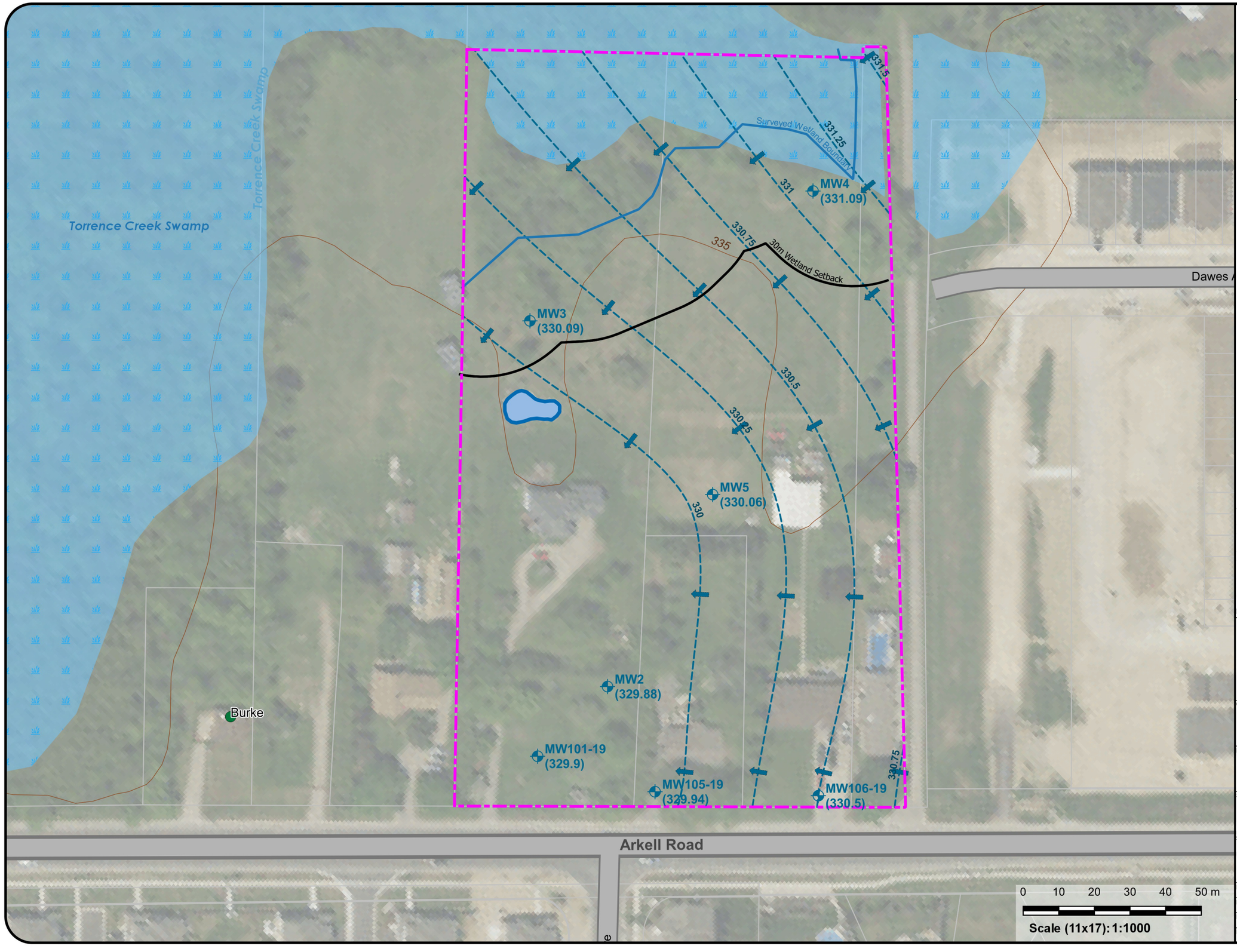
PROJECT: Hydrogeological Assessment

SITE: 190-216 Arkell Road Guelph, ON

TITLE: Geological Cross-Section B-B'

| | | | |
|---|---|---|---|
| Reviewed By | PAG | | |
| Prepared By | KLW | Project No. | 42063-104 |
| Drawn By | KLW | Figure No. | 8 |
| Date | Nov. 2021 | | |

Project: 42063-104 CAD: P:\P\42063\104\42063-104-EV2.DWG
GWR2.8
Aug. 30, 2021 — 3:49 PM — Plotted By: KWallace




NORTH

PROJECT NORTH

## Legend

- Subject Lands
- Study Area (500m)
- Municipal Well (GRCA)
- Monitoring Well (Groundwater Elevation (mamsl))
- Local Groundwater Elevation Contour (mamsl) & Flow Direction (Aug. 4, 2021)

**Surface Water**

- Surface Water Body
- Watercourse
- Provincally Significant Wetland (GRCA)

**Ground Surface Elevation Contour (mamsl)**

- Major Contour (10m)
- Minor Contour (5m)

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*South Central Ontario Orthophotography Project (2018). Source: Data provided by Ontario Ministry of Natural Resources and Forestry. ©*

Project CRS: NAD83 / UTM zone 17N

MTE
Engineers,Scientists, Surveyors
Ph. (519) 743-6500

Client: Crescent Homes Ltd.

Project: Hydrogeological Assessment

Site: 190-216 Arkell Road, Guelph

Title: Local Groundwater Flow Interpretation (Aug. 4, 2021)

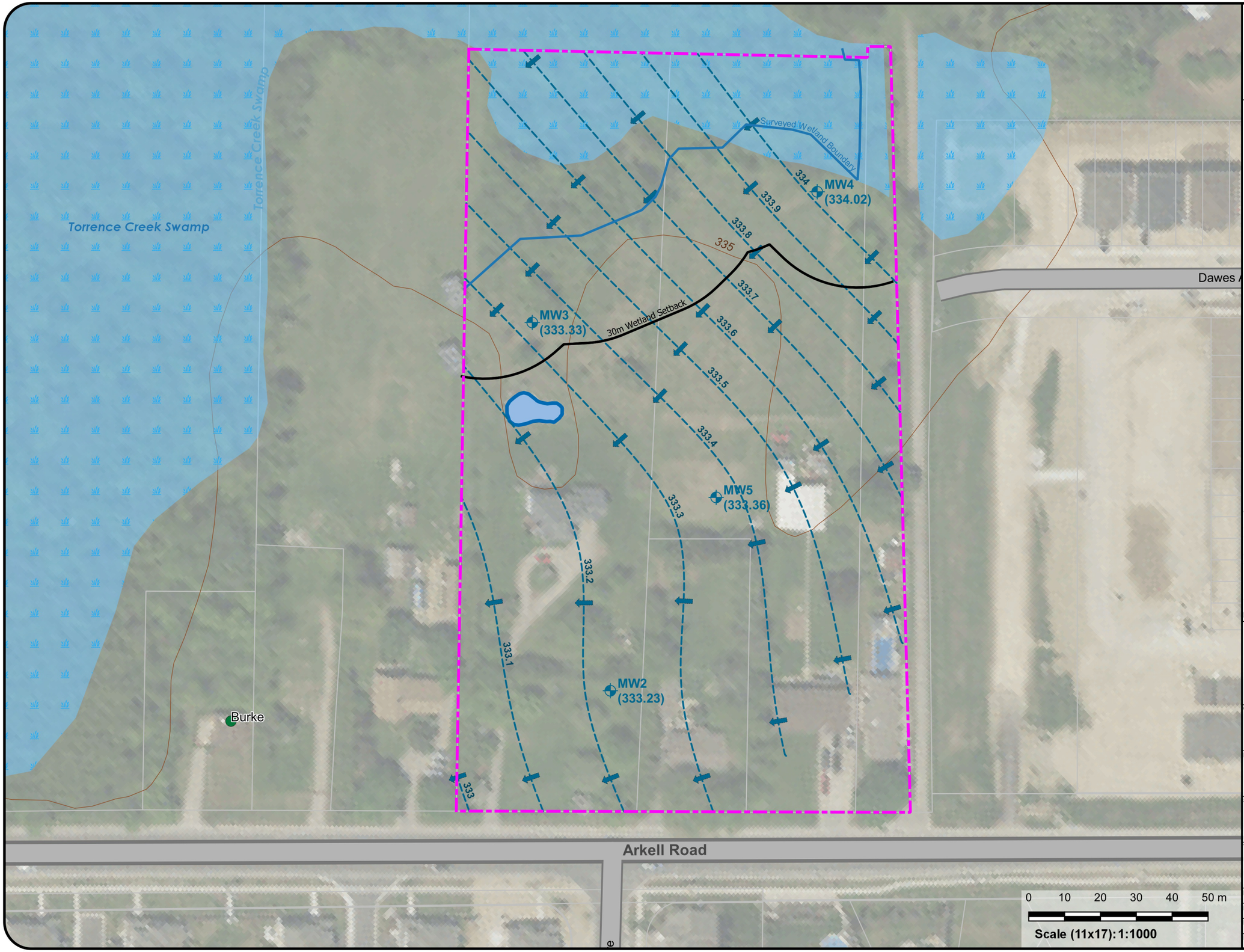
| | | | |
|---|---|---|---|
| Reviewed By | PAG | | |
| Prepared By | KLW | Project No | 42063-200 |
| Drawn By | KLW | Figure No | 9A |
| Date | November 2021 | | |

Project No: 42063-200 Q:\42063\1041Hydrogeology\42063-104 QGIS.qgs
GWR2.9A
November 07, 2021 - 18:35 - Plotted By: KWallace

Project No: 42063-200 Q:\42063\1041Hydrogeology\42063-104 QGIS.qgs

GWR2.9B

November 08, 2021 - 09:27 - Plotted By: KWallace




NORTH

PROJECT NORTH

## Legend

- Subject Lands
- Study Area (500m)
- Municipal Well (GRCA)
- Monitoring Well (Groundwater Elevation (mamsl))
- Seasonal High Groundwater Elevation Contour (mamsl) & Flow Direction (May 6, 2017)

### Surface Water

- Surface Water Body
- Watercourse
- Provincally Significant Wetland (GRCA)

### Ground Surface Elevation Contour (mamsl)

- Major Contour (10m)
- Minor Contour (5m)

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Project CRS: NAD83 / UTM zone 17N

MTE
Engineers,Scientists, Surveyors
Ph. (519) 743-6500

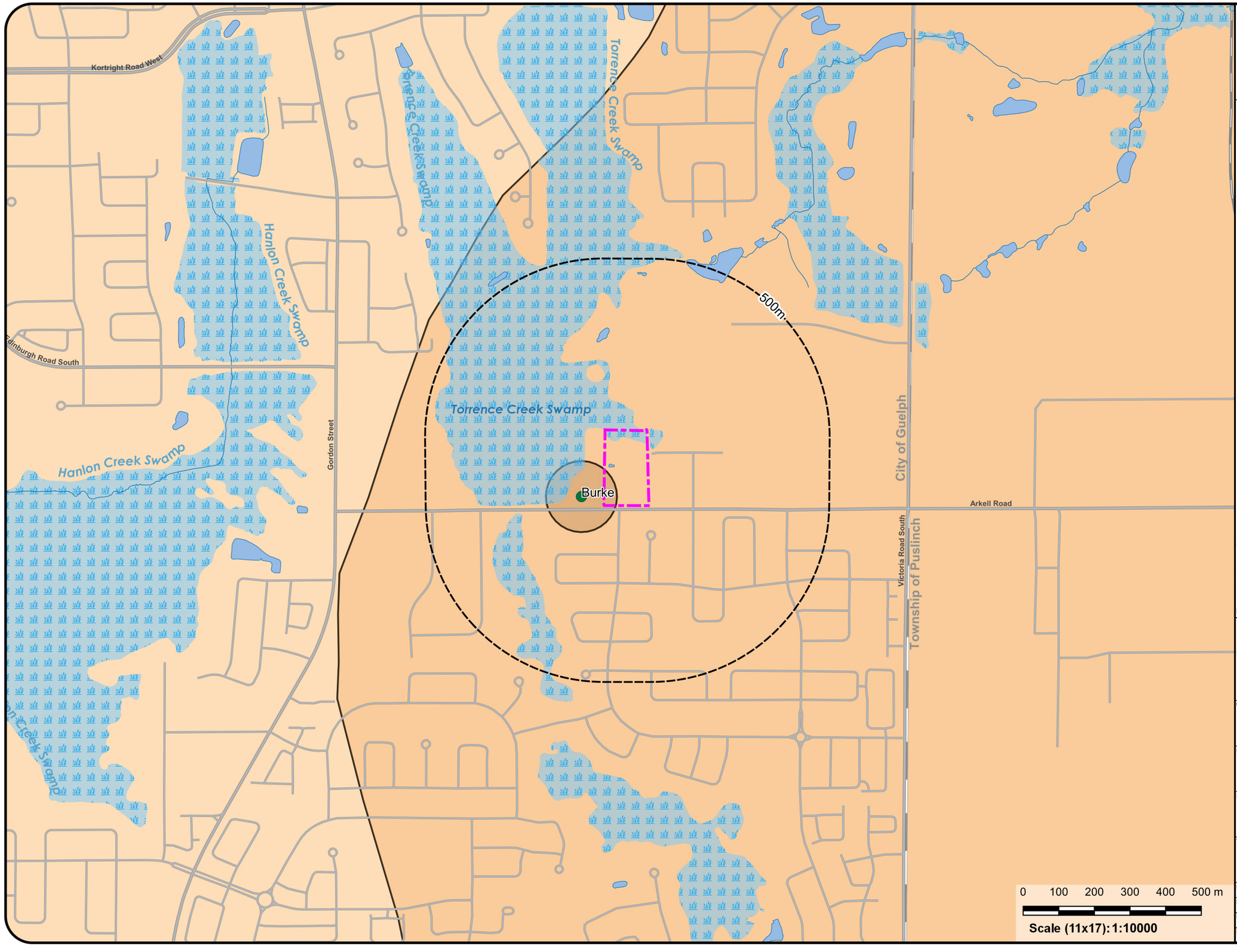
Client: Crescent Homes Ltd.

Project: Hydrogeological Assessment

Site: 190-216 Arkell Road, Guelph

Title: Seasonal High Groundwater Flow Interpretation (May 6, 2017)

| | | | |
|---|---|---|---|
| Reviewed By | PAG | | |
| Prepared By | KLW | Project No | 42063-200 |
| Drawn By | KLW | Figure No | 9B |
| Date | November 2021 | | |




NORTH

PROJECT NORTH

## Legend

- Subject Lands
- Study Area (500m)
- Municipal Well (GRCA)

**Surface Water**

- Surface Water Body
- Watercourse
- Provincally Significant Wetland (GRCA)

**WHPA-Wellhead Protection Area (GRCA)**

- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D

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Project CRS: NAD83 / UTM zone 17N

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Engineers,Scientists, Surveyors

Ph. (519) 743-6500

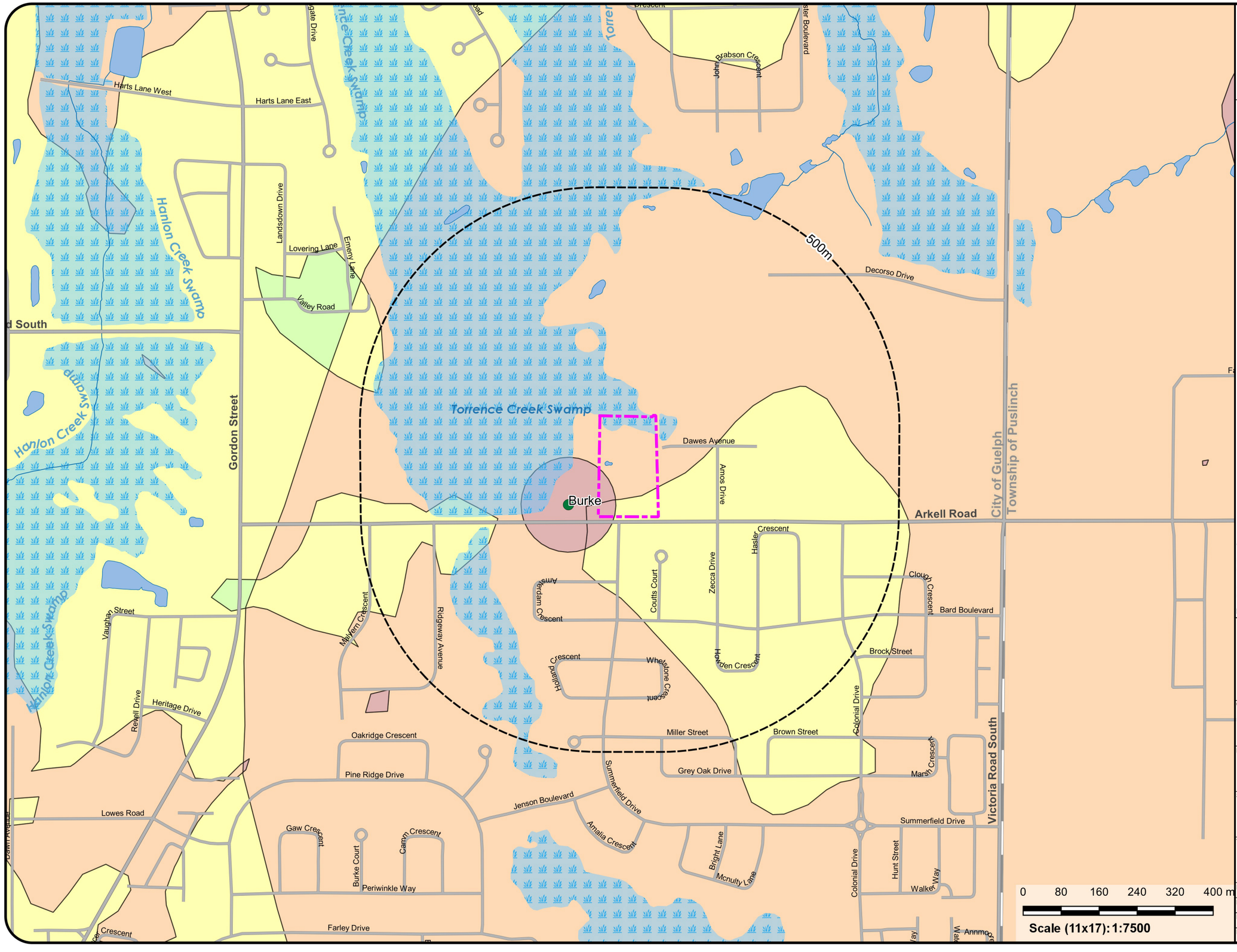
| | |
|---|---|
| Client | Crescent Homes Ltd. |
| Project | Hydrogeological Assessment |
| Site | 190-216 Arkell Road, Guelph |
| Title | WHPAs |

| | | | |
|---|---|---|---|
| Reviewed By | PAG | | |
| Prepared By | KLW | Project No | 42063-200 |
| Drawn By | KLW | Figure No | 10 |
| Date | November 2021 | | |

Project No: 42063-200 Q:\42063\104\Hydrogeology\42063-104 QGIS.qgs

GWR2.10

November 08, 2021 - 16:35 - Plotted By: KWallace




Project No: 42063-200 Q:\42063\104Hydrogeology\42063-104 QGIS.qgs

GWR2.11

November 08, 2021 - 17:02 - Plotted By: KWallace

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Project CRS: NAD83 / UTM zone 17N

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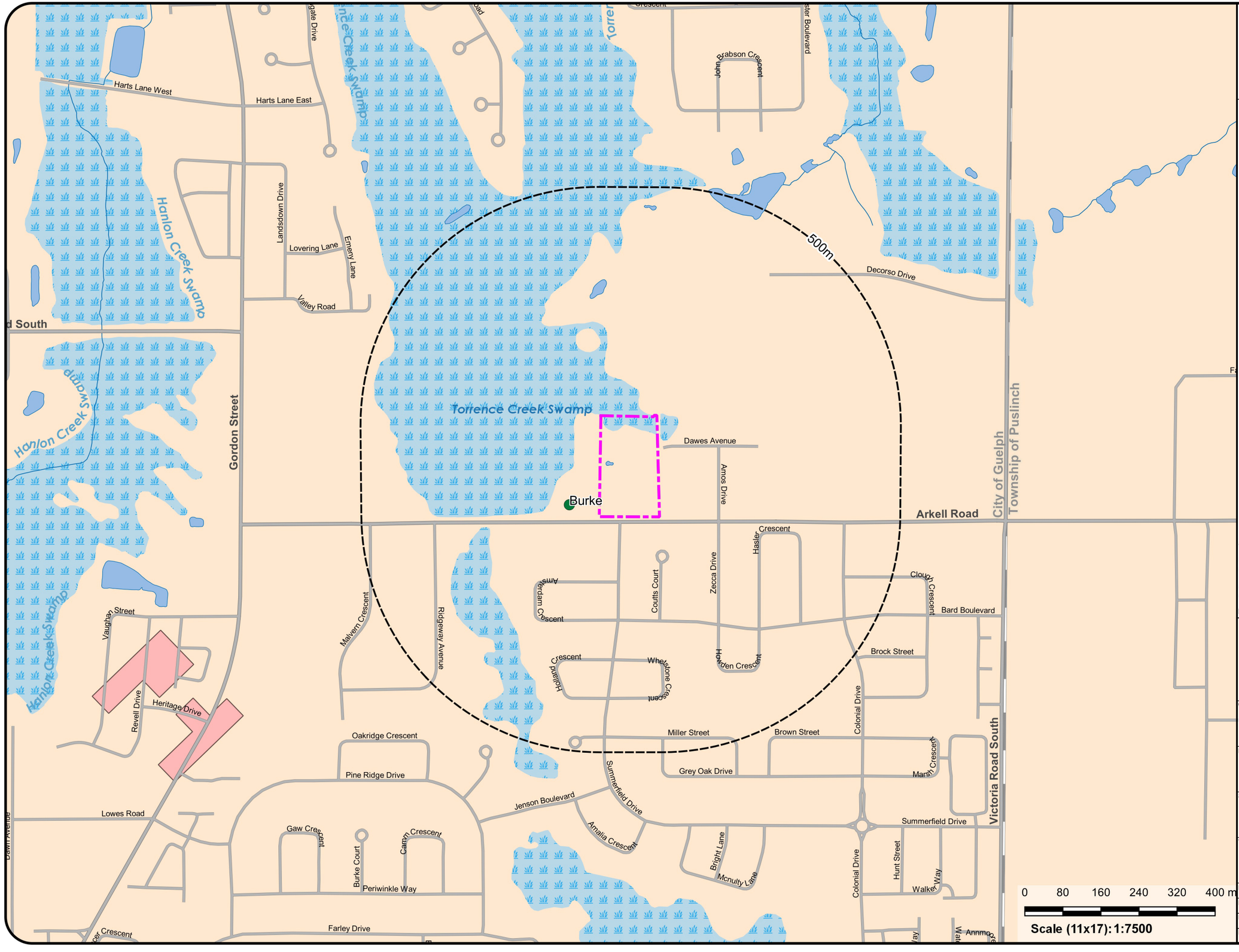
| | |
|---|---|
| Client | Crescent Homes Ltd. |
| Project | Hydrogeological Assessment |
| Site | 190-216 Arkell Road, Guelph |
| Title | WHPA Vulnerability Scoring |

| | | | |
|---|---|---|---|
| Reviewed By | PAG | | |
| Prepared By | KLW | Project No | 42063-200 |
| Drawn By | KLW | Figure No | 11 |
| Date | November 2021 | | |




Project No: 42063-200 Q:\42063\104\Hydrogeology\42063-104 QGIS.qgs

GWR2.12

November 08, 2021 - 17:09 - Plotted By: KWallace

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Project CRS: NAD83 / UTM zone 17N

MTE

Engineers,Scientists, Surveyors

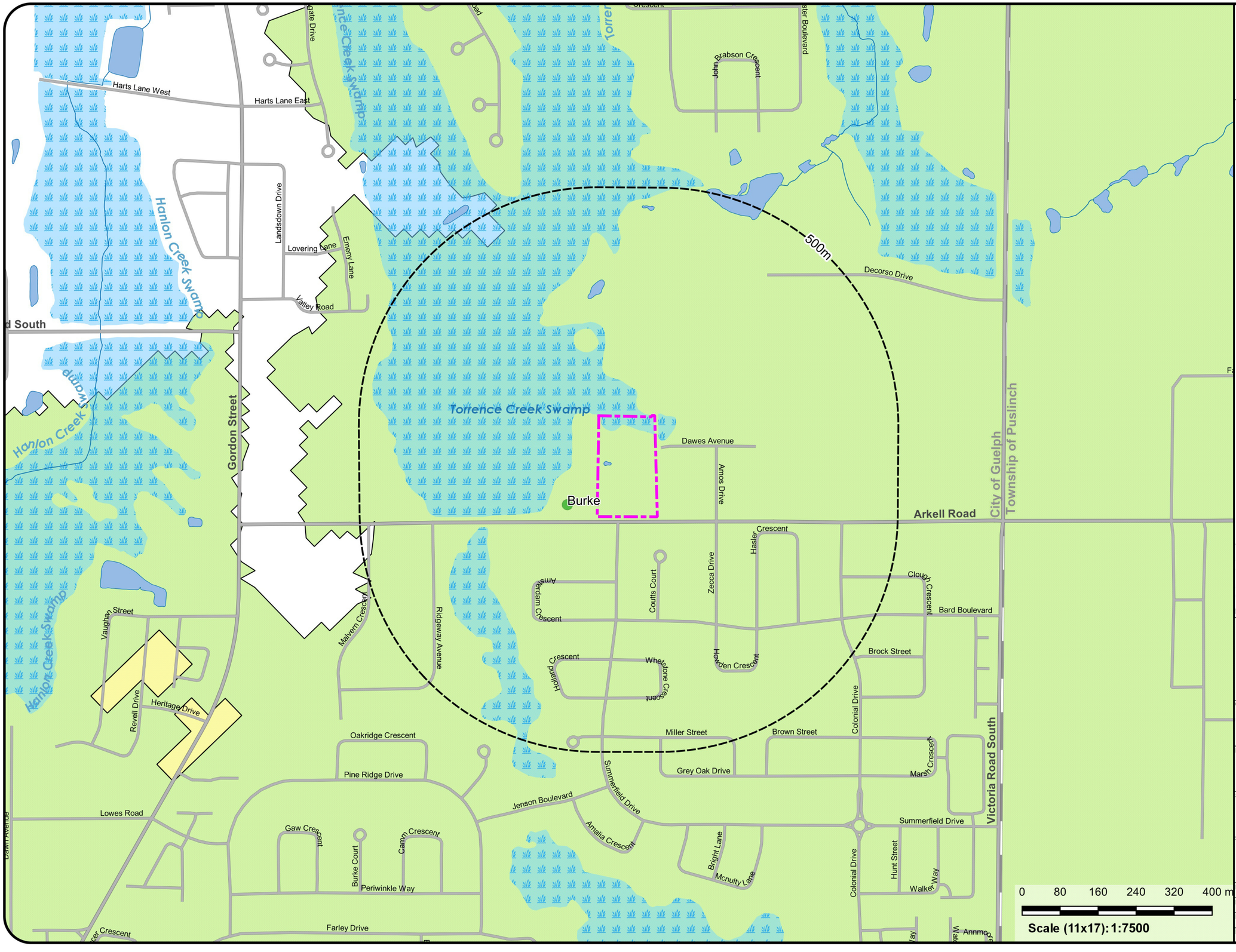
Ph. (519) 743-6500

| | |
|---|---|
| Client | Crescent Homes Ltd. |
| Project | Hydrogeological Assessment |
| Site | 190-216 Arkell Road, Guelph |
| Title | Intrinsic Aquifer Vulnerability |
| Reviewed By | PAG |
| Prepared By | KLW |
| Project No | 42063-200 |
| Drawn By | KLW |
| Figure No | 12 |
| Date | November 2021 |

Project No: 42063-200 Q:\42063\104\Hydrogeology\42063-104 QGIS.qgs

GWR2.13

November 08, 2021 - 17:12 - Plotted By: KWallace




NORTH

PROJECT NORTH

## Legend

- Subject Lands
- Study Area (500m)
- Municipal Well (GRCA)

**Surface Water**

- Surface Water Body
- Watercourse
- Provincially Significant Wetland (GRCA)

**SGRA Vulnerability (GRCA)**

- 2
- 4
- 6

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Project CRS: NAD83 / UTM zone 17N


MTE

Engineers,Scientists, Surveyors

Ph. (519) 743-6500

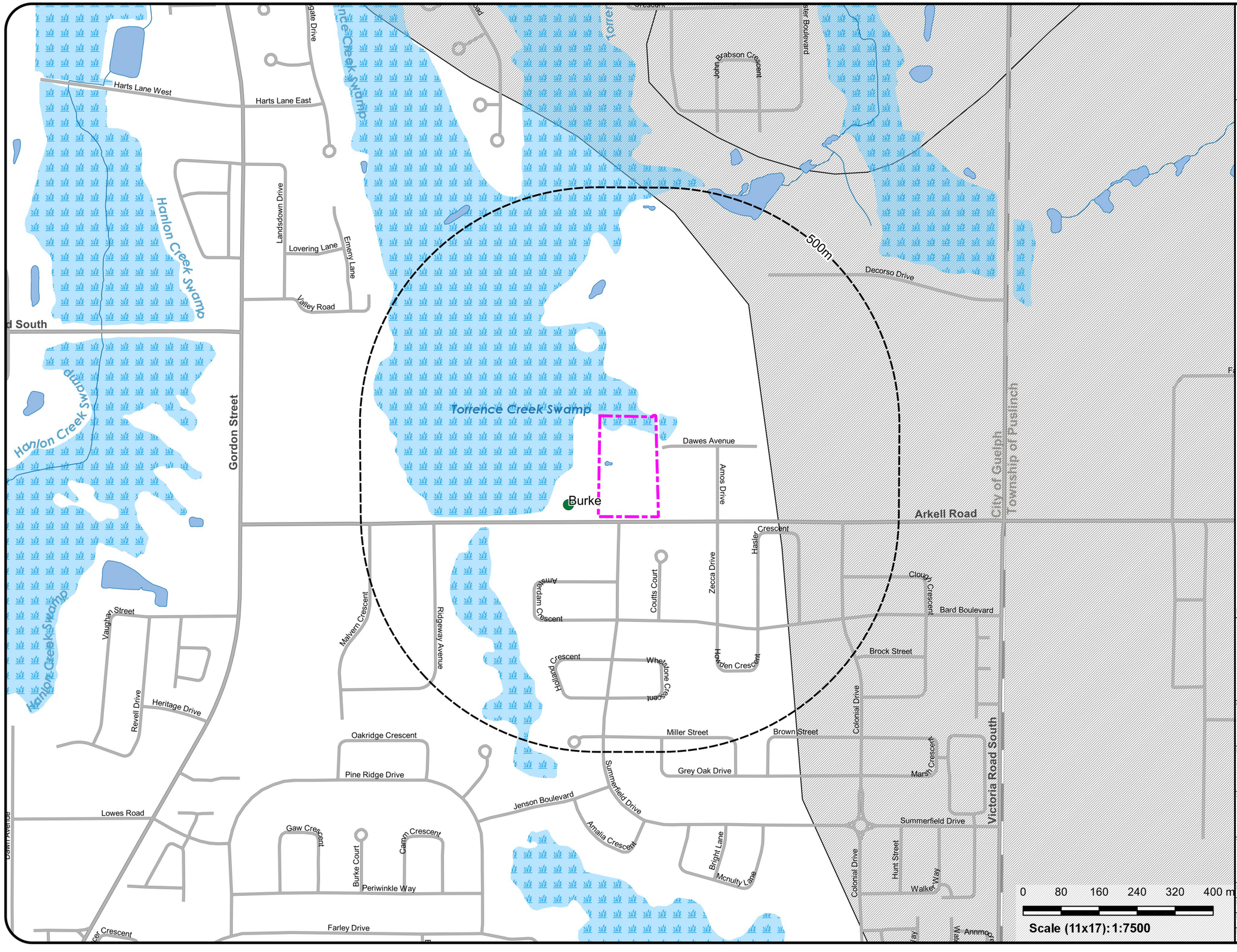

Client: Crescent Homes Ltd.

Project: Hydrogeological Assessment

Site: 190-216 Arkell Road, Guelph

Title: SGRA & Vulnerability Scoring

| | | | |
|---|---|---|---|
| Reviewed By | PAG | | |
| Prepared By | KLW | Project No | 42063-200 |
| Drawn By | KLW | Figure No | 13 |
| Date | November 2021 | | |

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Project CRS: NAD83 / UTM zone 17N

MTE
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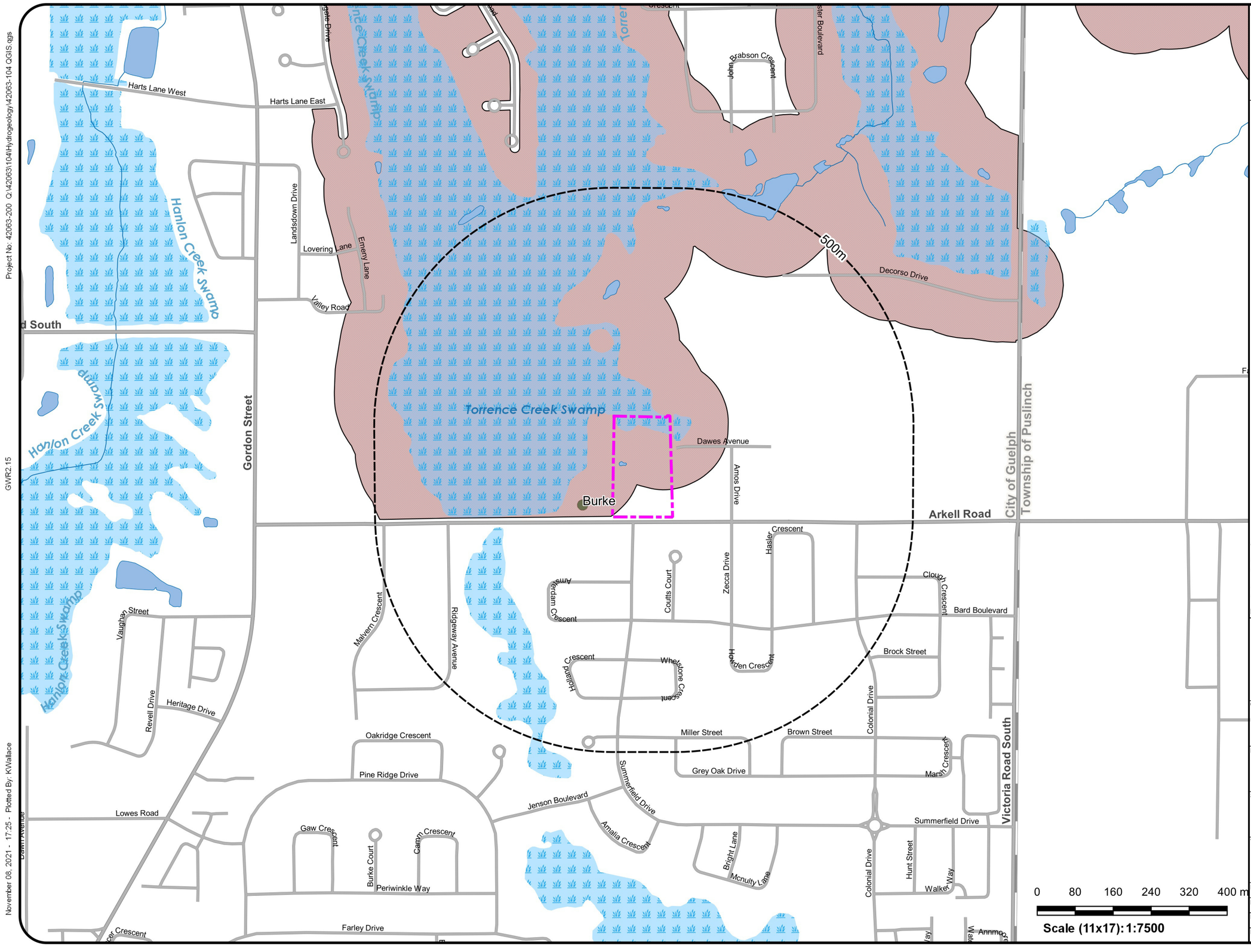
Ph. (519) 743-6500

| | |
|---|---|
| Client | Crescent Homes Ltd. |
| Project | Hydrogeological Assessment |
| Site | 190-216 Arkell Road, Guelph |
| Title | ICAs |
| Reviewed By | PAG |
| Prepared By | KLW |
| Drawn By | KLW |
| Date | November 2021 |
| Project No | 42063-200 |
| Figure No | 14 |

Project No: 42063-200 Q:\42063\104Hydrogeology\42063-104 QGIS.qgs

GWR2.14

November 08, 2021 - 17:18 - Plotted By: KWallace




Project No: 42063-200 Q:\42063\104\Hydrogeology\42063-104 QGIS.qgs

GWR2.15

November 08, 2021 - 17:25 - Plotted By: KWallace

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Project CRS: NAD83 / UTM zone 17N

MTE

Engineers,Scientists, Surveyors

Ph. (519) 743-6500

Client: Crescent Homes Ltd.

Project: Hydrogeological Assessment

Site: 190-216 Arkell Road, Guelph

Title: GUDI & Vulnerability Scoring

| | | | |
|---|---|---|---|
| Reviewed By | PAG | | |
| Prepared By | KLW | Project No | 42063-200 |
| Drawn By | KLW | Figure No | 15 |
| Date | November 2021 | | |

# Tables

Table 1A: Groundwater Levels

| ID | MW-2 | | MW-3 | | MW-4 | | MW-5 | | MW101-19 | | MW105-19 | | MW106-19 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOC Elevation (mAMSL) | 335.04 | | 334.31 | | 333.99 | | 334.83 | | 335.83 | | 334.76 | | 334.80 | |
| GS Elevation (mAMSL) | 334.29 | | 333.64 | | 333.24 | | 334.02 | | 334.68 | | 334.84 | | 334.88 | |
| Stickup (m) | 0.75 | | 0.67 | | 0.75 | | 0.81 | | 1.15 | | -0.08 | | -0.08 | |
| Date | mbtoc | mbgs | mbtoc | mbgs | mbtoc | mbgs | mbtoc | mbgs | mbtoc | mbgs | mbtoc | mbgs | mbtoc | mbgs |
| 2-Mar-17 | 2.77 | 2.02 | 1.77 | 1.10 | NI | - | NI | - | NI | - | NI | - | NI | - |
| 27-Mar-17 | 2.71 | 1.96 | 1.75 | 1.08 | 0.58 | -0.17 | 2.32 | 1.51 | NI | - | NI | - | NI | - |
| 10-May-17 | 1.95 | 1.20 | 1.17 | 0.50 | 0.04 | -0.71 | 1.57 | 0.76 | NI | - | NI | - | NI | - |
| 7-Jun-17 | 2.38 | 1.63 | 1.56 | 0.89 | 0.51 | -0.24 | 2.06 | 1.25 | NI | - | NI | - | NI | - |
| 2-Nov-17 | 4.4 | 3.65 | 3.51 | 2.84 | 2.81 | 2.06 | 4.12 | 3.31 | NI | - | NI | - | NI | - |
| 26-Mar-18 | 2.97 | 2.22 | 2.09 | 1.42 | 1.15 | 0.40 | 2.62 | 1.81 | NI | - | NI | - | NI | - |
| 26-Jun-18 | 2.57 | 1.82 | 1.79 | 1.11 | 0.98 | 0.23 | 2.26 | 1.45 | NI | - | NI | - | NI | - |
| 17-Jun-19 | 2.76 | 2.01 | 1.95 | 1.28 | 0.77 | 0.02 | 2.50 | 1.69 | NI | - | NI | - | NI | - |
| 26-Jun-19 | 2.93 | 2.18 | - | - | - | - | - | - | NI | - | NI | - | NI | - |
| 2-Jul-19 | 2.96 | 2.21 | 2.17 | 1.50 | 1.10 | 0.35 | 2.72 | 1.91 | NI | - | NI | - | NI | - |
| 5-Sep-19 | 4.18 | 3.43 | 3.31 | 2.64 | 2.47 | 1.72 | 3.93 | 3.12 | NI | - | NI | - | NI | - |
| 29-Oct-19 | 4.68 | 3.93 | 3.78 | 3.11 | 2.76 | 2.01 | 4.37 | 3.56 | 5.40 | 4.25 | 4.30 | 4.38 | 4.15 | 4.23 |
| 6-Dec-19 | 4.52 | 3.77 | 3.49 | 2.82 | 2.34 | 1.59 | 4.17 | 3.36 | 5.27 | 4.12 | NM | - | NM | - |
| 12-Mar-20 | 3.27 | 2.52 | 2.12 | 1.45 | 0.74 | -0.01 | 2.87 | 2.06 | 4.08 | 2.93 | NM | - | NM | - |
| 1-Jun-20 | 3.94 | 3.19 | 2.93 | 2.26 | 1.78 | 1.03 | 3.65 | 2.84 | 4.69 | 3.54 | NM | - | NM | - |
| 26-Aug-20 | 4.55 | 3.80 | 3.64 | 2.97 | 2.73 | 1.98 | 4.21 | 3.40 | 5.42 | 4.27 | NM | - | NM | - |
| 3-Nov-20 | 5.29 | 4.54 | 4.39 | 3.72 | 3.49 | 2.74 | 5.02 | 4.21 | 6.04 | 4.89 | 4.95 | 5.03 | 4.51 | 4.59 |
| 1-Feb-21 | 5.46 | 4.71 | 4.45 | 3.78 | 3.17 | 2.42 | 5.09 | 4.28 | 6.25 | 5.10 | 5.17 | 5.25 | NM | NM |
| 4-May-21 | 5.05 | 4.30 | 3.89 | 3.22 | 2.33 | 1.58 | 4.57 | 3.76 | 5.88 | 4.73 | 4.79 | 4.87 | 4.38 | 4.46 |
| 4-Aug-21 | 5.16 | 4.41 | 4.22 | 3.55 | 2.90 | 2.15 | 4.77 | 3.96 | 5.93 | 4.78 | 4.82 | 4.90 | 4.30 | 4.38 |

***Notes:***

TOC = Top of Casing

GS = Ground Surface

NI = Not Installed

NM = Not Measured

mAMSL = metres above mean sea level

Negative water level values indicate saturated soil conditions at ground surface

Negative stickup values indicate well is a flushmount well

Table 1B: Groundwater Elevations (mAMSL)

| ID | MW2 | MW3 | MW4 | MW5 | MW101-19 | MW105-19 | MW106-19 |
|---|---|---|---|---|---|---|---|
| TOC Elevation (mAMSL) | 335.04 | 334.31 | 333.99 | 334.83 | 335.83 | 334.76 | 334.80 |
| 2-Mar-17 | 332.27 | 332.54 | NI | NI | NI | NI | NI |
| 27-Mar-17 | 332.33 | 332.56 | 333.41 | 332.51 | NI | NI | NI |
| 10-May-17 | 333.09 | 333.14 | 333.95 | 333.26 | NI | NI | NI |
| 7-Jun-17 | 332.66 | 332.75 | 333.48 | 332.77 | NI | NI | NI |
| 2-Nov-17 | 330.64 | 330.80 | 331.18 | 330.71 | NI | NI | NI |
| 26-Mar-18 | 332.07 | 332.22 | 332.84 | 332.21 | NI | NI | NI |
| 26-Jun-18 | 332.47 | 332.53 | 333.02 | 332.57 | NI | NI | NI |
| 17-Jun-19 | 332.28 | 332.36 | 333.22 | 332.33 | NI | NI | NI |
| 2-Jul-19 | 332.08 | 332.14 | 332.89 | 332.11 | NI | NI | NI |
| 5-Sep-19 | 330.86 | 331.00 | 331.52 | 330.90 | NI | NI | NI |
| 29-Oct-19 | 330.37 | 330.53 | 331.23 | 330.46 | 330.43 | 330.46 | 330.65 |
| 12-Nov-19 | NM | NM | NM | NM | NM | NM | NM |
| 6-Dec-19 | 330.52 | 330.82 | 331.65 | 330.66 | 330.56 | NM | NM |
| 12-Mar-20 | 331.77 | 332.19 | 333.25 | 331.96 | 331.75 | NM | NM |
| 1-Jun-20 | 331.10 | 331.38 | 332.21 | 331.18 | 331.14 | NM | NM |
| 26-Aug-20 | 330.49 | 330.67 | 331.26 | 330.62 | 330.41 | NM | NM |
| 3-Nov-20 | 329.75 | 329.92 | 330.50 | 329.81 | 329.79 | 329.81 | 330.29 |
| 1-Feb-21 | 329.58 | 329.86 | 330.82 | 329.74 | 329.58 | 329.59 | NM |
| 4-May-21 | 329.99 | 330.42 | 331.66 | 330.26 | 329.95 | 329.97 | 330.42 |
| 4-Aug-21 | 329.88 | 330.09 | 331.09 | 330.06 | 329.90 | 329.94 | 330.50 |

mAMSL = metres above mean sea level

*Notes:*

Table 1C: Minipiezometer Groundwater and Surface Water Measurements

| Date | Location | MP1-19 | |
|---|---|---|---|
| | TOC Elevation (mamsl) | 334.48 | |
| | GS Elevation (mamsl) | 333.32 | |
| | | mbtoc | mamsl |
| 8-Oct-19 | Inside Level (IL) | DRY | - |
| | Outside Level (OL) | DRY | - |
| | Vertical Hydraulic Gradient (m/m) | - | |
| 29-Oct-19 | Inside Level (IL) | DRY | - |
| | Outside Level (OL) | DRY | - |
| | Vertical Hydraulic Gradient (m/m) | - | |
| 12-Nov-19 | Inside Level (IL) | DRY | - |
| | Outside Level (OL) | DRY | - |
| | Vertical Hydraulic Gradient (m/m) | - | |
| 6-Dec-19 | Inside Level (IL) | DRY | - |
| | Outside Level (OL) | DRY | - |
| | Vertical Hydraulic Gradient (m/m) | - | |
| 12-Mar-20 | Inside Level (IL) | 1.46 | 333.02 |
| | Outside Level (OL) | DRY | - |
| | Vertical Hydraulic Gradient (m/m) | - | |
| 21-Apr-20 | Inside Level (IL) | 1.97 | 332.51 |
| | Outside Level (OL) | DRY | - |
| | Vertical Hydraulic Gradient (m/m) | - | |
| 1-Jun-20 | Inside Level (IL) | DRY | - |
| | Outside Level (OL) | DRY | - |
| | Vertical Hydraulic Gradient (m/m) | - | |
| 26-Aug-20 | Inside Level (IL) | DRY | - |
| | Outside Level (OL) | DRY | - |
| | Vertical Hydraulic Gradient (m/m) | - | |
| 3-Nov-20 | Inside Level (IL) | DRY | - |
| | Outside Level (OL) | DRY | - |
| | Vertical Hydraulic Gradient (m/m) | - | |
| 1-Feb-21 | Inside Level (IL) | DRY | - |
| | Outside Level (OL) | DRY | - |
| | Vertical Hydraulic Gradient (m/m) | - | |
| 4-May-21 | Inside Level (IL) | DRY | - |
| | Outside Level (OL) | DRY | - |
| | Vertical Hydraulic Gradient (m/m) | - | |
| 4-Aug-21 | Inside Level (IL) | DRY | - |
| | Outside Level (OL) | DRY | - |
| | Vertical Hydraulic Gradient (m/m) | - | |

***Notes:***

TOC = Top of Casing

GS = Ground Surface

mamsl = metres above mean sea level

IL = Inside Level (Groundwater)

OL = Outside Level (Surface Water)

**Table 2: Groundwater Chemistry Summary - 2018**

| Parameter | Units | DL | MW-2 | MW-4 |
|---|---|---|---|---|
| | | | 5-Oct-18 | |
| | | | L2119092-1 | L2119092-2 |
| **Physical Tests** | | | | |
| Colour, Apparent | CU | 2 | 77.6 | 455 |
| Conductivity | umhos/cm | 3 | 712 | 770 |
| Hardness (as CaCO3) | mg/L | 10 | 250 | 380 |
| pH | pH units | 0.1 | 7.89 | 7.63 |
| Total Dissolved Solids | mg/L | 20 | 546 | 452 |
| Turbidity | NTU | 0.1 | >4000 | >4000 |
| **Anions and Nutrients** | | | | |
| Alkalinity, Total (as CaCO3) | mg/L | 10 | 230 | 313 |
| Ammonia, Total (as N) | mg/L | 0.02 | 0.035 | 0.041 |
| Chloride (Cl) | mg/L | 0.5 | 76 | 35.9 |
| Fluoride (F) | mg/L | 0.02 | 0.062 | 0.051 |
| Nitrate (as N) | mg/L | 0.02 | 1.59 | 6.29 |
| Nitrite (as N) | mg/L | 0.01 | <0.010 | <0.010 |
| Orthophosphate-Dissolved (as P) | mg/L | 0.003 | <0.0030 | <0.0030 |
| Sulfate (SO4) | mg/L | 0.3 | 13.6 | 14.2 |
| **Dissolved Metals** | | | | |
| Dissolved Metals Filtration Location | | | FIELD | FIELD |
| Aluminum (Al)-Dissolved | mg/L | 0.01 | <0.010 | <0.010 |
| Antimony (Sb)-Dissolved | mg/L | 0.005 | <0.0050 | <0.0050 |
| Arsenic (As)-Dissolved | mg/L | 0.001 | <0.0010 | <0.0010 |
| Barium (Ba)-Dissolved | mg/L | 0.01 | 0.028 | 0.058 |
| Beryllium (Be)-Dissolved | mg/L | 0.001 | <0.0010 | <0.0010 |
| Bismuth (Bi)-Dissolved | mg/L | 0.001 | <0.0010 | <0.0010 |
| Boron (B)-Dissolved | mg/L | 0.05 | <0.050 | <0.050 |
| Cadmium (Cd)-Dissolved | mg/L | 0.00009 | <0.000090 | <0.000090 |
| Calcium (Ca)-Dissolved | mg/L | 0.5 | 67.5 | 98.6 |
| Chromium (Cr)-Dissolved | mg/L | 0.0005 | <0.00050 | <0.00050 |
| Cobalt (Co)-Dissolved | mg/L | 0.0005 | <0.00050 | <0.00050 |
| Copper (Cu)-Dissolved | mg/L | 0.001 | 0.0034 | 0.0043 |
| Iron (Fe)-Dissolved | mg/L | 0.05 | <0.050 | <0.050 |
| Lead (Pb)-Dissolved | mg/L | 0.001 | <0.0010 | <0.0010 |
| Magnesium (Mg)-Dissolved | mg/L | 0.5 | 19.7 | 32.5 |
| Manganese (Mn)-Dissolved | mg/L | 0.001 | <0.0010 | <0.0010 |
| Molybdenum (Mo)-Dissolved | mg/L | 0.001 | <0.0010 | <0.0010 |
| Nickel (Ni)-Dissolved | mg/L | 0.002 | <0.0020 | <0.0020 |
| Phosphorus (P)-Dissolved | mg/L | 0.05 | <0.050 | <0.050 |
| Potassium (K)-Dissolved | mg/L | 1 | 1.9 | 7.5 |
| Selenium (Se)-Dissolved | mg/L | 0.0004 | <0.00040 | <0.00040 |
| Silicon (Si)-Dissolved | mg/L | 1 | 2.4 | 4.6 |
| Silver (Ag)-Dissolved | mg/L | 0.0001 | <0.00010 | <0.00010 |
| Sodium (Na)-Dissolved | mg/L | 0.5 | 60.4 | 21.6 |
| Strontium (Sr)-Dissolved | mg/L | 0.001 | 0.0735 | 0.111 |
| Thallium (Tl)-Dissolved | mg/L | 0.0003 | <0.00030 | <0.00030 |
| Tin (Sn)-Dissolved | mg/L | 0.001 | <0.0010 | <0.0010 |
| Titanium (Ti)-Dissolved | mg/L | 0.002 | <0.0020 | <0.0020 |
| Tungsten (W)-Dissolved | mg/L | 0.01 | <0.010 | <0.010 |
| Uranium (U)-Dissolved | mg/L | 0.005 | <0.0050 | <0.0050 |
| Vanadium (V)-Dissolved | mg/L | 0.001 | <0.0010 | <0.0010 |
| Zinc (Zn)-Dissolved | mg/L | 0.003 | 0.0132 | 0.0293 |
| Zirconium (Zr)-Dissolved | mg/L | 0.004 | <0.0040 | <0.0040 |

***Notes:***

DL = Detection Limit

Table 3. MECP WWIS Water Well Summary and Impact Assessment

| Well Details | | | | | | | | Impact Assessment | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Well ID | Date Completed | Easting | Northing | Final Status | Primary Use | Secondary Use | Well Depth (m) | Distance from Site (m) | Location in Reference to the Site | Anticipated Impact from Proposed Development |
| 6702583 | 1950-06-21 | 564957.3 | 4818525 | Water Supply | Domestic | | 15.54 | 329 | South | None Anticipated |
| 6702585 | 1951-09-17 | 565065.3 | 4818651 | Water Supply | Livestock | Domestic | 34.44 | 163 | South | |
| 6702593 | 1959-07-13 | 564854.3 | 4818418 | Water Supply | Domestic | | 34.44 | 477 | South | |
| 6702592 | 1959-09-14 | 564882.3 | 4818427 | Water Supply | Domestic | | 35.66 | 451 | South | |
| 6702594 | 1959-09-26 | 564915.3 | 4818441 | Water Supply | Domestic | | 37.8 | 418 | South | |
| 6702584 | 1961-10-27 | 564959.3 | 4818639 | Water Supply | Domestic | | 28.04 | 247 | South | |
| 6702590 | 1962-10-24 | 565238.3 | 4818775 | Water Supply | Domestic | | 19.81 | 0 | On-Site | |
| 6702611 | 1963-02-11 | 564965.3 | 4818330 | Water Supply | Domestic | | 40.84 | 472 | South | |
| 6702612 | 1963-06-20 | 564945.3 | 4818348 | Water Supply | Domestic | | 42.67 | 469 | South | |
| 6702614 | 1963-10-17 | 565241.3 | 4818239 | Water Supply | Domestic | | 26.21 | 490 | South | |
| 6702605 | 1964-06-11 | 565234.3 | 4818250 | Water Supply | Domestic | | 21.34 | 479 | South | |
| 6702620 | 1965-02-03 | 565074.3 | 4818355 | Water Supply | Domestic | | 18.29 | 401 | South | |
| 6702591 | 1965-05-14 | 564855.3 | 4818385 | Water Supply | Domestic | | 41.45 | 500 | South | |
| 6702589 | 1965-11-03 | 565445.3 | 4819012 | Water Supply | Livestock | Domestic | 36.58 | 235 | East | |
| 6702627 | 1965-11-24 | 565195.3 | 4818298 | Water Supply | Domestic | | 25.6 | 431 | South | |
| 6702607 | 1965-11-25 | 565156.3 | 4818278 | Water Supply | Domestic | | 24.38 | 455 | South | |
| 6700904 | 1966-01-14 | 564990.3 | 4818440 | Water Supply | Domestic | | 41.15 | 368 | South | |
| 6700905 | 1966-01-27 | 565061.3 | 4818385 | Water Supply | Domestic | | 40.23 | 378 | South | |
| 6701524 | 1966-02-03 | 564991.3 | 4818373 | Water Supply | Domestic | | 24.69 | 422 | South | |
| 6700906 | 1966-02-04 | 565142.3 | 4818309 | Water Supply | Domestic | | 25.3 | 427 | South | |
| 6700908 | 1966-02-09 | 565034.3 | 4818402 | Water Supply | Domestic | | 40.23 | 375 | South | |
| 6700911 | 1966-03-04 | 565127.3 | 4818317 | Water Supply | Domestic | | 37.49 | 422 | South | |
| 6700912 | 1966-03-11 | 565067.3 | 4818380 | Water Supply | Domestic | | 37.49 | 380 | South | |
| 6700913 | 1966-03-15 | 565037.3 | 4818467 | Water Supply | Domestic | | 40.54 | 318 | South | |
| 6700919 | 1966-06-17 | 565012.3 | 4818422 | Water Supply | Domestic | | 40.23 | 370 | South | |
| 6702582 | 1966-10-07 | 565198.3 | 4819368 | Water Supply | Livestock | Domestic | 45.72 | 407 | South | |
| 6700907 | 1967-01-19 | 565241.3 | 4818268 | Water Supply | Domestic | | 36.58 | 461 | South | |
| 6700930 | 1967-05-01 | 565184.3 | 4818310 | Water Supply | Domestic | | 24.69 | 420 | South | |
| 6700915 | 1967-07-10 | 565007.3 | 4818295 | Water Supply | Domestic | | 38.1 | 483 | South | |
| 6700914 | 1967-07-20 | 565041.3 | 4818457 | Water Supply | Domestic | | 40.23 | 325 | South | |
| 6700939 | 1967-10-12 | 565157.3 | 4818293 | Water Supply | Domestic | | 24.38 | 440 | South | |
| 6703092 | 1968-01-04 | 565064.3 | 4818293 | Water Supply | Domestic | | 28.96 | 462 | South | |
| 6703579 | 1969-09-27 | 565194.3 | 4818733 | Water Supply | Domestic | | 28.35 | 14 | South | |
| 6703602 | 1970-01-08 | 565314.3 | 4818933 | Water Supply | Domestic | | 37.8 | 89 | East | |
| 6704236 | 1972-04-11 | 565134.3 | 4818583 | Water Supply | Domestic | | 23.77 | 168 | South | |
| 6704293 | 1972-07-12 | 565014.3 | 4818283 | Water Supply | Domestic | | 40.54 | 490 | South | |
| 6705233 | 1974-08-22 | 565015.3 | 4818427 | Water Supply | Domestic | | 28.96 | 364 | South | |
| 6711291 | 1993-09-22 | 565322.3 | 4818655 | Water Supply | Domestic | | 22.86 | 126 | South | |
| 6711601 | 1994-11-14 | 565092.3 | 4818353 | Water Supply | Domestic | | 27.74 | 396 | South | |
| 6712543 | 1998-05-21 | 565123.3 | 4818905 | Water Supply | Domestic | | 24.38 | 0 | On-Site | |

# Appendix A

# Draft Plan of Subdivision

# CONCEPT PLAN A

**Legal Description**

PART OF LOT 6, CONCESSION 8, GEOGRAPHICAL TOWNSHIP OF PUSLINCH.
**CITY OF GUELPH**

**Owner's Certificate**

I HEREBY AUTHORIZE MACNAUGHTON HERMSEN BRITTON CLARKSON PLANNING LIMITED TO SUBMIT THIS PLAN FOR APPROVAL.

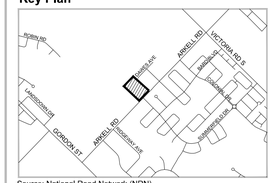
DATE:_____

**Surveyor's Certificate**

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE SUBDIVIDED ON THIS PLAN AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN.

DATE:_____

**Key Plan**




Additional Information Required Under Section 51(17) of the Planning Act R.S.O. 1990, c.P.13 as Amended

| | | |
|---|---|---|
| A. AS SHOWN | B. AS SHOWN | C. AS SHOWN |
| D. MULTIPLE RESIDENTIAL, OPEN SPACE | | |
| E. AS SHOWN | F. AS SHOWN | G. AS SHOWN |
| H. MUNICIPAL WATER SUPPLY | I. LOAM | J. AS SHOWN |
| K. ALL SERVICES AS REQUIRED | L. AS SHOWN | |

**Area Schedule** **61T_____**

| Description | Lots/Blocks | Units | Area (ha) |
|---|---|---|---|
| Multiple Residential | 1-5 | 70 | 1.062 |
| Open Space | 6 | | 0.862 |
| Stormwater Management | 7 | | 0.242 |
| Road Widening | 8 | | 0.063 |
| Roads | | | 0.348 |
| **Total** | **8** | **70** | **2.577** |

**Notes**
1. All dimensions are in metres unless otherwise shown
2. Dripline Limits - Natural Resource Solutions Inc. (NRSI) June, 2016
3. Wetland Limits - Natural Resource Solutions Inc. (NRSI) August, 2016
4. Property boundary is approximate, based on MTE Existing Conditions Plan and Wellington County Survey plans 61R-773, 61R-2819
5. Surrounding parcel boundaries are approximate/ taken from Vumap (First Base Solutions) aerial imagery
6. Unit yield based on Conceptual Site Plan prepared by MHBC Planning
7. Building footprints outside of subject lands gathered from City of Guelph open data

| Revision No. | Date | Issued / Revision | By |
|---|---|---|---|
| 12. | April 28, 2021 | Adjust Stormwater, Residential Blocks; | G.C. |
| 11. | January 28, 2021 | Stacked Townhouse Orientation; | G.C. |
| 10. | March 18, 2020 | SWM revision; | G.C. |
| 9. | January 6, 2020 | Update/ Issued for Review; | G.C. |
| 8. | December 11, 2019 | Update/ Issued for Review; | G.C. |
| 7. | October 9, 2019 | Update/ Issued for Review; | G.C. |
| 6. | July 8, 2019 | Update/ Issued for Review; | G.C. |
| 5. | December 6, 2018 | Update/ Issued for Review; | G.C. |
| 3. | September 12, 2018 | Update/ Issued for Review; | G.C. |
| 2. | July 4, 2017 | Update/ Issued for Review; | G.C. |
| 1. | March 13, 2017 | Issued for Review; | G.C. |


MHBC PLANNING URBAN DESIGN & LANDSCAPE ARCHITECTURE
200-540 BINGEMANS CENTRE DR. KITCHENER, ON. N2B 3X9 | P: 519.576.3650 F: 519.576.0121 | WWW.MHBCPLAN.COM


**Approval Stamp**

| | |
|---|---|
| **Date** | April 28, 2021 |
| **File No.** | 15246A |
| **Plan Scale** | 1:400 (36x24) |
| **Drawn By** | G.C. |
| **Checked By** | D.A. |
| **Other** | |

**Project** Arkell Road - Guelph

**Applicant**
Crescent Homes
151 Curzon Crescent
Guelph, ON. N1K OB3
P: 647.523.6487

**File Name** **CONCEPT PLAN**

**Dwg No.** **1 of 1**

**Scale Bar** 2.5 0 5 10 25m

K:\15246A-Crescent Homes-Arkell Road-Guelph\Concept\Concept A April 29 2021.dwg

# Appendix B

# Borehole Logs

Peto MacCallum Ltd.
CONSULTING ENGINEERS

# LOG OF BOREHOLE NO. 1

**PROJECT** Proposed Arkell Road Subdivision
**LOCATION** Arkell Road, Guelph, Ontario
**BORING METHOD** Continuous Flight Hollow Stem Augers
**BORING DATE:** 2017 02 13
**PML REF.:** 17KF002
**ENGINEER** K. Hanes
**TECHNICIAN** H. Shinwary

GROUND ELEVATION 334.56

| DEPTH in METRES | DESCRIPTION | NUMBER | TYPE | BLOWS/0.3m N - VALUES | ELEVATION SCALE |
|---|---|---|---|---|---|
| 0.10 | TOPSOIL: Dark brown silt, trace sand, numerous rootlets, damp | 1 | SS | 7 | |
| 0.46 | | | | | |
| 0.69 | FILL: Brown sand and gravel, trace silt, moist | | | | |
| 333.87 | SILT: Loose brown silt, trace sand, occasional rootlets, damp | 2 | SS | 42 | |
| | SAND AND GRAVEL: Dense to very dense brown sand and gravel, trace to some silt, numerous cobbles, damp | 3 | SS | 50/150mm | |
| 2.1 | | | | | |
| 332.5 | becoming moist | 4 | SS | 39 | |
| 2.9 | | | | | |
| 331.7 | becoming compact, no cobbles, saturated, contains saturated silt layers | 5 | SS | 23 | |
| 4.0 | | | | | |
| 330.6 | SAND: Compact brown sand, trace to some silt, trace gravel, saturated | 6 | SS | 12 | |
| 6.6 | | 7 | SS | 16 | |
| 328.0 | BOREHOLE TERMINATED AT 6.6 m | | | | |

SHEAR STRENGTH $C_u$ (kPa) 50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M 20 40 60 80

LIQUID LIMIT ____ $W_L$
PLASTIC LIMIT ____ $W_P$
WATER CONTENT ___ W
$W_P$ W $W_L$
WATER CONTENT % 10 20 30

UNIT WEIGHT $\gamma$ kN/m³

GROUND WATER OBSERVATIONS AND REMARKS

GR SA SI&CL

Sampler wet from SS5

Upon completion of augering
Wet cave to 3.1 m

**NOTES:** Headspace: SS1 0ppm, SS2 0ppm, SS3 0ppm, SS4 0ppm, SS5 0ppm, SS6 0ppm, SS7 0ppm

WATER LEVEL OBSERVED DURING / UPON COMPLETION OF DRILLING
WATER LEVEL MEASURED IN MONITORING WELL

UNDISTURBED FIELD VANE
REMOLDED FIELD VANE
LAB SHEAR TEST
POCKET PENETROMETER
POCKET TORVANE

CHECKED BY KH

Peto MacCallum Ltd.
CONSULTING ENGINEERS

# LOG OF BOREHOLE NO. 2

**PROJECT** Proposed Arkell Road Subdivision
**LOCATION** Arkell Road, Guelph, Ontario
**BORING METHOD** Continuous Flight Hollow Stem Augers
**BORING DATE:** 2017 02 13
**PML REF.:** 17KF002
**ENGINEER** K. Hanes
**TECHNICIAN** H. Shinwary

| DEPTH in METRES | DESCRIPTION | NUMBER | TYPE | BLOWS/0.3m N - VALUES |
|---|---|---|---|---|
| | GROUND ELEVATION 335.16 | | | |
| 0.25 / 334.91 | TOPSOIL: Dark brown silt, trace sand, numerous rootlets, damp | 1 | SS | 3 |
| 0.69 / 334.47 | SILT: Loose dark brown silt, some sand, trace gravel, occasional rootlets, damp | 2 | SS | 57 |
| | SAND AND GRAVEL: Very dense sand and gravel, trace to some silt, numerous cobbles, damp | 3 | SS | 64 |
| 2.1 / 333.1 | SAND: Compact to dense brown sand, trace to some silt, trace gravel, occasional cobbles, saturated | 4 | SS | 34 |
| | | 5 | SS | 31 |
| | | 6 | SS | 30 |
| | | 7 | SS | 26 |
| 7.7 / 327.1 | SILT: Dense brown silt, trace sand, trace gravel, wet | 8 | SS | 39 |
| 8.1 | BOREHOLE TERMINATED AT 8.1 m | | | |

SHEAR STRENGTH $C_u$ (kPa) 50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M 20 40 60 80

LIQUID LIMIT ____ $W_L$
PLASTIC LIMIT ____ $W_P$
WATER CONTENT ___ W
$W_P$ W $W_L$
WATER CONTENT % 10 20 30

UNIT WEIGHT $\gamma$ kN/m³

GROUND WATER OBSERVATIONS AND REMARKS

Stick up
GR SA SI&CL
Concrete
Sampler wet from SS4
Bentonite Seal
50 mm Plastic Riser
Filter Sand
Screen

Water Level Readings:
Initial: 3.40 m
Elevation: 331.76

2017-04: 2.51 m
Elevation: 332.45

**NOTES:** Headspace: SS1 0ppm, SS2 0ppm, SS3 0ppm, SS4 0ppm, SS5 5ppm, SS6 0ppm, SS7 0ppm, SS8 0ppm

WATER LEVEL OBSERVED DURING / UPON COMPLETION OF DRILLING
WATER LEVEL MEASURED IN MONITORING WELL

UNDISTURBED FIELD VANE
REMOLDED FIELD VANE
LAB SHEAR TEST
POCKET PENETROMETER
POCKET TORVANE

CHECKED BY KH

Peto MacCallum Ltd.
CONSULTING ENGINEERS

# LOG OF BOREHOLE NO. 3

**PROJECT** Proposed Arkell Road Subdivision
**LOCATION** Arkell Road, Guelph, Ontario
**BORING METHOD** Continuous Flight Hollow Stem Augers
**BORING DATE:** 2017 02 13
**PML REF.:** 17KF002
**ENGINEER** K. Hanes
**TECHNICIAN** H. Shinwary

| DEPTH in METRES | DESCRIPTION | NUMBER | TYPE | BLOWS/0.3m N - VALUES | ELEVATION SCALE |
|---|---|---|---|---|---|
| | GROUND ELEVATION 334.42 | | | | |
| 0.20 | TOPSOIL: Dark brown silt, trace sand, numerous rootlets, moist | 1 | SS | 5 | 334 |
| 0.51 | | | | | |
| 333.91 | SILT: Loose dark brown silt, some sand, occasional rootlets | 2 | SS | 3 | |
| 1.4 | SAND AND GRAVEL: Very loose brown sand and gravel, trace to some silt, occasional cobbles, damp | | | | 333 |
| 333.1 | becoming compact, saturated | 3 | SS | 35 | |
| | | 4 | SS | 31 | 332 |
| 2.9 | | | | | |
| 331.5 | SAND: Compact to dense brown sand, trace to some silt, trace gravel, occasional cobbles, saturated | 5 | SS | 24 | 331 |
| | | 6 | SS | 42 | 330 |
| | | 7 | SS | 27 | 329 |
| 7.8 | | | | | 328 |
| 8.0 | SILT: Compact brown silt, trace sand, trace gravel, wet | 8 | SS | 21 | 327 |
| 326.4 | BOREHOLE TERMINATED AT 8.0 m | | | | |

SHEAR STRENGTH $C_u$ (kPa): 50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M: 20 40 60 80

LIQUID LIMIT _____ $W_L$
PLASTIC LIMIT ____ $W_P$
WATER CONTENT ___ W
$W_P$ W $W_L$
WATER CONTENT %: 10 20 30

UNIT WEIGHT $\gamma$ kN/m³

GROUND WATER OBSERVATIONS AND REMARKS

Stick up
Concrete
Sampler wet from SS3
Bentonite Seal
50 mm Plastic Riser
Filter Sand
Screen

Water Level Readings:
Initial: 1.95 m
Elevation: 332.47

2017-04: 1.86 m
Elevation: 332.56

**NOTES:** Headspace: SS1 0ppm, SS2 0ppm, SS3 0ppm, SS4 0ppm, SS5 5ppm, SS6 0ppm, SS7 5ppm, SS8 0ppm

WATER LEVEL OBSERVED DURING / UPON COMPLETION OF DRILLING
WATER LEVEL MEASURED IN MONITORING WELL

UNDISTURBED FIELD VANE
REMOLDED FIELD VANE
LAB SHEAR TEST
POCKET PENETROMETER
POCKET TORVANE

CHECKED BY KH

Peto MacCallum Ltd.
CONSULTING ENGINEERS

# LOG OF BOREHOLE NO. 4

**PROJECT** Proposed Arkell Road Subdivision
**LOCATION** Arkell Road, Guelph, Ontario
**BORING METHOD** Continuous Flight Hollow Stem Augers
**BORING DATE:** 2017 03 21
**PML REF.:** 17KF002
**ENGINEER** K. Hanes
**TECHNICIAN** H. Shinwary

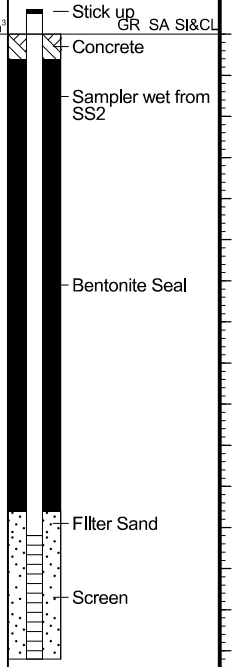
| DEPTH in METRES | DESCRIPTION | NUMBER | TYPE | BLOWS/0.3m N - VALUES | ELEVATION SCALE |
|---|---|---|---|---|---|
| | GROUND ELEVATION 334.13 | | | | |
| 0.30 | TOPSOIL: Dark brown silt, trace sand, numerous rootlets, moist | 1 | SS | 6 | 334 |
| 0.69 | | | | | |
| 333.44 | SAND AND GRAVEL: Compact brown sand and gravel, trace to some silt, occasional cobbles, moist | 2 | SS | 13 | 333 |
| 1.5 | becoming saturated | | | | |
| 332.7 | SAND: Compact brown sand, trace to some silt, trace gravel, saturated | 3 | SS | 14 | 332 |
| | | 4 | SS | 11 | |
| | | 5 | SS | 12 | 331 |
| | | | | | 330 |
| | | 6 | SS | 18 | |
| | | | | | 329 |
| | | 7 | SS | 10 | 328 |
| | | | | | 327 |
| 8.1 | | 8 | SS | 25 | |
| 326.0 | BOREHOLE TERMINATED AT 8.1 m | | | | |

SHEAR STRENGTH $C_u$ (kPa) 50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M 20 40 60 80

LIQUID LIMIT ____ $W_L$
PLASTIC LIMIT ____ $W_P$
WATER CONTENT ___ W
$W_P$ W $W_L$
WATER CONTENT % 10 20 30

UNIT WEIGHT $\gamma$ kN/m³

GROUND WATER OBSERVATIONS AND REMARKS




Water Level Readings:
Initial: 0.75 m
Elevation: 333.38

2017-04: 0.44 m
Elevation: 333.55

**NOTES:** Headspace: SS1 0ppm, SS2 5ppm, SS3 0ppm, SS4 5ppm, SS5 0ppm, SS6 0ppm, SS7 0ppm, SS8 0ppm

WATER LEVEL OBSERVED DURING / UPON COMPLETION OF DRILLING
WATER LEVEL MEASURED IN MONITORING WELL

UNDISTURBED FIELD VANE
REMOLDED FIELD VANE
LAB SHEAR TEST
POCKET PENETROMETER
POCKET TORVANE

CHECKED BY KH

Peto MacCallum Ltd.
CONSULTING ENGINEERS

# LOG OF BOREHOLE NO. 5

**PROJECT** Proposed Arkell Road Subdivision
**LOCATION** Arkell Road, Guelph, Ontario
**BORING METHOD** Continuous Flight Hollow Stem Augers
**BORING DATE:** 2017 03 21
**PML REF.:** 17KF002
**ENGINEER** K. Hanes
**TECHNICIAN** H. Shinwary

| DEPTH in METRES | DESCRIPTION | NUMBER | TYPE | BLOWS/0.3m N - VALUES | ELEVATION SCALE |
|---|---|---|---|---|---|
| | GROUND ELEVATION 334.97 | | | | |
| 0.25 / 334.72 | TOPSOIL: Dark brown silt, trace sand, trace gravel, numerous rootlets, damp | 1 | SS | 13 | |
| | SAND AND GRAVEL: Dense brown sand and gravel, trace to some silt, numerous cobbles, damp | 2 | SS | 49 | 334 |
| | | 3 | SS | 31 | |
| 2.2 / 332.8 | SAND: Compact brown sand, some gravel, trace to some silt, occasional cobbles, saturated | 4 | SS | 24 | 333 |
| | | 5 | SS | 27 | 332 |
| 5.6 / 329.4 | becoming very dense | 6 | SS | 14 | 331 |
| | | 7 | SS | 51 | 330 |
| 7.1 / 327.9 | SAND AND GRAVEL: Very dense brown sand and gravel, trace silt, numerous cobbles, saturated | 8 | SS | 52 | 329 |
| 8.1 / 326.9 | BOREHOLE TERMINATED AT 8.1 m | | | | 328 / 327 |

SHEAR STRENGTH $C_u$ (kPa) 50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M 20 40 60 80

LIQUID LIMIT ____ $W_L$
PLASTIC LIMIT ____ $W_P$
WATER CONTENT ___ W
$W_P$ W $W_L$
WATER CONTENT % 10 20 30

UNIT WEIGHT $\gamma$ kN/m³

GROUND WATER OBSERVATIONS AND REMARKS

Stick up
GR SA SI&CL
Concrete
Sampler wet from SS4
Bentonite Seal
Filter Sand
Screen

Water Level Readings:
Initial: 2.3 m
Elevation: 332.67

2017-04: 2.18 m
Elevation: 332.65

**NOTES:** Headspace: SS1 0ppm, SS2 0ppm, SS3 5ppm, SS4 5ppm, SS5 0ppm, SS6 0ppm, SS7 0ppm, SS8 0ppm

WATER LEVEL OBSERVED DURING / UPON COMPLETION OF DRILLING
WATER LEVEL MEASURED IN MONITORING WELL

+ UNDISTURBED FIELD VANE
⊕ REMOLDED FIELD VANE
⊛ LAB SHEAR TEST
▲ POCKET PENETROMETER
◆ POCKET TORVANE

CHECKED BY KH

Peto MacCallum Ltd.
CONSULTING ENGINEERS

# LOG OF BOREHOLE NO. 6

**PROJECT** Proposed Arkell Road Subdivision
**LOCATION** Arkell Road, Guelph, Ontario
**BORING METHOD** Continuous Flight Hollow Stem Augers
**BORING DATE:** 2017 03 21
**PML REF.:** 17KF002
**ENGINEER** K. Hanes
**TECHNICIAN** H. Shinwary

| DEPTH in METRES | DESCRIPTION | LEGEND | NUMBER | TYPE | BLOWS/0.3m N - VALUES | ELEVATION SCALE |
|---|---|---|---|---|---|---|
| | GROUND ELEVATION 334.0 | | | | | |
| 0.20 | TOPSOIL: Dark brown silt, trace sand, numerous rootlets, damp | | 1 | SS | 18 | |
| 0.41 | | | | | | |
| 0.69 | FILL: Dark brown silt, some sand, trace gravel, occasional rootlets, damp | | 2 | SS | 45 | 333 |
| 333.31 | | | | | | |
| 1.5 | SAND AND GRAVEL: Dense brown sand and gravel, trace to some silt, numerous cobbles, damp | | 3 | SS | 36 | |
| 332.6 | becoming moist | | | | | 332 |
| 2.2 | becoming saturated | | | | | |
| 331.8 | SILT: Compact brown silt, trace sand, trace gravel, trace clay, wet to saturated | | 4 | SS | 12 | |
| | | | 5 | SS | 10 | 331 |
| | | | | | | 330 |
| | | | 6 | SS | 16 | |
| 5.8 | | | | | | 329 |
| 328.2 | SILT TILL: Very dense brown silt, some sand, some gravel, occasional cobbles, damp | | 7 | SS | 50/75mm | 328 |
| 6.6 | | | | | | |
| 327.4 | BOREHOLE TERMINATED AT 6.6 m | | | | | |

SHEAR STRENGTH $C_u$ (kPa) 50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M 20 40 60 80

LIQUID LIMIT _____ $W_L$
PLASTIC LIMIT ____ $W_P$
WATER CONTENT ___ W
$W_P$ W $W_L$
WATER CONTENT % 10 20 30

UNIT WEIGHT $\gamma$ kN/m³

GROUND WATER OBSERVATIONS AND REMARKS

GR SA SI&CL

Sampler wet from SS3

Upon completion of augering
Cave to 2.0 m
Free water at 1.83 m

**NOTES:** Headspace: SS1 0ppm, SS2 0ppm, SS3 0ppm, SS4 5ppm, SS5 0ppm, SS6 0ppm, SS7 0ppm

WATER LEVEL OBSERVED DURING / UPON COMPLETION OF DRILLING
WATER LEVEL MEASURED IN MONITORING WELL

UNDISTURBED FIELD VANE
REMOLDED FIELD VANE
LAB SHEAR TEST
POCKET PENETROMETER
POCKET TORVANE

CHECKED BY KH

## ID Number: MW101-19

**Project:** Phase II ESA

**Project No:** 42063-200

**Client:** Crescent Homes Ltd.

**Site Location:** 190-216 Arkell Rd., Guelph

**Drill Date:** 10/4/2019

**Drilling Contractor:** Altech Drilling

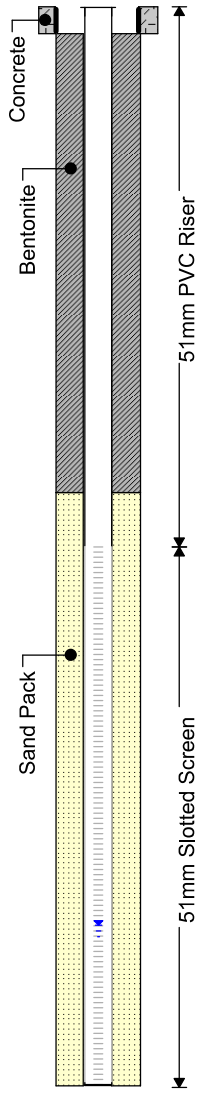
**Drill Rig:** Geoprobe 7822DT

**Drill Method:** Direct-Push

**Protective Cover:** Monument

| Depth (ft) | Depth (m) | Symbol | Soil Description | Elevation (masl) / Depth (m) | Number | Type | Recovery (%) | Soil Sample Lab Analysis | Headspace: PID ppm (20 40 60 80) / Hydrocarbon ppm (100 200 300 400) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Ground Surface | 334.6 | | | | | |
| 0 | 0 | | **TOPSOIL** Dark brown silt topsoil, trace sand, moist red brick fragments at 0.23m | 0.0 | | | | | |
| | | | **FILL** Dark brown silt, trace sand, trace to some gravel (potential cobbles), moist | | 1 | DP | 38 | Metals, As, Sb, Se, PAHs | 0.55 |
| 2 | | | | | 2 | DP | 38 | | |
| 4 | | | | | | | | | |
| 6 | | | | 332.8 | 3 | DP | 62 | | |
| | 2 | | **SILTY SAND AND GRAVEL** Light brownish-grey silty sand and gravel (potential cobbles), moist | 1.8 | | | | | 0.35 |
| 8 | | | | | 4 | DP | 62 | | |
| 10 | | | increasing moisture with depth | | 5 | DP | 65 | | |
| 12 | | | | | | | | | |
| | 4 | | | | 6 | DP | 65 | | |
| 14 | | | | 330.0 | | | | | |
| | | | **SAND AND GRAVEL** Brown medium to coarse-grained sand and gravel, some silt, saturated below 4.6m | 4.6 | 7 | DP | 62 | PHCs, BTEX | 0.55 |
| 16 | | | | | | | | | |
| 18 | | | | | 8 | DP | 62 | | |
| | 6 | | | 328.5 | | | | | 0.45 |
| 20 | | | Drilling Terminated | 6.1 | | | | | |

**Well Completion Details**




**Field Technician:** KLW

**Drafted by:** KLW

**Reviewed by:** RMR

**Sheet:** 1 of 1

Notes:
Water level measured October 8, 2019.
Metal pipe encountered in first attempted borehole at approximately 0.3mbgs. Moved borehole off pipe and redrilled.
No noticeable staining or odours.

## *ID Number: BH102-19*

**Project:** Phase II ESA

**Project No:** 42063-200

**Client:** Crescent Homes Ltd.

**Site Location:** 190-216 Arkell Rd., Guelph

**Drill Date:** 10/4/2019

**Drilling Contractor:** Altech Drilling

**Drill Rig:** Geoprobe 7822DT

**Drill Method:** Direct-Push

**Protective Cover:** NA

| SUBSURFACE PROFILE | | | SAMPLE | | | | | HEADSPACE | |
|---|---|---|---|---|---|---|---|---|---|
| Depth (ft / m) | Symbol | Soil Description | Elevation (masl) Depth (m) | Number | Type | Recovery (%) | Soil Sample Lab Analysis | PID ppm (20 40 60 80) / Hydrocarbon ppm (100 200 300 400) | Well Completion Details |
| 0 ft / 0 m | | Ground Surface | 0.0 | | | | | | |
| | | **FILL** Brown sandy silt, some gravel, moist | 0.0 | 1 | DP | 53 | Metals*, PAHs, PHCs* | 45 | |
| 2 ft | | | -0.9 | | | | | | |
| | | **SILTY SAND AND GRAVEL** Light brownish-grey silty sand and gravel (potential cobbles), moist | 0.9 | 2 | DP | 53 | | 30 | Bentonite |
| 4 ft / 1.5 m | | Drilling Terminated | 1.5 | | | | | | |
| 6 ft / 2 m | | | | | | | | | |
| 8 ft | | | | | | | | | |
| 10 ft / 3 m | | | | | | | | | |
| 12 ft | | | | | | | | | |
| 14 ft / 4 m | | | | | | | | | |
| 16 ft | | | | | | | | | |
| 18 ft / 5 m | | | | | | | | | |
| 20 ft / 6 m | | | | | | | | | |

**Field Technician:** KLW

**Drafted by:** KLW

**Reviewed by:** RMR

MTE

**Sheet:** 1 of 1

Notes:
Borehole advance on top of fill pile.
Metals* - sample analyzed for Metals, As, Sb and Se
PHCs* - sample analyzed for PHCs and BTEX
No noticeable staining or odours.

## *ID Number: BH103-19*

**Project:** Phase II ESA

**Project No:** 42063-200

**Client:** Crescent Homes Ltd.

**Site Location:** 190-216 Arkell Rd., Guelph

**Drill Date:** 10/4/2019

**Drilling Contractor:** Altech Drilling

**Drill Rig:** Geoprobe 7822DT

**Drill Method:** Direct-Push

**Protective Cover:** NA

| SUBSURFACE PROFILE | | | SAMPLE | | | | | HEADSPACE | |
|---|---|---|---|---|---|---|---|---|---|
| Depth (ft / m) | Symbol | Soil Description | Elevation (masl) Depth (m) | Number | Type | Recovery (%) | Soil Sample Lab Analysis | PID ppm (20 40 60 80) / Hydrocarbon ppm (100 200 300 400) | Well Completion Details |
| 0 / 0 | | Ground Surface | 0.0 | | | | | | |
| | | **FILL** Brown sandy silt, some gravel, moist | 0.0 | 1 | DP | 33 | Metals*, PAHs, PHCs* | 0 45 | |
| 2 | | | -0.8 | | | | | | |
| | | **SILTY SAND AND GRAVEL** Light brownish-grey silty sand and gravel (potential cobbles), moist | 0.8 | 2 | DP | 33 | | 0 25 | Bentonite |
| 4 | | | -1.5 | | | | | | |
| | | Drilling Terminated | 1.5 | | | | | | |
| 6 / 2 | | | | | | | | | |
| 8 | | | | | | | | | |
| 10 | | | | | | | | | |
| 12 / 4 | | | | | | | | | |
| 14 | | | | | | | | | |
| 16 | | | | | | | | | |
| 18 | | | | | | | | | |
| 20 / 6 | | | | | | | | | |

**Field Technician:** KLW

**Drafted by:** KLW

**Reviewed by:** RMR

MTE

**Sheet:** 1 of 1

Notes:
Borehole advance on top of fill pile.
Metals* - sample analyzed for Metals, As, Sb and Se
PHCs* - sample analyzed for PHCs and BTEX
No noticeable staining or odours.

## *ID Number: BH104-19*

**Project:** Phase II ESA

**Project No:** 42063-200

**Client:** Crescent Homes Ltd.

**Site Location:** 190-216 Arkell Rd., Guelph

**Drill Date:** 10/4/2019

**Drilling Contractor:** Altech Drilling

**Drill Rig:** Geoprobe 7822DT

**Drill Method:** Direct-Push

**Protective Cover:** NA

| SUBSURFACE PROFILE | | | SAMPLE | | | | | HEADSPACE | |
|---|---|---|---|---|---|---|---|---|---|
| Depth (ft / m) | Symbol | Soil Description | Elevation (masl) Depth (m) | Number | Type | Recovery (%) | Soil Sample Lab Analysis | PID ppm (20 40 60 80) / Hydrocarbon ppm (100 200 300 400) | Well Completion Details |
| 0 ft / 0 m | | Ground Surface | 0.0 | | | | | | |
| | | **FILL** Brown sandy silt, some gravel, moist | 0.0 | 1 | DP | 38 | Metals*, PAHs, PHCs* | 035 | |
| 2 ft | | | -0.6 | | | | | | |
| | | **SILTY SAND AND GRAVEL** Light brownish-grey silty sand and gravel (potential cobbles), moist | 0.6 | 2 | DP | 38 | | 045 | Bentonite |
| 4 ft | | | -1.5 | | | | | | |
| | | Drilling Terminated | 1.5 | | | | | | |
| 6 ft / 2 m | | | | | | | | | |
| 8 ft | | | | | | | | | |
| 10 ft | | | | | | | | | |
| 12 ft / 4 m | | | | | | | | | |
| 14 ft | | | | | | | | | |
| 16 ft | | | | | | | | | |
| 18 ft | | | | | | | | | |
| 20 ft / 6 m | | | | | | | | | |

**Field Technician:** KLW

**Drafted by:** KLW

**Reviewed by:** RMR

MTE

**Sheet:** 1 of 1

Notes:
Borehole advance on top of fill pile.
Metals* - sample analyzed for Metals, As, Sb and Se
PHCs* - sample analyzed for PHCs and BTEX
No noticeable staining or odours.

## ID Number: MW105-19

**Project:** Phase II ESA

**Project No:** 42063-200

**Client:** Crescent Homes Ltd.

**Site Location:** 190-216 Arkell Rd., Guelph

**Drill Date:** 10/4/2019

**Drilling Contractor:** Altech Drilling

**Drill Rig:** Geoprobe 7822DT

**Drill Method:** Direct-Push

**Protective Cover:** Flushmount

| Depth (ft / m) | Symbol | Soil Description | Elevation (masl) / Depth (m) | Number | Type | Recovery (%) | Soil Sample Lab Analysis | Headspace: PID ppm (20 40 60 80) / Hydrocarbon ppm (100 200 300 400) |
|---|---|---|---|---|---|---|---|---|
| 0 / 0 | | Ground Surface | 334.8 | | | | | |
| 0 / 0 | | **ASPHALT** | 0.0 | | | | | |
| 2 | | **SILT**<br>Greyish-brown silt, trace gravel, moist | | 1 | DP | 58 | | |
| | | | 333.8 | | | | | |
| 4 | | **SILTY SAND**<br>Brown medium to coarse-grained silty sand, gravelly, moist | 0.9 | 2 | DP | 58 | | 030 |
| 6 / 2 | | | | 3 | DP | 77 | | |
| 8 | | | | 4 | DP | 77 | | |
| 10 | | | | 5 | DP | 65 | | |
| 12 / 4 | | | | 6 | DP | 65 | | |
| 14 | | | | 7 | DP | 85 | | |
| 16 | | | 329.6 | | | | | |
| 18 | | **SAND**<br>Brown medium to coarse-grained sand, trace to some silt, trace gravel, saturated | 5.2 | | | | Metals*, PAHs, PHC* | 035 |
| | | fine-grained sand seam | 329.0 | 8 | DP | 85 | | |
| 20 / 6 | | | 5.8<br>328.7 | | | | | 045 |
| | | Drilling Terminated | 6.1 | | | | | |

**Well Completion Details:** Concrete; Bentonite; Sand Pack; 51mm PVC Riser; 51mm Slotted Screen

**Field Technician:** KLW

**Drafted by:** KLW

**Reviewed by:** RMR

**Sheet:** 1 of 1

Notes:
Water level measured October 8, 2019.
Metals* - sample analyzed for Metals, As, Sb, Se
PHCs* - sample analyzed for PHCs and BTEX
No noticeable staining or odours.

## ID Number: MW106-19

**Project:** Phase II ESA

**Project No:** 42063-200

**Client:** Crescent Homes Ltd.

**Site Location:** 190-216 Arkell Rd., Guelph

**Drill Date:** 10/4/2019

**Drilling Contractor:** Altech Drilling

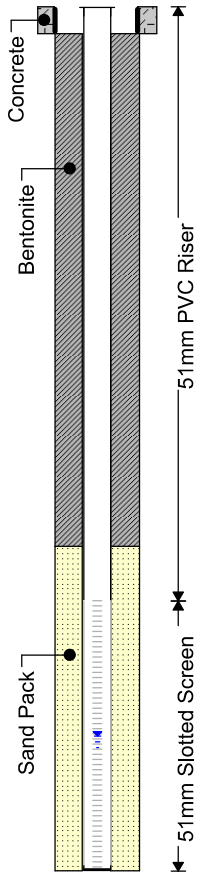
**Drill Rig:** Geoprobe 7822DT

**Drill Method:** Direct-Push

**Protective Cover:** Flushmount

| Depth (ft / m) | Symbol | Soil Description | Elevation (masl) / Depth (m) | Number | Type | Recovery (%) | Soil Sample Lab Analysis | Headspace: PID ppm (20 40 60 80) / Hydrocarbon ppm (100 200 300 400) |
|---|---|---|---|---|---|---|---|---|
| 0 ft / 0 m | | Ground Surface | 334.8 | | | | | |
| 0 – 2 ft | | **FILL** Brown silt, trace to some sand, some gravel, moist (potential fill) | 0.0 | 1 | DP | 60 | | |
| 2 – 4 ft | | | | 2 | DP | 60 | M*, PHC* | 040 |
| 4 – 6 ft | | **SILTY SAND** Brownish-grey medium to coarse-grained silty sand, gravelly, moist | 333.3 / 1.5 | 3 | DP | 62 | | 035 |
| 6 – 8 ft | | | | 4 | DP | 62 | | |
| 8 – 10 ft | | | | 5 | DP | 57 | | |
| 10 – 12 ft | | | | 6 | DP | 57 | | |
| 12 – 14 ft | | | 330.2 | | | | | |
| 14 – 16 ft | | **SAND AND GRAVEL** Brown medium to coarse-grained sand and gravel, some silt, saturated below 4.7m | 4.6 / 329.9 | 7 | DP | 73 | M*, PHC*, P* | 030 |
| 16 – 18 ft | | **SILT** Brown silt, trace sand, trace gravel, saturated | 4.9 | 8 | DP | 73 | | |
| 18 – 20 ft | | | | | | | | 035 |
| 20 ft / 6 m | | Drilling Terminated | 328.7 / 6.1 | | | | | |

**Well Completion Details**




**Field Technician:** KLW

**Drafted by:** KLW

**Reviewed by:** RMR

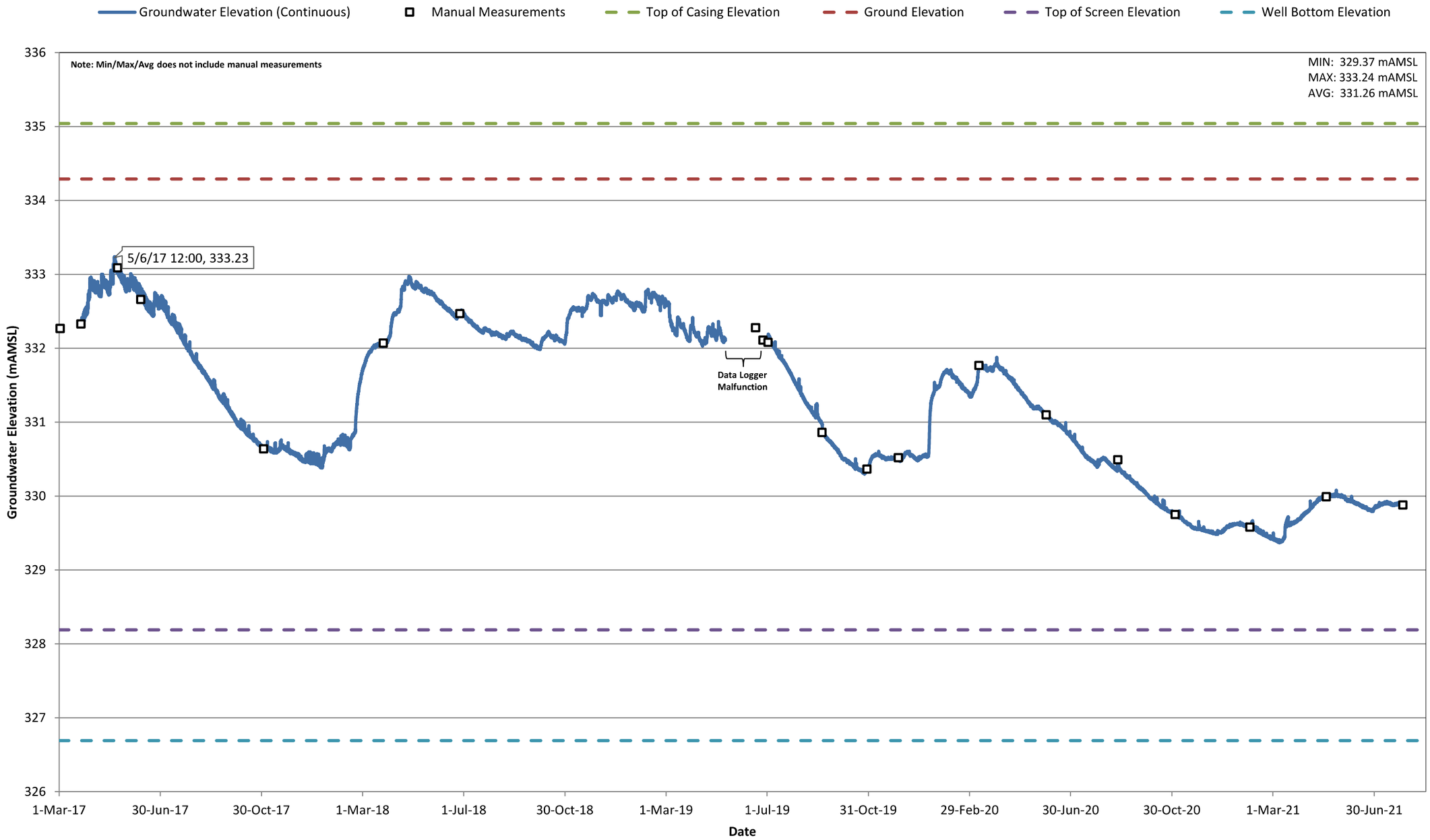
**Sheet:** 1 of 1

Notes:
Water level measured October 8, 2019.
Metals* - sample analyzed for Metals, As, Sb, Se
PHCs* - sample analyzed for PHCs and BTEX
P* - sample analyzed for PAHs
No noticeable staining or odours.

# Appendix C

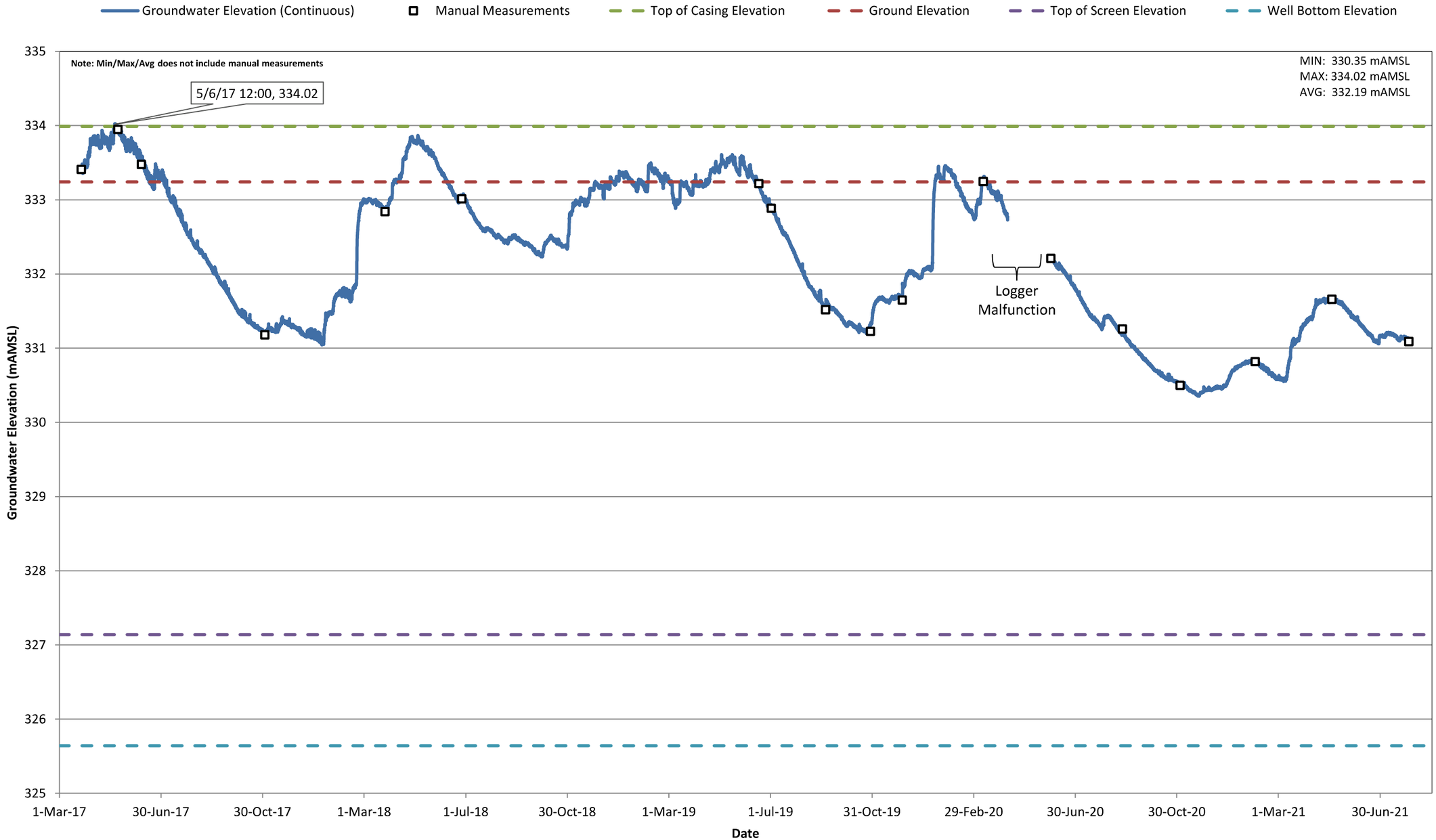
# Hydrographs

# Hydrograph 1: Groundwater Elevations (mAMSL) - MW2-17

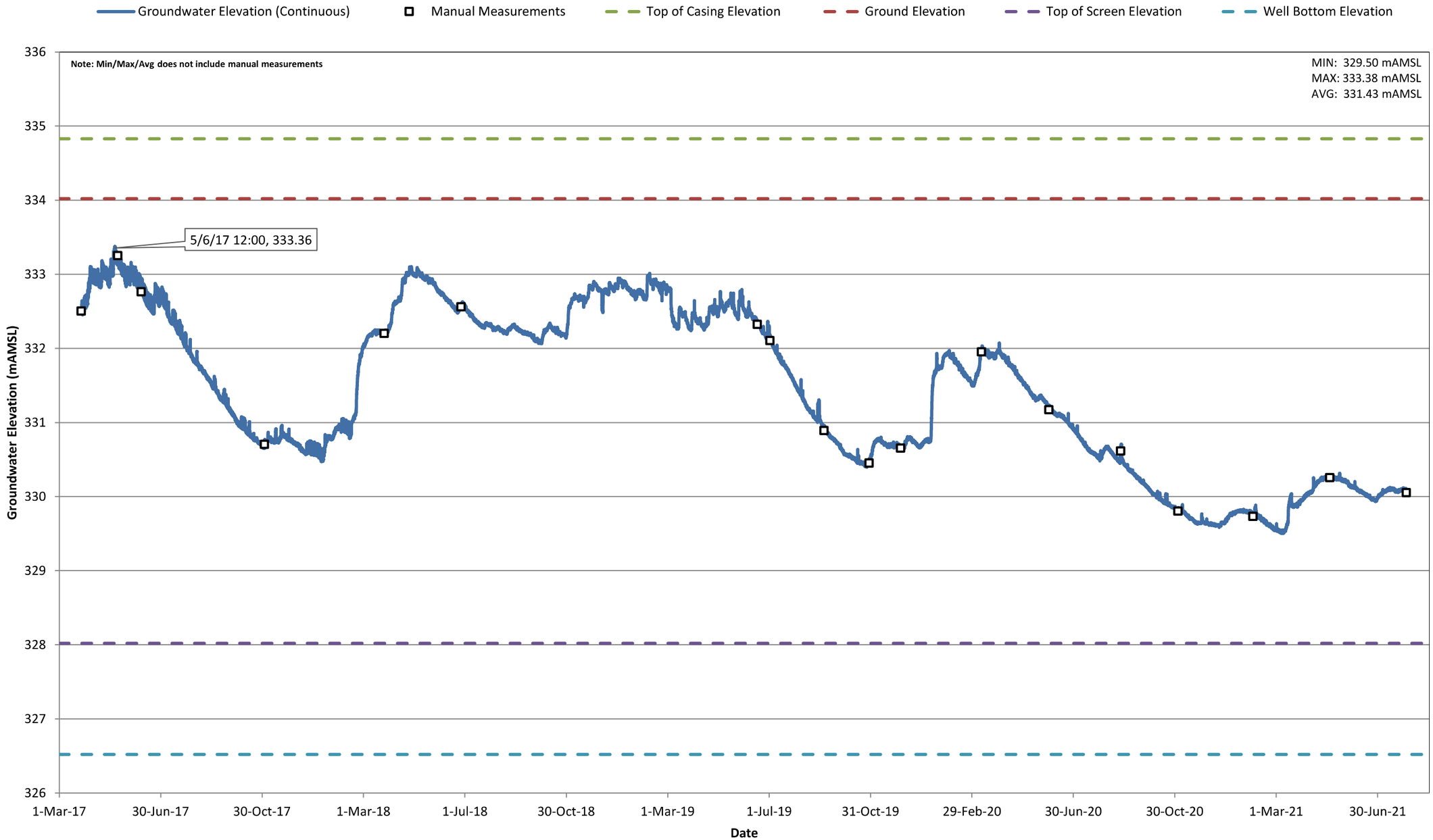


# Hydrograph 2: Groundwater Elevations (mAMSL) - MW3-17

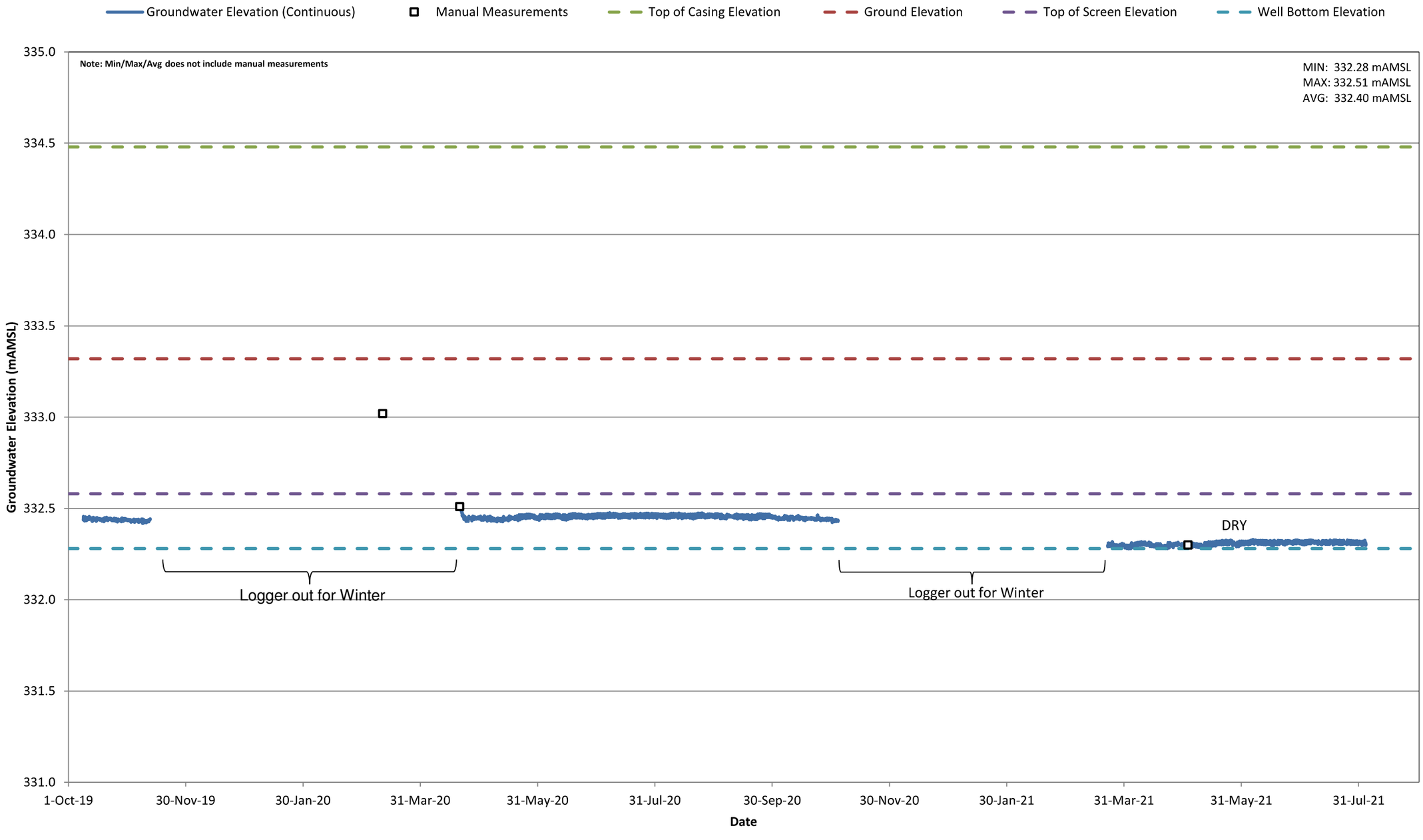
# Hydrograph 3: Groundwater Elevations (mAMSL) - MW4-17



# Hydrograph 4: Groundwater Elevations (mAMSL) - MW5-17



# Hydrograph 1: Groundwater Elevations (mAMSL) - MP1-19

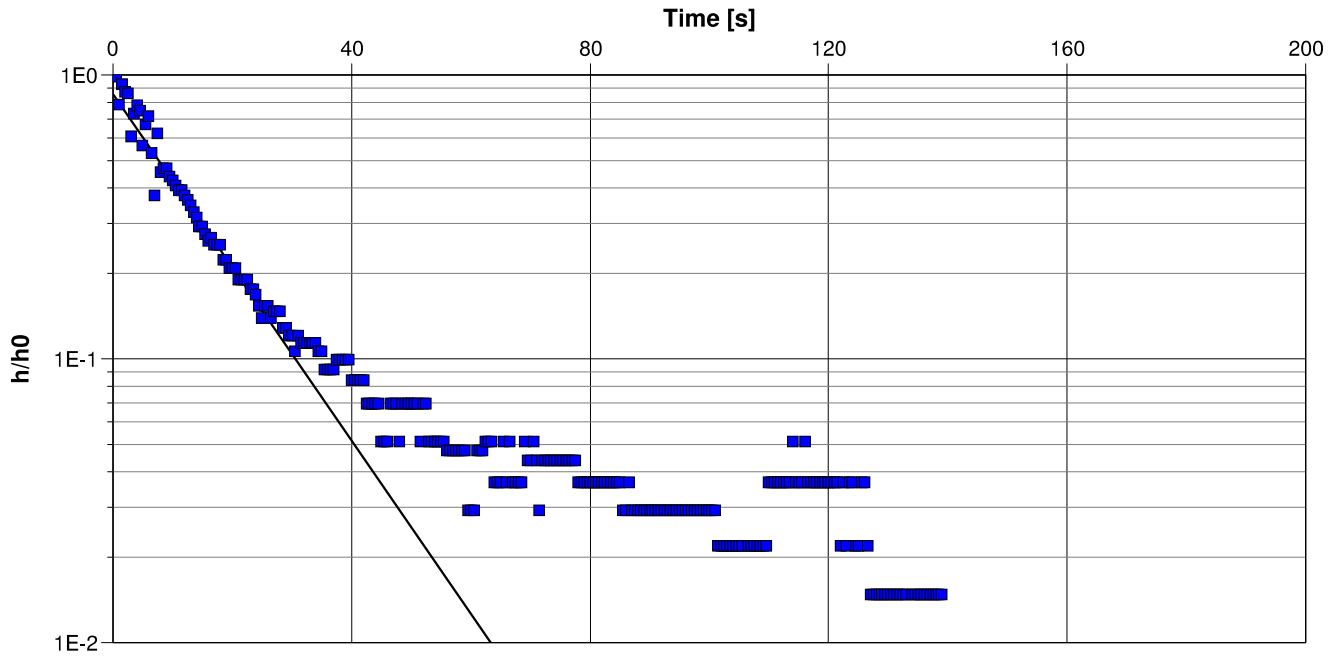


# Appendix D

# AquiferTest Data Sheets

| | | |
|---|---|---|
| | **Slug Test Analysis Report** | D |
| | Project: Arkell Road Properties | |
| | Number: 42063-104 | |
| | Client: Crescent Homes | |

| | | |
|---|---|---|
| Location: 202 Arkel Road, Guelph, ON | Slug Test: MW2-17 | Test Well: MW2-17 |
| Test Conducted by: YXM | | Test Date: 3/3/2017 |
| Analysis Performed by: MDE | Bouwer and Rice | Analysis Date: 5/12/2017 |
| Aquifer Thickness: 5.67 m | | |

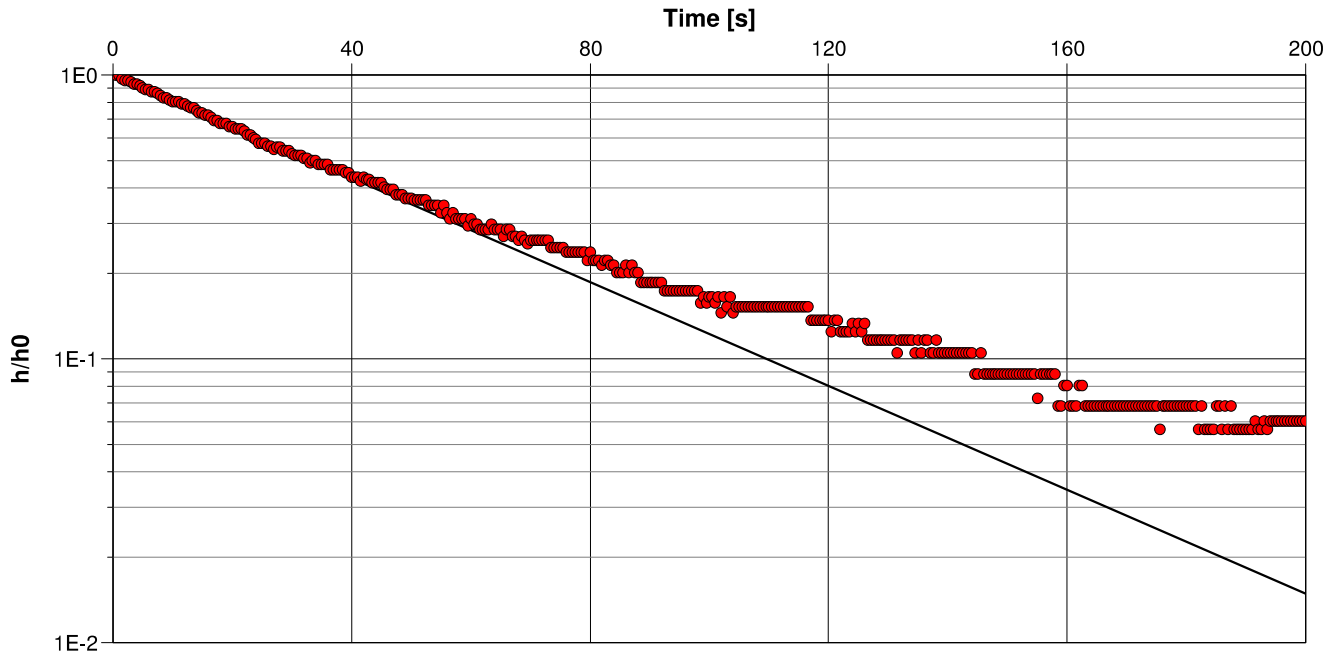



Calculation using Bouwer & Rice

| Observation Well | Hydraulic Conductivity [m/s] | |
|---|---|---|
| MW2-17 | $5.52 \times 10^{-5}$ | |

| | | |
|---|---|---|
| | **Slug Test Analysis Report** | D |
| | Project: Arkell Road Properties | |
| | Number: 42063-104 | |
| | Client: Crescent Homes | |

| | | |
|---|---|---|
| Location: 202 Arkel Road, Guelph, ON | Slug Test: MW3-17 | Test Well: MW3-17 |
| Test Conducted by: YXM | | Test Date: 3/2/2017 |
| Analysis Performed by: MDE | Bouwer and Rice | Analysis Date: 5/12/2017 |
| Aquifer Thickness: 6.88 m | | |

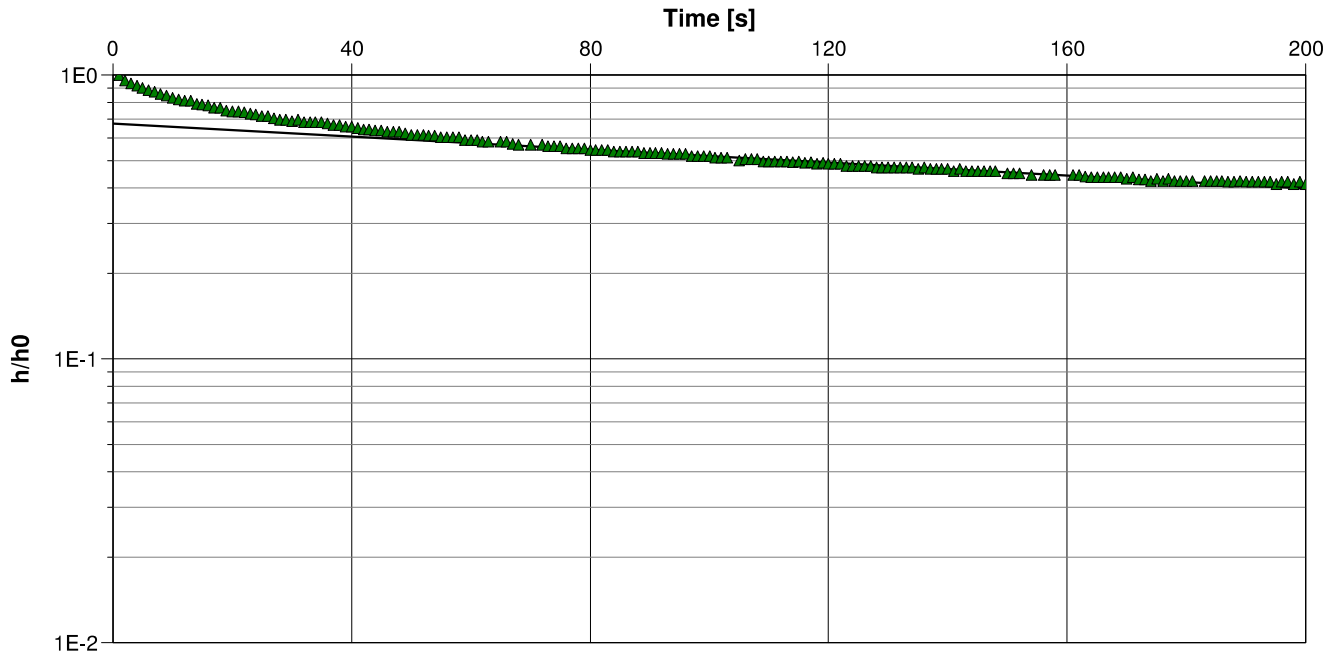



Calculation using Bouwer & Rice

| Observation Well | Hydraulic Conductivity [m/s] | |
|---|---|---|
| MW3-17 | $1.62 \times 10^{-5}$ | |

| | | |
|---|---|---|
| | **Slug Test Analysis Report** | D |
| | Project: Arkell Road Properties | |
| | Number: 42063-104 | |
| | Client: Crescent Homes | |

| | | |
|---|---|---|
| Location: 202 Arkel Road, Guelph, ON | Slug Test: MW4-17 | Test Well: MW4-17 |
| Test Conducted by: MDE | | Test Date: 5/10/2017 |
| Analysis Performed by: MDE | Bouwer and Rice | Analysis Date: 5/12/2017 |
| Aquifer Thickness: 8.10 m | | |

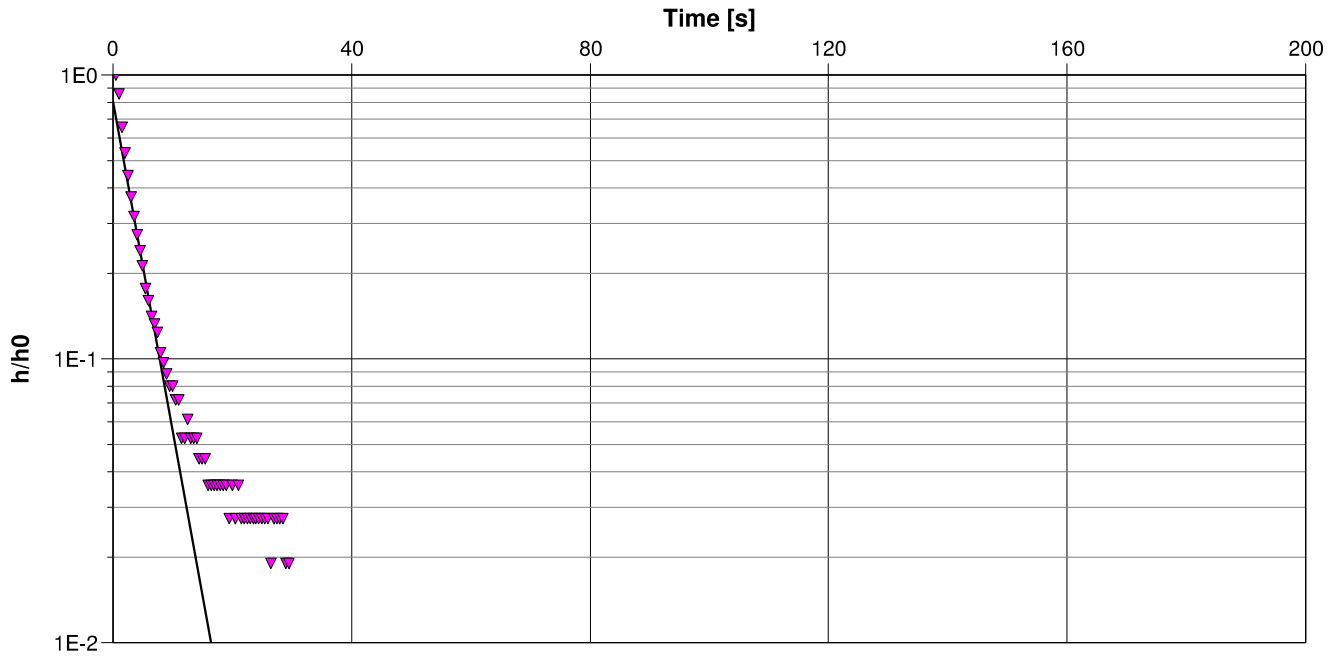



Calculation using Bouwer & Rice

| Observation Well | Hydraulic Conductivity [m/s] | |
|---|---|---|
| MW4-17 | $2.06 \times 10^{-6}$ | |

| | | |
|---|---|---|
| | **Slug Test Analysis Report** | D |
| | Project: Arkell Road Properties | |
| | Number: 42063-104 | |
| | Client: Crescent Homes | |

| | | |
|---|---|---|
| Location: 202 Arkel Road, Guelph, ON | Slug Test: MW5-17 | Test Well: MW5-17 |
| Test Conducted by: MDE | | Test Date: 5/10/2017 |
| Analysis Performed by: MDE | Bouwer and Rice | Analysis Date: 5/12/2017 |
| Aquifer Thickness: 7.30 m | | |




Calculation using Bouwer & Rice

| Observation Well | Hydraulic Conductivity [m/s] | |
|---|---|---|
| MW5-17 | $2.05 \times 10^{-4}$ | |

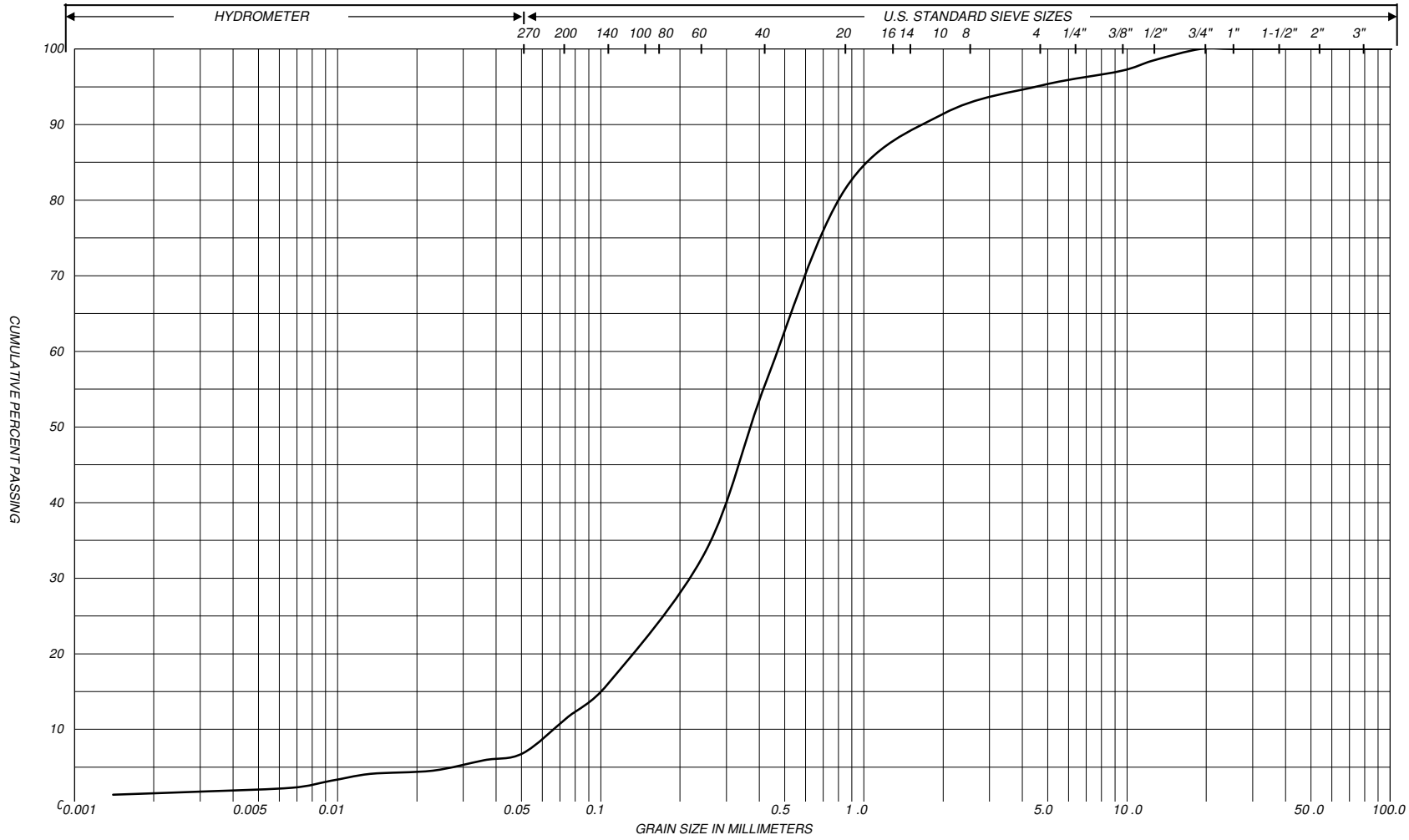
# Appendix E

# Particle Size Distribution Graphs

**Peto MacCallum Ltd.**
CONSULTING ENGINEERS

# PARTICLE SIZE DISTRIBUTION CHART

PML REF. 17KF002
REPORT NO. 1
FIGURE. 1




| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SILT & CLAY | | | FINE | MEDIUM | COARSE | GRAVEL | COBBLES | UNIFIED |
| | | | SAND | | | | | |
| CLAY | FINE | MEDIUM | COARSE | FINE | MEDIUM | COARSE | GRAVEL | COBBLES | M.I.T. |
| | SILT | | | SAND | | | | | |
| CLAY | SILT | | VERY FINE | FINE | MEDIUM | COARSE | GRAVEL | | U.S. BUREAU |
| | | | SAND | | | | | | |

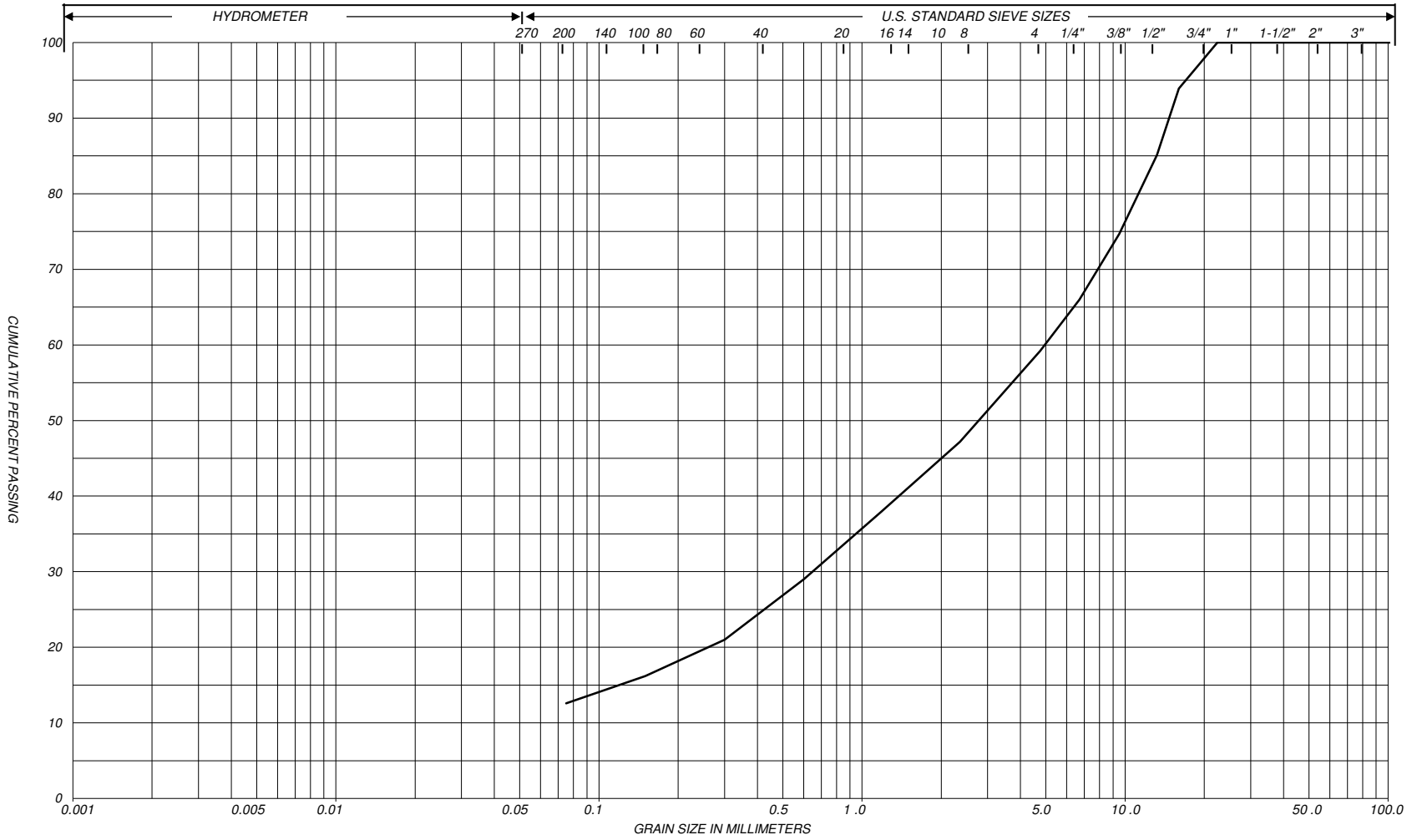
REMARKS Borehole 1, Sample SS6, Depth 4.5 to 5.0 m

SAND, SOME SILT, TRACE GRAVEL

**Peto MacCallum Ltd.**
CONSULTING ENGINEERS

# PARTICLE SIZE DISTRIBUTION CHART

PML REF. 17KF002
REPORT NO. 1
FIGURE. 2




| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SILT & CLAY | | | | FINE | MEDIUM | COARSE | GRAVEL | | | | COBBLES | UNIFIED |
| | | | | SAND | | | | | | | | |
| CLAY | FINE | MEDIUM | COARSE | FINE | MEDIUM | COARSE | GRAVEL | | | | COBBLES | M.I.T. |
| | SILT | | | SAND | | | | | | | | |
| CLAY | SILT | | | VERY FINE | FINE | MEDIUM | COARSE | GRAVEL | | | | U.S. BUREAU |
| | | | | SAND | | | | | | | | |

REMARKS Borehole 2, Sample SS2, Depth 0.7 to 1.2 m

SAND AND GRAVEL, SOME SILT

# Appendix F

# Laboratory Certificates of Analysis

MTE CONSULTANTS INC.
ATTN: ANDREW BINGEMAN
520 BINGEMANS CENTRE DRIVE
KITCHENER ON N2B 3X9

Date Received: 26-JUN-18
Report Date: 04-JUL-18 14:43 (MT)
Version: FINAL

Client Phone: 519-743-6500

# Certificate of Analysis

Lab Work Order #: L2119092
Project P.O. #: NOT SUBMITTED
Job Reference: 42063-104
C of C Numbers: 17-624726
Legal Site Desc:

Mary-Lynn Pike
Client Services Supervisor

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| Sample Details/Parameters | Result | Qualifier* | D.L. | Units | Extracted | Analyzed | Batch |
|---|---|---|---|---|---|---|---|
| L2119092-1 MW-2<br>Sampled By: CLIENT on 26-JUN-18 @ 12:00<br>Matrix: WATER | | | | | | | |
| **Physical Tests** | | | | | | | |
| Colour, Apparent | 77.6 | | 2.0 | CU | | 27-JUN-18 | R4099703 |
| Conductivity | 712 | | 3.0 | umhos/cm | | 27-JUN-18 | R4099089 |
| Hardness (as CaCO3) | 250 | | 10 | mg/L | | 28-JUN-18 | |
| pH | 7.89 | | 0.10 | pH units | | 27-JUN-18 | R4099089 |
| Total Dissolved Solids | 546 | DLDS | 20 | mg/L | | 29-JUN-18 | R4110482 |
| Turbidity | >4000 | | 0.10 | NTU | | 27-JUN-18 | R4098100 |
| **Anions and Nutrients** | | | | | | | |
| Alkalinity, Total (as CaCO3) | 230 | | 10 | mg/L | | 28-JUN-18 | R4101190 |
| Ammonia, Total (as N) | 0.035 | | 0.020 | mg/L | | 27-JUN-18 | R4100330 |
| Chloride (Cl) | 76.0 | | 0.50 | mg/L | | 28-JUN-18 | R4104567 |
| Fluoride (F) | 0.062 | | 0.020 | mg/L | | 28-JUN-18 | R4104567 |
| Nitrate (as N) | 1.59 | | 0.020 | mg/L | | 28-JUN-18 | R4104567 |
| Nitrite (as N) | <0.010 | | 0.010 | mg/L | | 28-JUN-18 | R4104567 |
| Orthophosphate-Dissolved (as P) | <0.0030 | | 0.0030 | mg/L | | 27-JUN-18 | R4100351 |
| Sulfate (SO4) | 13.6 | | 0.30 | mg/L | | 28-JUN-18 | R4104567 |
| **Dissolved Metals** | | | | | | | |
| Dissolved Metals Filtration Location | FIELD | | | | | 27-JUN-18 | R4097954 |
| Aluminum (Al)-Dissolved | <0.010 | | 0.010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Antimony (Sb)-Dissolved | <0.0050 | | 0.0050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Arsenic (As)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Barium (Ba)-Dissolved | 0.028 | | 0.010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Beryllium (Be)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Bismuth (Bi)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Boron (B)-Dissolved | <0.050 | | 0.050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Cadmium (Cd)-Dissolved | <0.000090 | | 0.000090 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Calcium (Ca)-Dissolved | 67.5 | | 0.50 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Chromium (Cr)-Dissolved | <0.00050 | | 0.00050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Cobalt (Co)-Dissolved | <0.00050 | | 0.00050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Copper (Cu)-Dissolved | 0.0034 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Iron (Fe)-Dissolved | <0.050 | | 0.050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Lead (Pb)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Magnesium (Mg)-Dissolved | 19.7 | | 0.50 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Manganese (Mn)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Molybdenum (Mo)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Nickel (Ni)-Dissolved | <0.0020 | | 0.0020 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Phosphorus (P)-Dissolved | <0.050 | | 0.050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Potassium (K)-Dissolved | 1.9 | | 1.0 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Selenium (Se)-Dissolved | <0.00040 | | 0.00040 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Silicon (Si)-Dissolved | 2.4 | | 1.0 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Silver (Ag)-Dissolved | <0.00010 | | 0.00010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Sodium (Na)-Dissolved | 60.4 | | 0.50 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| Sample Details/Parameters | Result | Qualifier* | D.L. | Units | Extracted | Analyzed | Batch |
|---|---|---|---|---|---|---|---|
| L2119092-1 MW-2<br>Sampled By: CLIENT on 26-JUN-18 @ 12:00<br>Matrix: WATER | | | | | | | |
| **Dissolved Metals** | | | | | | | |
| Strontium (Sr)-Dissolved | 0.0735 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Thallium (Tl)-Dissolved | <0.00030 | | 0.00030 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Tin (Sn)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Titanium (Ti)-Dissolved | <0.0020 | | 0.0020 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Tungsten (W)-Dissolved | <0.010 | | 0.010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Uranium (U)-Dissolved | <0.0050 | | 0.0050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Vanadium (V)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Zinc (Zn)-Dissolved | 0.0132 | | 0.0030 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Zirconium (Zr)-Dissolved | <0.0040 | | 0.0040 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| L2119092-2 MW-4<br>Sampled By: CLIENT on 26-JUN-18 @ 13:04<br>Matrix: WATER | | | | | | | |
| **Physical Tests** | | | | | | | |
| Colour, Apparent | 455 | DLHC | 4.0 | CU | | 27-JUN-18 | R4099703 |
| Conductivity | 770 | | 3.0 | umhos/cm | | 27-JUN-18 | R4099089 |
| Hardness (as CaCO3) | 380 | | 10 | mg/L | | 28-JUN-18 | |
| pH | 7.63 | | 0.10 | pH units | | 27-JUN-18 | R4099089 |
| Total Dissolved Solids | 452 | DLDS | 20 | mg/L | | 29-JUN-18 | R4110482 |
| Turbidity | >4000 | | 0.10 | NTU | | 27-JUN-18 | R4098100 |
| **Anions and Nutrients** | | | | | | | |
| Alkalinity, Total (as CaCO3) | 313 | | 10 | mg/L | | 28-JUN-18 | R4101190 |
| Ammonia, Total (as N) | 0.041 | | 0.020 | mg/L | | 27-JUN-18 | R4100330 |
| Chloride (Cl) | 35.9 | | 0.50 | mg/L | | 28-JUN-18 | R4104567 |
| Fluoride (F) | 0.051 | | 0.020 | mg/L | | 28-JUN-18 | R4104567 |
| Nitrate (as N) | 6.29 | | 0.020 | mg/L | | 28-JUN-18 | R4104567 |
| Nitrite (as N) | <0.010 | | 0.010 | mg/L | | 28-JUN-18 | R4104567 |
| Orthophosphate-Dissolved (as P) | <0.0030 | | 0.0030 | mg/L | | 27-JUN-18 | R4100351 |
| Sulfate (SO4) | 14.2 | | 0.30 | mg/L | | 28-JUN-18 | R4104567 |
| **Dissolved Metals** | | | | | | | |
| Dissolved Metals Filtration Location | FIELD | | | | | 27-JUN-18 | R4097954 |
| Aluminum (Al)-Dissolved | <0.010 | | 0.010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Antimony (Sb)-Dissolved | <0.0050 | | 0.0050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Arsenic (As)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Barium (Ba)-Dissolved | 0.058 | | 0.010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Beryllium (Be)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Bismuth (Bi)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Boron (B)-Dissolved | <0.050 | | 0.050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Cadmium (Cd)-Dissolved | <0.000090 | | 0.000090 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Calcium (Ca)-Dissolved | 98.6 | | 0.50 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Chromium (Cr)-Dissolved | <0.00050 | | 0.00050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Cobalt (Co)-Dissolved | <0.00050 | | 0.00050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Copper (Cu)-Dissolved | 0.0043 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| Sample Details/Parameters | Result | Qualifier* | D.L. | Units | Extracted | Analyzed | Batch |
|---|---|---|---|---|---|---|---|
| L2119092-2 MW-4<br>Sampled By: CLIENT on 26-JUN-18 @ 13:04<br>Matrix: WATER | | | | | | | |
| **Dissolved Metals** | | | | | | | |
| Iron (Fe)-Dissolved | <0.050 | | 0.050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Lead (Pb)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Magnesium (Mg)-Dissolved | 32.5 | | 0.50 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Manganese (Mn)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Molybdenum (Mo)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Nickel (Ni)-Dissolved | <0.0020 | | 0.0020 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Phosphorus (P)-Dissolved | <0.050 | | 0.050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Potassium (K)-Dissolved | 7.5 | | 1.0 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Selenium (Se)-Dissolved | <0.00040 | | 0.00040 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Silicon (Si)-Dissolved | 4.6 | | 1.0 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Silver (Ag)-Dissolved | <0.00010 | | 0.00010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Sodium (Na)-Dissolved | 21.6 | | 0.50 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Strontium (Sr)-Dissolved | 0.111 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Thallium (Tl)-Dissolved | <0.00030 | | 0.00030 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Tin (Sn)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Titanium (Ti)-Dissolved | <0.0020 | | 0.0020 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Tungsten (W)-Dissolved | <0.010 | | 0.010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Uranium (U)-Dissolved | <0.0050 | | 0.0050 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Vanadium (V)-Dissolved | <0.0010 | | 0.0010 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Zinc (Zn)-Dissolved | 0.0293 | | 0.0030 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |
| Zirconium (Zr)-Dissolved | <0.0040 | | 0.0040 | mg/L | 27-JUN-18 | 27-JUN-18 | R4099009 |

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

# Reference Information

## QC Samples with Qualifiers & Comments:

| QC Type Description | Parameter | Qualifier | Applies to Sample Number(s) |
|---|---|---|---|
| Matrix Spike | Chloride (Cl) | MS-B | L2119092-1, -2 |
| Matrix Spike | Barium (Ba)-Dissolved | MS-B | L2119092-1, -2 |
| Matrix Spike | Calcium (Ca)-Dissolved | MS-B | L2119092-1, -2 |
| Matrix Spike | Magnesium (Mg)-Dissolved | MS-B | L2119092-1, -2 |
| Matrix Spike | Silicon (Si)-Dissolved | MS-B | L2119092-1, -2 |
| Matrix Spike | Sodium (Na)-Dissolved | MS-B | L2119092-1, -2 |
| Matrix Spike | Strontium (Sr)-Dissolved | MS-B | L2119092-1, -2 |
| Matrix Spike | Uranium (U)-Dissolved | MS-B | L2119092-1, -2 |
| Matrix Spike | Ammonia, Total (as N) | MS-B | L2119092-1, -2 |
| Matrix Spike | Nitrate (as N) | MS-B | L2119092-1, -2 |

## Sample Parameter Qualifier key listed:

| Qualifier | Description |
|---|---|
| DLDS | Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity. |
| DLHC | Detection Limit Raised: Dilution required due to high concentration of test analyte(s). |
| MS-B | Matrix Spike recovery could not be accurately calculated due to high analyte background in sample. |

## Test Method References:

| ALS Test Code | Matrix | Test Description | Method Reference** |
|---|---|---|---|
| ALK-WT | Water | Alkalinity, Total (as CaCO3) | EPA 310.2 |

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

| | | | |
|---|---|---|---|
| CL-IC-N-WT | Water | Chloride by IC | EPA 300.1 (mod) |

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

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

| | | | |
|---|---|---|---|
| COLOUR-APPARENT-WT | Water | Colour | APHA 2120 |

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

| | | | |
|---|---|---|---|
| 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-D-CCMS-WT | Water | Dissolved Metals in Water by CRC ICPMS | APHA 3030B/6020A (mod) |

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

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

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

| | | | |
|---|---|---|---|
| NH3-WT | Water | Ammonia, Total as N | EPA 350.1 |

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

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

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

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

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

| | | | |
|---|---|---|---|
| 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). Holdtime for samples under this regulation is 28 days

# Reference Information

| | | | |
|---|---|---|---|
| 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 |

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

| | | | |
|---|---|---|---|
| TURBIDITY-WT | Water | Turbidity | APHA 2130 B |

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

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

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

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

**Chain of Custody Numbers:**

17-624726

**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 weight of sample*
*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.*

# Quality Control Report



Client: MTE CONSULTANTS INC.
520 BINGEMANS CENTRE DRIVE
KITCHENER ON N2B 3X9
Contact: ANDREW BINGEMAN

| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| ALK-WT | Water | | | | | | | |
| **Batch R4101190** | | | | | | | | |
| **WG2809810-11 CRM** | | **WT-ALK-CRM** | | | | | | |
| Alkalinity, Total (as CaCO3) | | | 92.5 | | % | | 80-120 | 28-JUN-18 |
| **WG2809810-3 CRM** | | **WT-ALK-CRM** | | | | | | |
| Alkalinity, Total (as CaCO3) | | | 93.4 | | % | | 80-120 | 28-JUN-18 |
| **WG2809810-12 DUP** | | **L2119092-2** | | | | | | |
| Alkalinity, Total (as CaCO3) | | 313 | 318 | | mg/L | 1.7 | 20 | 28-JUN-18 |
| **WG2809810-10 LCS** | | | | | | | | |
| Alkalinity, Total (as CaCO3) | | | 96.3 | | % | | 85-115 | 28-JUN-18 |
| **WG2809810-2 LCS** | | | | | | | | |
| Alkalinity, Total (as CaCO3) | | | 97.9 | | % | | 85-115 | 28-JUN-18 |
| **WG2809810-1 MB** | | | | | | | | |
| Alkalinity, Total (as CaCO3) | | | <10 | | mg/L | | 10 | 28-JUN-18 |
| **WG2809810-9 MB** | | | | | | | | |
| Alkalinity, Total (as CaCO3) | | | <10 | | mg/L | | 10 | 28-JUN-18 |
| CL-IC-N-WT | Water | | | | | | | |
| **Batch R4104567** | | | | | | | | |
| **WG2809480-2 LCS** | | | | | | | | |
| Chloride (Cl) | | | 101.2 | | % | | 90-110 | 28-JUN-18 |
| **WG2809480-1 MB** | | | | | | | | |
| Chloride (Cl) | | | <0.50 | | mg/L | | 0.5 | 28-JUN-18 |
| COLOUR-APPARENT-WT | Water | | | | | | | |
| **Batch R4099703** | | | | | | | | |
| **WG2808121-2 LCS** | | | | | | | | |
| Colour, Apparent | | | 106.7 | | % | | 85-115 | 27-JUN-18 |
| **WG2808121-1 MB** | | | | | | | | |
| Colour, Apparent | | | <2.0 | | CU | | 2 | 27-JUN-18 |
| EC-WT | Water | | | | | | | |
| **Batch R4099089** | | | | | | | | |
| **WG2808019-10 LCS** | | | | | | | | |
| Conductivity | | | 99.9 | | % | | 90-110 | 27-JUN-18 |
| **WG2808019-6 LCS** | | | | | | | | |
| Conductivity | | | 99.7 | | % | | 90-110 | 27-JUN-18 |
| **WG2808019-5 MB** | | | | | | | | |
| Conductivity | | | <3.0 | | umhos/cm | | 3 | 27-JUN-18 |
| **WG2808019-9 MB** | | | | | | | | |
| Conductivity | | | <3.0 | | umhos/cm | | 3 | 27-JUN-18 |
| F-IC-N-WT | Water | | | | | | | |

# Quality Control Report



| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| F-IC-N-WT | Water | | | | | | | |
| **Batch R4104567** | | | | | | | | |
| **WG2809480-2 LCS** | | | | | | | | |
| Fluoride (F) | | | 101.3 | | % | | 90-110 | 28-JUN-18 |
| **WG2809480-1 MB** | | | | | | | | |
| Fluoride (F) | | | <0.020 | | mg/L | | 0.02 | 28-JUN-18 |
| MET-D-CCMS-WT | Water | | | | | | | |
| **Batch R4099009** | | | | | | | | |
| **WG2807911-2 LCS** | | | | | | | | |
| Aluminum (Al)-Dissolved | | | 105.6 | | % | | 80-120 | 27-JUN-18 |
| Antimony (Sb)-Dissolved | | | 101.3 | | % | | 80-120 | 27-JUN-18 |
| Arsenic (As)-Dissolved | | | 104.9 | | % | | 80-120 | 27-JUN-18 |
| Barium (Ba)-Dissolved | | | 102.5 | | % | | 80-120 | 27-JUN-18 |
| Beryllium (Be)-Dissolved | | | 103.7 | | % | | 80-120 | 27-JUN-18 |
| Bismuth (Bi)-Dissolved | | | 102.5 | | % | | 80-120 | 27-JUN-18 |
| Boron (B)-Dissolved | | | 99.6 | | % | | 80-120 | 27-JUN-18 |
| Cadmium (Cd)-Dissolved | | | 99.8 | | % | | 80-120 | 27-JUN-18 |
| Calcium (Ca)-Dissolved | | | 103.8 | | % | | 80-120 | 27-JUN-18 |
| Chromium (Cr)-Dissolved | | | 103.0 | | % | | 80-120 | 27-JUN-18 |
| Cobalt (Co)-Dissolved | | | 103.1 | | % | | 80-120 | 27-JUN-18 |
| Copper (Cu)-Dissolved | | | 103.0 | | % | | 80-120 | 27-JUN-18 |
| Iron (Fe)-Dissolved | | | 97.6 | | % | | 80-120 | 27-JUN-18 |
| Lead (Pb)-Dissolved | | | 102.6 | | % | | 80-120 | 27-JUN-18 |
| Magnesium (Mg)-Dissolved | | | 107.9 | | % | | 80-120 | 27-JUN-18 |
| Manganese (Mn)-Dissolved | | | 103.5 | | % | | 80-120 | 27-JUN-18 |
| Molybdenum (Mo)-Dissolved | | | 103.7 | | % | | 80-120 | 27-JUN-18 |
| Nickel (Ni)-Dissolved | | | 102.4 | | % | | 80-120 | 27-JUN-18 |
| Phosphorus (P)-Dissolved | | | 106.0 | | % | | 80-120 | 27-JUN-18 |
| Potassium (K)-Dissolved | | | 101.3 | | % | | 80-120 | 27-JUN-18 |
| Selenium (Se)-Dissolved | | | 102.8 | | % | | 80-120 | 27-JUN-18 |
| Silicon (Si)-Dissolved | | | 100.7 | | % | | 60-140 | 27-JUN-18 |
| Silver (Ag)-Dissolved | | | 99.3 | | % | | 80-120 | 27-JUN-18 |
| Sodium (Na)-Dissolved | | | 109.4 | | % | | 80-120 | 27-JUN-18 |
| Strontium (Sr)-Dissolved | | | 97.7 | | % | | 80-120 | 27-JUN-18 |
| Thallium (Tl)-Dissolved | | | 105.6 | | % | | 80-120 | 27-JUN-18 |
| Tin (Sn)-Dissolved | | | 100.3 | | % | | 80-120 | 27-JUN-18 |
| Titanium (Ti)-Dissolved | | | 101.6 | | % | | 80-120 | 27-JUN-18 |

# Quality Control Report



| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| MET-D-CCMS-WT | Water | | | | | | | |
| **Batch R4099009** | | | | | | | | |
| **WG2807911-2 LCS** | | | | | | | | |
| Tungsten (W)-Dissolved | | | 98.1 | | % | | 80-120 | 27-JUN-18 |
| Uranium (U)-Dissolved | | | 102.5 | | % | | 80-120 | 27-JUN-18 |
| Vanadium (V)-Dissolved | | | 106.6 | | % | | 80-120 | 27-JUN-18 |
| Zinc (Zn)-Dissolved | | | 97.8 | | % | | 80-120 | 27-JUN-18 |
| Zirconium (Zr)-Dissolved | | | 99.5 | | % | | 80-120 | 27-JUN-18 |
| **WG2807911-1 MB** | | | | | | | | |
| Aluminum (Al)-Dissolved | | | <0.0050 | | mg/L | | 0.005 | 27-JUN-18 |
| Antimony (Sb)-Dissolved | | | <0.00010 | | mg/L | | 0.0001 | 27-JUN-18 |
| Arsenic (As)-Dissolved | | | <0.00010 | | mg/L | | 0.0001 | 27-JUN-18 |
| Barium (Ba)-Dissolved | | | <0.00010 | | mg/L | | 0.0001 | 27-JUN-18 |
| Beryllium (Be)-Dissolved | | | <0.00010 | | mg/L | | 0.0001 | 27-JUN-18 |
| Bismuth (Bi)-Dissolved | | | <0.000050 | | mg/L | | 0.00005 | 27-JUN-18 |
| Boron (B)-Dissolved | | | <0.010 | | mg/L | | 0.01 | 27-JUN-18 |
| Cadmium (Cd)-Dissolved | | | <0.0000050 | | mg/L | | 0.000005 | 27-JUN-18 |
| Calcium (Ca)-Dissolved | | | <0.050 | | mg/L | | 0.05 | 27-JUN-18 |
| Chromium (Cr)-Dissolved | | | <0.00050 | | mg/L | | 0.0005 | 27-JUN-18 |
| Cobalt (Co)-Dissolved | | | <0.00010 | | mg/L | | 0.0001 | 27-JUN-18 |
| Copper (Cu)-Dissolved | | | <0.00020 | | mg/L | | 0.0002 | 27-JUN-18 |
| Iron (Fe)-Dissolved | | | <0.010 | | mg/L | | 0.01 | 27-JUN-18 |
| Lead (Pb)-Dissolved | | | <0.000050 | | mg/L | | 0.00005 | 27-JUN-18 |
| Magnesium (Mg)-Dissolved | | | <0.0050 | | mg/L | | 0.005 | 27-JUN-18 |
| Manganese (Mn)-Dissolved | | | <0.00050 | | mg/L | | 0.0005 | 27-JUN-18 |
| Molybdenum (Mo)-Dissolved | | | <0.000050 | | mg/L | | 0.00005 | 27-JUN-18 |
| Nickel (Ni)-Dissolved | | | <0.00050 | | mg/L | | 0.0005 | 27-JUN-18 |
| Phosphorus (P)-Dissolved | | | <0.050 | | mg/L | | 0.05 | 27-JUN-18 |
| Potassium (K)-Dissolved | | | <0.050 | | mg/L | | 0.05 | 27-JUN-18 |
| Selenium (Se)-Dissolved | | | <0.000050 | | mg/L | | 0.00005 | 27-JUN-18 |
| Silicon (Si)-Dissolved | | | <0.050 | | mg/L | | 0.05 | 27-JUN-18 |
| Silver (Ag)-Dissolved | | | <0.000050 | | mg/L | | 0.00005 | 27-JUN-18 |
| Sodium (Na)-Dissolved | | | <0.050 | | mg/L | | 0.05 | 27-JUN-18 |
| Strontium (Sr)-Dissolved | | | <0.0010 | | mg/L | | 0.001 | 27-JUN-18 |
| Thallium (Tl)-Dissolved | | | <0.000010 | | mg/L | | 0.00001 | 27-JUN-18 |
| Tin (Sn)-Dissolved | | | <0.00010 | | mg/L | | 0.0001 | 27-JUN-18 |
| Titanium (Ti)-Dissolved | | | <0.00030 | | mg/L | | 0.0003 | 27-JUN-18 |

# Quality Control Report



| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| MET-D-CCMS-WT | Water | | | | | | | |
| **Batch R4099009** | | | | | | | | |
| **WG2807911-1 MB** | | | | | | | | |
| Tungsten (W)-Dissolved | | | <0.00010 | | mg/L | | 0.0001 | 27-JUN-18 |
| Uranium (U)-Dissolved | | | <0.000010 | | mg/L | | 0.00001 | 27-JUN-18 |
| Vanadium (V)-Dissolved | | | <0.00050 | | mg/L | | 0.0005 | 27-JUN-18 |
| Zinc (Zn)-Dissolved | | | <0.0010 | | mg/L | | 0.001 | 27-JUN-18 |
| Zirconium (Zr)-Dissolved | | | <0.00030 | | mg/L | | 0.0003 | 27-JUN-18 |
| NH3-WT | Water | | | | | | | |
| **Batch R4100330** | | | | | | | | |
| **WG2808125-6 LCS** | | | | | | | | |
| Ammonia, Total (as N) | | | 98.7 | | % | | 85-115 | 27-JUN-18 |
| **WG2808125-5 MB** | | | | | | | | |
| Ammonia, Total (as N) | | | <0.020 | | mg/L | | 0.02 | 27-JUN-18 |
| NO2-IC-WT | Water | | | | | | | |
| **Batch R4104567** | | | | | | | | |
| **WG2809480-2 LCS** | | | | | | | | |
| Nitrite (as N) | | | 100.7 | | % | | 70-130 | 28-JUN-18 |
| **WG2809480-1 MB** | | | | | | | | |
| Nitrite (as N) | | | <0.010 | | mg/L | | 0.01 | 28-JUN-18 |
| NO3-IC-WT | Water | | | | | | | |
| **Batch R4104567** | | | | | | | | |
| **WG2809480-2 LCS** | | | | | | | | |
| Nitrate (as N) | | | 100.7 | | % | | 70-130 | 28-JUN-18 |
| **WG2809480-1 MB** | | | | | | | | |
| Nitrate (as N) | | | <0.020 | | mg/L | | 0.02 | 28-JUN-18 |
| PH-WT | Water | | | | | | | |
| **Batch R4099089** | | | | | | | | |
| **WG2808019-10 LCS** | | | | | | | | |
| pH | | | 7.00 | | pH units | | 6.9-7.1 | 27-JUN-18 |
| **WG2808019-6 LCS** | | | | | | | | |
| pH | | | 6.99 | | pH units | | 6.9-7.1 | 27-JUN-18 |
| PO4-DO-COL-WT | Water | | | | | | | |
| **Batch R4100351** | | | | | | | | |
| **WG2808131-2 LCS** | | | | | | | | |
| Orthophosphate-Dissolved (as P) | | | 106.3 | | % | | 70-130 | 27-JUN-18 |
| **WG2808131-1 MB** | | | | | | | | |
| Orthophosphate-Dissolved (as P) | | | <0.0030 | | mg/L | | 0.003 | 27-JUN-18 |
| SO4-IC-N-WT | Water | | | | | | | |

# Quality Control Report



| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| SO4-IC-N-WT | Water | | | | | | | |
| **Batch R4104567** | | | | | | | | |
| **WG2809480-2 LCS** | | | | | | | | |
| Sulfate (SO4) | | | 101.9 | | % | | 90-110 | 28-JUN-18 |
| **WG2809480-1 MB** | | | | | | | | |
| Sulfate (SO4) | | | <0.30 | | mg/L | | 0.3 | 28-JUN-18 |
| SOLIDS-TDS-WT | Water | | | | | | | |
| **Batch R4110482** | | | | | | | | |
| **WG2810907-3 DUP** | | **L2119092-1** | | | | | | |
| Total Dissolved Solids | | 546 | 543 | | mg/L | 0.5 | 20 | 29-JUN-18 |
| **WG2810907-2 LCS** | | | | | | | | |
| Total Dissolved Solids | | | 97.0 | | % | | 85-115 | 29-JUN-18 |
| **WG2810907-1 MB** | | | | | | | | |
| Total Dissolved Solids | | | <10 | | mg/L | | 10 | 29-JUN-18 |
| TURBIDITY-WT | Water | | | | | | | |
| **Batch R4098100** | | | | | | | | |
| **WG2807987-2 LCS** | | | | | | | | |
| Turbidity | | | 104.0 | | % | | 85-115 | 27-JUN-18 |
| **WG2807987-1 MB** | | | | | | | | |
| Turbidity | | | <0.10 | | NTU | | 0.1 | 27-JUN-18 |

**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 |

**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.

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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 (C Request

L2119092-COFC

Canada Toll Free: 1

e label here

COC Number: 17 - 624726

Page 1 of 1

| Report To | Contact and company name below will appear on the final report |
|---|---|
| Company: | MTE Consultants Inc. |
| Contact: | |
| Phone: | |
| | Company address below will appear on the final report |
| Street: | |
| City/Province: | |
| Postal Code: | |
| Invoice To | Same as Report To [X] YES [ ] NO |
| | Copy of Invoice with Report [ ] YES [ ] NO |
| Company: | |
| Contact: | |

**Report Format / Distribution**

Select Report Format: [X] PDF [ ] EXCEL [X] 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: abdinmahamed85@gmail.com
Email 2: kwallace@mte85.com
Email 3:

**Invoice Distribution**

Select Invoice Distribution: [X] EMAIL [ ] MAIL [ ] FAX
Email 1 or Fax:
Email 2:

**Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)**

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

PRIORITY (Business Days):
- 4 day [P4-20%] [ ]
- 3 day [P3-25%] [ ]
- 2 day [P2-50%] [ ]

EMERGENCY:
- 1 Business day [E-100%] [ ]
- Same Day, Weekend or Statutory holiday [E2-200% (Laboratory opening fees may apply)] [ ]

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 #: | 42063-104 |
| PO / AFE: | |
| LSD: | |
| ALS Lab Work Order # (lab use only): | L2119092 Rec 26/6 |

| Oil and Gas Required Fields (client use) | | | |
|---|---|---|---|
| AFE/Cost Center: | | PO# | |
| Major/Minor Code: | | Routing Code: | |
| Requisitioner: | | | |
| Location: | | | |
| ALS Contact: | ML | Sampler: | KLW |

**Analysis Request**

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

| ALS Sample # (lab use only) | Sample Identification and/or Coordinates (This description will appear on the report) | Date (dd-mmm-yy) | Time (hh:mm) | Sample Type | Geochem | SAMPLES ON HOLD | Sample is hazardous (please provide further details) | NUMBER OF CONTAINERS |
|---|---|---|---|---|---|---|---|---|
| | MW-2 | 26/06/18 | 12:00 | W | X | | | 4 |
| | MW-4 | | 13:04 | | X | | | 4 |

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

Are samples taken from a Regulated DW System?
[ ] YES [X] NO

Are samples for human consumption/ use?
[ ] YES [X] NO

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

**SAMPLE CONDITION AS RECEIVED (lab use only)**

| | | | | | |
|---|---|---|---|---|---|
| Frozen | [ ] | SIF Observations | Yes [ ] | No | [ ] |
| Ice Packs | [X] | Ice Cubes [X] | Custody seal intact | Yes [ ] | No [ ] |
| Cooling Initiated | [ ] | | | | |

| INITIAL COOLER TEMPERATURES °C | | | | FINAL COOLER TEMPERATURES °C | | | |
|---|---|---|---|---|---|---|---|
| | | | | 12.1°C | | | |

**SHIPMENT RELEASE (client use)**

| Released by: | Date: | Time: |
|---|---|---|
| Kassandra Wallace | 26/06/18 | |

**INITIAL SHIPMENT RECEPTION (lab use only)**

| Received by: | Date: | Time: |
|---|---|---|
| | | |

**FINAL SHIPMENT RECEPTION (lab use only)**

| Received by: | Date: | Time: |
|---|---|---|
| | JUNE 26/18 | 15:50 |

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JULY 2017 FRONT

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

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